REPORT

EDF Sizewell C Nuclear New Build

Eels Regulations Compliance Assessment

Client: SZC Co.

Reference: PB6582-RHD-ZZ-XX-RP-Z-0010

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HASKONINGDHV UK LTD.

Stratus House
Emperor Way
Exeter
EX1 3QS
Industry & Buildings
VAT registration number: 792428892

+44 1392 447999 T
+44 1392 446148 F
info.exeter@uk.rhdhv.com E
royalhaskoningdhv.com W

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Author(s):	**Dr Peter R Brunner (Migratory Fish Specialist)**
Drafted by:	**Dr Peter R Brunner**
Checked by:	Alexia Chapman
Date / initials:	28/02/2020
Approved by:	**Dr Ian Dennis**
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Please note that the red line boundary used in the figures within this document was amended after this document was finalised, and therefore does not reflect the boundaries in respect of which development consent has been sought in this application. However, the amendment to the red line boundary does not have any impact on the findings set out in this document and all other information remains correct

Executive Summary

SZC Co.[1] is proposing to build and operate a new nuclear power station at Sizewell on the Suffolk Coast, north of the existing Sizewell B power station. The design of this new power station, Sizewell C, will take into account the sensitive nature of the surrounding environment, while providing enough space to build and operate the power station safely and efficiently to support approximately 7% of the UK's electricity (or approximately six million homes). However, under the Eels (England and Wales) Regulations 2009 (S.I. 2009 No. 3344) (the 'Eels Regulations'), companies that intend to build new developments, such as the Sizewell C Project are required to make provision for the safe passage of European eels (*Anguilla anguilla*), an International Union for Conservation of Nature 'red list' of 'critically endangered' species.

This Eels Regulations Compliance Assessment (ERCA), undertaken to support to the Development Consent Order (DCO) and Water Discharge Activity (WDA) Permit for Sizewell C, has shown that the key onshore and offshore construction and operation components of Sizewell C will not, overall, impact European eel populations and silver eel escapement. It is acknowledged that some operational components (such as the drum screens with a proposed 10mm mesh) will not comply with Best Practice, however, given the Alternative Measures to be implemented (such as the low velocity side entry (LVSE) intake configuration and Fish Recovery and Return (FRR) systems) the Sizewell C Project should be deemed acceptable in relation to the Eels Regulations.

In order to ensure compliance with the Eels Regulations, the following mitigation measures would be implemented for the Sizewell C Project:

Freshwater elements

- Control measures defined in the **Code of Construction Practice** (**CoCP**) (Doc Ref. 8.11).
- Eel rescue carried out (if required) prior to any in-stream works.
- Incorporation of suitable bed and bank protection (using bioengineering solutions) either upstream and/or downstream of culverts.
- Careful operational management of water control structures to ensure adequate environment flows for in-stream eel habitat and survival.
- No permanent in-stream barriers to eel migration to be constructed and operated without full consideration of eel migration, including the installation of appropriate eel passes at water control structures.

Marine elements

- Control measures defined in the **CoCP** (Doc Ref. 8.11).
- Low velocity side entry type intake head design;
- Fish Recovery and Return systems to be fully integrated within the cooling water infrastructure; and, to include 'fish-friendly' elevator ledges or 'buckets' optimised for eels.
- Ongoing entrainment and impingement monitoring of eels at Sizewell C to be undertaken.



[1] *NNB Generation Company (SZC) Limited, whose registered office is at 90 Whitfield Street, London, W1T 4EZ; referred to in this document as 'SZC Co.'.*

1 Introduction

1.1 Background

1.1.1 SZC Co. is proposing to build and operate a new nuclear power station at Sizewell on the Suffolk Coast, north of the existing Sizewell B power station. The design of the new Sizewell C power station (a description of which is provided in **Section 3**), will take into account the sensitive nature of the surrounding environment, while providing enough space to build and operate the power station safely and efficiently to support approximately 7% of the UK's electricity (or approximately six million homes). Under the Eels (England and Wales) Regulations 2009 (S.I. 2009 No. 3344) (the 'Eels Regulations'), no new infrastructure, including nuclear new builds (NNBs), is to be constructed without provision for European eels (*Anguilla anguilla*), an International Union for Conservation of Nature red list 'critically endangered' species.

Objectives

1.1.2 This Eels Regulations Compliance Assessment (ERCA) has been undertaken to support the DCO and WDA permit for the Sizewell C. The ERCA ensures the Eels Regulations have been fully considered for Sizewell C, including the associated developments (ADs) required during construction, regarding the protection and safe passage of the European eel and their life cycle as presented in **Figure 1.1**. For this ERCA, the term "eels" refers to all life stages of European eels (i.e. eggs, larvae, glass eels, elvers, yellow eels, silver eels, spawning silver eels).

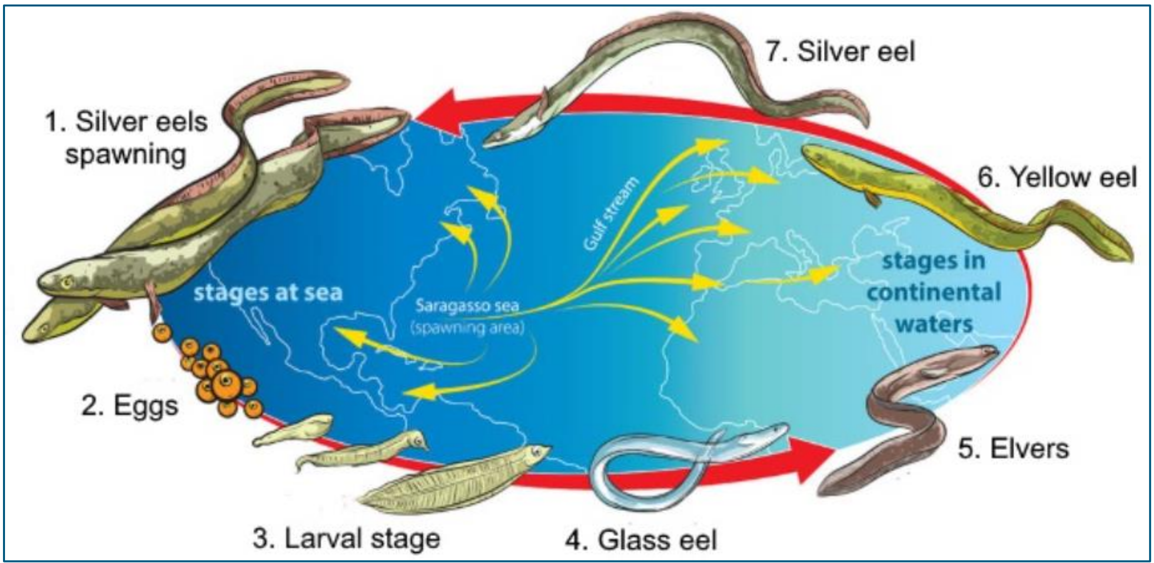

Figure 1.1 Lifecycle of the European Eel (Source: https://www.123rf.com/profile_lukaves)

Scope of Works

1.1.3 This ERCA consists of the following key activities:

- Review of Eels Regulations and initial consultation with the Environment Agency (including the National Eels Regulations Advisors).
- Desk based review of European eel migration routes and Eel Management Plans (EMP) for the Suffolk Coast.

- Review of the Sizewell C Project construction and operation components, in relation to key aspects which may impact upon European eel, namely:
  - intakes and outfall associated with the main development site;
  - in-channel structures and channel modifications associated with the main development site (i.e. Sites of Special Scientific Interest (SSSI) Crossing; and Sizewell Drain Realignment); and
  - in-channel structures and channel modifications associated with the two village bypass; and the Sizewell link road.
- Review of assessments undertaken to support the DCO and WDA submissions, including the assessment of impacts associated with fish impingement and entrainment, thermal and chemical discharges, and terrestrial ecological assessments (including reference to the appropriate reports).
- Undertake an ERCA for Sizewell C based upon the above activities which may potentially impact European eel populations.
- Proposed mitigation measures and monitoring strategies will be included as defined within the **Environmental Statement** (Doc Ref. Book 6) and other supporting documentation (with additional or alternative measures identified, if required).

1.2 Report Structure

1.2.1 This report is divided into seven discrete sections and **Table 1.1** below provides a brief description of the contents of the report.

Table 1.1 Outline of Report

Sections of Report		Description
1	**Introduction**	Introduces Sizewell C; outlines the main objectives of the report; and summarises the scope of works required to achieve the objectives. A report structure is also provided.
2	**Eels Regulations and Assessment Approach**	Summary of why European eels are in decline; and key legislation, permits and licences that ensure the safe passage and protection of European eel. The approach undertaken to assess Sizewell C against the Eels Regulations is also presented.
3	**The Study Area – Sizewell C and European eel**	Summary of the main components of Sizewell C; European eel habitats and population dynamics for the study area; and a review of impingement, entrainment and discharge impacts on European eel associated with nuclear power stations, including Sizewell C.
4	**Potential Eels Regulations Implications for Sizewell C**	Based on **Section 3** above, potential construction and operational components of Sizewell C that could compromise the Eels Regulations are identified.
5	**Sizewell C Eels Regulations Compliance Assessment (ERCA)**	ERCA for Sizewell C based upon **Section 1 to 4**; with particular emphasis placed on the onshore and offshore construction and operational components which may potentially impact European eel populations.
6	**Summary**	A summary of the ERCA along with mitigation measures and monitoring strategies are provided.
7	**References**	Literature used to inform this report.

2 Eels Regulations and Assessment Approach

2.1 Introduction

2.1.1 This section of the report provides background into the status of European eel and key legislation, permits and licences to which new infrastructure projects have to comply to ensure the safe passage and protection of European eel. The overall approach in undertaking this ERCA for Sizewell C is also presented, along with supporting sources of information used for this report.

2.2 Eel Decline and Key Legislation, Permits and Licences

2.2.1 European eel are migratory fish that spend the majority of their adult lives in freshwater (although some eels mature or are resident as adults in coastal/estuarine waters), returning to the sea to spawn in the Sargasso Sea as presented in **Figure 1.1**). In recent years the species has undergone a sharp decline in recruitment, yield and stock and is classified as critically endangered in the International Union for Conservation of Nature red list. Following high recruitment levels in the late 1970s, there was a rapid decreasing trend over three decades, with the recruitment level in 2017 estimated at 1.6% for the North Sea; and 8.7% elsewhere in the distribution area (International Council for the Exploration of the Seas (ICES), 2017), with respect to 1960–1979 averages presented in **Figure 2.1**. Changes in ocean conditions affecting the survival of larvae, reduction in the number and quality of spawning eels driven by anthropogenic factors such as habitat loss, pollution, and parasite introductions as well as overexploitation and barriers to migration have been pointed out as main drivers of the eel recruitment decline (Correia et al. 2018; Friedland et al., 2007; Kettle et al., 2008; Belpaire et al., 2009; ICES, 2017). For this reason, action is being taken throughout Europe to fulfil the goals of the European Union (EU) recovery plan for eel.

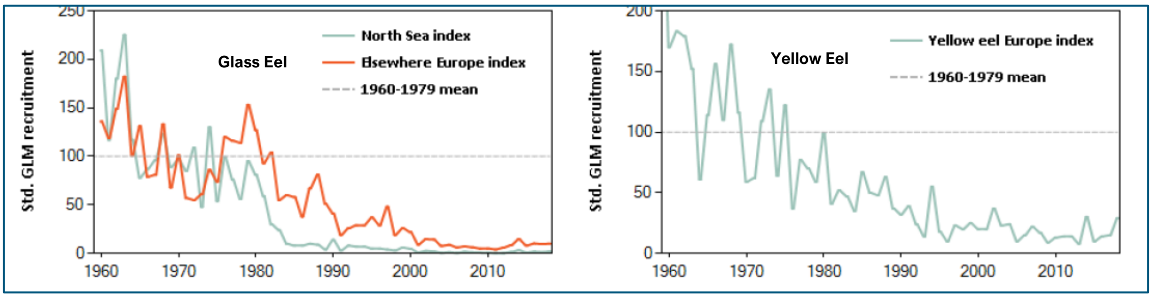

Figure 2.1 Decline in European Eel recruitment (Source: ICES, 2018)

2.2.2 The European Council (EC) Regulation 1100/2007 requires EU Member States (which currently includes the UK) to put in place Eel Management Plans (EMPs). These plans aim to deliver an increase in escapement of adult (silver) eel back to sea for them reproductive migration. The target is 40% of pristine escapement levels in the long-term. EC Regulation 1100/2007 is delivered in England and Wales by The Eels (England and Wales) Regulations 2009 Statutory Instrument No. 3344. Of relevance to nuclear power stations, the Eels Regulations require that:

- no new infrastructure be constructed, or existing structures modified, without provision for European eel;
- appropriate physical exclusion or alternative measures be provided at all potentially harmful water abstraction or intake systems or flow points (more than 20m^3 per day); and

- a continuous by-wash immediately upstream from the eel screen which allows eels to return by as direct a route as practicable to the waters from which they entered the diversion structure be implemented.
- structural measures to make rivers passable and improve river habitats, together with other environmental measures;
- transportation of silver eel from inland waters to waters from which they can escape freely to the Sargasso Sea;
- combating predators; and
- temporary switching-off of hydro-electric power turbines.

2.2.3 In England, eel legislation and policy is determined through the Department for Environment, Food and Rural Affairs (Defra). Delivery of the UK EMPs for inland waters, and tidal waters to a distance of 6 nautical miles, is the responsibility of the Environment Agency.

2.2.4 The Eels Regulations specify that "*each EMP monitor and verify that the measures implemented (such as eel passage) permit with high probability the escapement to the sea of at least 40 % of the silver eel biomass relative to the best estimate of escapement that would have existed if no anthropogenic influences had impacted the stock*" (article 2, paragraph 7 of the EU Eel Regulation). Reducing the impacts of entrainment, impingement and entrapment on eel and making rivers passable for juvenile and adult eel is a key element of the UK EMPs.

2.2.5 In addition to the EMPs, the Water Framework Directive (WFD) (Directive 2000/60/EC) is a key driver in improving the passage and safety of eels, as it requires the achievement of good ecological status (or for heavily modified or artificial water bodies, good ecological potential) for surface waters by 2021, although this can be extended to 2027. Sustainable natural fish populations, including eel, contribute to good ecological status and barriers to fish migration will cause failure of the WFD objective. Hence, the implementation of fish friendly measures will be required at the construction of new infrastructure (such as the Sizewell C project) as well as the refurbishment of existing infrastructure.

2.2.6 As such, and in accordance with recommendations set out in the Eels Regulations, River Basin Districts (RBDs) developed for the WFD have been established as management units for UK EMPs.

2.2.7 Other key legislative drivers for improving the passage of eels include:

- Part 7 (Fisheries), Chapter 3 (Migratory and freshwater fish) of the Marine and Coastal Access Act 2009 (c.51) (The Marine Act);
- Sections 24 or 25 of the Water Resources Act (WRA) 1991 (c.57);
- Land Drainage Act 1991 (c.59) section 61 A-D; and
- United Kingdom Biodiversity Action Plan (UK BAP) and The Natural Environment and Rural Communities (NERC) Act (2006).

2.2.8 Key permits and licences that are of particular relevance to nuclear power stations which indirectly ensure the safeguard of European eel include:

- Water Discharge Activity (WDA) Environment permit has been incorporated under the Environmental Permitting (England and Wales) Regulations 2010. All extant discharge consents (which did not automatically become exempt registrations) have automatically migrated to bespoke environmental permits on 6 April 2010. The WDA permit is of particular relevance to nuclear power stations regarding the operation of cooling water discharges and potential mortality to European eel from exposure to thermal and chemical plumes (assessed in **Section 5** of this ERCA). In addition, a second WDA permit specifically for the construction phase will be required for surface water drainage, groundwater drainage, treated sewage discharge and several construction and commissioning discharges from the main construction site.

- Under the Marine and Coastal Access Act (2009), many activities that take place in, over or near the sea below the Mean High Water Spring (MHWS) tidal mark require a Marine Licence, including typical construction components of nuclear power stations, such as cooling water intakes and outfalls; and dredging and disposal at sea.

2.3 Eels Regulations Compliance Assessment Approach

Approach (Implementation of the Eels Regulations)

2.3.1 There is no standard methodology for undertaking an ERCA. In the absence of an agreed methodology, this ERCA follows the principles of the Guidelines for Ecological Impact Assessment (EcIA) (2018); and takes into consideration and the requirements of the Eels Regulations, including the Environment Agency Best Practice Guidelines. The ERCA also considers the UK EMP assessment against the target for silver eel escapement and on generic measures that may assist in achieving compliance (Defra, 2010a). The first stage of the assessment identifies the key receptors that may be impacted by specific components (elements) of the project or scheme, and the second stage provides further detailed impact assessments to determine the magnitude of effect of the elements on the key receptors before and after mitigation.

2.3.2 Many of the measures relate to management of eel fisheries, although the UK EMP does include recognition of the need to minimise effects of entrainment and impingement at water intakes and hydropower plants.

Guidance and Key Reports

2.3.3 Key guidance and sources of reports, data and analysis used to inform the Sizewell C Project include:

Environment Agency Reports

- Eel Management Plans for Anglian River Basin District (Defra, 2010a).
- Solomon, D.J. (2010). Eel passage at tidal structures and pumping stations. Environment Agency, Thames Region.
- Solomon, D. J. and Beach, M. H. (2004a). Fish pass design for eel and elver. R&D Technical Report W2- 070/TR1, Environment Agency, Bristol.
- Solomon, D. J. and Beach, M. H. (2004b). Manual for provision of upstream migration facilities for eel and elver. Science Report SC020075/SR2, Environment Agency, Bristol.
- Screening at intakes and outfalls: Measures to protect eel (the eel manual) (Environment Agency, 2011a).
- Fish Pass Manual: Guidance notes on the legislation, selection and approval of fish passes in England and Wales (Environment Agency, 2010, 2015).
- Elver and eel passes – A guide to the design and implementation of passage solutions at weirs, tidal gates and sluices (Environment Agency, 2011b).

- Monitoring elver and eel populations (Environment Agency, 2011c).
- Protection of biota from cooling water intakes at nuclear power stations: scoping study (Environment Agency 2018).
- Safe Passage for Eel – Operational Instruction (Environment Agency, 2014).
- Safe Passage for Eel – Alternative Measures (Environment Agency, 2017).
- Nuclear power station cooling waters: evidence on 3 aspects (Environment Agency,2019).
- The French National Agency for Water and Aquatic Environments (2014). The ICE Protocol for Ecological Continuity – Assessing the Passage of Concepts, Design and Application.
- Gough, P., Philipsen, P., Schollema, P. and Wanningen, H. (2012). From sea to source: International guidance for the restoration of fish migration highways.
- Guidelines for Ecological Impact Assessment (EcIA) (2018).

3 Background: Sizewell C and European eel

3.1 Introduction

3.1.1 This section of the report provides a summary of the key construction and operational components of Sizewell C with particular emphasis on those components which may impact the safe passage of European eels. Ecological characteristics, habitat and population dynamics of European eel with reference to the wider environment of Sizewell C is also summarised along with existing investigations on the effects of nuclear power stations on European eel.

3.2 Sizewell C Project Study Area

The Site

3.2.1 The proposed Sizewell C nuclear power station would be located on land immediately to the north of the existing Sizewell B nuclear power station, on the Suffolk coast approximately midway between Lowestoft to the north and Ipswich to the south. It would comprise two UK EPR™ units together with associated infrastructure and facilities. The key components of the Sizewell C Project are shown in **Figure 3.1** and comprise the main development site, offshore works, a temporary construction area and other land, and a series of off-site Associated Development (AD) Sites.

3.2.2 The Sizewell C main development site covers up to approximately 350 hectares (ha), of which approximately 35ha would be occupied permanently by the new power station. Most of the rest of the site would only be needed temporarily for construction purposes and would be restored in accordance with the operational masterplan and the **outline Landscape and Ecology Management Plan** (**oLEMP**) (Doc Ref. 8.2) once the new power station has been developed. A full description of Sizewell C is provided in **Volume 1**, **Chapter 2** of the **Environmental Statement** (**ES**) (Doc Ref. 6.3), a summary of which is provided below.

3.2.3 It is proposed to build a new access road to link the Sizewell C site to the B1122. Once in place, this would be the main route to bring workers and road-based freight onto the site during construction and the main access for Sizewell C when the power station is operational. The existing Sizewell access would be used initially and would then provide the secondary access to Sizewell C once the new access road is available.

3.2.4 Under an integrated freight management strategy, a direct rail connection would also be constructed to the main development site from the existing Leiston Branch Line.

3.2.5 In order to construct Sizewell C, there would also be a need for associated developments, including temporary workers' campus accommodation and park and ride facilities, as well as other improvements to rail and highway infrastructure.

3.2.6 The proposals for Sizewell C include a Beach Landing Facility (BLF) for delivery of Abnormal Indivisible Loads (AILs) during construction, which would be retained for operational purposes.

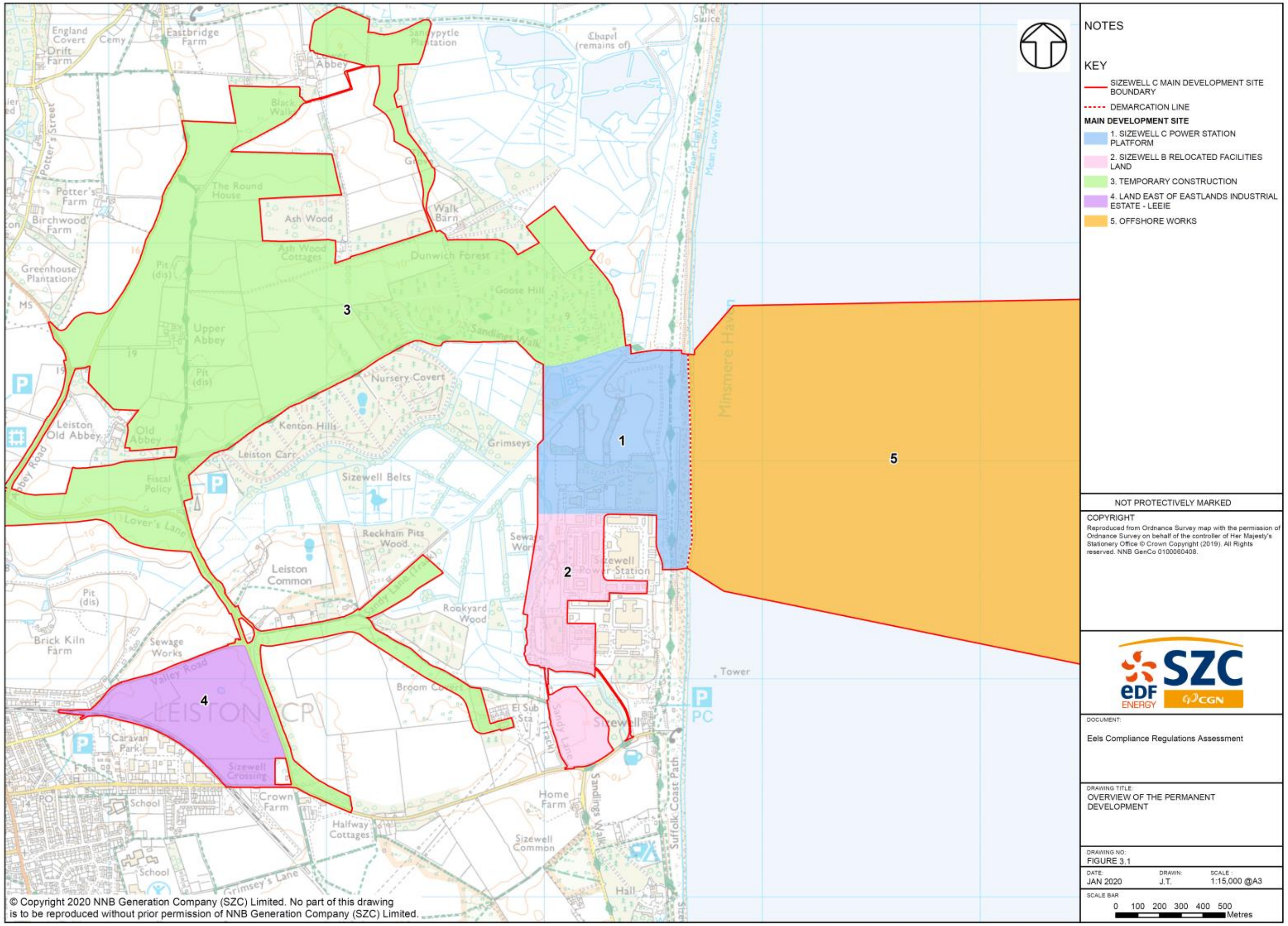

Figure 3.1 Location and Key components of Sizewell C

Main Development Site

3.2.7 A full description of the main development site is provided in **Volume 2, Chapter 2** of the **ES** (Doc Ref. 6.3), a summary of which is provided below.

3.2.8 The main development site comprises five components, which are described below and illustrated in **Figure 3.1** (above):

- the power station platform (main platform) - the area that would become the power station itself;
- the Sizewell B relocated facilities and National Grid land - the area that certain Sizewell B facilities would be moved to in order to release their existing locations for the proposed development and land required for the National Grid transmission network;
- the temporary construction area - the area located primarily to the north and west of the proposed Sizewell Marshes Site of Special Scientific Interest (SSSI) crossing, which would support construction activity on the main platform;
- Land East of Eastlands Industrial Estate (LEEIE) - the area including and directly to the north of Sizewell Halt, which would be used to support construction of the main platform and temporary construction area; and
- the offshore works area - the area where offshore cooling water infrastructure and other marine works would be located.

Permanent Development

3.2.9 Key permanent development within the Sizewell C main development site would include:

- two UK EPR™ reactor units comprising reactor buildings and associated buildings (the 'Nuclear Island'), turbine halls and electrical buildings (the 'Conventional Island');
- two cooling water pumphouses and associated infrastructure (including cooling water tunnels extending approximately 3km out to sea, intake and outfall headworks on the seabed, and measures to mitigate the impingement and entrainment of marine organisms);
- an Interim Spent Fuel Store (ISFS) and an Equipment Store to store transport and handling equipment used when spent fuel is transferred to the ISFS;
- an access road to join the B1122 and related junction arrangements (comprising retention of the roundabout proposed for the construction phase);
- a causeway/culvert to provide access to the power station site across the Sizewell Marshes SSSI connecting the power station to the new access road to the north;
- cut-off wall between Sizewell Marshes SSSI and the main platform;
- permeant surface water drainage;
- alignment of the Sizewell Drain;
- car parking, some ancillary buildings;
- flood defence and coastal protection measures (sea defences);
- the BLF retained to receive occasional deliveries of Abnormal Indivisible Loads (AILs) by sea throughout the power station's operational life;
- landscaping of the areas to be restored following their use during construction in accordance with the **oLEMP** (Doc Ref. 8.2);
- internal roads, car-parking and a helipad;
- emergency equipment store and back-up generator at Upper Abbey Farm;
- fencing, lighting and other security provisions; and

- National Grid 400 Kilovolts (kV) substation and associated relocation of an existing pylon and power line south of the main development site.

3.2.10 Further, to mitigate the effects of Sizewell C, permanent off-site facilities are proposed including marsh harrier compensation areas, fen meadow compensation land and off-site sports facilities.

Temporary Development

3.2.11 The proposed temporary land-use within the Sizewell C main development site would include:

- construction working areas - laydown areas, workshops and storage;
- an induction centre and site offices;
- temporary structures, including a concrete batching plant;
- management of spoil/stockpile arrangements, including the potential sourcing of construction fill materials from on-site ‘borrow pits’;
- a crossing between the power station and adjacent construction areas;
- construction works areas on the beach for the installation of sea defences;
- construction roads, fencing, lighting and security features;
- site access arrangements and coach, lorry and car parking;
- water management zones;
- utilities and services infrastructure;
- landscape bunds and screening; and
- an accommodation campus.

Associated Development

3.2.12 To support the construction of Sizewell C, SZC Co. also needs additional land for off-site associated developments (as defined in Section 115 of the Planning Act 2008) to support the movement of materials and staff to and from the main development site during construction. This includes the following:

- Two temporary park and ride facilities adjacent to the A12 to reduce the amount of traffic generated by the construction workforce on local roads and through local villages. One park and ride site is located to the north of Sizewell C main development site at Darsham (the ‘northern park and ride’, see **Volume 3, Chapter 2** of the **ES** (Doc Ref. 6.4) for a full description), and one to south at Wickham Market (the ‘southern park and ride’, see **Volume 4, Chapter 2** of the **ES** (Doc Ref. 6.5) for a full description; **Figure 2.3**).
- Permanent road improvements on the A12 to bypass Stratford St Andrew and Farnham (the ‘two village bypass’, see **Volume 5, Chapter 2** of the **ES** (Doc Ref. 6.6) for a full description; **Figure 2.4**).
- A road linking the A12 with the B1122 east of Theberton (the ‘Sizewell link road’, see **Volume 6, Chapter 2** of the **ES** (Doc Ref. 6.7) for a full description; **Figure 2.5**).
- A new roundabout to replace the existing priority junction at the A12/Yoxford junction. The proposed new roundabout would provide a safer and more efficient solution than signalising the existing junction (see **Volume 7, Chapter 2** of the **ES** (Doc Ref. 6.8) for a full description; **Figure 2.6**).
- A temporary ‘freight management facility’ at Seven Hills on land to the south-east of the A12/A14 junction to provide spaces for up to 154 Heavy Goods Vehicles (HGVs) (see **Volume 8, Chapter 2** of the **ES** (Doc Ref. 6.9) for a full description; **Figure 2.7**).
- A temporary extension of the existing Saxmundham to Leiston branch line and other permanent rail improvements on the Saxmundham to Leiston branch line in order to transport

freight to the main development site and remove large numbers of HGVs from the regional and local road network (the 'Green rail route', see **Volume 9, Chapter 2** of the **ES** (Doc Ref. 6.10) for a full description; **Figure 2.8**).

3.2.13 Key Sizewell C development components detailed above that could impact the safe passage and protection of European eel are described in further detailed below. A full description of the proposed construction and operation regime for Sizewell C, in particular for the main development site, is provided in **Volume 2, Chapters 2, 3 & 4** of the **ES** (Doc Ref. 6.3).

Offshore Development

3.2.14 The BLF would be required during the operational phase for occasional delivery of AILs, such as the reactor pressure vessel, during maintenance. The landward termination of the BLF would be at approximately 6.0m Above Ordnance Datum (AOD) to provide the necessary depth to accommodate the required barges. The BLF would include a temporary deck structure that can be removed when not in use, leaving minimum visible elements. The BLF would be approximately 10m wide and 80m long.

3.2.15 Seawater for cooling the power station would be abstracted via a series of intake structures and tunnels. Each UK EPR™ reactor unit would have a single dedicated 6m internal diameter intake tunnel extending approximately 3km out and 30m under the seabed. The predicted maximum atmospheric pressure associated with the operation of the intake tunnels would be 4bar (0.4MPa). At the seaward end of each tunnel, two vertical shafts would extend upwards to provide a connection to the sea via a seabed-mounted intake head (one head per shaft). Each of the intake heads would comprise a concrete and steel headworks designed to abstract seawater at a depth of only a few metres above the seabed. A 'velocity capped' design, or a simplified version of the Low-velocity Side-entry (LVSE) Hinkley Point C design, is proposed for Sizewell C. This is discussed further below.

3.2.16 Numerical modelling of the Hinkley Point C LVSE design has demonstrated that it achieved the target intake approach velocity of $0.3ms^{-1}$ m/s along much of its length and was considered compliant with respect to fish protection. For Sizewell C, BEEMS Scientific Position Paper SPP099 determined an intake velocity of $0.3ms^{-1}$ was achieved within approximately 0.7m from the intake faces (tidally averaged) and, compared with the spatial domain that the migrating fish (including eels) move within, this risk zone is considered to be very small (further detailed in **Section 5**).

3.2.17 A single 8m internal diameter outfall tunnel serving both reactor units would return the cooling water to sea, with two vertical shafts at its seaward end each leading upwards to a single outfall headworks, again mounted on the seabed, shown on **Figure 3.2**.

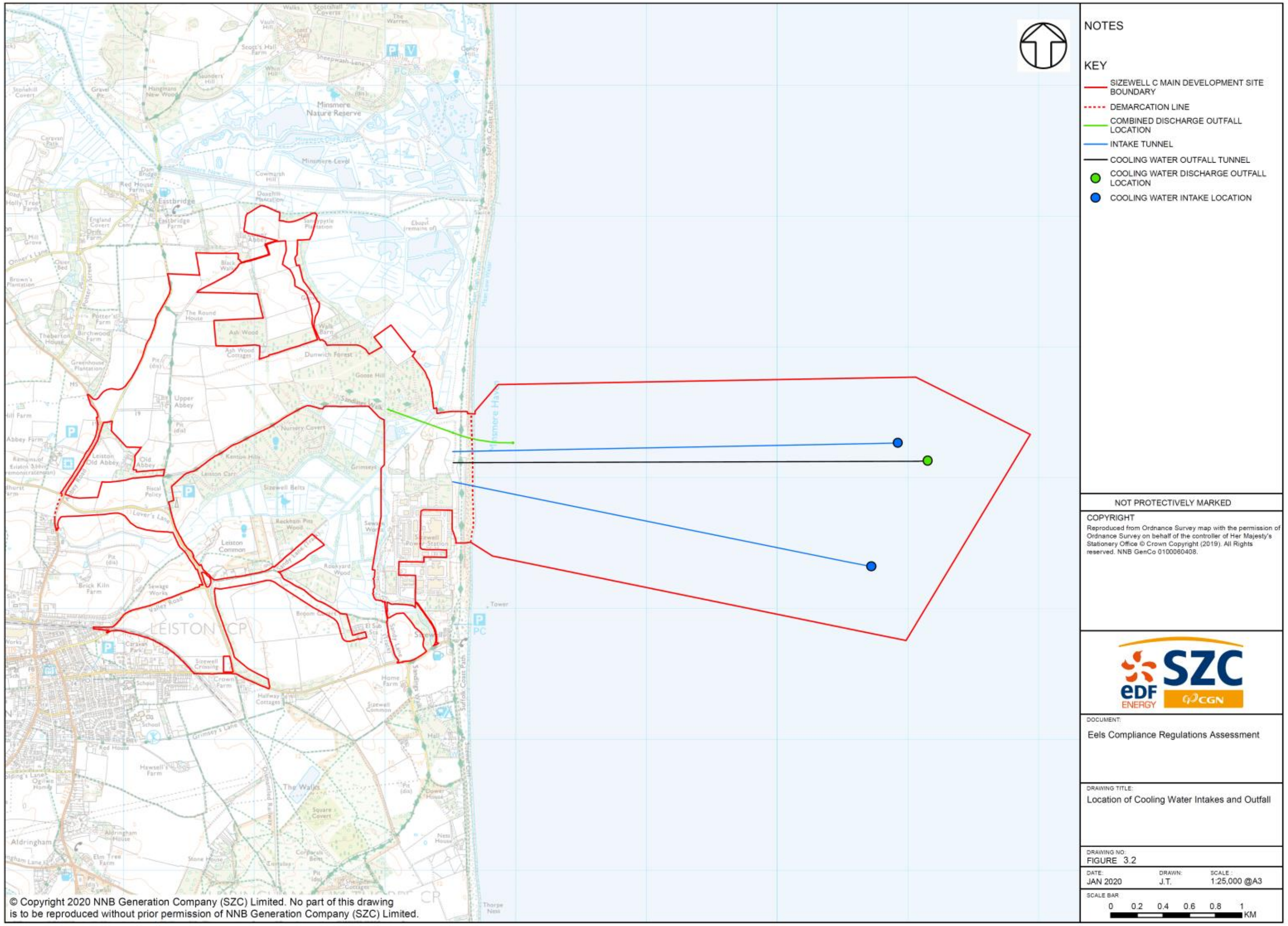

Figure 3.2 Location of Sizewell C Cooling Water Intake and Outfall Tunnels

3.2.18 The two cooling water intake tunnels and one outfall tunnel would be excavated by tunnel boring machines (TBM) from landward. Each tunnel is expected to take 12 months. Waste water arising during the tunnelling process would be treated by a siltbuster, or similar technology, to reduce suspended sediments prior to being discharged at sea via the combined drainage outfall (CDO).

3.2.19 Prior to placement of the head structures, dredging of approximately 17,400 m^3 per intake head would be required to expose the bedrock. The most likely dredge method is via a cutter suction dredger with spoil to be deposited locally. The heads would be prefabricated and lowered into place. A single dredge event is anticipated for each of the four intake heads. Dredging is expected to take 34 hours in total (8.5 hours per head).

3.2.20 Sizewell C would require a continuous supply of seawater via the intake tunnels at approximately 132 m^3s^{-1} (combined) at mid-tide level for cooling; of which approximately 91% would supply the cooling water system and the remainder would supply the safety and auxiliary systems. After being used to cool the condensors, the seawater would then be discharged back to the Suffolk Coast, via the outfall tunnel, with a mean excess temperature of approximately 11.6°C above ambient. Under maintenance conditions the flow is halved so the discharge temperature is 23.2°C above ambient.

3.2.21 Returned abstracted water would be the main waste stream from Sizewell C and would represent approximately 99.9% by volume of the total overall daily discharge of non-radioactive effluent. Several smaller waste streams would be combined with the returned abstracted cooling water before being discharged to sea. The potential mortality on European eel resulting from thermal and chemical plumes is assessed in **Section 5** of this ERCA.

3.2.22 There would be one forebay for each UK EPR^{TM} reactor unit, each served by an intake tunnel. The forebays serve to smooth the water flow into the cooling water cooling water system pumphouse, accounting for the tidal range of the North Sea. Each forebay would have a mechanically raked screen with associated collection gutter for removal of large debris and any very large fish, and transport to the filtering debris recovery building.

3.2.23 There would be one cooling water pumphouse for each UK EPR^{TM} reactor unit, which would draw water from the forebays. The cooling water pumphouses would contain equipment supplying seawater as coolant for:

- the nuclear and conventional Islands' auxiliary and safety cooling water systems; and
- the condenser cooling system that cools the turbine exhaust steam and condenses it to liquid water for reuse as feed water within the secondary circuit.

3.2.24 Each cooling water pumphouse would incorporate screening systems including two drum and two band screens, each specifically designed to prevent the blockage of key elements of plant further downstream within Sizewell C. The layout and operation of the pumphouses would be similar to those under construction for Hinkley Point C, shown on **Figure 3.3**, in which the majority of abstracted sea water would exit the forebay through water channels leading into the high flow volume drum screens, with the remaining water passing through the lower flow volume band screens (NNB GenCo (HPC) Ltd, 2017).

3.2.25 The two drum screens would be made up of a horizontal axis drum whose outer circumference would be made up of panels of a smooth ('fish friendly') fine mesh; the proposed mesh size is 10mm. The inner circumference of each drum screen would have 'fish-friendly' elevator ledges or 'buckets', which would lift debris and marine organisms including fish. Continuous wash-water sprays would then flush the collected material into 'hoppers' which would in turn flush into a gutter for onward flow to the filtering debris recovery building. Very low pressure (1bar) sprays are used first to gently encourage fish to leave the buckets. During normal operation, the drum screens would rotate at a low speed but if there is any indication of blockage both the rate of rotation and the flow rate of wash-water would be increased.

3.2.26 The two sets of rotating band screens associated with each of the cooling water pumphouses would remove debris from the lateral water channels, prior to passage through the fine bore heat exchanger systems that follow. The band screens would be made up of a continuous belt of linked smooth-mesh plates, again proposed 10mm mesh size. The band screens rotate around two horizontal rollers, one positioned at the foot of the waterway and one above and similarly aligned with a catch bucket and gully for fish return that discharges into the filtering debris recovery building.

3.2.27 Located immediately before the drum and band screens will be a series of trash racks (with proposed bar spacing of 75mm), designed to protect the screens from debris but which may also prevent the passage of very large fish. These racks have automated rakes that can be raised across the racks to remove any impinged material and fish that cannot pass through the bars and place it in a gutter for onward transfer to the filtering debris recovery building.

3.2.28 The filtering debris recovery building has another trash rack with, 200mm bar spacing, to prevent blockage of the FRR tunnel and fish that pass through this secondary trash rack pass into the FRR tunnel and returned to sea. Before fish enter the FRR tunnel they would pass through a bypass gutter for fish sampling.

3.2.29 The FRR system would be fully integrated within the cooling water system of Sizewell C and its purpose would be to recover fish and other marine organisms that are entrapped in the cooling water system and caught on both the drum and band screens and return them to the sea. There would be one ca 0.65m internal diameter FRR tunnel for each UK EPR™ that would exit from the base of the filtering debris recovering building and extending approximately 400m offshore.

3.2.30 It should be noted the FRR outfall heads will be strategically placed to ensure fish which have been returned to the sea via the FRRs do not immediately enter the cooling water system cooling water system of Sizewell B to the south on a flood tide. **Figure 3.3** provides an schematic of the Hinkley Point C cooling water system and FRR system. The Sizewell C design is similar with a few significant amendments including a simplified LVSE head, removal of the Archimedes' screw from the filtering debris recovery building and a dedicated FRR tunnel for each filtering debris recovery building.

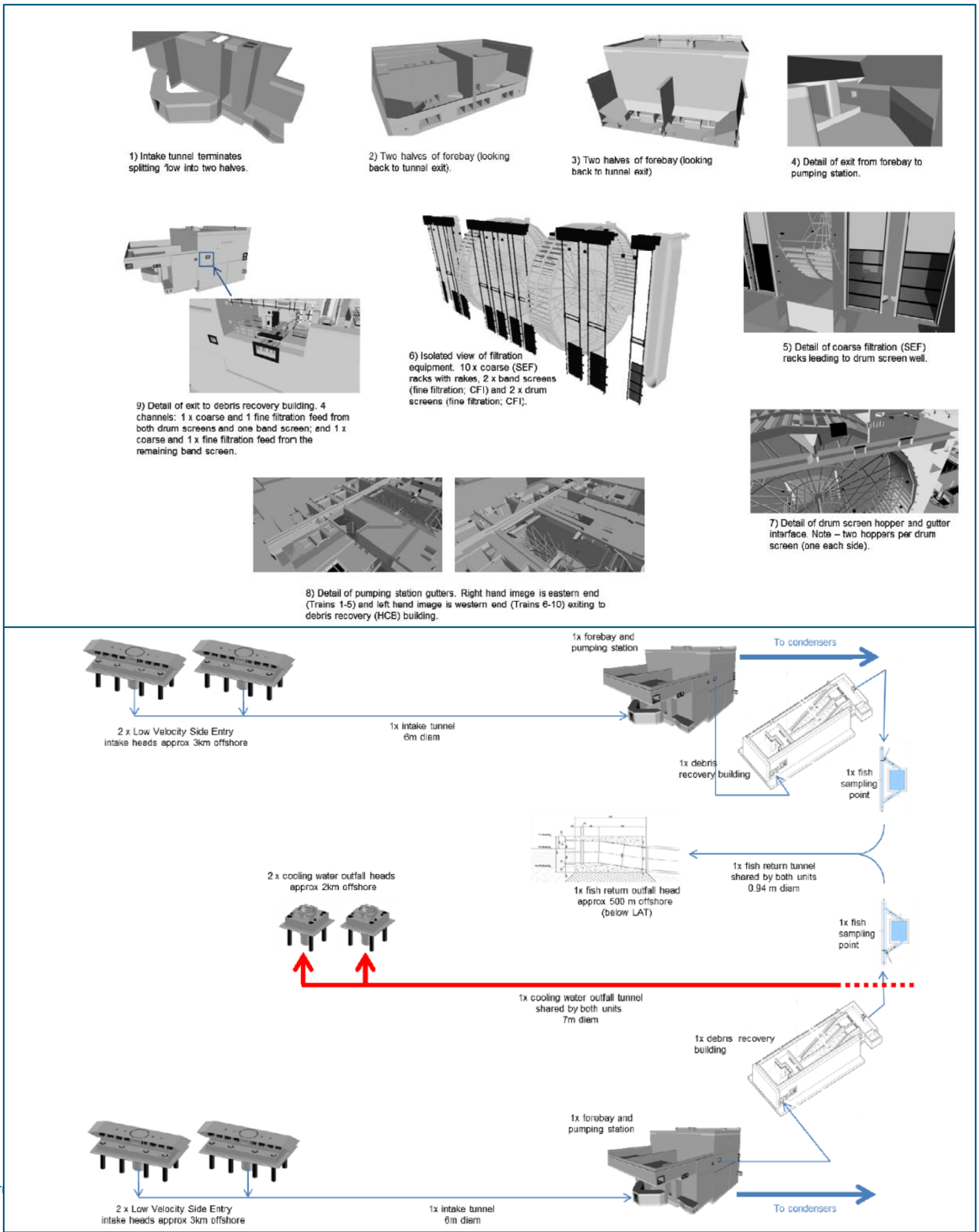

Figure 3.3 Schematic of Hinkley Point C Cooling Water System, FRR System and Pumphouse (Source: NNB Genco (HPC) Ltd, 2017)

Onshore Development

Permanent Site Drainage

3.2.31 Permanent site drainage systems would be installed to treat surface water run-off and then discharge it into the power station forebay(s), where it would mix with cooling water before being disposed to sea. In some areas, the permanent systems may utilise parts of the construction drainage infrastructure. The CDO would not be used in the operational period.

Realignment of Sizewell Drain

3.2.32 The current alignment of the Sizewell Drain is within the footprint of the proposed Sizewell C power station; and its realignment is essential for the protection of designated wetland habitats within the Sizewell Marshes SSSI when the power station is constructed. The diverted watercourse would be constructed with a falling gradient and width to provide, at minimum, the same capacity as the watercourse it replaces. Banks and cross sections would be varied to provide a more natural appearance. The existing Sizewell Drain would be retained until the replacement is complete, allowing diversion of flow. A temporary culvert (approximately 600mm in width) or construction plant crossing points would be provided to avoid access restrictions within the main platform before the existing drain can be removed.

3.2.33 Water control features would also be installed in the realigned drain to enable manipulation of the water levels within Sizewell Marshes SSSI to help ensure that any alterations to the hydrological regime caused by construction activities can be brought back to the correct parameters needed to safeguard retained areas of fen meadow; and reedbed habitats. The water control features would incorporate fish and eel passage measures, the details of which will be clarified during the detailed design stage.

3.2.34 Initial access would be made via the north or the south to provide access for vegetation clearance and species relocation. Ground improvement works may also be necessary in the form of piles or equivalent, dependent on ground conditions. The trench for the realigned drain would be excavated from the east to minimise harm to the SSSI, using standard wheeled excavation equipment where possible. Sheet piling may be installed on the eastern bank of the drain. Matting may be used during the works to prevent settlement of machinery into the soft ground. The reclaimed area described above would be infilled with granular material to provide a suitable formation, initially for the creation of the cut-off wall platform. The platform would be constructed around the perimeter of the location of the cut-off wall and would include a perimeter access corridor. The platform would be constructed to a level of 3m AOD to enable a uniform level to construct the cut-off wall. There would be a retaining slope from the platform to the newly aligned Sizewell Drain.

3.2.35 The proposed activities needed to construct the cut-off wall would be:

- Installation of continuous flight augered piles to a depth of approximately 12m to support soft strata during installation of the cut-off wall.
- Installation of the cut-off wall to depths of approximately 50m below ground level using grabs and / or hydromill machines. These machines would excavate the material, replacing it with bentonite in the short-term. Bentonite would be used to stabilise the trench cutting during excavation, to stop the sides of the excavation from collapsing.

- Bentonite would be produced on-site at a 'bentonite farm', which would mix the required solution as well as clean returned bentonite. Bentonite waste would either be removed to an approved landfill site or retained on-site and used in the fill of the borrow pits. Bentonite wastewater would be treated and either discharged via the CDO or tankered off-site.
- Installation of large full-length reinforcement cages, prior to being filled in with concrete and creating a capping beam. Concrete for the main cut-off wall supply would be provided by the on-site concrete batching plant. Supply of concrete would need to be robust and resilient to maintain the large volume and quality of the pour. Due to this requirement, limiting bentonite use, and the contiguous nature of the cut-off wall, works would be conducted 24 hours a day, 7-days a week.

Sizewell Marshes SSSI Crossing

3.2.36 The SSSI crossing provides an essential pedestrian and vehicular connection across Sizewell Marshes SSSI, linking Sizewell C with the new access road. The design comprises an embankment and culvert (causeway), with the culvert (a three-sided culvert without a base) of sufficient dimensions to leave the bank and channel of the Leiston Drain intact. The culvert would also be of sufficient size to facilitate the passage of fish and eels (and other animals) through the structure, with appropriate ecological lighting and noise protection incorporated. A drainage system, compliant with the requirements of the Design Manual for Roads and Bridges, would collect surface water run-off from the road where it would outfall into a swale and infiltrate to ground. Run-off from the SSSI crossing infrastructure, therefore, would be diverted away from the SSSI.

3.2.37 Construction of the crossing would begin with site clearance and establishment of a temporary works areas for the SSSI crossing to the North and South. To assist in going construction works, early access from the temporary construction area to the main platform area would be provided using a short-term bridge and would be designed to cater for lighter site traffic and material deliveries. Prior to this, all construction traffic including materials, plant, equipment and labour would access the main platform via the Sizewell B site access route.

3.2.38 Ground stabilisation works across the footprint of the causeway would be undertaken and piling may be required.

3.2.39 Part of the pre-cast concrete culvert would then be installed, allowing a temporary causeway connection to be made. This would be followed by removal of the short-term bridge, installation of the remaining part of the box culvert and completion of the causeway to provide the construction phase connection.

3.2.40 Following the completion of the construction phase for the SSSI crossing, as set out above, the western-most access route across the causeway would be maintained to provide operational access to the power station.

3.2.41 The easternmost access route would be removed and the causeway appropriately landscaped. Due to the post-construction settlement limit, a load transfer platform and column spacing that transfers all the embankments loads.

Road Improvements

3.2.42 The road improvements on the A12 to bypass Stratford St Andrew and Farnham (the ‘two village bypass’)and a road linking the A12 with the B1122 east of Theberton (the ‘Sizewell link road’), will require in-channel structures and channel modifications associate with the watercourses of the River Alde and Minsmere Old River.

Sea Defences

3.2.43 The proposed permanent sea defence would be in the form of two components; a hard coastal defence feature (HCDF) and a soft coastal defence feature (SCDF). The HCDF would be constructed using rock armour wrapped in a geotextile matting and dressed in a shingle/sand/soil matrix to encourage vegetation growth. Sheet piling will be used to secure the haul road terminus (at the BLF) until the HCDF is complete. A rock armour slope will protect the sheet piling once complete. The SCDF sediment would be placed in the swale between the HCDF and the existing 5m bund and be constructed using terrestrial construction vehicles.

3.3 European Eel Habitats and Population Dynamics

Migratory Behaviour of European Eels: General Life Cycle

3.3.1 European eels are believed to breed in the Sargasso Sea, a region of the North Atlantic Ocean bounded by four currents, that together form a circulating ocean stream called a gyre (see **Figure 1.1**). After their first transatlantic migration, larvae metamorphose into glass eels and swim into estuarine areas of river deltas (Bruijs and Durif, 2009). Research by Tesch (1975) found that glass eels display a poor homing instinct during migrations, with no home-water ‘printing’ and do not home to their natal river system and all European eel can, therefore, be considered as a common stock. Based on recent consultation with the Environment Agency, there is potential that more female adult (silver) eels are present on the east coast of England, however, the route of the eel migration still remains uncertain (Righton et al. 2016).

3.3.2 Glass eels develop into elvers (6-7cm) which then swim up rivers. They generally enter the inland waters of the United Kingdom between February and April. After reaching a length between 12cm and 14cm elvers become yellow eels which have moved further upstream inland and continue to grow for some 8-15 years (males) and 10-18 years (females) (Bruijs and Durif, 2009). After their period of growth, in preparation of their return trip to the spawning grounds (Sargasso Sea), the eels transform into silver eels (see **Figure 1.1**). The migration run for silver eels in the United Kingdom, is generally between November and February (Bruijs and Durif, 2009).

Migratory Behaviour of Glass Eels and Elvers

3.3.3 Glass eels and elvers have a natural instinct to follow freshwater flows and require background temperatures of between 9°C and 11°C for upstream migration. February appears to be the earliest month for the onset of migration from the English Channel (Gascuel, 1986; Tesch, 2003), although glass eels can often remain within the estuary for at least a year, transforming into elvers before they start to migrate further upstream. By the end of September, temperatures may start to drop too low for migration to continue (White and Knights, 1997).

3.3.4 Glass eel entering coastal waters use Selective Tidal Stream Transport (STST) to migrate to the coast and into river systems. This is an effective mechanism to rapidly colonise a catchment, as it requires little energy to float with the flood stream, up to the upper limit of the tidal movements – usually far beyond the marine/freshwater-interface. To progress further upstream, active migration into the river is required, swimming against the river flow (see below). It should be noted recent evidence suggests that silver eels also use STST (Verhelst et al. 2018).

3.3.5 Laboratory experiments have indicated that at water velocities up to $0.38ms^{-1}$, elvers migrate upstream within the boundary layer created at the stream bed and avoid free stream velocities If water speeds exceed $0.38ms^{-1}$, elvers move upstream by swimming in bursts in the water column. This requires much more energy, so the elvers then spend time recovering within the substrate them to pay back the oxygen debt (Barbin and Krueger, 1994).

3.3.6 Glass eels and elvers naturally move away from light (a negative phototactic response). They therefore gravitate to the bottom of the water column during the day, where they spend much of their time within the substrate avoiding light. Gascuel (1986) observed glass eels rising in the water column at night. As glass eels transform to elvers, migration occurs at greater depths. Although they use the edge of the midstream current, elvers are no longer found as close to the stream's banks (Tesch, 2003).

3.3.7 River migration is typically nocturnal. Dutil et al. (1989) have noted that river entry by the American eel (*A. rostrate*), mainly occurs between 21:00 and 23:00. Lunar cycles have been shown to influence migration activity. Tesch (2003) reported that the greatest activity was recorded during the last quarter of the moon and at new moon. In 2014, the Environment Agency and authorised fishermen collected European eels as part of the Sustainable Eel Group project, in which more than 1.2 million elvers were caught in the River Parrett, Somerset, England during a spring tide at night. However, as stated above, river migration is also dependant on various cues, such as water salinity and temperature.

Migratory (Escapement) Behaviour of Silver Eels

3.3.8 Silver eels typically migrate at night in groups and migration is correlated with environmental factors that result in increased discharge (e.g. rainfall, flood events, dam openings) and low light conditions (wind, increased turbidity, atmospheric depressions and moon phases) (Bruijs and Durif, 2009). This was clearly evident during a study undertaken by Royal HaskoningDHV for the Environment Agency in 2013 on silver eel escapement at Huntspill Sluice analysing DIDSON acoustic camera data, in which the following key results were obtained:

- It was found that fewer eels migrated in December and January (approximately 30%) compared to July-November for a previous study. Eel numbers migrating in January were very low and December probably marked the end of the silver eel migration season in 2011.
- Eel migration was found to be extremely episodic with the majority of eels migrating over a short time period. Eel movements were triggered by heavy rainfall and elevated flows, with most eels migrating within a day or so of heavy rains. Virtually all of the eels migrated at night, with only 1% migrating during the day, regardless of rainfall and water level.
- Other variables including moon phase, tide state and water temperature had no significant effect on eel migration within the study period.

Key Ecological Features of European Eels

3.3.9 European eel has a physostomous swim bladder (connection with the stomach), although is on the verge of becoming physoclistous, in which the duct is caught in the very act of enlargement into a separate chamber and has an extremely long distance between the swim bladder and the ear. This overall results in European eel being more tolerable to noise thresholds compared to other fish species and fall under the classification of hearing generalists. For example, audiogram measurements have shown that eels are sensitive to sound pressure at frequencies centring on 90Hz (with an upper limit of 320Hz) and to vibrations of approximately 40Hz (Jerkø et al., 1989). In early experiments, carried out by Fawley Aquatic Research Laboratories, silver eels were exposed to a range of pure tones, bursts of noise and chirps. These sounds were produced by a large military sound projector in the range 50-2,000Hz at levels of up to approximately 180dB re 1μPa (EA, 2014). The experiments revealed no signs that the eels detected the noise, even when almost touching the sound projectors. Detection of sound pressure in teleost fish is enhanced by the swimbladder organ, a factor that may influence the sensitivity of eels to sound, is infestation with the swimbladder parasite, *Anguillicoloides (Anguillicola) crassu*s, which can cause thickening of the swimbladder walls (EA, 2014). Recent river trials also demonstrated silver eel migrations are successfully influenced by an infrasound source (EA, 2014).

3.3.10 A study by Kastelein et al. 2008 showed the comparison between the reaction to noise between the two hearing generalists fish species, the European eel and sea bass (*Dicentrarchus labrax*). For sea bass, 50% reaction threshold ranges were reached for noise signals between 0.1 and 0.7kHz, while for European eel, no 50% reaction thresholds could be reached, further highlighting the high tolerance to noise of European eel compared to other fish species with swim bladders involved in hearing. For example, Atlantic herring is a hearing specialist and is able to perceive sounds in the frequency range 30Hz – 4kHz (Mason, 2012). Overall, the presence and type of swim bladder (physoclistous or physostomous) is expected to determine the vulnerability for sound pressure exposure. Least susceptible to sound pressure induced injuries are fish with no swim bladder and most susceptible are fish with a physoclistous swim bladder. In the recently published sound exposure guidelines (Popper et al. 2014), a distinction was made between no swim bladder, swim bladder involved in hearing and swim bladder not involved in hearing, each with different thresholds for mortal and potential mortal injuries. Fish with a swim bladder involved in hearing are expected to be most susceptible to mortal and potentially mortal injuries.

3.3.11 European eel perform extensive diurnal migrations and swim at a depth of about 100-300m, although can swim down to 1000m; and are thus exposed to large hydrostatic pressures up to 8.21MPa (82bar); and typically don't experience barotrauma.

3.3.12 The effects of light, or the lack of it, on fish migration remains an area of debate and is often referenced as a key obstruction to the migration of fish and eels. For example, the UK Design Manual for Roads and Bridges (2004), Volume 4, Section 2, which provides guidance on detailing of outfall structures to highway drainage systems and design of culverts, states that *"fish are reluctant to pass through dark waterways and consequently fish migration may be impeded"*. Although further detailed in **Section 5** of this ERCA, Dane (1978) concluded that darkness inside culverts was not a major determinant in controlling migration and should only be accounted for in design as a safety factor. Elvers and silver eels generally tend to migrate more at night, so passage in dark culverts (tunnels) is not an issue for them.

3.3.13 European eels rarely follow direct routes. For example, a study by Piper et al. 2015 showed initially, eels align with streamlines near channel banks approach flow intakes semi-passively. A switch to more energetically costly avoidance behaviours occur on encountering constricted flow, prior to physical contact with structures. Under high water velocity gradients, eels then tend to escape rapidly back upstream, whereas exploratory 'search' behaviour is common when acceleration is low. This study highlights the importance of hydrodynamics in informing eel behaviour which offers potential to develop behavioural guidance, improve eel passage and protection solutions and enhance traditional physical screening.

Suffolk Coast and EMP for Anglian River Basin District

3.3.14 Historically, strong fisheries for adult European eels existed in East Anglian rivers, but due to the reduced number of eels, fishing is now largely a subsistence activity, although a fyke net fishery still operates in the River Thames (Potts et al., 1993). A commercial glass eel fishery has also operated in the East Anglian region (Defra, 2010a), showing that European eels are present in the waters adjacent Sizewell C. In the River Stour, glass eel recruitment monitoring has been carried out to improve information on stock status (Defra, 2010a), and in 2014 glass eels recruited into the river between March and August.

3.3.15 A review of scientific literature suggests that glass eels generally arrive in the North Sea in January to February. However, this is dependent on met-ocean conditions over Northern Europe and the relative strength of the Gulf Stream and associated currents around the British Isles. Observations suggest that eels enter the North Sea from both the English Channel and from the north, following currents that flow around Scotland and southwards into the southern North Sea. However, little is known about the residence times of glass eels in the southern North Sea. The eels reach the coast and seek a salinity cue to transition from oceanic waters to coastal ones, so the time spent in the open North Sea is dependent on when they sense this behavioural cue.

3.3.16 It is possible to catch glass eels in the southern North Sea from January to mid-May depending on the prevailing met-ocean conditions. Environment Agency eel recruitment data from fish weirs and traps on the Rivers Stour and Blackwater indicate that glass eels migrate upstream in rivers from April through the year and can be found as late in the year as September.

3.3.17 Numbers recorded in these local rivers in recent years appear to peak in May/June. Sampling for glass eels on tributaries of the River Thames is carried out annually between April and September also suggesting that glass eels would be present in the East Anglia marine environment prior to entering freshwater, in or around April and May (BEEMS 2016a).

3.3.18 The most comprehensive assessment available for the status of the eel population in East Anglia is provided in the EMP for the Anglian River Basin District (RBD). Data on yellow eel populations for Essex and Suffolk catchments were derived from electric fishing surveys, carried out as part of the Environment Agency's routine monitoring programme. An assessment based on combined data gathered from 2009 to 2011 and reported to the European Commission in June 2012 as part of the UK's EMP Progress Report, estimated a total output of 62.3t of silver eels from the Anglian RDB each year (Defra, 2012). Estimates were updated and presented for individual years in 2015 and 2018 (Defra, 2015, 2018).

3.3.19 No eels were found in the BEEMS 2m beam trawl and otter trawl surveys of the Greater Sizewell Bay between 2008 and 2012. In April and May 2015, an additional survey was undertaken targeted towards glass eels in the area of the current SZC and proposed SZC intakes, using similar techniques that had previously been applied at Hinkley Point (BEEMS 2016a). Although the survey was undertaken during daylight, the survey was undertaken based on Environment Agency eel recruitment data from fish weirs and traps on the Rivers Stour and Blackwater, which indicated that glass eels migrate upstream in rivers from April and peak numbers appear to be present in May/June. In addition, the surveys did include bottom surveys (2m off the seabed to prevent snagging). Only one glass eel was captured from the 105 valid hauls and given that this equipment had been successfully utilised at Hinkley Point, it was concluded that this lack of glass eels at Sizewell was indicative of the extremely low local abundance and high level of dispersal of this particular life stage in this open coastal area of the North Sea.

3.3.20 A further explanation for the capture of only one eel could be the distance from the coast at which glass eels migrate en route to finding rivers. It is thought that glass eels hug the coast as they are probably attracted to the estuaries of the major rivers by the presence of fresh water discharging into the sea (Malcolm et al., 2010). However, they need a cue to and transition from oceanic waters to coastal ones. The most rapid transit route for glass eels to the East Anglian coast is via high salinity (more than 34.5) water that has flowed through the English Channel. Once around North Foreland (tip of Kent coast) the Thames Estuary will act as a salinity cue, as evidenced by the eel fishery in the Thames. The Essex and Suffolk rivers (Crouch, Blackwater, Colne, Stour, Orwell and Deben) rivers also contribute fresh water so that there is a lower salinity regime inshore. Depending on the tide and meteorological conditions those glass eels that can enter these systems will; while others however will be carried further north in the high salinity water. At the location of Greater Sizewell Bay the fresh water contribution from the rivers further south has been mixed and reduced significantly so that the normal range of salinities in Sizewell Bay is 33 – 34 (**Appendix 21B** of this volume). Locally the River Blyth is a very small discharge and its salinity signal is very weak. Greater Sizewell Bay itself therefore offers no salinity cue to draw those glass eels left offshore inshore.

3.3.21 Overall, the resulting low catch of the above survey indicates that within the sampling parameters (month of sampling, part of the lunar cycle), the abundance of glass eels in the vicinity of the current and proposed intakes is extremely low. The assessment of glass eel populations for the Greater Sizewell Bay is further detailed in **Section 3** of this ERCA, in which monitoring programmes undertaken by Cefas over 10 years, which include 24 hour sampling, thus all phases of the tide and lunar cycle which influence eel behaviour and population counts, was fully considered.

3.3.22 Although historical information, based on the EMP for the Anglian RBD (Defra, 2010a), the EMP has also concluded there have been very low numbers of glass eels/elvers caught within the Anglian RBD. This indicates the relatively low numbers of glass eels returning to the East Coast. The EMP concluded this was probably due, in part, to the distance of the Anglian coast from the Continental Shelf, tending to produce low densities of eels within rivers on the North Sea coast. It is important to continue this type of monitoring, for example the above April and May 2015 survey, to enable long-term trends to be observed (see **Appendix 22G** of this volume).

3.3.23 The distribution of eels throughout the Anglian RBD is shown in **Figure 3.4**. The overall general trend for eels within these catchments based on the EMP for the Anglian RBD is downwards for both density and biomass. The only catchments which showed exception to this are the Welland, where both density and biomass increased between 2000 and 2005, and the Stiffkey in Norfolk (1988-2000), where biomass increased but density decreased. The low eel density for rivers within close proximity to the proposed Sizewell C site is clearly shown on **Figure 3.4**. As stated above, although based on historical information, such information presented in **Figure 3.4** is vital as baseline which can be compared against ongoing eel population surveys, for example the above April and May 2015 survey, to enable long-term trends to be observed.

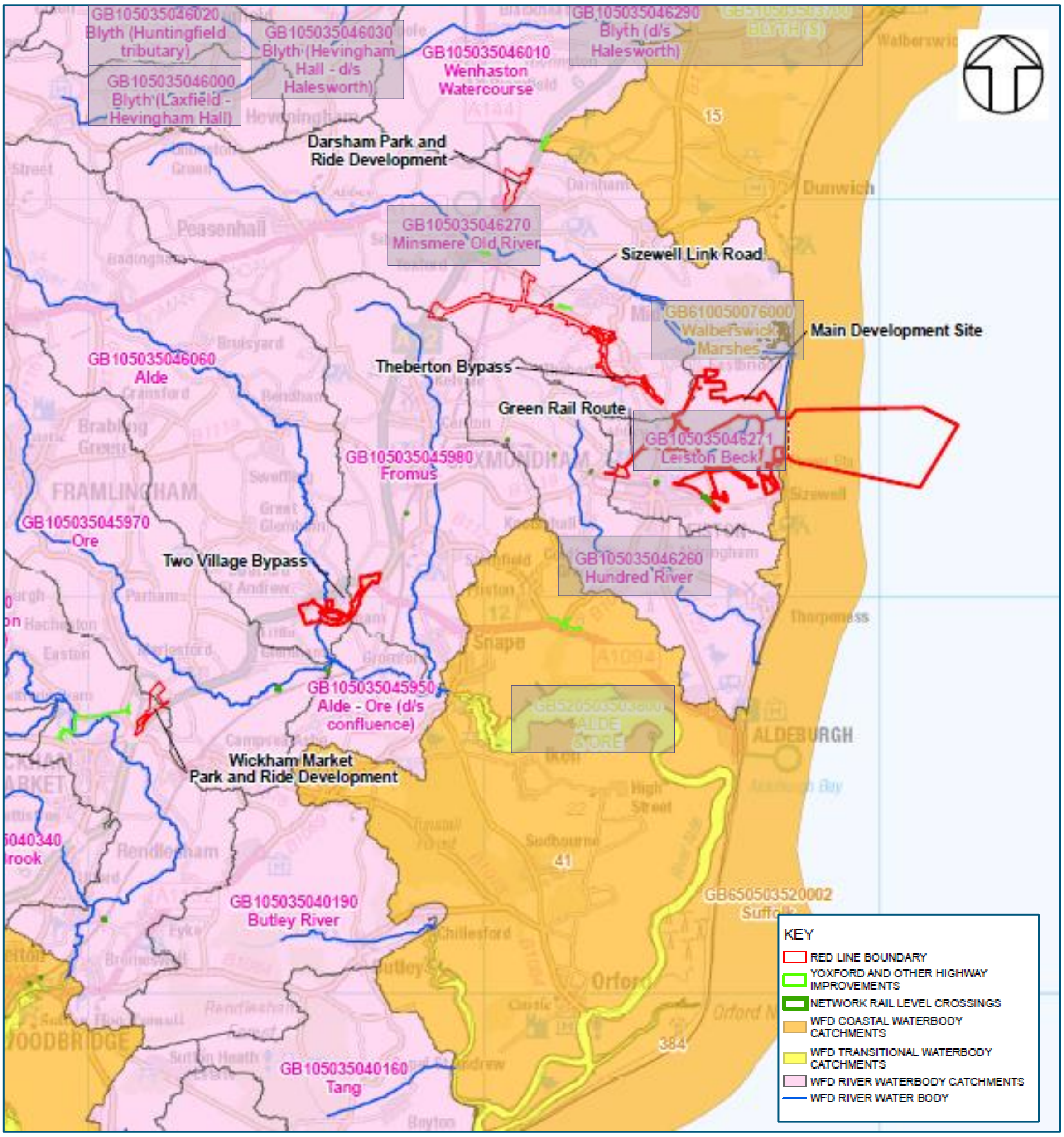

Figure 3.4 Distribution of eel in the Anglian RBD (2001 - 2005) (Source: Defra, 2010a)

3.3.24 The rivers and waterways throughout the Anglian RBD have been extensively modified over the last several centuries, and particularly in the latter half of the last century for the purpose of flood defence. This has led to a restriction or loss of migratory eel routes and thus access to habitat, coupled with further complete loss of habitat resulting from land drainage practices to optimise the land available for agriculture. The other key river systems, other than those previously stated above, for the example the River Blyth (which are both WFD and EA main rivers) within close proximity to Sizewell C and provide a direct route from the sea to inland habitats are: Minsmere Old River; Walberswick Marshes; Leiston Beck/Sizewell Drain; Hundred River; and the Alde and Ore, as shown on **Figure 3.4**.

3.3.25 Despite attempts to improve understanding, the confidence in what affects eel numbers and distribution remains low. EC regulation compliance assessments have concluded that many EMPs are failing the 40% escapement target for silver eels (ICES, 2018; Defra 2015; Defra 2018). Improving this situation will require implementation of cost-effective measures, in many cases involving substantial capital investment. A good understanding of the distribution of eel natural habitat, and the likelihood of eels were existing barriers not present, will be needed in order to make appropriate investment decisions.

3.3.26 The timescale over which improvements in eel populations should be achieved is ill-defined in the legislation. The EC regulation requires Member States to develop eel management plans. An objective of these is to ensure at least 40% of the silver eel biomass (relative to the best estimate of escapement that would have existed if no anthropogenic influences had impacted the stock) escapes to the sea. This should be achieved by reducing anthropogenic mortality of eels. The timescale over which this target should be achieved is left vague – simply that it should be achieved in the long-term. The regulation stipulates that the eel management plans should set out a timescale over which the target level of escapement should be achieved. The plans should also implement measures to reduce mortality as soon as possible.

3.3.27 The Anglian EMP sets out a number of measures to address barriers to migrations, entrainment and impingement between 2009 and 2012. However, it makes clear these are subject to resources being available. Measures beyond 2012 to achieve the escapement objective, in particular, were to be reviewed in response to the success of the measures implemented. Beyond this, whilst the eel management plans establish a deadline by which the 40% escapement should be achieved, shown on **Figure 3.5**, they do not set out long-term action plan or programme of measures through which the escapement target should be met.

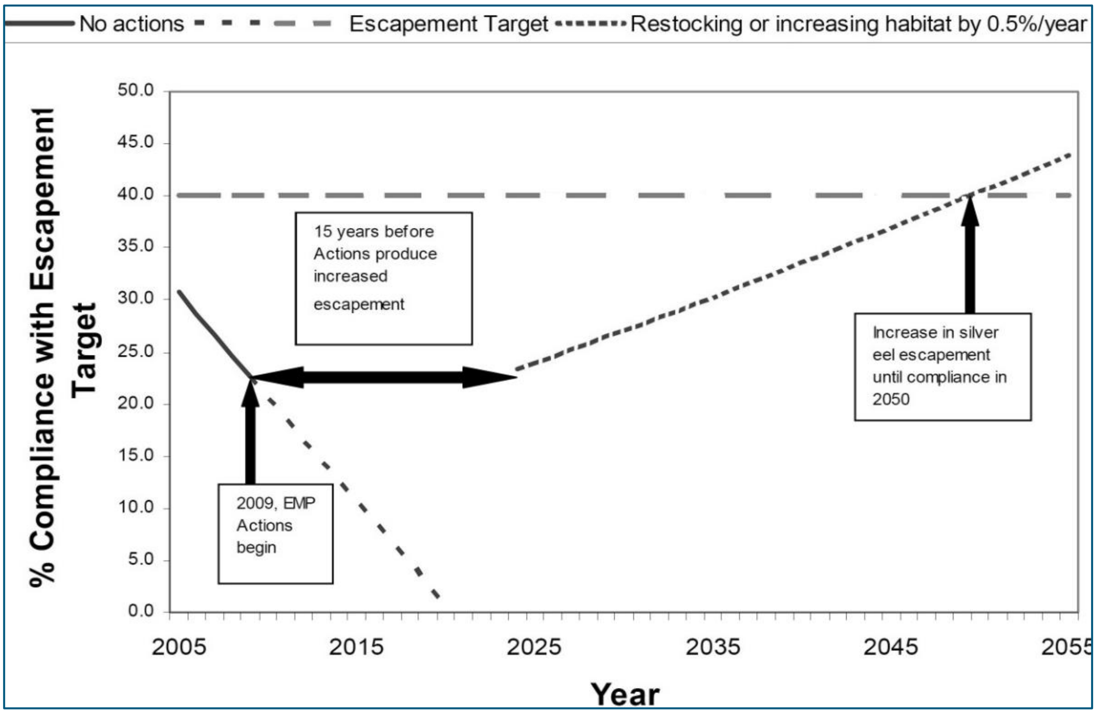

Figure 3.5 Estimated Timeline for Meeting 40% Escapement (Source: Defra,2010b)

3.4 European Eel and Nuclear Power Stations

3.4.1 Coastal power stations use large volumes of seawater in their cooling systems to condense turbine steam. The current Sizewell B station abstracts approximately 51.5m^3 s^{-1} of seawater; and the proposed new nuclear build, Sizewell C, would abstract approximately 132m^3 s^{-1}. Most fish and crustaceans that pass through the intake screens are removed through impingement on fine-mesh drum or band screens before the water enters the power station cooling system, to prevent them blocking the condenser tubes (see **Figure 3.3**). Smaller planktonic organisms (fish eggs and larvae, invertebrate zooplankton and phytoplankton) are entrained, that is they pass through the power station cooling system before being discharged back into the environment.

3.4.2 Entrained organisms at Sizewell C would be subject to a variety of physical and chemical stresses before they pass finally back out to sea. These stresses include fluctuations in pressure (up to 3bar), mechanical turbulence, a rapid increase in temperature of about 11.6 °C and exposure to chlorine based anti-fouling agents which, when added to seawater, form oxidants (mainly hypobromous acid and hypobromite) that have biocidal properties. It is often assumed that these stresses cause sufficient damage that 100 % of all entrained organisms die during, or shortly after, passage through the power station, but experimental evidence shows significant levels of survival for some species (BEEMS 2016b). Although further detailed in **Section 5** of this ERCA, worst case exposure of entrained glass eel is 69ng/l, with hydrazine only to be added to the Sizewell C cooling water flow for a maximum of 2.3h per 24h day at this concentration. Canadian Federal Water Quality Guidelines for hydrazine indicate concentrations below 200 ng/l have a low probability of adverse effects for marine life i.e. no predicted effect from hydrazine (Environment Canada, 1999).

3.4.3 A summary of key investigations related to impingement and entrainment associated with EDF existing and proposed NNBs are provided below.

Sizewell B and Sizewell C

3.4.4 Later life stages of European eel beyond the glass eel stage, were routinely caught during impingement sampling at Sizewell B, as part of the Cefas Comprehensive Impingement Monitoring Programme (2009-2017). The Sizewell B impingement monitoring during the Comprehensive Impingement Monitoring Programme (with 10mm mesh filtration) detected two glass eels (67.5mm long); and a number of yellow eels ranging in length from 228mm to 893mm (**Figure 3.6a** and **Figure 3.6b**) i.e. with body widths from 14.25mm to 55.8mm (using morphological data reported in Environment Agency, 2005). Ninety percent of these eels were greater than 280mm in length with a median length of approximately 400mm.

3.4.5 Yellow eels were caught throughout the year with the peak period of impingement in October and November and lowest catches in February to April and in December (**Figure 3.6c**). From the length data and the Sizewell B 10mm mesh size, it can reasonably be hypothesised that small (i.e., very young) yellow eels and elvers were not present at Sizewell; if young yellow eels had been present the length distribution would have been expected to continue down to below 160mm. Similarly, elvers were unlikely to have been present in any significant numbers as these larger fish would have been more likely to have been impinged than the two glass eels and would be unlikely to be present without young yellow eels. No glass eels or elvers were found in entrainment sampling. From these data it was concluded that yellow eels above 228mm will be at risk of impingement at Sizewell C with the majority of fish at risk having a length greater than 280mm. All of the yellow eels are expected to be able to pass through the proposed 75mm trash bar spacing at Sizewell C and returned back to the sea via the FRR (see **Section 5**).

3.4.6 Furthermore, very few silver eels were impinged during the Cefas Comprehensive Impingement Monitoring Programme (BEEMS 2011a, 2011b, 2012a and 2015), and it is likely that the majority were yellow eels that were probably moving between different river systems along the East Anglian coast or living in coastal waters locally (**Appendix 22D** of this volume)BEEMS TR345). The general decline in eel populations across Europe is reflected in the inshore Young Fish Surveys; although there has been no appreciable decrease in catches on the Sizewell B screens over the four years of impingement monitoring, though the time series is too short to furnish conclusions on local trends with any degree of confidence (**Appendix 22D** of this volume). However, based on the Sizewell B Comprehensive Impingement Monitoring Programme, not finding silver eels being impinged was not surprising, as this eel life stage is known to migrate near to the surface at night and would be at a low risk of impingement at Sizewell B's seabed mounted intakes and much less at Sizewell C due to the deeper intakes (see **Section 5**).

3.4.7 **Appendix 22G** of this volumepredicted entrainment losses in the proposed Sizewell C power station on the key fish species using calculated using data on entrainment of species in the Sizewell B station (abstraction of approximately 51.5 $m^3\ s^{-1}$), scaled to the level of abstraction planned for Sizewell C, which at the time of writing was approximately 125 $m^3\ s^{-1}$.

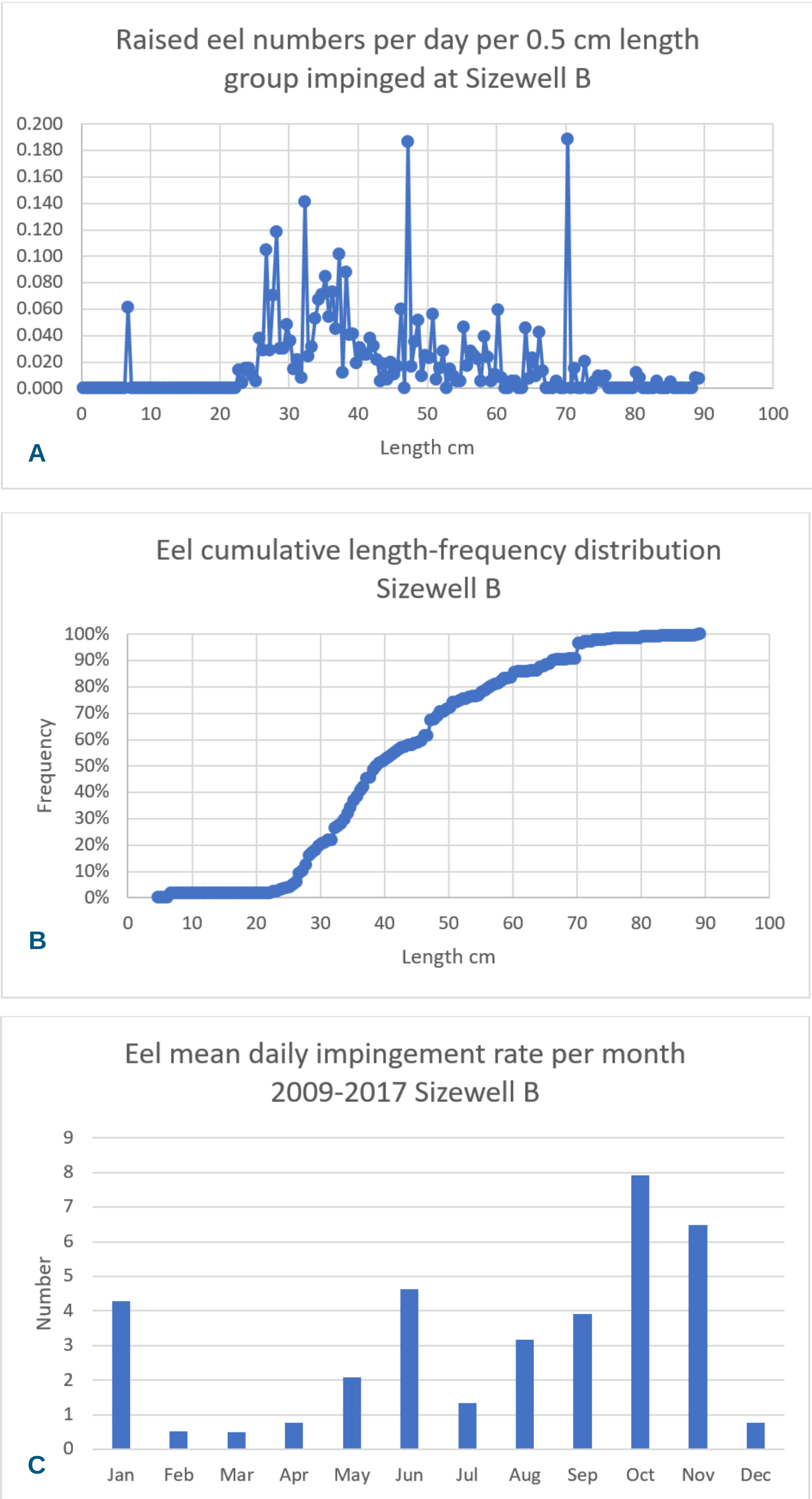

Figure 3.6 Sizewell B Impinged Data 2009 – 2017 (Source: Appendix 22I of this volume)

3.4.8 **Appendix 22G** of this volumestated that although the glass eel phase does migrate past Sizewell in very low numbers and is, theoretically, vulnerable to entrainment, as stated, glass eels make use of STST to migrate to suitable estuaries at or near to the sea surface where they would not be at risk of entrainment from the deep Sizewell C intakes except possibly at slack water. In addition, as previously stated the Greater Sizewell Bay offers no salinity cue to draw large populations of glass eels offshore inshore. However, if some glass eels were entrained (including pigmented elvers), BEEMS entrainment simulations (BEEMS 2016b) showed no mortality from a simulated passage through the Sizewell C cooling water system at planned operational conditions (i.e. chlorinated cooling water with a temperature elevation of 11.6°C). The entrainment risk to glass eels is was therefore considered negligible (**Appendix 22G** of this volume)). It should be noted the above BEEMS technical reports are based on comprehensive impingement and entrainment monitoring programmes undertaken by Cefas over 10 years which include 24 hour sampling, thus all phases of the tide and lunar cycle which influence eel behaviour and population counts was fully considered. An updated investigation by Cefas on impingement predictions based upon specific cooling water system design for Sizewell C, was completed in January 2020 (**Appendix 22I** of this volume 6), which overall concluded the sensitivity of eel to impingement with FRR mitigation in place is predicted to be low; and this is further discussed in Section 5 of this ERCA.

3.4.9 A summary of the key eel surveys (which considered all eel life stages, from glass eels to silver eels) undertaken over the 10 years by Cefas which have contributed to the above baseline information on eel populations within the area of Sizewell B and Sizewell C (and overall Greater Sizewell Bay, as discussed in **Section 3.3**):

- BEEMS beam and otter trawl surveys of the Greater Sizewell Bay between 2008 and 2012.
- Cefas Comprehensive Impingement Monitoring Programmes 2009 - 2017 (BEEMS 2011a, 2011b, 2012a, 2015).
- Entrainment Mimic Unit (EMU) Experimental Programme Report: European eel (*Anguilla anguilla*) November 2013 (BEEMS 2013).
- EMU European eel (*Anguilla anguilla*) - glass eel, Sizewell extended profile August 2016 (BEEMS 2016b). This included all stages of glass eels, including pigmented elvers.
- Sizewell glass eel surveys August 2016 (BEEMS 2016a).
- Coastal pelagic fish survey of Greater Sizewell Bay carried out in March and June 2015.
- Predictions of entrainment by Sizewell C in relation to adjacent fish and invertebrate populations 2016, Revised 2020 (**Appendix 22G** of this volume; BEEMS TR318).
- Sizewell C – Impingement predictions based upon specific cooling water system design January 2020 (**Appendix 22I** of this volume;).
- Additional information from sources such as sampling undertaken during the operation of the Sizewell A Station, characterisation studies for other marine developments in the local area, inshore fishing surveys off the Suffolk coast and international stock assessments.

Fish Protection Measures

3.4.10 The proposed design for the cooling water infrastructure fish protection measures or FRR for Hinkley Point C, as set out in the Report to Discharge DCO Requirement CW1 (Paragraph 1) and Marine Licence Condition 5.2.31 (NNB Genco (HPC), 2017) takes account of this latest guidance and has been approved by the MMO in consultation with the Environment Agency (Figure 3.3). Subject to design of the FRR system complying with Best Practice as defined in the guidance (Environment Agency, 2011a) and the further guidance on FRR systems included in Environment Agency (2010), silver eel survival in excess of 80% is expected (Environment Agency, 2005). This is dependent on fish buckets of the drum and band screens being fitted with inward curved lips that retain 80% of eels at first capture attempt, without eels escaping to the screen well to be recaptured, possibly multiple times and the design of the FRR having sufficient capacity to return all fish captured, allowing variations in abstraction with tidal level. It should be noted the fish buckets will be designed to ensure they are optimised for eels to ensure they are not able to fall out of the buckets if they writhe and wriggle.

3.4.11 A similar system to that designed for Hinkley Point C (**Figure 3.3**) will be adapted for Sizewell C as detailed in **Section 3.2** of this ERCA.

3.4.12 There are no formal UK regulatory guidelines for assessing the significance of fish mortality levels caused by impingement in coastal power stations, however based upon internationally accepted scientific practice for the sustainability of fish stocks under anthropogenic pressures, the below provide a guideline threshold:

- For commercially exploited stocks and conservation species (which includes stocks that are not currently exploited): 1% of the spawning stock biomass or, as a highly conservative proxy, 1% of international landings of the stock.
- For unexploited stocks: 10% of the spawning stock biomass or, as a highly conservative proxy, 10% of international landings of the stock.

3.4.13 Overall, for European eel, there is a is high confidence that Hinkley Point C impingement will not affect the sustainability of the population. This conclusion is detailed in **Section 5** of this ERCA.

3.5 Environment Agency Best Practice Eel Guidelines

3.5.1 It is important that there is a consistent approach taken to implementing the Eels Regulations. The Safe Passage for Eel Operational Instruction (Environment Agency, 2014) sets out the Environment Agency`s risk based approach, including the requirement for an Eels Regulations Cost Benefit Analysis, although as stated for new builds such as the proposed new build construction of Islington Pumping Station, this Cost Benefit Analysis is not required and all elements of “Best Practice Screening” (e.g. screening and bypass) should be implemented for this site. To ensure consistency, the Environment Agency have also introduced "Alternative Measures” for when best practice screening is not cost beneficial to ensure that asset owners do all that is reasonable to protect eel (Environment Agency, 2017). It should be noted that current Environment Agency guidance on the Eels Regulations as of October 2019 is deemed appropriate for this ERCA, although new Eels Regulations guidance is being developed by the Environment Agency for 2020.

Best Practice Screening

3.5.2 The principal requirements of physical exclusion screening are listed in **Table 3.1**; the most important aspect of any work is that the screening protects the appropriate eel life stage present, or likely to be present at the site. Where it is cost beneficial, compliance with Best Practice screening must be given priority over all other feasible modifications to intakes because there is a risk that other modifications will be less effective at preventing entrainment of eel.

Alternative Measures

3.5.3 The Alternative Measures document shows that dispensations exist for Flood and Coastal Risk Management sites. It also provides a useful hierarchy of less than Best Practice options, as shown in **Table 3.2**. It should be noted that the Environment Agency`s Alternative Measures document and process has been framed around implementing upgrades at existing sites. It should be noted that the document provides a useful hierarchy of less than Best Practice options for other sites and shows exemptions can be applied to NNB sites. If Alternative Measures are the only alternative to Best Practice screening for eels, then to ensure agreement with Environment Agency (Fisheries, Biodiversity and Geomorphology), a detailed audit trail or clear justification must be made why Best Practice screening for eels cannot be achieved, and measures to compensate any impacts upon eels (if required).

Table 3.1 Best Practice Screening

River Location (d/s to u/s range)	Life stage/size of eel likely to be present
From estuary to tidal limit	Glass eel
From tidal limit to 30kn u/s	Elver & Yellow eel
>30km u/s of tidal limit	Eel>30cm

Eel life stage (minimim size protected)	Mesh size/bar spacing for exclusion (mm)	
	Screen angle Φ >20 deg	Screen angle Φ ≤20 deg
Elver/glass eel	1-2*	1-2*
Yellow (14cm)	3	3
Yellow/silver (30cm)	9	12.5
Silver (50cm)	15	20

Life stage	Screen angle Φ 21 to 90 deg	Screen angle Φ ≤ 20 deg
Elver/glass eel	10 cms^{-1}	25 cms^{-1} (screen length<10m)
Yellow >14cm	15 cms^{-1}	30 cms^{-1}
Yellow >30cm/silver eel	20 cms^{-1}	40 cms^{-1}
Silver eel	40 cms^{-1}	50 cms^{-1}

Source: Environment Agency (2011).

Table 3.2 Alternative Measures by Engineered Solutions

Most to Least Protective Option	*Alternative Measures Options by Engineered Solution - Examples*
	Improve existing screening, but to a less protective standard than Best Practice, (e.g. greater than Best Practice slot width/ approach velocity); and include a **Fish Recovery Return (FRR)** system and monitoring.
	Effective FRR system installed onto existing drum/band screen.
	Effective fish friendly pump or turbine installed (where through-passage is beneficial).
	Improve existing screening, but to less protective standard than BP gap size/approach velocity specifications, including monitoring.
	Improvements made to existing FRR system.
	Eel-specific bypass added e.g. bed bypass, Venturi attracting flows.
	KLAWA (or other approved) silver eel bypass system added.
	Intake flows altered by the addition of flow deflectors/baffles.
	Intake location altered.
	Trap and transport.
	Behavioural deterrent added with monitoring.

Source: Environment Agency (2017).

4 Potential Implications of Sizewell C on European eel

4.1 Introduction

4.1.1 This section of the report identifies the key construction and operation components of Sizewell C which may impact the life cycle of European eel. The identified construction and operation components are then assessed against the Eels Regulations in **Section 5** of this report.

4.2 Onshore Construction and Operational Components

4.2.1 The key onshore construction and operation activities of Sizewell C which have the potential to impact the safe passage of the European eel and their life cycle based on **Section 3.2** are provided below.

Main Development Site

- Alignment of the Sizewell Drain
  - The current alignment of the Sizewell Drain is within the footprint of the proposed Sizewell C power station and its realignment is essential for the protection of designated wetland habitats within the Sizewell Marshes SSSI when the power station is constructed.
  - Sizewell Drain would be diverted and realigned along the western edge of the platform, in a single channel adjacent to the south-western corner of the platform. Open connections would remain at the intersection of the drain with the floodplain ditches.
  - Towards the north-western corner of the platform a new flow path would be created through Goodram's Fen and new drain connections (in the form of open connections and pipe dams) are proposed in five locations to provide pollution control and manage water levels. Beyond this, to the north, the diverted drain would tie in with the retained Leiston Beck upstream (to the west) of its current confluence.
  - The revised confluence of the Sizewell Drain and Leiston Beck may require a water level control structure during the construction phase, which may remain in place once the power station is operational. This would consist of a tilting structure, set-back from the confluence of the Sizewell Drain and Leiston Beck by a short distance to create a backwater on Leiston Beck. The water control structures would be fish friendly, with the designs allowing for the passage of eels (see **Section 5.2.8**).
  - The construction and operation activities for the alignment of the Sizewell Drain could have short-term and long-term effects on the habitat and safe passage of European eel along Sizewell Drain and Leiston Beck.

- SSSI Crossing
  - The SSSI crossing provides an essential pedestrian and vehicular connection across Sizewell Marshes SSSI, linking Sizewell C with the new access road. The design comprises a causeway with a half-round box culvert, through which Leiston Drain would flow.
  - Following the conclusion of the construction phase, the western-most access route across the causeway would be maintained to provide operational access to the power station. The easternmost part of the causeway would be appropriately landscaped, helping to create a landscape boundary between the power station development and its surroundings.

- The width of the embankment at road level would be approximately 35m and the overall width of the crossing at its base would be approximately 65m. The half-round box culvert would be of sufficient size to leave the bank and channel of Leiston Drain completely intact.
- A drainage system, compliant with the requirements of the Design Manual for Roads and Bridges, would collect surface water run-off from the road where it would outfall into a swale and infiltrate to ground. Run-off from the SSSI crossing infrastructure, therefore, would be diverted away from the SSSI.
- The construction and operation activities for SSSI crossing for Sizewell C could have both short-term and long-term effects on the habitat and safe passage of European eel along Leiston Beck.

Associated Development Sites

- Two village bypass
  - Construction of the two village bypass would require the construction of a single span overbridge across the River Alde, and culverts across two smaller watercourses (Parkgate Farm Drain and Whin Covert Drain). The construction and operation activities for the two village bypass for Sizewell C could have short-term and long-term effects on the habitat and safe passage of European eel along the River Alde, shown on **Figure 4.1**, and Parkgate Farm Drain and Whin Covert Drain shown on **Figure 4.2**.

Figure 4.1 River Alde Upstream and Downstream of Proposed Bypass

Figure 4.2 Parkgate Farm Drain and Whin Covert Drain

- Sizewell link road
  - Construction of the Sizewell link road would require the construction of a series of culverts across minor watercourses which drain into the Minsmere Old River, including the Middleton Watercourse, Theberton Watercourse and unnamed ordinary watercourses. Minsmere Old River discharges to the sea via Minsmere Sluice, although some ingress of seawater into the freshwater system has been factored into the design of the sluice. The

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construction and operation activities for the Sizewell link road could have short-term and long-term effects on the habitat and safe passage of European eel along the watercourses which drain into the Minsmere Old River.

4.2.2 The location of the above key associated development sites (and watercourses) are presented below in **Figure 4.3,** and also **Figure 3.5**.

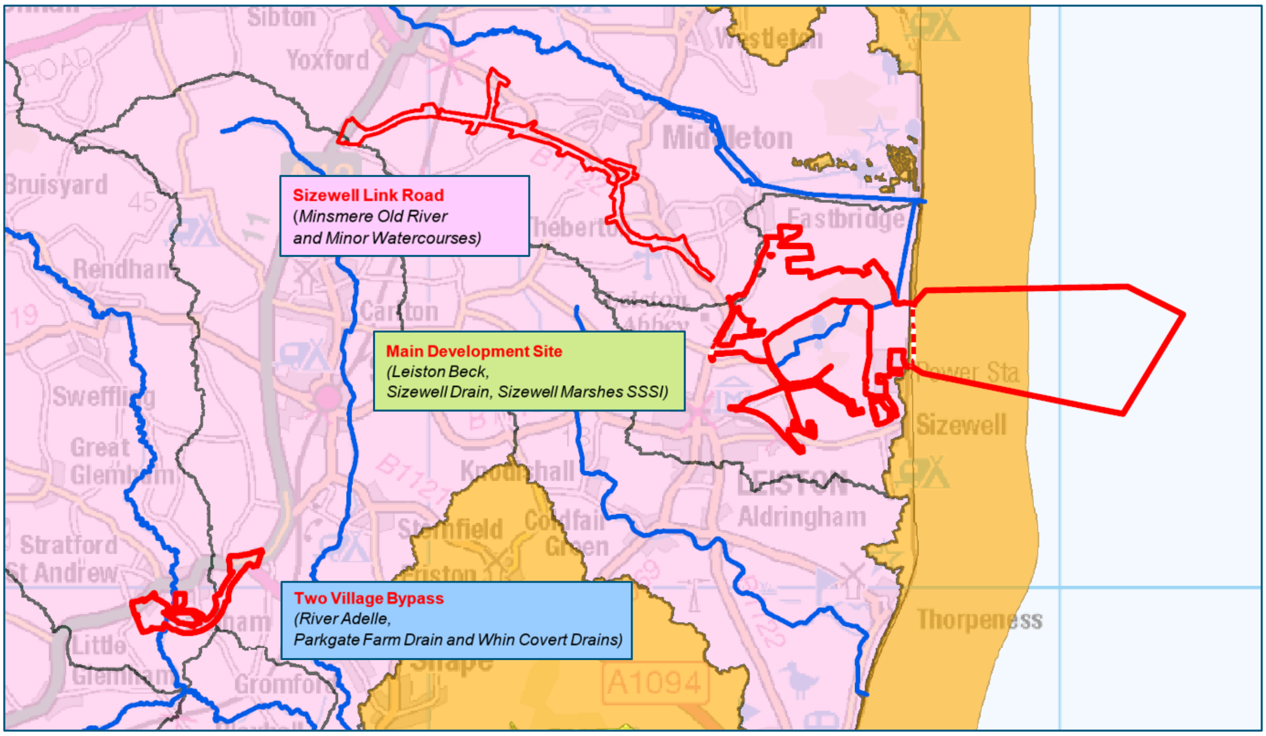

Figure 4.3 Sizewell C main development site and key associated development sites

4.3 Offshore Construction and Operational Components

4.3.1 The key offshore construction and operation activities of Sizewell C which have the potential to impact the safe passage of the European eel and their life cycle based on **Section 3.2** are provided below.

- Marine structures and Beach Landing Facility (BLF):
  - Construction and permanent presence and operation of all marine structures, including dredging to maintain access to BLF. Potential for both short-term and long-term effects on the habitat and safe passage of European eel.

- Cooling water system – intake and pumphouse:
  - Construction and permanent presence and operation of the cooling water intake tunnels of a continuous supply of water to cool the operational infrastructure, including dredging and disposal at sea. Potential for both short-term and long-term effects on the habitat and safe passage of European eel, in particular the potential impingement and entrainment of eel during the operation of the cooling water pumphouse and associated infrastructure i.e. cooling water tunnels extending approximately 3km out to sea and intake headworks on the seabed.

- Cooling water system – discharge:
  - Construction and permanent presence and operation of the cooling infrastructure (including outfall tunnel). In addition, dredging and disposal at sea associated with construction of the outfall tunnel and outfall headworks on the seabed. Potential for both short-term and long-term effects on the habitat and safe passage of European eel.
- Operation of the Fish Recovery and Return (FRR) systems and discharge of trade effluent:
  - Overall operation of the FRR system, including discharge of polluting matter. Potential for both long-term effects on the habitat and safe passage of European eel, in particular eel migration behavioural characteristics and eel mortality.

4.4 Consultation to Date with the Environment Agency

4.4.1 To ensure the concerns of the Environment Agency were fully met regarding this Eels Regulations Compliance Assessment, a meeting was held with specialists from the Environment Agency, including the National Eels Regulations Advisors on the 29/10/2019.

4.4.2 In summary the meeting included discussion on the following:

- the status of Eels Regulations as of November 2019;
- the application of Best Practice, including approach velocities and mesh screen size;
- the application of Alternative Measures and exemptions if Best Practice cannot be achieved for a project;
- key onshore and offshore components of Sizewell C which will need to be considered in the Eels Regulations Compliance Assessment; and
- an overview of eel surveys and monitoring undertaken to date on the Suffolk Coast.

4.4.3 The Environment Agency have also provided comments on the previous version of this ERCA (dated November 2019).

5 Sizewell C Eels Regulations Compliance Assessment

5.1 Introduction

5.1.1 Building upon the information presented in **Section 1** to **Section 4**, this section of the report presents the Eels Regulations Compliance Assessment (ERCA) for Sizewell C, with particular emphasis placed on the onshore and offshore construction and operational components stated in **Section 4** which may potentially impact the safe passage of European eel and, thus, non-compliance with the Eels Regulations.

5.2 Onshore Eels Regulations Assessment

Alignment of the Sizewell Drain

Construction

5.2.1 The existing alignment of the Sizewell Drain lies within the footprint of the proposed Sizewell C power station (see **Figure 4.3**). Realignment of the drain is essential for the construction of the main power station platform but then also the protection of designated wetland habitats within the Sizewell Marshes SSSI during construction. However, the construction activities for the realignment of the Sizewell Drain could have short-term and long-term impacts on eel passage and eel population status along Sizewell Drain and Leiston Beck.

5.2.2 The realignment of the Sizewell Drain has three potential impacts prior to mitigation:

- physical barriers to eels leading to short-term temporary impacts upon eel passage;
- entrapment of eels leading to long-term population decline; and
- changes in water quality leading to long-term population decline in eels.

5.2.3 During the realignment of the Sizewell Drain, an eel rescue would be carried out to ensure any stranded or trapped eels that may be present at the time are safely relocated across to the new realigned drain or undisturbed section of the Sizewell Drain (prior to infilling of the original drain alignment). As stated, in **Section 3.3.2**, small eels (elvers) generally enter the inland waters of the United Kingdom between February and April and escape downstream to the sea between November and February (Bruijs and Durif, 2009). As such, if in-stream works are undertaken during day light in combination with an eel rescue (if required), it is anticipated that no eels would be trapped. No impacts are therefore predicted upon the passage of eels in response to the realignment of the Sizewell Drain.

5.2.4 A suite of control measures embedded in the **Code of Construction Practice** (**CoCP**) (Doc Ref. 8.11) has been developed for Sizewell C which aims to provide a clear and consistent approach to the control of Sizewell C construction activities and to minimise impacts on people and the environment. Such measures would prevent significant changes to water quality and would therefore prevent adverse impacts on the eel population.

5.2.5 Overall, for the works directly associated with the realignment of the Sizewell Drain, no short-term and long-term impacts upon European eel population status and silver eel escapement are predicted, with the above mitigation measures in place.

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Operation

5.2.6 The presence or operation of the realigned Sizewell Drain could have long-term impacts on eel passage and eel population along Sizewell Drain and Leiston Beck.

5.2.7 The operation of the realigned Sizewell Drain has three potential impacts without mitigation:

- changes in flow regime leading to impacts upon eel habitat;
- physical barriers to eels leading to impacts upon eel passage; and
- changes in water quality leading to eel population decline.

5.2.8 The diverted Sizewell Drain would have a similar morphology to the existing uniform trapezoidal channel, with near-vertical banks and a gentle longitudinal profile. The flow regime along the drain would not be affected by the existing open connections with the floodplain ditches and new drain connections (in the form of open connections and pipe dams). As stated, the revised confluence of the Sizewell Drain and Leiston Beck may require a water level control structure. To ensure eel passage is not comprised a suitable elver pass would be incorporated into the structure, such as a tilting weir/sluice mounted elver pass, or an up-and-over (pumped) eel pass. The elver pass should comply with the Environment Agency's guidance on eel passes (Environment Agency, 2011b). Given, silver eels generally escape downstream during increased discharge (e.g. following rainfall or during flood events) (Bruijs and Durif, 2009) (also see **Section 3.3.8**), the water level control structure would be overflowing (or drowned out) and not provide a physical barrier to the downstream escapement for silver eels. In addition, the establishment of the structure would create a backwater on Leiston Beck providing additional habitat and resting locations for eel.

5.2.9 The realigned Sizewell Drain would potentially have five locations along its length which would provide pollution control and a filter drain would be installed to capture surface water run-off and prevent direct discharge to the drain, and as such these measures would prevent significant long-term changes to water quality in the drain and, thus, avoid impacts on the eel population.

5.2.10 Overall for the operation of the realigned Sizewell Drain, no long-term impacts upon European eel population status and silver eel escapement are predicted, once the above stated mitigation measures are in place.

SSSI Crossing

Construction

5.2.11 The SSSI crossing provides an essential pedestrian and vehicular connection across Sizewell Marshes SSSI, linking Sizewell C with the new access road. The design comprises a causeway with a half-round box culvert, through which Leiston Beck would flow. However, the construction activities for the SSSI crossing could have short-term and long-term impacts on eel passage and eel population status.

5.2.12 The SSSI crossing has three potential impacts without mitigation:

- physical and noise barriers to eels leading to short-term temporary impacts upon eel passage;
- entrapment of eels leading to long-term population decline; and

- changes in water quality leading to long-term population decline in eels.

5.2.13 To ensure the initial in-stream preparation works do not impede eel passage, an eel rescue would be carried out to ensure any stranded or trapped eels that may be present at the time are safely relocated prior to the commencement of the main works. In addition, given the potential for sheet piling and disturbance to eels, if in-stream works are undertaken during day light and an eel rescue (if required) is undertaken, it is anticipated that no eels will be trapped. If these measures are implemented, no impacts are predicted upon the passage of eels in response to the construction works for the SSSI crossing.

5.2.14 In the event that the construction of the SSSI crossing is undertaken during the key period of eel migration, adverse potential impacts of both construction noise and vibration remain unlikely because (also refer to **Section 3.3**):

- Silver eels typically escape/migrate downstream at night during heavy rainfall events. Given that no piling will be undertaken at night, the potential impacts of any piling noise on silver eel escapement would be unlikely.
- Similar to adult eels, elvers also predominantly migrate upstream at night (when piling activity would not be occurring) and during certain tidal conditions.
- European eel has a physostomous swim bladder (connection with the stomach), although is on the verge of becoming physoclistous, in which the duct is caught in the very act of enlargement into a separate chamber and has an extremely long distance between the swim bladder and the ear. In general, this results in the European eel being more tolerable to noise thresholds compared to other fish species and fall under the classification of hearing generalists (medium hearing sensitivity).
- In addition, European eels are prone to infestation with the swimbladder parasite, *Anguillicoloides crassus*, which can cause thickening of the swim bladder walls and further influence the sensitivity of eels to sound (Simon et al. 2018). This information is provided as reference only and may not be the only reason for European eels being less sensitive to noise within the Greater Sizewell Bay.

5.2.15 The suite of control measures embedded in the **CoCP** (Doc Ref. 8.11) developed for Sizewell C would prevent significant changes to the physico-chemistry of the watercourses and, therefore, impacts on the eel population.

5.2.16 Overall for the works directly associated with the SSSI crossing, no short-term or long-term impacts upon European eel population status and silver eel escapement are predicted, once the above stated mitigation measures are in place.

Operation

5.2.17 The presence or operation of the SSSI crossing (causeway) could have long-term impacts on eel passage and eel population along the Leiston Beck.

5.2.18 The operation of the SSSI crossing has four potential impacts without mitigation:

- changes in flow regime leading to impacts upon eel habitat;
- changes in existing eel habitat leading to population decline;
- physical barriers to eels leading to impacts upon eel passage; and
- changes in water quality leading to eel population decline.

5.2.19 The flow regime of the Leiston Beck, similar to the Sizewell C Drain, will not be impacted upon by the overall operation of Sizewell C, including the operation of the proposed causeway. This is in response to the proposed water management structures (with incorporated eel passage, as described in **Section 5.2.8**) which would also allow for easy manipulation of the water levels and flows. Therefore, levels and flows within the Leiston Beck could be environmentally managed (in conjunction with the management of the other watercourse) to ensure adequate flow conditions for eels is maintained along the Leiston Beck. In addition, based on the analysis presented in the Sizewell C SSSI Crossings: Environmental Appraisal of Options under Consideration (Atkins, Hyder and Royal HaskoningDHV, 2015), the assessment identified the predicted maximum changes in surface water level immediately adjacent to the crossing and within the crossing itself, are well within the baseline variation of water levels that is observed under current conditions. Further verifying the flow regime of the Leiston Beck (and consequently flow conditions for eels) would not be impacted upon by the operation of the proposed causeway.

5.2.20 The proposed causeway would result in the loss of approximately 68m river channel, and as such the loss of natural habitats to eels cannot be directly mitigated. However, the length of channel lost and replaced with a culvert is very small in comparison to the total length of habitat available for eels along the Leiston Beck (5.75km from Abbey Road to Minsmere Sluice), accounting for only 1.12% of the total watercourse length. Primary mitigation measures to create replacement reedbed and ditch habitat associated with the SSSI crossing have already been implemented at Aldhurst Farm, adjacent to the western edge of Sizewell Marshes SSSI (**Figure 5.1**). Ecological connectivity for eels in the ditch habitats of the Sizewell Marshes SSSI are not considered likely to be affected by the proposed causeway, since these species would continue to migrate along the ditch systems without the culvert directly impeding the passage of eels.

Figure 5.1 Reedbed Habitat at Aldhurst Farm (2018)

5.2.21 The culvert for the proposed causeway, a three sided culvert without a base, would be designed to facilitate natural sediment transport and prevent impoundment and be ideally sized to avoid very shallow water depths ("sheet flows") during periods of lower flow (e.g. less than Q50) to ensure that sediment transport and eel passage is not impeded. For example, a culvert that is significantly larger than the current natural channel could result in much shallower flows through the structure than in adjacent unmodified reaches. Furthermore, by allowing natural sediment transport, the design of the culvert (i.e. three sided culvert without a base) would allow for continued sediment processes, for example downstream transport, and avoid fast-laminar flows typical of box culverts (with a base) which may impeded eel passage.

5.2.22 Although the effects of a lack of light on fish migration remains an area of debate and is often referenced as a key obstruction to the migration of fish and eels, Dane (1978) concluded that darkness inside culverts was not a major determinant in controlling migration and should only be accounted for in design as a safety factor. Elvers and silver eels tend to migrate only at night, so passage in dark culverts is not an issue for them. Furthermore, until studies have shown conclusively that light does affect passage, with little evidence to support this in the United Kingdom (CIRIA, 2010), incorporating artificial lighting in the design of long culverts may not be necessary. However, to maximise the amount of light reaching the centre of long culverts, it is recommended that culverts be installed in a straight line (Boubee et al. 1999), similar to the culvert for the proposed SSSI crossing. As such, it is predicted there will be no impacts upon eel migration in regard to the effects of darkness associated with the construction of the culvert for the proposed SSSI crossing for Sizewell C.

5.2.23 In addition, the incorporation of suitable bed and bank protection (using sustainable green engineering solutions as far as possible) at the downstream outlet of the culvert would reduce the likelihood of increased bed and bank scour ensuring that potential future geomorphological change that could cause damage to the culvert is minimised, thus further ensuring the safe passage for eels. Overall, the culvert design will ensure that there will be no change in level at the culvert inlet and outlet; the natural bed will be retained (as stated above), water flowing through the culvert will be a suitable depth and velocity for eels, and there will be no local increase in velocity.

5.2.24 The drainage system for the SSSI crossing would be compliant with the requirements of the Design Manual for Roads and Bridges and would collect surface water run-off from the road where it would outfall into a swale and infiltrate to ground. Run-off from the SSSI crossing infrastructure, therefore, would be diverted away from the Sizewell Marshes SSSI via either a drainage network or infiltration. As such the operation of the proposed causeway is not considered have a long-term impact upon the infiltration rates and physico-chemistry of the Leiston Beck drain and, thus, impacts on the eel population.

5.2.25 Overall, for the works directly associated with the SSSI crossing, no long-term impacts upon European eel population status and silver eel escapement are predicted, once the above stated mitigation is in place.

Two Village Bypass

Construction

5.2.26 The two village bypass is required to mitigate the effects of increased traffic on the A12 at Farnham due to Sizewell C and would comprise a new, permanent, 2.4km single carriageway road (see **Figure 4.3**), which would require the construction of an overbridge across the River Aldeand and culverts across two smaller watercourses (Parkgate Farm Drain and Whin Covert Drain). The construction activities for the bypass could have short-term and long-term impacts on eel passage and eel population status.

5.2.27 The bypass has three potential impacts without mitigation:

- physical barriers to eels leading to short-term temporary impacts upon eel passage;
- entrapment of eels leading to long-term population decline; and
- changes in water quality leading to long-term population decline in eels.

5.2.28 The overbridge would be located approximately 7.5m above the floodplain with an offset between the river banks and bridge abutments; as such, there would be no direct interaction between the bridge, current river channel and associated riparian habitats with no impact upon eel passage predicted.

5.2.29 As stated, the Parkgate Farm Drain and Whin Covert Drain would both be crossed using culverts which may require coffer dams during the installation of the culverts which could act as a barrier to eel passage. However, the impacts are only anticipated when the dams are in place, with the river continuity (eel passage) restored once the temporary barriers are removed. Furthermore, as stated for realignment of the Sizewell Drain, an eel rescue would be carried out to ensure any stranded or trapped eels that may be present at the time are safely relocated prior to the commencement of the works.

5.2.30 The suite of control measures embedded in the **CoCP** (Doc Ref. 8.11) developed for Sizewell C would prevent significant changes to the physico-chemistry of the watercourses during the construction of the two village bypass (TVB); and, thus impacts on the eel population.

5.2.31 Overall for the works directly associated with the bypass, no short-term and long-term impacts upon European eel population status and silver eel escapement are predicted, once the above stated mitigation are in place.

Operation

5.2.32 The presence or operation of the bypass could have long-term impacts on eel passage and eel population along the River Alde.

5.2.33 The operation of the bypass has three potential impacts without mitigation:

- changes in flow regime leading to impacts upon eel habitat;
- changes in existing eel habitat leading to population decline; and
- physical barriers to eels leading to impacts upon eel passage.

5.2.34 Changes in water quality can lead to eel population decline. The proposed operation of single span overbridge would be a clear-span structure, with no direct interaction with the River Alde itself while flows would be confined within the banks. However, the permanent presence of an embankment across the floodplain of the River Alde could act as a barrier to the free movement of water across the floodplain during periods of higher (out of bank) flow. Existing natural flow paths would be disrupted, with water movement restricted to within the bridge aperture and the flood relief culverts on the floodplain. The concentration of flood water within these apertures could result in increased scour (velocities) in the channel of the main River Alde and adjacent to the floodplain culverts, which could influence the flow conditions for eels. However, the large size of the span means that, although upstream water levels would change there would not be a significant change in flow velocities (Two Village Bypass Modelling Report, Royal HaskoningDHV, 2019), which could impede the migration of eels. In addition, there would be minimal risk of increased scour or any other geomorphological adjustments occurring in the River Alde which could promote the development of a physical barrier to eels.

5.2.35 The operational presence of culverts on Parkgate Farm Drain and Whin Covert Drain could result in reduced flow and sediment conveyance. This could cause a barrier for the migration of eels, although the culverts would be designed to ensure that any impacts on river continuity and eel passage are minimised. The culverts would have sufficient capacity to avoid impounding within-bank flows, and the bed of the culverts would be installed 200mm below the active bed of the drains so that sediment continuity and movement of eels can be maintained (Royal HaskoningDHV, 2019). This would also promote sediment deposition which would assist in breaking up potentially fast-laminar flow which may impeded eel passage.

5.2.36 No impacts upon the physico-chemistry of the watercourses are predicted from the operation of the TVB and, thus, impacts on the eel population would not be affected.

5.2.37 Overall for the operation of the bypass, no long-term impacts upon European eel population status and silver eel escapement are predicted, once the above stated mitigation are in place.

Sizewell Link Road

Construction

5.2.38 The Sizewell link road (SLR) incorporates a bypass around Theberton and would also bypass Middleton Moor, joining the A12 south of Yoxford (see **Figure 4.3**). The purpose of the link road is to substantially reduce traffic volumes passing through Yoxford, Middleton Moor and Theberton, resulting in the reduction in noise, vibration and severance impacts. The construction of the Sizewell link road would require the construction of a series of culverts across minor watercourses which drain into the Minsmere Old River, including the Middleton Watercourse, Theberton Watercourse and unnamed ordinary watercourses. Minsmere Old River discharges to the sea via Minsmere Sluice. However, the construction activities for the SLR could have short-term and long-term impacts on eel passage and eel population status.

5.2.39 The SLR has three potential impacts without mitigation:

- physical barriers to eels leading to short-term temporary impacts upon eel passage;
- entrapment of eels leading to long-term population decline; and
- changes in water quality leading to long-term population decline in eels.

5.2.40 The proposed construction activities associated with the SLR would not directly interact with the main channel of the Minsmere Old River, with the works confined to watercourses which drain into the main water body. Similar to the construction of the TVB, the watercourses would be crossed using culverts and potentially require coffer dams which could act as a barrier to eel passage. However, the impacts will be temporary with the river continuity (eel passage) restored once the barriers are removed. Furthermore, as stated for realignment of the Sizewell Drain, an eel rescue would be carried out along each watercourse to ensure any stranded or trapped eels are safely relocated prior to the commencement of the works. As such based, on the implementation of the aforementioned mitigation, no impacts upon eel passage is predicted in response to the construction of the culverts for the SLR.

5.2.41 The suite of control measures embedded in the **CoCP** (Doc Ref. 8.11) developed for Sizewell C would prevent significant changes to the physico-chemistry of the watercourses during the construction of the SLR and, thus, impacts on the eel population.

5.2.42 Overall for the works directly associated with the Sizewell link road, no long-term impacts upon European eel population status and silver eel escapement are predicted, once the above stated mitigation are in place.

<u>Operation</u>

5.2.43 The operational presence of the watercourse culverts could result in reduced flow and sediment conveyance, which could cause a barrier for the migration of eels. However, the culverts would be designed to ensure that any impacts on eel passage are minimised. The culverts would have sufficient capacity to avoid impounding within-bank flows, and the bed of the culverts would be installed 300mm below the active bed of the channels so that sediment continuity and movement of eels can be maintained (Royal HaskoningDHV, 2019).

5.2.44 The maintenance of sediment transport would also promote sediment deposition which would assist in breaking up potential fast-laminar flow which may impeded eel passage.

5.2.45 No impacts upon the physico-chemistry of the watercourses are predicted from the operation of the SLR and, thus, impacts on the eel population would not be affected.

5.2.46 Overall for the operation of the Sizewell link road, no long-term impacts upon European eel population status and silver eel escapement are predicted, once the above stated mitigation are in place.

Minsmere Sluice

5.2.47 It should be noted regarding the potential impacts of the thermal plumes associated with operation of cooling water outfall and Minsmere Sluice (see **Figure 4.3**), eel passage will not be impacted upon by a potential chemical barrier caused by the plume. In Technical Report 302 (BEEMS, 2016), the results from available laboratory thermal preference experiments were used and examination of the modelling results shows that glass eel and silver eel, with avoidance thresholds of ≥3°C, would not experience a barrier to migration in a transect from the coast to the Sizewell C Project outfalls and, thus, eel migration routes from sea to freshwater (and vice versa) would not be impacted (also see **Figure 5.2**).

5.2.48 Furthermore, modelling for the chemical plume associated with the operational of Sizewell C, total residual oxidants (TRO) and bromoform plumes do not intersect with the Suffolk Coast at concentrations above the Environmental Quality Standards (EQS) which could impact both eel passage and population.

5.2.49 To assess the spatial extent of the hydrazine plume and compare the resulting concentrations with the Predicted No Effect Concentrations (PNEC) values (chronic and acute), the mean and 95th percentile of the hydrazine concentrations were extracted from the 31-day General Estuarine Transport Model run. The model results predict the concentrations are higher at the surface than at the seabed, showing the stratification of the hydrazine plume caused by the difference in salinity. Given the very small areas over which the exceedance will occur, the tidally dominated system and the fact that hydrazine is rapidly degraded in the marine environment, the impact predicted is very small on a water body scale.

5.2.50 There is also limited likelihood of hydrazine entering Minsmere Sluice and impacting the eel passage and population in response to the behaviour of tidal flows and the sluice operational protocol. The Minsmere sluice opens for half an hour after high tide, allowing saltwater to enter the system. At Sizewell the tide floods in a southerly direction. As the proposed development of Sizewell C is south of the Minsmere sluice, discharges are only transported northward on an ebb tide, when water levels are lowering. During the ebb tide, the hydrazine plume is transported northward towards Minsmere. During the month-long model run the acute PNEC was exceeded briefly (less than 5 hours) on several occasions with a maximum instantaneous concentration of $76ngl^{-1}$ predicted during the worst-case model scenario. However, exceedance of PNEC concentrations always occurred 1.25 hours or more after high water when water levels would be falling, limiting the likelihood of hydrazine entering Minsmere and impacting eel passage and population.

5.2.51 In addition, a threshold of $2.6\mu gl^{-1}$ has been applied for freshwater environments based on a greater availability of data. As such, the highest instantaneous concentration modelled at the sluice is below the threshold for low probability of adverse effects. If hydrazine was to enter the sluice, the low concentration and rapid degradation rates indicate that eels within the site are unlikely to be affected. Furthermore, hydrazine has a low bioconcentration factor meaning the bioaccumulation potential is low. Therefore, direct effects on eels within the site are unlikely to be significant. As a result, the potential for effects on Minsmere Old River or Leiston Beck are not predicted; and thus, no impacts upon eels will occur.

In-combination effects: CDO, thermal and chemical discharges from Sizewell B and Sizewell C

5.2.52 During the construction phase discharges from the CDO would overlap with those from the cooling water discharge from Sizewell B.

5.2.53 Construction discharges containing metals and un-ionised ammonia (including commissioning discharges) and potentially surfactants from tunnelling have very small areas of EQS exceedance close to the CDO.

5.2.54 Chlorine and ammonia can react in seawater to form predominantly dibromamine which has higher toxicity than TRO alone. However, the TRO concentration derived from Sizewell B that would intersect the CDO discharges would be ca, 20µg/l and the ammonia concentration rapidly declines to background beyond 25 metres of the discharge meaning that the concentration of any combination products would be insignificant.

5.2.55 Although hydrazine discharges at Predicted No Effect Concentrations extend over larger areas around the CDO, interactions with TRO from Sizewell B would be at very low concentrations and interaction if any may reduce hydrazine concentration but is likely to be insignificant.

5.2.56 Thermal elevation in proximity to the CDO discharge is also relatively low (several degrees higher than background) and would not be expected to significantly change the assessment for the individual discharges from the CDO (see above).

5.2.57 A negligible effect assessment is therefore made for the interaction of the CDO discharge (metals, the un-ionised ammonia, tunnelling surfactants or hydrazine); and Sizewell B cooling water discharge (including TRO, chlorination bi-products, thermal elevation) with individual chemical discharge assessments unchanged as not significant. As such, no impacts are predicted upon the Minsmere Sluice, the Blyth and Ore/Alde estuaries; and thus no impacts upon eels are also predicted in response to CDO, thermal and chemical discharges from Sizewell B and Sizewell C.

5.2.58 Further details on the thermal and chemical modelling and potential impacts is provided in **Volume 1, Chapter 6** of the **Environmental Statement** (**ES**); **Volume 2, Chapter 21** of this volume; and **Appendix 21E** of this volume.

5.2.59 The above assessment is further expanded upon in **Section 5.3** below for the offshore elements of Sizewell C.

5.3 Offshore Eels Regulations Assessment

Marine Structures and Beach Landing Facility (BLF)

<u>*Construction*</u>

5.3.1 The Beach Landing Facility (BLF) would be required for the operation of Sizewell C to facilitate transport across the shore of large loads too heavy for transportation by road and potentially perform a role in coastal protection through its design and location. The BLF would be constructed either using a group of steel tubular piles, or in a steel sheet piled enclosure filled with plain and reinforced concrete in the shallow water. The construction method for subtidal piling would involve the use of a jack-up barge. Prior to this, dredging would be required of approximately 4600m^3 of material via plough dredging. The construction activities for the BLF could have short-term and long-term impacts on eel passage and eel population status.

5.3.2 The BLF has two potential impacts without mitigation:

- non-physical barriers to eels (e.g. water quality changes) leading to short-term temporary impacts upon eel passage; and
- changes in water quality leading to long-term population decline in eels.

5.3.3 As stated, approximately 4600 m^3 of material via plough dredging would be required to facilitate the construction of the BLF which may influence eels entering nearby watercourses which drain into the sea (see **Figure 3.5**) in response to increased suspended-sediment concentration (SSC) (turbidity).

5.3.4 However, it has been shown that turbidity increases in water bodies, although affecting some fish species to complete their migration routes do not impact European eel (Vohs et al 1993; De Casamajor et al. 1999). The vertical location of glass eels is also related mainly to turbidity (and phases of lunar cycle), with migrating individuals in turbid waters found through the entire water column, while in clear water they move close to the bottom of the river or sea bed (De Casamajor et al. 1999) (also see **Section 3.3**). In addition, dredge modelling undertaken for the BLF (**Appendix 22J** of this volume) indicate that depth average concentration plots show the maximum concentrations of suspended solids to be greater than 100mg/l above background extend approximately 5km north and south of the dredge area. However, plots of the 95 percentile concentrations show a marked decrease thus highlighting the short lived duration of the plume and return back to baseline conditions within 12 hours of completion of dredging. As such, the impacts of dredging for the BLF on eel migration is not predicted.

5.3.5 The impacts of piling and sediment plumes on eel migration are also not predicted in response to similar conclusions stated above for the main dredging activity for the BLF; while no impacts of piling noise on eel migration are predicted in response to the following:

- piling to be restricted to day light operations only;
- potential migratory watercourses which may be used by eels (see **Figure 3.5**), are located some distance away from the source of piling noise; and
- European eel has a physostomous swim bladder (connection with the stomach), although is on the verge of becoming physoclistous, in which the duct is caught in the very act of enlargement into a separate chamber and has an extremely long distance between the swim bladder and the ear. This overall results in European eel being more tolerable to noise thresholds compared to other fish species and fall under the classification of hearing generalists (medium hearing sensitivity).

5.3.6 The suite of control measures embedded in the **CoCP** (Doc Ref. 8.11) developed for Sizewell C would prevent significant changes to the physico-chemistry of the watercourses during the construction of the BLF and, thus, impacts on the eel population.

5.3.7 Any coatings or treatments applied to the BLF or other infrastructure must be suitable for use in the marine environment in accordance with best environmental practice (Guidance for Pollution Prevention), and this will be a condition of the Marine Licence. Therefore, no effects from chemicals leaching from structures is predicted which could impact the mortality of eels.

5.3.8 Overall for the works directly associated with the BLF, no short-term and long-term impacts upon European eel population status and silver eel escapement are predicted, once the above stated mitigation measures are in place.

Operation

5.3.9 The presence or operation of the BLF could have long-term impacts on eel passage and eel population.

5.3.10 The operation of the BLF has two potential impacts without mitigation:

- non-physical barriers to eels (e.g. water quality changes) leading to long-term impacts upon eel passage; and
- changes in water quality leading to long-term population decline in eels.

5.3.11 It is assumed that dredging during the operation phase for the BLF would be limited to clipping and sidecasting by plough. The nature or frequency of the dredging would depend on the bathymetric profile and can be expected to vary by season, with more dredging required in winter when sand suspension and infilling rates would be higher on average. It is assumed two to four dredges on the outer bar and once every two weeks on the inner bar. However, the effects of maintenance dredging required for the BLF on eel passage and also changes in water quality, is not predicted in response to similar conclusions and mitigation measures outlined for construction (capital) dredging for the BLF, with maintenance dredging having similar effects.

5.3.12 Overall for the operation of the BLF, no long-term impacts upon European eel population status and silver eel escapement are predicted.

Cooling Water System Intake and Pumphouse

Construction

5.3.13 Seawater for cooling Sizewell C would be abstracted via a series of cooling water intake structures and tunnels. Each UK EPR^{TM} reactor unit would have a single dedicated 6m internal diameter intake tunnel extending approximately 3km out under the seabed (see **Figure 3.2**). At the seaward end of each tunnel, two vertical shafts would extend upwards to provide a connection to the sea via a seabed-mounted intake head (one head per shaft). Each of the intake heads would comprise a concrete and steel headworks designed to abstract seawater at a depth of only a few metres above the seabed.

5.3.14 A simplified version of the Hinkley Point C LVSE design, is proposed. The cooling water system will be essential for the safe operation of Sizewell C. However, the construction activities for the cooling water system could have short-term and long-term impacts on eel passage and eel population status.

5.3.15 The cooling water system has two potential impacts without mitigation:

- non-physical barriers to eels (e.g. water quality changes) leading to short-term temporary impacts upon eel passage; and
- changes in water quality leading to long-term population decline in eels.

5.3.16 The two cooling water intake tunnels would be excavated by TBMs from landward (each tunnel is expected to take 12 months). Prior to placement of the head structures, dredging of approximately 17,406 m^3 per intake head would be required to expose the bedrock. The most likely dredge method is via a cutter suction dredger with spoil to be deposited locally, although the dredging could cause temporary increases in SSC and disturbance to eel migration. Plumes with instantaneous SSC of more than 100mg/l above background levels are expected to form over an area of up to 373ha (depth averaged, 291ha at the sea surface) (**Appendix 22J** of this volume). However, based on dredge modelling undertaken for the cooling water system (**Appendix 22J** of this volume), dredging would temporarily increase the classification of the surface waters to 'turbid'. SSC are anticipated to return to background levels several days after dredging activities cease, while dredging on the spring tides (tide/lunar cycles favoured for eel migration), the sedimentation is typically short lived, with re-erosion occurring within one tidal cycle.

5.3.17 When the dredge occurs on neap tides, the time for which sediment remains on the bed and suspended in the water column is more prolonged. Based on this information, along with the ecological tolerance of eels to turbidity, impacts of dredging prior to placement of the intake head structures on eel migration is not predicted. The same ecological principals associated with eel behaviour and aforementioned mitigation can be applied for potential sediment plumes associated with the TBMs.

5.3.18 The noise associated with dredging the intakes would be present in the existing soundscape of the surrounding coastal zone of Sizewell C, where the baseline is characterised by operational noise and vibration from Sizewell B, surf noise (waves breaking on the beach), and noise from passing fishing vessels (BEEMS, 2014d). The duration of dredging would be short-lived and sound levels from plough dredging are expected to be substantially less than using Trailing Suction Hopper Dredging (TSHD).

5.3.19 As stated for the construction of the BLF and given the high overall tolerance of European eel to sound, with eels known not to detect sounds up to 180dB re 1µPa (Environment Agency, 2011a), no impact on eel migration is predicted from construction noise associated with the two cooling water intake tunnels.

5.3.20 Contaminant levels in the intake areas to be dredged are relatively low. Polyaromatic hydrocarbons (PAHs) have a low water solubility and hydrophobic nature; therefore, they tend to be associated with inorganic and organic material within sediments and therefore remain bound. Most PAHs (with the exception of some low-molecular weight compounds, such as naphthalene) will be strongly sorbed by particulate matter and biota in the aquatic environment (Canadian Council of Ministers of the Environment, 1992). Thus, it is highly likely that a large percentage will remain bound to the material. Further information is provided in the **Volume 02, Chapter 21** (Marine Water Quality and Sediments) of the **ES**.

5.3.21 As such, it is concluded that water quality due to the suspension of chemical contaminants in the sediment due to dredging at the intakes would not have a detrimental effect on eel populations. In addition, Marine Licence conditions will ensure that potential contaminates associated with marine dredging and drilling activities do not enter the marine environment and thus potentially leading to long-term population declines in European eel.

5.3.22 Overall for the works directly associated with the cooling water system intake, no short-term and long-term impacts upon European eel population status and silver eel escapement are predicted, once the above stated mitigation are in place.

Operation

5.3.23 The presence or operation of the cooling water system and pumphouse could have long-term impacts on eel passage and eel populations, as two intake tunnels would provide a continuous supply of seawater at 132 m^3s^{-1} at mid-tide level for cooling of the Sizewell C nuclear reactors.

5.3.24 Operation of the cooling water system and pumphouse has three potential impacts without mitigation:

- physical barriers to eels leading to long-term impacts upon eel passage;
- entrainment and impingement leading to long-term population decline in eels;
- chemical and physical (pressure) changes leading to long-term population decline in eels.

5.3.25 Although the cooling water intakes will be protected by widely spaced bars to prevent the intake of cetaceans, seals, and large items of debris, a significant number of small organisms (small fish and crustaceans, and plankton) will inevitably enter the cooling water intake, including adult and young European eel (e.g. glass eels to silver eels). However, potential entrapmente of eels through the intake tunnels will be minimised by the simplified version of the Hinkley Point C low-velocity side-entry (LVSE) design for the intake heads. Please see **Section 3** and **Figure 3.3** for specific details on the LVSE and predicted approach velocities.

5.3.26 The Hinkley Point C design has been demonstrated by numerical modelling to show that target intake velocities 30cms^{-1} are met across much of its length and compliant with respect to fish protection (Environment Agency, 2011b). The simplified Sizewell C design will achieve intake velocities of 30cm s^{-1} within approximately 0.7m from its intake face (the risk of fouling at Sizewell being too great for lower velocities) although it is acknowledged that an ideal intake velocity for eels would be less than 25cms^{-1}.

5.3.27 FRR systems would be fully integrated within the cooling water infrastructure and their purpose would be to recover and return fish, eels and other marine organisms that are entrapped in the cooling water system and caught on both the drum and band screens (see **Figure 3.2** and **Figure 3.3**). Silver eels which use the FRR system further detailed below, have an 80% survival rate (Environment Agency, 2005). This is dependent on fish buckets of the drum and band screens being fitted with inward curved lips that retain 80% of eels at first capture attempt, without eels escaping to the screen well to be recaptured, possibly multiple times and the design of the FRR having sufficient capacity to return all fish captured, allowing for variations in abstraction rate with tidal level**.** For Sizewell C, the inner circumference of each drum screen would have ‘fish-friendly’ elevator ledges or ‘buckets’ optimised for eels to ensure eels do not writhe and fall out of the buckets.

Potential impingement of silver and yellow eels

5.3.28 Although comparisons of eel mortalities due to impingement with population estimates for individual catchments are theoretically possible, there is uncertainty as to which are the relevant populations, and the European eel is considered to be a single reproductive stock throughout its distribution range. Given the small scale of the yellow and silver eel fisheries along the Suffolk coast, the most appropriate indicator of the perceived impact of Sizewell C on local eel stocks is considered to be a comparison between impingement data for eels by life stage (raised to an equivalent silver eel biomass assuming 90g for males; 570g for females; and a 1:1 sex ratio, Cefas, pers. Comm.). Furthermore, the most appropriate indicator for fisheries is considered to be the combined mean yellow and silver eel catch for 2010-2017 (13.9t), while the most appropriate indicator for population is considered to be the mean estimated silver eel production for the Anglian River Basin District (RBD) (78.6t).

5.3.29 Based on the Sizewell C impingement predictions based upon specific cooling water system design by Cefas (**Appendix 22I** of this volume), assuming that the proposed LVSE intake head design and the FRR are to be incorporated within the operation of the cooling water system and pumphouse, the total annual predicted impingement of eel at Sizewell C, would be approximately 356 fish.

5.3.30 Using a length-weight conversion factor of 0.329kg per fish derived assuming a 50:50 sex ratio (males mature at 89.9g and females mature at 568.9g; cf. Aprahamian, 1988), 356 eels equates to 0.12t, equivalent to 0.15% of the estimated RBD biomass. This latter figure is an overestimate as, due to the lack of necessary biological and population data, it was not possible to date to derive an Equivalent Adult Value for eel, so a worst-case value of 1 has been assumed in Sizewell C impingement predictions. Based on the eye index (Beullens et al., 1997) of biologically sampled impinged individuals at Sizewell B (n = 89), all eels impinged were yellow eels and would have had an Equivalent Adult Value of less than 1 due to the natural mortality experienced by yellow eels in their many year growth period before maturation to silver eels. For example, the natural mortality of yellow eels is estimated to be 13% per annum (Dekker 2000). Assuming that the yellow eels abstracted by Sizewell B would have spent on average 5 more years at Sizewell before maturation, the predicted Sizewell C impingement effect would be reduced by 50% to 0.075% of the RBD silver eel biomass.

5.3.31 Another means of putting the Sizewell C impingement estimate into context is to consider the predicted eel loss of 0.12t per annum in the context of the estimated total EU anthropogenic impact on the stock of approximately 4,900t per annum (**Appendix 22I** of this volume)). The SZC impact is equivalent to 0.002% of the total EU anthropogenic impact (primarily from licenced fishing but also from hydropower and pumps operating largely in rivers).

5.3.32 The predicted effect of Sizewell C entrainment on glass eel recruitment from Sizewell C is considered negligible (**Appendix 22G** of this volume).

Potential entrainment of elvers and glass eels

5.3.33 There is potential that for young eels (less than 14cm), such as glass eels and elvers will be entrained through the drum and band screen mesh (and into the condensers for Sizewell C) given the proposed 10mm mesh size (see **Section 3.2.22**). However, the drum screen mesh size of 10mm is essential to ensure the successful and safe operation of Sizewell C, with a smaller mesh size (1mm to 2mm), although compliant with the Eels Regulations, will be susceptible to clogging by ctenophores (e.g. sea gooseberrires) and cnidarians (e.g. jellyfish) and thus compromise the nuclear safety considerations of Sizewell C (further detailed below).

5.3.34 The glass eel migration pattern around the UK, the strength and direction of coastal currents and the large number of freshwater rivers that the eels would encounter en route would mean that glass eel densities at Sizewell would be expected to be very low and amongst the lowest on the UK coast (on the eel migration route). This low density conclusion is supported by the detailed monitoring data undertaken by Cefas (see **Section 3.4.8** of this ERCA). However, monitoring data does confirm that a few glass eels do transit past Sizewell whilst seeking freshwater signals. On energy efficiency grounds this migration is most likely to use a form of STST in near surface waters. When the tide is in the 'wrong' direction the evidence suggests that glass eels are stationary on, or even buried in, the bottom sediments to avoid being carried away from their preferred migration course. Such a migration strategy will mean that there is a low risk of abstraction into power stations with bottom mounted intakes which do not abstract surface water except minimally at slack water. The deeper the intakes, the lower the risk of abstraction. It would therefore be expected that glass eel abstraction at Sizewell B would be greater than at Sizewell C due to substantially deeper water at the proposed Sizewell C intakes. The abstraction risk zone for the Sizewell C intake heads depends on the swimming ability of the species.

5.3.35 Glass eels are weak swimmers and can sustain approximately 0.25ms^{-1} for only 3 minutes before exhaustion and have a sustained swimming speed of no more than 0.05ms^{-1} for long periods (McCleave 1980). Glass eels resting on the seabed would be unlikely to be abstracted as the Sizewell C intake surfaces would be 1.5 to 3.5m above the bed. The only times that glass eels would be at risk is when they were settling towards or moving off the seabed and then only for those that were within a few metres of the intakes. This represents a very small volume of water at the Sizewell C intakes compared to the potential volume that the eels could settle in within Sizewell Bay and the abstraction risk is, therefore, considered minimal. The same argument would apply at Sizewell B (whilst recognising that the risk would probably be larger due to the shallower water at the Sizewell B intakes); and combined with the expected low glass eel densities at the site and their migration pattern in surface waters would provide a coherent explanation of the absence of glass eels in the Sizewell B entrainment monitoring surveys.

5.3.36 In addition, glass eels migrating on the coast will preferentially swim close to the coast and that their density offshore at the location of the Sizewell C intakes would be lower than at the Sizewell B intakes. Some evidential support for this hypothesis is provided by glass eel behaviour in lower estuaries where it is known that they occur in the highest densities closest to the estuary shorelines when migrating up the estuary (for example at Hinkley Point). Furthermore, given the intakes are approximately 3km offshore, the degree of turbidity within lower water column near the proposed intake heads compared to the higher water column is relatively low; and as such the implications for intake risk for eels will also be low. Further details provided in **Appendix 22I** of this volume and BEEMS (2016b).

5.3.37 It is acknowledged that there could be 100% eel mortality with regards to glass eels and elvers which are entrained and discharged though the outfall tunnel. However the overall entrainment risk to glass eels and contribution to eel population decline is considered low, in response to the very low numbers of glass eels that migrate past Sizewell and the low likelihood of mortality of glass eels through the Sizewell C cooling water system at planned operational conditions.

5.3.38 Overall for the operation of the cooling water system and pumphouse, based on the above assessment for impingement and entrainment, no long-term impacts upon European eel population status and silver eel escapement are predicted, once the stated mitigation, LVSE and FRR are in place.

Potential pressure and chemical changes on European eel

5.3.39 The glass eel life stage of the European eel is also small enough to pass through the proposed 10mm mesh screens and to be entrained into Sizewell C; although as stated above the overall entrainment risk to glass eels and contribution to eel population decline is considered low. However, to address this potential hazard, of young eels being entrained through the whole cooling water system and pumphouse, Cefas have undertaken detailed research studies for Sizewell C that simulate the main physical and chemical changes experienced by entrained eels and to estimate eel entrainment mortality (BEEMS 2012b, 2013, 2016b). A summary of these studies is provided below with specific details presented in BEEMS Technical Report 395 (BEEMS 2016b).

5.3.40 Entrainment Mimic Unit (EMU) Experimental Programme: European eel (June 2013) (BEEMS 2013): Although this programme was undertaken for the Hinkley Point C power station, given the proposed cooling water system of Sizewell C will be similar, inference can be made from the outcomes of the study in regard to the likely impacts upon eels from the Sizewell C cooling water system.

- A laboratory based simulation apparatus, the EMU (the core of which is a power station condenser) (**Figure 5.2**), was used to enable exposure of 600 supplied glass eels to the physical and chemical stresses associated with entrainment to be assessed for the proposed conditions of the Hinkley Point C power station; and thus, estimate the mortality rates of entrained eels.

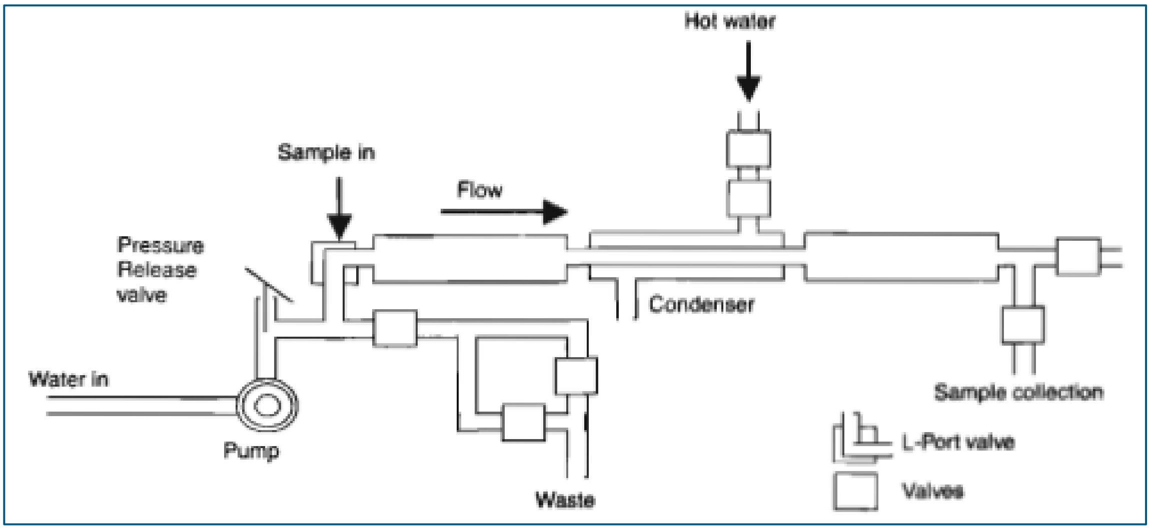

Figure 5.2 Schematic Diagram of an Entrainment Mimic Unit (EMU) (2018) (Source: Turnpenny and Taylor,2000)

- The key conditions assessed in the June 2013 EMU study included pressure (a profile designed to mimic the predicted pressures that entrained eels would experience at Hinkley Point); temperature (the predicted ΔT is 11.6ºC); and Chlorine (Total Residual Oxidant). These conditions mimicked the journey undertaken by potentially entrained eels through the cooling water system (and discharge outfall) of nuclear power stations. Further details provided BEEMS Technical Report 273 (BEEMS, 2013).
- EMU passage (in the absence of pressure, temperature and chlorine stresses) for the June 13 EMU study resulted in lowered survival and applying pressure and temperature stresses did not decrease survival more than that associated with the mechanical stress of EMU passage alone. However, greater total residual oxidant concentrations were strongly correlated with a further decrease in survival, though the rate of decay of chlorine was also strongly correlated to the number of eels in the exposure vessel.
- Thus, glass eels based on the June 13 EMU study appear to be sensitive to some degree to mechanical and chemical stress when passing through the cooling water system, although pressure appears to make little extra contribution to mortality; and there is no clear evidence of sensitivity to temperature change within the range tested.
- Under standard Hinkley Point C operating conditions, the June 13 EMU study concluded the survival of entrained glass eels was predicted to be between 73.5 and 93.4%, although the mortality attributable to damage from the impeller blades, as the eels pass through the pump may further reduce this survival rate by 1.8%. Hence, the survival rate of glass eels passing through the cooling water system of Hinkley Point C could be as low as 71.7%.

5.3.41 Entrainment Mimic Unit (EMU) Experimental Programme European eel (June 2016) (BEEMS 2016b): This programme was undertaken specifically for Sizewell C (SZC); and as stated the EMU (**Figure 5.2**) simulates, as realistically as is practically possible, the full range of physical and chemical conditions experienced by entrained eels during passage through a power station cooling water system. For this study, 450 supplied glass eels were used to assess the physical and chemical stresses associated with potential eel entrainment for the proposed conditions of Sizewell C power station; and thus, estimate the mortality rates of entrained eels.

- The key conditions assessed in the June 2016 EMU study included temperature (the predicted ΔT is 11.6ºC); and Chlorine (TRO). Further details provided BEEMS Technical Report 273 (BEEMS, 2013). It should be noted, the background starting temperature in this study ranged between 9.0 – 9.7°C; and actual ΔTs attained in this study were 8.9 – 12.4°C giving rise to a final temperature range of 18.3 – 21.6°C. These temperatures are representative of entrainment temperatures that glass eels at SZC could experience in the period mid-March – early May in a typical year.
- Entrainment simulation using glass eels included handling controls (HC), rapid temperature elevation (T), chlorine exposure as a single addition I as well as temperature elevation and single dose chlorination in combination (TC).
- The results of the studies were modelled to predict survival at the designed ΔT of 11.6°C, with an outfall maximum exposure concentration of 0.2mg l^{-1} total residual oxidants during periods of chlorine dosing. There was 100 % survival in the HC treatment groups and this was also the case for T and TC treatment groups indicating that this combination of entrainment conditions has no impact on survival of glass eels.
- While this study did not include the SZC pressure profile, a comparative study did, but using the Hinkley Point C pressure profile. Data using the Hinkley Point C profile indicate that survival of glass eels is still very high (i.e. 88-100%) up to ΔTs of 13.9°C and final temperatures of 28.8°C. However, at an initial starting temperature of around 20 °C and final temperatures of 31.8°C the survival of glass eel is reduced to around 37% (BEEMS 2012b). At starting temperatures around 16 °C and when final temperatures are at 27.5°C glass eel are similarly tolerant of elevated chlorination levels with around 80-100% survival at a total residual oxidant concentration of 0.5 – 0.6mg l^{-1} and 50% survival at a total residual oxidant concentration of 0.74mg l^{-1} (BEEMS 2013).
- The data from June 2016 EMU study and previous BEEMS reports, suggest that during the main migration period January to May, the mortality of entrained glass eel through the whole cooling water and discharge system of Sizewell C will be negligible. The test data also indicate that survival, would only be significantly reduced at the elevated temperatures likely during the mid-summer period June-August when glass eels are not present.

Nuclear safety perspective

5.3.42 Although the 10mm mesh size is not compliant with the Eels Regulations, given the Alternative Measures described above regarding the low velocity intake configuration (LVSE) combined with the FRR systems (which also relate to **Table 3.2**), it is considered that the proposed mesh size of 10mm for the Sizewell C drum screens should be deemed acceptable in relation to the Eels Regulations. Furthermore, a 2mm mesh size, although compliant with the Eels Regulations, is not acceptable from a nuclear safety perspective).

5.3.43 As such, to comply with the long-term nuclear health and safety operational procedures for Sizewell C, it is essential that the mesh size of the drum screens is 10mm. It should be noted, although not yet confirmed, glass eels will pass through screens under 10mm, with evidence to suggest glass eels will pass through 5mm screens (Cefas pers. comm. February 2020).

Cooling Water Discharge

Construction

5.3.44 A single 8m internal diameter outfall tunnel serving both reactor units would return the cooling water to sea, with either one or two vertical shafts at its seaward end each leading upwards to a single outfall headworks, again mounted on the seabed (see **Figure 3.2**). However, the construction activities for the outfall tunnel could have short-term and long-term impacts on eel passage and eel population status.

5.3.45 The outfall tunnel has two potential impacts without mitigation:

- non-physical barriers (e.g. water quality changes) to eels leading to short-term temporary impacts upon eel passage; and
- changes in water quality leading to long-term population decline in eels.

5.3.46 Similar to the construction of the two intake tunnels, the outfall tunnel would be excavated by a TBM from landward and, prior to placement of the head structure, dredging of approximately 11,750 m^3 would be required to expose the bedrock. The most likely dredge method is via a cutter suction dredger with spoil to be deposited locally. The outfall head would be prefabricated and lowered into place.

5.3.47 Given the same concerns, conclusions and mitigation measures associated with the construction of the intake tunnels are relevant to the construction of the outfall tunnel, no short-term and long-term impacts upon European eel population status and silver eel escapement are predicted, once similar mitigation for the construction of the intake tunnels are in place.

Operation

5.3.48 The presence or operation of the cooling water discharge (outfall tunnels) could have long-term impacts on eel passage and eel population, as the outfall tunnel would return used seawater back into the Suffolk Coast. Returned abstracted water would be the main waste stream from Sizewell C and would represent approximately 99.9% by volume of the total overall daily discharge of non-radioactive effluent. The thermal uplift in the discharged cooling water is assumed to be 11.6°C (132.5m^3s^{-1}) and 23.2°C for the maintenance scenario (62.5m^3s^{-1}).

5.3.49 The operation of the cooling water discharge has two potential impacts without mitigation:

- thermal barrier to eels leading to long-term impacts upon eel passage; and
- changes in water quality leading to long-term population decline in eels.

5.3.50 Based on detail modelling of temperature and thermal uplift created by the cooling water discharge (BEEMS 2016c; 2019) presented in **Table 5.1**, the Sizewell C thermal plumes are not predicted to present a barrier to the migration of eels. This is further detailed below based on the conclusions of the modelling:

- Thermal standards for transitional waters specify that an estuary's cross section should not have an area larger than 25% with a temperature uplift above 2˚C, for more than 5% of the time to avoid potential barriers to migratory fish.
- The percentage of the coastal transect predicted to experience the more than 2°C and more than 3°C uplift is shown in **Figure 5.3**, with migration periods of glass and silver eel indicated.
- Based on the available evidence for thermal avoidance of migratory species off Sizewell a precautionary 3°C thresholds may be applied for glass eel and silver eel. For these species, modelling results show that potential avoidance thresholds would occur over 25% of the coastal corridor for less than 5% of the time during their migration periods. Therefore, no occlusion effects are predicted.
- The sensitivity of migratory fish to thermal occlusion from the operational thermal discharge of both Sizewell B and Sizewell C in-combination, is assessed as not sensitive, with only minor behavioural changes predicted.
- No barriers to fish and eel migration are predicted.

5.3.51 Chemicals such as bromoform and hydrazine associated with the cooling water discharge will not impact the eel passage or eel populations, in response to outfall headworks located 3km offshore in deep water which will allow for initial mixing and minimise intersection with the Suffolk Coast coastline.

5.3.52 Overall for the operation of the cooling water discharge, no long-term impacts upon European eel population status and silver eel escapement are predicted.

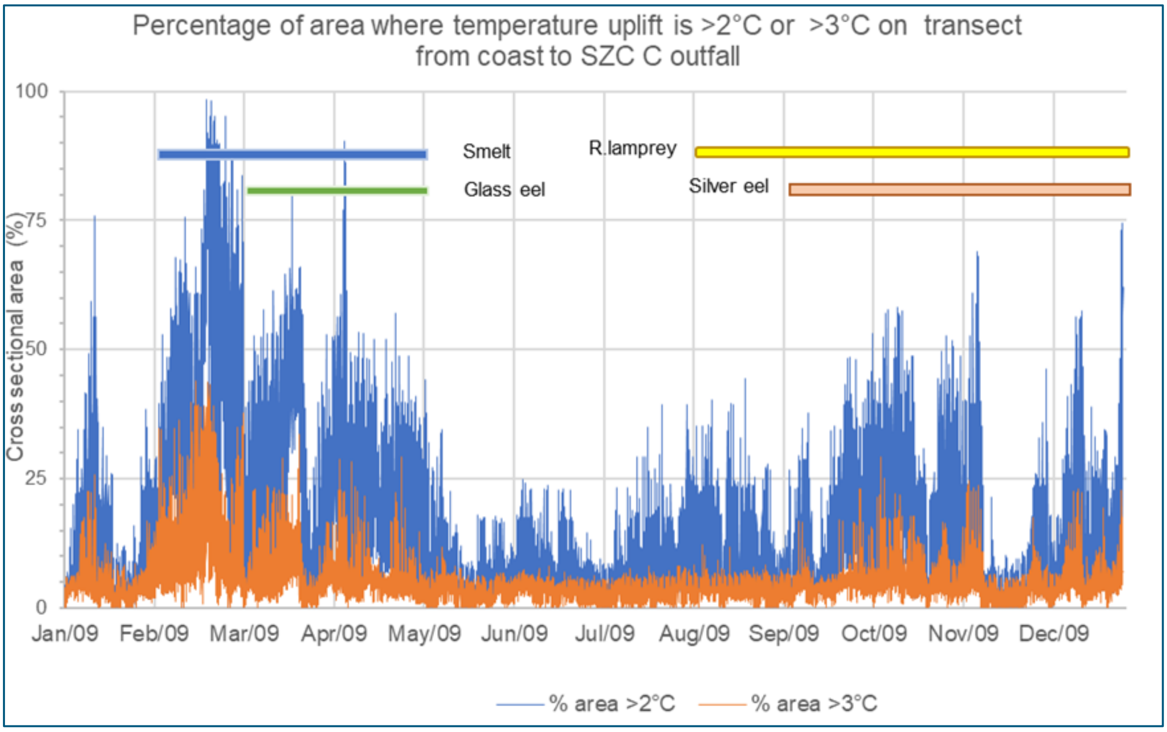

Figure 5.3 Percentage of Sizewell C Transect with >2°C and >3°C Uplift (Source: BEEMS 2016c)

Table 5.1 Total Areas of Exceedance for Absolute Temperature & Thermal Uplift

Model Run	Absolute Water Temperature (as a 98^{th} percentile).			Thermal Uplift (as a 98^{th} percentile).		
	Temperature	Status	Position	Uplift	Status	Position
Sizewell B only.	20ºC - ≤ 23ºC	Good		> 2ºC	Good	Surface 2,433ha.
						Seabed 2,127ha.
	23ºC - ≤ 28ºC	Moderate	Surface 44.9ha.	> 3ºC	Moderate	Surface 1,263ha.
			Seabed 8.75ha.			Seabed 668ha.
	> 28ºC	Poor	Surface 0ha.			
			Seabed 0ha.			
Sizewell B + Sizewell C. (most conservative case for Impact).	20ºC - ≤ 23ºC	Good	-	> 2ºC	Good	Surface 7,899ha.
			-			Seabed 6,241ha.
	23ºC - ≤ 28ºC	Moderate	Surface 89.6ha.	> 3ºC	Moderate	Surface 2,200ha.
			Seabed 25.6ha.			Seabed 1,553ha.

	> 28ºC	Poor	Surface 0.11ha.			
			Seabed 0ha.			
Sizewell C only.	20ºC - ≤ 23ºC	Good	-	> 2ºC	Good	Surface 1,551ha.
						Seabed 170.6ha.
	23ºC - ≤ 28ºC	Moderate	Surface 0ha.	> 3ºC	Moderate	Surface 305.7ha.
			Seabed 0ha.			Seabed 0ha.
	> 28ºC	Poor	Surface 0ha.			
			Seabed 0ha.			

Fish Recovery and Return (FRR) and Combined Drainage Outfall (CDO) Discharges

Construction and Operation

5.3.53 As stated, the FRR systems will be essential for the safe return of fish and eels to the sea and along with the construction of the Combined Drainage Outfall (CDO), will require dredging of the FRR system outfalls (see **Figure 3.2**). For each FRR system, estimates of dredge area have been calculated at 207 m^2 with a total of 1845 m^3 dredge volume per FRR outfall. This includes dredging for both the head placement and for scour protection. Dredge spoil will be disposed of via a pipe that transports the dredge material 500m down drift. The design of the CDO head has not yet been undertaken and is assumed to be similar dimensions to the FRR. Therefore, the dredge volume is also approximately 1,845 m^3 and disposal will occur in the same manner as for the FRR system outfalls.

5.3.54 Given the same concerns, conclusions and mitigation measures associated with the construction of the intake and outfall tunnels are relevant to the construction of the FRRs and CDO, no short-term and long-term impacts upon European eel population status and silver eel escapement are predicted, once similar mitigation for the construction of the intake and outfall tunnels are in place.

5.3.55 The operation of the FRR systems for Sizewell C has been previously discussed above regarding silver eel escapement, while no long-term impacts upon European eel population status and silver eel escapement are predicted in response to the operation of the CDO.

6 Summary

6.1 Sizewell C and Compliance with the Eels Regulations

6.1.1 SZC Co. is proposing to build and operate a new nuclear power station at Sizewell on the Suffolk Coast, north of the existing Sizewell B power station. The design of this new power station – Sizewell C, will take into account the sensitive nature of the surrounding environment, while providing enough space to build and operate the power station safely and efficiently to support approximately 7% of the UK's electricity (or approximately six million homes). However, under the Eels (England and Wales) Regulations 2009 (S.I. 2009 No. 3344) (the 'Eels Regulations'), new developments are required to make provision for the safe passage of European eels (*Anguilla anguilla*), an International Union for Conservation of Nature red list 'critically endangered' species.

6.1.2 However, this Eels Regulations Compliance Assessment (ERCA) undertaken to support to the DCO and WDA Permit for Sizewell C, has shown that the key onshore and offshore construction and operation components of Sizewell C will not overall impact European eel populations and silver eel escapement, although it is acknowledged that some operational components (such as the drum screens with a proposed 10mm mesh) will not comply with Best Practice, however, given the Alternative Measures to be implemented (such as the low velocity side entry (LVSE) intake configuration and Fish Recovery and Return (FRR) systems) Sizewell C drum screens should be deemed acceptable in relation to the Eels Regulations.

6.2 Mitigation Measures and Monitoring

6.2.1 In order to ensure compliance with the Eels Regulations, the following mitigation measures and monitoring should be implemented for Sizewell C (those stated in the **ES** are denoted with *):

Freshwater Elements

- Control measures associated with the **Code of Construction Practice** (**CoCP**) (Doc Ref. 8.11)*.
- Eel rescue carried out (if required) prior to any in-stream works*.
- No piling at night to be carried out.
- Incorporation of suitable bed and bank protection (using bioengineering solutions) either upstream and/or downstream of culverts*.
- Careful operational management of water control structures to ensure adequate environment flows for in-stream eel habitat and survival.
- No permanent in-stream barriers to eel migration to be constructed and operated without full consideration of eel migration, including the installation of appropriate eel passes at water control structures*.

Marine Elements

- Control measures defined in the **CoCP** (Doc Ref. 8.11)*.
- Low velocity side entry type intake head design*;
- Fish Recovery and Return systems to be fully integrated within the cooling water infrastructure*.
- FRR to include fish-friendly elevator ledges or 'buckets' optimised for eels*.

Monitoring

- Ongoing entrainment and impingement monitoring of eels at Sizewell C to be undertaken to implement alternative measures if deemed necessary*.

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Royal HaskoningDHV

Acronyms

Acronym	Acronym description
AIL	Abnormal Indivisible Load
BLF	Beach Landing Facility
DCO	Development Consent Order
Defra	Department of Environment, Food and Rural Affairs
EC	European Commission
ES	Environmental Statement
ERCA	Eels Regulations Compliance Assessment
EMU	Entrainment Mimic Unit
EMP	Eel Management Plan
HCDF	Hard Coastal Defence
HGV	Heavy Goods Vehicle
LEMP	Landscape Environmental Management Plan
LVSE	Low-velocity Side-entry
NNB	Nuclear New Build
PAH	Polycyclic Aromatic Hydrocarbons
TBM	Tunnel Boring Machine
TSHD	Trailing Suction Hooper Dredging
RBD	River Basin District
SLR	Sizewell Link Road

SCDF	Soft Coastal Defence Feature
STST	Selective Tidal Stream Transport
SSSI	Sites of Special Scientific Interest
TVB	Two Village Bypass
WDA	Water Discharge Activity
WFD	Water Framework Directive

Glossary

Glossary Term	Glossary Text
B_0 (biomass)	Spawner escapement biomass in absence of any anthropogenic impacts.
Entrainment	Entrainment mainly affects aquatic species small enough to pass through the particular size and shape of intake screen mesh.
Entrapment	Entrapment is associated with aquatic species which are drawn into the seawater intake and are blocked by physical barriers such as intake walls and screens. Such aquatic species are said to be entrapped.
Eel Escapement	The amount of silver eel that leaves (escapes) a waterbody, after taking account of all natural and anthropogenic losses.
Elver	Young eel, in its first year following recruitment from the ocean. The elver stage is sometimes considered to exclude the glass eel stage. To avoid confusion, pigmented 0+ cohort age eel is included in the glass eel term (below).
Glass eel	Young, unpigmented eel, recruiting from the sea into continental waters. Generally, all recruits of the 0+ cohort age. In some cases, however, also includes the early pigmented stages.
Impingement	Impingement typically involves adult aquatic organisms (fish, crabs, etc.) that are large enough to actually be retained by intake screens,
River Basin District	The area of land and sea, made up of one or more neighbouring river basins together with their associated surface and groundwaters, transitional and coastal waters, which is identified under Article 3(1) of the Water Framework Directive as the main unit for management of river basins. The term is used in relation to the EU Water Framework Directive.
Silver eel	Migratory phase following the yellow eel phase. Eel in this phase are characterized by darkened back, silvery belly with a clearly contrasting black lateral line, enlarged eyes. Silver eel under-take downstream migration (escapement) towards the sea. This phase mainly occurs in the second half of calendar years, although some are observed throughout winter and following spring.