SSSI assessment for Sizewell C operational permits

Radioactive substances activity, combustion activity and water discharge activity

July 2022

Version 1

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1. Introduction

A CRoW assessment is required for the granting of any consent, licence or permit for activities likely to damage Sites of Special Scientific Interest (SSSI). Under Section 28I of the Wildlife and Countryside Act 1981 (as amended by the Countryside and Rights of Way Act (CRoW) 2000) we must seek advice (consult NE or other Statutory Nature Conservation Body (SNCB)) before permitting any activities that may damage a SSSI. Natural England are being consulted on this final CRoW assessment during the Public Consultation process.

Permissions considered within this assessment are operational permits for:

- combustion activities (CA) permit application (reference: EPR/MP3731AC/A001)
- radioactive substances activities (RSA) permit application (reference: EPR/HB3091DJ/A001)
- water discharge activities (WDA) permit application (reference: EPR/CB3997AD/A001)

NNB Generation Company (SZC) Limited (NNB GenCo) proposes to construct and operate a new nuclear power station at Sizewell in Suffolk (TM 47270 64145), to be known as Sizewell C (SZC), permit application reference number EPR/MP3731AC/A001.

The proposed SZC nuclear power station is located to the north of the existing Sizewell B power station on the Suffolk coast, which is approximately halfway between Felixstowe and Lowestoft, to the north-east of the town of Leiston (Figure 1). The power station, together with the proposed associated developments, is referred to as the Sizewell C project.

The power station will comprise 2 UK European Pressurised Reactor (EPR™) units, with an expected net electrical output of approximately 1,670 megawatts (MW) per unit, giving a total site capacity of approximately 3,340MW.

Figure 1: Location of SZC (indicated by the red star) on the Suffolk Coast

2. Radioactive substances activity

2.1. SSSIs relevant for assessment

SSSIs within 2km of the proposed Sizewell C (SZC) were identified using the Environment Agency's mapping tool are shown in Table 1. It is considered that replacement SSSI at Aldhurst Farm is represented by Sizewell Marshes SSSI.

Table 1: SSSI's within 2km of SZC, their broad habitat type and supported wildlife

Site name	Habitat T – terrestrial; F – freshwater; M – marine	Wildlife
Leiston - Aldeburgh SSSI	Leiston-Aldeburgh contains a rich mosaic of habitats, including acid grassland, heath, scrub, woodland, fen, open water and vegetated shingle. (T, F, M)	The variety of habitats support a diverse and abundant community of breeding and overwintering birds, a high number of dragonfly species and many scarce plants.
Alde-Ore Estuary SSSI	The scientific interests of the site are outstanding and diverse. The site also contains a number of coastal formations and estuarine features, including mud-flats, saltmarsh, vegetated shingle and coastal lagoons which are of special botanical and ornithological value. (T, F, M)	The botanical interest of this site is significant, including many salt marsh species and shingle species. The site is of national importance for its birdlife. Avocets, gadwall, shoveler, oystercatcher, ringed plover, common tern, Arctic tern, sandwich tern and little tern, common gull, short-eared owl, wheatear and marsh harrier. There are also very large breeding colonies of black-headed gull, lesser-black-backed gull and herring gull.

Site name	Habitat T – terrestrial; F – freshwater; M – marine	Wildlife
		The site is also home to nationally rare invertebrates.
Minsmere-Walberswick Heaths and Marshes SSSI	This site contains a complex series of habitats, notably mudflats, shingle beach, reedbeds, heathland and grazing marsh, which combine to create an area of exceptional scientific interest. (T, F, M)	Variety of saltmarsh and shingle plant species. Tidal mudflats of the River Blyth estuary form sheltered feeding grounds for wildfowl and shorebirds, notably wigeon, shelduck, redshank and dunlin. Reed beds are home to reed warbler, bearded tit, marsh harrier, bittern, cetti’s warbler, garganey and water rail. The marshes have a rich insect fauna, particularly moths, which includes a number of rare species. At Minsmere, shallow lagoons are home to wading birds and wildfowl. Heathland provides a valuable habitat for 2 nationally decreasing birds, the nightjar and woodlark. Mature woodlands provide additional habitat diversity for birds and invertebrates.
Sizewell Marshes SSSI	Large area of lowland, unimproved wet meadows.	Supports variety of invertebrates, breeding

Site name	Habitat T – terrestrial; F – freshwater; M – marine	Wildlife
	(T, F)	birds and nationally scarce plants.

Following a review of all possible sites, it was concluded that the range of habitats and wildlife are well represented by 2 local SSSIs: the southern end of Minsmere-Walberswick Heaths and Marshes SSSI and Sizewell Marshes SSSI. If it is possible to conclude no damage to the features of these SSSIs, the same conclusion will be inferred for the more distant SSSIs.

Should it be concluded that there will be damage to these SSSIs, an assessment will also be carried out at the more distant SSSIs.

2.2. Type of permission

NNB Generation Company (SZC) Limited (NNB GenCo) proposes to construct and operate a new nuclear power station at Sizewell in Suffolk (TM 47270 64145), to be known as Sizewell C (SZC). The reference number for the radioactive substances activity (RSA) permit is EPR/ HB3091DJ /A001.

The operation of SZC requires various permissions from the Environment Agency, including an RSA permit for radioactive discharges to the environment (atmosphere and sea) resulting from normal operation of the site.

2.3. Proposed timing of the permission

The RSA permit will cover the commissioning and operational lifetime of SZC, currently expected to be 60 years.

2.4. Description of the proposal

The following information on the description of the proposal is taken from the Environment Agency’s Radiological Impact Assessment for Proposed Sizewell C Nuclear Power Station, December 2020, (Environment Agency, 2020) completed as part of the RSA permit determination process.

Radioactive waste would be produced by activities associated either directly or indirectly with operating and maintaining the proposed nuclear reactors at SZC. The operation and maintenance of the proposed SZC power station would produce solid, aqueous and gaseous radioactive waste, some of which would be discharged to the environment.

Most gaseous radioactive waste would be discharged to the environment via 2 main emission stacks, one for each reactor, at a height of 70m above ground level. Aqueous radioactive waste would be discharged with the cooling water into the North Sea via 2 outfall structures approximately 3.5 kilometres off-shore with OS grid references (651080, 264125) and (651155, 264125). Low-level solid radioactive waste and waste oils and solvents would be transferred to off-site treatment and disposal facilities, while higher activity solid waste would be stored on-site until suitable disposal facilities are made available.

An RSA environmental permit will be required for radioactive discharges to the environment (atmosphere and sea) resulting from normal operation of the site. Normal operation includes the operational fluctuations, trends and events that are expected to occur over the lifetime of the facility, such as start-up, shutdown and maintenance. It does not include increased discharges arising from other events, inconsistent with the application of best available techniques (BAT), such as accidents, inadequate maintenance, and inadequate operation (including inadequate training and supervision).

Radiation exposure of wildlife in the vicinity of the Sizewell nuclear site will depend on many factors, including local dispersion conditions, the type of habitat occupied, radionuclide uptake rates and behavioural patterns, such as time spent at different locations.

The diversity of habitats and wildlife means that it is not possible to calculate dose rates to all species. Radiological impact assessment for wildlife is a developing field which is currently limited by the amount of data that are available to determine exposures to flora and fauna. So far, data sets have been compiled for some critical organisms which were chosen to be representative of the large diversity of wildlife species. Consequently, radiological impact assessments generally focus on these organisms. This assessment uses the reference organisms (ROs) from the Environmental Risk from Ionising Contaminants: Assessment and Management (ERICA) tool (Brown and others, 2016). If the dose rate to the most exposed RO is below the relevant criterion, and it can be demonstrated that the ROs adequately represent the wildlife requiring protection, then it is reasonable to assume that the habitat and wildlife that occupy it will be unaffected. An important step in this approach is to demonstrate a clear link between the wildlife to be protected and the ROs for which the dose assessment is carried out. Where this is not possible, additional organisms must be included in the assessment.

The full set of ROs are provided in Appendix I of this assessment and have been applied to the features of the relevant SSSIs.

2.5. Operations requiring consent

This CRoW assessment will determine whether:

- there is a potential risk from the permit application, which could affect the features of the relevant SSSIs, either directly or indirectly, and if the features are sensitive to the risks

- there is a pathway such that the potential risk could affect the interest features of the site, and the exposure of the feature to this risk
- for each risk, the potential scale or magnitude of any effect could result in an operation likely to damage the features of the SSSIs

An independent radiological impact assessment of radioactive discharges from the proposed SZC has been carried out on behalf of the Environment Agency to support our determination of the RSA permit application submitted by NNB Generation Company Limited (NNB GenCo) SZC. We have used the results of that assessment to inform this CRoW assessment (as described in Environment Agency, 2022).

The approach to radiological impact assessment adopted is consistent with that described in the dose assessment principles document (Environment Agency and others, 2012). The models used are well established and readily available, and input data have been derived from recognised sources.

2.5.1. Minsmere to Walberswick Heaths and Marshes SSSI

Minsmere to Walberswick Heaths and Marshes SSSI is adjacent to the northern boundary of SZC.

Reference was made to the advice on 'Operations likely to damage the special interest' of Minsmere to Walberswick Heaths and Marshes SSSI (OLD1000721) when determining the operations requiring consent for the RSA permit.

The relevant operation is:

- Reference No. 7: Dumping, spreading or discharge of any materials

We consider this is the relevant operation as the RSA has the potential for direct effects on the features of the SSSI from the discharge of aerial emissions of radioactive substances (Reference No. 7).

An assessment will therefore be made to determine whether there will be damage to the SSSI as a result of the direct radiological effects of the aerial emissions.

Minsmere to Walberswick Heaths and Marshes SSSI features

The features of the SSSI have been assigned to the reference organisms used in the assessment (Table 2, Table 3 and Table 4).

Table 2: Terrestrial reference organisms, Minsmere-Walberswick Heaths and Marshes SSSI

Reference organism	SSSI features
Bird	Aggregations of breeding birds**:** Avocet (Recurvirostra avosetta) Bearded tit (Panurus biarmicus) Bittern (Botaurus stellaris) Cetti's warbler (Cettia cetti) Garganey (Anas querquedula*)* Marsh harrier (Circus aeruginosus*)* Variety of breeding bird species (70) Variety of passage bird species (150) Variety of wintering bird species (90)
Flying insect	Invertebrate assemblage
Grasses and herbs	H1 – Calluna vulgaris - Festuca ovina heath H8 – Calluna vulgaris - Ulex gallii heath SD1 – Rumex crispus - Glaucium flavum shingle community SD2 – Cakile maritima - Honkenya peploides strandline community SD6 – Ammophila arenaria mobile dune community SD11 – Carex arenaria - Cornicularia aculeate, dune community SD12 – Carex arenaria - Festuca ovina - Agrostis capillaris dune grassland SD6 – Ammophila arenaria mobile dune community U1 b,c,d,f – Festuca ovina - Agrostis capillaris - Rumex acetosella grassland

Reference organism	SSSI features
	SM14 – Atriplex portulacoides saltmarsh SM24 – Elytrigia atherica saltmarsh Vascular plant assemblage Population of Schedule 8 plant – Filago lutescens, Red-tipped cudweed
Lichen and bryophytes	H1 – Calluna vulgaris - Festuca ovina heath H8 – Calluna vulgaris - Ulex gallii heath
Shrub	H1 – Calluna vulgaris - Festuca ovina heath H8 – Calluna vulgaris - Ulex gallii heath
Tree	W6 – Alnus glutinosa - Urtica dioica woodland

Table 3: Marine reference organisms, Minsmere-Walberswick Heaths and Marshes SSSI

Reference organism	SSSI feature
Bird	Wigeon, shelduck, redshank and dunlin
Polychaete worm	Saline coastal lagoons Sheltered muddy shores (including estuarine muds)
Vascular plants	SD2 – Cakile maritima - Honkenya peploides strandline community

Table 4: Freshwater reference organisms, Minsmere-Walberswick Heaths and Marshes SSSI

Reference organism	SSSI feature
Bird	Aggregations of breeding birds: Avocet (Recurvirostra avosetta) Bittern (Botaurus stellaris) Garganey (Anas querquedula)

Reference organism	SSSI feature
	Marsh harrier (Circus aeruginosus)
Insect larvae	Invertebrate assemblage
Vascular plant	M22 – Juncus subnodulosus - Cirsium palustre fen meadow M23 - Juncus effusus/acutiflorus - Galium palustre rush pasture M27 - Filipendula ulmaria - Angelica sylvestris mire S2 - Cladium mariscus swamp and sedge-beds S26 - Phragmites australis - Urtica dioica tall-herb fen S4 - Phragmites australis swamp and reed-beds S7 - Carex acutiformis swamp Lowland ditch systems

2.5.2. Sizewell Marshes SSSI

Sizewell Marshes SSSI is adjacent to the western and northern boundary of SZC.

Reference was made to the advice on 'Operations likely to damage the special interest' of Sizewell Marshes SSSI (OLD 1003416) when determining the operations requiring consent for the RSA permit.

The relevant operation is:

- Reference No. 7: Dumping, spreading or discharge of any materials

We consider this is the relevant operation as the RSA has the potential for direct effects on the features of the SSSI from aerial emissions of radioactive substances (Reference No. 7).

An assessment will therefore be made to determine whether there will be damage to the SSSI as a result of the direct radiological effects of the aerial emissions.

Sizewell Marshes SSSI features

The features of the SSSI have been assigned to the reference organism groups to be used in the assessment (Table 5 and Table 6). They may appear in more than one grouping.

Table 5: Terrestrial reference organisms, Sizewell Marshes SSSI

Reference organism	SSSI feature
Arthropod - detritivorous	Invertebrate assemblage
Bird	Assemblages of breeding birds – lowland damp grasslands
Flying insect	Invertebrate assemblage
Grasses and herbs	M22 - Juncus subnodulosus - Cirsium palustre fen meadow M23 - Juncus effusus/acutiflorus - Galium palustre rush pasture S26 - Phragmites australis - Urtica dioica tall-herb fen Vascular plant assemblage

Table 6: Freshwater reference organism, Sizewell Marshes SSSI

Reference organism	SSSI feature
Bird	Assemblages of breeding birds – lowland damp grasslands
Insect larvae	Invertebrate assemblage
Vascular plant	M22 - Juncus subnodulosus - Cirsium palustre fen meadow M23 - Juncus effusus/acutiflorus - Galium palustre rush pasture S26 - Phragmites australis - Urtica dioica tall-herb fen

2.6. Assessment of effects

The following overview of the assessment of effects is taken from Environment Agency, 2022.

Current guidance (ICRP, 2008 and IAEA, 2018) recommends that the impact of ionising radiation on wildlife and their habitats can be assessed by calculating dose rates to the reference organisms (ROs). The European research project, ‘Framework for assessment of environmental impact’ (FASSET), concluded that the threshold for statistically significant effects on organisms is about 100 microgray per hour (µGy/h). Allowing for the dose rate from natural background, which is at most about 60µGy/h, we have adopted a value of 40µGy/h as the level below which we consider there will be no damage to SSSIs.

If the dose rate to the most exposed RO is below the relevant dose rate criterion, and it can be demonstrated that the ROs adequately represent the wildlife requiring protection, then it is reasonable to assume that the condition of the habitat and wildlife that occupy it will be unaffected. An important step in this approach is to demonstrate a clear link between the wildlife to be protected and the ROs for which the dose assessment is carried out. Where this is not possible, additional reference organisms must be included in the assessment.

The RSA permit application included an assessment of the impact of the proposed discharges at the proposed limits on wildlife. The applicant’s assessment used outputs from the PC-CREAM 08 model marine dispersal model (DORIS), the (ERICA) approach and assessment tool (Brown and others, 2016) and the 'Ar-Kr-Xe dose calculator’ (Vives, Batlle and others, 2015), together with information on protected sites.

We reviewed the applicant's assessment and concluded that the approach taken was valid and followed appropriate guidance. We also verified the outcomes the applicant presented by performing our own assessment of the information provided. We were able to reproduce the outcomes and therefore consider the applicant’s assessment to be adequate.

2.7. Assessment of radioactive discharges

The assessment of radioactive discharges has been carried out in line with the guidance in Environment Agency, 2012.

The impact on wildlife from ionising radiation is assessed by calculating the absorbed dose rate to the most exposed RO, where the RO is representative of the wildlife being protected. The dose rate is modelled assuming discharges are made at the discharge limits requested by the applicant using information they provided on the expected breakdown of radionuclides within the discharge limits. PC-CREAM 08 (Smith and Simmonds, 2009) was used to calculate environmental activity concentrations at the selected receptor locations.

Absorbed dose rates to wildlife were calculated using the Environmental Risk from Ionising Contaminants: Assessment and Management (ERICA) tool (Brown and others, 2016) and, for noble gases, the 'Ar-Kr-Xe dose calculator’ (Vives and others, 2015) using environmental activity concentrations derived.

Absorbed dose rates were calculated to wildlife inhabiting 2 SSSIs: Minsmere-Walberswick Heaths and Marshes SSSI and Sizewell Marshes SSSI. We selected these sites as they represent those which would be worst affected due to their proximity to the Sizewell C site.

To assess the impact of marine discharges on the features of the Minsmere-Walberswick Heaths and Marshes SSSI, results were used from the assessment to inform the Habitats Regulations Assessment for the Outer Thames Estuary SPA. This is appropriate because the parameters used to model the local marine environment would be the same for both the Minsmere-Walberswick Heaths and Marshes SSSI and the Outer Thames Estuary SPA.

If the dose rate to the most exposed RO is less than the relevant criterion of 40µGy/h, then it is reasonable to assume that the RSA will not be an operation likely to damage the features of the relevant SSSI.

2.7.1. Minsmere-Walberswick Heaths and Marshes SSSI

Assessments were carried out at specific receptor points within Minsmere – Walbersiwck Heaths and Marshes SSSI and Outer Thames Estuary SPA (Table 7 and Table 8).

Table 7: Location of site-specific receptor points for discharges to atmosphere, relative to the south stack within Minsmere-Walberswick Heaths and Marshes SSSI

Location	Grid reference	Distance (m)	Angle (º) clockwise from north
Point nearest to SZC	TM47406450	590	19
Point in middle of scrape region	TM47506672	2,800	6

Table 8: Location of site-specific receptor points for discharges to atmosphere, relative to the north stack within Minsmere-Walberswick Heaths and Marshes SSSI

Location	Grid reference	Distance (m)	Angle (º) clockwise from north
Point nearest to SZC	TM47406450	380	30
Point in middle of scrape region	TM47506672	2,570	6

The Sizewell local compartment of the DORIS model in PC-CREAM-08 was used to determine activity concentrations in the marine environment resulting from the proposed liquid discharges.

Modelling assessment

Our assessment considered all of the default ROs in the ERICA tool, including 2 additional ROs to represent bats and badgers. Those relevant to the features of the SSSI are provided in Table 2, Table 3 and Table 4. The full list of reference organisms is provided in Appendix 1.

The highest dose rates from discharges to atmosphere at the Minsmere-Walberswick Heaths and Marshes SSSI are predicted to be experienced by the freshwater insect larvae and polychaete worm ROs (Table 9). The dose rates calculated represent the exposure of the RO to a single environment. Exposures from more than one environment have not been added together because it is assumed that each RO remains in a single environment for 100% of the time. Actual occupancy rates for different environments are difficult to determine, so by assuming that the RO remains exposed to a high local contamination all the time, will result in a worst-case scenario.

An assessment has also been made of the dose rate to wildlife at Minsmere-Walberswick Heaths and Marshes SSSI from the proposed Sizewell C discharges in combination with permitted radioactive discharges from the Sizewell A and Sizewell B sites. The impact of current permitted radioactive discharges was taken into consideration using our previous assessment for radioactive substances work completed in 2017 (Allott and others, 2019). In this report, we assessed the impact of all permitted discharges in 2017 on European sites (Special Areas of Conservation and Special Protection Areas for birds) in England and, in each case, reported the total dose rate to the worst affected reference organism.

The total dose rate is calculated as the sum of the dose rates to the worst affected reference organism in the aquatic and terrestrial environments; this is a cautious calculation as these organisms were not necessarily the same.

These results will be used to inform this assessment under Section 28I of the Wildlife and Countryside Act 1981 (as amended by the Countryside and Rights of Way Act (CRoW) 2000), as European sites are underpinned by SSSIs.

By summing the dose rates to the worst affected ROs from proposed SZC discharges and dose rates from existing discharges, we have calculated total dose rates to the worst affected RO at Minsmere-Walberswick Heaths and Marshes SSSI (Table 9 and Table 10).

Table 9: Dose rates to worst affected RO at Minsmere-Walberswick Heaths and Marshes SSSI from proposed aerial discharges from Sizewell C and existing radioactive discharges

Reference organism	Sizewell C proposed discharges µGy/h	Existing discharges (Allott and others, 2019) µGy/h	Total µGy/h
Freshwater insect larvae	$9.4\ 10^{-2}$	$8.1\ 10^{-1}$	$9.0\ 10^{-1}$

Table 10: Dose rates to worst affected RO at Minsmere-Walberswick Heaths and Marshes SSSI from proposed marine discharges from Sizewell C and existing radioactive discharges

Reference organism	Sizewell C proposed discharges µGy/h	Existing discharges (Allott and others, 2019) µGy/h	Total µGy/h
Polychaete worm	$6.0\ 10^{-2}$	$8.1\ 10^{-1}$	$1.8\ 10^{0}$

All total dose rates are well below the threshold of 40µGy/h, below which it is possible to conclude that there will be no adverse effect on the integrity of a European site (Allott and others, 2019), and also no damage to the features of SSSIs.

Conclusion

It has been possible to conclude that there will be no damage to the features of the Minsmere to Walberswick Heaths and Marshes SSSI from discharges to terrestrial, estuarine and marine environments.

While there are aerial and marine pathways of effect from Sizewell C, and sensitive receptors within the SSSI, it has been determined in this assessment under Section 28I of the Wildlife and Countryside Act 1981 (as amended by the Countryside and Rights of Way Act (CRoW) 2000) that the potential scale or magnitude of any effect **would not result in an operation likely to damage the features of the SSSI.**

Minsmere-Walberswick Heaths and Marshes SSSI features

The list of notified features was provided by Natural England on 21 January 2021.

Aggregations of breeding birds:

- avocet
- bearded tit

- bittern
- Cetti's warbler
- garganey
- marsh harrier

Supporting habitat: Lowland damp grasslands

Supralittoral sediment:

- SD1 - Rumex crispus - Glaucium flavum shingle community
- SD2 - Cakile maritima - Honkenya peploides strandline community
- SD6 - Ammophila arenaria mobile dune community
- SD11 - Carex arenaria - Cornicularia aculeate, dune community
- SD12 - Carex arenaria - Festuca ovina - Agrostis capillaris dune grassland
- SD6 - Ammophila arenaria mobile dune community

Dwarf shrub heath:

- H1 - Calluna vulgaris - Festuca ovina heath
- H8 - Calluna vulgaris - Ulex gallii heath

Fen, marsh and swamp habitats:

- M22 - Juncus subnodulosus - Cirsium palustre fen meadow
- M23 - Juncus effusus/acutiflorus - Galium palustre rush pasture
- M27 - Filipendula ulmaria - Angelica sylvestris mire
- S2 - Cladium mariscus swamp and sedge-beds
- S26 - Phragmites australis - Urtica dioica tall-herb fen
- S4 - Phragmites australis swamp and reed-beds
- S7 - Carex acutiformis swamp

Littoral sediment:

- SM14 - Atriplex portulacoides saltmarsh
- SM24 - Elytrigia atherica saltmarsh

Acid grassland:

- U1 b,c,d,f - Festuca ovina - Agrostis capillaris - Rumex acetosella grassland

Broadleaved, mixed and yew woodland:

- W6 - Alnus glutinosa - Urtica dioica woodland

Assemblages:

- invertebrate assemblage
- vascular plant assemblage

- variety of breeding bird species (70)
- variety of passage bird species (150)
- variety of wintering bird species (90)

Other habitat features:

- lowland ditch systems
- aline coastal lagoons
- sheltered muddy shores (including estuarine muds)
- population of Schedule 8 plant - Filago lutescens, Red-tipped cudweed

2.7.2. Sizewell Marshes SSSI

Assessments were carried out at specific receptor points within Sizewell Marshes SSSI as set out in Table 11 and Table 12.

Table 11: Location of site-specific receptor points for discharges to atmosphere, relative to the south stack within Sizewell Marshes SSSI

Location	Grid reference	Distance (m)	Angle (°) clockwise from north
Point nearest to SZC	TM47096420	290	335
Point in middle of Sizewell Marshes	TM46566383	660	260

Table 12: Location of site-specific receptor points for discharges to atmosphere, relative to the north stack within Sizewell Marshes SSSI

Location	Grid reference	Distance (m)	Angle (°) clockwise from north
Point nearest to SZC	TM47096420	120	284
Point in middle of Sizewell Marshes	TM46566383	730	242

Modelling assessment

Both terrestrial and freshwater biota of the Sizewell Marshes SSSI are potentially affected by SZC discharges. Dose rates to terrestrial biota were calculated for 2 locations within this region: the point nearest to the proposed SZC nuclear plant and the mid-point of this region. This was done to scope the range of possible dose rates. Dose rates to freshwater biota were only calculated for a point in the middle of the SSSI.

Our assessment considered all of the default ROs in the ERICA tool, including 2 additional ROs to represent bats and badgers. Those relevant to the features of the SSSI are provided in Table 5 and Table 6. The full list of reference organisms is provided in Appendix 1, with the full results of the modelling.

The highest dose rates resulting from discharges to atmosphere at the Sizewell Marshes SSSI are predicted to be experienced by the freshwater insect larvae RO (Table 9). The dose rates calculated represent the exposure of the RO to a single environment. Exposures from more than one environment have not been added together because it is assumed that each RO remains in a single environment. Actual occupancy rates for different environments are difficult to determine so assuming the RO remains exposed to high local contamination all of the time will capture the worst-case scenario.

An assessment has also been made of the dose at Sizewell Marshes SSSI from the proposed Sizewell C discharges in combination with the current permitted radioactive discharges from Sizewell A and Sizewell B. The impact of current permitted discharges was taken into consideration using our previous assessment for radioactive substances work completed in 2017 (Allott and others, 2019).

The total dose rate was the sum of the dose rates to the worst affected reference organism in the aquatic and terrestrial environments; this is a cautious calculation as these organisms were not necessarily the same.

These results will be used to inform this assessment under Section 28I of the Wildlife and Countryside Act 1981 (as amended by the Countryside and Rights of Way Act (CRoW) 2000), as European sites are underpinned by SSSIs. The results for Minsmere-Walberswick Heaths and Marshes SAC will be used to inform this assessment for Sizewell Marshes SSSI as the closest European site.

By summing the dose rates to the ROs from proposed SZC discharges and dose rates from existing discharges, we have calculated total dose rates to the worst affected RO at Sizewell Marshes SSSI (Table 13).

Table 13: Assessment of highest aerial discharges at Sizewell Marshes SSSI

Reference organism	Sizewell C proposed discharges µGy/h	Existing discharges (Allott and others, 2019) µGy/h	Total µGy/h
Freshwater insect larvae	$2.3\ 10^{-1}$	$8.1\ 10^{-1*}$	$1.0\ 10^{0}$

*Dose rate for Minsmere-Walberswick Heaths and Marshes SSSI.

The highest modelled total dose rate at Sizewell Marshes SSSI is well below the threshold of 40µGy/h, below which it is possible to conclude that there will be no adverse effect on the integrity of a European site (Allott and others, 2019), and therefore also conclude there will be no damage to the features of SSSIs.

Conclusion

It has been possible to conclude there will be no damage to the features of Sizewell Marshes SSSI from discharges to terrestrial, estuarine and marine environments.

While there are aerial and marine pathways of effect from Sizewell C, and sensitive receptors within the SSSI, it has been determined in this assessment under Section 28I of the Wildlife and Countryside Act 1981 (as amended by the Countryside and Rights of Way Act (CRoW) 2000) that the potential scale or magnitude of any effect **would not result in an operation likely to damage the features of the SSSI.**

Sizewell Marshes SSSI features

The list of notified features was provided by Natural England on 21 January 2021.

Fen, marsh and swamp habitats:

- M22 - Juncus subnodulosus - Cirsium palustre fen meadow
- M23 - Juncus effusus/acutiflorus - Galium palustre rush pasture
- S26 - Phragmites australis - Urtica dioica tall-herb fen

Assemblages:

- vascular plant assemblage
- assemblages of breeding birds – lowland damp grasslands
- invertebrate assemblage

Other habitat features:

- lowland ditch systems

2.7.3. Leiston-Aldeburgh SSSI

An assessment has been carried out at the closest SSSIs to SZC, representing the greatest risk of damage from the emissions of radioactive material to air and the marine environment. This assessment was able to demonstrate that dose rates to all ROs at the modelling points within the Minsmere-Walberswick Heaths and Marshes SSSI and Sizewell Marshes SSSI are well below the threshold for damage of 40µGy/h. Dose rates within the remaining SSSIs within 2km of SZC will also be below this threshold.

Conclusion

While there are aerial and marine pathways of effect from Sizewell C, and sensitive receptors within the Leiston-Aldeburgh SSSI, it has been determined in this assessment under Section 28I of the Wildlife and Countryside Act 1981 (as amended by the Countryside and Rights of Way Act (CRoW) 2000) that the potential scale or magnitude of any effect **would not result in an operation likely to damage the features of the SSSIs**.

2.8. Appendix 1

2.8.1. Minsmere-Walberswick Heaths and Marshes SSSI reference organisms and dose rates

Table 14: Dose rates to terrestrial wildlife due to discharges to atmosphere from SZC at proposed limits

Reference organism	Dose rate at location nearest to SZC µGy/h	Dose rate at east and west scrape µGy/h
Amphibian	$4.5\ 10^{-3}$	$2.4\ 10^{-4}$
Annelid	$1.8\ 10^{-3}$	$9.9\ 10^{-5}$
Arthropod - detritivorous	$1.8\ 10^{-3}$	$9.9\ 10^{-5}$
Bird	$4.6\ 10^{-3}$	$2.5\ 10^{-4}$
Flying insect	$1.8\ 10^{-3}$	$9.6\ 10^{-5}$
Grasses and herbs	$3.1\ 10^{-3}$	$1.7\ 10^{-4}$
Lichen and bryophytes	$3.2\ 10^{-3}$	$1.7\ 10^{-4}$
Mammal – large	$4.6\ 10^{-3}$	$2.5\ 10^{-4}$
Mammal – small-burrowing	$4.6\ 10^{-3}$	$2.5\ 10^{-4}$
Mollusc – gastropod	$1.8\ 10^{-3}$	$9.8\ 10^{-5}$
Reptile	$4.6\ 10^{-3}$	$2.5\ 10^{-4}$
Shrub	$3.1\ 10^{-3}$	$1.7\ 10^{-4}$
Tree	$4.5\ 10^{-3}$	$2.4\ 10^{-4}$
Badger	$4.6\ 10^{-3}$	$2.5\ 10^{-4}$
Bat	$4.6\ 10^{-3}$	$2.5\ 10^{-4}$

Table 15: Dose rates to freshwater wildlife due to discharges to atmosphere from SZC at proposed limits

Reference	Dose rate at east and west scrape µGy/h
Amphibian	$4.3\ 10^{-3}$
Benthic fish	$4.2\ 10^{-2}$
Bird	$4.4\ 10^{-3}$
Crustacean	$4.9\ 10^{-2}$
Insect larvae	$9.4\ 10^{-2}$
Mammal	$4.4\ 10^{-3}$
Mollusc – bivalve	$4.5\ 10^{-2}$
Mollusc – gastropod	$4.6\ 10^{-2}$
Pelagic fish	$4.5\ 10^{-3}$
Phytoplankton	$1.2\ 10^{-4}$
Reptile	$4.2\ 10^{-2}$
Vascular plant	$4.5\ 10^{-2}$
Zooplankton	$3.7\ 10^{-3}$

Table 16: Dose rates to marine wildlife due to liquid discharges from SZC at proposed limits

Reference organism	Dose rate within local compartment μGy/h
Benthic fish	$2.7\ 10^{-2}$
Bird	$1.4\ 10^{-3}$
Crustacean	$2.7\ 10^{-2}$
Macroalgae	$2.9\ 10^{-2}$
Mammal	$2.6\ 10^{-3}$
Mollusc - bivalve	$2.8\ 10^{-2}$
Pelagic fish	$9.7\ 10^{-4}$
Phytoplankton	$3.8\ 10^{-4}$
Polychaete worm	$6.0\ 10^{-2}$
Reptile	$2.6\ 10^{-3}$
Sea anemone and true coral	$2.9\ 10^{-2}$
Vascular plants	$2.8\ 10^{-2}$
Zooplankton	$3.8\ 10^{-3}$

2.8.2. Sizewell Marshes SSSI reference organisms and dose rates

Table 17: Dose rates to terrestrial wildlife due to discharges to atmosphere from SZC at proposed limits

Reference organism	Dose rate at Sizewell Marshes location nearest to SZC µGy/h	Dose rate at Sizewell Marshes mid-point of region µGy/h
Amphibian	$2.2\ 10^{-3}$	$9.5\ 10^{-4}$
Annelid	$8.8\ 10^{-4}$	$3.9\ 10^{-4}$
Arthropod - detritivorous	$8.8\ 10^{-4}$	$3.9\ 10^{-4}$
Bird	$2.2\ 10^{-3}$	$9.8\ 10^{-4}$
Flying insect	$8.6\ 10^{-4}$	$3.8\ 10^{-4}$
Grasses and herbs	$1.5\ 10^{-3}$	$6.7\ 10^{-4}$
Lichen and bryophytes	$1.6\ 10^{-3}$	$6.8\ 10^{-4}$
Mammal - large	$2.3\ 10^{-3}$	$9.9\ 10^{-4}$
Mammal - small-burrowing	$2.3\ 10^{-3}$	$9.9\ 10^{-4}$
Mollusc - gastropod	$8.8\ 10^{-4}$	$3.8\ 10^{-4}$
Reptile	$2.2\ 10^{-3}$	$9.8\ 10^{-4}$
Shrub	$1.5\ 10^{-3}$	$6.7\ 10^{-4}$
Tree	$2.2\ 10^{-3}$	$9.6\ 10^{-4}$
Badger	$2.2\ 10^{-3}$	$9.8\ 10^{-4}$
Bat	$2.2\ 10^{-3}$	$9.7\ 10^{-4}$

Table 18: Dose rates to freshwater wildlife due to discharges to atmosphere from SZC at proposed limits

Reference organism	Dose rate at Sizewell Marshes mid-point of region µGy/h
Amphibian	$1.6\ 10^{-2}$
Benthic fish	$1.1\ 10^{-1}$
Bird	$1.7\ 10^{-2}$
Crustacean	$1.2\ 10^{-1}$
Insect larvae	$2.3\ 10^{-1}$
Mammal	$1.7\ 10^{-2}$
Mollusc - bivalve	$1.1\ 10^{-1}$
Mollusc - gastropod	$1.1\ 10^{-1}$
Pelagic fish	$1.7\ 10^{-2}$
Phytoplankton	$4.6\ 10^{-4}$
Reptile	$1.0\ 10^{-1}$
Vascular plant	$1.1\ 10^{-1}$
Zooplankton	$1.5\ 10^{-2}$

3. Combustion activity

3.1. SSSIs relevant for assessment

The applicant identified SSSIs within 2km of the proposed SZC, in line with Environment Agency, 2012a guidance, as follows:

- Minsmere-Walberswick Heaths and Marshes SSSI, adjacent - north
- Sizewell Marshes, adjacent – west
- Leiston-Aldeburgh, 1.7km south

3.2. Type of permission

The operation of SZC requires various permissions from the Environment Agency, including a combustion activity (CA) permit for the use of diesel generators (DG) during commissioning and routine maintenance of the power station, and during any loss of operation power (LOOP) scenarios. Further information is provided below.

3.3. Proposed timing of permission

The CA permit will cover the operational lifetime of SZC, currently expected to be 60 years. However, the operation of the DGs will not occur continuously over this period.

Commissioning of SZC will last for 2 years, with each unit being commissioned individually for one year, after which the generators will undergo routine testing. Routine testing is the ongoing testing of the generators to make sure they are available to perform their role, as a critical nuclear safety function, should a LOOP event occur. Each essential diesel generator (EDG) and ultimate diesel generator (UDG) is tested individually for a total of 60 hours a year for an aggregated total of 720 hours of testing per year.

Each generator is also tested individually for a full 24-hour period following a maintenance outage, which aggregates to 288 hours of testing.

For the LOOP scenario, the applicant has stated that: "… an exact period of operation under such a scenario cannot be specified. Such an event is not intended to occur at all, is statistically unlikely to occur more than once in the plant design life and in such an event is likely to last for well under 24-hours." (EDF, 2021)

3.4. Description of the proposal

Sizewell C combustion plant installation consists of:

- 8 x 23.1MWth EDGs
- 4x 10.53MWth ultimate diesel generators UDGs
- associated fuel storage tanks and interconnecting pipework

All of these will be housed within purpose-built concrete buildings, each containing 2 EDGs and one UDG.

Each generator would require:

- an exhaust stack on roof at a height of 27.2m (for dispersion of generator combustion gases), 3 stacks per building, one per generator
- 2 fresh-air intakes at mid-level, one either side of the building (per generator), therefore a total of 6 per generator building
- 2 fresh-air in/warm air out louvres per generator at higher level, therefore a total of 6 per generator building

These 3 elements would comprise the sound sources during the operation of the back-up generators.

The installation has an aggregated thermal input of 227MWth and will operate under Part 1 of Schedule 1 of the Environmental Permitting Regulations (EPR): Section 1.1 A1(a) - Burning any fuel in an appliance with a rated thermal input of 50 or more megawatts.

The diesel generators are safety classified standby plants and, once commissioning of the power station has completed, will only be operated in the event of a power failure, maintenance purposes and during periodic testing.

The main emissions are to air via exhaust stacks of approximately 27.2 metres in height and will consist of combustion gases containing oxides of sulphur, nitrogen and carbon and particulates.

The conceptual design stack locations are provided in the combustion activity permit application (EDF, 2020a), and replicated in Figure 2.

Source reference, boiler type and grid reference:

- A1: EDG, NGR 647224, 264307
- A2: EDG, NGR 647243, 264307
- A3: UDG, NGR 647259, 264307
- A4: EDG, NGR 647224, 264133
- A5: EDG, NGR 647243, 264133
- A6: UDG, NGR 647259, 264132
- A7: EDG, NGR 647224, 264074
- A8: EDG, NGR 647243, 264074
- A10: EDG, NGR 647224, 263900
- A11: EDG, NGR 647243, 263900
- A12: UDG, NGR 647259, 263900

Figure 2: Proposed location of the purpose-built concrete buildings, each containing 2 EDGs and one UDG. Units A1, A2 and A3 are closest to the adjacent Minsmere-Walberswick Heaths and Marshes SSSI. Taken from Fig. 12C.1, EDF, 2020a

3.5. Operations requiring consent

This CRoW assessment will determine whether:

- there is a potential risk from the permit application, which could affect the features of the relevant SSSIs, either directly or indirectly, and if the features are sensitive to the risks
- there is a pathway such that the potential risk could affect the interest features of the site, and the exposure of the feature to this risk
- for each risk, the potential scale or magnitude of any effect could result in an operation likely to damage the features of the SSSIs

The applicant has provided information and modelling to inform our assessment, which has been reviewed by our Air Quality Modelling and Assessment Unit (AQMAU) (Environment Agency, 2021c).

3.5.1. Minsmere-Walberswick Heaths and Marshes SSSI

Minsmere-Walberswick Heaths and Marshes SSSI is adjacent to the northern boundary of SZC.

Reference was made to the advice on 'Operations likely to damage the special interest' of Minsmere-Walberswick Heaths and Marshes SSSI (OLD1000721) when determining the operations requiring consent for the CA.

The relevant operations are:

- Reference No. 5: Application of manure, fertilisers and lime
- Reference No. 7: Dumping, spreading or discharging of any material
- Reference No. 27: Recreational or other activities likely to damage the vegetation or disturb wildlife

We consider these are the relevant operations as the CA will contribute aerial nutrient enrichment and acidification and the potential for direct toxic effects on vegetation from aerial emissions (Reference No.5 and 7). Also, the generators will produce noise which has the potential to disturb wildlife (Reference No.27).

An assessment will therefore be made to determine whether there will be damage to the SSSI as a result of the direct toxic effects of aerial emissions, deposition resulting in nutrient enrichment and acidification, and from noise resulting in disturbance.

SSSI features

The SSSI features have been placed into broad habitat groups as used by [APIS] (accessed 18/08/21) to enable an assessment of the effects of aerial emissions and deposition. The list of notified features was provided by Natural England on 21 January 2021.

Aggregations of breeding birds:

- avocet (Recurvirostra avosetta)
- bearded tit (Panurus biarmicus)
- bittern (Botaurus stellaris)
- Cetti's warbler (Cettia cetti)
- garganey (Anas querquedula)
- marsh harrier (Circus aeruginosus)

Supralittoral sediment:

- SD1 - Rumex crispus - Glaucium flavum shingle community
- SD2 - Cakile maritima - Honkenya peploides strandline community
- SD6 - Ammophila arenaria mobile dune community
- SD11 - Carex arenaria - Cornicularia aculeate, dune community
- SD12 - Carex arenaria - Festuca ovina - Agrostis capillaris dune grassland
- SD6 - Ammophila arenaria mobile dune community

Dwarf shrub heath:

- H1 - Calluna vulgaris - Festuca ovina heath
- H8 - Calluna vulgaris - Ulex gallii heath

Fen, marsh and swamp habitats:

- M22 - Juncus subnodulosus - Cirsium palustre fen meadow (no broad habitat assigned within APIS for acidification, acidity class is acid grassland)
- M23 - Juncus effusus/acutiflorus - Galium palustre rush pasture (no broad habitat assigned within APIS for acidification, acidity class is acid grassland)
- M27 - Filipendula ulmaria - Angelica sylvestris mire (no broad habitat assigned within APIS for acidification, acidity class is acid grassland)
- S2 - Cladium mariscus swamp and sedge-beds
- S26 - Phragmites australis - Urtica dioica tall-herb fen
- S4 - Phragmites australis swamp and reed-beds
- S7 - Carex acutiformis swamp

Littoral sediment:

- SM14 - Atriplex portulacoides saltmarsh
- SM24 - Elytrigia atherica saltmarsh

Acid grassland:

- U1 b,c,d,f - Festuca ovina - Agrostis capillaris - Rumex acetosella grassland

Broadleaved, mixed and yew woodland:

- W6 - Alnus glutinosa - Urtica dioica woodland

Assemblages:

- invertebrate assemblage
- vascular plant assemblage
- variety of breeding bird species (70)
- variety of passage bird species (150)
- variety of wintering bird species (90)

Other habitat features:

- lowland ditch systems
- lowland damp grasslands
- saline coastal lagoons
- sheltered muddy shores (including estuarine muds)
- population of Schedule 8 plant – red-tipped cudweed (Filago lutescens)

3.5.2. Sizewell Marshes SSSI

Sizewell Marshes SSSI is adjacent to the western and northern boundary of SZC.

Reference was made to the advice on ‘Operations likely to damage the special interest’ of Sizewell Marshes SSSI (OLD 1003416) when determining the operations requiring consent for the CA.

The relevant operation is:

- Reference No. 6: Application of manure, fertilisers and lime
- Reference No. 7: Dumping, spreading or discharge of any materials
- Reference No.27: Recreational or other activities likely to damage features of interest

We consider these are the relevant operations as the CA will contribute aerial nutrient enrichment and acidification and the potential for direct toxic effects on vegetation from aerial emissions (Reference No. 6). Also, the generators will produce noise which has the potential to disturb wildlife (Reference No. 27).

An assessment will be made to determine whether there will be damage to the SSSI as a result of the direct toxic effects of aerial emissions, and deposition resulting in nutrient enrichment and acidification, and from noise resulting in disturbance.

SSSI features

The SSSI features have been placed into broad habitat groups as used by APIS (accessed 18/08/21) to enable an assessment of the effects of aerial emissions and deposition. The list of notified features was provided by Natural England on 21 January 2021.

Fen, marsh and swamp habitats:

- M22 - Juncus subnodulosus - Cirsium palustre fen meadow
- M23 - Juncus effusus/acutiflorus - Galium palustre rush pasture
- S26 - Phragmites australis - Urtica dioica tall-herb fen

Assemblages:

- vascular plant assemblage
- assemblages of breeding birds – lowland damp grasslands
- invertebrate assemblage

Other habitat features:

- lowland ditch systems

3.5.3. Leiston-Aldeburgh SSSI

Leiston-Aldeburgh SSSI is located 1.7km to the south of SZC.

Reference was made to the advice on ‘Operations likely to damage the special interest’ of Leiston-Aldeburgh SSSI (OLD 2000370) when determining the operations requiring consent for the CA.

The relevant operations are:

- Reference No. 5: Application of manure, slurry, silage liquor, fertilisers and lime
- Reference No. 7: Dumping, spreading or discharge of any materials
- Reference No. 27: recreational or other activities likely to damage the vegetation or disturb birds

We consider these are the relevant operations as the CA will contribute aerial nutrient enrichment and acidification and the potential for direct toxic effects from the aerial emissions (Reference No. 5 and 7). Also, the generators will produce noise which has the potential to disturb wildlife (Reference 27).

An assessment will therefore be made to determine whether there will be damage to the SSSI as a result of the direct toxic effects of aerial emissions, deposition resulting in nutrient enrichment and acidification, and from noise resulting in disturbance.

SSSI features

The SSSI features have been placed into broad habitat groups as used by [APIS] (accessed 18/08/21) to enable an assessment of the effects of aerial emissions and deposition. The list of notified features was provided by Natural England on 21 January 2021.

Aggregations of breeding birds:

- gadwall (Anas strepera)
- marsh harrier (Circus aeruginosus)
- woodlark (Lullula arborea)
- gadwall (Anas strepera)
- shoveler (Anas clypeata)
- white-fronted goose (Anser albifrons albifrons)

Heathland habitats:

- H1 - Calluna vulgaris - Festuca ovina heath

Fen, marsh and swamp habitats:

- S4 - Phragmites australis swamp and reed-beds

Supralittoral sediment:

- SD1 - Rumex crispus - Glaucium flavum shingle community

Acid grassland habitats:

- U1 b,c,d,f - Festuca ovina - Agrostis capillaris - Rumex acetosella grassland

Woodland habitats:

- W1 - Salix cinerea - Galium palustre woodland
- W2 - Salix cinerea - Betula pubescens - Phragmites australis woodland
- W6 - Alnus glutinosa - Urtica dioica woodland

Assemblages:

- vascular plant assemblage
- outstanding dragonfly assemblage
- variety of breeding bird species (70)

Other habitat features:

- lowland ditch systems
- lowland damp grasslands and lowland open waters and their margins

The applicant has noted that the fen, marsh and swamp, acid grassland and broadleaved deciduous woodland habitats are all located more than 2km from SZC and are therefore not relevant for assessment (EDF,2020, Table A4).

3.6. Assessment of effects

Section 3 of the combustion activity permit application Appendix C (EDF, 2020a) sets out the scenarios assessed in the modelling for combustion activities. These are commissioning and routine maintenance scenarios and loss of operation power event (LOOP) scenario.

These scenarios will be used to determine whether there will be damage to the features of the SSSIs from the direct toxic effects of NOx and SO_2, nutrient enrichment and acidification on broad habitats and noise resulting in disturbance to protected bird species.

3.6.1. Site operation and modelled scenarios – combustion activity

Scenario 1 – Commissioning

The first modelled scenario is for commissioning, where all of the generators are tested for reliability and performance prior to the start of nuclear activities. Each of the 8 EDGs are tested for 242.5 hours, and each of the 4 UDGs are tested for 738 hours. Unit 1 will undergo commissioning first and unit 2 will undergo commissioning the following year. Therefore, each year, 4 EDGs and 2 UDGs are tested, which aggregates to 2,446 hours of testing per year. While unit 2 is undergoing commissioning, unit 1 will begin undergoing routine operational testing.

Commissioning will also involve simulated LOOP events for each unit. The 4 EDGs are tested all together for a 3-hour period. The applicant has not stated how often these simulated LOOP events are likely to occur. The applicant has suggested that it is possible that a 3-hour simulated LOOP event during commissioning of unit 2 could coincide with 5 hours of routine operational testing of unit 1. Therefore, a worst-case scenario during a 24-hour period is 5 EDGs running simultaneously for 3 hours and one of the EDGs running for an additional 2 hours.

The applicant has modelled the long-term (LT) process contributions (PCs) for the commissioning phase by running a single generator all year and using time-varying emissions data to factor the PCs down to 2,446 hours per year. This method captures worst-case meteorological conditions. It has assumed that this generator is always an EDG, which has much higher emission rates than the UDG. There are twice as many EDGs than UDGs. However, around 60% of the testing will be UDGs, therefore we consider the modelling assumptions to be conservative.

The applicant has modelled the short-term (ST) PCs for commissioning by assuming a worst-case scenario. It has run this scenario all year to capture worst-case meteorological conditions. We consider this modelled scenario to be reasonably worst case.

Scenario 2 – Routine testing

Following a year of commissioning for each unit, the generators will undergo routine testing. Routine testing is the ongoing testing of the generators to make sure they are available to perform their role, as a critical nuclear safety function, should a LOOP event occur. Each EDG and UDG is tested individually for a total of 60 hours a year for an aggregated total of 720 hours of testing per year.

Each generator is also tested individually for a full 24-hour period following a maintenance outage. The maintenance outage is carried out every 18 months, therefore equating to 16 hours per year. This aggregates to 192 hours of testing per year. The maintenance outage replaces any routine testing for that month.

The applicant has modelled the LT PCs for routine testing by running a single generator all year and using time-varying emissions data to factor the PCs down to 720 hours per year. This method captures worst-case meteorological conditions. It has assumed that this generator is always an EDG, therefore, we consider these modelling assumptions to be conservative because only around 66% of the testing will be EDGs.

The applicant has modelled the ST PCs for routine testing by running one EDG all year. This method captures worst-case meteorological conditions. The consultant has assumed a worst-case scenario where one EDG is tested for 24 hours following a maintenance outage. We consider this to be an appropriate worst-case scenario.

Scenario 3 – Loss of offsite power (LOOP)

A LOOP event involves running all 8 EDGs for the duration of the event. It is not easily determined how often a LOOP event is likely to occur or how long it will last. The applicant suggests that "a short LOOP event (<2 hours) is expected to occur a limited number of times during the lifetime of the plant and a long LOOP event (2-24 hours) is expected to occur about once in the lifetime of a fleet of nuclear sites."

While the applicant has modelled the ST PCs for the LOOP event by running all 8 EDGs all year, an assessment was not carried out at the SSSIs, with the following justification: "the Centre for Ecology and Hydrology in a recent book on nitrogen, NOx concentrations and vegetation, states that UN/ECE Working Group on Effects strongly recommended the use of the annual mean value, as the long-term effects of NOx are thought to be more significant than the short-term effects.*"* (EDF, 2020a).

3.7. Assessment of aerial emissions and deposition

The assessment of aerial emissions has been carried out in line with the guidance in Environment Agency, 2012a and Environment Agency, 2012b. A detailed assessment of aerial emissions and deposition is required where the process contribution (PC) is greater than 1% of the critical level or critical load, and the predicted environmental concentration (PEC, PC + background) is greater than 70% of the critical level or load. These can be termed as 'decision making thresholds'.

Emissions and deposition less than 1% of the PC are considered to be inconsequential.

A predicted PEC less than 70% of PEC will not result in damage to the vulnerable features of SSSIs due to headroom.

Emissions or deposition above these decision-making thresholds require further detailed assessment.

3.7.1. Detailed assessment

The applicant used ADMS 5.2 air dispersion modelling software to predict impacts of emissions from the facility. The Air Quality Assessment Unit (AQMAU) audited the applicant’s assessment.

AQMAU (Environment Agency, 2021c) concludes that critical levels and critical loads are predicted to be exceeded during all operational scenarios based on conservative modelling submitted with the permit application. However, modelled scenarios with more realistic combinations of generators could reduce predicted short-term NOx concentrations and nutrient nitrogen and acid deposition concentrations. Therefore, for features where the need for a detailed assessment was triggered, and in order to carry out a more realistic assessment of the air emissions predicted impact, a Schedule 5 Notice was sent to the applicant on 21 May 2021 to request further information. The request included the requirement to:

- assess the impacts against daily NOx critical level for a LOOP event. This had not been included in the original assessment. This was to be carried out for the maximum number of hours a day the generators could be operational for
- assess real combinations of generators rather than assuming EDGs are running all the time
- provide information about typical number of hours a day that the generators could be operational for in all of the operational scenarios, allowing a better understanding of the likelihood of exceedances occurring
- provide some additional information regarding the ‘maintenance outages’ during routine testing, including information on what these are and how often they are likely to occur
- clarify whether the 24-hour testing of all the generators which occur after a maintenance outage are already included in the annual testing hours

A response was received from the applicant on 21 June 2021 (EDF, 2021), and was subsequently reviewed by AQMAU (Environment Agency, 2021b).

The applicant’s response provided the following additional information on the original and revised modelling approach:

“The routine operation assessment is based on the assumption of one EDG operating continuously throughout the year, with pro-rata emissions based on 720 hours of annual operation.

The 12 DGs are spread over a relatively large area, with approximately 500m between the most northerly positioned DGs and the most southerly positioned DGs. The DGs that are closest to a specific receptor will result in the maximum impacts at that receptor, while the DGs furthest away will result in lower impacts at the same receptor.”

The assessment presented in Appendix C of the environmental permit application (EDF, 2020a) reported impacts at each receptor based on the operation of the EDG that resulted in the highest impact at that receptor (the closest EDG), rather than taking into account that the operation of that EDG would only actually be for 60 hours, and operation of EDGs leading to lower results would account for a large proportion of the testing hours.

In addition, no consideration was given in the assessment to the fact that the 4 smaller ultimate diesel generators (UDGs) have much lower emissions of NOx. Therefore, of the 720 hours of annual operation for the routine testing scenario, 480 hours would be associated with EDG operation, but 240 hours would be associated with UDG operation and therefore would result in considerably lower impacts due to the much lower NOx emissions of these units.

The applicant provided the following on assessing a LOOP event, "Such an event is not intended to occur at all, is statistically unlikely to occur more than once in the plant design life and in such an event is likely to last for well under 24-hours. The daily NOx critical level is also intended to protect habitat sites from concentrations occurring at that level each day, not to qualify a potential single 24-hour event occurring over the entire design life of an operational facility."

After carrying out check modelling and sensitivity analysis of the revised modelling, AQMAU concluded that (Environment Agency, 2021b):

- the daily NOx PCs predicted to occur during a LOOP event to be reasonably representative of a worst-case LOOP scenario occurring during the worst-case 24-hour period of meteorological conditions
- the nutrient nitrogen and acid deposition PCs predicted to occur during commissioning and routine testing to be reasonably representative

The applicant referenced the Air Pollution Information System (APIS) to identify the features at greatest risk from the combustion activity emissions, and the criteria used to assess the direct toxic effects of the emissions (critical levels) and the deposition of nutrient nitrogen and acidification (critical loads).

Direct toxic effect

APIS (accessed 22/07/21) provides the following information on the direct effects of toxic contamination from emissions of NOx.

"It is likely that the strongest effect of emissions of nitrogen oxides across the UK is through their contribution to total nitrogen deposition. However, direct effects of gaseous nitrogen oxides, may also be important, especially in areas close to sources (e.g. roadside verges). The critical level for all vegetation types from the effects of NOx has been set to 30 µg/m^3. Experimental evidence suggests that moderate concentrations of NOx may produce both positive and negative growth responses, with the potential for synergistic interactions with sulphur dioxide (SO_2) being very important. There is substantial evidence to suggest that the effects of NO_2 are much more likely to be negative in the presence of equivalent concentrations of SO_2. At the same time the ratio of SO_2 to NO_2 has decreased greatly in urban areas of the UK over the past 30 years."

APIS also states that “Background level concentrations of SO_2 in the UK have fallen so much that there is no longer a threat to plant health.” However, it is still relevant to assess the emissions of SO_2 against the relevant critical levels.

Critical levels

Critical levels are defined as "concentrations of pollutants in the atmosphere above which direct adverse effects on receptors, such as human beings, plants, ecosystems or materials, may occur according to present knowledge." (APIS)

Critical levels cover broad vegetation types, with more stringent values where sensitive lichens and bryophytes are an integral part of the habitat being assessed.

Sulphur dioxide

- 10µg/m^3 where lichens or bryophytes are present, annual
- 20µg/m^3 where lichens or bryophytes are present, annual

Nitrogen oxide (present as nitrogen oxide)

- 30µg/m^3, annual
- 75µg/m^3, daily
- 200µg/m^3, 4-hourly mean

Nutrient enrichment

An overview of nitrogen deposition effects on habitats and species is available on APIS (accessed 22/07/21), and is provided in part below:

“Communities most at risk from N eutrophication are those rich in bryophytes and where species richness is comprised of slow growing species. Many semi-natural plants do not have the capacity to assimilate nitrogen in the presence of increased N availability (from N deposition) and can be outcompeted by plants that can, e.g. many graminoids (grass) species. This species loss is caused by shading or an inability to compete for other limiting resources. Low growing species such as forbs and non-vascular plants are especially at risk. Such species replacements can lead to loss of specialised communities and ecosystems, e.g. heathland transformed into grassland in the Netherlands.

N deposition can also increase the risk of damage from abiotic factors, e.g. drought (summer and winter) and frost. Where N deposition leads to enhanced foliar N concentrations there is increased risk of damage from pests and pathogens both above and below ground. Detrimental impacts of N below-ground include loss of species diversity with respect to ectomycorrhiza and reductions in decomposer populations, e.g. enchytraeid worms. Nitrogen can also increase litter fall, reducing the amount of light passing through to ground dwelling species.”

Critical loads

The critical loads were provided in Table 5-15 EDF, 2020a, and have been cross-referenced with APIS.

Critical loads are defined as: " a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge." (APIS)

Guidance is provided by the Centre of Ecology and Hydrology (CEH) on the setting of empirical critical loads for nutrient nitrogen for different habitat types. They are based on observed changes in the structure or function of ecosystems, or, in a few cases, dynamic ecosystems modelling.

Each ecosystem or broad habitat is assigned a critical load range, minimum and maximum, taking account of:

1. intra-ecosystem variation between different regions where an ecosystem has been investigated
2. the finite intervals between additions of nitrogen in experiments
3. uncertainties in estimated total atmospheric deposition values

An indication of the confidence in the critical loads is given by an uncertainty rating:

- ‘reliable’ where a number of published papers of various studies showed comparable results
- ‘quite reliable’ when the results of some studies were comparable
- ‘expert judgement’ when no empirical data were available for the ecosystem and the nitrogen critical load was based on expert judgement and knowledge of comparable ecosystems

There is more certainty that an exceedance of a ‘reliable’ critical load will result in damage to the sensitive features of SSSIs.

The applicant used the most stringent and precautionary (lower) critical load from the range provided in its assessment.

Acidification

An overview of acidification effects on habitats and species is available on APIS (accessed 22/07/21), and is provided in part below:

“Acid deposition represents the mix of air pollutants that deposit from the atmosphere leading to acidification of soils and freshwaters. It mainly consists of pollutants emitted by the combustion of fossil fuels (e.g., power generation). The removal of these pollutants from the atmosphere is in the form of wet deposition in rainfall, cloud-water or occult deposition, mist and dew, but also includes dry deposited acidifying gases.

Many effects of acid deposition are indirect, associated with acid deposition lowering soil pH and increasing solubility of toxic Al^{3+} ions, which is often associated with reduced base cation concentrations. Leaching of base cations, especially magnesium from soils, have been linked to leaf chlorosis, a common symptom on trees in some German forests in the 1980s, where this yellowing was associated with forest decline. Decomposition rates can be reduced in acid soils which will mean nutrient availability is compromised as mineral nutrients remain immobilised. Acid deposition can lead to calcium being leached from conifer needles, e.g. red spruce, which become less able to withstand winter freezing / desiccation damage. The effect on food crops is minimised by the application of lime and fertilizers to replace lost nutrients and maintain a more neutral soil pH."

Critical loads

The critical loads were provided in the Table 5-16 AECOM, 2020, and have been cross-referenced with APIS.

Critical loads are defined as: "a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge." (APIS).

Critical loads for acidification are presented as a critical load function comprising of the maximum critical load for sulphur (CLmaxS), minimum critical load for nitrogen (CLminN) and maximum critical load for nitrogen (CLmaxN). When compared with deposition data for sulphur and nitrogen, they can be used to assess critical load exceedances.

The applicant used the most stringent and precautionary (lower) critical load function from the range provided in its assessment.

3.7.2. Minsmere-Walberswick Heaths and Marshes SSSI

Direct toxic effects

The results of modelling carried out by the applicant for the commissioning and routine operation of SZC are provided in Table 19 andTable 20, with the exception of short-term effects of NOx. The applicant did not model for short-term effects during commissioning, stating that emissions would not occur over a 24-hour period. AQMAU modelling, completed to support the permit determination, has therefore been used to inform the commissioning short-term NOx assessment.

These results have been used to determine if a detailed assessment is required to conclude whether there will be damage to the features of the SSSI. They are taken from EDF, 2020a.

Table 19: Assessment of direct toxic effects, Minsmere-Walberswick Heaths and Marshes SSSI, commissioning.

Pollutant	Critical level (µg/m³)	PC (µg/m³)	PC >Y% CL	Background	PEC (µg/m³)	PEC > 70% CL
NOx (long term)	30	13.5	Yes 45%	10.06	23.56	Yes 79%
NOx (short term)	75	223.8	Yes 298%	N/A	N/A	N/A
SO_2	20	0.5	Yes 2%	0.95	1.45	No 7%
SO_2 (lower plants)	10	0.5	Yes 10%	0.95	1.45	No 15%

Y = 1%, long term; 10% short term NOx

It is possible to conclude **no damage** to the features of the SSSI from the direct toxic effects of emissions of SO_2 during commissioning of SZC.

Further assessment is required for the long and short-term effects of NOx during commissioning of SZC.

Table 20: Assessment of direct toxic effects, Minsmere-Walberswick Heaths and Marshes SSSI, routine testing

Pollutant	Critical level (µg/m^3)	PC (µg/m^3)	PC >Y% CL	Background (µg/m^3)	PEC (µg/m^3)	PEC > 70%
NOx (long term)	30	3.9	Yes 13%	10.06	13.96	No 47%
NOx (short term)	75	303.6	Yes 405%	N/A	N/A	N/A
SO_2	20	0.1	No 0.7%	N/A	N/A	N/A
SO_2 (lower plants)	10	0.1	No 0.7%	N/A	N/A	N/A

Y = 1%, long term; 10% short term NOx

It is possible to conclude **no damage** to the features of the SSSI from the long-term direct toxic effects of SO_2 and NOx during the routine testing of DGs.

Further assessment is required for the short-term effects of NOx on Minsmere-Walberswick Heaths and Marshes SSSI during the commissioning and routine testing of DGs.

Detailed assessment

The applicant assessed the short-term effects of NOx against the critical level of 75µg/m^3 as part of its permit application. This indicated that under worst-case modelling scenarios the short-term CL of 75µg/m^3 would be exceeded over an area of Minsmere-Walberswick Heaths and Marshes SSSI, as shown in Figure 3.

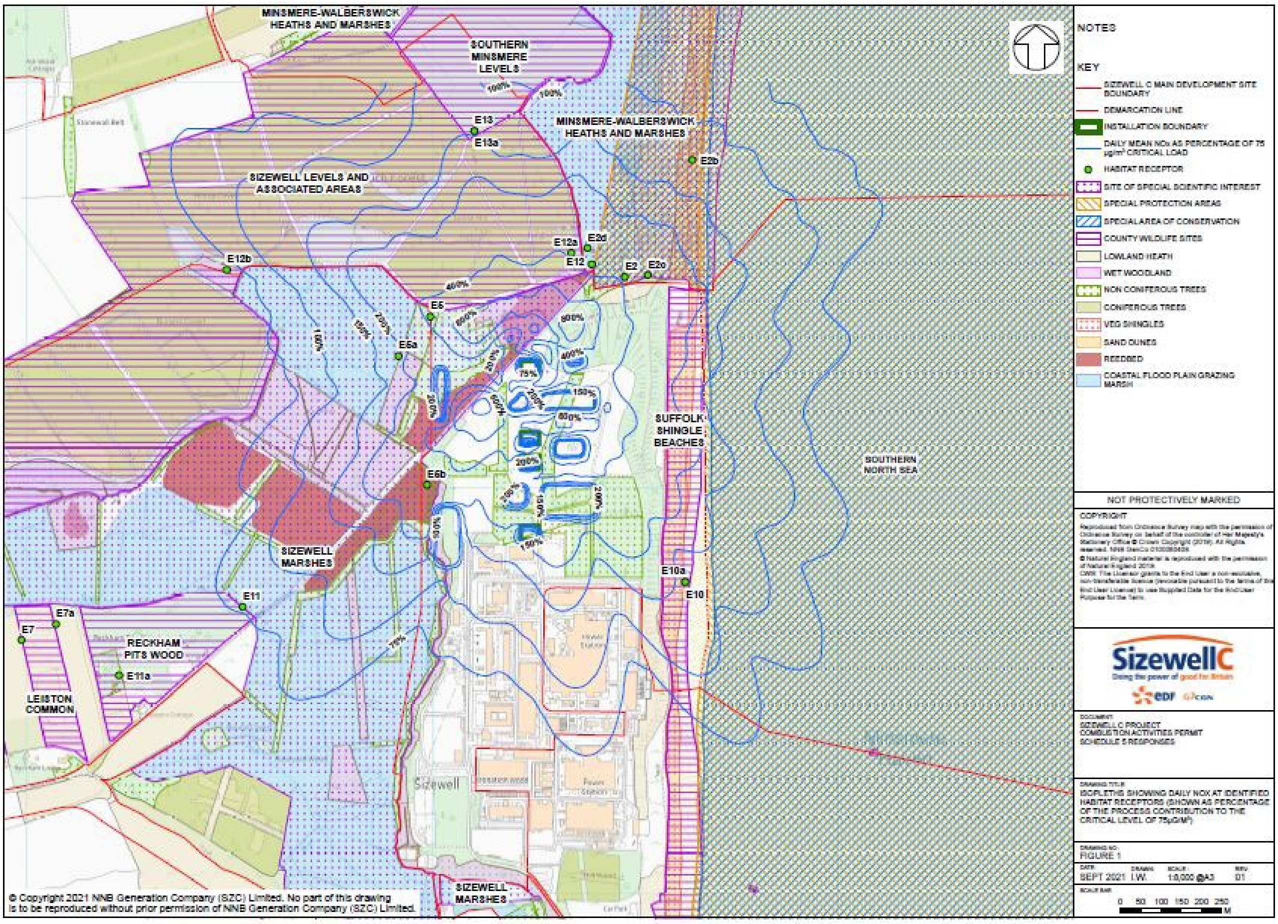


Figure 3: Isopleths showing daily NOx levels at identified habitat receptors, with process contributions shown as a percentage of the critical level of 75µg/m³

Guidance on the assessment of the short-term effects of NOx emissions (Holman and others, 2020) states that:

"The relative importance of the long term mean compared to the short term mean is reflected in several studies which state that the *'UNECE Working Group on Effects strongly recommended the use of the annual mean value, as the long term effects of NOx are thought to be more significant than the short term effects'*. This guidance, therefore, recommends that only the annual mean NOx concentration is used in assessments unless specifically required by a regulator; for instance, as part of an industrial permit application where high, short term peaks in emissions, and consequent ambient concentrations, may occur."

It is therefore appropriate to give some consideration to the short-term effects of NOx, the probability of them occurring and the area over which they will occur.

Commissioning and routine operation

The applicant has proposed that its PCs predicted for routine testing be used for commissioning as well. The worst-case scenario during commissioning involves simulating a LOOP event, whereby 4 EDGs are tested simultaneously for a 3-hour period. This scenario emits less NO_x over a 24-hour period compared to the worst-case scenario during routine testing, which involves testing a single generator for 24 hours following a maintenance outage. Therefore, using routine testing PCs for commissioning is likely to be more conservative.

The applicant has calculated the probability of exceedances actually happening (AECOM, 2021), stating that: “This found that (assuming 100% operation of an Emergency Diesel Generator (EDG)) the daily NOx Critical Level is exceeded up until the 80th percentile for the worst-case year of met data, and therefore an exceedance of the Critical Level could only occur for 20% of the time. As the DGs are only operational for 8% of hours (720 ÷ 8760) for planned annual routine operation, this results in a probability of the unfavourable met conditions and the DG operation occurring at the same time having a 1.6% chance of actually occurring (20% x 8% = 1.6%).”

However, AQMAU (Environment Agency, 2021b) considers that this is incorrect because an exceedance of the daily critical level could occur if one or more exceedance days coincides with any of the 30 operational days. AQMAU have calculated the probability of one or more exceedances of the daily NOx critical level at habitat sites occurring during any year of routine testing. Based on the consultant’s 73 exceedance days per year with 30 operational events per year, AQMAU calculates the probability of one or more exceedances to be approximately 99.9%.

The PC for routine testing of DGs is predicted to be a maximum of 303.6$\mu g/m^3$ at modelling point E2.

It can be seen that the modelled exceedance of the short-term 75$\mu g/m^3$ critical level is localised to the southern-most tip of Minsmere-Walberswick Heaths and Marshes SSSI, areas of coastal floodplain and grazing marsh, and coastal sand dunes. This represents a small proportion of the SSSI which extends over an area of 2,325.89ha.

While an exceedance of the critical level is expected on one or more of the 30 operational days during any given year of operation, it is unlikely its scale within the SSSI and short-term nature, when considering the relative importance of the long-term mean compared to the short-term mean, will result in direct toxic effects on the features of Minsmere-Walberswick Heaths and Marshes SSSI.

It should also be noted that this assessment is based upon the worst-case operational scenario for SZC CA routine testing. The applicant has modelled the ST PCs for routine testing by running one EDG all year, which would capture the worst-case meteorological conditions. The applicant has also assumed a worst-case scenario where one EDG is tested for 24 hours following a maintenance outage and that this EDG is closest to the SSSI.

This approach does not factor in that each generator will only operate for 60 hours per year, and that the EDGs are spread over the SZC site as shown in Figure 2 so emission levels will vary at the SSSI depending upon the EDG being tested and that the UDGs have lower NOx emissions than EDGs.

It is therefore possible to conclude **no damage** to the features of the Minsmere-Walberswick Heaths and Marshes SSSI from the short-term effects of NOx during the commissioning and routine operation of SZC.

LOOP

The applicant provided an assessment of the LOOP scenario at the Minsmere-Walberswick Heaths and Marshes SSSI in section 2.2.2 of their Schedule 5 Notice response (EDF, 2021). An assessment was not made in the permit application as "…an exact period of operation under such a scenario cannot be specified. Such an event is not intended to occur at all, is statistically unlikely to occur more than once in the plant design life and in such an event is likely to last for well under 24-hours. The daily NOx critical level is also intended to protect habitat sites from concentrations occurring at that level each day, not to qualify a potential single 24-hour event occurring over the entire design life of an operational facility."

The applicant has predicted that, based upon the modelled assumption that 8 EDGs are operational concurrently, continuously throughout the year (ensuring that the assessment takes account of the meteorological conditions that result in the worst-case impacts) the PC will be 875.8µg/m^3. This is 1,168% of the daily CL of 75µg/m^3.

While these exceedances are extreme, the LOOP scenario is not expected to happen during the lifetime of the plant. The applicant predicted in its Schedule 5 response (EDF, 2021) that:

"A short LOOP (i.e. less than 2 hours) event has a predicted frequency of 3.72 x 10^{-2} per reactor year, therefore assuming the SCZ site is operational for 60 years, a short LOOP event is predicted to occur up to 4 times (2 times per reactor) during the site's operational lifetime.

"A long LOOP event between 2 – 24 hours is predicted to occur 4.99 x 10^{-3} times per reactor year, therefore in terms of the SZC site it is predicted to occur 0.6 times during the site's 60 year operational lifetime (taking into account the 2 reactors). Such an event is therefore not likely to occur at all."

It is therefore possible to conclude **no damage** to the features of the Minsmere-Walberswick Heaths and Marshes SSSI from the short-term effects of NOx due to a LOOP event.

Nutrient enrichment

The assessment of nutrient deposition at Minsmere-Walberswick Heaths and Marshes SSSI is based upon the broad habitat groups identified in 3.5.1. of this report. Critical loads and background levels were obtained from APIS on 9 September 2021. Background levels are for the midyear of 2018, with total N deposition to moorland or forest used dependent upon habitat type assessed at the closest point (5km gridsquare) to SZC.

Critical loads are not available for the following features:

- invertebrate assemblage
- vascular plant assemblage
- variety of breeding bird species (70)
- variety of passage bird species (150)
- variety of wintering bird species (90)
- lowland damp grasslands
- supralittoral sediment (Rumex crispus – Glaucium flavum shingle community)
- bearded tit
- Cetti's warbler
- red-tipped cudweed

The following features are not sensitive to the effects of nutrient enrichment either directly, or through impacts on their supporting habitats:

- Phragmites australis swamp and reed-beds
- Carex acutiformis swamp
- garganey

The lower end of the critical loads presented in Table 22 is used in the assessment, with the maximum PC at the SSSI and highest background deposition rate used to represent worst-case scenario.

Nutrient enrichment was modelled at the following points within the SSSI, representative of the terrestrial features of the SSSI:

- E2b – coastal stable dunes, NGR 647639, 264809
- E2c – dry heath dwarf shrub heath, NGR 647530, 264525
- E2d – fen, marsh and swamp (rush pasture), NGR 647382, 264592
- E2e – fen, marsh and swamp (swamp and reed beds), NGR 647106, 266290
- E2f – littoral sediment, NGR 649540, 274132

Modelling point E2f is greater than 2km from SZC and is therefore not relevant for consideration in this assessment.

The results of worst-case modelling scenarios for commissioning and routine testing of DGs are provided in Table 21and Table 22.

Table 21: Assessment of nutrient enrichment, Minsmere-Walberswick Heaths and Marshes SSSI, commissioning

Notable feature	Critical load range (KgN/ha/yr)	PC (KgN/ha/yr)	PC >1% CL	Background	PEC (KgN/ha/yr)	PEC > 70%
Coastal stable dunes E2b	8 - 15	0.44	Yes 6%	13.8	14.24	Yes 178%
Dwarf shrub heath E2c	10 - 20	1.14	Yes 11%	13.8	14.94	Yes 149%
Fen, marsh and swamp E2d	15 - 25	1.09	Yes 7.3%	13.8	14.89	Yes 99%
Fen, marsh and swamp E2e	15 - 30	0.07	No 0.5%	N/A	N/A	N/A

The PC is predicted to be less than 1% of the critical load for the broad habitat fen, marsh and swamp at modelling point E2e. This is an area of swamp and reed beds.

As the maximum PC is predicted to be more than 1% of the relevant critical loads at modelling points E2b, c and d, further assessment needs to be carried out on the deposition of nutrient nitrogen from the commissioning of SZC.

Table 22: Assessment of nutrient enrichment, Minsmere-Walberswick Heaths and Marshes SSSI, routine operation

Notable feature	Critical load Range (KgN/ha/yr)	PC (KgN/ha/yr)	PC >1% CL	Background	PEC (KgN/ha/yr)	PEC > 70%
Coastal stable dunes **E2b**	8 - 15	0.13	Yes 2%	13.8	13.93	Yes 174%
Dwarf shrub heath **E2c**	10 - 20	0.33	Yes 3%	13.8	14.13	Yes 141%
Fen, marsh and swamp **E2d**	15 - 25	0.31	Yes 2%	13.8	14.11	Yes 94%
Fen, marsh and swamp **E2e**	15 - 30	0.02	No 0.1%	N/A	N/A	N/A

The PC is predicted to be less than 1% of the critical load for the broad habitat fen, marsh and swamp at modelling point E2e. This is an area of swamp and reed beds.

As the maximum PC is predicted to be more than 1% of the relevant critical loads at modelling points E2b, c and d, further assessment needs to be carried out on the deposition of nutrient nitrogen from the routine operation of SZC.

Detailed assessment

Nutrient enrichment was re-modelled at the following points within the SSSI:

- E2b – coastal stable dunes, NGR 647639, 264809
- E2c – dwarf shrub heath, NGR 647530, 264525
- E2d – fen, marsh and swamp, NGR 647382, 264592

Commissioning

For commissioning, the Schedule 5 response (EDF, 2021) states that "The model has been run assuming that all DGs are operational continuously, and the emission rate has been factored for the anticipated commissioning hours for the EDGs of 242.5 each (242.5/8760 = 2.8%) and for the UDGs 738 hours each (738/8760 = 8.4%). Commissioning of unit 1 DGs and unit 2 DGS are anticipated to occur in separate years, and therefore all unit 1 DGs have been assessed operating together, and all unit 2 DGs have been assessed as operating together. The worst-case results from unit 1 and unit 2 have then been reported."

The results of the detailed, more realistic modelling are provided in Table 23

Table 23: Detailed assessment of nutrient enrichment, Minsmere-Walberswick Heaths and Marshes SSSI, 12 diesel generators factored for commissioning hours

Notable feature/ modelling point	Critical load range (KgN/ha/yr)	PC (KgN/ha/yr)	PC % CL	Background	PEC (KgN/ha/yr)	PEC % CL
Coastal stable dunes **E2b**	8 - 15	0.18	2%	13.8	13.98	175%
Dwarf shrub heath **E2c**	10 - 20	0.44	4%	13.8	14.24	142%
Fen, marsh and swamp **E2d**	15 - 25	0.39	3%	13.8	14.19	95%

It is possible to conclude **no damage** to the fen, marsh and swamp (E2d) habitat features, from the deposition of the nutrient nitrogen during commissioning. The PEC is not predicted to exceed the minimum critical load of 15kg N/ha/yr, which is based on "expert judgement" when no empirical data were available for the ecosystem and the nitrogen critical load was based on expert judgement and knowledge of comparable ecosystems.

Critical loads are based on an annual average quantity, the critical loads for nitrogen deposition are based on an assumption of exposure to nutrient loadings of 20 to 30 years (Air Quality Advice Note 2021). Commissioning is expected to last for a period of 2 years, with the 2 reactor units being commissioned separately, for a prescribed length of time (as described in Scenario 1 – Commissioning).

Background levels of nutrient nitrogen within the SSSI already exceed the minimum critical load for dwarf shrub heath habitat, and coastal stable dunes, whereas background deposition is below the minimum critical load for the fen, marsh and swamp feature.

It is not expected that an additional maximum modelled nutrient-nitrogen contribution, ranging between 2% of the critical load for coastal stable dunes ("quite reliable" critical load), and 4% of the critical loads for dwarf shrub heath ("reliable" critical load), will directly lead to measurable damage of its features over the limited period of 2 years. In addition, the predicted concentrations will not be experienced over the entire SSSI, but will be localised, reducing beyond the modelling points.

As deposition is predicted to be low and localised and in the context of already exceeded critical loads, it is not expected that there will be a measurable cumulative or residual effect from the two-year commissioning of SZC.

The applicant did not assess deposition on the woodland feature of the SSSI. The closest SSSI units to SZC are 54 and 112, neither of these units have broadleaved, mixed and yew woodland as the main habitat feature. The closest SSSI unit with broadleaved, mixed and yew woodland as a main habitat type is located at more than 2km from SZC.

Acid grassland has the same critical load range as coastal stable dunes, 8 to 15kg N/ha/yr, the closest area of acid grassland is within Unit 55 of the SSSI at approximately 1km from SZC. Deposition from SZC will therefore be less than that predicted at modelling point E2b (coastal stable dunes).

It is possible to conclude **no damage** to the habitat features and the species they support from the deposition of the nutrient nitrogen during commissioning of SZC at Minsmere-Walberswick Heaths and Marshes SSSI.

Routine operation

For the routine operation of SZC the Schedule 5 response (EDF, 2021) provides the following, "The routine operation assessment was based on the assumption of one EDG operating continuously throughout the year, with pro-rata emissions based on 720 hours of annual operation.

The twelve DGs are spread over a relatively large area, with approximately 500m between the most northerly positioned DGs and the most southerly positioned DGs. The DGs that are closest to a specific receptor will result in the maximum impacts at that receptor, whilst the DGs furthest away will result in lower impacts at the same receptor.

The assessment presented in Appendix C of the Environmental Permit application (EDF, 2020a) reported impacts at each receptor based on the operation of the EDG that resulted in the highest impact at that receptor (i.e. the closest EDG, as detailed above), rather than taking into account that the operation of that EDG would only actually be for 60 hours, and operation of EDGs leading to lower results would account for a large proportion of the testing hours.

In addition, no consideration was given in the assessment to the fact that the four smaller Ultimate Diesel Generators (UDGs) have much lower emissions of NOx. Therefore, of the 720 hours of annual operation for the routine testing scenario, 480 hours would be associated with EDG operation, but 240 hours would be associated with UDG operation and therefore would result in considerably lower impacts due to the much lower NOx emissions of these units."

The applicant carried out further modelling to represent the most realistic scenario during the operational lifetime of SZC, as set out in 3.7.1. The results are presented in Table 24.

Table 24: Detailed assessment of nutrient enrichment, Minsmere-Walberswick Heaths and Marshes SSSI, routine testing based upon 12 DGs factored for 60 hours operation each

Notable feature/ modelling point	Critical load range (KgN/ha/yr)	PC (KgN/ha/yr)	PC % CL	Background	PEC (KgN/ha/yr)	PEC % CL
Coastal stable dunes **E2b**	8 - 15	0.06	0.8%	N/A	N/A	N/A
Dwarf shrub heath **E2c**	10 - 20	0.14	1%	13.8	13.94	139%
Fen, marsh and swamp **E2d**	15 - 25	0.12	0.8%	N/A	N/A	N/A

It is possible to conclude **no damage** to the following features of the SSSI as modelled deposition is considered to be inconsequential at below 1% of the relevant critical loads:

- fen, marsh and swamp habitat features
- coastal stable dunes

Deposition is predicted to be 1.4% of the minimum critical load for dwarf shrub heath, the applicant states that modelling point E2c is "scrub encroached, suggesting a lack of management in some locations according to the Natural England condition assessment, so some scrub management would probably counteract any slight increase in N-deposition. Existing nitrogen deposition already far exceeds the minimum critical load for this habitat such that additional nitrogen will have a limited effect as there is likely to already be ample nitrogen for more competitive plants to respond. Therefore, any botanical effect, while it might occur, is likely to be significantly less than it would be if background nitrogen deposition rates were lower. This is supported by Natural England's Commissioned Report 210 (Caporn and others, 2016), Table 21 and Appendix 5, which show that the scale of change in various parameters from adding a given dose of nitrogen is smaller when the existing deposition rates are higher." (EDF, 2021)

The closest lowland heathland habitat as listed in the Priority Habitat Inventory, is located at more than 900m from the location of SZC (Figure 5). Deposition at this distance from SZC will be inconsequential.

Acid grassland has the same critical load range as coastal stable dunes, 8 to 15kg N/ha/yr, the closest area of acid grassland is within Unit 55 of the SSSI. Deposition from SZC will be less than that predicted at modelling point E2b (coastal stable dunes), and will be inconsequential, located beyond the 0.05kg N/ha/yr isopleth.

The nitrogen deposition isopleths provided in Figure 4 illustrate the localised nature of the deposition of nutrient nitrogen during the routine operation of SZC.

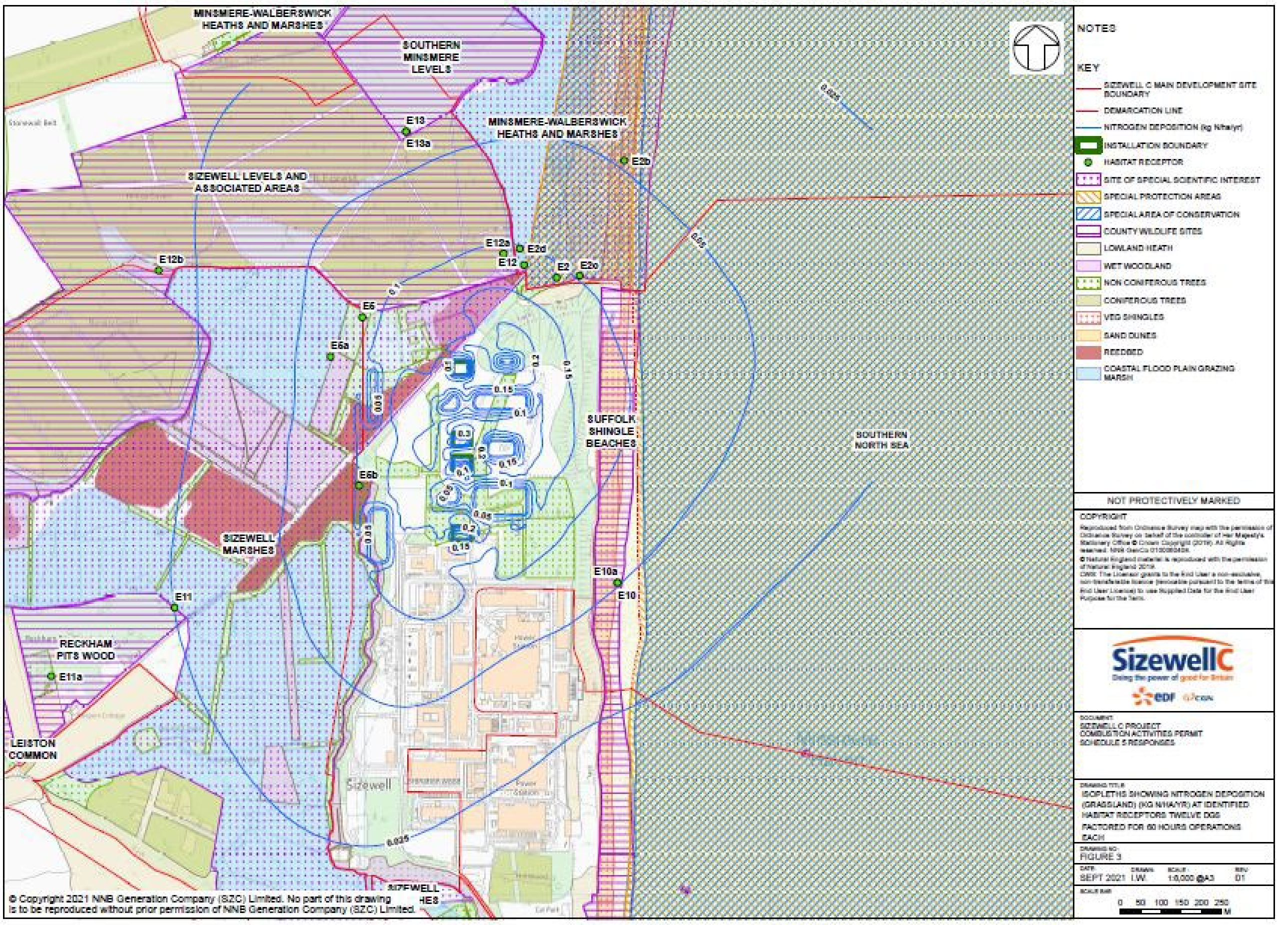


Figure 4: Isopleths showing nitrogen deposition (kg N/ha/yr) at identified habitat receptors based upon 12 DGs factored for 60 hours operation each

MAGIC

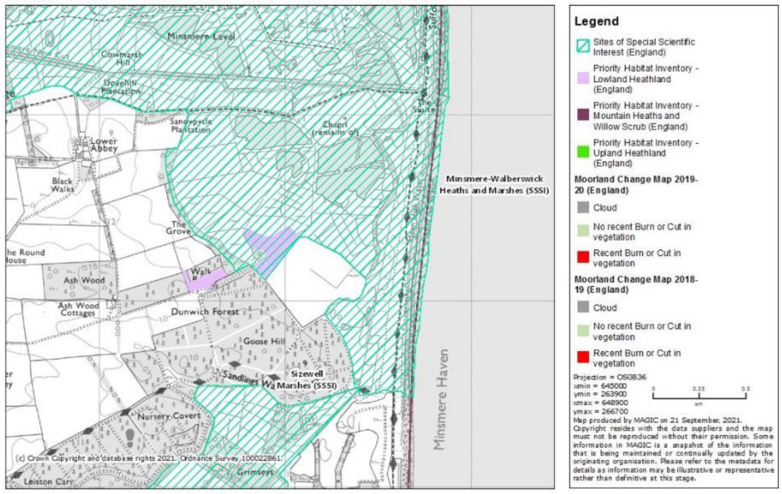


Figure 5: Map showing the location of lowland heathland within Minsmere-Walberswick Heaths and Marshes SSSI from the priority habitat inventory. Source MagicMap

It is possible to conclude **no damage** to the dwarf shrub heath feature of the Minsmere-Walberswick Heaths and Marshes SSSI from the deposition of nitrogen.

LOOP

No quantitative assessment was carried out for a LOOP scenario in the permit application.

The LOOP scenario is not expected to happen during the lifetime of the plant, the Schedule 5 Notice response (EDF, 2021) states that “Such an event is not intended to occur at all, is statistically unlikely to occur more than once in the plant design life and in such an event is likely to last for well under 24-hours.”

There is no potential for a LOOP scenario to result in long-term nutrient enrichment, it is therefore possible to conclude **no damage** to the interest features of the Minsmere-Walberswick Heaths and Marshes SSSI from a LOOP scenario.

Acidification

The assessment of acidification at Minsmere-Walberswick Heaths and Marshes SSSI is based upon the broad habitat groups identified in 3.5.1., critical loads and background levels were obtained from APIS on 18 August 2021.

The following features are not sensitive to the effects of acidification either directly, or indirectly through impacts on their supporting habitats:

- avocet (Recurvirostra avosetta)
- bittern (Botaurus stellaris)
- Cetti's warbler (Cettia cetti)
- garganey (Anas querquedula)

- marsh harrier (Circus aeruginosus)
- S7 - Carex acutiformis swamp
- S2 - Cladium mariscus swamp and sedge-beds
- S26 - Phragmites australis - Urtica dioica tall-herb fen
- S4 - Phragmites australis swamp and reed-beds
- SD1 - Rumex crispus - Glaucium flavum shingle community

There are no acid critical loads assigned for the following features:

- bearded tit (Panurus biarmicus)
- SD11 - Carex arenaria - Cornicularia aculeate*,* dune community
- SD12 - Carex arenaria - Festuca ovina - Agrostis capillaris dune grassland
- SM14 - Atriplex portulacoides saltmarsh
- SM24 - Elytrigia atherica saltmarsh
- population of Schedule 8 plant - Filago lutescens, red-tipped cudweed
- invertebrate assemblage
- vascular plant assemblage
- variety of breeding bird species (70)
- variety of passage bird species (150)
- variety of wintering bird species (90)
- lowland damp grasslands
- lowland ditch systems
- saline coastal lagoons
- sheltered muddy shores (including estuarine muds)

The minimum critical load functions are used in the assessment, with the maximum PC at the SSSI and highest background deposition rate used to represent worst-case scenario.

Acidification was modelled at the following points within, the SSSI:

- E2b – coastal stable dunes, NGR 647639, 264809
- E2c – dry heath dwarf shrub heath, NGR 647530, 264525
- E2d – fen, marsh and swamp (rush pasture), NGR 647382, 264592
- E2e – fen, marsh and swamp (swamp and reed beds), NGR 647106, 266290

Table 25: Assessment of process contribution of acidification, Minsmere-Walberswick Heaths and Marshes SSSI, commissioning

Notable feature	minCLMinN Keq/ha/yr	minCLMaxN Keq/ha/yr	minCLMaxS Keq/ha/yr	PC N keq/ha/yr	PC S keq/ha/yr	PC>1% CL
Coastal stable dunes **E2b**	0.223	0.568	0.202	0.03	0.02	Yes 9%
Dwarf shrub heath **E2c**	0.714	1.237	0.202	0.08	0.05	Yes 11%
Fen, marsh and swamp **E2d**	0.223	0.568	0.202	0.08	0.04	Yes 21%
Fen, marsh and swamp **E2e**	0.223	0.568	0.202	0.005	0.003	Yes 1%

As the PCs are in excess of 1% of the critical load function for acidification, consideration of the PEC is needed for each vulnerable feature.

Table 26: Assessment of predicted environmental concentration of acidification, Minsmere-Walberswick Heaths and Marshes SSSI, commissioning

Notable feature	Background N keq/ha/yr	Background S keq/ha/yr	PEC N keq/ha/yr	PEC S keq/ha/yr	PEC > 70%CL
Coastal stable dunes **E2b**	1.0	0.1	1.03	0.21	Yes 203%
Dwarf shrub heath **E2c**	1	0.1	1.08	0.15	Yes 99%
Fen, marsh and swamp **E2d**	1	0.1	1.08	0.14	Yes 215%
Fen, marsh and swamp **E2e**	1	0.1	1.01	0.1	Yes 195%

The PECs are > 70% of the critical load functions, therefore further assessment of acidification from the commissioning of SZC is required.

Table 27: Assessment of process contribution of acidification, Minsmere-Walberswick Heaths and Marshes SSSI, for routine testing

Notable feature	Min CLMinN Keq/ha/yr	Min CLMaxN Keq/ha/yr	Min CLMaxS Keq/ha/yr	PC N keq/ha/yr	PC S keq/ha/yr	PC>1 % CL
Coastal stable dunes **E2b**	0.223	0.568	0.202	0.009	0.005	Yes 2%
Dwarf shrub heath **E2c**	0.714	1.237	0.202	0.02	0.01	Yes 2%
Fen, marsh and swamp **E2d**	0.223	0.568	0.202	0.02	0.01	Yes 5%
Fen, marsh and swamp **E2e**	0.223	0.568	0.202	0.001	0.0008	No 0%

It is possible to conclude **no damage** to the fen, marsh and swamp (swamp and reed beds) feature of the Minsmere-Walberswick Heaths and Marshes SSSI, the PC is predicted to be <1% of the critical load function.

The remaining PCs are in excess of 1% of the critical load function for acidification, therefore consideration of the PEC is needed for coastal stable dunes, dwarf shrub heath and fen, marsh and swamp (fen pasture).

Table 28: Assessment of predicted environmental concentration of acidification, Minsmere-Walberswick Heaths and Marshes SSSI, for routine testing

Notable feature	Background N keq/ha/yr	Background S keq/ha/yr	PEC N keq/ha/yr	PEC S keq/ha/yr	PEC > 70%CL
Coastal stable dunes **E2b**	1	0.1	1.01	0.11	Yes 196%
Dwarf shrub heath **E2c**	1	0.1	1.02	0.11	Yes 91%
Fen, marsh and swamp **E2d**	1	0.1	1.02	0.11	Yes 199%

The PECs are >70% of the critical load functions, therefore further assessment of acidification is required from the routine testing of DGs during the operation of SZC.

Detailed assessment

The modelling assumptions used by the applicant to represent a more realistic commissioning and operating scenario are set out in section 3.6.1.

Commissioning

For commissioning, the Schedule 5 Notice response (EDF, 2021) states that “The model has been run assuming that all DGs are operational continuously, and the emission rate has been factored for the anticipated commissioning hours for the EDGs of 242.5 each (242.5/8760 = 2.8%) and for the UDGs 738 hours each (738/8760 = 8.4%). Commissioning of Unit 1 DGs and Unit 2 DGS are anticipated to occur in separate years, and therefore all Unit 1 DGs have been assessed operating together, and all Unit 2 DGs have been assessed as operating together. The worst-case results from Unit 1 and Unit 2 have then been reported.”

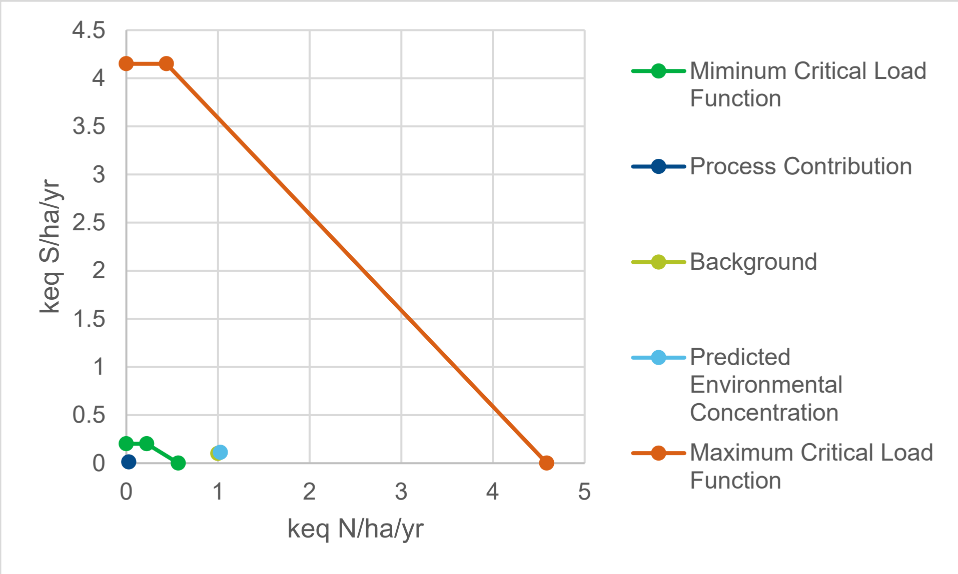
The results of the detailed, more realistic modelling are provided in Table 29.

Table 29: Detailed assessment of acidification, Minsmere-Walberswick Heaths and Marshes SSSI, 12 diesel generators factored for commissioning hours

Notable feature	PC N keq/ha/yr	PC S keq/ha/yr	PC % CL	PEC %CL
Coastal stable dunes **E2b**	0.013	0.006	3%	197%
Fen, marsh and swamp **E2d**	0.028	0.012	7%	201%
Fen, marsh and swamp **E2e**	0.002	0.001	0%	194%

The modelling of more realistic operating scenarios has resulted in a reduction in modelled process contributions of both N and S. Figure 6 shows the process contribution, background and predicted environmental concentration plotted against the minimum and maximum critical load functions for modelling point E2d, which is predicted to have the highest impact from SZC commissioning, at 7% of the minimum critical load function. The PC is well below the minimum critical load function, and the PEC is within the critical load range.

Figure 6: PC, background and PEC in relation to the critical load functions at modelling point E2d, fen, marsh and swamp



This represents the maximum acidification within the SSSI, as with nitrogen deposition, the PC will decrease with distance from SZC.

Information on APIS on the effects and implications of acid deposition on fen, marsh and swamp habitats states that "There is a paucity of data on acid deposition effects on this habitat type but it can be assumed that where non vascular plants are present these might be sensitive, especially to N enrichment." The Applicant concludes in their Schedule 5 Notice response (EDF, 2021) that "Non-vascular plants are not a core feature of the habitats in this SSSI. Given that there is no strong evidence that acid deposition on these habitats is negative, that other factors are far more likely to influence the botanical composition of the sward and that the critical load is already so far exceeded that the further acid deposition forecast for this project is a relatively small difference, the ecological effect is likely to be minimal."

The maximum PC predicted at modelling point E2b is 3% of the minimum critical load function for stable coastal dunes. APIS states that "Soil acidification as a result of acid deposition has relatively little impact in UK dunes because sand dune soils are generally well-buffered, with the exception of the few acidic dune systems...Sand dune habitats are one of the most natural remaining vegetation types in the UK, supporting over 70 nationally rare or red-data book species. In sand dunes, decalcification (in response to rainfall) reduces pH and this has the strongest influence upon forb diversity for this habitat. The majority of dune systems in the UK are calcareous, well buffered and low in heavy metals so should be tolerant of acid deposition."

The applicant did not model the effects of acidification on the acid grassland feature of the SSSI. However, the coastal stable dunes and fen, marsh and swamp features have the same critical load function as acid grassland, with a PC of 7% of the critical load function. The closest area of acid grassland is within Unit 55 of the SSSI. Deposition from SZC will therefore be less than that predicted at modelling point E2d.

The applicant did not assess deposition on the woodland feature of the SSSI. The closest SSSI units to SZC are 54 and 112, neither of these units have broadleaved, mixed and yew woodland as the main habitat feature. The closest SSSI unit with broadleaved, mixed and yew woodland as a main habitat type is located at more than 2km from SZC.

It is not expected that acidification from the commissioning of SZC would result in measurable damage on the features of Minsmere-Walberswick Heaths and Marshes SSSI, given the expected reduction in acidification with distance from SZC.

Commissioning will only take place over 2 years, pre-operation, as set out in section 3.3.

Routine operation

The applicant carried out further modelling to represent the most realistic scenario during the operational lifetime of SZC, as set out in 3.7.1., the results are presented in Table 30.

Table 30: Detailed assessment of acidification, Minsmere-Walberswick Heaths and Marshes SSSI, routine testing based upon 12 DGs factored for 60 hours operation each

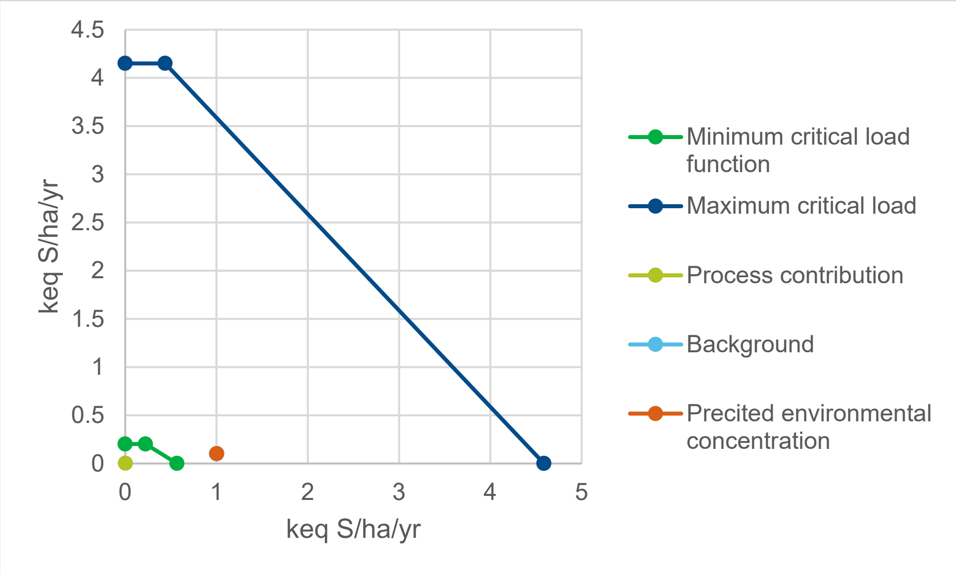
Notable feature	PC N keq/ha/yr	PC S keq/ha/yr	PC % CL	PEC %CL
Coastal stable dunes E2b	0.004	0.002	3%	197%
Dwarf shrub heath E2c	0.01	0.005	1%	90%
Fen, marsh and swamp E2d	0.005	0.003	1%	195%

It is possible to conclude **no damage** to the dwarf shrub heath feature of the SSSI, the maximum PEC is predicted to be below the minimum critical load function.

The maximum PC for acidification is at modelling point E2b, coastal stable dunes, which is 3% of the minimum critical load function, and is located at approximately 320m within the SSSI. Levels of acidification will drop further beyond this point, in line with reductions experienced in nutrient nitrogen deposition as shown in Figure 4.

Figure 7 shows that the maximum predicted PC is well below the minimum critical load function for coastal stable dunes, and that the PEC is within the critical load range.

Figure 7: PC, background and PEC in relation to the critical load functions for modelling point E2b, coastal stable dunes



As stated in the commissioning assessment, the “majority of dune systems in the UK are calcareous, well buffered and low in heavy metals so should be tolerant of acid deposition.”

The PC is predicted to be 1% of the minimum critical load function for fen, marsh and swamp (rush pasture) at modelling point E2b. This is approximately 100m within the SSSI boundary, again demonstrating the expected localised effects of SZC on Minsmere-Walberswick Heaths and Marshes SSSI.

It is possible to conclude **no damage** to the features of Minsmere-Walberswick Heaths and Marshes SSSI due to acidification from the routine operation of SZC.

LOOP

No quantitative assessment was carried out for a LOOP scenario in the permit application.

The LOOP scenario is not expected to happen during the lifetime of the plant, the Schedule 5 Notice response (EDF, 2021) states that “Such an event is not intended to occur at all, is statistically unlikely to occur more than once in the plant design life and in such an event is likely to last for well under 24-hours.”

There is no potential for a LOOP scenario to result in long-term acidification, it is therefore possible to conclude **no damage** to the interest features of the Minsmere-Walberswick Heaths and Marshes SSSI from a LOOP scenario.

Conclusion

It has been possible to conclude no damage to the broad habitats of the Minsmere-Walberswick Heaths and Marshes SSSI, and the species that they support, from the commissioning and routine operation of EDG and UDG at Sizewell C.

While there are aerial pathways of effect from the commissioning and routine testing of the DGs at Sizewell C, and sensitive receptors within the SSSI, it has been determined in this assessment under Section 28I of the Wildlife and Countryside Act 1981 (as amended by the Countryside and Rights of Way Act (CRoW) 2000) that the potential scale or magnitude of any effect **would not result in an operation likely to damage the features of the SSSI**.

Aggregations of breeding birds:

- avocet (Recurvirostra avosetta)
- bearded tit (Panurus biarmicus)
- bittern (Botaurus stellaris)
- Cetti's warbler (Cettia cetti)
- garganey (Anas querquedula)
- marsh harrier (Circus aeruginosus)

Supralittoral sediment:

- SD1 - Rumex crispus - Glaucium flavum shingle community
- SD2 - Cakile maritima - Honkenya peploides strandline community
- SD6 - Ammophila arenaria mobile dune community
- SD11 - Carex arenaria - Cornicularia *aculeate*, dune community
- SD12 - Carex arenaria - Festuca ovina - Agrostis capillaris dune grassland
- SD6 - Ammophila arenaria mobile dune community

Dwarf shrub heath:

- H1 - Calluna vulgaris - Festuca ovina heath
- H8 - Calluna vulgaris - Ulex gallii heath

Fen, marsh and swamp habitats:

- M22 - Juncus subnodulosus - Cirsium palustre fen meadow (no broad habitat assigned within APIS for acidification, acidity class is acid grassland)
- M23 - Juncus effusus/acutiflorus - Galium palustre rush pasture (no broad habitat assigned within APIS for acidification, acidity class is acid grassland)
- M27 - Filipendula ulmaria - Angelica sylvestris mire (no broad habitat assigned within APIS for acidification, acidity class is acid grassland)
- S2 - Cladium mariscus swamp and sedge-beds
- S26 - Phragmites australis - Urtica dioica tall-herb fen
- S4 - Phragmites australis swamp and reed-beds
- S7 - Carex acutiformis swamp

Littoral sediment:

- SM14 - Atriplex portulacoides saltmarsh

- SM24 - Elytrigia atherica saltmarsh

Acid grassland:

- U1 b,c,d,f - Festuca ovina - Agrostis capillaris - Rumex acetosella grassland

Broadleaved, mixed and yew woodland:

- W6 - Alnus glutinosa - Urtica dioica woodland

Assemblages:

- invertebrate assemblage
- vascular plant assemblage
- variety of breeding bird species (70)
- variety of passage bird species (150)
- variety of wintering bird species (90)

Other habitat features:

- lowland ditch systems
- lowland damp grasslands
- saline coastal lagoons
- sheltered muddy shores (including estuarine muds)
- population of Schedule 8 plant - Filago lutescens, Red-tipped Cudweed

Detailed assessment of the expected commissioning and operational scenarios have demonstrated that emissions of NOx and SO_2, and resultant deposition will be localised covering a small area of the SSSI.

A conclusion of no damage can also be drawn for species that are vulnerable to impacts on their broad habitat type, including bittern, marsh harrier, garganey and avocet.

3.7.3. Sizewell Marshes SSSI

Direct toxic effects

The results of modelling carried out by applicant for the commissioning and routine operation of SZC are provided in Table 31and Table 32, with the exception of short-term effects of NOx. The applicant did not model for short-term effects during commissioning, stating that emissions would not occur over a 24-hour period. AQMAU modelling has therefore been used to inform the commissioning short-term NOx assessment.

These results have been used to assess if a detailed assessment is required to determine whether there will be damage to the features of the SSSI and are taken from Appendix C – Air Quality Modelling Assessment (EDF, 2020a).

Table 31: Assessment of direct toxic effects, Sizewell Marshes SSSI, commissioning

Pollutant	Critical level (µg/m^3)	PC (µg/m^3)	PC >Y% CL	Background	PEC (µg/m^3)	PEC > 70% CL
NOx (long term)	30	3.9	Yes 13%	12.58	16.48	No 55%
NOx (short term)	75	251.5	Yes 335%	N/A	N/A	N/A
SO_2	20	0.1	No 0.5%	N/A	N/A	N/A

Y = 1%, long term; 10% short term NOx

It is possible to conclude **no damage** to the features of the SSSI from the direct toxic effects of emissions of SO_2 and the long-term effects of NOx emissions during the commissioning of SZC.

Further assessment is required for the short-term effects of NOx.

Table 32: Assessment of direct toxic effects, Sizewell Marshes SSSI, routine operation

Pollutant	Critical level (µg/m^3)	PC (µg/m^3)	PC >Y% CL	Background	PEC (µg/m^3)	PEC > 70% CL
NOx (long term)	30	1.1	Yes 4%	9.6	10.7	No 36%
NOx (short term)	75	327.5	Yes 437%	N/A	N/A	N/A
SO_2	20	0.04	No 0.2%	N/A	N/A	N/A

Y = 1%, long term; 10% short term NOx

It is possible to conclude **no damage** to the features of the SSSI from the direct toxic effects of emissions of SO_2 and the long-term effects of NOx emissions during the routine operation of SZC.

Further assessment is required for the short-term effects of NOx.

Detailed assessment

Guidance on the assessment of the short-term effects of NOx emissions (Holman and others, 2020) states that:

"The relative importance of the long-term mean compared to the short-term mean is reflected in several studies which state that the 'UNECE Working Group on Effects strongly recommended the use of the annual mean value, as the long term effects of NOx are thought to be more significant than the short term effects'. This guidance, therefore, recommends that only the annual mean NOx concentration is used in assessments unless specifically required by a regulator; for instance, as part of an industrial permit application where high, short-term peaks in emissions, and consequent ambient concentrations, may occur."

It is therefore appropriate to give some consideration to the short-term effects of NOx, the probability of them occurring and the area over which they will occur.

Commissioning and routine operation

The applicant has proposed that its PCs predicted for routine testing be used for commissioning as well. The worst-case scenario during commissioning involves simulating a LOOP event, whereby 4 EDGs are tested simultaneously for a 3-hour period. This scenario emits less NO_x over a 24-hour period compared to the worst-case scenario during routine testing, which involves testing a single generator for 24 hours following a maintenance outage. Therefore, using routine testing PCs for commissioning is likely to be more conservative.

The applicant has calculated the probability of exceedances actually happening, stating that: “This found that (assuming 100% operation of an Emergency Diesel Generator (EDG)) the daily NOx Critical Level is exceeded up until the 80th percentile for the worst-case year of met data, and therefore an exceedance of the Critical Level could only occur for 20% of the time. As the DGs are only operational for 8% of hours (720 ÷ 8760) for planned annual routine operation, this results in a probability of the unfavourable met conditions and the DG operation occurring at the same time having a 1.6% chance of actually occurring (20% x 8% = 1.6%).”

However, AQMAU considers that this is this incorrect because an exceedance of the daily critical level could occur if one or more exceedance days coincides with any of the 30 operational days (Environment Agency, 2021b). AQMAU have calculated the probability of one or more exceedances of the daily NOx critical level at habitat sites occurring during any year of routine testing. Based on the consultant’s 73 exceedance days per year with 30 operational events per year, AQMAU calculates the probability of one or more exceedances to be approximately 99.9%.

The PC for routine testing of DGs is predicted to be a maximum of 307.4μg/m^3 at modelling point E4. The PC will reduce with distance from the emission points, as illustrated in Figure 3.

The highest contribution to the exceedance of the short-term 75μg/m^3 critical level is within the area of the SSSI to the north of SZC, within Unit 2, Goodram’s Fen. Goodram’s Fen (Figure 8) will be permanently lost as a result of the construction of SZC, with compensatory habitat having been created at Aldhurst Farm, which is located at more than 2km from SZC.

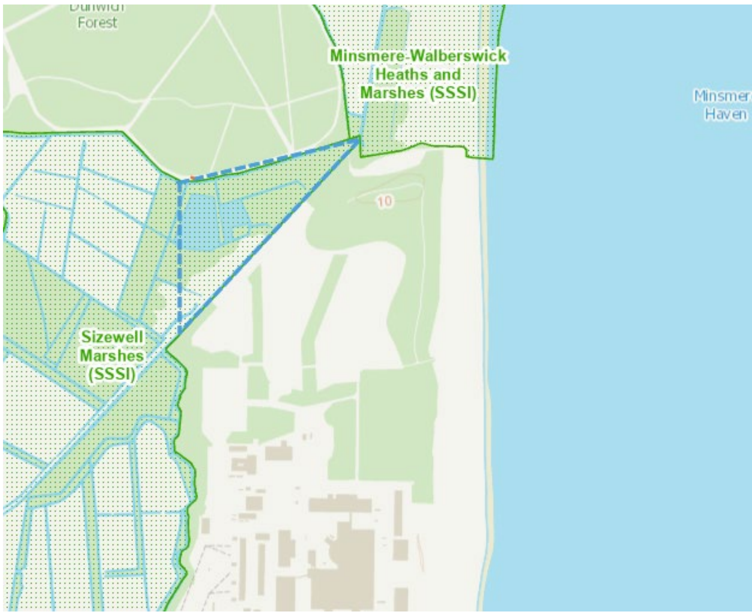


Figure 8: Goodram's Fen approximate shown in dashed-blue line, indicative area within Sizewell Marshes SSSI lost to SZC construction

An exceedance of the short-term critical level is predicted to occur outside of Goodram Fen within the functionally linked land at Sizewell Marshes SSSI. However, as stated above, this assessment is based upon the worst-case operational scenario, without factoring the 60 hours of operation for each generator, the location of the generators within the SZC development, or the relative importance of the long-term mean compared to the short-term mean.

It is therefore possible to conclude **no damage** to the features of the Sizewell Marshes SSSI from the short-term effects of NOx during the commissioning and routine operation of SZC.

LOOP

The applicant provided an assessment of the LOOP scenario at the Sizewell Marshes SSSI in section 2.2.2 of the Schedule 5 Notice response (EDF, 2021).

The applicant has predicted that, based upon the modelled assumption that 8 EDGs are operational concurrently, continuously throughout the year (ensuring that the assessment takes account of the meteorological conditions that result in the worst-case impacts) the PC will be 827.3µg/m^3. This is 1,103% of the daily CL of 75µg/m^3 and 414% of the daily 200µg/m^3 CL.

While these exceedances are extreme, the LOOP scenario is not expected to happen during the lifetime of the plant, with the applicant predicting that a long LOOP scenario will only occur 0.6 times (EDF, 2021).

It is therefore possible to conclude **no damage** to the features of the Sizewell Marshes SSSI from the short-term effects of NOx due to a LOOP event.

Nutrient enrichment

The assessment of nutrient deposition at Sizewell Marshes SSSI is based upon the broad habitat groups identified in section 3.5.2. Sizewell Marshes SSSI, critical loads and background levels were obtained from APIS on 18 August 2021.

Critical loads are not available for the following features:

- vascular plant assemblage
- assemblages of breeding birds - lowland damp grasslands
- invertebrate assemblage

The following feature is not sensitive to the effects of nutrient enrichment:

- Phragmites australis swamp and reed-beds

The following critical loads have been assigned to the remaining SSSI features:

- M22 - Juncus subnodulosus - Cirsium palustre fen meadow: rich fens, 15 to 30kg N/ha/yr
- M23 - Juncus effusus/acutiflorus - Galium palustre rush pasture: moist and wet oligotrophic wetlands, 15 to 25kg N/ha/yr

The lower end of the critical loads is used in the assessment, with the maximum PCs at the SSSI and total N deposition to grid average background deposition rate used to represent worst-case scenario.

Nutrient enrichment was modelled at the following points within the SSSI, representative of the features of the SSSI:

- 5a – fen marsh and swamp (rich fens), NGR 646916, 264326
- 5b – fen marsh and swamp (rush pasture), NGR 646986, 264008

The results of the worst-case modelling scenarios for commissioning and routine testing of DGs are provided in Table 33 and Table 34.

Table 33: Assessment of nutrient enrichment, Sizewell Marshes SSSI, commissioning

Notable feature	Critical load range (KgN/ha/yr)	PC (KgN/ha/yr)	PC >1% CL	Background	PEC (KgN/ha/yr)	PEC > 70%
Fen, marsh and swamp (rich fens) **E5a**	15 - 30	0.28	Yes 2%	13.8	14.08	Yes 94%
Fen, marsh and swamp (rush pasture) **E5b**	15 - 25	0.48	Yes 3%	13.8	14.28	Yes 95%

Detailed assessment of nutrient deposition to the Sizewell Marshes SSSI from the commissioning of SZC is therefore required.

Table 34: Assessment of nutrient enrichment, Sizewell Marshes SSSI, routine operation

Notable feature	Critical load range (KgN/ha/yr)	PC (KgN/ha/yr)	PC >1% CL
Fen, marsh and swamp (rich fens) **E5a**	15 - 30	0.09	No 0.6%
Fen, marsh and swamp (rush pasture) **E5b**	15 - 25	0.14	No 0.9%

It is possible to conclude **no damage** from the routine operation of SZC. Maximum deposition within the SSSI is predicted to be inconsequential at less than 1% of the minimum critical load for fen, marsh and swamp habitats.

Detailed assessment

Detailed modelling, representing a more realistic operating scenario as described in section 3.7.1., resulted in the results presented at points within, or close to, the SSSI, as provided in the Schedule 5 Notice response (EDF, 2021).

Commissioning

For commissioning, the Schedule 5 Notice response (EDF, 2021) states that "The model has been run assuming that all DGs are operational continuously, and the emission rate has been factored for the anticipated commissioning hours for the EDGs of 242.5 each (242.5/8760 = 2.8%) and for the UDGs 738 hours each (738/8760 = 8.4%). Commissioning of Unit 1 DGs and Unit 2 DGs are anticipated to occur in separate years, and therefore all Unit 1 DGs have been assessed operating together, and all Unit 2 DGs have been assessed as operating together. The worst-case results from Unit 1 and Unit 2 have then been reported."

The results of the detailed, more realistic modelling are provided in Table 35.

Table 35: Detailed assessment of nutrient enrichment, Sizewell Marshes SSSI, 12 diesel generators factored for commissioning hours

Notable feature	Critical load range (KgN/ha/yr)	PC (KgN/ha/yr)	PC >1% CL	Background	PEC (KgN/ha/yr)	PEC > 70%
Fen, marsh and swamp (rich fens) **E5a**	15 - 30	0.17	Yes 1%	13.8	13.97	Yes 93%
Fen, marsh and swamp (rush pasture) **E5b**	15 - 25	0.25	Yes 2%	13.8	14.05	Yes 94%

It is possible to conclude **no damage** to the features of the SSSI from the commissioning of SZC. The highest PC of 2% of the critical load is predicted to occur at modelling point 5b, which is at the boundary of Sizewell Marshes SSSI. The PEC is not expected to exceed the minimum critical loads.

LOOP

No quantitative assessment was carried out for a LOOP scenario in the permit application.

The LOOP scenario is not expected to happen during the lifetime of the plant, the Schedule 5 Notice response (EDF, 2021) states that "Such an event is not intended to occur at all, is statistically unlikely to occur more than once in the plant design life and in such an event is likely to last for well under 24-hours."

There is no potential for a LOOP scenario to result in long-term nutrient enrichment and acidification. It is therefore possible to conclude **no damage** to the interest features of the Sizewell Marshes SSSI from a LOOP scenario resulting in nutrient enrichment.

Acidification

The assessment of acidification at Sizewell Marshes SSSI is based upon the broad habitat groups identified in section 3.5.2., critical loads and background levels were obtained from APIS on 18 August 2021.

The following feature is not sensitive to the effects of acidification:

- Phragmites australis swamp and reed-beds

There are no acid critical loads assigned for the following features:

- vascular plant assemblage
- assemblages of breeding birds - lowland damp grasslands
- invertebrate assemblage

The minimum critical load functions are used in the assessment, with the maximum PC at the SSSI and highest background deposition rate used to represent worst-case scenario.

The acid grassland critical load function has been used for the features that are sensitive to acidification, these being:

- M22 - Juncus subnodulosus - Cirsium palustre fen meadow
- M23 - Juncus effusus/acutiflorus - Galium palustre rush pasture

Table 36: Assessment of process contribution of acidification, Sizewell Marshes SSSI, commissioning

Notable feature	minCLMinN Keq/ha/yr	minCLMaxN Keq/ha/yr	minCLMaxS Keq/ha/yr	PC N keq/ha/yr	PC S keq/ha/yr	PC>1% CL
Fen, marsh and swamp (rich fens) E5a	0.223	0.713	0.49	0.02	0.01	Yes 4%
Fen, marsh and swamp (rush pasture) E5b	0.223	0.713	0.49	0.04	0.02	Yes 8%

As the PCs are in excess of 1% of the critical load function for acidification, consideration of the PEC is needed for each vulnerable feature.

Table 37: Assessment of predicted environmental concentration of acidification, Sizewell Marshes SSSI, commissioning

Notable feature	Background N keq/ha/yr	Background S keq/ha/yr	PEC N keq/ha/yr	PEC S keq/ha/yr	PEC > CL
Fen, marsh and swamp (rich fens) **E5a**	1	0.1	1.02	0.11	Yes 159%
Fen, marsh and swamp (rush pasture) **E5b**	1	0.1	1.04	0.12	Yes 163%

The PECs are in excess of the critical load functions, therefore further detailed assessment is required for the commissioning of SZC.

Table 38: Assessment of process contribution of acidification, Sizewell Marshes SSSI, routine operation

Notable feature	Min CLMinN Keq/ha/yr	Min CLMaxN Keq/ha/yr	Min CLMaxS Keq/ha/yr	PC N keq/ha/yr	PC S keq/ha/yr	PC>1% CL
Fen, marsh and swamp (rich fens) **E5a**	0.223	0.713	0.49	0.006	0.004	Yes 1%
Fen, marsh and swamp (rush pasture) **E5b**	0.223	0.713	0.49	0.01	0.006	Yes 3%

As the PCs are in excess of 1% of the critical load function for acidification, consideration of the PEC is needed for each vulnerable feature.

Table 39: Assessment of predicted environmental concentration of acidification, Sizewell Marshes SSSI, commissioning

Notable feature	Background N keq/ha/yr	Background S keq/ha/yr	PEC N keq/ha/yr	PEC S keq/ha/yr	PEC > CL
Fen, marsh and swamp (rich fens) **E5a**	1	0.1	1.006	0.104	Yes 156%
Fen, marsh and swamp (rush pasture) **E5b**	1	0.1	1.01	0.106	Yes 157%

The PECs are in excess of the critical load functions, therefore further detailed assessment is required for the routine operation of SZC.

Detailed assessment

Detailed modelling, representing a more realistic operating scenario as described in section 3.7.1. was provided in the Schedule 5 response (EDF, 2021) at the following points:

- 5a – fen marsh and swamp (fen meadow), NGR 646916, 264326
- 5b – fen marsh and swamp (rush pasture etc), NGR 646986, 264008

Commissioning

For commissioning, the Schedule 5 Notice response (EDF, 2021) states that "The model has been run assuming that all DGs are operational continuously, and the emission rate has been factored for the anticipated commissioning hours for the EDGs of 242.5 each (242.5/8760 = 2.8%) and for the UDGs 738 hours each (738/8760 = 8.4%). Commissioning of Unit 1 DGs and Unit 2 DGs are anticipated to occur in separate years, and therefore all Unit 1 DGs have been assessed operating together, and all Unit 2 DGs have been assessed as operating together. The worst-case results from Unit 1 and Unit 2 have then been reported."

The results of the detailed, more realistic modelling are provided in Table 40.

Table 40: Detailed assessment of acidification, Sizewell Marshes SSSI, 12 diesel generators factored for commissioning hours

Notable feature	PC N keq/ha/yr	PC S keq/ha/yr	PC % CL	PEC %CL
Fen, marsh and swamp **E5a**	0.012	0.012	3%	157%
Fen, marsh and swamp **E5b**	0.018	0.018	4%	159%

The modelling of more realistic operating scenarios has resulted in a reduction in modelled process contributions of both N and S. Information on APIS on the effects and implications of acid deposition on fen, marsh and swamp habitats states that "There is a paucity of data on acid deposition effects on this habitat type but it can be assumed that where non vascular plants are present these might be sensitive, especially to N enrichment." The Applicant goes on to conclude in their Schedule 5 Notice response (EDF, 2021) that "Non-vascular plants are not a core feature of the habitats in this SSSI. Given that there is no strong evidence that acid deposition on these habitats is negative, that other factors are far more likely to influence the botanical composition of the sward and that the critical load is already so far exceeded that the further acid deposition forecast for this project is a relatively small difference, the ecological effect is likely to be minimal."

It is possible to conclude **no damage** to Sizewell Marshes SSSI from acidification during the commissioning of SZC, will only take place over 2 years, pre-operation, as set out in section 3.3.

Routine operation

The PC at E5a is predicted to be 0.005keqN/ha/yr and 0.003keqS/ha/yr, which is 1% of the minimum acid critical load function for fen, marsh and swamp broad habitats. Background levels of acidification (APIS) at E5a are 1keqN/ha/yr and 0.1keqS/ha/yr, with a PEC of 156% of the minimum CL function.

The PC at E5b is predicted to be 0.007keqN/ha/yr and 0.004keqS/ha/yr, which is 4% of the minimum acid critical load function for fen, marsh and swamp broad habitats. Background levels of acidification (APIS) at E5b are 1keqN/ha/yr and 0.1keqS/ha/yr, with a PEC of 159% of the minimum CL function.

Predicted acid deposition from the routine operation of SZC is reduced to a maximum of 4% of the minimum critical load function fen, marsh and swamp broad habitats. This will be reduced further with distance from SZC. It is unlikely that this level of input from SZC will result in a measurable effect within the SSSI.

As with the commissioning scenario, it is possible to conclude **no damage** to Sizewell Marshes SSSI from acidification during the routine operation of SZC.

LOOP

No quantitative assessment was carried out for a LOOP scenario in the permit application.

The LOOP scenario is not expected to happen during the lifetime of the plant, the Schedule 5 Notice response (EDF, 2021) states that "Such an event is not intended to occur at all, is statistically unlikely to occur more than once in the plant design life and in such an event is likely to last for well under 24-hours."

There is no potential for a LOOP scenario to result in long-term nutrient enrichment and acidification. It is therefore possible to conclude **no damage** to the interest features of the Sizewell Marshes SSSI from a LOOP scenario resulting in acidification.

Conclusion

It has been possible to conclude no damage to the broad habitats of the Sizewell Marshes SSSI from the commissioning and routine operation of EDG and UDG at Sizewell C.

While there are aerial pathways of effect from the commissioning and routine testing of the DGs at Sizewell C, and sensitive receptors within the SSSI, it has been determined in this assessment under Section 28I of the Wildlife and Countryside Act 1981 (as amended by the Countryside and Rights of Way Act (CRoW) 2000) that the potential scale or magnitude of any effect **would not result in an operation likely to damage the features of the SSSI**.

Fen, marsh and swamp habitats:

- M22 - Juncus subnodulosus - Cirsium palustre fen meadow
- M23 - Juncus effusus/acutiflorus - Galium palustre rush pasture
- S26 - Phragmites australis - Urtica dioica tall-herb fen

Assemblages:

- vascular plant assemblage
- assemblages of breeding birds – lowland damp grasslands
- invertebrate assemblage

Other habitat features:

- lowland ditch systems

Modelling has demonstrated that emissions and deposition from SZC are largely restricted to a small area of the SSSI, and this is the area that will be lost due to the construction of SZC. Replacement habitat has been secured, which is more than 2km from SZC, and therefore out of scope for assessment.

3.7.4. Leiston-Aldeburgh SSSI

Direct toxic effects

The results of modelling carried out by the applicant for the commissioning and routine operation of SZC are provided in Table 41andTable 42, with the exception of short-term effects of NOx. The applicant did not model for short-term effects during commissioning, stating that emissions would not occur over a 24-hour period. AQMAU modelling has therefore been used to inform the commissioning short-term NOx assessment.

These results have been used to assess if a detailed assessment is required to determine whether there will be damage to the features of the SSSI and are taken from Appendix C – Air Quality Modelling Assessment (EDF, 2020a).

Table 41: Assessment of direct toxic effects, Leiston-Aldeburgh SSSI, commissioning

Pollutant	Critical level (µg/m³)	PC (µg/m³)	PC >Y% CL	Background	PEC (µg/m³)	PEC > 70% CL
NOx (long term)	30	0.3	Yes 1.1%	9.89	10.19	No 34%
NOx (short term)	75	18	Yes 24%	N/A	N/A	N/A
SO_2	20	0.01	No 0.1%	N/A	N/A	N/A
SO_2	10	0.01	No 0.1%	N/A	N/A	N/A

Y = 1%, long term; 10% short term NOx

It is possible to conclude **no damage** to the features of the SSSI from the direct toxic effects of emissions of SO_2 and the long-term effects of NOx emissions during the commissioning of SZC.

Further assessment is required for the short-term effects of NOx.

Table 42: Assessment of direct toxic effects, Leiston-Aldeburgh SSSI, routine testing

Pollutant	Critical level (µg/m³)	PC (µg/m³)	PC >Y% CL
NOx (long term)	30	0.09	No 0.3%
NOx (short term)	75	16.1	Yes 21%
SO_2	20	0.003	No 0.0%
SO_2	10	0.003	No 0.0%

Y = 1%, long term; 10% short term NOx

It is possible to conclude **no damage** to the features of the SSSI from the direct toxic effects of emissions of SO_2 and the long-term effects of NOx emissions during the commissioning of SZC.

Further assessment is required for the short-term effects of NOx.

Detailed assessment

When assessing the worst-case emissions of NOx against the short-term critical level of 75µg/m³, the following results are obtained:

- commissioning: PC 24% CL
- routine testing: PC 21% CL

The applicant has proposed that its PCs predicted for routine testing be used for commissioning as well. The worst-case scenario during commissioning involves simulating a LOOP event, whereby 4 EDGs are tested simultaneously for a 3-hour period. This scenario emits less NO_x over a 24-hour period compared to the worst-case scenario during routine testing, which involves testing a single generator for 24 hours following a maintenance outage. Therefore, using routine testing PCs for commissioning is likely to be more conservative.

Emissions from both commissioning and routine testing of DGs are below the short-term critical level for NOx.

It is possible to conclude **no damage** from the short-term effects of NOx on the features of the SSSI.

LOOP

The applicant provided an assessment of the LOOP scenario at the Leiston-Aldeburgh SSSI as set out in section 2.2.2 of its Schedule 5 response (EDF, 2021).

The applicant has predicted that, based upon the modelled assumption that 8 EDGs are operational concurrently, continuously throughout the year (ensuring that the assessment takes account of the meteorological conditions that result in the worst-case impacts), the PC will be 92.9µg/m^3. This is 124% of the daily CL of 75µg/m^3.

The LOOP scenario is not expected to happen during the lifetime of the plant. The applicant has predicted that a long LOOP scenario will only occur 0.6 times during the operational lifetime of SZC (EDF, 2021).

It is therefore possible to conclude **no damage** to the features of the Minsmere-Walberswick Heaths SSSI from the short-term effects of NOx due to a LOOP event.

Nutrient enrichment

The assessment of nutrient deposition at Leiston-Aldeburgh SSSI is based upon the broad habitat groups identified in section 3.5.3. Critical loads were obtained from APIS on 18 August 2021.

Critical loads are not available for the following features:

- SD1 - Rumex crispus - Glaucium flavum shingle community
- vascular plant assemblage
- shoveler (Anas clypeata)
- gadwall (Anas strepera)
- lowland damp grasslands and lowland open waters and their margins
- outstanding dragonfly assemblage
- variety of breeding bird species (70)

The following feature is not sensitive to the effects of acidification either directly, or through impacts on their supporting habitats:

- white-fronted goose (Anser albifrons albifrons)

The applicant has identified that the reedbed, acid grassland and broadleaved deciduous woodland features of the SSSI are all located at >2km from SZC and are therefore not included in this assessment of nutrient enrichment. The assessment will focus on the lowland heath feature of the SSSI.

The maximum PC is predicted to be 0.07kg N/ha/yr at the SSSI during commissioning, which is <1% of the minimum critical load of 10kg N/ha/yr for dwarf shrub heath broad habitat. This is based upon the worst-case operating scenario; actual deposition of N is expected to be even lower.

As stated in section 3.3, the commissioning of SZC will last for a period of 2 years, followed by the routine testing of the DGs during the 60-year operational phase of SZC. Each EDG and UDG will be tested individually for a total of 60 hours a year for an aggregated total of 720 hours of testing per year. This equates to 8% operational hours annually (720 ÷ 8760).

It is possible to conclude **no damage** to the features of the Leiston-Aldeburgh SSSI from nutrient enrichment during commissioning of SZC. The modelled PC is inconsequential at <1% of the minimum critical load.

The maximum PC is predicted to be 0.02kg N/ha/yr at the SSSI during the routine operation of SZC, which is <1% of the minimum critical load of 10kg N/ha/yr for dwarf shrub heath broad habitat. This is based upon the worst-case operating scenario, assuming that one EDG is operating continuously throughout the year, with pro-rata emissions based on 720 hours of annual operation. This does not take account of the spread of EDG over the SZC site, nor the testing of less polluting UDGs. Emissions from the routine testing of DGs will be even lower than predicted at Leiston-Aldeburgh SSSI.

It is possible to conclude **no damage** to Leiston-Aldeburgh SSSI from nutrient enrichment during routine testing of DGs at SZC. The modelled PC is inconsequential at <1% of the minimum critical load for dwarf shrub heath broad habitat, all other features are beyond the 2km screening distance.

LOOP

No quantitative assessment was carried out for a LOOP scenario in the permit application.

The LOOP scenario is not expected to happen during the lifetime of the plant, the Schedule 5 Notice response (EDF, 2021) states that “Such an event is not intended to occur at all, is statistically unlikely to occur more than once in the plant design life and in such an event is likely to last for well under 24-hours.”

There is no potential for a LOOP scenario to result in long-term nutrient enrichment or acidification. It is therefore possible to conclude **no damage** to the interest features of the Leiston-Aldeburgh SSSI from a LOOP scenario resulting in nutrient enrichment.

Acidification

The assessment of acidification at Leiston-Aldeburgh SSSI is based upon the broad habitat groups identified in section 3.5.3., critical loads and background levels were obtained from APIS on 18 August 2021.

The following features are not sensitive to the effects of acidification either directly, or through impacts on their supporting habitats:

- gadwall
- marsh harrier
- woodlark
- shoveler
- white-fronted goose

There are no acid critical loads assigned for the following features:

- S4 - Phragmites australis swamp and reed-beds
- SD1 - Rumex crispus - Glaucium flavum shingle community
- vascular plant assemblage
- lowland damp grasslands and lowland open waters and their margins
- outstanding dragonfly assemblage
- variety of breeding bird species (70)

The applicant has identified that the reedbed, acid grassland and broadleaved deciduous woodland features of the SSSI are all located at >2km from SZC and are therefore not included in this assessment of acidification.

Table 43: Assessment of process contribution of acidification, Leiston-Aldeburgh SSSI, for commissioning

Notable feature	Min CLMinN Keq/ha/yr	Min CLMaxN Keq/ha/yr	Min CLMaxS Keq/ha/yr	PC N keq/ha/yr	PC S keq/ha/yr	PC>1% CL
Dwarf shrub heath	0.714	1.372	0.48	0.01	0.01	No 0.74%

As stated in section 3.3., the commissioning of SZC will last for a period of 2 years, followed by the routine testing of the DGs during the 60-year operational phase of SZC. Each EDG and UDG will be tested individually for a total of 60 hours a year for an aggregated total of 720 hours of testing per year. This equates to 8% operational hours annually (720 ÷ 8760).

It is possible to conclude **no damage** to Leiston-Aldeburgh SSSI from acidification during the commissioning of SZC. The modelled PC is inconsequential at <1% of the minimum critical load function for dwarf shrub heath broad habitat. All other features are beyond the 2km screening distance.

Table 44: Assessment of process contribution of acidification, Leiston-Aldeburgh SSSI, for routine testing

Notable feature	minCLMinN Keq/ha/yr	minCLMaxN Keq/ha/yr	minCLMaxS Keq/ha/yr	PC N keq/ha/yr	PC S keq/ha/yr	PC>1 % CL
Dwarf shrub heath	0.714	1.372	0.48	0.002	0.01	No 0.87%

This result is based on the worst-case operating scenario, assuming that one EDG is operating continuously throughout the year, with pro-rata emissions based on 720 hours of annual operation. This does not take account of the spread of EDG over the SZC site, nor the testing of less polluting UDGs. Emissions from the routine testing of DGs will be even lower than predicted at Leiston-Aldeburgh SSSI.

It is possible to conclude **no damage** to Leiston-Aldeburgh SSSI from acidification during the routine testing of the DGs. The modelled PC is inconsequential at <1% of the minimum critical load function for dwarf shrub heath broad habitat. All other features are beyond the 2km screening distance.

LOOP scenario

No quantitative assessment was carried out for a LOOP scenario in the permit application.

The LOOP scenario is not expected to happen during the lifetime of the plant, the Schedule 5 Notice response (EDF, 2021) states that “Such an event is not intended to occur at all, is statistically unlikely to occur more than once in the plant design life and in such an event is likely to last for well under 24-hours.”

There is no potential for a LOOP scenario to result in long-term nutrient enrichment or acidification. It is therefore possible to conclude **no damage** to the interest features of the Leiston-Aldeburgh SSSI from a LOOP scenario resulting in acidification.

Conclusion

It has been possible to conclude no damage to the broad habitats of the Leiston-Aldeburgh SSSI and the species they support from the commissioning and routine operation of EDG and UDG at Sizewell C.

While there are aerial pathways of effect from the commissioning and routine testing of the DGs at Sizewell C, and sensitive receptors within the SSSI, it has been determined in this assessment under Section 28I of the Wildlife and Countryside Act 1981 (as amended by the Countryside and Rights of Way Act (CRoW) 2000) that the potential scale or magnitude of any effect **would not result in an operation likely to damage the features of the SSSI**.

Aggregations of breeding birds:

- gadwall (Anas strepera)
- marsh harrier (Circus aeruginosus)
- woodlark (Lullula arborea)
- gadwall (Anas strepera)
- shoveler (Anas clypeata)
- white-fronted goose (Anser albifrons albifrons)

Supporting habitat: Lowland damp grasslands and lowland open waters and their margins.

Heathland habitats:

- H1 - Calluna vulgaris - Festuca ovina heath

Fen, marsh and swamp habitats:

- S4 - Phragmites australis swamp and reed-beds

Supralittoral sediment:

- SD1 - Rumex crispus - Glaucium flavum shingle community

Acid grassland habitats:

- U1 b,c,d,f - Festuca ovina - Agrostis capillaris - Rumex acetosella grassland

Woodland habitats:

- W1 - Salix cinerea - Galium palustre woodland
- W2 - Salix cinerea - Betula pubescens - Phragmites australis woodland
- W6 - Alnus glutinosa - Urtica dioica woodland

Assemblages:

- vascular plant assemblage
- outstanding dragonfly assemblage
- variety of breeding bird species (70)

Other habitat features:

- lowland ditch systems

The conclusion is reached for the worst-case modelling scenario, which has shown that the maximum process contributions for the features vulnerable to direct toxic effects of SO_2, and deposition of nutrient nitrogen and acidification are inconsequential at less than 1% of the relevant critical level and critical loads.

Maximum short-term process contributions of NOx are predicted to be inconsequential at less than 10% of the critical level of 200µg/m^3.

A conclusion of no damage can also be drawn for species that are vulnerable to impacts on their broad habitat type, including woodlark, marsh harrier, white fronted goose, shoveler, and gadwall.

3.8. Assessment of noise and disturbance

The applicant did not carry out an assessment of the potential for damage to the SSSIs from noise associated with the operational CA permit. The results of modelling submitted in the shadow HRA for the permit application (EDF, 2020b) will be used to inform the assessment of Minsmere-Walberswick Heaths SSSI. There is no modelling available for the Leiston-Aldeburgh SSSI, therefore a qualitative assessment will be carried out using information available in the Appendix E Noise Assessment (EDF, 2020c).

Appendix E – Noise Assessment (EDF, 2020c) sets out the methodology used for the assessment of noise. AQMAU has audited the modelling that was used by the applicant and consider that the applicant's conclusions can be used for permit determination (Environment Agency, 2021a).

The modelling scenarios for the DGs at SZC are described in section 3.6.1.and summarised as follows:

- During commissioning, there will only be a single generator operating at a time, each unit will be commissioned separately for one year for a total of 2,446 hours per year.
- Routine testing will take place during daytime hours, for a period of 720 hours of testing per year, or 8% operational hours per year.
- The LOOP scenario has the potential to generate the most noise as DGs would be on full power until the off-site power is restored, or longer-term power provision has been made. However, this event is unlikely to occur. The noise assessment carried out by the applicant was based on a LOOP event as a worst-case scenario. No modelling of the noise levels from commissioning or routine testing was carried out, therefore the results of the LOOP assessment will be used to inform a full assessment of the operation of SZC.

The applicant identified the primary sound sources used in the sound level model (EDF, 2020c) as:

- exhaust stacks on roof at a height of 34.5m (for dispersion of generator combustion gases). Three stacks per building, one per generator
- two fresh-air intakes at mid-level, one either side of the building (per generator), therefore a total of 6 per generator building.
- two fresh-air in/warm air out louvres per generator at higher level, therefore a total of 6 per generator building

3.8.1. Minsmere-Walberswick Heaths and Marshes SSSI

Noise from the diesel generators is not expected to have an impact on the bird features of the SSSI in the long term due to their intermittent operation and location within concrete buildings.

The applicant's modelling has predicted a sound level at the SSSI of 45dB resulting from a LOOP event. For the worst-case LOOP event the duration of the noise could be for a period of 72 hours. However, the applicant stated in the Schedule 5 Notice response (EDF, 2021) that "such an event is likely to last for well under 24-hours" and that a long LOOP scenario is only expected to occur 0.6 times during the operational lifetime of SZC.

During commissioning, each of the 8 EDGs are tested for 242.5 hours and each of the 4 UDGs are tested for 738 hours. Unit 1 will undergo commissioning first and unit 2 will undergo commissioning the following year. Therefore, each year, 4 EDGs and 2 UDGs are tested, which aggregates to 2,446 hours of testing per year. While unit 2 is undergoing commissioning, unit 1 will begin undergoing routine operational testing.

Routine testing of DGs will involve the testing of each EDG and UDG individually for a total of 60 hours a year for an aggregated total of 720 hours of testing per year. This equates to DGs being operational for 8% of hours (720 ÷ 8760) for planned annual routine operation.

Background levels of 48dB (day) and 43dB (night) were measured at Minsmere-Walberswick Heaths SSSI. Worst-case operational noise levels (experienced during a LOOP scenario) are expected to be consistent with background levels experienced at the SSSI, with a modelled level of 45dB. A ground-level (1.5m) noise contour map is provided in Figure 9.

The applicant concluded in the shadow HRA (used to inform this assessment under the CRoW Act) that "LSE can be excluded for potential noise effects in all cases due to the minimal predicted change relative to ambient noise levels."

We accept the applicant's conclusions and agree that noise, either prolonged or intermittent, will not result in damage to the SSSI features, and further detailed assessment is not considered necessary.

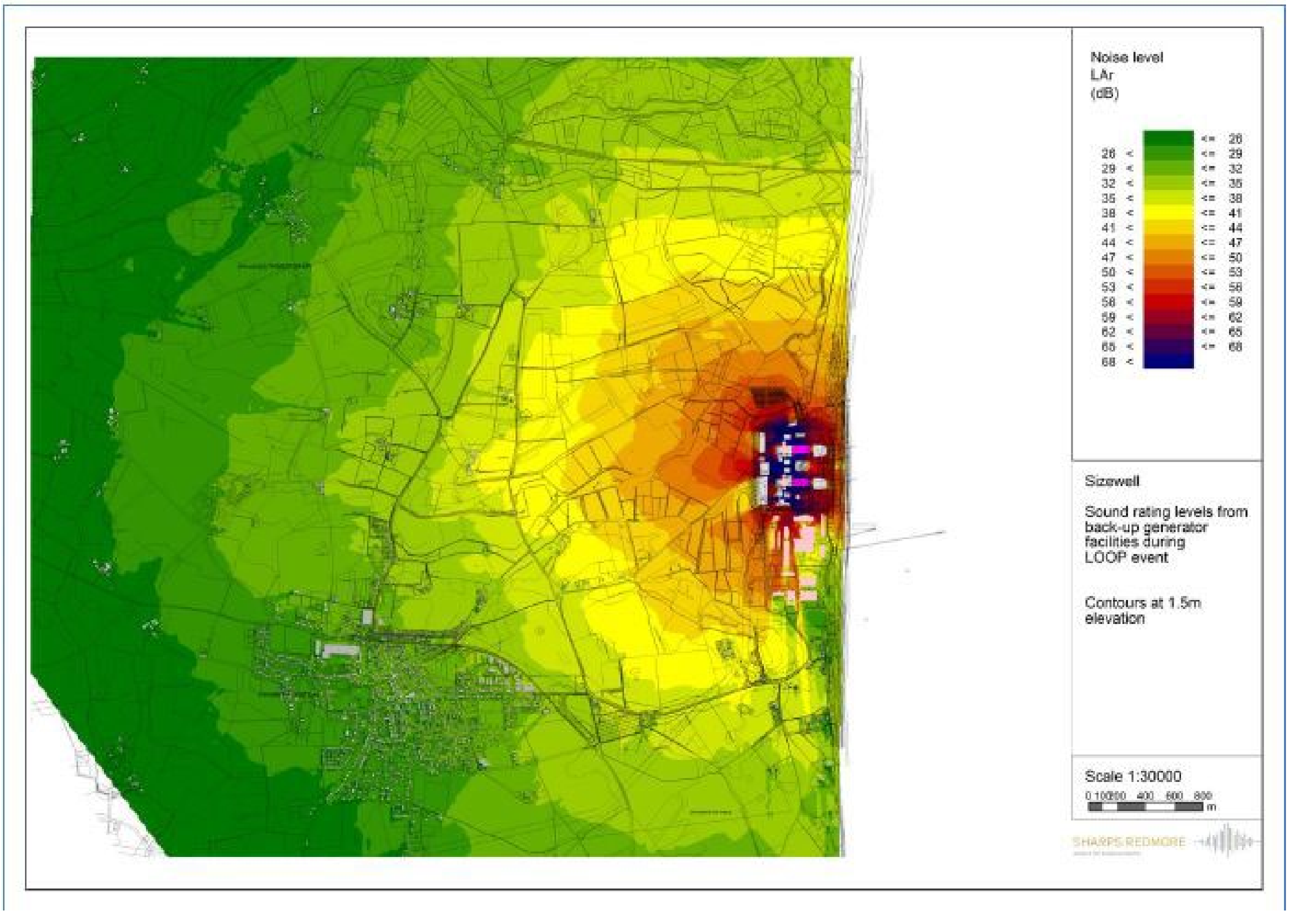


Figure 9: Heat map of sound rating levels from back-up generator facilities during a LOOP event. Purple represents the highest noise levels, dark green the lowest. Taken from SZC CA Appendix E - Noise Assessment (EDF, 2020c)

Conclusion

It has been possible to conclude no damage to the bird species and assemblages of birds of Minsmere-Walberswick Heaths and Marshes SSSI from noise generated during the commissioning and routine operation of EDGs and UDGs, and LOOP scenario at Sizewell C.

While there are aerial pathways of effect from the commissioning and routine testing of the DGs, and LOOP scenario at Sizewell C, and sensitive receptors within the SSSI, it has been determined in this assessment under Section 28I of the Wildlife and Countryside Act 1981 (as amended by the Countryside and Rights of Way Act (CRoW) 2000) that the potential scale or magnitude of any effect **would not result in an operation likely to damage the features of the SSSI**.

Aggregations of breeding birds:

- avocet (Recurvirostra avosetta)
- bearded tit (Panurus biarmicus)
- bittern (Botaurus stellaris)
- Cetti's warbler (Cettia cetti)

- garganey (Anas querquedula)
- marsh harrier (Circus aeruginosus)

Assemblages:

- variety of breeding bird species (70)
- variety of passage bird species (150)
- variety of wintering bird species (90)

3.8.2. Sizewell Marshes SSSI

An assessment of noise levels on Sizewell Marshes SSSI was not carried out by the applicant, a qualitative assessment will therefore be completed.

The assessment for Minsmere-Walberswick Heaths and Marshes SSSI has demonstrated that noise levels from a LOOP scenario are within ambient noise levels. This would also be expected to be the scenario within the Sizewell Marshes SSSI, as indicated by modelling of noise levels submitted by the applicant to support its CA permit application (EDF, 2020c). The area of the SSSI subject to the highest predicted noise levels is in the location of Goodram's Fen, the location of which is indicated in Figure 8. Goodram's Fen will be lost during the construction of SZC, so alternative habitat has been created >2km from SZC.

Indicative modelled noise levels are shown in Figure 9.

Conclusion

It has been possible to conclude no damage to the bird species and assemblages of birds of Sizewell Marshes SSSI from noise generated during the commissioning and routine operation of EDG and UDG, and LOOP scenario at Sizewell C.

While there are aerial pathways of effect from the commissioning and routine testing of the DGs, and LOOP scenario at Sizewell C, and sensitive receptors within the SSSI, it has been determined in this assessment under Section 28I of the Wildlife and Countryside Act 1981 (as amended by the Countryside and Rights of Way Act (CRoW) 2000) that the potential scale or magnitude of any effect **would not result in an operation likely to damage the features of the SSSI**.

Assemblages:

- assemblages of breeding birds

3.8.3. Leiston-Aldeburgh SSSI

An assessment of noise levels on Leiston-Aldeburgh SSSI was not carried out by the applicant, a qualitative assessment will therefore be completed.

The assessment for Minsmere-Walberswick Heaths and Marshes SSSI has demonstrated that noise levels from a LOOP scenario are within ambient noise levels within a short distance of SZC. This would also be expected to be the scenario within the Leiston-

Aldeburgh SSSI, which is located at 1.7km to the south of SZC, as indicated by modelling of noise levels submitted by the applicant to support its CA permit application (Sharps Redmore, 2020). This is demonstrated in Figure 9.

Conclusion

It has been possible to conclude no damage to the bird species and assemblages of birds of Leiston-Aldeburgh SSSI from noise generated during the commissioning and routine operation of EDG and UDG, and LOOP scenario at Sizewell C.

While there are aerial pathways of effect from the commissioning and routine testing of the DGs, and LOOP scenario at Sizewell C, and sensitive receptors within the SSSI, it has been determined in this assessment under Section 28I of the Wildlife and Countryside Act 1981 (as amended by the Countryside and Rights of Way Act (CRoW) 2000) that the potential scale or magnitude of any effect **would not result in an operation likely to damage the features of the SSSI**.

Aggregations of breeding birds:

- gadwall (Anas strepera)
- marsh harrier (Circus aeruginosus)
- woodlark (Lullula arborea)
- gadwall (Anas strepera)
- shoveler (Anas clypeata)
- white-fronted goose (Anser albifrons albifrons)

Assemblages:

- variety of breeding bird species (70)

4. Water discharge activity

4.1. SSSIs relevant for assessment

- Pakefield to Easton Bavents SSSI
- Minsmere-Walberswick Heaths and Marshes SSSI
- Leiston to Aldeburgh SSSI
- Alde-Ore Estuary SSSI

These SSSI sites are also European sites, which are protected under European and UK law. European sites include Special Areas of Conservation (SAC), Special Protection Areas (SPA), and Ramsar sites.

The Minsmere-Walberswick Heaths and Marshes SSSI covers the Minsmere to Walberswick Heaths and Marshes SAC, the Minsmere-Walberswick Ramsar and the Minsmere–Walberswick SPA.

The Alde-Ore Estuary SSSI covers the Alde-Ore and Butley Estuaries SAC, the Alde-Ore Estuary Ramsar, the Alde-Ore Estuary SPA and Orfordness to Shingle Street SAC.

Pakefield to Easton Bavents SSSI covers Benacre to Easton Bavents SPA and SAC.

The features designated under the SSSIs are largely the same as the features of the associated European sites. We have fully considered the potential for effect on the European sites in our habitats regulations assessment report (HRAR) (Environment Agency 2022).

The methodology and approaches used to assess the potential effect in this formal SSSI assessment are the same as those used in the HRAR for their equivalent European sites. Information and main arguments presented in the HRAR are used in this assessment where appropriate.

4.2. Type of permission

The focus of this assessment is the water discharge activity (WDA) permit which was applied for under application reference number EPR/CB3997AD/A001.

4.3. Proposed timing

The WDA permit will cover the operational lifetime of SZC, currently expected to be 60 years.

Commissioning of SZC will last for 2 years and it is expected that unit 1 of SZC will become operational in 2033 while unit 2 is expected to become operational in 2034.

SZC will be constructed immediately to the north of the existing Sizewell B power station (SZB). Construction of SZB began in 1988 and electricity generation began in 1995.

SZB is expected to continue to operate until 2035, although there is potential for an extension of SZB's operational lifetime by 20 years to 2055 at the latest. Therefore, there will be a period – from 2 to 22 years – where SZB and SZC are operating at the same time.

SZC and SZB have the same kinds of discharges and will operate at the same time and so our precautionary approach will consider the effect of SZC alone alongside the effects of SZB. As this SSSI assessment is conducted based on the information and analyses provided for the HRAR, this assessment will refer to SZB, when appropriate. Although we will reference SZB discharges, the permission that is being considered in this assessment is the SZC permit. This assessment cannot directly consider any effects of the SZB permission. SZB is at times used in comparison to SZC, as SZC will operate in a similar way to SZB and will have the same kinds of discharges. It is also used as a baseline, as an existing pressure on the environment.

4.4. Description of the proposal

SZC will be constructed immediately to the north of the existing Sizewell B (SZB) power station and will permanently occupy an area of approximately 35 hectares (ha) once constructed (see Figure 10)

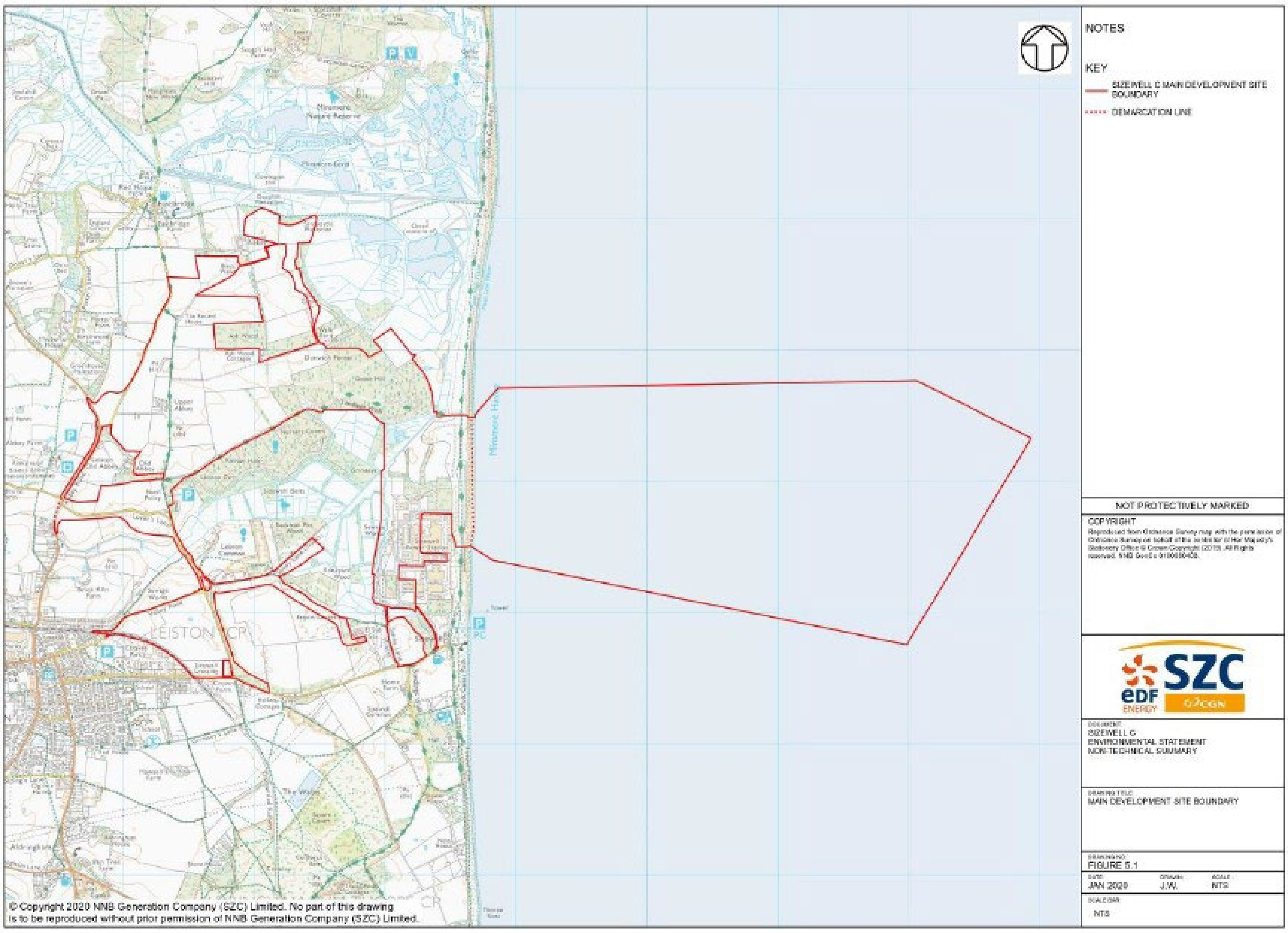


Figure 10: Location of the SZC main development site (indicated by the red outline). Taken from Figure 5-1 in NNB GenCo, 2020b

SZC will be direct cooled which is also known as 'open-cycle cooling', with each of the 2 UK EPR™ units having its own dedicated cooling water (CW) intake tunnel extending approximately 3.0 to 3.5km offshore into the Greater Sizewell Bay area of the North Sea (Figure 10). During operation SZC will require a continuous supply of cooling water at a rate of 132m³/s at mid-tide levels of seawater which will vary between 125 and 140m³/s.

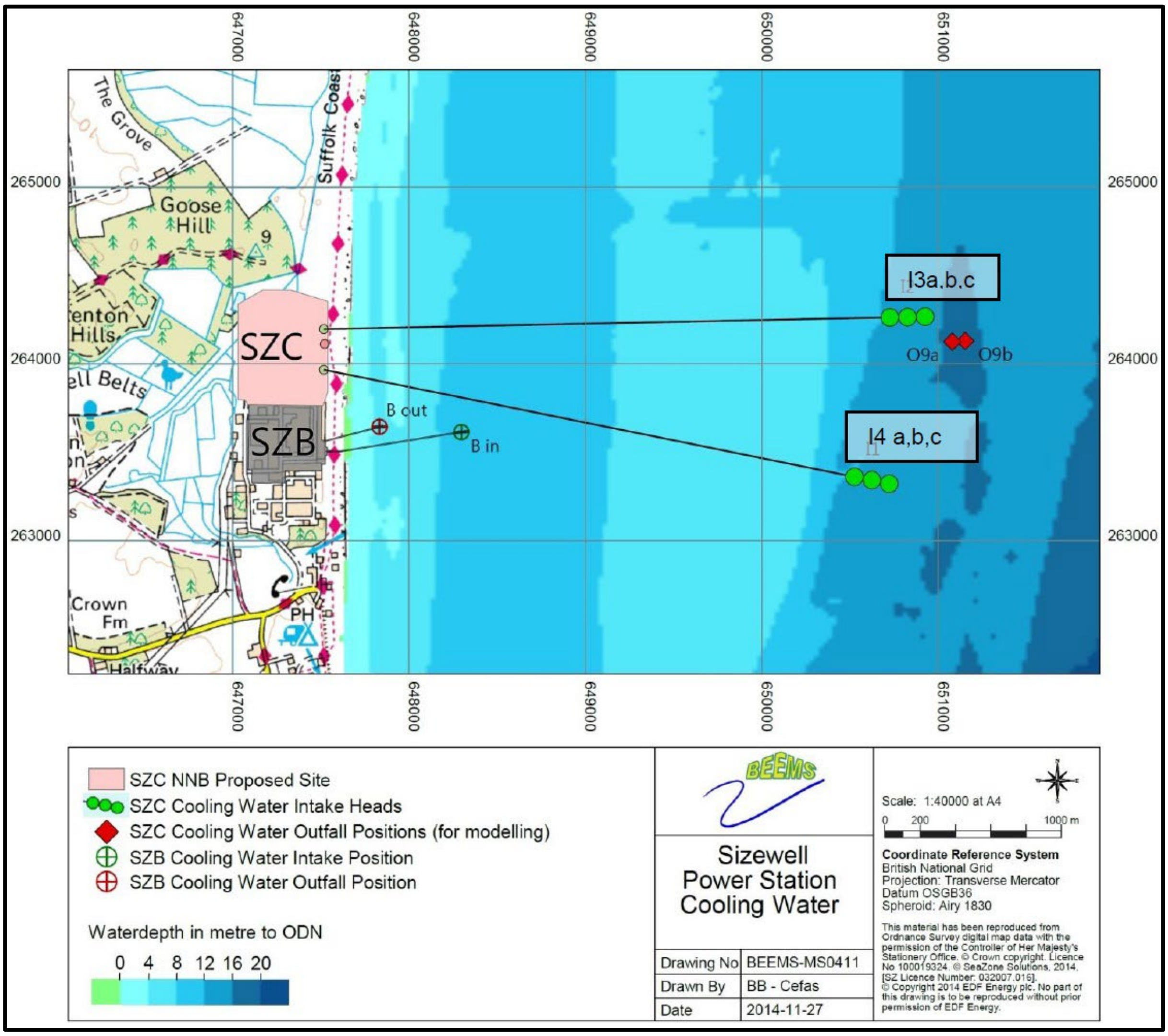


Figure 11: Location of the SZC cooling intake and outlet structures in proximity to those at SZB (NNB GenCo, 2020c; TR302)

After being used the seawater would then be discharged back to the Suffolk coast via an outlet tunnel (Figure 11) and on its return will have a mean excess temperature of 11.6˚C above ambient background. In practice, both the temperature and volume will 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.

Both EPR units will incorporate a fish recovery and return (FRR) system. This system will return any fish that become impinged on screens within the cooling water system (CWS) to a location within the Greater Sizewell Bay where they are not likely to be recirculate through the cooling water intakes.

The design of the 2 SZC FRR systems will largely replicate that used by the Hinkley Point C (HPC) FRR system design.

The proposed permit application covers the operational WDAs from hot functional testing during commissioning, through operation, and up until decommissioning begins.

The predicted environmental effect of SZC is defined by the operating criteria of the site, as set out in the environmental assessments carried out by the applicant. It is these assessments that this assessment is primarily based on. We carried out additional work in relation to the FRR system discharge. The additional work was prompted by uncertainty in the analysis of impingement data presented by the applicant, as detailed in EA 2022.

Should the design or operation of SZC differ from that set out in the application documents, the environmental effect of the station may alter from that considered in this assessment. The effect of such changes would need to be assessed through a permit variation application, and a new SSSI assessment would be carried out at that point as any increase in environmental effect may alter the conclusions of this assessment. Any change in environmental effect would depend on the scale of the change and the nature of the process, or design aspect, that is altered.

The following are SZC operational components or processes which are relied on in this SSSI assessment. The alteration of any of these would be expected to lead to a change in environmental effect:

- location and design of cooling water outlets
- location and design of cooling water intakes
- cooling water abstraction and discharge rate
- generating capacity of power station and design of cooling water system, and discharge temperature of cooling water
- cooling water chlorination strategy, in terms of dose rate, duration of year when dosing is required, and the point in the cooling water circuit at which chlorination occurs (specifically whether it occurs before or after the FRR system)
- hydrazine treatment process and thereby effluent concentration
- the design aspects of the FRR system that affect the survivability of organisms passing through the cooling water system
- processes undertaken for hot functional testing (HFT)
- outfall used to dispose of HFT effluents

Proposed discharges from SZC are characterised as waste streams A to H.

Waste stream A

Waste stream A is the discharge of abstracted cooling water at a rate of 132m^3/s (as a tidal mean). This is the most significant discharge in terms of flow and will be warmed, having removed waste heat from the condenser. Chlorination is used to prevent biofouling of the cooling water system infrastructure. When it is taking place, waste stream A will contain by-products of the chlorination process, namely total residual oxidant (TRO) and chlorination by-products (CBPs, particularly bromoform).

Waste stream A will be discharged in admixture with waste streams B to G. These being:

- trade effluents generated by operations within the nuclear island waste monitoring and discharge system (waste stream B), and the steam generator blowdown system (waste stream C), with a combined maximum discharge rate of 1,500m³/day
- trade effluent generated from the turbine hall and uncontrolled area floor drains (waste stream D) with a maximum discharge rate of 1,500m³/day
- trade effluent generated from the site drainage system (waste stream E), discharged on an intermittent basis with a maximum rate of 35,000m³/day
- trade effluent from the production of demineralised water (waste stream F), with a maximum discharge rate of 4,000m³/day
- domestic sewage, comprising treated sanitary effluent from administration and mess facilities (waste stream G), discharged at a maximum rate of 190m³/day

Waste stream H

Waste stream H is trade effluent consisting of returned abstracted seawater from the 2 FRR systems, with a maximum discharge of 25,920m³/day per FRR system. Waste stream H is separate from waste streams A to G and is discharged through the FRR system outlets. A proportion of the biota abstracted with the cooling water will not survive transit through the FRR systems, and any dead or moribund biota will be returned to the receiving waterbody within waste stream H.

4.4.1. Screening assessment

The applicant carried out a screening assessment, known as an H1 assessment, to determine elements (in addition to temperature effects) that needed to be considered further (NNB GenCo, 2021a; TR193). Elements needing further consideration are:

- total residual oxidant (from waste stream A)
- chlorination by-products (from waste stream A)
- hydrazine (an oxygen scavenger used to prevent corrosion and discharge in waste streams B, C and D)
- ammonia (from waste streams G and H)
- phosphate and nitrate (nutrients discharged in waste streams G and H)
- the potential for deoxygenation (including as a result of the decay of dead biota discharged by the FRR systems as waste stream H)
- the potential for organic enrichment (including as a result of the decay of dead biota discharged by the FRR systems as waste stream H)

Hydrazine is an oxygen scavenger used to prevent corrosion and discharged with waste streams B, C and D. Ammonia, phosphate and nitrate will be discharged from the treatment of sewage (waste stream G), while changes in levels in the Greater Sizewell Bay may also occur from the decay of dead biota discharged by the FRR systems (waste stream H). Similarly, deoxygenation and organic enrichment may occur, not just as a result of discharges from the sewage treatment works (waste stream G), but also due to the decay of dead biota from waste stream H.

4.5. Defining and identifying relevant SSSI for this assessment

The applicant carried out a detailed assessment to identify a potential 'zone of influence' (ZoI) of the discharge (NNB GenCo, 2021a; TR193). This is a geographic area around SZC, and anything within this area could potentially be affected by the discharges due to proximity.

For SZC, discharges occur both within the Sizewell-Dunwich Bank (waste stream H/FRR systems) and beyond it (waste streams A to G). The applicant used several methods to determine the volume of water that may be influenced by these discharges. We agree with the applicant that sites beyond the geographic extent of the areas defined by these methods can be considered to be outside the ZoI of the discharges (Figure 12).

The normal seaward limit of SSSI is above mean low water mark (Defining ASSI/SSSIs with 'marine biological components' and setting out a process for determining their contribution to the UK MPA network (jncc.gov.uk)). This means there is limited direct connectivity of the ZoI with any of the SSSI sites along the coast as the discharge is into the marine environment (Figure 13). Despite this, there is potential for features of the sites, especially mobile species such as birds, to forage offshore from the SSSI so that we need to consider any connectivity. The coastal sites within this broad ZoI are from north to south:

Pakefield to Easton Bavents (SSSI) SSSI detail (naturalengland.org.uk)

"Description and reasons for notification: Pakefield to Easton Bavents is nationally important for the geological exposures of the Lower Pleistocene Norwich Crag formations and associated Pleistocene vertebrate assemblages, and the coastal geomorphology of Benacre Ness. The site is also nationally important for its vegetated shingle features, saline lagoons, floodplain fens, an assemblage of nationally rare and nationally scarce vascular plants, scarce breeding birds, 4 breeding bird assemblages in 4 different habitats and wintering bitterns (Botaurus stellaris)."

Minsmere-Walberswick Heaths and Marshes SSSI detail (naturalengland.org.uk)

"Description and reasons for notification: This composite site is situated on the coast of Suffolk between Southwold in the north and Sizewell in the south. It contains a complex series of habitats, notably mudflats, shingle beach, reedbeds, heathland and grazing marsh, which combine to create an area of exceptional scientific interest."

Leiston to Aldeburgh SSSI detail (naturalengland.org.uk)

"Description and reasons for notification: Leiston-Aldeburgh contains a rich mosaic of habitats, including acid grassland, heath, scrub, woodland, fen, open water and vegetated shingle. This mix of habitats in close juxtaposition and the associated transition of communities between habitats is unusual in the Suffolk Coast and Heaths. The variety of habitats support a diverse and abundant community of breeding and overwintering birds, a high number of dragonfly species and many scarce plants."

Alde Ore Estuary SSSI [SSSI detail (naturalengland.org.uk)]

"Description and reasons for notification: This site stretches along the coast from Bawdsey to Aldeburgh and inland to Snape. It includes Orfordness, Shingle Street, Havergate Island, and the Butley, Ore and Alde Rivers. The scientific interests of the site are outstanding and diverse. The shingle structures of Orfordness and Shingle Street are of great physiographic importance, while the cliff at Gedgrave is of geological interest. The site also contains a number of coastal formations and estuarine features, including mud-flats, saltmarsh, vegetated shingle and coastal lagoons which are of special botanical and ornithological value."

It is considered there is no connectivity between the marine discharges and the freshwater features of Sizewell Marshes SSSI and so this will not be considered further.

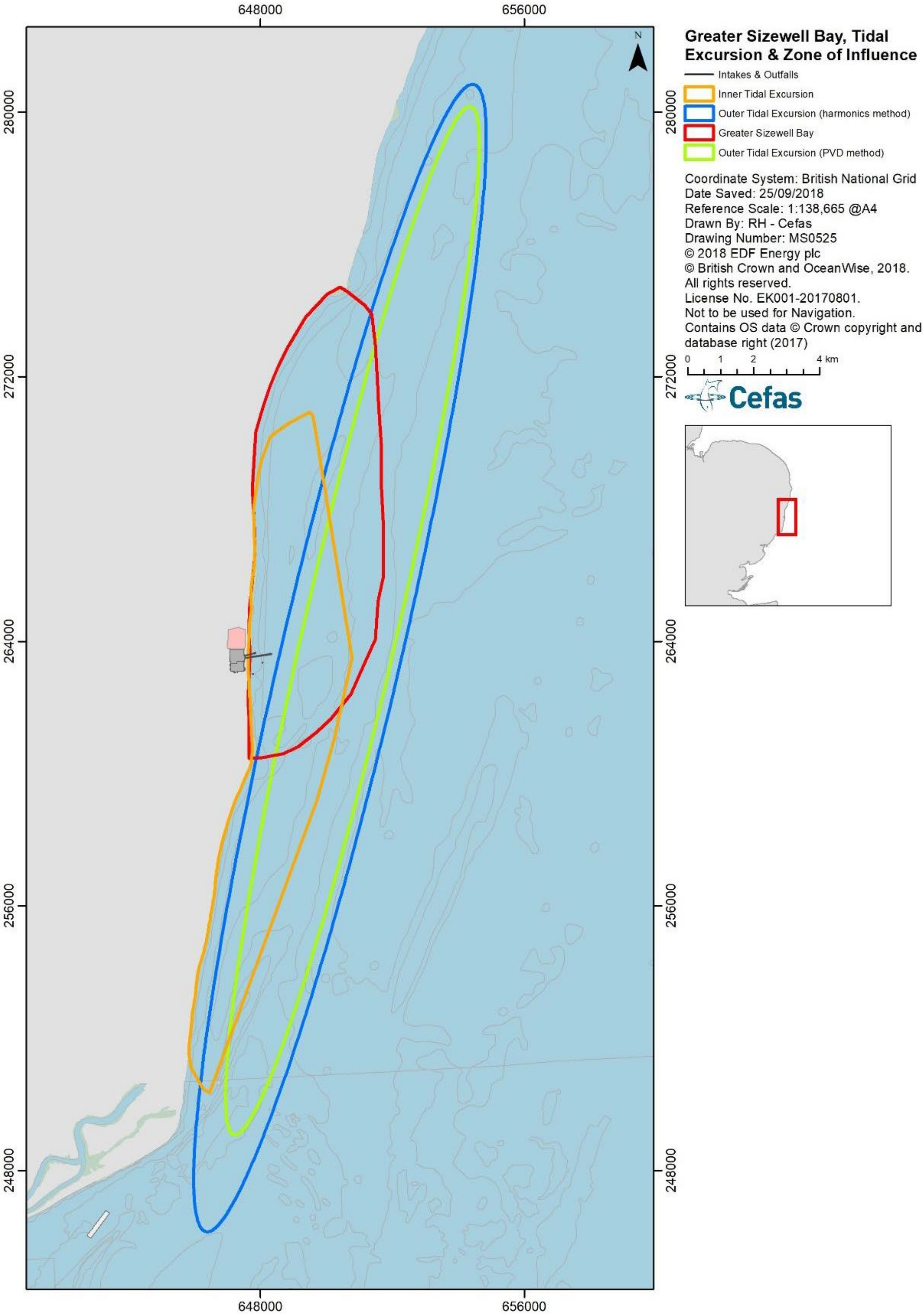


Figure 12: The area of the tidal excursion from the Sizewell C CDO/FRR and outfall during spring tides, the outer tidal ellipse and the Greater Sizewell Bay body of water. Taken from NNB GenCo, 2021a; TR193

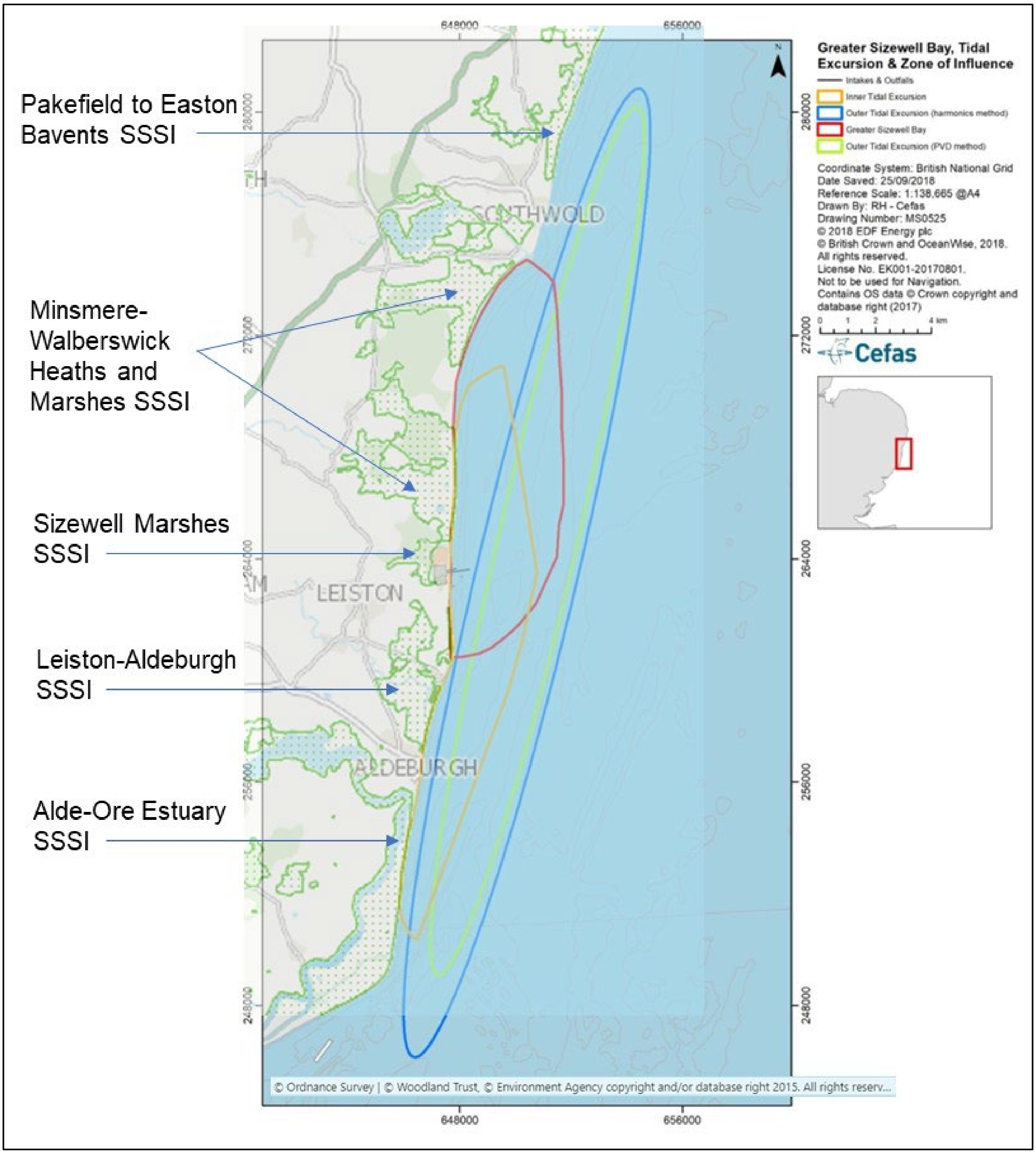


Figure 13: SSSI sites from the Environment Agency's Easimap system overlaid onto the applicant's zones of influence from SZC

4.6. Operations requiring consent

This CRoW assessment will determine whether:

- there is a potential risk from the permit application, which could affect the features of the relevant SSSIs, either directly or indirectly, and if the features are sensitive to the risks
- there is a pathway such that the potential risk could affect the interest features of the site, and the exposure of the feature to this risk
- for each risk, the potential scale or magnitude of any effect could result in an operation likely to damage the features of the SSSIs

The applicant has provided information and modelling to inform our assessment, and we have reviewed this information.

Using advice from Natural England on 'Operations likely to damage the special interest' for the 4 SSSIs, we consider the relevant operation for all 4 is reference number 7, 'dumping, spreading or discharge of any materials.'

The operation of SZC will result in discharges that could potentially affect the SSSIs and their features. The cooling water discharges will result in a chemical and thermal plume, while the fish recovery and return (FRR) system will result in a discharge of organic matter, dead and moribund fish. The discharge from the FRR system may cause an increase in nutrient enrichment and potentially alter the water quality. There is also a wastewater discharge (waste stream G) that could affect the water quality.

An assessment will therefore be made to determine whether there will be any damage to the SSSIs because of these discharges.

4.7. Assessment of risks posed by WDA

The discharges that will be an important element of the operation of SZC pose several risks.

4.7.1. Change to thermal regime

The operation of SZC will require a continuous supply of cooling water which, following its use, will be returned to the Suffolk Coast via a long outlet tunnel. The cooling water discharge will create a thermal plume due to the water being discharged at a higher temperature than that of the sea. This assessment will consider whether this thermal plume has the potential to affect the identified SSSIs and their features. If there is potential for damage, then we will assess its scale and significance.

Depending on the temperature of a discharge, it can potentially cause a significant increase or decrease in receiving waterbody temperatures. Water temperature influences aquatic organisms and affects the composition of biological communities. The effects can be seen in their growth and development, tolerance to toxic substances, success in reproduction, disease resistance, and survival. Temperature can also have an indirect effect on aquatic species by causing changes to water chemistry, for example, oxygen is less soluble in warmer water.

The discharge of heated water can potentially affect features both directly and indirectly. A direct effect would be if a feature encountered the heated water directly, by swimming into it. An example of an indirect effect would be if fish, that are prey species of birds protected under an SSSI, avoid the area of heated water. This displacement of prey could result in less food being available for the birds or require them to expend further energy locating the displaced or new prey.

The seabed immediately surrounding a thermal outlet receives little warming effect as the warmer water rises towards the surface. As a result, species that live in the water column may be affected more than benthic species. As the plume spreads, its temperature falls rapidly due to dilution and loss of heat to the atmosphere, meaning that when the plume does reach the seabed, it is at a much-reduced temperature.

There are no specific water temperature thresholds for SSSIs. However, the UK Technical Advisory Group on Water Quality for the Water Framework Directive recommended temperature thresholds for assessing the effect of thermal discharges on European sites (SACs and SPAs). This included a 2°C deviation from ambient as a maximum allowable concentration at the edge of the mixing zone, as a 100th percentile (WQTAG sub-group, 2006). The annual 100th percentile plume describes the area within which thermal uplift greater than the specified value is exceeded at any point during the year. Thermal uplift of 2°C is not considered to have any link to specific ecological effects, but serves as a precautionary threshold to trigger further investigation (NNB GenCo, 2021b).

The assessment process for the change to the thermal regime as a result of the water discharge activities of SZC is detailed in Environment Agency 2022.

We have accepted the applicant’s modelling of the thermal plume. It predicts that the surface area of the annual 2°C (100th percentile) thermal uplift plume from SZC would be 16,775ha (167.75km^2) at the surface and 12,244ha (122.44km^2) at the seabed, (NNB GenCo, 2021b).

The area within the annual ≥2°C thermal uplift (100th percentile) plume includes any model cell for which ≥2°C thermal uplift is experienced at any point during the year, regardless of the duration of the exceedance. For example, a model cell experiencing ≥2°C thermal uplift for one hour out of the whole year would be within the plume. Having established that there would be exceedance of the annual ≥2°C thermal uplift (as a 100th percentile) threshold as a result of the cooling water system discharge of SZC, the applicant investigated further by using its model to predict thermal uplift plumes, as annual 98th percentiles. The annual 98th percentile plume describes the area within which ≥2°C thermal uplift is exceeded for at least 2% of the time steps modelled. Outside of the annual 98th percentile plume, thermal uplift is less than the specified value for 98%, or more, of the time steps modelled.

The area of the annual ≥2°C thermal uplift plume (as a 98th percentile) is 1,551ha (15.5km²) at the sea surface for SZC alone, as compared to the 16,775ha (167.75km²) of the equivalent 100th percentile plume (NNB GenCo, 2020d; TR306).

The applicant's modelling shows that the ≥2°C (98th percentile) thermal uplift plume from Sizewell C does not reach the coast (Figure 14), and as such when SZC is operating alone, the coastal SSSIs experience thermal uplift of ≥2°C for less than 2% of the year and, given the distance from the contour, probably considerably less than 2% of the year.

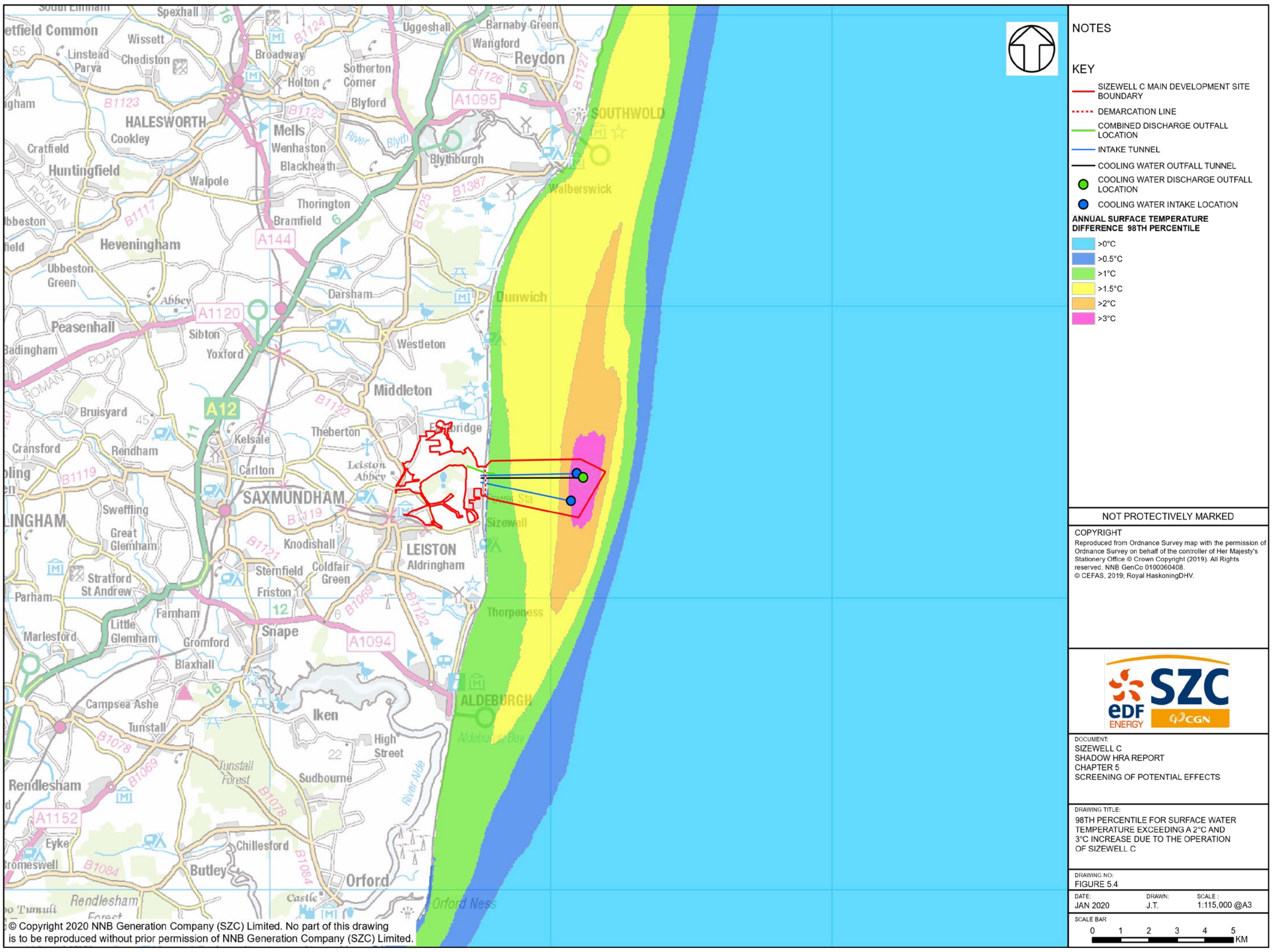


Figure 14: Annual thermal uplift (98th percentile) plumes for SZC. Reproduced from Figure 5.4 in NNB GenCo, 2021b; shadow HRA

4.7.2. Toxic contamination

Chemicals will be discharged via the cooling water system discharge and those chemicals can potentially result in toxic contamination. Emissions from WDAs can potentially be toxic or harmful to protected/designated sites and their features. Flora and fauna can potentially be affected both directly and indirectly. Direct effects would be if a feature came directly into contact with the chemical discharge, for example, a seabird diving into it. Indirect effects could occur if, for example, a bird grazed on vegetation that has been contaminated by the discharge.

All significant direct sources of chemicals discharged to the environment are controlled and generally assessed against recognised standards such as environmental quality standards (EQS), groundwater quality standards or formal thresholds. These standards are designed to protect aquatic habitats and species.

The discharges from SZC will result in a chemical plume; an area of water within which concentrations of chemicals are above EQS or background levels. This assessment will consider whether this chemical plume, and the changes it may cause in the receiving waterbody, has the potential to damage the identified SSSIs and their features. If there is potential for damage, then we will assess the scale and significance of that effect.

The assessment process is detailed in Environment Agency 2022, with the H1 screening process determining that 3 chemicals (or their breakdown products) used during the operation of SZC required further consideration, these being:

- chlorine as total residual oxidant (TRO)
- bromoform
- hydrazine

TRO originates from the combination of chlorine and organic material during chlorination of the cooling water system. Chlorination deters settling of biofouling organisms and is only anticipated to be needed continuously when temperatures are 10°C or higher, although spot chlorination (short-duration chlorination) may occur outside of this temperature range (NNB GenCo, 2021b; shadow HRA). To protect the marine environment, chlorine has a maximum allowable concentration (MAC) EQS expressed as a 95th percentile (as TRO) of 10 micrograms per litre (µg/l) for discharges to transitional and coastal (TRaC) waters (Environment Agency, 2019).

The applicant has modelled the TRO resulting from the combination of chlorine and organic material in the abstracted water, based on laboratory testing of seawater at Sizewell (NNB GenCo, 2019; TR303)

Chlorinated by-products (CBPs) also result from chlorination of the cooling water system. 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 were considered as for TRO. There is no published EQS for bromoform, so the applicant proposed a calculated predicted no effect concentration (PNEC) of 5µg/l as a 95th percentile. 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 outlet.

Hydrazine is an oxygen scavenger used in power plants to inhibit corrosion in steam generation circuits. The applicant proposes to use hydrazine at SZC. Liquid effluent containing residual hydrazine concentrations will be generated from the site’s boiler cooling water circuits to control pH and prevent corrosion (present within SZC waste streams B/C and D). This effluent will be released periodically (also known as a ‘batched’ discharge) to the environment via the main cooling water stream (waste stream A) and its 2 long sea outlets. There is evidence that hydrazine is harmful to aquatic organisms at low concentrations, with a low to moderate persistence within the marine environment, depending on its concentration and the receiving water quality. There is no established EQS for hydrazine, so the applicant proposed a chronic PNEC of 0.4 nanograms per litre (ng/l) for long-term effects (calculated as the mean of the concentration values) and an acute PNEC of 4.0ng/l for short-term effects (represented by the 95th percentile) (NNB GenCo, 2021b; Shadow HRA)).

The modelled mixing zones (areas within which the EQS/PNEC is exceeded) for total residual oxidants (TRO), bromoform and hydrazine are offshore and there is no connectivity with the SSSIs or their estuary features (Figure 15, Figure 16, Figure 17 and Figure 18).

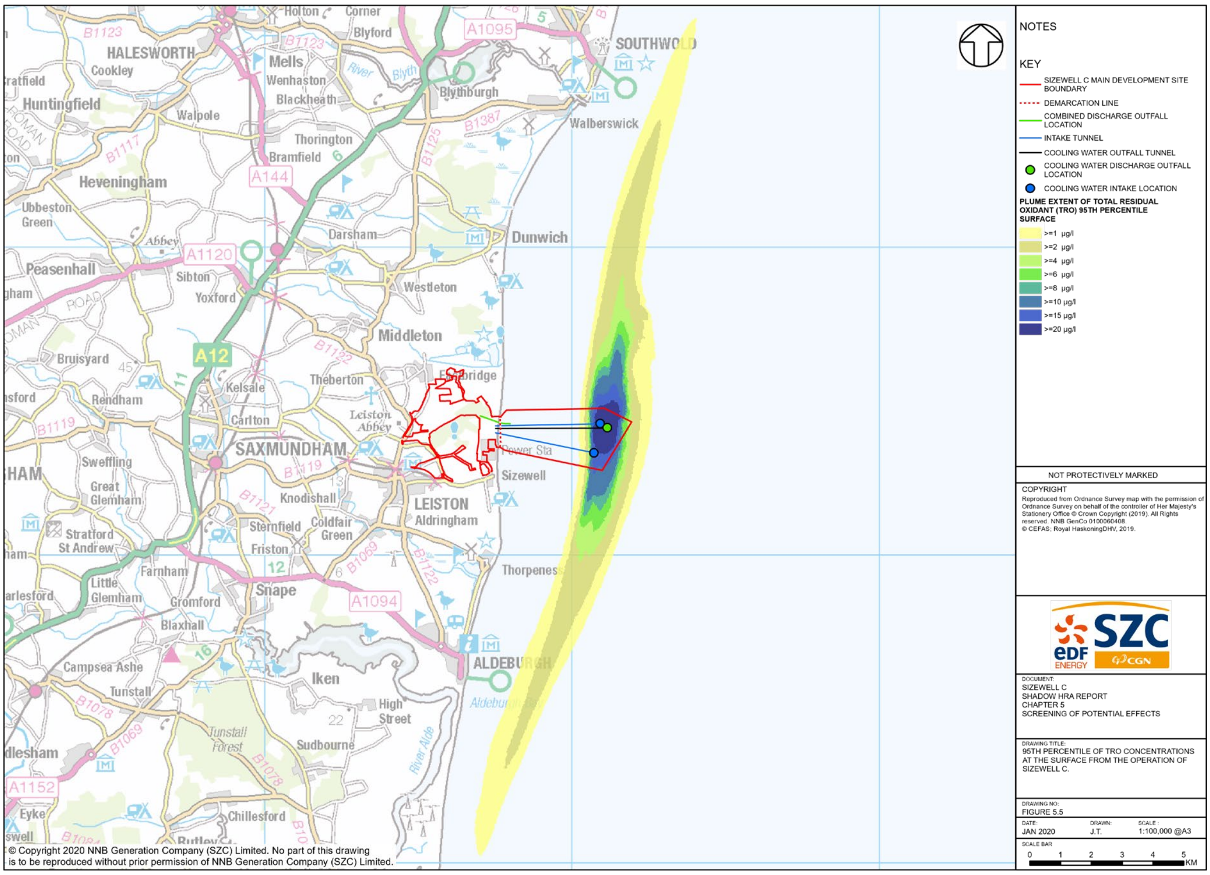


Figure 15: The applicant's modelling of surface TRO concentrations (as 95th percentiles) for SZC alone. Map reproduced from Figure 5.5 of NNB GenCo, 2021b; shadow HRA

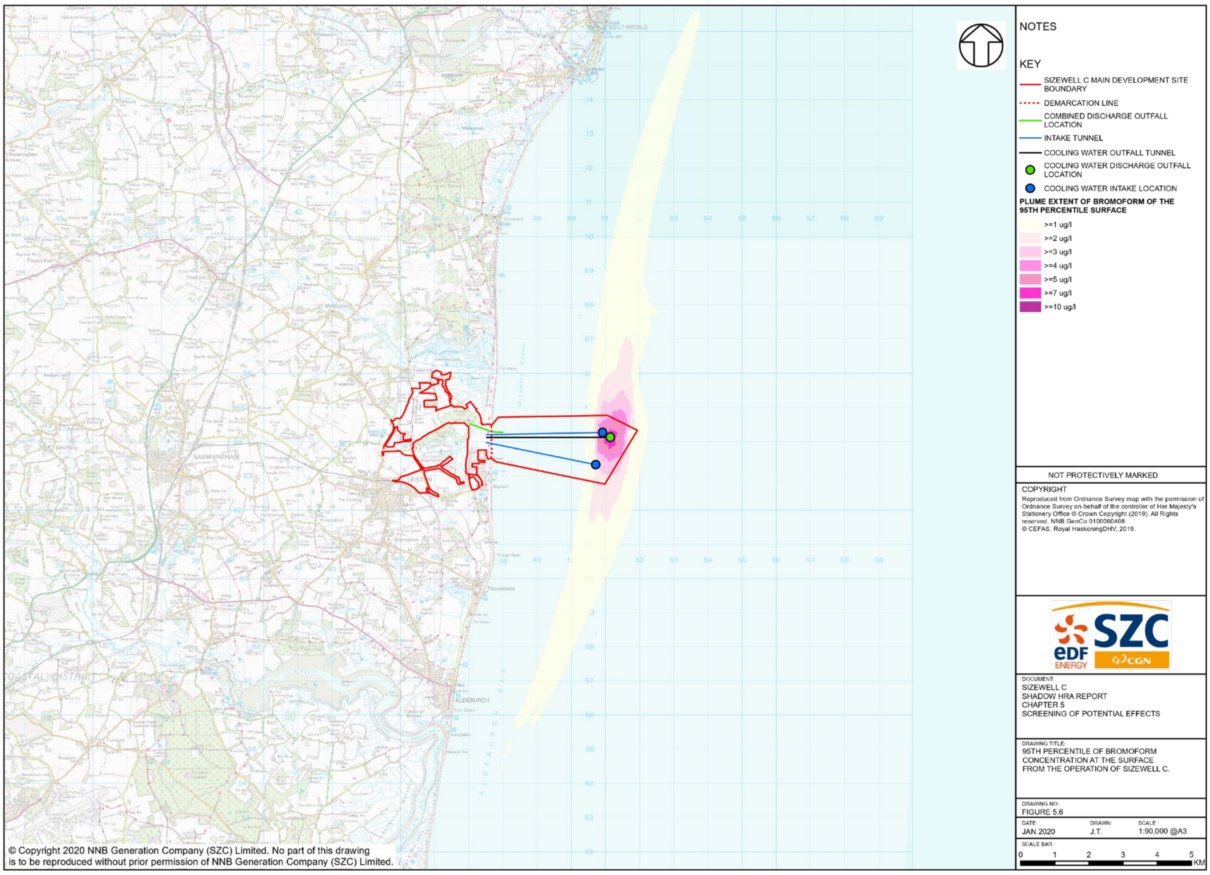


Figure 16: The applicant's modelling of surface bromoform concentrations (as 95th percentiles) for SZC alone. Map reproduced from Figure 5.6 of NNB GenCo, 2021b; shadow HRA

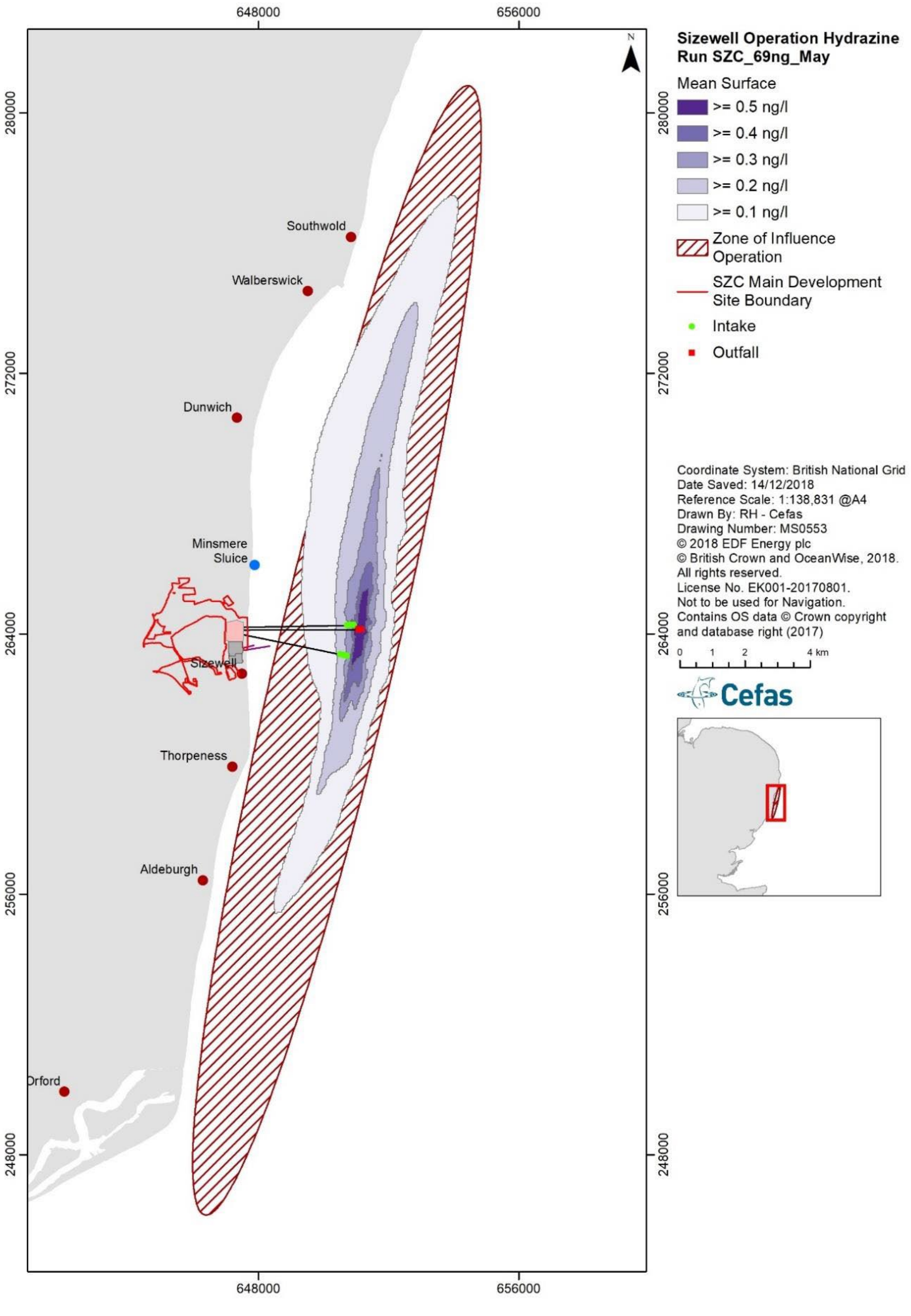


Figure 17: The applicant's modelling of mean hydrazine concentrations at the surface after release of 69ng/l in pulses of 2.32h from SZC. The ≥0.4ng/l contour represents the chronic PNEC value. Map reproduced from NNB GenCo, 2021a; TR193

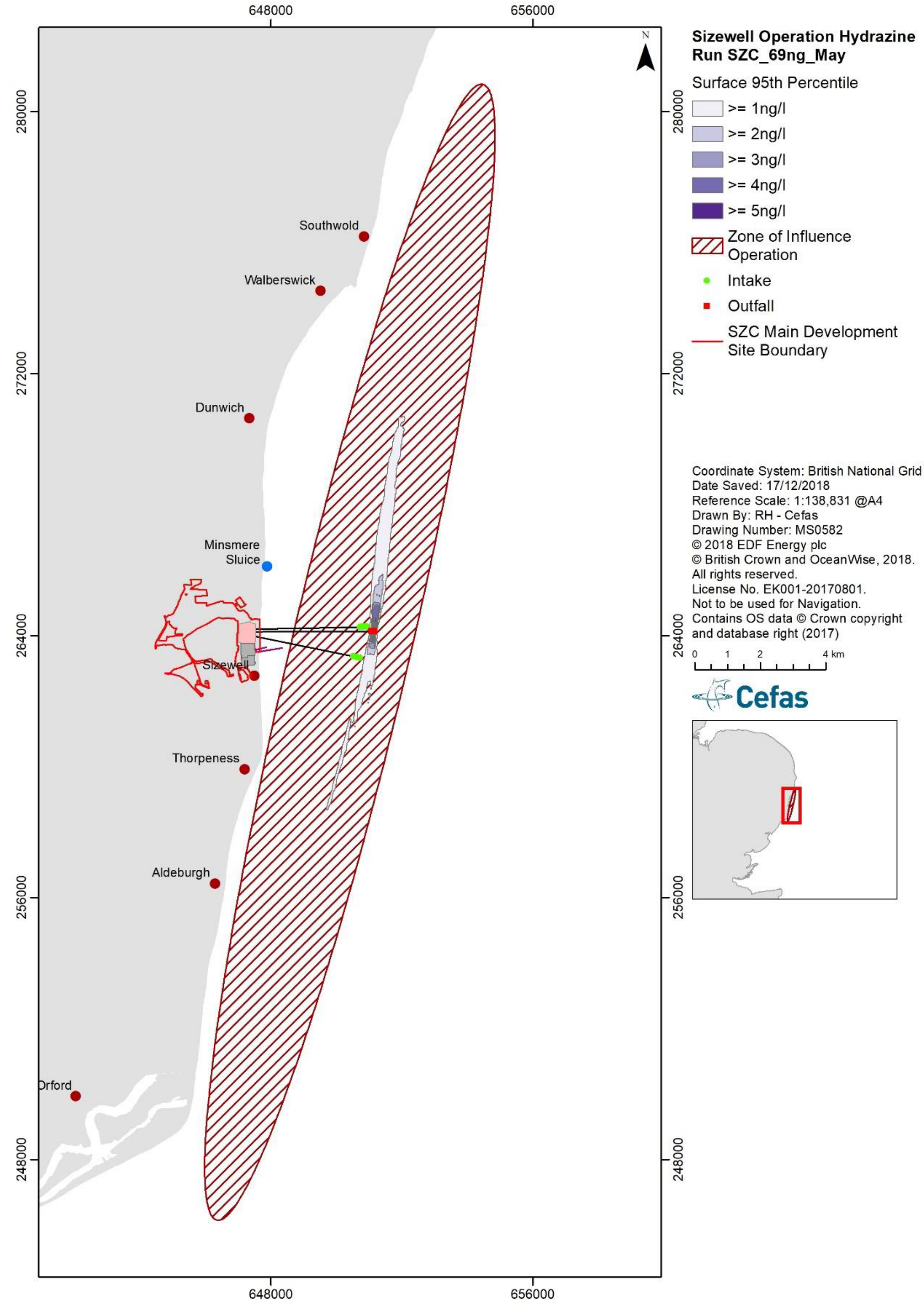


Figure 18: The applicant's modelling of the 95th percentile of hydrazine concentrations at the surface after release of 69ng/l in pulses of 2.32h from SZC. The ≥ 4.0ng/l contour represents the acute PNEC value. Map reproduced from NNB GenCo, 2020d TR306

4.7.3. Nutrient and organic enrichment

Discharges from SZC include waste stream G (from the onsite sewage treatment works (STW)) and waste stream H (from the fish recovery and return systems). Both discharges have the potential to cause nutrient enrichment, with the discharge from the FRR systems contributing via the decomposition of discharged dead (or moribund) biota.

Eutrophication is the gradual increase and enrichment of ecosystems by nutrients such as nitrogen (N) and/or phosphorus (P). WDAs containing treated sewage effluent will typically have elevated phosphorus and nitrogen levels relative to the receiving waterbody. Nutrient enrichment has the potential to affect SSSIs and their features directly and indirectly. As for previous risks discussed, if the nutrient-rich discharges come into direct contact with species, then they may be affected directly. But, species can also be affected indirectly if, for example, increasing nutrients lead to common plant species growing more vigorously and outcompeting rarer plant species for which the site is designated.

When there are excessive nutrients in intertidal habitats, dense mats of opportunistic macroalgae can form, and they can smother the intertidal habitat, therefore preventing oxygen and nutrient flow and blocking light. These algal mats can also form a barrier to birds which feed by probing intertidal muds. This can then affect the area's overall availability and suitability for bird breeding, rearing, feeding, and roosting. In saltmarshes, changes to the nutrient status of the underlying sediment and the processes that allow the effective cycling of nutrient may affect the local vegetation communities.

High concentrations of nutrients in the water column can also cause phytoplankton and opportunistic macroalgae blooms, leading to a reduction in dissolved oxygen availability. This can affect sensitive fish, as well as biological communities living on or within the substrate and therefore adversely affect the availability and suitability of bird breeding, rearing, feeding, and roosting habitats.

Nutrient enrichment can also lead to increases in turbidity. Turbidity is a measure of the amount of suspended solids present within the water, and levels can change rapidly as a result of a variety of factors, including biological (for example, plankton blooms), physical (for example, storms/floods), or human (for example, physical disturbance from coastal development or discharge activities).

The nutrient-rich discharges associated with the operation of SZC pose a risk to turbidity only via biological factors, as the nutrients released could lead to an increase in plankton production. Increased turbidity associated with suspended solids, such as plankton production, can decrease the depth to which light is able to penetrate, which can then affect photosynthesis by plants and macroalgae. This could affect invertebrates directly and as food for birds.

This assessment will consider whether nutrients in discharges from SZC, and the changes they may cause in the receiving waterbody, have the potential to affect the identified SSSIs and their features. If there is potential for an effect, then we will assess the scale and significance of that effect.

While not a nutrient itself, potential effects of unionised ammonia are also considered in this section as this input derives from sewage treatment works (STW) and FRR systems discharges. Unionised ammonia can be toxic to the fish prey of seabirds such as the terns and gulls designated forthe Alde-Ore Estuary SSSI.

This section will also consider organic enrichment, which is the carbon released by the decomposition of dead fish and invertebrates discharged from the FRR systems.

The assessment process is detailed in Environment Agency 2022 which shows that the increase in organic and nutrient enrichment will have no adverse effect in the Greater Sizewell Bay area. As described in the following sections, there will be no negative effects on sites as a result of changes to levels of unionised ammonia or dissolved oxygen.

Nutrient enrichment

The applicant's modelling showed that the release of nitrogen as N in the cooling water would be 484.3µg/l, a combination of the background level of N in the seawater and the amount of N discharged by the power station, which includes 4.4kg/day (1,595kg/y) from sanitary effluent. A release of 484.3µg/l is 49% of the EQS value of 980µg/l (as a 99th percentile); this EQS is the winter standard for waterbodies of intermediate turbidity. We accepted the applicant's cooling water assessment. We did not accept the applicant's separate assessment of nutrients from the FRR systems. We carried out our own assessment of the nutrient input from the FRR systems of SZC (waste stream H) and it is not expected to exceed 20.4kg of phosphate (P) per day and 142.9kg of nitrogen (N).

The applicant modelled the effect of phosphate and nitrates discharged from both the cooling water and FRR systems discharges at SZC on phytoplankton productivity, concluding that while there may be an increase in local phytoplankton productivity, the effect of discharged nutrients would be more than offset by phytoplankton entrainment mortality through the cooling water system.

We used a reasonable worst-case scenario for impingement which calculated a daily input of N from the FRR system discharge of around 4 times the amount of N input used by the applicant in its modelling assessment, but this higher level of input would also have a negligible effect on phytoplankton growth.

Unionised ammonia

The applicant calculated 24-hour discharge figures for unionised ammonia (NH_3) in the cooling water discharges of SZC and SZB combined of 7.92µg/l, with no areas at the surface within the receiving waterbody exceeding the annual average EQS of 21µg/l. Although no figures were provided for SZC operating on its own, the SZC figure would be lower than the SZC and SZB combined figure. Since the SZC and SZB combined figure is below the EQS, it follows that the SZC alone figure would also be below the EQS.

For the FRR system discharge, we used our reasonable worst-case scenario for impingement and calculated a surface area of just 428.3m² (with thermal uplift) is required to dilute the unionised ammonia (NH_3) resulting from the FRR systems discharges of SZC to its EQS of 21µg/l (as an annual mean). This does not mean that there would in fact be an area of exceedance of these dimensions. The actual area of exceedance, if any, will be much smaller as biota are discharged throughout the day and night from 2 outlets, rather than over one short time period, and all in a single location. Biota will also be dispersed away from the outlets, with a proportion consumed by scavengers, rather than all settling in one place. The applicant's particle tracking modelling indicated sprat-like particles may disperse over an area of up to 32.7km² (NNB GenCo, 2021d; TR511). Furthermore, the discharge is taking place in a tidal environment, with a flow of water moving past the discharge points with the tides. The surface area of water required to dilute the unionised ammonia resulting from the FRR system discharge of SZC alone to its EQS value is slightly below 0.001% of the tidal excursion (43.6km²) (NNB GenCo, 2020d; TR306). The tidal excursion is the horizontal area over which a particle would be transported through the ebb and flow of a tidal cycle.

Dissolved oxygen

Based on the maximum SZC site population and the standard by which effluent must be treated to a biochemical oxygen demand ($BOD_{5\text{-atu}}$) concentration of 20mg/l, the $BOD_{5\text{-atu}}$ loading of waste stream G will be 1,387kg/year. This will have little or no effect on the receiving environment, particularly given the diluting effect of the cooling water (waste stream A).

The surface area required to meet the daily oxygen demand of the discharge from the FRR systems of SZC, was calculated as being 1.056km (using our reasonable worst-case scenario for impingement, Environment Agency, 2022). This does not mean that there will in fact be a de-oxygenated area of this size. The actual areas over which effects on oxygen levels occur will be smaller due to the continuous discharge of biota from 2 separate outlets, the dispersal of that biota away from the outlets, the consumption of a proportion of that biota by scavengers and the tidal movement of water past the outlets. The surface area of water required to meet the daily oxygen demand of the discharge from the FRR systems of SZC alone (1.05km²) is just 2.4% of the tidal excursion (43.6km²) (NNB GenCo, 2020d; TR306).

Organic enrichment

Organic enrichment refers to carbon released by the decomposition of dead fish and invertebrates discharged from the FRR systems. As a proxy for an EQS, 100g organic carbon/m^2/year has been used as an acceptable baseline to assess the negative effects of organic enrichment.

Birds can be affected indirectly through changes to supporting habitats or their prey. Tyler-Walters and others (2018) describe how organic enrichment encourages the productivity of suspension and deposit feeding detritivores and allows other species to colonise the affected area to take advantage of the enhanced food supply. Other pressures are exerted on the habitat, such as an accumulation of organic matter on the seabed – smothering organisms – and oxygen depletion (Tyler-Walters and others, 2018). The benthic invertebrate community response is characterised by decreasing numbers of species, total number of individuals and total biomass, and dominance by a few pollution-tolerant annelid worms.

We assessed the potential effect of organic enrichment by referring to the maximum potential area of organic exceedance. This is the largest area over which the annual discharge of dead fish and invertebrates from the FRR systems discharge could theoretically be spread to achieve an even thickness that will release carbon at the proxy EQS rate over the whole area. As such, the maximum potential area of organic exceedance is the largest area over which biology could be affected by organic enrichment from the FRR systems discharge. Should biota be dispersed further away from the outlet than the boundary of the maximum potential area of organic exceedance, then the release of carbon over that wider area would occur at less than the proxy EQS rate of 100g carbon/m²/year.

Using our reasonable worst-case scenario for impingement, we calculated that the maximum potential area of organic exceedance for SZC was 9.16km². Using tidal parameters from the applicant's calculation of the thermal plume, we then scaled this to an approximation of a plume forming an ellipse 8.296km long by 1.406km wide (Figure 19).

Based on the maximum potential area of organic exceedance for SZC there appears to be potential for the Minsmere-Walberswick Heaths and Marshes SSSI, and perhaps also the Leiston-Aldeburgh SSSI, to be affected by organic enrichment. However, the applicant's particle tracking study (NNB GenCo, 2021c; TR316) provides evidence that biota will in fact be transported further than the boundary of the maximum potential area of organic exceedance. As such, the input of organic carbon will be below the proxy EQS at these sites. The particle tracking study modelled the distribution of sprat-sized particles from the SZC FRR systems discharge, showing that they would be distributed over at least 32.7km², over 3 times greater than the 9.16km² maximum potential area of organic exceedance for SZC (Figure 20).

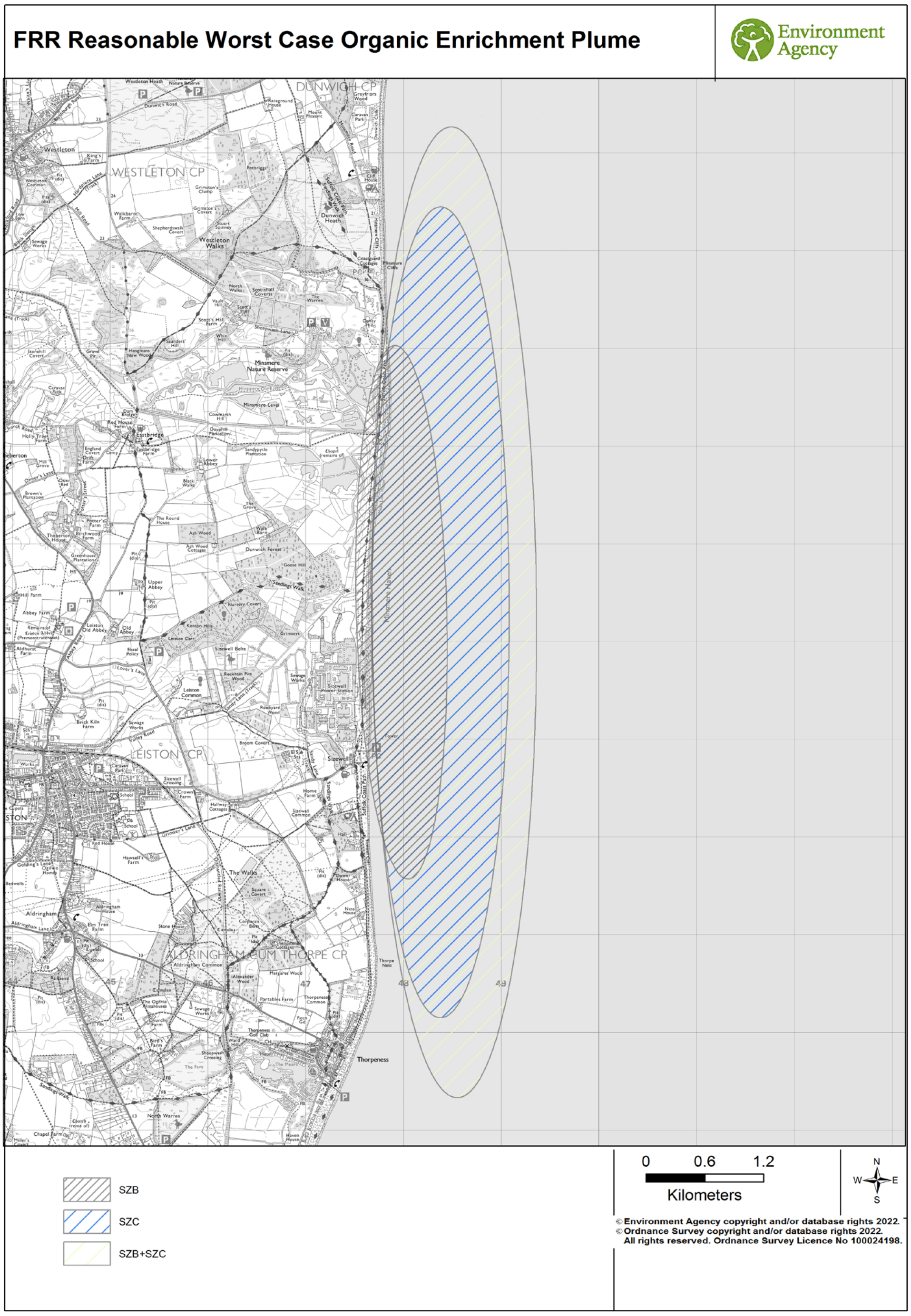


Figure 19: The maximum potential area of organic exceedance for SZC alone, SZB alone, and SZC and SZB in combination, based on the upper 95% confidence limit of the mean of the Environment Agency's precautionary 'worst-case with invertebrates' scenario

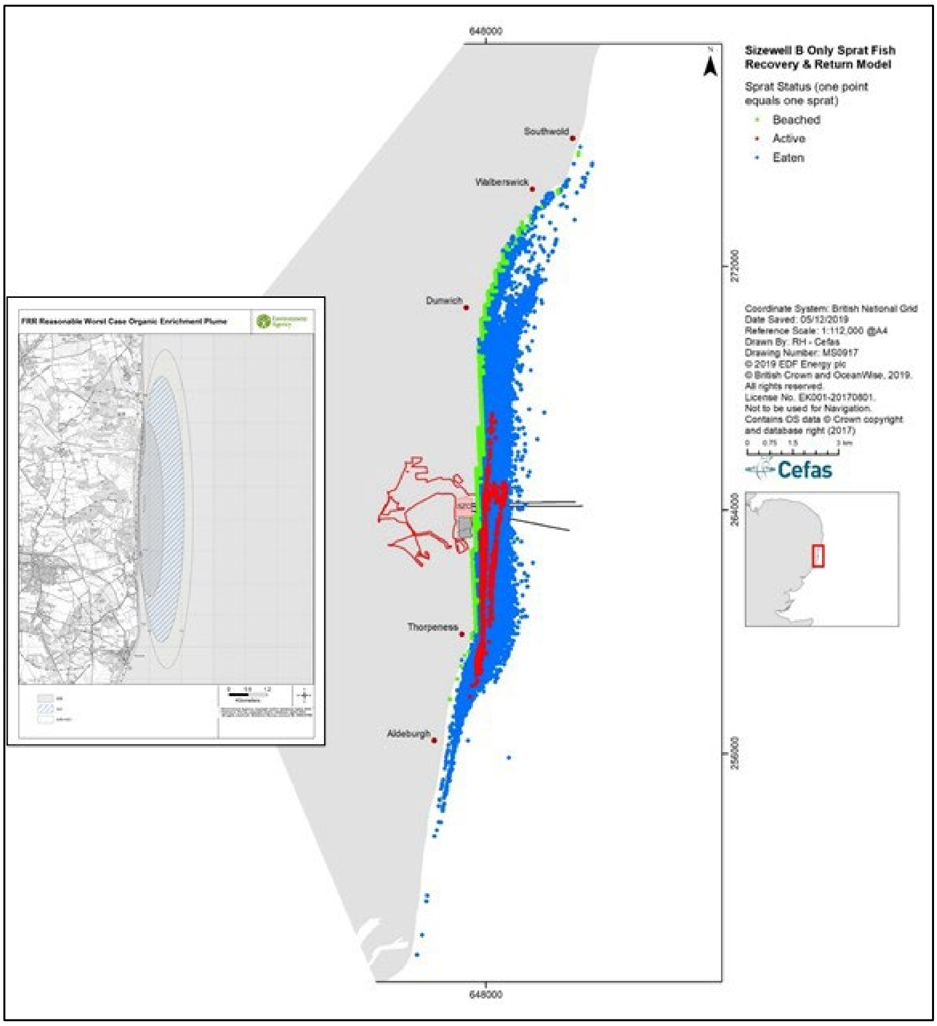


Figure 20: The Environment Agency's maximum potential area of organic exceedance for SZC alone, SZB alone, and SZC and SZB in combination (left inset) compared to the distribution of sprat-like particles in the applicant's particle tracking study (main map – reproduced from Figure 7 in NNB GenCo, 2021d; TR511)

4.8. Assessment of relevant SSSIs

The following SSSIs were identified in section 4.5 as requiring assessment:

- Pakefield to Easton Bavents SSSI
- Minsmere-Walberswick Heaths and Marshes SSSI
- Leiston to Aldeburgh SSSI
- Alde Ore Estuary SSSI

4.8.1. Pakefield to Easton Bavents SSSI

The list of notified features provided by Natural England on 15 November 2021:

Aggregations of breeding birds

- bearded tit (Panurus biarmicus)
- bittern (Botaurus stellaris)
- little tern (Sterna albifrons)
- marsh harrier (Circus aeruginosus)
- water rail (Rallus aquaticus)

Aggregations of non-breeding birds

- bittern (Botaurus stellaris)

Aggregations of breeding birds, supporting habitats

- lowland heath
- lowland open waters and their margins
- scrub
- woodland

Geological features

- EC - Pleistocene Vertebrata
- EC - quaternary of East Anglia
- IA - coastal geomorphology

Coastal features

- isolated saline lagoons
- MC5 - Armeria maritima - Cerastium diffusum ssp. diffusum maritime therophyte community
- percolated saline lagoons
- S21 - Scirpus maritimus swamp
- saline coastal lagoons
- SD1 - Rumex crispus - Glaucium flavum shingle community
- SD6 - Ammophila arenaria mobile dune community
- SD7 - Ammophila arenaria - Festuca rubra semi-fixed dune community

Wetland features

- S25 - Phragmites australis - Eupatorium cannabinum tall-herb fen
- S26 - Phragmites australis - Urtica dioica tall-herb fen
- S4 - Phragmites australis swamp and reed beds

Assemblage

- vascular plant assemblage

Features relevant for assessment

The main cooling water discharges from the operational SZC permit are around 3km offshore. The assessment in our HRAR shows the modelled areas of thermal plume and those exceeding the EQS/predicted no effect concentration (PNEC) for total residual oxidants (TRO), bromoform and hydrazine are offshore (shown in Figure 15, Figure 16, Figure 17 and Figure 18) and do not interact with the coastline. The assessment shows that there is no significant increase in organic or nutrient enrichment in the Greater Sizewell Bay area and therefore there will be no effect on the SSSI or estuary features.

With the exception of little tern, which could forage offshore, all the features are above the mean high water, or are terrestrial or geological, and there is therefore no potential for damage. Little tern will be considered further in section 4.9.

4.8.2. Minsmere-Walberswick Heaths and Marshes SSSI

Features list

The list of notified features provided by Natural England on 15 November 2021:

Aggregations of breeding birds

- avocet (Recurvirostra avosetta)
- bearded tit (Panurus biarmicus)
- bittern (Botarus stellaris)
- Cetti’s warbler (Cettia cetti)
- garganey (Anas querquedula)
- marsh harrier (Circus aeruginosus)

Aggregations of breeding birds, supporting habitat

- lowland damp grasslands

Heathland features

- H1 – Calluna vulgaris – Festuca ovina heath
- H8 – Calluna vulgaris – Ulex galli heath

Assemblages

- invertebrate assemblage
- variety of breeding bird species (70)
- variety of passage bird species (150)
- variety of wintering bird species (90)
- vascular plant assemblage

Other habitat features and species

- lowland ditch systems

- population of Schedule 8 plant – Filago lutescens, red-tipped cudweed

Wetland habitats

- M22 – Juncus subnodulosis – Cirsium palustre fen meadow
- M23 – Juncus effusus/acutiflorus – Galium palustre rush pasture
- M27 – Filipendula ulmaria – Angelica sylvestris mire
- S2 – Caldium mariscus swamp and sedge-beds
- S26 – Phragmites australis – Urtica dioica tall-herb fen
- S4 – Phragmites australis swamp and reed beds
- S7 – Carex acutiformis swamp

Coastal features

- SD1 – Rumex crispus – Galucium flavum shingle community
- SD11 – Carex arenaris – Cornicularis aculeata dune community
- SD2 – Cakile maritima – Honkenya peploides strandline community
- SD6 – Ammophila arenaria – Mobile dune community
- sheltered muddy shores (including estuarine muds)
- SM14 – Atriplex portulacoides saltmarsh
- SM24 – Elytrigia atherica saltmarsh

Woodland features

- W6 – Alnus glutinosa – Urtica dioica woodland

Features relevant for assessment

The Minsmere-Walberswick Heaths and Marshes SSSI is designated for a variety of features, not all of them are at risk from the SZC discharges.

The only pathway for effect between the SZC discharges and the Minsmere-Walberswick Heaths and Marshes SSSI is via the Minsmere Sluice. This allows seawater into the site and into the freshwater marshes within the Minsmere RSPB reserve, which is important in maintaining the brackish element of the marshes in that area. Any change to the sea water due to the SZC operational discharges could therefore potentially affect the site and its features via the sluice.

The applicant provided the following information about the sluice in its response to our Schedule 5 request Number 5 (NNB GenCo, 2021e):

> "The sluice is divided into two chambers, each with its own gravity outlet culvert. The northern chamber receives flows from the northern culvert of the Minsmere New Cut, while the southern chamber receives flows from Leiston Drain and Scott's Hall drain. The southern chamber is also connected to the Minsmere New Cut through its southern culvert, which includes a penstock at its upstream face. The penstock is opened to alleviate high water levels in the catchment. When river levels exceed sea levels, water flows from river to sea. When sea levels exceed

river levels, flow will cease, and water stored upstream of the sluice. Some ingress of seawater into the freshwater system has been factored into the design.

… water quality in the surface watercourses in influenced by the input of saline water from Minsmere sluice, which results in elevated salinity and sulphate levels in the immediate vicinity of the sluice. This suggests that saline influence is localised to the sluice and/or that saline intrusion is infrequent and does not have a lasting effect on upstream surface water quality.”

Some of the SSSI features will not be assessed further as it is considered that there is no pathway. This lack of pathway can be due to the nature of the feature itself and a lack of sensitivity to the risks any discharge into the marine environment would pose. The lack of pathway can also be due to the location of the feature within the SSSI; features that are a significant distance away from the sluice or not joined to the waterbodies/channels connected to the sluice will not be at risk from the seawater that comes into the site from the sluice (for example, features above mean high water level, or terrestrial features).

Features that will not be assessed further are:

Heathland features

- H1 – Calluna vulgaris – Festuca ovina heath
- H8 – Calluna vulgaris – Ulex galli heath

Other habitats or features

- Population of schedule 8 plant – Filago lutescens – Red-tipped cudweed

Coastal features

- SD11 – Carex arenaris – Corniculus aculeata dune community
- SD6 – Ammophila arenaria – Mobile dune community
- Sheltered muddy shores (including estuarine muds)
- SM14 – Atriplex portulacoides saltmarsh
- SM24 – Elytrigia atherica saltmarsh
- SD1 – Rumex crispus – Galucium flavum shingle community
- SD2 – Cakile maritima – Honkenya peploides strandline community

Woodland feature

- W6 – Alnus glutinosa – Urtica dioica woodland

Aggregations of breeding birds, supporting habitat

- lowland damp grasslands

The remaining assemblages, supporting habitat and wetland features notified for this site are potentially at risk as a result of the sluice providing a mechanism for the thermal and chemical plumes and/or organic enrichment to potentially affect the site and its features. It should be noted that any potential effect is likely to be localised to the area surrounding the sluice.

Features to be assessed further are:

Aggregations of breeding birds

- avocet (Recurvirostra avosetta)
- bearded tit (Panurus biarmicus)
- bittern (Botarus stellaris)
- Cetti's warbler (Cettia cetti)
- garganey (Anas querquedula)
- marsh harrier (Circus aeruginosus)

Assemblages

- invertebrate assemblage
- variety of breeding bird species (70)
- variety of passage bird species (150)
- variety of wintering bird species (90)
- vascular plant assemblage

Other habitat features and species

- lowland ditch systems

Wetland habitats

- M22 – Juncus subnodulosis – Cirsium palustre fen meadow
- M23 – Juncus effusus/acutiflorus – Galium palustre rush pasture
- M27 – Filipendula ulmaria – Angelica sylvestris mire
- S2 – Caldium mariscus swamp and sedge-beds
- S26 – Phragmites australis – Urtica dioica tall-herb fen
- S4 – Phragmites australis swamp and reed beds
- S7 – Carex acutiformis swamp

4.8.3. Leiston to Aldeburgh SSSI

The list of notified features provided by Natural England on 15 November 2021:

Aggregations of breeding birds

- gadwall (Mareca strepera)
- marsh harrier (Circus aeruginosus)
- woodlark (Lullula arborea)

Aggregations of non-breeding birds

- gadwall (Mareca strepera)
- shoveler (Anas clypeata)
- white-fronted goose (Anser albifrons albifrons)

Aggregations of breeding birds, supporting habitats

- lowland damp grasslands
- lowland open waters and their margins

Heathland, acid grassland habitats

- H1 - Calluna vulgaris - Festuca ovina heath
- U1 b,c,d,f - Festuca ovina - Agrostis capillaris - Rumex acetosella grassland

Assemblages

- outstanding dragonfly assemblage
- variety of breeding bird species (70)
- vascular plant assemblage

Wetland habitats

- S4 - Phragmites australis swamp and reed-beds
- lowland ditch systems

Coastal habitats

- SD1 - Rumex crispus - Glaucium flavum shingle community

Woodland

- W1 - Salix cinerea - Galium palustre woodland
- W6 - Alnus glutinosa - Urtica dioica woodland
- W2 - Salix cinerea - Betula pubescens - Phragmites australis woodland

Features relevant for assessment

There is no connectivity from the discharge into the marine environment with the features of this site as they are freshwater or terrestrial. The coastal feature is above mean high water, so there is no connectivity with the marine environment and the discharges.

No further assessment is required.

4.8.4. Alde Ore Estuary SSSI

The list of notified features provided by Natural England on 15 November 2021:

Aggregation of breeding birds

- avocet (Recurvirsotra avosetta)
- black-headed gull (Chroicocephalus ridibundus)
- herring gull (Larus argentatus)
- lesser black-backed gull (Larus fuscus)
- little tern (Sterna albifrons)
- marsh harrier (Circus aeruginosus)
- Sandwich tern (Sterna sandvicensis)
- shoveler (Anas clypeata)

Aggregations of non-breeding birds

- avocet, Recurvirsotra avosetta
- Bewick's swan (Cygnus columbianus bewickii)
- redshank (Tringa tetanus)
- shelduck (Tadorna tadorna)
- teal (Anas crecca)
- wigeon (Anas penelope)

Assemblages of breeding birds, supporting habitat

- lowland damp grasslands

Geological

- EC – Neogene
- IA – coastal geomorphology

Coastal features

- estuaries
- anemone
- saline coastal lagoons
- SD1 – Rumex crispus – Galucium flavum shingle community
- SD2 – Cakile maritima – Honkenya peploides strandline community
- SM14 – Atriplex portulacoides saltmarsh

Assemblage

- vascular plant assemblage

Features relevant for assessment

The Alde-Ore Estuary SSSI is designated for a variety of species, but not all of them are at risk from the SZC discharges.

The following features are geological and not sensitive to water quality changes and will not be assessed further:

- EC – Neogene
- IA – coastal geomorphology

All the remaining features notified for this site are potentially sensitive to the risk and will therefore be assessed further.

This site is designated for aggregations of several breeding and non-breeding birds and bird assemblages associated with lowland wet grassland. It is also designated for a variety of species and habitats, with a reliance on marine influence within the Alde Ore Estuary.

The location of this site in relation to the SZC main development site does mean that the way in which it and its features could be affected is limited. Figure 14 shows that the SZC ≥2°C thermal uplift exceedance plume (as a 98th percentile) does not reach the site. We can therefore conclude that any potential change to the thermal regime affected by the discharge from SZC will not damage this site and its features.

The modelled areas exceeding the EQS or PNEC for total residual oxidants (TRO), bromoform and hydrazine modelled plumes are offshore as shown Figure 15, Figure 16, Figure 17 and Figure 18 and there is no connectivity with the site or its features. We can therefore conclude that any potential toxic contamination resulting from the chemical discharge will not damage this SSSI or its features.

There is potential for some of the bird species to be affected by the thermal and chemical plumes as birds are by nature mobile species and often travel significant distances to find food. Theoretically therefore, if any of the bird species feed offshore, they may come into contact with the plumes. This is only a risk for a small number of the SSSIs' bird features as most of them are freshwater or estuarine feeders and will not come into contact with the chemical and thermal plumes. The features that could potentially be affected by the chemical and thermal plumes are aggregations of breeding birds; the herring gull, black-headed gull, lesser black-backed gull, little tern and Sandwich tern. These are considered in 4.9.

4.9. Assessment of effects: Seabird species linked to Pakefield to Easton Bavents SSSI and Alde-Ore Estuary SSSI

The potential risks posed by the WDA were identified and discussed in section 4.7 of this assessment. In this section, we will assess the ways in which the discharges may damage the Alde-Ore Estuary SSSI and Pakefield to Easton Bavents SSSI and the birds that could feed offshore.

4.9.1. Seabird features

For Pakefield to Easton Bavents SSSI:

- aggregations of breeding birds, little tern

For Alde-Ore Estuary SSSI:

- aggregations of breeding birds
    - herring gull
    - lesser black-backed gull
    - little tern
    - black-headed gull
    - Sandwich tern

The risk to these breeding seabird features will now be considered.

4.9.2. Methodology

We will apply the methodology used in our associated HRAR (Environment Agency 2022) to consider the potential for changes to the thermal regime and toxic contamination to affect the Pakefield to Easton Bavents and Alde-Ore Estuary SSSI breeding seabirds. Of the species discussed in our HRAR, little tern, Sandwich tern and lesser black-backed gull are also features of the relevant SSSIs. In addition to these, the Alde-Ore Estuary SSSI also has 2 other breeding seabirds that might feed offshore – the black-headed gull and the herring gull.

To assess the potential to affect seabird features, we considered the percentage overlap between foraging areas for breeding seabirds based on generic foraging ranges provided in Woodward and others (2019), reproduced in Table 45, and the thermal and chemical plumes calculated by the applicant. Foraging areas were centred on known colonies, or on the closest coastal point to the SZC main development site within a particular SSSI as an approximation to a worst-case scenario to account for not knowing where seabird colonies may establish over the 60-year operational period of SZC.

For breeding seabird features, 3 descriptions of foraging areas were used:

- mean maximum and standard deviation (SD) foraging area
- mean maximum foraging area
- mean foraging area

The mean maximum foraging area is the area within an arc centred on the colony location, with a radius equivalent to the mean maximum foraging range for the feature. The mean maximum foraging range describes the usual maximum extent of the foraging area for the breeding sea bird feature.

The mean maximum + SD foraging area is the area within an arc centred on the colony location, with a radius equivalent to the mean maximum foraging range for the feature plus its standard deviation. This too is a description of the usual maximum extent of the foraging area for the breeding seabird feature, but with an added allowance for the variability within the datasets considered by Woodward and others (2019).

The mean foraging area is the area within an arc centred on the colony location, with a radius equivalent to the mean foraging range for the feature. In our assessments the mean foraging area is used as a proxy for areas of concentrated foraging closer to the colony. The mean foraging area is the smallest of the foraging areas for which overlaps have been calculated and, as such, is the most precautionary of the foraging areas to use.

Table 45: Mean maximum plus standard deviation (SD), mean maximum, and mean foraging ranges, in kilometres, for the lesser black-backed gull, sandwich tern, little tern, black-headed gull and sandwich tern, from Woodward and others. (2019).

Breeding seabird feature	Mean maximum + SD	Mean maximum	Mean
Lesser black-backed gull	236.0	127.0	43.3
Sandwich tern	57.5	34.3	9.0
Little tern	-	5.0	3.5
Black-headed gull	-	18.5	7
Herring gull	85.6	58.8	14.9

For the lesser black-backed gull, the generic mean has been used, rather than the larger site-specific mean of 49.9km given in the same paper for the Alde-Ore Estuary SPA Orfordness colony. The use of the generic mean (43.3km) is precautionary and is consistent with the use of generic foraging ranges for the other seabird features. Woodward and others (2019) do not provide a standard deviation for the mean maximum foraging range of little tern or black-headed gull.

While foraging areas were used to investigate the potential for adverse effects, we recognise that breeding seabirds do not in fact have an equal probability of foraging at any point within the area. Our HRAR therefore also referred to information the applicant supplied regarding preferred foraging locations recorded during visual surveys.

Localised areas of upwelling can sometimes be attractive to fish and seabirds such as can be seen at the shallow, nearshore SZB cooling water outlet, which also discharges fish from the station's FRR system. Unlike the SZB outlet, SZC will have separate outlets for the cooling water which will be 3 to 3.5km offshore and around 16m deep, and the FRR systems which will be closer inshore and in shallower water. The cooling water outlet is deep enough that, while there will be a discharge plume, we don't expect to see a surface boil from the cooling water discharge.

The water column in Greater Sizewell Bay is well mixed, and the SZC intake heads and cooling water outlets are close enough together that SZC will not be drawing in nutrient-rich water and discharging into relatively nutrient-depleted surface waters. Prey will not be concentrated in the cooling water and plankton density will be no higher in the discharged water than at the point of abstraction (the FRR systems have their own separate discharge points closer inshore). As such, it is unlikely that the cooling water discharge from SZC will be attractive to fish and seabirds.

The FRR systems for SZC will return fish relatively close to shore, outside of the mixing zones for TRO, bromoform and hydrazine. This means that should scavenging seabirds forage at the FRR systems outlets, the EQS or PNEC values for these substances will not be met or exceeded at this location because of the water discharge activities of SZC.

4.9.3. Discussion

Pakefield to Easton Bavents SSSI

We conclude that the thermal and chemical plumes will not cause damage to the little tern feature of Pakefield to Easton Bavents SSSI as the SSSI is around 15km to the north of SZC and there are no overlaps between the mean or mean max foraging areas of breeding little tern (3.5km and 5km) from Pakefield to Easton Bavents SSSI and any of the thermal or chemical plumes, or the maximum potential area of organic exceedance.

Alde Ore Estuary SSSI

We conclude that the discharges from the operational WDA will not cause damage to the breeding seabird features of the Alde-Ore Estuary SSSI. We have reached this conclusion for several reasons.

The Alde-Ore Estuary SSSI is less at risk than other sites due to its location. Our HRAR assessed the overlap between the mean foraging area for all breeding seabird features identified for the European sites (little tern, Sandwich tern, lesser black-backed gull) and the thermal and chemical plumes. The overlaps between the plumes and the foraging ranges of the seabird features offshore from the Alde-Ore Estuary SSSI are small. For the tern species, this is a result of the distance of the SSSI from the SZC main development area, whereas for lesser black-backed gull the thermal and chemical plumes form only a small proportion of their potential extensive foraging area (Table 45).

For the thermal effects, the WQTAG guidance for thermal discharges into SPAs will not be exceeded when SZC is operating.

Surface water temperatures will not exceed the internal body temperature of seabirds. None of the SSSI’s breeding seabird features dive deeper than 2m when feeding (Furness and others, 2012). The cooling water outlets for SZC will be around 12 to 15m below the surface (NNB GenCo, 2020d; TR306), with the actual outlet raised above the seabed. The cooling water process raises water temperatures by around 11.6°C (NNB GenCo, 2020d; TR306), but even at the discharge point itself, temperatures would still be below the birds’ internal body temperature. So, even if the birds could get to the discharge point, they would not be harmed by the temperature increase. Fish prey species may avoid areas of warmed water and we have used a threshold of ≥ 3°C thermal uplift (as a 98^{th} percentile) in our HRAR to assess the area over which this avoidance behaviour may occur. Where the percentage of the mean foraging area that overlaps with the 3°C thermal plume (as a 98^{th} percentile) is less than 1%, there will be no damage to a breeding seabird feature. This is because the proportion of the mean foraging area that will be affected by the thermal plume is a small part of the wider potential foraging area for the feature. When the percentage overlap is over 1%, further consideration still led us to conclude that there would be no damage to the site's features as other factors ensured no effect. For example, in the case of the Sandwich tern, the overlap may exceed 1% at times, but this slight increase will not have a significant effect on the species, as a considerable portion of their foraging areas will still be unaffected and they are able to adapt their foraging behaviour in response to environmental conditions. It should also be noted that for some species any risk is further reduced due to their specific feeding habits. Lesser black-backed gulls, for example, are generalist feeders, meaning that these gulls are less at risk from the indirect effects of the thermal plume causing prey fish avoidance behaviour.

Regarding the chemical plume, there will be no damage to the site's breeding seabird features for several reasons.

The percentage of mean foraging areas that will be within the mixing zone for TRO, bromoform and hydrazine is extremely small, and it is therefore unlikely that many birds will enter these areas within which EQS or PNEC values are exceeded. Seabirds are also expected to display lower levels of sensitivity to such chemicals than, for example, fishes, as they will have far less direct contact with seawater. Direct exposure of seabirds to TRO or CBPs, for example, would be expected to be of a short duration when diving for food and so they will not experience any prolonged exposure.

In terms of indirect effects, the relatively small area of mixing zone within the foraging areas means there will be no appreciable effect on the water quality. Indirect effects on breeding seabird features due to prey fish avoidance behaviour will not result in damage as the proportion of the overall foraging area that could be affected is very low.

The nutrient and organic enrichment risks from the STW and FRR systems discharges will not cause deterioration in water quality in the marine environment (section 4.7.3.). There will be no direct or indirect effects on the seabird features foraging offshore.

While our HRAR did not examine herring gull or black-headed gull, due to the extensive foraging range of herring gull and its generalist diet, there will be no effect on this species. The foraging area of the black-headed gull is smaller than that of the herring gull, but again the feature's generalist diet will limit any effect. The effects of changes to the marine environment would be expected to be limited in these species, with Kubetzki and Garthe (2003) describing herring gulls as foraging primarily in the intetidal zone, and black-headed gulls as dividing their foraging between the intertidal zone and terrestrial habitats, while being scarcely at sea. Similarly, Götmark (1984) describes black-headed gull during the breeding season as "mostly feeding on terrestrial food even when nesting along the coast" and noting that "fish is taken less frequently" than in the other species of gull studied.

4.10. Assessment of effects: Features linked to Minsmere to Walberswick Heaths and Marshes SSSI

4.10.1. Discussion

This SSSI is designated for a number of breeding bird species as well as for several general bird features such as ‘variety of passage bird species’.

All the bird features notified under this SSSI are freshwater species, meaning they feed from freshwater sources. However, this does not mean that they could not potentially be affected by the SZC discharges. As previously explained, the Minsmere Sluice allows sea water into the site and if that sea water was affected by the SZC discharges, then that could lead to an effect on the habitats and prey species the bird features rely on. Should sea water entering the site be affected by the chemical plume, it could for example lead to effects on prey items that the birds feed on. Introducing heated water could affect fish health and availability and therefore affect the birds that feed on them. Nutrient enrichment could potentially alter habitats, affecting their suitability for bird roosting, breeding and feeding.

The applicant’s modelling of the thermal plume created by the SZC cooling water discharge shows that there is potential for the thermal plume to interact with the coastline at the location of the Minsmere Sluice. The modelled results are below the threshold of concern, with the annual surface temperature difference at the coast predicted to be less than 1.5˚C. Any water affected by the thermal plume that enters the site via the sluice will not be at a high enough temperature to damage the freshwater habitats and the species that rely on them.

The modelling of the chemical plumes shows the areas of exceedances are well offshore and there is therefore no mechanism for chemicals from the operational discharges of SZC to reach the site or enter it via the sluice.

Organic enrichment from the STW and FRR systems could reach the intake, however the increase in organic enrichment is not at a level to cause a deterioration in water quality, therefore there will be no damage to the SSSI or its features.

The saline incursion through Minsmere Sluice is localised to the area around the sluice and is unaffected by thermal uplift, chemical plumes or organic enrichment from SZC. There will be no damage to the bird species as a result of the connectivity between the freshwater and marine environments.

Bittern could theoretically still be indirectly affected though. Their main food and prey are European eel, rudd, roach, frogs and toads, with eel having a marine component to their life cycle. Minsmere Sluice is fitted with an eel pass to facilitate migration of eel into the Minsmere Marshes and we must therefore consider whether the outlets from the WDA could act as a barrier to eel migration. Eel could also potentially be affected by encountering the chemical and thermal plumes or the area of organic enrichment outside of the SSSI.

The bittern feature is potentially at risk from nutrient enrichment, changes to the thermal regime and toxic contamination.

The applicant considered the potential for the thermal and chemical plumes from the operational discharge to act as a barrier to eel passage (NNB GenCo, 2020f; Eels Regulations Compliance Assessment and NNB GenCo, 2021f; Eels Regulations Addendum).

The location of the outlet headworks, 3km offshore in deep water, will allow for some initial mixing and therefore minimise intersection with the Suffolk Coast coastline. There will therefore be no overlap of the chemical plumes above EQS/PNEC or thermal plumes with the Minsmere Sluice outlet.

The applicant also considered if the offshore thermal uplift could prove a barrier along the coast. It concluded there was no barrier based on the available evidence for thermal avoidance of migratory species off Sizewell using thermal uplift thresholds applied for glass eel and silver eel (Table 46). Modelling results showed that temperatures in excess of potential avoidance thresholds would exceed 25% of the coastal corridor (a 3km transect from the coast to the SZC outfalls) for less than 5% of the time during their migration periods. Therefore, no occlusion effects were predicted. Silver eel are the outward migrating pre-adult life stage and, as such, would not be available as food to bitterns once they have left freshwater. The thermal uplift threshold the applicant applied to glass eels (>+12°C) is high compared to that used for silver eel (>3°C) (Table 46). However, the applicant’s data shows that it is rare for more than 25% of the cross-sectional area of the 3km coastal corridor to experience thermal uplift in excess of 3°C during the glass eel migration period. As such, no occlusion effect would be predicted for glass eel even if applying the thermal uplift threshold used for silver eel.

Considering the potential for nutrient enrichment from the STW and FRR systems shows that it will be insufficient to lead to increased opportunistic macroalgal or phytoplankton blooms and therefore no effect on eels.

As the eel prey of bittern will not be affected by the water discharge activities of SZC, there will also be no effect on the bittern feature itself as a result of the WDA of SZC.

Table 46: Percentage of Sizewell C transect experiencing >25% exceedance of thermal thresholds for glass eel and silver eel

Life stage	Assumed thermal threshold	Migration period	Percentage of migration period during which >25% of the 3km migration corridor exceeds the assumed thermal threshold	Conclusion
Glass eel	>+12°C	March - April	0%	Would not experience a barrier to migration in a transect from the coast to the SZC outfalls.
Silver eel	3°C	September - December	0.07%	Would not experience a barrier to migration in a transect from the coast to the SZC outfalls.

There will be no negative effect on freshwater habitats of birds or freshwater plant species as a result of the connectivity between the freshwater and marine environments. This is due to the saline incursion through Minsmere Sluice being localised to the area around the sluice, and this saline incursion in any event being unaffected by thermal uplift, chemical plumes or organic enrichment from SZC.

In conclusion, although there is connectivity between the sites and the point of discharge via the Minsmere Sluice, the thermal and chemical plumes are located so far offshore that they will not reach the sluice intake. The nutrient and organic enrichment risks from the STW and FRR systems discharges will not cause deterioration in water quality in the marine environment and will therefore not alter the water quality of the freshwater environment.

4.11. WDA CRoW Act assessment conclusion

Pakefield to Easton Bavents SSSI, Minsmere-Walberswick Heaths and Marshes SSSI, Leiston to Aldeburgh SSSI and Alde-Ore Estuary SSSI have all been identified as being potentially at risk from the operational discharges of SZC. These operational discharges will create a thermal plume and a chemical plume and will also result in areas of nutrient and organic enrichment as a result of waste discharges and discharge from the site’s fish recovery and return systems.

We conclude that the pathway of potential effect on these sites is limited. For Minsmere-Walberswick Heaths and Marshes SSSI the effect can only occur via the Minsmere Sluice or via indirect effects on European eel, a prey species for bittern. The thermal and chemical plume will not reach the site via this mechanism due to occurring far offshore. The organic and nutrient enrichment will not be at a high enough level to affect the site or its species. The water discharge activities of SZC will not affect the ability of eel to migrate into the SSSI and consequently their availability as a food source for bittern.

For Leiston to Aldeburgh SSSI all the features are above the mean high watermark, so the thermal plume, chemical plume and the area of organic enrichment will not reach the site.

For the Alde-Ore Estuary SSSI and Pakefield to Easton Bavents SSSI, the thermal plume, chemical plume and the area of organic enrichment cannot reach the site, so the only potential pathway for effect is for breeding seabird species that venture offshore for feeding. For those species, we can conclude no effect as the temperature, chemical and nutrient/organic matter inputs are not of a scale that could result in any significant effect.

It has been determined in this assessment under Section 28I of the Wildlife and Countryside Act 1981 (as amended by the Countryside and Rights of Way Act (CRoW) 2000) that the WDA for the operational phase of Sizewell C power station would not result in an operation likely to damage the features of the Pakefield to Easton Bavents SSSI, Minsmere-Walberswick Heaths and Marshes SSSI, Leiston to Aldeburgh or to the Alde-Ore Estuary SSSI.

References

Radioactive Substances Activity:

Allott, R., Cailes, C., Titley, J. and Rowe, J. 2019.
Habitats assessments for radioactive substances: 2017 review. Version 1.0. Bristol: Environment Agency.

Brown, J.E., Alfonso, B., Availa, R., Beresford, N.A., Copplestone, D. and Hosseini, A. 2016.
A new version of the ERICA tool to facilitate impact assessments of radioactivity on wild plants and animals'. Journal of Environmental Radioactivity, Volume 153, pages 141-148.
http://www.erica-tool.com/

Environment Agency, 2022.
Radiological Impact Assessment for Proposed Sizewell C Nuclear Power Station. Bristol: Environment Agency.
https://consult.environment-agency.gov.uk/psc/ip16-4ur-nnb-generation-company-szc-ltd-hb3091dj

Environment Agency, Scottish Environment Protection Agency, Northern Ireland Environment Agency, Food Standards Agency and Health Protection Agency, 2012.
Principles for the Assessment of Prospective Public Doses arising from Authorised Discharges of Radioactive Waste to the Environment (Issue 2). Penrith: Environment Agency.
https://www.gov.uk/government/publications/assessment-of-prospective-public-doses-from-authorised-discharges

International Atomic Energy Agency, 2018.
Prospective Radiological Environmental Impact Assessment for Facilities and Activities, IAEA Safety Standards Series No. GSG-10, IAEA, Vienna. 2018.
Prospective Radiological Environmental Impact Assessment for Facilities and Activities | IAEA

International Commission on Radiological Protection, 2008.
Environmental Protection - the Concept and Use of Reference Animals and Plants. ICRP Publication 108. Ann. ICRP 38, 4-6.
https://www.icrp.org/publication.asp?id=icrp%20publication%20108

Vives, J., I Batlle, I. and others, 2015
A method for estimating 41Ar, 85,88Kr and 131m,133Xe doses to non-human biota. Journal of Environmental Radioactivity, Volume 144, June 2015, Pages 152-161.
https://www.sciencedirect.com/science/article/pii/S0265931X15000685#

Combustion Activity:

Caporn, S., Field, C., Payne, R., Dise, N., Britton, A., Emmett, B., Jones, I., Phoenix, G., Power, S., Sheppard I. and Stevens, C., 2016.
Assessing the effects of small increments of atmospheric nitrogen deposition (above the critical load) on semi-natural habitats of conservation importance. Natural England Commissioned Reports, Number 210.

EDF, 2020a.
EDF, 2020. Appendix C, Air Quality Modelling. Report No: 100200192, Revision 02. NNB Generation Company (SZC) Limited.

EDF, 2020b.
EDF, 2020. Appendix D, Combustion Activity Permit Application, Shadow HRA Report. report No: 100207664. Version 01. NNB Generation Company (SZC) Limited.

EDF, 2020c.
EDF, 2020. Appendix E, Combustion Activity Permit Application, Noise Assessment, Report No: 100207665, Revision 01. NNB Generation Company (SZC) Limited.

EDF, 2021. Response to Schedule 5 No. 5. NNB Generation Company (SZC) Limited.

Environment agency, 2012a.
Environment agency, 2012. Operational Instruction 66_12. Simple assessment of the impact of aerial emissions from new or expanding IPPC regulated industry for impacts on nature conservation. Environment Agency.

Environment agency, 2012b.
Environment agency, 2012. Operational Instruction 67_12. Detailed assessment of the impact of aerial emissions from new or expanding IPPC regulated industry for impacts on nature conservation. Environment Agency.

Environment agency, 2021a.
Environment agency, 2021. Sizewell C Nuclear New Build, AQMAU_C2106_RP_01. Environment Agency.

Environment agency, 2021b.
Environment Agency, 2021. Sizewell C Nuclear New Build. Audit of Air Quality Assessment Schedule 5 response. AQMAU_C2193_WD01. Environment Agency.

Environment agency, 2021c.
Environment agency, 2021. Sizewell C Nuclear New Build. Audit of Air Quality Assessment. AQMAU_C2104_RP01. Environment Agency.

Holman and others, 2020. A guide to the assessment of air quality impacts on designated nature conservation sites - Version 1.1. London: Institute of Air Quality Management.

Water Discharge Activity:

NNB GENERATION COMPANY (SZC) LIMITED (NNB GenCo), 2019. TR303 Sizewell chemical plume modelling: TRO, CBP's, hydrazine, DO and ammonia. NNB GenCo (SZC) Ltd, London. Edition 4.

NNB GENERATION COMPANY (SZC) LIMITED (NNB GenCo), 2020a. The Sizewell C Project: 6.1, Volume 1 Introduction to the Environmental Statement Chapter 2 Overview of the Sizewell C Project Figure 2.1. PINS Reference Number: EN010012.

NNB GENERATION COMPANY (SZC) LIMITED (NNB GenCo), 2020b. The Sizewell C Project: 6.1, Environmental Statement – Non-technical Summary. NNB GenCo (SZC) Ltd, London. PINS Reference Number: EN010012.

NNB GENERATION COMPANY (SZC) LIMITED (NNB GenCo), 2020c. TR302 Sizewell Thermal Plume Modelling: GETM Stage 3 results with the preferred SZC cooling water configuration. NNB GenCo (SZC) Ltd, London. Version 6 Edition 3.

NNB GENERATION COMPANY (SZC) LIMITED (NNB GenCo), 2020d.TR306 Sizewell marine water and sediment quality synthesis report MSR2/5. NNB GenCo (SZC) Ltd, London. Edition 5.

NNB GENERATION COMPANY (SZC) LIMITED (NNB GenCo), 2020e. TR520 Sizewell C water quality effects of the fish recovery and return system. NNB GenCo (SZC) Ltd, London. Revision 1.

NNB GENERATION COMPANY (SZC) LIMITED (NNB GenCo), 2020f. Eels Regulations Compliance Assessment. NNB Generation Company (SZC) Limited. NNB GenCo (SZC) Ltd, London. Available via Planning Inspectorate website

NNB GENERATION COMPANY (SZC) LIMITED (NNB GenCo), 2021a. TR193 SZC discharges H1 type assessment supporting data report. NNB GenCo (SZC) Ltd, London. Revision 3. Edition 5.

NNB GENERATION COMPANY (SZC) LIMITED (NNB GenCo), 2021b. Appendix C – Information for the Habitats Regulations Assessment. Shadow HRA Report – operational water discharge Environmental Permit application. NNB GenCo (SZC) Ltd, London. Document 100232391.

NNB GENERATION COMPANY (SZC) LIMITED (NNB GenCo), 2021c. TR316 Evaluation of chlorination dosing options for Sizewell C. NNB GenCo (SZC) Ltd, London. Edition 6 Revision 10.

NNB GENERATION COMPANY (SZC) LIMITED (NNB GenCo), 2021d. TR511 Particle tracking study of impinged sprat from the proposed Sizewell C Fish Recovery and Return. NNB GenCo (SZC) Ltd, London. Revision 2.

NNB GENERATION COMPANY (SZC) LIMITED (NNB GenCo), 2021e. Sizewell C Project: water discharge activity permit application: Response to Schedule 5 No. 5. NNB GenCo (SZC) Ltd, London.

NNB GENERATION COMPANY (SZC) LIMITED (NNB GenCo), 2021f. Eels Regulations Compliance Assessment – Addendum. NNB GenCo (SZC) Ltd, London. Available via Planning Inspectorate website.

ENVIRONMENT AGENCY, 2019. Permitting of hazardous chemicals and elements in discharges to surface waters. Operational instruction: LIT13134. Version 2.0.

ENVIRONMENT AGENCY, 2022. Book 3 Water discharge activity operational permit HRAR for proposed Sizewell C nuclear power station. Bristol: Environment Agency. https://consult.environment-agency.gov.uk/psc/ip16-4ur-nnb-generation-company-szc-ltd-cb3997ad/

FURNESS, R.W., WADE, H.M., OBBINS, A.M., AND MASDEN, E.A., 2012. Assessing the sensitivity of seabird populations to adverse effects from tidal stream turbines and wave energy devices. ICES Journal of Marine Science. 69 (8), 1466-1479. https://doi.org/10.1093/icesjms/fss131.

GÖTMARK, F., 1984. Food and foraging in five European *Larus* gulls in the breeding season: a comparative review. Ornis Fennica 61: 9-18 https://lintulehti.birdlife.fi:8443/pdf/artikkelit/752/tiedosto/of_61_9-18_artikkelit_752.pdf.

KUBETZKI, U. AND GARTHE, S., 2003. Distribution, diet and habitat selection by four sympatrically breeding gull species in the south-eastern North Sea. Marine Biology (2003) 143: 199-207. DOI 10.1007/s00227-003-1036-5.

TYLER-WALTERS, H., TILLIN, H.M., D'AVACK, E.A.S., PERRY, F. AND STAMP, T., 2018. Marine Evidence-based Sensitivity Assessment (MarESA) – A Guide. Marine Life Information Network (MarLIN). Marine Biological Association of the UK, Plymouth, pp. 91. Available from MarLIN - The Marine Life Information Network - MarLIN publications.

WOODWARD, I., THAXTER, C.B., OWEN, E. AND COOK. A.S.C.P., 2019. Desk-based revision of seabird foraging ranges used for HRA screening. BTO Research Report No. 724. British Trust for Ornithology, Thetford. ISB 978-1-912642-12-0.

WQTAG SUB-GROUP, 2006. Guidance on assessing the impact of thermal discharges on European Marine Sites. Habitats Directive Technical Advisory Group on Water Quality.

List of abbreviations

Radioactive Substances Activity:

Term	Meaning
BAT	Best available techniques/technology, usually referring to the technique or process that will yield the greatest environmental benefit or cause the least environmental damage.
DORIS	PC-CREAM 08 model marine dispersal model.
ERICA	Environmental Risk from Ionising Contaminants: Assessment and Management.
FASSET	Framework for assessment of environmental impact.
Gy, μGy	Abbreviation meaning gray, microgray. A unit of absorbed dose.
ICRP	International Commission on Radiological Protection.
PC- CREAM 08	Radiological Impact Assessment Software.
RO	Reference organism.
RSA	Radioactive substances activity.
RSR	Radioactive Substances Regulation.
SAC	Special Area of Conservation. A protected area designated under the Conservation of Habitats and Species Regulations 2017 (as amended) in England and Wales, or the Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended) for UK offshore areas.
SPA	Special Protection Area. Special Protection Areas are protected areas for birds classified under the Wildlife & Countryside Act 1981 (as

Term	Meaning
	amended), the Conservation of Habitats and Species Regulations 2010 (as amended) and the Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended).
SSSI	Site of Special Scientific Interest.
SZC	Sizewell C.
μGy/h	Abbreviation meaning microgray per hour.

Combustion Activity:

Term	Meaning
ADMS	Air dispersion modelling software.
APIS	Air Pollution Information System.
AQMAU	Air Quality Modelling and Assessment Unit.
CEH	Centre for Ecology and Hydrology.
CL	Critical level.
CLmaxN	Maximum critical load for nitrogen.
CLmaxS	Maximum critical load for sulphur.
CLminN	Minimum critical load for nitrogen.
CRoW	Conservation and Rights of Way Act 2000.
DG	Diesel generators.
EDF	Électricité de France.

Term	Meaning
EDG	Essential diesel generator.
EPR	Environmental Permitting Regulations.
EPR™	European Pressurised Reactor.
LOOP	Loss of operational power.
LT	Long-term.
MAGIC	Online mapping tool. Magic Map Application (defra.gov.uk)
MW_{th}	Megawatt of thermal output.
NNB GenCo	NNB Generation Company (SZC) Limited
NGR	National Grid reference.
NO_2	Nitrogen dioxide.
NOx	Nitrous dioxide.
OLD	Operations likely to damage.
PC	Process contribution.
PEC	Predicted environmental concentration.
SO_2	Sulphur dioxide.
SSSI	Site of Special Scientific Interest.
ST	Short-term.
UDG	Ultimate diesel generator.

Water Discharge Activity:

Term	Meaning
BOD	Biochemical oxygen demand
CBPs	Chlorinated by-products
COD	Chemical oxygen demand
CRoW	Countryside and Rights of Way Act
CW	Cooling water
EPR™	UK European Pressured Reactor
EQS	Environmental quality standard
FRR system	Fish recovery and return system
HFT	Hot functional testing
HPC	Hinkley Point C
MW	Megawatts
NNB	Nuclear new build
PNEC	Predicted no effect concentration
RSR	Radioactive Substances Regulations
SSSI	Site of Special Scientific Interest
SZC	Sizewell C
TRO	Total residual oxidant
WDA	Water discharge activity

Glossary

Radioactive Substances Activity:

Term	Meaning
Activity	A generic title for the practices or operations which require to be permitted (unless exempted from the need for a permit).
Applicant	NNB Generation Company (SZC) Limited, the body applying for the RSR permit.
Dose rate	The quantity of radiation absorbed per unit of time, for example microgray per hour, μGy/h.
European sites	Sites such as SPAs and SACs which are protected under European and UK law. Ramsar sites are also included in line with government policy.
Scrape	This is the name for a series of shallow pools studded with islands within the Minsmere-Walberswick Heaths and Marshes SSSI.
Source term	The types, quantities, and physical and chemical forms of the radionuclides present in a nuclear facility that have the potential to give rise to exposure to ionising radiation, radioactive waste or discharges.
Wind rose	A graphic tool used by meteorologists to give a succinct view of how wind speed and reaction are typically distributed at a particular location.

Combustion Activity:

Term	Meaning
Acidification or acid deposition	Represents the mix of air pollutants that deposit from the atmosphere leading to acidification of soils and freshwater. It mainly consists of pollutants emitted by the combustion of fossil fuels. Source: Acid deposition | Air Pollution Information System (apis.ac.uk)
Air Pollution Information System	A searchable database and information on pollutants and their impacts on habitats and species. Air Pollution Information System | Air Pollution Information System (apis.ac.uk)
Applicant	NNB Generation Company (SZC) Limited, the body applying for the RSR permit.
Commissioning	Where all of the generators are tested for reliability and performance prior to the start of nuclear activities. Unit 1 will undergo commissioning first and unit 2 will undergo commissioning the following year. While unit 2 is undergoing commissioning, unit 1 will begin undergoing routine operational testing.
Critical levels	Defined as "concentrations of pollutants in the atmosphere above which direct adverse effects on receptors, such as human beings, plants, ecosystems or materials, may occur according to present knowledge." Critical level is the gaseous concentration of a pollutant in the air. (Source: https://www.icpmapping.org/Definitions_and_abbreviations)
Critical Loads Function	Deposition of both sulphur and nitrogen compounds can contribute to acidification and therefore to the exceedance of acidity critical loads. A Critical Loads Function (CLF) has been developed that defines combinations of sulphur and nitrogen deposition that will not cause harmful effects, that is, separate acidity critical loads in terms of sulphur and nitrogen. The CLF is a three-node line graph representing the acidity critical load,

Term	Meaning
	and the intercepts of the CLF on the sulphur and nitrogen axes define the sulphur and nitrogen critical load values (CLmaxS, CLminN and CLmaxN). Combinations of sulphur and nitrogen deposition above the CLF exceed the critical load, while all areas on or below the CLF line represent an “envelope of protection” where critical loads are not exceeded. Source: Critical Load Exceedances | Critical Loads and Dynamic Modelling (ceh.ac.uk)
Critical loads	Defined as " a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge." Relates to the quantity of the pollutant deposited from air to the ground. (Source: https://www.icpmapping.org/Definitions_and_abbreviations)
Direct toxic effect of the pollutants	Exposure to toxic pollutant concentrations in the atmosphere. Assessment of the direct toxicity to air pollutants is generally assessed by comparing measured pollutant air concentrations with "critical levels", which are set for a range of air pollutants.
Loss of operational power	A LOOP event involves running all 8 EDGs for the duration of the event. It is not easily determined how often a LOOP event is likely to occur or how long it will last for.
Nitrogen enrichment of nitrogen (N) deposition	Describes the input of reactive nitrogen from the atmosphere to the biosphere both as gases, dry deposition and in precipitation as wet deposition. Source: Nitrogen deposition | Air Pollution Information System (apis.ac.uk)
Notable features	The features for which the SSSI is designated and protected and managed for conservation.
Routine testing	Ongoing testing of the generators to make sure they are available to perform their role, as a critical nuclear safety function, should a LOOP event occur.

Water Discharge Activity:

Term	Meaning
Admixture	The act of mixing or mingling.
Benthic	Organisms that live on, in and near the bottom of a body of water.
Biota	In the context of our assessment, biota refers to animals (intact or otherwise) that have passed through the fish recovery and return system (ctenophores and jellyfish are excluded from our impingement mortality calculations).
Chemical exceedance	Concentrations of a chemical in excess of a water quality threshold.
Chemical plume	An area of water within which concentrations of chemicals are above background levels, as a result of a discharge activity.
Commissioning	The process by which a nuclear power station/reactor is inspected, checked and tested in order to allow it to begin operation.
Decommissioning	The process by which a nuclear power station/reactor has its fuel removed, the plant and facilities taken down and the site restored to an agreed end state.
Ecotoxicology	The nature, effects and interactions of substances that are harmful to the environment.
Environmental quality standard (EQS)	The concentration and a corresponding statistic (for example, mean or 95th percentile) below which a substance is not believed to be detrimental to aquatic life, based on the results of toxicity tests on organisms covering a range of levels within food chains. Each substance has its own EQS, which can differ depending on whether the receiving environment is fresh, transitional or coastal water.
Eutrophication	The increase in primary productivity and subsequent effects on an ecosystem that arise as a result of inputs of

	nutrients (which can be human) raising ambient nutrient concentrations.
European site	Sites such as SPAs and SACs which are protected under European and UK law. Ramsar sites are also included in line with government policy.
Fish recovery and return system	A system by which impinged fish and invertebrates will be washed off the rotating screens that protect the cooling water system and returned to sea through dedicated outlets.
Glass eel	A European eel (Anguilla anguilla) in its transparent, post-larval stage – prior to entering estuaries and becoming a pigmented elver.
Hot functional testing	Part of the commissioning process which involves increasing the temperature of the reactor coolant system and carrying out comprehensive tests to ensure that coolant circuits and safety systems are operating as they should.
Macroalgae	Opportunistic macroalgal species are a natural component of intertidal ecosystems, but where excess nutrients occur they are able to outcompete other seaweed species.
Moribund	Where an organism is at the point of death. In our mortality calculation, we have used the term moribund biota to mean biota passing through the FRR system that is dead and acts as a polluting matter.
Nutrient enrichment	The introduction of additional and/or new nutrients into a waterbody or other environment. This can cause disruption to the existing water quality regime and therefore effect on species and habitats.
Predicted no effect concentration (PNEC)	The concentration of a chemical which marks the limit below which no adverse effects of exposure in an ecosystem are measured. The PNEC is used for substances for which an EQS has not been set.

Schedule 5 request	A formal instruction to the applicant to provide further information to provide clarification on points made in the permit application or to address gaps in that application.
Silver eel	A European eel, Anguilla anguilla, characterised by its silver colouration and developing into sexual maturity while undergoing physiological adaption for its marine spawning migration.
Sizewell-Dunwich Bank	A bank if sediment located offshore which acts as a natural sea defence.
Source receptor pathway	A framework for assessing the risk of a proposal on the environment. The source refers to the hazard – something that has the potential to cause harm. The receptor is the something could suffer harm from a hazard. The pathway is the way in which a hazard can come into contact with a receptor.
Thermal plume	The area of heated water caused by the discharges from a cooling water system.
Thermal regime	Refers to the existing temperature system of an area/waterbody.
Thermal uplift or thermal excess	The increase in temperature of a body of water as the result of a thermal input.
Turbidity	Turbidity is the amount of cloudiness in the water. High turbidity would result in low visibility due to the presence of suspended material such as mud, silt and sand, bacteria and chemical precipitates. Visibility would be greater in low turbidity conditions.

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