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NUCLEAR POWER

WYLFA NEWYDD

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Wylfa Newydd Project

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Contents

13 The marine environment

13.1 Introduction

13.1.1 This chapter describes the assessment of potential marine environment effects resulting from the construction, operation and decommissioning of the Power Station, other on-site development as described in chapter A1 (introduction) (Application Reference Number: 6.1.1) of this Environmental Statement), Marine Works and the Site Campus within the Wylfa Newydd Development Area. It also considers potential effects at the Disposal Site of Holyhead North.

13.1.2 Please refer to chapter B13 (the marine environment) (Application Reference Number: 6.2.13) for the technical basis for the assessment including a summary of legislation, policy and guidance; key points arising in consultation that have guided the marine environment assessment; and assessment methodologies and criteria.

13.1.3 The assessment herein supports the Development Consent Order application and also the application for a Marine Licence to cover Licensable Marine Activities, required separately under the Marine and Coastal Access Act 2009.

13.2 Study area

13.2.1 This section describes the study area relevant to the marine environment assessment for the Wylfa Newydd Development Area and the Disposal Site.

13.2.2 Since 2010, surveys to determine the marine ecology baseline have focused on an area 5km from the Wylfa Newydd Development Area. This survey area is termed the ‘central study area’ in this chapter (see figure D13-1, Application Reference Number: 6.4.101).

13.2.3 The spatial extent of the central study area was defined based on an understanding of the tidal excursion along the north coast of Anglesey and the results of preliminary hydrodynamic modelling, which provided an initial indication of the dispersion of the Cooling Water discharge from the Power Station. As a worst case, it was considered that potential effects were most likely to occur within the central study area.

13.2.4 For certain marine receptors, additional data and/or information have been gathered from outside the central study area to further characterise the marine ecology baseline. This included mobile receptors such as marine mammals, seabirds and fish to allow the potential effects on populations to be assessed.

13.2.5 The term ‘wider study area’ is used to describe the full spatial extent of baseline survey data and information considered within the assessment of effects for the Wylfa Newydd Development Area (if greater than the 5km central study area). The spatial extent of the wider study area is receptor-specific and has been described under the relevant headings within section 13.3.

13.2.6 The marine environment assessment also considers effects on marine receptors at the Disposal Site and a further study area has been defined specific to this assessment. The 'Disposal Site study area', much like the wider study area, encompasses the spatial extent of all baseline survey data and information considered within the assessment of effects. The spatial extent of the Disposal Site study area is receptor-specific and has been described under the relevant headings in section 13.4.

13.2.7 It is acknowledged that marine receptors will exhibit a degree of connectivity between the two study areas delineated. Consequently, characterisation of the baseline environment for the Wylfa Newydd Development Area (section 13.3) and the Disposal Site (section 13.4) marine assessments may have drawn upon the same survey data and information where appropriate.

13.3 Wylfa Newydd Development Area baseline environment

13.3.1 This section provides a summary of the baseline conditions for the marine environment within the central study area described in section 13.2. Where a wider study area has been defined to characterise the baseline for a particular receptor, further description is provided below.

13.3.2 The environmental baseline data within this section (13.3) are supported by the following appendices and are cross-referenced in the text where relevant:

- D9-16 Wylfa Freshwater Baseline Surveys 2011 to 2015 (Application Reference Number: 6.4.49);
- D13-1 Water quality and plankton surveys report (Application Reference Number: 6.4.83);
- D13-2 Benthic ecology report (Application Reference Number: 6.4.84);
- D13-3 Porth-y-pistyll biotope Survey Report (Application Reference Number: 6.4.85);
- D13-4 Fish surveys report (Application Reference Number: 6.4.86);
- D13-5 Subtidal dive surveys at the Cooling Water outfall at the Existing Power Station (Application Reference Number: 6.4.87);
- D13-6 Marine mammal baseline review (Application Reference Number: 6.4.88);
- D13-7 Seabirds baseline review (Application Reference Number: 6.4.89);
- D13-8 Marine hydrodynamic modelling report – Wylfa Newydd Development Area (Application Reference Number: 6.4.90); and
- D13-10 Entrapment of marine organisms at the Existing Power Station (Application Reference Number: 6.4.92).

Conservation designations

13.3.3 There are a number of sites subject to nature conservation designations of international and national importance within and surrounding the Wylfa Newydd Development Area. These include Special Areas of Conservation (SACs), Special Protection Areas (SPAs), and Sites of Special Scientific Interest (SSSI).

13.3.4 The designated and candidate sites of national/international importance that are considered to be relevant to the assessment are listed in table D13-1 and shown in figure D13-1 (Application Reference Number: 6.4.101). A separate Shadow Habitats Regulations Assessment (HRA) Report (Application Reference Number: 5.2) has been undertaken which considers internationally designated sites on a wider geographic scale which are not listed in table D13-1. The Shadow HRA (Application Reference Number: 5.2) is provided as a separate supporting report to the Development Consent Order and Marine Licence application.

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Table D13-1 Statutory designated sites for nature conservation relevant to the marine environment in proximity of the Wylfa Newydd Development Area

Site	Designation	Approximate distance from the Wylfa Newydd Development Area	Primary reason for designation
Bae Cemlyn/ Cemlyn Bay	SAC	Approximately 100m north-west of the Wylfa Newydd Development Area	The coastal lagoon habitat, including a bryozoan (*Conopeum seurati*), the lagoon cockle (*Cerastoderma glaucum*) and the lagoonal mud snail (*Ecrobia ventrosa*) as well as a number of uncommon plant species such as the brackish water-crowfoot (*Ranunculus baudotii*) and beaked tasselweed (*Ruppia maritima*). Perennial vegetation of stony banks is present as a qualifying feature but is not the primary reason for designation [RD1].
Morwenoliaid Ynys Môn / Anglesey Terns	SPA	Within the Wylfa Newydd Development Area	In January 2017, a marine extension to the existing Ynys Feurig, Cemlyn Bay and The Skerries SPA was designated to include the marine area used by foraging terns during the breeding season. The site, now incorporating the nesting birds of Ynys Feurig, Cemlyn Bay and The Skerries SPA,

Site	Designation	Approximate distance from the Wylfa Newydd Development Area	Primary reason for designation
			and their foraging areas, was renamed the 'Anglesey Terns/Morwenoliaid Ynys Môn SPA.' The SPA supports four species of breeding tern: Arctic tern (*Sterna paradisaea*) (five year mean of 1,290 pairs representing 2.9% of population in the UK, 1992–1996); common tern (*Sterna hirundo*) (five year mean of 189 pairs representing 1.5% of population in the UK, 1992-1996); roseate tern (*Sterna dougallii*) (five year mean of three pairs representing 5% of population in the UK, 1992–1996); Sandwich tern (*Thalasseus sandvicensis*) (five year mean of 460 pairs representing 3.3% of population in the UK, 1993 to 1997) [RD2]. Terns are known to nest on the islands in Cemlyn Lagoon.
Gogledd Môn Forol / North Anglesey Marine	Candidate SAC (cSAC)	Within the Wylfa Newydd Development Area	Proposed for harbour porpoise (*Phocoena phocoena*).

Site	Designation	Approximate distance from the Wylfa Newydd Development Area	Primary reason for designation
Cemlyn Bay	SSSI	Approximately 100m north-west of the Wylfa Newydd Development Area	The breeding bird assemblage comprising Arctic tern, common tern, roseate tern and Sandwich tern is the primary reason for designation. Vegetated shingle which is characterised by sea kale (*Crambe maritima*), sea radish (*Raphanus raphanistrum* subsp. *maritimus*) and yellow horned-poppy (*Glaucium flavum*).
Puffin Island	SSSI	35km	Sea cliffs, maritime grassland, intertidal rocks, breeding seabird assemblage.
The Skerries	SSSI	8km	Low maritime cliffs, maritime grassland, rockpools, breeding bird assemblage, grey seals.
Holy Island Coast	SSSI	15km	Vegetated sea cliffs, European dry heaths, maritime grassland, vascular plants assemblage, breeding bird assemblage.

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Value of receptors

13.3.5 The nationally/internationally designated and candidate sites identified in table D13-1 are considered under the receptor ‘all designated sites of nature conservation importance and supporting features’ which has been assigned a high value.

Water quality

13.3.6 Marine water quality sampling was carried out at nine sites which were all located within the central study area (5km from the Wylfa Newydd Development Area) between May 2010 and November 2014 (figure D13-2, Application Reference Number: 6.4.101). In addition, four long-term, fixed-point mooring buoys were deployed within the central study area between July 2010 and August 2011 which recorded temperature, salinity, currents and waves (figure D13-2, Application Reference Number: 6.4.101). Data collected by National Resources Wales (NRW) have been used to provide information on Water Framework Directive (WFD) water bodies and bathing water quality [RD3]. Following cessation of the discharge from the Existing Power Station, two additional water quality surveys were carried out in close proximity to the Cooling Water outfall (OF1 and OF2) in December 2015 and February 2016 to provide an indication of non-operational water quality conditions (figure D13-2, Application Reference Number: 6.4.101).

13.3.7 There are three coastal water bodies designated under the WFD in close proximity to the Power Station. The Anglesey North water body is currently achieving ‘moderate’ ecological status and The Skerries water body is at ‘high’ ecological status; the central study area intersects both water bodies. These water bodies are characterised by strong tidal currents and a maximum tidal range of 7.5m. Cemlyn Lagoon water body is located within the central study area, approximately 100m north-west of the Wylfa Newydd Development Area. The lagoon habitat is separated from the coastal waters by a permeable shingle bank, with a narrow channel at the western end; it is fed by water from the Cemlyn catchment and from the sea. This water body is currently achieving ‘good’ ecological status.

Physico-chemical parameters

Temperature

13.3.8 The maximum, minimum and mean monthly temperatures recorded during each survey ranged from 6.08°C in March 2013 to 16.84°C in August 2014 (figure D13-3) and seasonal variation was consistent across the years with the highest temperatures typically observed in summer and the lowest in winter.

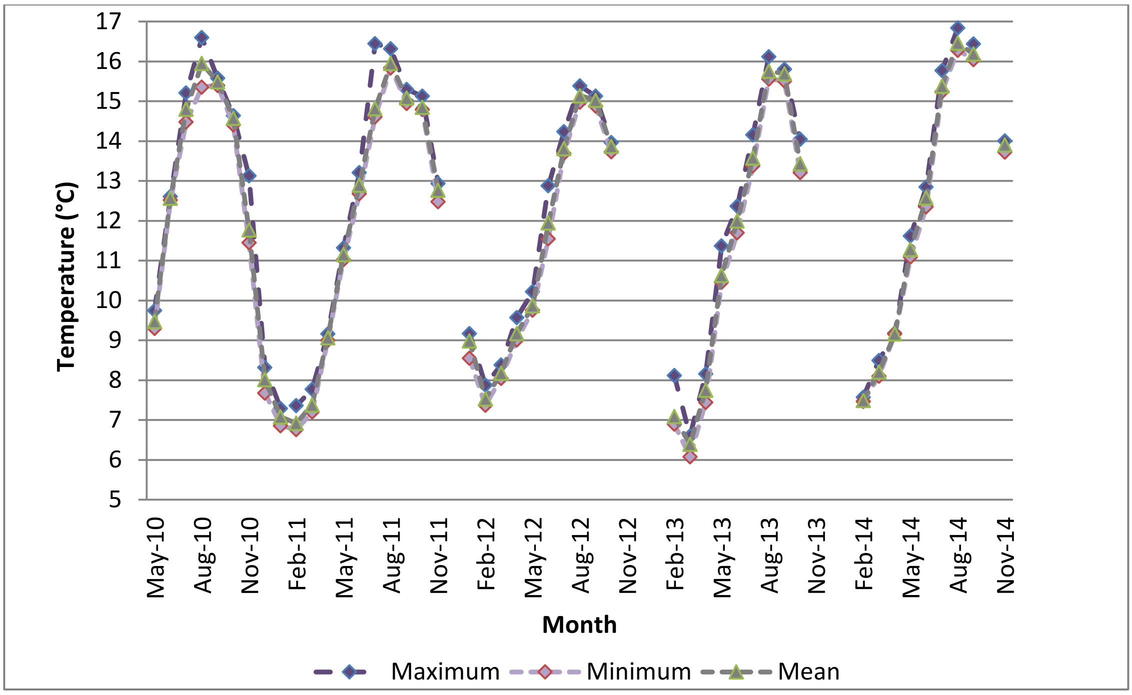
13.3.9 Temperature values were found to be stable throughout the water column (depth ranged between approximately 10m and 45m) and were indicative of a well-mixed water body over all seasons. The difference in temperature recorded within the water column (between surface and seabed) was generally lower than 0.4°C. A weak thermal stratification was occasionally observed at sites WQ2 and WQ6 (figure D13-2, Application Reference

Number: 6.4.101) which was likely to be the result of a number of factors including depth, weather conditions and tidal state, with possible localised short-term effects of the Cooling Water discharge from the Existing Power Station.

13.3.10 The Existing Power Station operated at half-load (with one reactor shut down) from April 2012 to December 2015, and there were no measurable differences recorded in temperature between the years preceding this and the years since half-load operation began.

13.3.11 Water temperatures in close proximity to the outfall (OF1 and OF2; figure D13-2, Application Reference Number: 6.4.101) were affected by the Cooling Water discharge of the Existing Power Station. This is evidenced by site OF1, situated 50m from the outfall, which showed temperatures ranging between 11.0°C at the bed to 15.2°C at the surface.

Figure D13-3 Maximum, minimum and mean water temperatures recorded monthly from sites WQ1 to WQ9 during water quality surveys



Salinity

13.3.12 Salinity ranged between a minimum of 32.80 in September 2012 and a maximum of 35.29 in May 2011. Salinity values were typically stable throughout the water column indicating a well-mixed water body; very weak haloclines were observed occasionally but no trends were observed in the location or timing of these. All values are in line with the expected values for inshore coastal waters of the Irish Sea (as reported by Turekian [RD4]).

Suspended solids

13.3.13 Monthly mean total suspended solids concentrations varied between 3.2mg/L in April 2011 and 21.6mg/L in March 2014; samples taken from surface and mid-depth from across the survey area (see appendix D13-1, Application Reference Number: 6.4.83). Calculated annual averages (AAs) ranged from 6.1mg/L in 2011 to 13.0mg/L in 2014. Based on the criteria for classifying water bodies in relation to turbidity conditions as set out by the WFD (Standards and Classification) Directions (England and Wales) 2015, the Anglesey North water body and The Skerries water body would be classified as clear to intermediate.

Oxygen

13.3.14 Dissolved oxygen saturation levels recorded from May 2010 to November 2014 ranged from 90.2% in September 2014 to 121.1% in October 2013, which would equate to a WFD Environmental Quality Standard (EQS) of high status. Values were found to be similar at all sites with only slight variations, which were observed infrequently. Vertical profiles typically followed the same pattern, with high dissolved oxygen at the surface and a decreasing level of dissolved oxygen saturation with depth. In some months during spring and summer, the highest levels of saturation were found at approximately 5m to 10m depth, which corresponded with the depth of maximum chlorophyll concentrations. The dissolved oxygen levels recorded in December 2015 and February 2016 were comparable across all sites.

pH

13.3.15 Values of pH ranged between 6.94 in June 2011 to 8.46 in July 2013 and June 2014, which is within the range expected for coastal waters [RD5].

Chlorophyll

13.3.16 Chlorophyll-a *in vivo* concentrations were generally higher within 5m of the water surface, with the highest concentrations typically recorded between May and August. Mean monthly values that were below 10µg/L, indicating good status of this parameter under WFD United Kingdom Technical Advisory Group guidance [RD6].

Chemical and biochemical parameters

13.3.17 Annual averages, monthly averages and maximum concentrations of chemical and biochemical parameters were calculated to compare the status of the coastal waters around the Wylfa Newydd Development Area (i.e. within the central study area) to WFD EQS. This showed that, between May 2010 and November 2014, the parameters that were measured in the two water bodies (Anglesey North and The Skerries) would meet the threshold EQS for good status.

13.3.18 All metals except mercury were consistently reported as below their relevant EQS. The mean monthly value for mercury (total fraction) exceeded the Maximum Allowable Concentration EQS (known as MAC-EQS) in only one month, October 2010, over the whole survey programme.

13.3.19 Mean monthly concentrations of nitrogen (as N), nitrogen oxidised (dissolved and total), ammoniacal nitrogen and nitrite were typically reported at close to or below the Minimum Reporting Value (MRV)[1]. Average concentrations of dissolved inorganic nitrogen (calculated from dissolved oxidised nitrogen and ammoniacal nitrogen) between November and February in 2010/2011 and 2011/2012 indicated high dissolved inorganic nitrogen standard (<12µmoles/L) under the WFD classification in 2010 to 2011 and 2011 to 2012. Nutrient concentrations (nitrate, nitrite, orthophosphate and silicate) in December 2015 and February 2016 were found at similar levels to those reported for the survey area during the 2010 to 2014 baseline surveys and also to NRW data from north Anglesey from 1998 to 2012. Total organic nitrogen, dissolved inorganic nitrogen and Kjeldahl nitrogen were all reported as below MRV.

13.3.20 All monthly means for total petroleum hydrocarbons, Polycyclic Aromatic Hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) were consistently found to be below the MRV. Volatile organic compounds were typically recorded below the MRV, with a few exceptions which were occasionally reported slightly above the MRV:

- toluene;
- bromoform;
- ethylbenzene;
- dimethylbenzene;
- 1,3-dichloropropene; and
- di-2-ethylhexyl phthalate.

13.3.21 The majority of phenolic compounds were reported as below the MRV in all samples; only 2-methylphenol, 4-methylphenol and 4-chloro-3-methylphenol were occasionally reported marginally above the MRV.

13.3.22 Chemical concentrations in water samples collected in December 2015 and February 2016 did not differ from those taken in May 2010 and November 2014.

Cemaes bathing water

13.3.23 Bathing water quality is monitored to protect human health and the environment under the European Commission Bathing Water Directive (2006/7/EC). Two microbial parameters – *Escherichia coli* (*E.coli*) and *intestinal enterococci* – are assessed using four years of sampling data. There are four classifications for bathing water quality: ‘excellent’, ‘good’, ‘sufficient’ and ‘poor’ [RD3]. The objective set out in the Bathing Water Directive is for all bathing waters to achieve sufficient status by 2015. Until 2015, Cemaes bathing water achieved sufficient status. However, in 2016 Cemaes bathing water was classed as poor for the first time.

[1] The MRVs are minimum concentrations selected for reporting purposes. MRVs are often higher than the statistically derived Limits of Detection method and provide higher confidence that a sample is different from a blank sample containing no determinand of interest.

13.3.24 Cemaes Bay is subject to short-term pollution issues which are caused when heavy rainfall washes faecal material into the sea from livestock, sewage and urban drainage via rivers and streams. There is a risk of reduced water quality after rainfall, but this typically returns to normal after one to three days [RD7].

Value of receptors

13.3.25 Two receptors have been identified in relation to marine water quality; EU-designated WFD water bodies (The Skerries, Anglesey North and Cemlyn Lagoon) and the EU-designated bathing water (Cemaes Bay). The WFD water body supports designated features of nature conservation importance. The bathing water is designated at European level, has high economic value and is nationally important. These receptors are of international importance and are assigned a high value.

Sediment quality

13.3.26 Bed sediments represent the ultimate sink for contaminants in marine environments and therefore they give a good indication of both spatial and temporal patterns of contamination. Sediment features and contamination may influence spatial and temporal patterns of benthic communities.

13.3.27 In 2010 and 2011, samples were collected as part of the subtidal benthic survey using a Hamon and mini-Hamon grab from 22 and 21 sites, respectively with the addition of a further three sites in 2011 (figure D13-4, Application Reference Number: 6.4.101). A total of 21 samples were collected within the central study area (5km from the Wylfa Newydd Development Area) with a further five samples collected from a wider study area which encompassed the north coast of Anglesey from Church Bay in the west to Red Wharf Bay in the east.

13.3.28 In 2011 and 2014 divers collected sediment samples in Porth-y-pistyll for faunal and particle size analysis. Sediment samples were also collected annually in summer between 2011 and 2014 from two sites in Porth-y-pistyll adjacent to sites WI04 and WI12, during the intertidal benthic survey.

13.3.29 Sediments were analysed for compounds known to be hazardous to aquatic life. The suite of substances included organics, PAHs, List I and II metals as designated under the Priority Hazardous Substances under Annex X of the WFD and Specific Pollutants under Annex VIII of the WFD.

13.3.30 Sublittoral substrates in the study area were found to be a mix of exposed rocks and sandy sediments while further offshore, mixed sediments were prevalent, which concurred with previous studies [RD8]. Further information on sediment characteristics within the study area is provided in appendix D13-2 (Application Reference Number: 6.4.84).

Metals and tributyltin

13.3.31 At present, there are no statutory EQSs for marine and estuarine sediments in the UK. However, Cefas have provided chemical Action Levels (sometimes known as sediment action levels) for the disposal of dredged material which can be used to assess sediment quality. Action Levels are not statutory contaminant concentrations for dredged material but are used as part of a weight of evidence approach to decision-making on the disposal of dredged material at sea. In general, contaminant levels in dredged material below Action Level 1 are of no concern and are unlikely to influence the licensing decision. However, dredged material with contaminant levels above Action Level 2 are generally considered unsuitable for sea disposal.

13.3.32 Comparison with Centre for Environment Fisheries and Aquaculture science (Cefas) Action Levels found no exceedance of Action Level 2 in any sample. A number of samples showed elevated metal concentrations above Action Level 1 including:

- nickel;
- chromium;
- arsenic;
- zinc; and
- lead.

13.3.33 The number of exceedances were low (see appendix D13-2, Application Reference Number: 6.4.84). These exceedances were predominantly at sites WS20 and WS24 (in Cemaes Bay) and at WS02 (just north of Wylfa Head) (figure D13-4, Application Reference Number: 6.4.101).

13.3.34 Threshold effect levels (TEL) and probable effect levels are defined by the Canadian sediment quality guidelines [RD9]. These are referred to in the absence of equivalent UK guidelines. The TEL of a substance is the concentration below which sediment associated chemicals are not considered to represent significant hazards to aquatic organisms. The probable effect level represents the lowest concentration of a substance that is known to have an adverse effect on aquatic organisms. Comparison with these thresholds found sediment-bound concentrations below the relevant TEL for:

- copper;
- zinc;
- cadmium;
- mercury;
- lead; and
- chromium.

13.3.35 Concentrations of arsenic exceeded the TEL at three sites (WS02, WS06 and WS16; figure D13-4, Application Reference Number: 6.4.101). The nickel TEL was also slightly exceeded at two sites (WS02 and WS20; figure D13-4, Application Reference Number: 6.4.101).

13.3.36 Concentrations of tributyltin in samples were below Cefas Action Level 1, with one exception in 2011 from Cemaes Bay (0.4mg/kg at site WS23; figure D13-4, Application Reference Number: 6.4.101), which was slightly above Action Level 1 but below the threshold for Action Level 2.

Organic contaminants

13.3.37 Several PAHs are highly toxic to aquatic organisms and a number are known to be carcinogenic and mutagenic. The relevant thresholds for comparison are the TELs and probable effect levels as defined by the Canadian sediment quality guidelines [RD9]. All PAH concentrations were below the probable effect level and the majority were lower than the TEL. Generally, PAH concentrations were higher in sediments at inshore sites, particularly in Cemaes Bay (site WS20; figure D13-4, Application Reference Number: 6.4.101) where, in 2011, one sample contained eight PAHs at concentrations above their respective TELs.

13.3.38 PCBs are organic compounds, which are highly toxic and persistent in the environment and are readily bioaccumulated in animals. Sediments were analysed for the International Council for the Exploration of the Sea (ICES) seven indicator PCB congeners (28, 52, 101, 118, 138, 153 and 180) which are known to be persistent in the environment. All total PCB concentrations were below Action Level 1 and the majority of individual sediment-bound PCB concentrations were less than the MRV.

Value of receptor

13.3.39 Sediment quality is not a receptor in itself; however, it supports a number of marine receptors including subtidal communities, invertebrates, general fish and fisheries, fish of conservation and commercial importance and seabirds. It is not therefore assigned a value but is considered within the receptor subtidal benthic communities, as it supports the communities present.

Phytoplankton and zooplankton

13.3.40 Phytoplankton and zooplankton sampling commenced in May 2010 and continued until June 2014 for zooplankton and September 2014 for phytoplankton. Samples were collected within the central study area (5km from the Wylfa Newydd Development Area). Five sites were monitored on a monthly basis from May 2010 to April 2012. An additional site, located in Porth-y-pistyll, was added to the programme in August 2011 and was monitored monthly until October 2012. Sampling resumed in March 2014 at a revised selection of the original sites including the site located in Porth-y-pistyll and an additional one in Cemlyn Bay. Sampling locations were the same as for the water quality surveys (see figure D13-2, Application Reference Number: 6.4.101).

Phytoplankton

13.3.41 Phytoplankton abundance and community composition in the study area exhibited seasonal patterns, driven by changes in the light and nutrient regime in the water column. There were no statistically significant differences in phytoplankton abundance or composition between the sites monitored. The start of the phytoplankton production period was characterised by a spring peak in abundance in May/June. Maximum phytoplankton abundances during the sampling period were typically around 81,000cells/L with a maximum of approximately 300,000cells/L on one occasion (April 2012), which do not indicate bloom concentrations under WFD guidelines [RD6] (bloom threshold $>10^6$cells/L).

13.3.42 Low phytoplankton abundance was also mirrored in the low chlorophyll-a concentrations observed between 2010 and 2014, and average values during the spring peak in abundance did not exceed 6.4mg/m^3 (maximum 8.2mg/m^3). Chlorophyll-a values were also below the indicator value set for chlorophyll-a bloom conditions under the WFD guidelines (bloom threshold >10µg/L or mg/m^3).

13.3.43 Diatoms were the most abundant phytoplankton group between 2010 and 2014, and they generally dominated the peak abundance in spring during all years that were sampled, in agreement with other observations from the Irish Sea. However, other groups such as microflagellates can represent an important component of the spring bloom.

13.3.44 During the monitoring period, 11 nuisance/harmful and 12 toxic algal species were reported at the sampling locations. The following algae which are listed among the nuisance or toxic species recorded were present at densities of approximately 1,000-6,000cells/L:

- *Phaeocystis globose*;
- *Chaetoceros danicus*;
- *Heterocapsa* sp.;
- *Karenia mikimotoi*;
- *Pseudo-nitzschia delicatissima*;
- *Pseudo-nitzschia seriata*; and
- *Protoperidinium* spp.

13.3.45 The remaining nuisance or toxic species were recorded at densities of <1,000cells/L. All cell densities were considered to be very low compared to the number at which an individual taxon is considered to reach bloom densities (>250,000cells/L).

13.3.46 Two non-native diatom species were recorded during the monitoring period: *Coscinodiscus wailesii* and *Odontella sinensis*. Only one cell (40cells/L) of *C.wailesii* was recorded from the samples between 2010 and 2014, in December 2010. *O.sinensis* was recorded on 10 occasions in total, in 2011, 2012 and 2014; this species was found at several of the monitoring sites, including Porth-y-pistyll, but at very low abundances of 40cells/L to 160cells/L. Both of these diatoms are well established in British and European waters.

Zooplankton

13.3.47 Zooplankton abundance was umerically dominated by Arthropoda, specifically Copepoda, and exhibited a lag response to the seasonal peaks in phytoplankton abundance. In all years, the highest zooplankton abundances were recorded in spring, whilst lowest numbers were recorded during winter. There were no statistically significant differences in zooplankton abundance or composition between the sites monitored.

13.3.48 Monthly total zooplankton abundance averaged 742 individuals/m^3 with the highest average abundance recorded in April 2012 (4,509 individuals/m^3). Other than Arthropoda, the phyla Annelida, Chordata, Mollusca and Bryozoa were also key contributors to the community assemblage.

13.3.49 The most abundant copepod was the calanoid copepod *Temora longicornis*; other calanoid copepods, such as *Centropages hamatus*, *Paracalanus parvus*, *Pseudocalanus elongatus* and *Acartia* spp., were also prevalent at certain seasons. The zooplankton community recorded was similar to other observations from the Irish Sea (e.g. [RD10] and [RD11]).

13.3.50 No protected species of zooplankton have been identified from the waters off north Anglesey; however, a number of benthic species of conservation importance, which have planktonic larval life stages have been identified from other baseline surveys of the monitoring programme and their presence within the zooplankton community, is expected. These species are:

- *Mytilus edulis* (blue mussel); blue mussel beds on sediment are a Section 7 of The Environment (Wales) Act 2016 priority habitat;
- *Modiolus modiolus* (horse mussel, previously named *Mytilus modiolus*); horse mussel beds are an Annex I of the Habitats Directive habitat;
- *Sabellaria spinulosa* and *S.alveolata*; Sabellaria reefs are an Annex I of the Habitats Directive habitat; and
- *Palinurus elephas* (spiny lobster); spiny lobster is a Section 7 of The Environment (Wales) Act 2016 priority species.

13.3.51 *Mytilus* spp. was recorded within the zooplankton and could therefore represent both the blue mussel and the horse mussel. *Sabellaria* sp. was also recorded within the zooplankton and could represent *S.spinulosa* and/or *S.alveolata*. The spiny lobster could have been recorded under the order Decapoda.

13.3.52 The invasive non-native barnacle *Austrominius modestus* was recorded from benthic surveys at the Power Station outfall and was most likely recorded in the zooplankton within the group of barnacle larvae (thoracica nauplii). *Caprella* sp. larvae were also identified from zooplankton samples; this could be a representative of the invasive Japanese skeleton shrimp, *Caprella mutica*, which is a non-native marine species of concern in north Wales.

Value of receptors

13.3.53 Phytoplankton and zooplankton are not considered to be of specific conservation value themselves, even though larval stages of species of conservation importance found around the coast of north Anglesey are expected to be found within the zooplankton community. However, they play a key role in the ecological function of marine ecosystems through the support of features of conservation value, as they provide a vital food resource for invertebrate and fish species. Plankton is of local importance and is relatively common in the coastal waters of north Anglesey, and therefore, the value assigned to this receptor is low.

Marine benthic habitats and species

13.3.54 Baseline data on marine benthic habitats and species were collected since between 2010 and 2016. Various techniques have been used to collect information on benthic habitats and species and these are outlined below.

13.3.55 The Joint Nature Conservation Committee (JNCC) habitat classification system [RD12] has been used to describe the distribution and location of habitats and species in the marine environment. The term 'biotope' is used to holistically describe a habitat in terms of the physical nature of the seabed and the plant and animal communities that are associated with the seabed. The biotope classification system uses a hierarchy of codes, beginning with the seabed type (e.g. 'LR' for littoral rock) and then defining the key characterising species (e.g. 'Lhyp' for *Laminaria hyperborea* (kelp)). The intertidal and subtidal biotopes in Porth-y-pistyll are shown in figure D13-5 (Application Reference Number: 6.4.101) and figure D13-6 (Application Reference Number: 6.4.101). The biotopes are referred to using codes and a full description of each biotope is provided in appendix D13-3 (Application Reference Number: 6.4.85).

Intertidal habitats and species

13.3.56 To characterise the intertidal benthic habitats and species, an initial quadrat survey and walkover was completed in 2010 followed by annual surveys from 2011 to 2014 covering upper, mid and lower shore heights at 13 different sites (figure D13-4, Application Reference Number: 6.4.101). Of these, 11 were located within the central study area whilst a further two were sampled from a wider study area which encompassed the north-east coast of Anglesey as far as Dulas Bay. The results showed a complex array of communities on exposed rocky substrates between Cemaes Bay and Cemlyn Lagoon which are clearly influenced by natural factors such as substrate, exposure and tidal height.

13.3.57 Upper-shore communities at all sites were consistently assigned the biotope *Pelvetia canaliculata* and barnacles on moderately exposed littoral fringe rock (LR.MLR.BF.PelB).

13.3.58 Mid-shore communities were characterised by brown seaweeds and two biotopes were identified: *Fucus serratus* on moderately exposed lower eulittoral rock (LR.MLR.BF.Fser) and *Fucus spiralis* on full salinity exposed to moderately exposed upper eulittoral rock (LR.MLR.BF.FspiB).

13.3.59 Two biotopes were consistently recorded on the lower shore: *Corallina officinalis* on exposed to moderately exposed lower eulittoral rock (LR.HLR.FR.Coff) and *Fucus serratus* on moderately exposed lower eulittoral rock (LR.MLR.BF.Fser).

13.3.60 The majority of the intertidal area surveyed was fissured bedrock which can often form a continuation with the sublittoral rocky habitats. Where the reef extends from the sublittoral uninterrupted into the intertidal zone, it is considered to be an example of 'reef' habitat listed at Annex I of the Habitats Directive, although it is not a qualifying feature of any nearby designated site.

This feature is present over considerable areas of the UK coastline, including extensive parts of the north Anglesey coast.

13.3.61 The Annex I habitat 'perennial vegetation of stony banks' is present within the Cemlyn Bay SAC.

Intertidal biotope mapping

13.3.62 An intertidal biotope validation mapping survey was carried out in and around Porth-y-pistyll. This survey identified 37 discrete biotope communities between Cerrig Brith in the east and Porth Gwartheg in the west (figure D13-5, Application Reference Number: 6.4.101). The intertidal areas of the bay were composed of a mosaic of habitats, ranging from muds and sands to exposed bedrock. The following habitats were recorded which are listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016:

- *Fucus serratus* and under-boulder fauna on exposed to moderately exposed lower eulittoral boulders (LR.MLR.BF.Fser.Bo);
- *Fucus ceranoides* on reduced salinity eulittoral rock (LR.LLR.FVS.Fcer);
- coastal saltmarsh (LS.LMp.Sm); and
- blue mussel (*Mytilus edulis*) beds on littoral mixed substrata (LS.LBR.LMus.Myt.Mx).

13.3.63 The blue mussel bed and *F.ceranoides* and coastal saltmarsh communities comprised small areas of the habitats mapped, therefore are not considered to be particularly important examples of the habitats, although it is recognised that their presence adds to the diversity of habitats and species within Porth-y-pistyll.

13.3.64 Many rock pools were recorded from the low to high shore at Porth-y-pistyll and Cerrig Brith, the majority of which were described as 'seaweed and sediment floored' pools. This habitat is noted as a feature of 'special interest' within the nearby Cemlyn Bay SSSI and, being relatively uncommon, rock pools are thought to add ecological value to the bay.

Subtidal habitats and species

13.3.65 The selection of sites for the benthic invertebrate sampling survey was informed by data from geophysical investigations (appendix D12-1 Coastal Geomorphology Baseline for the Wylfa Newydd Development, Application Reference Number: 6.4.80)). In 2010 quantitative benthic invertebrate sampling was carried out at 22 sites; this was repeated in 2011 with four further sites sampled (figure D13-4, Application Reference Number: 6.4.101). Additional benthic invertebrate sampling was undertaken during 2015 to determine the ongoing validity of earlier data. Of the total number of different sites sampled, 20 were located within the central study, with six additional sites sampled from a wider study area which encompassed the north coast of Anglesey from Church Bay in the west to Red Wharf Bay in the east.

13.3.66 Drop-down camera images were acquired from 68 and 54 sites sampled in June 2010 and 2011, respectively (figure D13-7, Application Reference Number: 6.4.101). Survey effort was concentrated within the central study area; the wider study area encompassed the north coast of Anglesey with further concentration of sampling in Church Bay and The Skerries in the west and Point Lynas in the east. Outfall diving surveys were carried out to consider the influence of the Cooling Water discharge from the Existing Power Station on the intertidal and subtidal benthic ecology around Wylfa Head (figure D13-7, Application Reference Number: 6.4.101).

13.3.67 The subtidal habitats and communities along the north Anglesey coast were found to be highly heterogeneous, driven by the complex seabed topography and tidal streams in the area (appendix D12-1, Application Reference Number: 6.4.80). The lack of demersal fishing activity, on account of the topography, means the North Anglesey Marine communities have received only low levels of physical anthropogenic disturbance.

13.3.68 Granulometric data from sedimentary habitats and field observations from the 2010 and 2011 subtidal surveys indicated that substrates varied considerably over the study area from muds to coarse gravel and cobbles. The pattern of sediments was clearly related to the scouring effects of the prevailing high-energy currents with a high degree of exposed bedrock surrounding the headland sites. Muddy sands were evident within Cemaes Bay, Cemlyn Bay and to the north of Porth-y-pistyll, which is consistent with their more sheltered locality.

13.3.69 The tide-swept headlands of Wylfa Head, Llanbadrig Head and beyond support diverse sponge and cnidarian (hydroids, soft corals, anemones, etc.) communities, particularly in the circalittoral (area of subtidal habitat below the algal zone, dominated by animal fauna).

13.3.70 Several habitats recognised as part of broader habitats (‘subtidal mixed sediments’, ‘fragile sponge and anthozoan communities on rocky habitats’ and ‘*Musculus discors* beds’) listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016, were identified during the subtidal benthic grab surveys including:

- *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment (shallow sites in Cemaes Bay and between Wylfa head and Cemlyn Bay);
- mixed turf of bryozoans and erect sponges with *Dysidea fragilis* and *Actinothoe sphyrodeta* on tide-swept wave-exposed circalittoral rock (approximately 3km east of Wylfa head, inshore at Llanlleiana Head); and
- Musculus discors beds on moderately exposed circalittoral rock (Cemaes Bay) (see appendix D13-2, Application Reference Number: 6.4.84).

Sabellaridae

13.3.71 Biogenic reefs are those, which are created by reef-building animals, such as tube-building worms, which can form aggregations. A reef is a structure that is solid (although it may be fragile), is at least several centimetres thick, raised above the seabed and remains in place for many years [RD13]. Biogenic reefs of *S.spinulosa* are recognised as part of the reefs habitat listed at Annex I of the Habitats Directive.

13.3.72 The results of the subtidal grab surveys were used in conjunction with the drop-down camera images to help assign appropriate *S.spinulosa* biotopes. Based on the criteria for determining presence of a biogenic reef, three offshore sites were identified with structures that represented elevations greater than 2cm (WS08, WS13 and WS18; figure D13-4, Application Reference Number: 6.4.101), but are not reefs [RD14]. Only one site contained several small (2cm to 5cm), elevated fragments from a single replicate in 2011. Despite many fragments recorded from a single replicate at WS18 in 2010 (figure D13-4, Application Reference Number: 6.4.101), the replicates in 2011 recorded small amounts of crusts with a single, small (2cm to 5cm) elevated fragment.

13.3.73 Site WS13 in Church Bay was the only site identified as a potential biogenic reef site, in respect of all parameters considered (see appendix D13-2, Application Reference Number: 6.4.84). WS08 and WS18 (figure D13-4, Application Reference Number: 6.4.101) had recorded elevated tube structures in the grab samples but are not considered representative of a reef when also considering the low patchiness of tubes observed (less than 10%).

13.3.74 During subtidal fish surveys, large areas of seabed were trawled using a beam trawl. Some crusts of *S.spinulosa* were occasionally observed, most notably at SF05 on the west of Anglesey, which is close to WS13. During the outfall surveys at the Existing Power Station, divers recorded the occasional presence of *S.spinulosa* but only as crusts and not in densities which would meet the criteria for a biogenic reef.

13.3.75 *S.spinulosa* reef was not recorded during the subtidal biotope mapping survey in Porth-y-pistyll in 2014. Further diver surveys were carried out in June 2016 to determine the presence of *S.spinulosa* within Porth-y-pistyll and the adjacent coastline (see appendix D13-2, Application Reference Number: 6.4.84). These surveys were designed to cover as much ground as possible and provide greater confidence in the likelihood of presence/absence of *S.spinulosa* reef structures in the area. *S.spinulosa* crusts were found but reef habitat was not recorded anywhere within or near the Wylfa Newydd Development Area (see appendix D13-2, Application Reference Number: 6.4.84).

Subtidal biotope mapping

13.3.76 A biotope mapping exercise of the subtidal habitats in Porth-y-pistyll was carried out by divers in June 2014 using a combination of rapid assessment transects and the Marine Nature Conservation Review phase II methodology [RD15].

13.3.77 The survey identified 19 biotopes (figure D13-6, Application Reference Number: 6.4.101). The gradation of biotopes from the infralittoral fringe to the sublittoral sediments is described as *Laminaria digitata* (kelp) communities leading down to dense forests of *L.hyperborea* (kelp) and on to sparser, but even more extensive, *L.hyperborea* parks (lower density of kelp). Within the middle of the bay were large patches of 'dense foliose red seaweeds on silty, moderately exposed infralittoral rock' (IR.MIR.KR.XFoR) and to a lesser extent 'infralittoral muddy sand' (SS.SSa.IMuSa).

13.3.78 Many of the subtidal biotopes recorded in and around the bay are recognised as part of broader habitats ('subtidal sands and gravels' and 'subtidal mixed muddy sediments') listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016, including:

- infralittoral coarse sediment (SS.SCS.ICS);
- infralittoral muddy sand (SS.SSa.IMuSa);
- *Arenicola marina* in infralittoral fine sand or muddy sand (SS.SSa.IMuSa.AreISa);
- circalittoral muddy sand (SS.SSa.CMuSa); and
- *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment (SS.SSa.CMuSa.AalbNuc).

13.3.79 Also present was the biotope complex 'Bryozoan turf and erect sponges on tide-swept circalittoral rock' (CR.HCR.XFa.ByErSp), which is recognised as part of the broader habitat 'fragile sponge and anthozoan communities on rocky habitats', which itself is listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016.

Non-native species

13.3.80 The North Wales Wildlife Trust (NWWT) has identified 17 non-native species of concern in north Wales (table D13-2). These invasive species have either already been recorded in Wales or are expected to arrive soon. In 2014, the Wales Marine Non-native Species Inshore Monitoring Network [RD16] recorded four of these species in Holyhead Harbour; carpet sea squirt (*Didenmum vexillum*), Japanese skeleton shrimp (*C.mutica*), orange-tipped sea squirt (*Corella eumyota*) and orange cloak sea squirt (*Botrylloides violaceus*).

13.3.81 Surveys undertaken in 2014 as part of the Welsh Government Resilient Ecosystems Fund [RD17] recorded three additional Invasive Non-Native Species (INNS) in Holyhead Harbour that have not been previously recorded; the leathery sea squirt (*Styela clava*), a colonial sea squirt (*Aplidium* cf *glabrum*) and Japanese kelp (*Undaria pinnatifida*).

Table D13-2 Non-native marine species of concern in north Wales [RD18]

Scientific name	Common name	Status	Distribution in Wales
Didemnum vexillum	Carpet sea squirt	Great Britain rapid response alert species	Established in Holyhead marina in north Wales.
Undaria pinnatifida	Japanese kelp / Wakame	High alert species	Recorded from Holyhead Harbour and Pembroke Dock [RD17].
Rapana venosa	Rapa whelk	High alert species	Not yet recorded in Wales; however, it is likely to arrive and will quickly spread.
Watersipora subtorquata	Red ripple bryozoan	High alert species	Not yet recorded in Wales; however, it is likely to arrive and will quickly spread.
Crepidula fornicata	American slipper limpet	Strategic priority species	Established in parts of south Wales.
Megallana gigas	Pacific oyster	Strategic priority species	No known self-recruiting populations though frequently farmed in aquaculture.
Sargassum muticum	Wireweed	Strategic priority species	Established in parts of Wales, particularly along the Lleyn Peninsula and Anglesey.
Eriocheir sinensis	Chinese mitten crab	Strategic priority species	Established in the River Dee.
Grateloupia turuturu	Devil’s tongue weed	Strategic priority species	Established in Milford Haven.
Ostrea chilensis	New Zealand flat oysters	Strategic priority species	Established in the Menai Strait.
Corella eumyota	Orange-tipped sea squirt	Low alert species	Known to be present in north Wales.
Hemigrapsus sanguineus	Asian shore crab	None given	Several sightings in the UK, with one sighting in south Wales.

Scientific name	Common name	Status	Distribution in Wales
Codium fragile	Gree sea- fingers	None given	Reported in waters off the Scilly Isles, the Channel Islands, areas of South Wales and the south coast of England and also as far as the west coast of Scotland (Argyll).
Caprella mutica	Japanese skeleton shrimp	None given	Limited reports of this species in Wales (includes Holyhead Harbour in 2014). Found in UK waters on the south coast of England, the west coast of Scotland and the Western Isles.
Styela clava	Leathery sea squirt	None given	Predominantly the south coast of England. Occurs on the west coast of Wales and Scotland. Recordings in Anglesey and the Lleyn, as well as other parts of north Wales.
Botrylloides violaceus	Orange cloak sea squirt	None given	Found in few areas of the UK, including Milford Haven and the south-west coast of England.
Asparagopsis armata	Harpoon weed	None given	Recorded on the Lleyn Peninsula and in areas of South Wales; however, it is more common in south-west England and has spread as far as the Shetland Isles.

13.3.82 The carpet sea squirt (*D.vexillum*) represents a significant risk to biodiversity and socioeconomic assets owing to the speed at which it can colonise artificial structures (e.g. marinas and aquaculture). Once established it can form large colonies, growing over existing sessile hard structure communities, resulting in significant alterations to the native species composition. It is thought to be native to the north-west Pacific and is likely to have spread from Japan to the UK via France through fouling of vessels, particularly leisure craft, movement of aquaculture stocks and ballast water. Natural dispersal is limited but outgrowths on floating structures can drop off and reattach.

13.3.83 The carpet sea squirt was first recorded in Holyhead Harbour in 2008 and, despite multiple eradication programmes; small colonies were still found to be present in September 2013. To date, the carpet sea squirt has not been recorded in any of the marine ecology surveys carried out for the Wylfa Newydd Project.

13.3.84 The leathery sea squirt (*S.clava*) is classified as having a high impact level [RD19]. It attaches to solid surfaces in shallow water, especially in harbours and marinas but also on wrecks and natural rock substrate. This species can reach high densities, dominating shallow sheltered habitats resulting in a decline in the abundance of other native shallow-water suspension feeding sessile invertebrates [RD20].

13.3.85 The Japanese kelp (*U.pinnatifida*) is listed by the NWWT as a high alert species, having been recorded in Holyhead Harbour. Originally from Japan, China and Korea [RD21], this species has spread around the world by international shipping and mariculture. It can tolerate a wide salinity and temperature range; its morphological and reproductive characteristics allow it to outcompete native kelp species in the shallow sublittoral/infralittoral zone [RD22].

13.3.86 The Japanese skeleton shrimp (*C.mutica*) is considered a moderate impact species under the WFD [RD19]. It was reported in Holyhead Harbour in 2014 [RD16]. It is an aggressive species and even at low densities can outcompete the native skeleton shrimps for food and space. They are found on a wide range of natural and artificial substrate including attached ropes, boats hulls and floating pontoons and can spread on drifting seaweed or artificial materials.

13.3.87 Recording of non-native benthic species has been carried out as part of the analysis of results from marine ecology surveys covering the north Anglesey coastline between Holyhead Bay and Red Wharf Bay since 2010 (see appendix D13-2 (Application Reference Number: 6.4.84), D13-3 (Application Reference Number: 6.4.85) and D13-5 (Application Reference Number: 6.4.87)). Non-native benthic species recorded during the survey programme are already known to occur around the coast of north Anglesey and are not unique to any particular area. These include red algae (*Asparagopsis armata*, *Anotrichium furcellatum* and *Dasysiphonia japonica*); green alga (*Codium fragile* sub sp. *tomentosoides*), brown alga (*Sargassum muticum*) and a barnacle species (*Austrominius modestus*) (see appendix D13-3, Application Reference Number: 6.4.85).

13.3.88 *D.japonica* was found during the diving surveys at three sites in 2011, at one site in 2012 and 2014, and at two sites in 2015. *A.armata* was recorded in fairly high densities in all years. The non-native red alga *A.furcellatum* was recorded for the first time in 2014 to the north-west of Cerrig Brith. *C.fragile* was recorded in the subtidal outfall surveys in 2011, 2012 and 2015 in abundances ranging from 'rare' to 'frequent'.

13.3.89 Non-native species are not considered receptors in themselves; however, the potential effects associated with non-native species has been discussed, and the potential effects on other receptors considered, as part of the assessment.

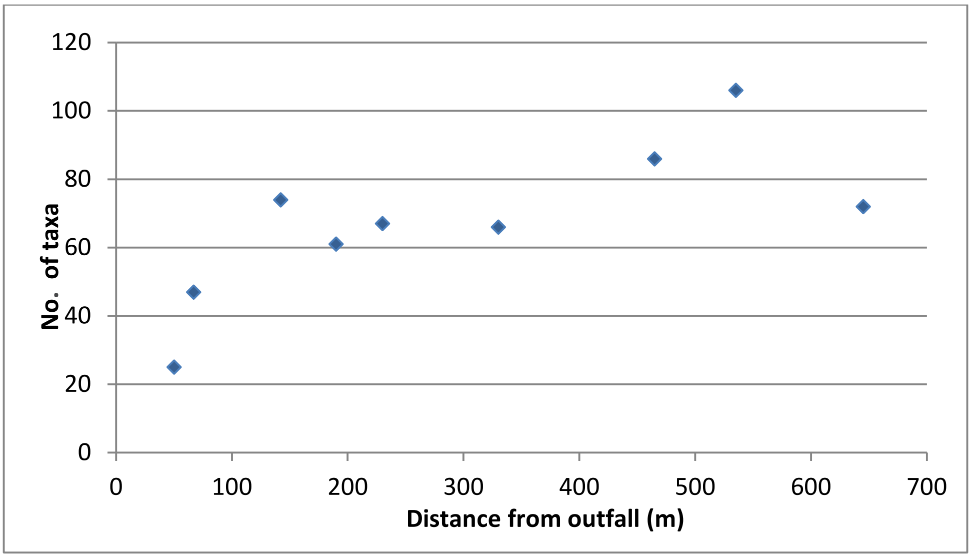
Outfall surveys

13.3.90 An intertidal outfall survey was carried out in 1987 to assess the changes in populations of dogwhelks (*Nucella lapillus*), barnacles and limpets (*Patella vulgata*), with increasing distance from the Existing Power Station outfall [RD23]. This survey was repeated using the same methodology in 2010 and 2015 (appendix D13-5, Application Reference Number: 6.4.87). The effect on intertidal habitats and species at the outfall was detectable up to a distance of 250m from the outfall, after which there were no measurable differences with comparable surrounding communities.

13.3.91 Dive surveys were carried out in 2011 and 2012 to gather baseline data on the influence of the Cooling Water discharge from the Existing Power Station on subtidal habitats and species (figure D13-7, Application Reference Number: 6.4.101). These surveys were repeated in 2015 to consider the effects on the benthic communities of a reduction in discharge from the Existing Power Station.

13.3.92 In all years, the subtidal surveys in the existing outfall channel, the existing outfall bay and beyond demonstrated a clear, acute effect on the infralittoral rocky reef communities within 100m (figure D13-8). Changes in the community were observed up to 300m of the existing outfall with noticeable changes in the dominant cover of algal species and numbers of sponge and tunicate taxa, despite species richness being similar in value to that obtained at reference sites.

Figure D13-8 Total number of taxa recorded (including all flora and fauna) during diver transect surveys in June 2011



Invertebrates (of conservation and commercial importance)

13.3.93 Two species listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016 were recorded in baseline surveys. During the outfall surveys in 2012, one European spiny lobster (*Palinurus elephas*) was recorded at Llanbadrig Head. In 2016 during a 'rapid assessment' diver survey, a single ocean quahog (*Arctica islandica*) (a species of edible clam) was recorded in Porth-y-pistyll (see appendix D13-2, Application Reference Number: 6.4.84). The invertebrate species that are fished commercially are considered in paragraphs 13.3.136 to 13.3.143.

Value of receptors

13.3.94 The Habitats Directive Annex I habitats 'coastal lagoons' and 'perennial vegetation of stony banks' were assigned high values, as they are a qualifying feature of the Cemlyn Bay SAC.

13.3.95 The intertidal and subtidal habitats that are listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016, which are rare or uncommon on a national scale, have been assigned a value of medium.

13.3.96 Much of the intertidal rocky shore is colonised by marine flora and fauna, and this is considered to be an example of reef habitat listed at Annex I of the Habitats Directive, although it is not a qualifying feature of any nearby designated site. Rock pool habitat is noted as a feature of special interest within the nearby Cemlyn Bay SSSI, and this habitat is considered to have ecological value in relation to the immediate surrounding area. Based on the important biodiversity characteristics of the intertidal rocky shore and rock pools, these receptors are assigned a medium value.

13.3.97 Other subtidal habitats identified throughout the surveys are common in the local area, have some biodiversity characteristics (e.g. naturalness, contribution to diversity) and are of local importance. *S.spinulosa* is commonly recorded as is the congeneric *S.alveolata* though at much lower abundances; however, there have been no biogenic reef structures recorded within the zone of influence. Habitats and species that are common and do not have any particular conservation importance are considered as part of the subtidal habitats and communities' receptor group, which is assigned a low value.

13.3.98 Given the likely presence of the spiny lobster and ocean quahog within the study area, these species have been included within the receptor category of 'invertebrates (of conservation and commercial importance)' and are assigned a value of medium. Table D13-4 sets out the receptors relevant to the marine environment and their assigned values.

Marine fish

13.3.99 Baseline data on fish communities were collected from within the central study area between 2010 and 2015. To capture the mobile nature of fish and to fully characterise fish communities, additional information from published literature has been gathered from a wider study area.

13.3.100 The wider study area primarily covered the eastern Irish Sea which is known to support important spawning and nursery grounds for both commercial and non-commercial species [RD24]. The abundance and distribution of these species along the north coast of Anglesey is considered to be related to source populations in the east.

13.3.101 For commercial species, landings data from coastal waters around the Isle of Anglesey have also been considered. The ICES considers this wider study area within the assessment rectangle 35E5 [RD25].

Ichthyoplankton

13.3.102 Ichthyoplankton communities were sampled from 2010 to 2014 to provide data on early life stages to include larval fish and eggs. During the first full year, surveys were carried out monthly with samples collected on both flood and ebb tides at five sites (figure D13-9, Application Reference Number: 6.4.101). Following analysis of these initial results, the sampling programme was rationalised to a single random tide and additional sites were added in Porth-y-pistyll.

13.3.103 Between 2010 and 2014, a total of 10,160 fish were recorded from filtering 35,685m^3 of seawater through Gulf sampling nets, representing 52 distinct taxa. Ichthyoplankton abundance followed a similar seasonal pattern at all sites with the highest abundances occurring from February to May and the lowest from October to January.

13.3.104 Samples were dominated by individuals from the family Ammodytidae (sandeel), which accounted for the highest proportion of total abundance (4,124 individuals, 41%), followed by Pleuronectidae (flatfish) (1,191 individuals, 12%), Clupeidae (herring family) (1,064 individuals, 11%) and Gobiidae (gobies) (633 individuals, 6%). The dominance of Ammodytidae and Pleuronectidae is unsurprising owing to the abundance of sandeel in the area and the location of a plaice spawning ground.

13.3.105 The ichthyoplankton communities at each site were found to be similar, although there were differences in overall abundance (averaged for all replicate samples per month and adjusted to numbers/10^6m^3) over sampling period, with a peak in abundance at site 1 in February 2012 (approximately $2.6x10^6$ individuals/10^6m^3; figure D13-9, Application Reference Number: 6.4.101). Peaks in ichthyoplankton abundance were also observed at sites 4 and 5 during March and April 2011 ($1.8x10^6$ individuals/10^6m^3 to $2.3x10^6$ individuals/10^6m^3) whilst lower abundances were observed at sites 2 and 3 (figure D13-9, Application Reference Number: 6.4.101).

13.3.106 The average egg abundance between May 2010 and September 2014 showed a similar pattern of abundance at all sites with a peak in spring months, followed by a decrease in abundance into summer and then very low numbers in autumn and winter. Peak egg abundances are thought to be largely driven by the spawning of sandeel, Dover sole (*Solea solea*) and dab (*Limanda limanda*).

13.3.107 Several species of conservation importance (which are listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016) have been recorded during the ichthyoplankton survey programme (see table D13-3). With the exception of Atlantic mackerel (*Scomber scombrus*) and cod (*Gadus morhua*) which were each observed on less than three occasions, these species occurred frequently over the survey programme.

13.3.108 The ichthyoplankton surveys confirmed the presence of low intensity spawning grounds for sandeel, whiting (Merlangius merlangus) and Dover sole around the north coast of Anglesey; high intensity spawning grounds for these species are present in the eastern Irish Sea [RD24]. According to Ellis et al., [RD24], the north coast of Anglesey (including the Wylfa Newydd Development Area) is a high intensity spawning ground for plaice (Pleuronectes platessa). Densities of larval plaice recorded during recent ichthyoplankton surveys did not suggest the presence of high intensity spawning; these data are considered to provide a more accurate indication of inshore spawning patterns within the vicinity of the Wylfa Newydd Development Area owing to the high spatial and temporal resolution of sampling.

Intertidal fish

13.3.109 Intertidal fish communities were sampled quarterly between 2010 and 2015 using a multi-method approach owing to the rocky nature of the near-shore environment. Seine netting was completed at 11 target sites (figure D13-9, Application Reference Number: 6.4.101). Baited fish traps were set at two sites and were left for up to 24 hours before retrieval. In 2010, dedicated diver surveys were carried out to examine fish communities associated specifically with exposed rocky habitats.

13.3.110 Between spring 2010 and autumn 2015, 45 taxa were identified in the seine nets and traps. Dominant species were:

- sandeel (*Ammodytes* spp.);
- clupeids;

- sand smelt (*Atherina presbyter*);
- plaice; and
- gobies (*Pomatoschistus* spp.).

13.3.111 The fish traps caught several that were not found in the seine nets:

- tompot blenny (*Parablennius gattorugine*);
- rock goby (*Gobius paganellus*);
- three-bearded rockling (*Gaidropsarus vulgaris*);
- lesser-spotted dogfish (*Scyliorhinus canicula*); and
- nursehound (*Scyliorhinus stellaris*).

13.3.112 An additional eight species were recorded during the diver surveys including:

- leopard spotted goby (*Thorogobius ephippiatus*);
- reticulated dragonet (*Callionymus reticulatus*);
- rock cook wrasse (*Centrolabrus exoletus*);
- butterfish (*Pholis gunnellus*);
- topknot (*Zeugopterus punctatus*);
- cuckoo wrasse (*Labrus mixtus*);
- black goby (*Gobius niger*); and
- conger eel (*Conger conger*).

13.3.113 The mean number of fish caught per net and the number of species caught per survey varied noticeably between seasons and from year to year (figure D13-10). From the 22 surveys between spring 2010 and autumn 2015, the highest catch per net was recorded in summer 2015: a result mainly owing to large numbers of fish caught at sites IF09, IF07, IF11 and IF12 (figure D13-9, Application Reference Number: 6.4.101), particularly clupeids, sandeel and sand smelt.

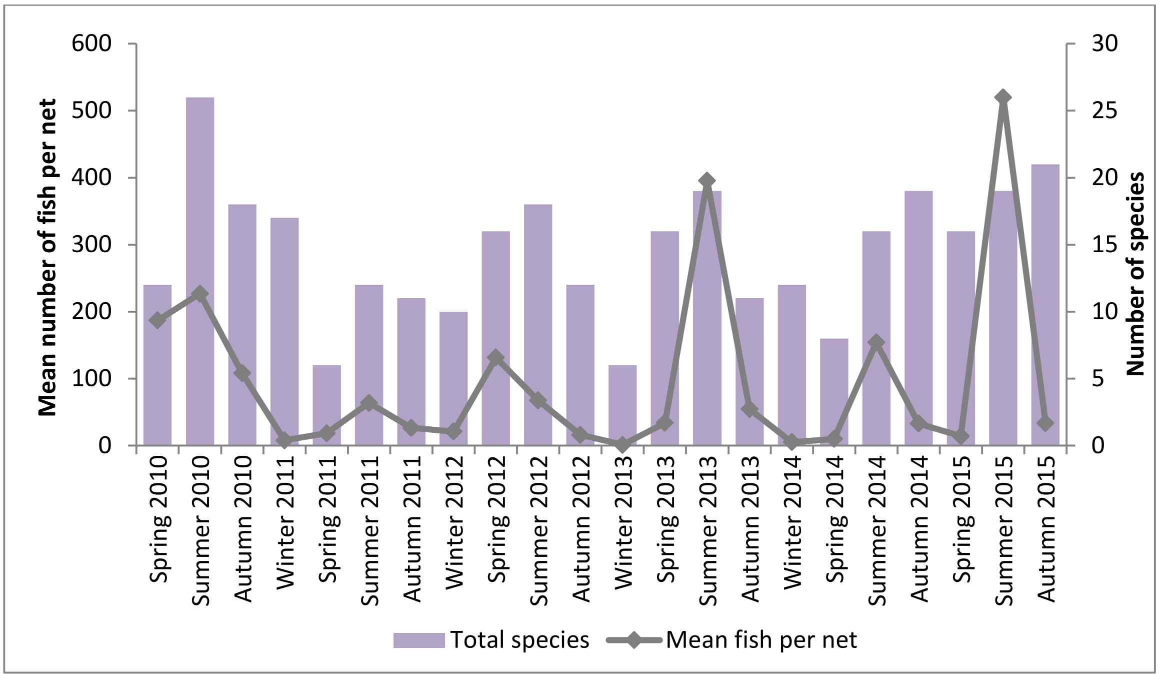
13.3.114 Overall, the highest abundances of fish in intertidal areas were found on the north-east coast of Anglesey; this is likely to be owing to the proximity of sampling sites to known spawning and nursery grounds in the eastern Irish Sea [RD24]. The lowest abundances of fish were observed on the north-west coast of Anglesey, with a clear gradient of overall fish abundance evident along the intervening coastline from east to west. Species-specific variations in abundance and distribution were however evident; these are believed to be linked to life history characteristics and habitat preferences. For example, a notable absence of flatfish and a lower abundance of sandeel were recorded in Porth-y-pistyll compared to other areas (e.g. Cemaes Bay) which is not unexpected as these taxa exhibit a preference for sandy substrates.

13.3.115 Several species of conservation importance (which are listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016 have been recorded during the intertidal fish survey programme (see table D13-3).

13.3.116 Sea trout (*Salmo trutta*) were identified in low numbers during surveys between 2010 and 2013 (none were recorded in 2014). Most individuals were recorded as smolts with a size range of 135mm to 205mm; however, a single parr was identified in the summer of 2010 measuring 45mm.

13.3.117 Of the other species of conservation importance, herring (*Clupea harengus*), plaice and Raitt's sandeel (*Ammodytes marinus*) constituted the highest abundances in the sampling programme.

Figure D13-10 Mean number of fish per seine net and total number of species recorded per season from spring 2010 to autumn 2015



Subtidal fish

13.3.118 Subtidal fish communities were sampled on a quarterly basis at five sites around north Anglesey between 2010 and 2014 (figure D13-9, Application Reference Number: 6.4.101). Otter trawls were used to characterise pelagic fish (those living in the water column or above the seabed) and demersal fish (those living just above the seabed), and beam trawls were used to characterise demersal fish and invertebrates within the subtidal zone.

13.3.119 Between spring 2010 and autumn 2014, a total of 75 taxa were identified. The most abundant species were dab and whiting, which represented approximately 47% and 33%, respectively, of all catches during the survey programme. Species such as the following also contributed heavily to the subtidal catches:

- poor cod (*Trisopterus minutus*);
- common dragonet (*Callionymus lyra*);
- plaice;
- lesser-spotted dogfish; and
- sprat (*Sprattus sprattus*).

13.3.120 Sandeel and herring abundances within the vicinity of the Wylfa Newydd Development Area were low; individuals were recorded most often and in the highest abundance at site SF05 in Church Bay.

13.3.121 Several species of conservation importance (which are listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016) have been recorded from subtidal fish surveys (Table D13-3). Many of these were recorded infrequently; however, throughout the programme, large numbers of whiting and, to a lesser degree, plaice and herring were present in the catch.

13.3.122 Of the elasmobranchs (sharks, skates and rays), thornback rays (*Raja clavata*) were the most commonly caught species listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016.

Impingement

13.3.123 Impingement and entrainment surveys were completed for 24-hour periods at the drum screens of the Cooling Water intake of the Existing Power Station at a rate of 40 surveys per annum. Surveys were scheduled on a random basis to avoid tidal bias. In total, 55 surveys were completed between 22 March 2011 and 31 July 2012.

13.3.124 Over the impingement-monitoring period, a total of 66 fish species were identified from screen surveys at the Existing Power Station. The most dominant species by abundance was sprat, and by biomass was lesser-spotted dogfish.

13.3.125 Fish classed as benthic species (living largely on or in the seabed) dominated the catches, representing 53% of all taxa, demersal species represented 39.4% and pelagic species represented 7.6%.

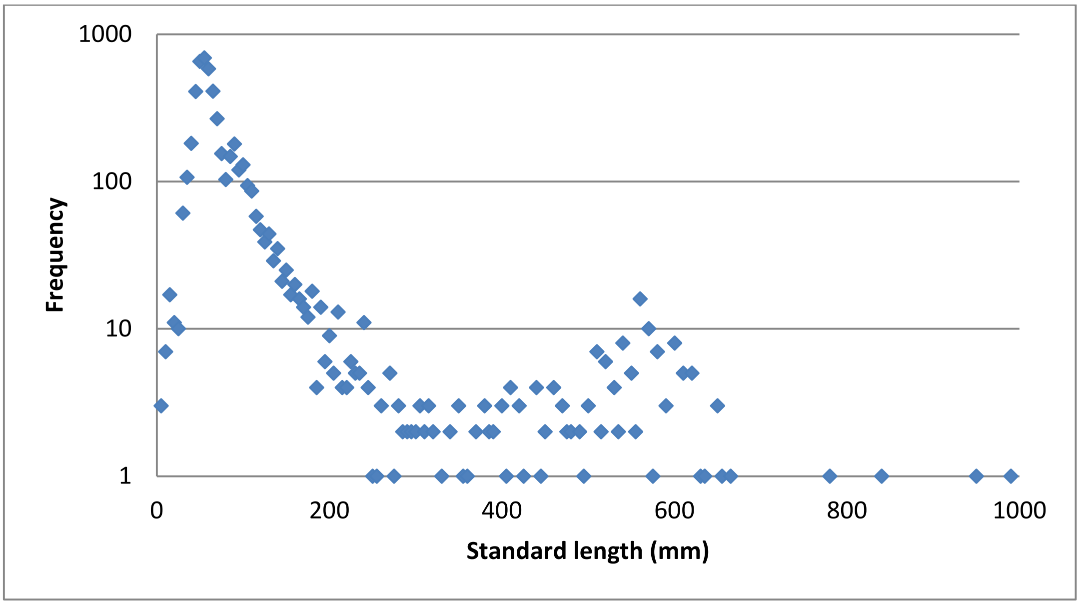
13.3.126 Several species of conservation importance (listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016) were identified within the impingement catches (table D13-3). Of the species with conservation designations, whiting and herring were the most frequently encountered. One river lamprey (*Lampetra fluviatilis*) was recorded during the survey, and this species is only considered as transient through the area for purposes of migration. Although European eel (*Anguilla anguilla*) was not recorded in these surveys, previous studies from the 1980s have observed this species at the intake of the Existing Power Station [RD26]. It is also known to be present in watercourses within the Wylfa Newydd Development Area (see chapter D9, terrestrial and freshwater ecology, Application Reference Number: 6.4.9 and appendix D9-16 Application Reference Number: 6.4.49).

13.3.127 The length-frequency distribution of fish impinged is shown in figure D13-11 and was dominated by fish smaller than 24cm. Larger individuals were also caught, but these were occasional and included species such as the conger eel, nursehounds (*Scyliorhinus stellaris*), lesser-spotted dogfish and rays. The high frequency of small fish was composed mainly of sprat, sand smelt and whiting.

13.3.128 Seasonal peaks in abundance and biomass were evident in the results, with peaks in abundance observed between late December and March when increased numbers of sprat, herring, dragonets (*Callionymus* sp.), long-spined sea scorpion and lesser-spotted dogfish were recorded.

13.3.129 The invertebrate fauna impinged represented 164 different taxa, with a large proportion being sessile in nature, suggesting that they had been dislodged from the seabed in the surrounding area or were growing within the Cooling Water intake itself; however, a combination of the two is most likely. Peaks in invertebrate impingement were observed to coincide with strong winds (autumn 2011 and winter 2012) and seasonal blooms of ctenophores and jellyfish (spring and early summer).

Figure D13-11 Length-frequency distribution of fish species impinged at the Existing Power Station between March 2011 and July 2012



13.3.130 On average, edible crab (*Cancer pagurus*) impinged was 206 individuals per 24 hours. Impingement of European lobster (*Homarus gammarus*) was uncommon with only seven individuals recorded over the whole monitoring period.

13.3.131 The dominant seaweed species varied with month and season and included kelps and wracks (*Laminaria* spp. and fucoids), red and green algae.

Entrainment

13.3.132 In total, 50 species were sampled, and the highest contributing families to larval abundance were dragonets (Callionymidae), gobies (Gobiidae) and blennies (Blenniidae). All species identified from the samples were as expected for the biogeographical region. Species with conservation designations were entrained in low numbers and included herring, whiting, plaice, Dover sole and lesser sandeel (*Ammodytes tobianus*).

13.3.133 Highest larval fish entrainment abundance was observed between early February and late August, with the lowest abundance occurring over autumn and winter. The abundance of eggs followed a similar trend with lowest abundance over the winter period and highest abundance in March/April.

Fish species of conservation importance

13.3.134 The species of conservation importance, which are listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016, that have been identified during all fish surveys are listed in table D13-3.

Table D13-3 Adult and larval fish species of conservation importance

Species	Ichthyoplankton	Intertidal	Subtidal	Impingement
Raitt's sandeel (*Ammodytes marinus*)	✓	✓	✓	
Lesser sandeel (*Ammodytes tobianus*)	✓	✓	✓	
Plaice (*Pleuronectes platessa*)	✓	✓	✓	✓
Herring (*Clupea harengus*)	✓	✓	✓	✓
Mackerel (*Scomber scombrus*)	✓		✓	
Cod (*Gadus morhua*)	✓	✓	✓	✓
Dover sole (*Solea solea*)	✓		✓	✓
Whiting (*Merlangius merlangus*)	✓	✓	✓	✓
Sea trout (*Salmo trutta*)		✓		
Nursehound (*Scyliorhinus stellaris*)		✓		
Spurdog (*Squalus acanthias*)			✓	
Tope (*Galeorhinus galeus*)			✓	
Scad/horse mackerel (*Trachurus trachurus*)			✓	✓ (single record)
Anglerfish (*Lophius piscatorius*)			✓	
Blonde ray (*Raja brachyura*)			✓	
Thornback ray (*Raja clavata*)			✓	✓
Ling (*Molva molva*)				✓ (single record)
River lamprey (*Lampetra fluviatilis*)				✓ (single record)
Spotted ray (*Raja montagui*)				✓ (single record)

13.3.135 Atlantic salmon (*Salmo salar*) has not been recorded in any marine baseline surveys between 2010 and 2015 (including entrapment surveys at the Existing Power Station from 2011 to 2012), nor has it been recorded in any freshwater baseline surveys (see appendix D9-16, Application Reference Number: 6.4.49). The North Wales Environmental Information Service (Cofnod) however, has a single individual recorded in Cemlyn Bay in July 2005. Although there are no known Atlantic salmon spawning streams in the central study area (within 5km of the Wylfa Newydd Development Area), it recognised that Atlantic salmon could potentially reside as juvenile life stages in optimal freshwater environments, with migration through the marine environment. Atlantic salmon is listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016.

Commercial fisheries

13.3.136 Within the ICES fisheries assessment area 35E5 [RD25], which encompasses Anglesey, the most important commercial species are whelk (*Buccinum undatum*), queen scallop (*Aequipecten opercularis*), king scallop (*Pecten maximus*) and European lobster. These species contributed 50%, 37%, 11% and 1%, respectively to the total tonnage landed from this sea area between 2010 and 2014 [RD25]. Dover sole, common prawn (*Palaemon* spp.) and edible crab each contributed less than 1% [RD25].

13.3.137 Commercial potting for shellfish is the primary fishery that operates along the north Anglesey coastline. Species targeted by inshore potting includes European lobster, edible crab and common prawns. To the west, potting for whelk occurs further offshore whilst an inshore fishery is present around the east coast of Anglesey [RD27]. Bottom set nets targeting demersal fish species are known to operate in isolated regions around Cemlyn Bay, Amlwch and to the north between The Skerries and Middle Mouse. Dredging for queen scallop occurs approximately 8km off the north coast of Anglesey whilst a king scallop fishery operates to the east in the vicinity of Red Wharf Bay and west of Holyhead [RD27]. No commercial trawling activities are known to operate off the north coast of Anglesey.

13.3.138 Within the Wylfa Newydd Development Area and wider study area the intensity of commercial potting is low (fewer than 730 pots lifted and dropped per 100ha/day) although medium and high intensity fisheries (730 to 1,825 and over 1,852 pots lifted and dropped per 100ha/day, respectively) operate to the east around Middle Mouse [RD28]. Hand gathering of periwinkles is also believed to occur within the study area [RD28]. The highest densities of queen and king scallop occur to the east of the study area in Liverpool Bay where reported densities exceed 19 individuals/100m^2 and six individuals/100m^2, respectively [RD29]. This area is dredged for queen scallop up to 10 times a year and up to three times a year for king scallops [RD28].

13.3.139 The main commercial fishing ports on Anglesey include Cemaes, Amlwch and Holyhead. Between 2010 and 2014, scallop (queen and king) constituted over 70% (13,291 tonnes) of all landings at these three ports whilst whelks, lobster and edible crab constituted 28% (5,406 tonnes), 0.46% (87 tonnes) and 0.17% (37 tonnes), respectively [RD25].

Value of receptors

13.3.140 A number of individual fish species have no specific conservation value themselves but need to be considered as a community owing to the importance they play in the wider environment. Fish communities are therefore considered as 'ichthyoplankton not of commercial or conservation value' and 'general fish and fisheries (intertidal and subtidal)', both of which are considered to be of low value.

13.3.141 There are two fish species of national/international importance which are known to be present in the central study area. River lamprey, which is listed on Annex II of the Habitats Directive, and European eel, which is protected by the Eels (England and Wales) Regulations 2009, are both considered high-value receptors. River lamprey and European eel must pass through the coastal environment during migration and therefore are considered as individual receptors.

13.3.142 As a precautionary approach, the assessment for the Wylfa Newydd Development Area has also given consideration to effects on Atlantic salmon. This species is listed on Annex II of the Habitats Directive and is considered to be of high value. Where relevant, this species has been considered as a separate receptor.

13.3.143 A number of fish species identified in surveys, listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016, are considered to be important on a regional level and have therefore been assigned a medium value. Table D13-4 sets out the receptors relevant to the marine environment and their assigned values.

Marine mammals

13.3.144 To account for the mobility of marine mammals and their feeding ranges, the study area for marine mammals incorporates the relevant Marine Mammal Management Units and takes account of populations from SACs that have been designated for one or more Annex II species within the Celtic and the Irish Sea. These data are complemented by site-specific survey work undertaken by specialist surveyors trained as marine mammal observers. Full details of the surveys undertaken are provided in appendix D13-6 (Application Reference Number: 6.4.88) and include the following.

- Dedicated vessel transect surveys covering 12 transects monthly carried out from May 2016. Data obtained from up to January 2017 are reported (figure D13-12, Application Reference Number: 6.4.101).
- Site-specific C-POD (autonomous underwater noise cetacean click detector) surveys using three C-PODs (figure D13-12, Application Reference Number: 6.4.101).
- Dedicated Vantage Point (VP) surveys carried out between Cemlyn Bay and Cemaes Bay from 2011 to 2013 (figure D13-12, Application Reference Number: 6.4.101).
- Site-specific land-based seal surveys.
- Incidental/casual sighting records maintained since April 2010.

13.3.145 The baseline information and assessment of potential effects on otters (*Lutra lutra*) are presented in chapter D9 (Application Reference Number: 6.4.9).

Cetaceans

13.3.146 All cetaceans are listed under Annex IV of the Habitats Directive as European Protected Species. A review of cetacean sightings in Welsh waters collated since 1990 [RD30] shows 18 species of cetacean in Welsh waters, with 14 having being sighted in north Wales within the last 10 years. Of these 14 species, most represent occasional sightings with only three species being frequently observed and identified in marine mammal observer data:

- harbour porpoise (*Phocoena phocoena*);
- bottlenose dolphin (*Tursiops truncatus*); and
- Risso's dolphin (*Grampus griseus*).

13.3.147 Baleen whales are more commonly found offshore and in the southern Celtic and Irish Sea (appendix D13-6, Application Reference Number: 6.4.88). Baseline surveys undertaken have reported two sightings of baleen whales (possibly minke) outside of the survey (appendix D13-6, Application Reference Number: 6.4.88).

13.3.148 Many cetacean species are known to have large home ranges, and evidence suggests that certain coastal populations might exploit food sources up to 200km from their residence [RD31] with a core area of 86km² in some instances for offshore species [RD32].

Harbour porpoise

13.3.149 The harbour porpoise is the most widely distributed cetacean found in the Irish Sea [RD30]. Harbour porpoise abundance within the Celtic and Irish Sea Management Unit has been estimated as 104,695 individuals (coefficient of variation (CV): 0.32; 95% Confidence Interval (CI): 56,774-193,065) using data sourced from Hammond *et al*., [RD33] and Macleod *et al*., [RD34]. Population estimate of the Irish Sea (SCANS II, survey block O) for harbour porpoise was 15,230 individuals (CV = 0.35) with a density equivalent of 0.34 individuals/km^2 [RD33].

13.3.150 Of key importance for harbour porpoise, is the fact that the Wylfa Newydd Development Area is located within the North Anglesey Marine cSAC. Harbour porpoise are present year round in waters around the north coast of Anglesey. Data sources from surveys local to the Wylfa Newydd Development Area, have all recorded harbour porpoise in the vicinity, specifically in and around both Cemlyn Bay (in the west) and Cemaes Bay (in the east) (appendix D13-6, Application Reference Number: 6.4.88). Surveys of 31 transect lines [RD35] at least once between May and September, between 2002 and 2004, reported a total of 213 sightings consisting of 347 individuals and estimated that the density was 1.261 individuals/km^2 using a g(0) estimate of 0.5 (assumes that 50% of animals on the trackline were missed). This produced an abundance of 618 individuals (CI 406-909) off north Anglesey, which represents 0.6% of the total Celtic and Irish Sea Management Unit population estimate [RD33].

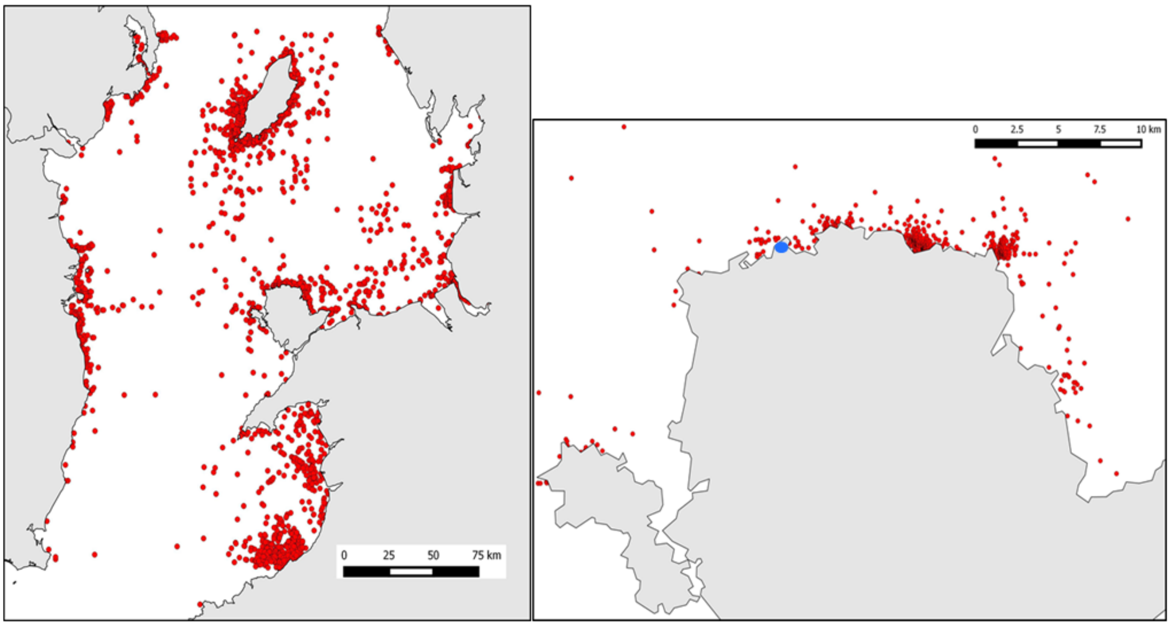
13.3.151 Across 12 transects, dedicated boat-based surveys have yielded 156 individuals from 110 sightings (appendix D13-6, Application Reference Number: 6.4.88) between May 2016 and January 2017. Density values have been calculated for September 2016 to January 2017 survey data, providing a density value using a g(0) = 0.5 of 0.680 individuals/km^2 without sea state correction and a corresponding abundance of 234 individuals (CI 145-380).

13.3.152 The C-POD monitoring indicates the importance of north Anglesey for harbour porpoise. The static C-POD surveys detected harbour porpoise presence every day (a survey period of 104 days) but also showed that levels of harbour porpoise activity varied between locations. The sites within Cemlyn Bay and Porth-y-pistyll had significantly fewer detections compared with Wylfa Head. The physical geography of the bays (Porth-y-pistyll and Cemlyn) is such that the harbour porpoise is likely to pass them en-route to other locations.

13.3.153 Land-based VP observations yielded 462 individuals of harbour porpoise, from 284 sightings, over 1,746 hours' survey effort across four years. During the five years of baseline surveys, a total of 250 individuals of harbour porpoise from 110 casual records were recorded; the average pod size was two animals. Other land-based surveys yielded 24 harbour porpoise individuals from 10 sightings. Higher numbers of harbour porpoise were sighted around Wylfa Head compared to in the shallow bays of Porth-y-pistyll and Cemaes.

13.3.154 The distribution of harbour porpoise sightings around the coast of Anglesey is shown in figure D13-13. The distribution shows hot spots along the north coast of Anglesey and extends north to the Isle of Man and off the west coast of the Lleyn Peninsula southwards into Cardigan Bay.

Figure D13-13 Distribution of harbour porpoise in the Irish Sea (left) and around the Isle of Anglesey (right). Data held by Sea Watch Foundation [RD30]. Blue circle denotes the approximate location of the Wylfa Newydd Development Area



Bottlenose dolphin

13.3.155 The bottlenose dolphin is one of the most common cetacean species to occur in the coastal waters throughout the UK and the second most frequently recorded (according to land-based effort) species [RD30]. Population estimates of the Irish Sea (SCANS II, survey block O) for bottlenose dolphin were reported to be in the region of 235 individuals (CV = 0.75) with a density equivalent of 0.0052 individuals/km^2 [RD33]. More specifically, Cardigan Bay is the largest population in the UK with annual estimates for the wider area varying between 254 and 330 animals (CV = 0.25 to 0.28) for the years 2011 and 2013 inclusive [RD36].

13.3.156 In Welsh waters, 33,174 individuals have been logged into the Sea Watch Foundation database, accounting for more than 50% of the total number of individual marine mammals recorded between 2004 and 2014 [RD30].

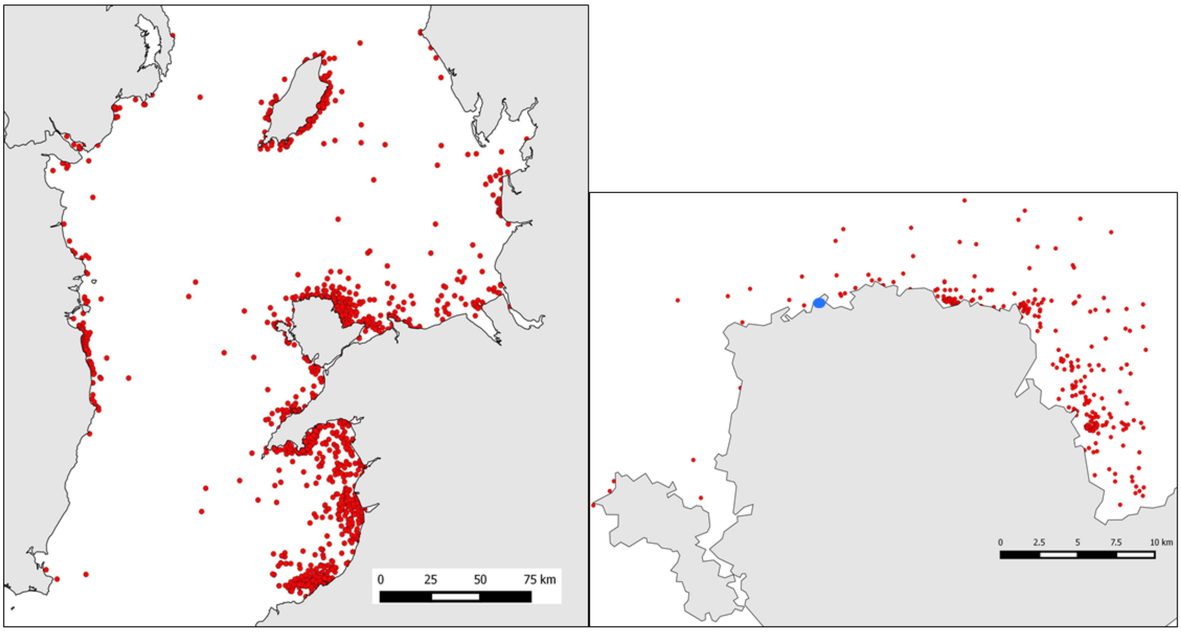
13.3.157 Across 12 transects, dedicated vessel transect surveys have yielded two sightings totalling 14 individuals of bottlenose dolphin (a pod of four and 10 individuals respectively) between May 2016 and January 2017 (appendix D13-6, Application Reference Number: 6.4.88).

13.3.158 Land-based VP surveys recorded 11 individuals, over 1,746 hours' survey effort across four years (appendix D13-6, Application Reference Number: 6.4.88). Since 2010, 202 individuals have been recorded from 10 casual records during baseline surveys; the average pod size was 20 animals. Other land-based surveys yielded 53 bottlenose dolphin individuals from two sightings.

13.3.159 Bottlenose dolphins are present throughout the year with most sightings occurring during the summer months. The average pod size in winter off Anglesey has been estimated to be 26.4 individuals.

13.3.160 Sea Watch Foundation records show the distribution of bottlenose dolphin is concentrated to the east of Anglesey along the coast between Bull Bay and Llandudno (figure D13-14). Baines and Evans [RD37] reported other hotspots located within Cardigan Bay SAC and around the Lleyn Peninsula and Sarnau SAC. Data from photo-ID studies [RD38] confirm that there is connectivity between the Cardigan Bay SAC and the waters surrounding north Anglesey, which means that any bottlenose dolphins sighted off Anglesey and in relation to the Wylfa Newydd Project should be considered to be part of the SAC population.

Figure D13-14 Distribution of bottlenose dolphin in the Irish Sea (left) and around the Isle of Anglesey (right). Data held by Sea Watch Foundation (2004-2014) [RD30]. Blue circle denotes the approximate location of the Wylfa Newydd Development Area



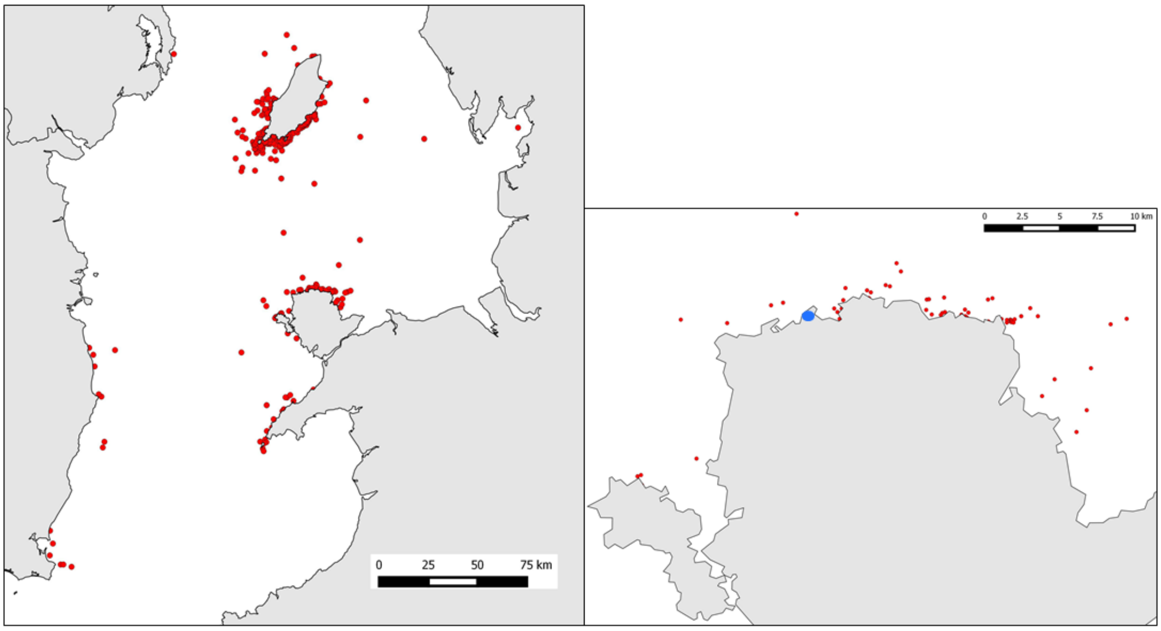
Risso's dolphin

13.3.161 Risso's dolphin has a relatively localised distribution in the Celtic and Irish Sea and is described as a wide band running from the south-west to the north-west, encompassing Pembrokeshire, the western end of the Lleyn Peninsula and Anglesey [RD30]. There were no sightings of Risso's dolphin during the land-based surveys (2011 to 2014) and only one sighting of a single individual was recorded during transit for the dedicated vessel transect surveys. The dedicated vessel transect surveys have yielded three sightings of Risso's dolphin with an average pod size of two individuals.

13.3.162 The species is regularly sighted around the western and northern part of the Lleyn Peninsula, particularly around Bardsey Island [RD30] but it is rare in Cardigan Bay (figure D13-15).

13.3.163 The seasonal distribution of Risso's dolphin shows that there is a presence along the north coast of Anglesey throughout the year with an increased abundance during the summer (May to September) and a peak in June.

Figure D13-15 Distribution of Risso's dolphin in the Irish Sea (left) and around the Isle of Anglesey (right). Data held by Sea Watch Foundation (2004-2014) [RD30]. Blue circle denotes the approximate location of the Wylfa Newydd Development Area



Pinnipeds

13.3.164 Two species of pinniped, the grey and harbour seal, frequent the Irish Sea and, of these, only the grey seal (*Halichoerus grypus)* has been recorded on a regular basis around north Anglesey [RD39]; [RD40]; [RD41] and [RD42]. Along the north coast of Anglesey, the estimated density of harbour seal at sea ranges between 0.00000976/km^2 to 0.0000304/km^2; with a slightly higher estimated density at The Skerries with 0.00004544/km^2 [RD43]. Since there is no documented evidence to suggest that harbour seals are present in Welsh waters or around Anglesey in any significant numbers, only grey seals are considered further.

Grey seal

13.3.165 Pinniped populations are generally estimated from a breeding census and, as such, pup counts as well as adult and juvenile grey seals are taken during the breeding season when pups and seals are hauled out. In the UK, the most recent grey seal population estimate was an estimated 56,988 pups (95% CI 56,317-57,683 (based on 2012 pupping surveys)) and 111,600 adults (95% CI 91,400–139,200) [RD44]. Wales is thought to have between 3% and 4% (1,650 individuals) of the total UK grey seal pup production [RD44]. Grey seals are present year round on both the Irish and Welsh coasts and are known to move between the two; the movement between the

Irish and Welsh coasts was at its greatest between the south-east coast of Ireland and the south-west coast of Wales [RD45].

13.3.166 There are a number of major haul-out sites identified in three districts of north Wales (Lleyn Peninsula, Anglesey, and West Hoyle Bank at the mouth of the Dee estuary), all of which have been surveyed between 2001 and 2003 for either pup production or site usage [RD39]; [RD40]; [RD41]. Grey seals spend most of their lives at sea, coming ashore to breed, rest or moult. In Wales, grey seals breed between August and December, with the peak month reported as September, and moult three to five months later during spring.

13.3.167 Telemetry tagging has allowed greater understanding of habitat usage and distances travelled by grey seal pups and adults. The results have shown that not only do grey seals move between SACs such as the Saltee Island (Ireland) SAC, Pembrokeshire Marine SAC and the Lleyn Peninsula and Sarnau SAC, but they also have the ability to travel great distances. The study by the Special Committee on Seals [RD44] showed grey seal pups cover an average maximum distance of 19.47km with the time between each haul-out location lasting 0.92 days (as a median). Grey seal adults covered an average maximum distance of 16.94km with the time between each haul-out location lasting 0.75 days (as a median) [RD44]. Overall, grey seals have large foraging ranges and they frequently travel over 100km between haul-out locations with foraging trips lasting anywhere between one and 30 days [RD46].

13.3.168 Within the study area, grey seals are present year round with peak sightings occurring between April and May. Sightings mostly occurred at VP1 (figure D13-12, Application Reference Number: 6.4.101) with a total of 61 individuals recorded between 2011 and 2014 out of a possible 199 individuals reported. Boat-based transect surveys yielded a total of 18 individuals across the four-month survey period (May 2016 to August 2016). The majority of these sightings occurred to the west of the Wylfa Newydd Development Area (particularly near The Skerries) and to the east of the Wylfa Newydd Development Area near to Ynys Dulas, Moelfre and Puffin Island. A total of two individuals were recorded near Cemaes Bay and Middle Mouse.

13.3.169 There are many suitable haul-out locations for grey seal across Anglesey, two of which (Carmel Head and The Skerries) are also known for grey seal breeding [RD39]; [RD41]. The dedicated land-based surveys (pupping and haul-out site investigations) of 2016 to 2017 (appendix D13-6, Application Reference Number: 6.4.88) indicates that the north Anglesey coastline between Hen Borth and Porth Padrig does not provide suitable habitat for breeding with no grey seal pups recorded. It is known that there are limited sites where grey seals are known to haul-out, these being Harry Furlough's Rocks (including Craig yr Iwrch) and occasionally on Cerrig Brith. Despite this, no seals were found to haul-out during the site-specific land-based seal surveys; five individuals were sighted in the water around Porth Wnal, Porth Padrig, Trwyn y Penrhyn and Cerrig Brith.

13.3.170 Across 12 transects, dedicated boat-based surveys have yielded 31 individuals from 30 sightings (appendix D13-6, Application Reference Number: 6.4.88) between May 2016 and January 2017. Site-specific land-based VP surveys yielded a total of 193 grey seal sightings and 201 individuals over 1,746 hours' survey effort across four years.

13.3.171 During the five years of baseline surveys, between 25 and 28 individuals of grey seal from 13 casual records were recorded. Other land-based surveys yielded eight casual records totalling 23 individuals. These casual records include two grey seal sightings (each on separate occasions) of between six and 15 individuals hauled out on Harry Furlough's Rocks (including the island, Craig yr Iwch). These are the intertidal rocks located to the west of Cemlyn Bay at a distance of approximately 1.3km for Porth-y-pistyll. There are no major haul-out sites within the Wylfa Newydd Development Area, but it is recognised that individual grey seals will haul-out intermittently wherever there is a suitable intertidal habitat.

13.3.172 Sea usage maps produced for grey seals show that they tend to be concentrated around The Skerries and Lleyn Peninsula and to the east of north Anglesey towards the mainland and West Hoyle Bank [RD43]. The density of grey seal at sea for north Anglesey reaches a maximum of 0.83/km^2 (95% CI 0-2.07) at The Skerries. Other areas such as the waters surrounding Middle Mouse and East Mouse have between five and 10 individuals/25km^2. Between Cemlyn and Cemaes Bay, the maximum number of grey seals in a given 25km^2 area has been calculated to be less than one individual.

Value of receptors

13.3.173 Each of the species of cetacean and pinniped discussed in the previous sections are considered to be of high value owing to their international and national importance. All cetacean and pinniped species are listed under the Habitats Directive (Annex II and/or IV, and/or V) and cetaceans are protected by the Wildlife and Countryside Act 1981, The Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention) and the Conservation of Habitats and Species Regulations 2017 (as amended). Table D13-4 (paragraph 13.3.239) sets out the receptors relevant to the marine environment and their assigned values.

Seabirds

13.3.174 To inform assessments of potential effects of the scheme on seabirds during the breeding and wintering season, a baseline data search and a range of land-based and boat-based surveys undertaken from 2010 to 2017 were carried out.

13.3.175 The key literature sources, scientific research and consultations used for the baseline assessment process comprised:

- Joint Nature Conservancy Council (JNCC) Seabird Monitoring Program Data;

- JNCC boat transect data from tern survey around Anglesey (2010/2011);
- JNCC and ECON Ecological Consultancy Ltd. Cemlyn Lagoon tern tracking data (2009);
- NWWT annual reports for Cemlyn; and
- Royal Society for Protection of Birds geolocator tracking data for The Skerries' Arctic terns (2016).

13.3.176 The survey methodologies used were:

- VP surveys within a study area out to a distance of approximately 1km from the coast (encompassing the area of sea between the westernmost edge of Cemlyn Bay, east to Cemaes);
- boat-based surveys, comprising tern tracking and European Seabirds at Sea transect surveys;
- intertidal surveys at Porth-y-pistyll and Cemlyn Bay;
- non-breeding season surveys of Cemlyn Lagoon;
- black-headed gull (*Chroicocephalus ridibundus*) surveys;
- gull colony counts; and
- disturbance monitoring surveys of terns and black-headed gulls at the Cemlyn colony.

13.3.177 Lists of target and secondary bird species were drawn up by Jacobs' ecologists in agreement with NRW (and their predecessor organisation), Royal Society for Protection of Birds and NWWT. The agreed aim was to focus surveys on target species, while recording secondary species when appropriate. Target species were defined as the qualifying species of the Anglesey Terns/Morwenoliaid Ynys Môn SPA, i.e. Arctic tern (*Sterna paradisaea*), common tern (*Sterna hirundo*), roseate tern (*Sterna dougallii*) and Sandwich tern (*Sterna sandvicensis*).

13.3.178 Secondary species are defined as those species that are specially protected or are of conservation concern as identified within the following documents (and are not target species as defined above):

- Annex I of European Council Directive 2009/147/EC on the conservation of wild birds (the 'Birds Directive'), or regularly occurring migratory species;
- Schedule 1 of the Wildlife and Countryside Act 1981;
- Red-listed Birds of Conservation Concern [RD47];
- UK Biodiversity Action Plan priority bird species list (http://jncc.defra.gov.uk/page-5163); and
- Section 7 of The Environment (Wales) Act 2016.

JNCC Seabird Monitoring Program Data

13.3.179 Seabird colony count data were extracted from the JNCC Seabird Monitoring Program database, specifically the Seabird 2000 surveys [RD48] in order to estimate the regional breeding populations for species that have been recorded within the areas studied for the Project. Regional populations for each species are defined as the number of birds, as taken from Seabird Monitoring Programme data colony counts, occurring within the mean/max foraging range of that species, measured from the outer limit of the worst case zones of effect for the Wylfa Newydd Development Area and Disposal Site (figure D13-16, Application Reference Number: 6.4.101). Worst case zones of effect were considered as 5km buffers from the Wylfa Newydd Development Area and from the Disposal Site, which is a precautionary distance encompassing all the potential pathways to significant effects on seabirds.

13.3.180 The breeding colonies located within the zones of effect themselves were also identified and totalled for each species to give a percentage of the regional breeding population present within each zone of effect.

13.3.181 The methodology used and the detailed results of this assessment are given in appendix D13-7 (Application Reference Number: 6.4.89). Results relating to the Wylfa Newydd Development Area are summarised below whilst results relating to the Disposal Site are presented in section 13.4 (see paragraphs 13.4.78 to 13.4.80).

13.3.182 Colony count data were available for 21 of the seabird species that have been recorded within the Project study areas (see appendix D13-7, Application Reference Number: 6.4.89, for full results).

13.3.183 Regional breeding population sizes for target species (terns) ranged from two (roseate terns) to 1,705 (Arctic tern). Percentages of target species which breed within the Wylfa Newydd Development Area zone of effects ranged from 0.12% (Arctic tern) to 100% (Sandwich tern) of the regional breeding populations.

13.3.184 Regional breeding populations for secondary species within the study area for the Wylfa Newydd Development Area ranged from zero (great skua and common gull, which do not breed locally) to 173,445 (Manx shearwater). Notable regional populations were shown for gannet (70,260), fulmar (31,831), guillemot (26,016) and kittiwake (3,111).

13.3.185 Within the Wylfa Newydd Development Area zone of effects, there were colonies of nine secondary species, ranging in numbers from shag (three pairs) to guillemot (2,464 pairs). Black-headed gull (440 pairs) was the species with the largest proportion (52.38%) of birds in comparison to its regional breeding population.

Tern population sizes and breeding success at Cemlyn

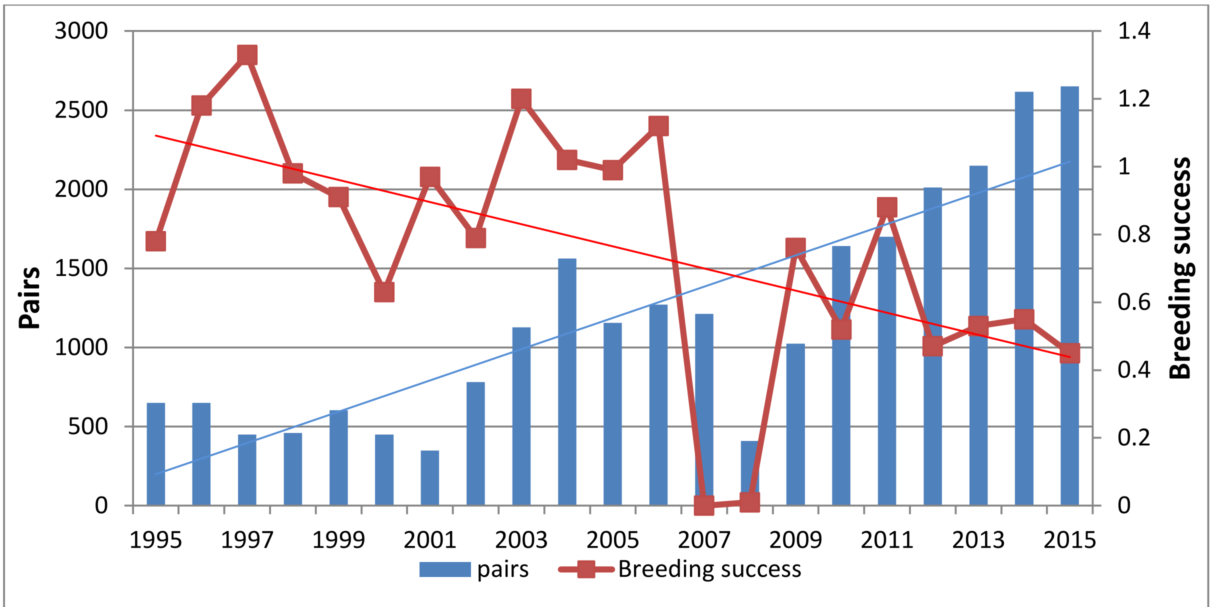
13.3.186 The population sizes and productivity (a measure of breeding success rate, defined by the average number of chicks successfully reared per adult pair) of the three tern species that are present at the Cemlyn Lagoon colony were extracted from the JNCC Seabird Monitoring Program database [RD48].

Data were available for most breeding seasons over a 30 year period from 1986 to 2015. All breeding records during this period are shown in appendix D13-7, (Application Reference Number: 6.4.89). Data from the period 1995 to 2015 for each tern species are also presented below.

13.3.187 Population sizes of Sandwich, Arctic and common tern at Cemlyn have all increased markedly over this period. Sandwich tern productivity has decreased, Arctic tern productivity has increased and common tern productivity shows no particular trend. The extent of available suitable nesting habitat at Cemlyn Lagoon is limited, suggesting the decrease in Sandwich tern productivity could be indicative of a population reaching its natural carrying capacity. It would be expected that productivity would decline as an increasing population approached carrying capacity. Data published by the British Trust for Ornithology on population dynamics of species with rapidly increasing populations often show dips in productivity towards the end of the study periods, despite continued population growth. Another possible contributing factor is that chicks are more difficult to count accurately in a large colony, leading potentially to an under-recording of chick numbers.

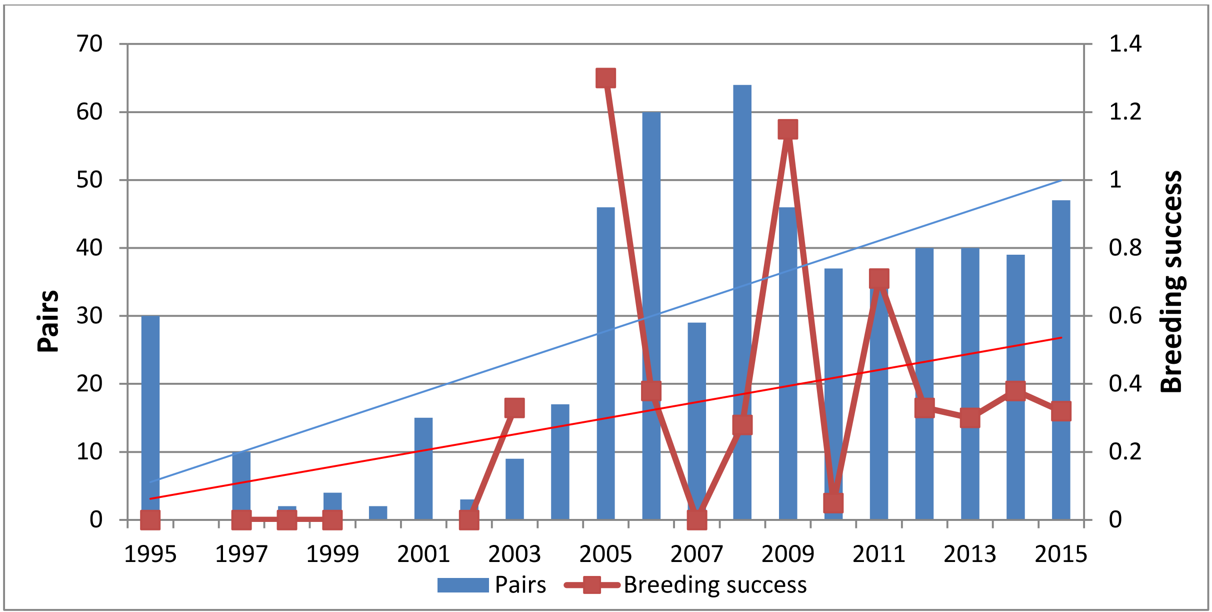
13.3.188 The fledge count (number of chicks successfully reared to fledging) for Sandwich tern at Cemlyn Lagoon has generally increased over the 30 year period, in line with the long-term increase in the number of breeding pairs. Productivity has however shown an overall decrease, particularly when taken from 1995 when fledge counts started to be recorded annually (figure D13-17). Productivity has ranged from 0.00 and 0.01 chicks fledged per pair (2007 and 2008, respectively, which were years of high predation levels) to a maximum of 1.33 chicks fledged per pair (1997).

Figure D13-17 Sandwich tern productivity and number of pairs at Cemlyn Lagoon since 1995



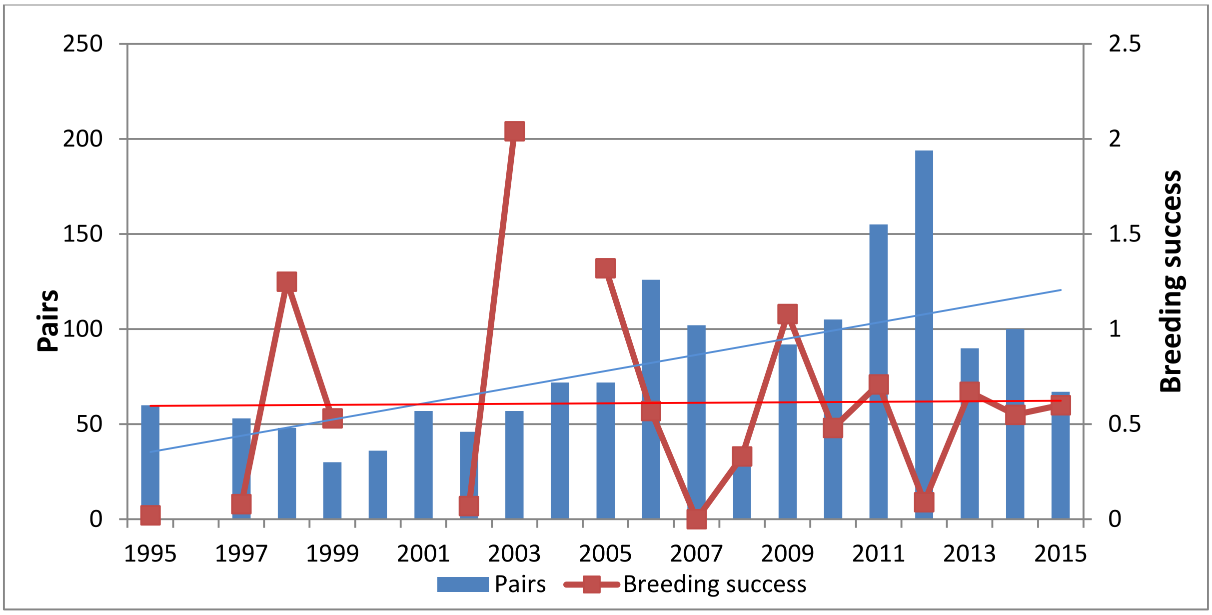
13.3.189 Arctic tern numbers have been slightly increasing since 1986, although the number of breeding pairs and fledge count has decreased since the 30 year peak in 1992 (300 pairs). Productivity shows an increasing trend (see figure D13-18) and has ranged from zero chicks fledged per pair (1995, 1997 to 1999 and 2002) to maxima of 1.3 and 1.2 chicks fledged per pair (2005 and 2009), respectively (see figure D13-18).

Figure D13-18 Arctic tern productivity and number of pairs at Cemlyn Lagoon since 1995



13.3.190 The trend in number of breeding pairs of common terns is an overall increase since 1986, although it has been in decline since its peak in 2012 (194 pairs). There have been sharp fluctuations in productivity since 1986 (ranging from 0.00 chicks fledged per pair in 2007 (a predation year) to 2.04 fledged per pair in 2003). Productivity trends since 1995 have generally been stable (see figure D13-18).

Figure D13-19 Common tern productivity and number of pairs at Cemlyn Lagoon since 1995



JNCC boat transect data (2010/2011)

13.3.191 Transect-based surveys for terns were carried out in June 2010 and June/July 2011, within the period when breeding terns are at their busiest, provisioning chicks. These surveys formed part of a wider study on identifying important marine areas for tern species breeding in the UK. Methods and results are described in detail in Wilson *et al*., [RD49]. In summary, surveys followed modified European Seabirds at Sea approach, but with snapshot point counts taken at 2km intervals along each transect, counting all terns observed in any direction from the boat.

13.3.192 JNCC boat transect data (2010 and 2011) generally show that Sandwich terns were distributed to the north and east of Anglesey, while common and Arctic terns were distributed off the west and north-west Anglesey coast in both 2010 and 2011. Sandwich tern was recorded more frequently within the first couple of kilometres from the Anglesey north-east coast compared with further offshore. Low numbers of Sandwich tern were recorded near the inshore bays of the Wylfa area, including Cemaes Bay, Porth Wnal, Porth-y-pistyll and Cemlyn Bay.

13.3.193 The majority of common and Arctic tern records were recorded around The Skerries. Apart from a count of one common tern recorded near the inshore bay of Porth-y-pistyll in 2011, common and Arctic terns were not recorded within the inshore bays of the Wylfa Head area.

13.3.194 The distribution of common and Arctic tern remained the same between 2010 and 2011. However, the highest densities of Sandwich tern shifted to some extent along the coast between 2010 and 2011, with Sandwich tern numbers at their highest at Dulas Bay in 2010 and at Point Lynas in 2011.

JNCC and ECON tern tracking data (2009)

13.3.195 In 2009, JNCC and ECON tracked foraging terns at sea using methodology detailed in Perrow *et al*., [RD50]. Sandwich, common and Arctic terns were tracked by JNCC between 9 June and 6 July and by ECON from 28 May to 10 July.

13.3.196 All tracks show a high level of foraging activity within approximately 5km of the colony, with continued high foraging activity further north and east, especially Sandwich tern.

13.3.197 No common or Arctic tern diving activity was recorded in any of the databases from within the inshore bays, i.e. Cemaes Bay, Porth Wnal, Porth-y-pistyll or Cemlyn Bay. No tracked common or Arctic terns were seen feeding within Cemaes Bay, Porth Wnal, Porth-y-pistyll or Cemlyn Bay.

Royal Society for Protection of Birds geolocator tracking data for The Skerries' Arctic terns

13.3.198 The 2016 tracking data for breeding Arctic tern fitted with Global Positioning System (GPS) loggers on The Skerries shows the foraging range, primarily radiating westwards from The Skerries into the Irish Sea (appendix D13-7, Application Reference Number: 6.4.89). Half (50%) of the birds' utilisation of the area was within approximately 15km of the colony, with 95% of utilisation extending out to approximately 35km from the colony (see appendix D13-7, Application Reference Number: 6.4.89).

North Wales environmental information service (Cofnod)

13.3.199 Historical data were obtained from consultation with the Cofnod detailing records of seabird species in and around Anglesey from 1995 to 2015 (see appendix D9-11, Breeding Bird Technical Summary Report, Application Reference Number: 6.4.44).

13.3.200 The Cofnod dataset provides a wide range of historic local records with varying level of detail. Due to the size of the dataset and available information relating to individual records it was not always possible to separate breeding and non-breeding records. The historic records do, however, reflect the common seabird activity, particular for target species (terns), surrounding Cemlyn Bay that have been recorded during more recent surveys for the purposes of the Project. Sandwich, common and Arctic tern were recorded in high numbers for all four time periods. Smaller numbers of roseate tern (13 records) were also recorded at Cemlyn during the most recent 2010 to 2012 period.

13.3.201 Manx shearwater is the most commonly recorded non-target (secondary) species (20,304 records). A number of species are under-recorded within this dataset due to their commonness. Rarer birds are more likely to be reported by the public and therefore appear within this dataset. This may contribute towards the inclusion of scarce species such as Balearic shearwater, black-necked grebe and red-necked grebe and the relatively low number of records of more common species such as guillemot and razorbill.

Land-based VP surveys

13.3.202 VP surveys were initially carried out over a 36-month period between September 2010 and August 2013, followed by a six-month validation programme in 2014 (April to September). The validation programme comprised a reduced survey effort undertaken to test whether there was any change to the baseline conditions observed in previous years, i.e. the behaviour of terns and other seabirds and of relative numbers of terns actively feeding in the bays. The locations of the VP survey areas are shown in figure D13-12 (Application Reference Number: 6.4.101). Full details on the methodology are given in appendix D13-7 (Application Reference Number: 6.4.89).

Target species (terns)

13.3.203 Four target species were recorded: Arctic tern, common tern, roseate tern and Sandwich tern in the VP survey area.

13.3.204 The recordings of Arctic and common terns were combined due to identification difficulties, and are subsequently referred to as ‘Arctic/common terns’. These species were observed during April to July each year, with numbers consistently highest in June. Over the four-year survey period, a peak count of 224 Arctic/common terns was recorded in VP4 during June

2014, with low numbers generally recorded in VP1, VP2 and VP3 (see appendix D13-7 Application Reference Number: 6.4.89).

13.3.205 Sandwich terns were observed during all months from April to August each year. High numbers were recorded between May and July and relatively low numbers recorded during April and August from 2011 to 2014. A peak count of 1,808 Sandwich terns was recorded from VP4 during July 2012 with high numbers recorded from VP1, VP2 and VP3 (see appendix D13-7, Application Reference Number: 6.4.89). Birds were counted in 15-minute count periods. The majority of terns were recorded in flight, passing through the VP study area, therefore double counting of birds during a 15-minute count period is likely, and numbers presented give an indication of rate of passage of birds rather than a study area population size estimate.

13.3.206 Roseate tern was only recorded on two occasions, both in June 2014, both of which were in flight within VP4.

13.3.207 The vast majority of both Arctic/common and Sandwich terns recorded were observed in flight within the VP areas, between the breeding colony and feeding areas. Peak counts of 40 Arctic/common and 64 Sandwich terns were recorded actively feeding in the VP survey area, representing approximately 2% of Arctic/common tern and 0.9% of Sandwich tern records were of those actively feeding within the VP areas.

Secondary species

13.3.208 Twenty-six secondary seabird species were recorded during the VP surveys from September 2010 to September 2014, of which 23 were recorded using (e.g. foraging, roosting or loafing for example) the VP survey area. The other three species were flying throughout the study area. The recordings of guillemot (*Uria aalge)* and razorbill (*Alca torda)* were combined due to identification difficulties and are subsequently referred to as ‘common auks’

13.3.209 The frequency and timing (i.e. seasonality) of observations of secondary species varied depending on the species, but was consistent over the survey years. The secondary species recorded using the VP survey area in greatest numbers were black-headed gull (peak count of 570 loafing during February 2013), common auks (peak count of 480 loafing and foraging during August 2011) and herring gull (*Larus argentatus*) (peak count of 210 recorded loafing and foraging during July 2013). Common gull (*Larus canus*) was also recorded in high numbers in the VP survey area.

13.3.210 Counts of birds sat on the water during VP surveys are likely to be an under-estimate of the actual number present within the study area. The detectability of birds sat on the water, particularly small species such as auks, decreases with distance from observer and with increasing sea state.

13.3.211 The black-headed gull colony at Cemlyn comprises a large proportion of the population in Wales (15% of the coastal population during the Seabird Colony Register and 52% during Seabird 2000 [RD51]).

Boat-based seabird surveys

13.3.212 Boat-based surveys were carried from May 2016 to June 2017. Two boat-based survey methods were adopted: monthly transect surveys based on the European Seabirds at Sea methodology, and tern tracking surveys following individual birds in flight (see appendix D13-7, Application Reference Number: 6.4.89, for full details).

Transect surveys

13.3.213 Transect surveys were carried out monthly between May 2016 and May 2017. These surveys employed modified European Seabirds at Sea (ESAS) methods to provide data on the abundance and distribution of birds within the study area, both in flight and on the water, at intervals of 500m along 23 transects orientated north to south off the north coast of Anglesey. Modifications from standard ESAS methods were used. These were using two observers simultaneously (one port side, one starboard), and taking ‘snapshot’ counts at specific waypoint locations rather than at set time intervals.

13.3.214 The primary study area for the transect surveys is defined as Block 1 shown in figure D13-12, (Application Reference Number: 6.4.101) and appendix D13-7 (Application Reference Number: 6.4.89), which has a boundary loosely described by a radius of approximately 12km centred on the Wylfa Newydd Development Area. The extent of the study area (Block 1) represents an area approximately six times that of the maximum predicted zone of influence, in keeping with guidance in Camphuysen *et al*., [RD52] (see figure D13-12, Application Reference Number: 6.4.101).

13.3.215 During the period May to September 2016 an additional survey area, Block 2, see figure D13-12 (Application Reference Number: 6.4.101) and appendix D13-7 (Application Reference Number: 6.4.89), was added to the study area. Block 2 was designed to incorporate the known foraging range of Sandwich terns from the Cemlyn Bay colony. The full results are given in appendix D13-7 (Application Reference Number: 6.4.89).

Target species (terns)

13.3.216 Sandwich terns were recorded in the study area from May to September 2016 and May 2017. The maximum estimated study area population size of Sandwich tern was 1,696 birds recorded in June 2016 (Block 1 and Block 2). The maximum relative density of Sandwich terns recorded in the study area was 7.21 birds/km^2 during June 2016.

13.3.217 The maximum estimated study area population size of Arctic/common tern was 988 birds in July, lower than the combined common tern and Arctic tern breeding populations recorded on The Skerries in 2015 (546 and 7,616 respectively), but higher than the breeding populations at Cemlyn Bay in 2015 (134 and 94 respectively). This indicates that birds from The Skerries as well as the Cemlyn Bay colonies were recorded within the study area. The maximum relative density of Arctic/common terns recorded in the study area was 3.87 birds/km^2 during July 2016.

Secondary species

13.3.218 A total of 22 species were recorded in the transect survey study area (Block 1 and Block 2) between May 2016 to May 2017. One great northern diver (April 2017) and one pomarine skua (May 2017) was recorded in the raw count data.

13.3.219 For the majority of species, study area population size estimates within both Block 1 and Block 2 were generally low. The highest peak population estimate was recorded for common scoter (15,174 birds) passing through Block 2 in September 2016, although population estimates recorded in other months for common scoter were generally much lower than this. The estimate of 15,174 common scoter is an over-estimate due to the unsuitability of the use of Distance Analysis for clumped data of this type. The raw count data show a flock of approximately 3,000 birds flying through Block 2, possibly disturbed by the presence of the survey vessel.

13.3.220 The second highest peak population estimate of 8,586 birds was recorded for guillemot in May 2016; moderate to high numbers of guillemots were recorded in every calendar month.

13.3.221 A peak population estimate of 1,503 Manx shearwaters was recorded in June 2016. Manx shearwater was recorded during the calendar months of April to September inclusive.

13.3.222 Kittiwake had the highest peak population estimate of any gull species recorded in the study area: 2,138 kittiwakes were estimated in August 2016 (Block 1 and Block 2). Low numbers of black-headed gull were recorded in the transect surveys; the highest raw count of 183 birds was recorded in November 2016, but only 94 of these black-headed gulls were in the sample area at the time of counting, the rest were outside of the transect survey area closer to the coast.

Tern tracking surveys

13.3.223 Tern tracking surveys were carried out in June and July 2016 (representing 19 days of survey effort) and again for five days in June 2017. These surveys followed the methodology described by Perrow *et al*., [RD53]; terns of all three species from the colony in Cemlyn Lagoon were tracked (visually during their foraging flights at sea) from a high-speed boat. Individual birds were typically followed to the full extent of their foraging range, including their return flights (normally carrying fish) back to the colony.

13.3.224 Tracking data for Sandwich tern showed a large foraging range in comparison to other tern species, primarily radiating eastwards from the Cemlyn Bay colony, along the north Anglesey coast and into the shallow sandy bays along the east of the island (see appendix D13-7, Application Reference Number: 6.4.89). Tracked Sandwich terns did not feed in Porth-y-pistyll or Cemaes Bay. Arctic and common terns were generally found to actively feed within 5km of the colony, with occasional tracks heading much further north and east with some notable feeding activity around 2km north of Cemlyn Lagoon (appendix D13-7, Application Reference Number: 6.4.89). Arctic/common terns were not recorded diving in Cemlyn Bay, Cemaes Bay or Porth-y-pistyll. The results of these surveys concur with findings of the VP surveys which recorded very little feeding activity in Porth-y-pistyll and the adjacent bays for all three tern species (appendix D13-7, Application Reference Number: 6.4.89).

Intertidal surveys

13.3.225 Intertidal zone seabird surveys at Porth-y-pistyll (figure D13-12, Application Reference Number: 6.4.101) were carried out over 36 months between April 2012 and March 2015, during which time 80 visits were undertaken at low tide and 19 at high tide, to record target and secondary species. Intertidal zone surveys at Cemlyn Bay (figure D13-12, Application Reference Number: 6.4.101) were carried out over six months between October 2014 and March 2015.

13.3.226 The intertidal zone surveys in Porth-y-pistyll recorded seven species of seabirds loafing and/or foraging. Herring gull and black-headed gull were recorded in relatively high numbers with peak counts of 163 (August 2012) and 150 (February 2014), respectively. Herring gull was present in all but one of the visits.

13.3.227 In Cemlyn Bay, the intertidal zone surveys recorded a total of eight seabird species between October 2014 and March 2015. Herring gull was recorded in relatively high numbers with peak count of 37 in January 2015.

Cemlyn Lagoon surveys

13.3.228 Surveys of Cemlyn Lagoon (figure D13-12, Application Reference Number: 6.4.101) were carried out in order to record the abundance, distribution and behaviour of birds using the lagoon, adjacent water bodies and shorelines. The surveys were carried out from September 2012 to April 2013 (non-breeding and early breeding season) to complement the breeding season data gathered by the reserve wardens during May to August.

13.3.229 A total of seven seabird species were recorded loafing and/or foraging in Cemlyn Lagoon between September 2012 and April 2013. Black-headed gull was recorded in the greatest numbers with a peak count of 812 during April. Herring gull was also recorded in relatively high numbers with a peak count of 364 during December.

13.3.230 The black-headed gull is a secondary species of notable importance as the colony located on islands within Cemlyn Lagoon during the breeding season is the largest in Wales with 450 pairs recorded in 2015 [RD54]. This species also exhibits a commensal relationship with Sandwich terns (and occasionally other tern species) during the breeding season[2]. Black-headed gulls use a variety of habitats for foraging and roosting in flocks during the winter including strandline and intertidal areas in Porth-y-pistyll and Cemlyn

[2] Black-headed gulls and Sandwich terns (and occasionally other tern species) frequently nest in close association with each other [RD55]. Within these relationships there is a degree of piracy by gulls stealing fish from terns (kleptoparasitism) which is detrimental [RD56], but black-headed gulls also provide increased predator protection to terns [RD57].

Lagoon as well as grasslands (semi improved and improved) (see appendix D13-7, Application Reference Number: 6.4.89).

Black-headed gull breeding and wintering surveys

13.3.231 Transect surveys were undertaken in the vicinity of the Wylfa Newydd Development Area during all winter periods from 2009/2010 to 2014/2015 (October to March), and again in winter 2016/2017 (January to March 2017 only). Transect surveys were also carried out during all breeding seasons in years 2010 to 2014, and again in 2017. Transect surveys in all seasons from 2009 to 2015 were undertaken as part of the wintering and breeding bird surveys (for all bird species) carried out in relation to the scheme. The surveys conducted in 2017 were carried out specifically for black-headed gull.

13.3.232 Overall, it was found that the usage of the habitats by black-headed gull within the survey area was limited. The results show that during the winter and breeding surveys, almost most records of birds within fields were of single individuals or small flocks (mostly less than five individuals).

13.3.233 The winter season data revealed a preference for intensively-grazed improved grassland, short sward grassland and also for areas of rocky shoreline (e.g. Porth-y-pistyll and Cemlyn Lagoon). Overall, black-headed gull numbers recorded in the area were higher during the winter season (peak of 190 birds recorded in 2016/17) compared with the breeding season (peak count of 75 birds recorded from 2010 to 2014). The 2016/17 winter peak count was recorded during mid–February to late March, when relatively large numbers of black-headed gulls were using the fields to the south and south-east of Wylfa Head.

13.3.234 During the breeding season, records were restricted to the western half of the survey area and, away from Cemlyn Lagoon, fewer large flocks were recorded. In contrast with the winter period, birds did not show a preference for intensively-grazed improved grassland. Rather, usage of fields appeared to be opportunistic and linked to habitat operations, with black-headed gulls mostly observed in ploughed arable farmland and recently-cut grassland.

Gull colony counts

13.3.235 Surveys of the gull colony at Porth Wnal to the north of the Existing Power Station were carried out during 23 and 24 April 2013 to coincide with the early incubation period for gulls and hence the maximum likelihood of birds being present at their nests.

13.3.236 Three species of gulls were recorded using colonies on the rocks at Porth Wnal to the north of the Existing Power Station during April 2013: herring gull (peak count of 223), lesser black-backed gull (*Larus fuscus*) (peak count of 156) and great black-backed gull (*Larus marinus*) (peak count of two).

13.3.237 The minimum number of breeding pairs for each species assessed to be using the colony during 2013 was considered to be 111 for herring gull, 78 for lesser black-backed gull and one for great black-backed gull.

Value of receptors

13.3.238 The seabird species referred to as 'target species' are those which are qualifying features of the Anglesey Terns/Morwenoliaid Ynys Môn SPA, i.e. Arctic tern, common tern, roseate tern and Sandwich tern, and these are assigned a high value. All other seabirds (secondary species) are assigned a value of medium. This includes secondary species such as regularly occurring migratory species (listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016) and some species which are listed on Annex I of the Wild Birds Directive, e.g. black-headed gull, or on Schedule 1 of the Wildlife and Countryside Act 1981 e.g. Mediterranean gull (*Ichthyaetus melanocephalus)*.

Summary of receptors

13.3.239 The receptors relevant to the marine environment assessment for the Wylfa Newydd Development Area and their values are presented in table D13-4.

Table D13-4 Summary of marine environment receptor value

Receptor	Value
All designated sites of nature conservation importance and supporting features (SACs, SPAs and SSSIs, including candidate SACs)	High
EU-designated WFD water bodies	High
EU-designated bathing water	High
Plankton (phytoplankton and zooplankton)	Low
Subtidal and intertidal habitats of conservation importance	Medium
Intertidal habitats and communities	Low
Subtidal habitats and communities	Low
Invertebrates (of conservation and/or commercial importance)	Medium
Ichthyoplankton (of conservation and/or commercial importance)	Medium
Ichthyoplankton (not of conservation and/or commercial importance)	Low
River lamprey	High
European eel	High
Atlantic salmon	High
Fish (of conservation and/or commercial importance)	Medium
General fish and fisheries (intertidal and subtidal)	Low
Marine mammals (pinnipeds and cetaceans)	High
Seabirds (target species)	High
Seabirds (secondary species)	Medium

Evolution of the baseline

13.3.240 The existing baseline conditions within the study area are considered to be relatively stable for many receptors as there have not been fundamental changes to environmental conditions or in the use of the marine environment in the local area for many years.

13.3.241 In recent years, the baseline environment has been influenced by the operation of the Existing Power Station including the associated Cooling Water discharge and discharge of treated waste water. The effects of the existing Cooling Water discharge on benthic habitats and species are described in paragraphs 13.3.90 to 13.3.92. The Existing Power Station had been running at half-load (one reactor) since April 2012 and ceased power generation altogether in December 2015. The baseline will evolve in response to this change, in particular from the cessation of Cooling Water discharge and the removal of the thermal plume and biocide effects.

13.3.242 In the absence of the Wylfa Newydd Project it is anticipated that there would be a recovery in the habitats and species which are currently affected by the Cooling Water discharge of the Existing Power Station. Where there are currently acute effects (within 100m) it is likely that in the medium-term (10 years) there would be a recovery close to natural conditions. For the area where only subtle effects were recorded (from around 100m to 300m) it is likely that recovery will be faster, and that within five years, conditions would return to near natural conditions. The assessment of effects relating to the Cooling Water discharge at the Existing Power Station takes a precautionary approach, assuming full recovery (and therefore value) of the habitats in this location.

13.3.243 The baseline will evolve as a result of global trends which include an increasing human population, global warming (climate change) and sea-level rise. One particular concern is changes in the distribution of non-native species (linked to warming sea temperature and movement of non-natives around the UK coastline). The evolution of the baseline due to climate change is considered further below.

13.3.244 A full assessment of likely effects of global trends has not been undertaken here as it is considered unlikely that these trends will significantly alter the baseline presented (for 2010 to 2015) and the period during which consent for the Wylfa Newydd Project would be considered. It is acknowledged that these global trends may affect the baseline prior to the Environmental Impact Assessment for decommissioning and therefore additional monitoring may be required.

Evolution of the baseline due to climate change

13.3.245 There are a number of models covering the UK which simulate the possible change in climate. The UK Climate Impact Programme [RD58] indicates winters may become generally wetter and summers substantially drier for the whole of the UK. Data from Jenkins *et al*., [RD58] also suggest that there may be more variability year-to-year, and the number of extreme years may increase, e.g. more intense storms and severe droughts. It is expected that there will be a warming trend in sea surface temperatures.

13.3.246 The UK Climate Projections (UKCP09) and the latest UK and Welsh Government guidance indicate a rise in sea levels [RD59]; [RD60]. Modelling outputs for the Wylfa Newydd Development Area Development

AMEC modelling [RD61] shows a 'reasonably foreseeable' future sea level rise from 2008 to 2023, to 2087 and to 2187 of 0.05m, 0.67m and 2.12m, respectively (0.07m, 0.48m and 1.48m in the Further Wave Model Phase 2 study) with no additional allowance for surge. However, it is recognised that there is continuing uncertainty with respect to sea level rise.

13.3.247 In the medium-term and long-term these changes may affect the marine environment baseline in particular from increasing frequency of high intensity storms, sea level rise and warming sea temperatures which could negatively affect certain receptors.

13.3.248 The effects of climate change on marine environment receptors may include:

- increases in sea level rise resulting in the potential loss of coastal habitat for seabirds;
- effects on migratory fish which may suffer from increased frequency and severity of droughts reducing water levels or drying-out of watercourses;
- changes in species distribution as Lusitanian species (those with an affinity for warm water) move further north around the coast into the study area due to increasing sea temperatures;
- changes in species distribution as boreal species (those with an affinity for cold water) move out of the study area as their optimal habitat range is pushed northwards or into deeper waters; and
- changes in timing of spawning and other lifecycle characteristics due to increasing sea temperatures.

13.3.249 The significance of rising seawater temperature in terms of the potential for seasonal advancement or delay as a result of Power Station operations will be assessed. The thermal tolerances of relevant habitats and species is used together with the sea temperature predictions from the hydrodynamic model to determine any significant effects under a range of conditions (see paragraphs 13.6.609 to 13.6.718).

13.3.250 The Wales Coastal Group Forum (2011) Shoreline Management Plan 2 [RD62] provides a broad-scale assessment of the risks associated with coastal evolution resulting from future sea level rise. It also presents a policy framework to address risk both to people and to the environment in a sustainable manner.

13.4 Disposal Site baseline environment

13.4.1 This section provides a summary of the baseline conditions for the marine environment within the Disposal Site study area described in section 13.2. Where a wider study area has been defined to characterise the baseline for a particular receptor, further description is provided below.

13.4.2 The Disposal Site for the Wylfa Newydd Project is defined as the newly designated Holyhead North (IS043) disposal site (see figure D13-20, Application Reference Number: 6.4.101). A comprehensive report of the baseline is provided in the Disposal Site characterisation report [RD63] and a summary of the environmental baseline for the Disposal Site is presented in the following sections. The following are key sources of information.

- Environmental characterisation surveys commissioned by Horizon in 2016 i.e. water quality, physico-chemical analyses of sediment and analysis of benthic communities.
- NRW-commissioned study encompassing the Disposal Site and surrounding area [RD64].
- The Environmental Statement and supporting technical appendices for the Minesto Deep Green Holyhead Deep Project [RD65].
- Predictive habitat mapping of the seabed from HABMAP project [RD66].
- Research thesis by Potter [RD67] investigating the historic Holyhead Deep disposal site.

13.4.3 This section is supported by the following appendices, which present environmental baseline data, and which are cross-referenced in the text where relevant:

- D13-1 Water quality and plankton surveys report (Application Reference Number: 6.4.83);
- D13-2 Benthic ecology report (Application Reference Number: 6.4.84);
- D13-4 Fish surveys report (Application Reference Number: 6.4.86);
- D13-6 Marine mammal baseline review (Application Reference Number: 6.4.88);
- D13-7 Seabird baseline review (Application Reference Number: 6.4.89);
- D13-8 Marine hydrodynamic modelling report – Wylfa Newydd Development Area (Application Reference Number: 6.4.90); and
- D13-12 Marine hydrodynamic modelling report – Disposal Site (Application Reference Number: 6.4.94).

Site description

13.4.4 The Disposal Site covers the northern half of the Holyhead Deep (IS040) disposal site which was closed in April 2017. Marine disposal has been taking place at Holyhead Deep since 1983 and it has received both capital and, more regularly, maintenance dredged material since this time. Historical environmental data for Holyhead Deep have therefore been utilised for the Disposal Site due to the geographical overlap in these two sites.

13.4.5 The closure of Holyhead Deep followed the granting of a Marine Licence to Minesto Limited to install tidal kites within the southern half of the Holyhead Deep disposal site. As such, baseline environmental data obtained by Minesto to support their Marine Licence application are particularly relevant to baseline information for the Disposal Site, providing recent data on the marine environment within and adjacent to the Disposal Site, and also from the wider sea area (i.e. the Irish Sea).

13.4.6 The Disposal Site is a rectangular area off the north-west coast of Anglesey in the Irish Sea. The north-western corner of the Disposal Site is the furthest point from shore at approximately 15km from Holyhead harbour and, at its nearest point, approximately 18km from Porth-y-pistyll. The total area of the site is approximately 28.8km² [RD63].

13.4.7 Within the Disposal Site is a natural depression on the seafloor. High-resolution multibeam bathymetry data collected by Sustainable Expansion of the Applied Coastal and Marine Sectors (SEACAMS) between 2013 and 2014 shows that the majority of the Disposal Site is greater than 50m deep, although within the middle of the depression a maximum of 96m is reached. There is a small rock platform protrusion on the northern boundary of the site, where depths range between 35m and 40m [RD68].

Conservation designations

13.4.8 The designated sites of national/international importance for nature conservation in proximity to the Disposal Site include (figure D13-21, Application Reference Number: 6.4.101):

- Bae Cemlyn/Cemlyn Bay SAC and SSSI;
- Gogledd Môn Forol/North Anglesey Marine cSAC;
- Morwenoliaid Ynys Môn SPA /Anglesey Terns;
- Glannau Ynys Gybi/Holy Island Coast SAC, SPA and SSSI;
- Puffin Island SSSI; and
- The Skerries SSSI.

13.4.9 The Disposal Site is located within the North Anglesey Marine cSAC (proposed for harbour porpoise) and the Anglesey Terns/Morwenoliaid Ynys Môn SPA. Glannau Ynys Gybi/Holy Island Coast SAC, SPA and SSSI are all located approximately 5km from the Disposal Site on the Holy Island Coast.

13.4.10 A separate Shadow HRA Report (Application Reference Number: 5.2) has been undertaken which considers internationally designated sites on a wider geographic scale which are not listed above. The Shadow HRA Report (Application Reference Number: 5.2) is provided as a separate supporting report to the Marine Licence application.

13.4.11 In January 2017, a marine extension to the existing Ynys Feurig, Cemlyn Bay and The Skerries SPA was designated to include the marine area used by foraging terns during the breeding season. The site, now incorporating the nesting birds of Ynys Feurig, Cemlyn Bay and The Skerries SPA, and their foraging areas, was renamed the 'Anglesey Terns/Morwenoliaid Ynys Môn SPA.'

13.4.12 This chapter will herein refer to the amalgamated SPA sites as the 'Anglesey Terns/Morwenoliaid Ynys Môn SPA' although the current conservation objectives for the Ynys Feurig, Cemlyn Bay and The Skerries SPA will continue to apply until Regulation 35 advice is formally issued by NRW.

Value of receptors

13.4.13 All nationally/internationally designated sites are assigned a high value.

Water quality

13.4.14 The Disposal Site is not located within a water body designated under the WFD. The nearest WFD water bodies are more than 12km from the Disposal Site; Caernarfon Bay North and The Skerries. Caernarfon Bay North is currently achieving good ecological status and The Skerries water body is at high ecological status [RD3]. In addition, there are no bathing waters in proximity of the Disposal Site, with the nearest being some 20km away.

13.4.15 A technical report on plankton ecology [RD11] classified areas of the Irish Sea with respect to hydrology, nutrient chemistry and ecology. The Disposal Site falls into an area classified as 'offshore mixed waters'. Here, waters are highly saline (>34) and exhibit moderate winter nutrient conditions. Waters in this typology are generally well-mixed, although a weak thermocline can develop during extended periods of fine weather.

13.4.16 Marine water quality was sampled at six sites within the Disposal Site itself, with two additional survey sites sampled within 1km to characterise marine water quality within the surrounding area (figure D13-20, Application Reference Number: 6.4.101). Marine water quality was sampled in October 2016, with physico-chemical and chemical results indicating a good chemical status, and many concentrations reported below the MRV (see paragraphs 13.4.22 to 13.4.26 and appendix D13-1, Application Reference Number: 6.4.83).

13.4.17 As the Disposal Site falls within the maximum tidal excursion south-west of the Wylfa Newydd Development Area, results of the 2010 to 2014 baseline water quality programme are also relevant to the understanding of water quality at the Disposal Site. Whilst the following sections summarise the dedicated survey carried out at the Disposal Site in 2016, it should be acknowledged that the Disposal Site study area for marine water quality encompasses the north coast of Anglesey and therefore survey data from the central study area for the Wylfa Newydd Development Area (see paragraphs 13.3.6 to 13.3.22 and appendix D13-1, Application Reference Number: 6.4.83).

Physico-chemical parameters

13.4.18 Temperature and salinity profiles sampled in the Disposal Site study area were very stable throughout the water column and across all sampling sites. This indicates a very well-mixed water body and the absence of permanent stratification within the area.

13.4.19 Dissolved oxygen values recorded within the vertical water column at all sites were high according to current WFD classification (>5.74mg/L).

13.4.20 The mean suspended solids (as total) reported in all samples was 5.5mg/L; based on this, the Disposal Site study area is classified as clear water under WFD criteria.

13.4.21 pH showed minimal variation, ranging between 8.18 and 8.23 across the survey sites.

Chemical and biochemical parameters

13.4.22 All results reported by the laboratory were compared with EQSs where applicable. No exceedance from AAs or MAC-EQS was reported for any of the determinands analysed, including metals. Moreover, all concentrations reported by the laboratory are in line with good chemical status, as defined by the WFD, and consistent with other coastal water with the absence of polluting substances.

13.4.23 Zinc concentration was reported above the relevant long-term EQS in one sample (HHD_18) at 34.5m. However, the AA concentration in all samples was 4.32µg/L, well below the EQS (6.8µg/L + 1.1µg/L background concentration). No MAC-EQS has been established for zinc.

13.4.24 Concentrations for boron, copper, zinc, arsenic and lead were all found within the expected values for coastal waters [RD4]. Nickel was reported marginally above the MRV in four samples, however, the mean value reported remained below the MRV. The following were all found below MRV in all samples

- vanadium;
- chromium;
- manganese;
- iron;
- cobalt;
- selenium;
- cadmium;
- tin; and
- mercury.

13.4.25 Most of the nitrogen and nutrient concentrations reported were found below the respective MRV, including total organic nitrogen (as N), inorganic nitrogen (as N), ammoniacal nitrogen (as N), nitrite (as N) and nitrate (as N). Total oxidised nitrogen (as N) was reported as below MRV (0.0040mg/L) in all samples except for one, reported marginally above (0.0056mg/L).

13.4.26 Total petroleum hydrocarbons and di-2-ethylhexyl phthalate were reported as below the MRV (0.2mg/L) in all samples collected.

Value of receptors

13.4.27 The Disposal Site is situated offshore in the Irish Sea. In relation to water quality, the Disposal Site's distance from the nearest EU-designated WFD water bodies (Caernarfon Bay North and The Skerries) and EU-designated bathing waters mean these are outside the zone of influence from disposal activity.

13.4.28 The water quality has a role in supporting the wider ecosystem but has limited economic value, is considered representative of the wider Irish Sea and is therefore not considered as a receptor for the Disposal Site. However, the potential effects of changes to water quality from the disposal activity are considered in relation to other marine receptors.

Seabed characteristics

13.4.29 The seabed off the north-west coast of Anglesey is largely defined by the presence of an extensive subsea platform of hard pre-Cambrian rock, which extends north-westerly to around 25km offshore [RD69]. The seabed therefore tends to be characterised by patches of either exposed bedrock or bedrock thinly overlain by boulders and lag gravel. There are also intermittent ribbons of sand where the remnants of glacial moraines or other protruding features baffle currents. Overall, it is an area of coarse tide-scoured rough ground [RD69].

13.4.30 Multibeam bathymetry collected by SEACAMS in 2013 and 2014 has indicated that the Disposal Site varies in depth from approximately 35m to 95m, though the majority of the site is deeper than 50m, with the seabed predominantly comprised of coarse sediments, boulder and bedrock [RD70].

13.4.31 Work by the British Geological Survey (BGS DigSBS250) and SEACAMS indicated that the majority of bedrock is found along the eastern and south-eastern boundary of the site, with estimates giving an area of 274ha (~10% of the whole Disposal Site) for bedrock. Adjacent to the bedrock, covering approximately 959ha is an area described as ‘rock and sediment’ with grab samples by SEACAMS recording ‘sandy coarse gravel’ to ‘very coarse gravel’ [RD70]. The areas of bedrock and rock tend to occupy the shallower waters (50m to 60m) with the coarse gravels found accumulated in the deeper plateaus.

13.4.32 Due to the depths of the Disposal Site, bed shear stress is dominated by tidal processes rather than wave climate, with values predicted to range between $6Nm^{-2}$ and $10Nm^{-2}$, with the bed shear stress threshold for bed transport of fine sediments at $0.18Nm^{-2}$ [RD67].

Sediment quality

13.4.33 Marine sediments were sampled at five sites within the Disposal Site itself, with an additional survey site sampled within 2km to characterise sediment quality within the surrounding area (figure D13-20, Application Reference Number: 6.4.101). Collectively, these sites represent the Disposal Site study area for sediment quality. Details of this work, including a map of the sampling locations, are contained within appendix D13-2 (Application Reference Number: 6.4.84), with a summary of the results presented below.

13.4.34 Grab samples were taken at depths ranging from 59m to 82m with all sites recording similar gravelly substrata. All metal concentrations were well below the relevant Cefas Action Level 1 threshold value with several metals below MRV. No metals exceeded the relevant Interim Sediment Quality Guidelines (ISQG) or Probable Effects Level (PEL) [RD9] with the exception of arsenic which just exceeded the ISQG at all sites.

13.4.35 All organic compounds monitored PAHs, PCBs, tributyltin (TBT) and other volatiles were below the relevant ISQG and Action Level 1 with many concentrations below MRV or only marginally above this value.

Value of receptors

13.4.36 Sediment quality is not a receptor in itself; however, it supports a number of marine receptors including subtidal communities, invertebrates, fish and seabirds. It is not therefore assigned a value but is considered within the receptor subtidal benthic communities, as it supports the communities present.

Phytoplankton and zooplankton

13.4.37 Considering the similarities in water quality characteristics and the mobility of plankton within currents, results of the phytoplankton and zooplankton monitoring programme, which was carried out in the central study area (within 5km of the Wylfa Newydd Development Area) between May 2010 and September 2014 (see paragraphs 13.3.40 to 13.3.53 and appendix D13-1, Application Reference Number: 6.4.83), are considered applicable to the Disposal Site.

Value of receptors

13.4.38 Phytoplankton and zooplankton are not considered to be of specific conservation value themselves, even though larval stages of species of conservation importance found around the coast of north Anglesey are expected to be found within the zooplankton community. However, they play a key role in the ecological function of marine ecosystems through the support of features of conservation value, as they provide a vital food resource for invertebrate and fish species. Plankton is of local importance and is relatively common in the coastal waters of north Anglesey, and therefore, the value assigned to this receptor is low.

Marine benthic habitats and species

Subtidal habitats and species

13.4.39 To characterise the subtidal benthic habitats and species within the Disposal Site, faunal grab samples were collected in 2016 from eight sites. At three of these, drop-down camera recordings were also taken in addition to 14 other sites. Survey effort was concentrated within the Disposal Site itself (17 of the 19 separate sites were located here), with the remaining located approximately 2km to the east to further characterise benthic habitats in this area (figure D13-20, Application Reference Number: 6.4.101). Collectively, these sites represent the Disposal Site study area for subtidal habitats and species

13.4.40 The recorded communities were as expected and align well with previous studies of the region (e.g. [RD69]; [RD71]) which found epifaunal benthic communities indicative of scoured environments.

13.4.41 Analyses of drop-down camera and, specifically, faunal grab samples revealed generally impoverished communities across the study area, likely a result of the mobile nature of some of the substrata and consequent scouring action. However, at several locations comparatively high faunal densities and numbers of taxa were recorded, with the richest site (HHD_20) recording 86 taxa, in contrast to the four taxa recorded at the most impoverished site (HHD_19) (figure D13-20, Application Reference Number: 6.4.101).

13.4.42 Annex I rocky reef feature was identified at 10 of the 19 sampling stations, predominantly as a result of 'stony reef' [RD72] with the exception of HHD_01 which was a 'bedrock reef'. Assessment of 'reefiness' was carried out (appendix D13-2, Application Reference Number: 6.4.84) resulting in four considered as medium reefiness and six as low [RD72].

13.4.43 The potential presence of the Annex I Ross worm (*S.spinulosa*) biogenic reef feature was noted at a number of sites. Similarly, these aggregations were assessed for reefiness [RD14]. This resulted in two sites, HHD_17 and HHD_20, considered as containing biogenic reef habitat of 'medium' and 'low' reefiness respectively. During analyses it was noted that the congeneric *S.alveolata* was often in high numbers and hence referred to as Sabellariidae biogenic formations from hereon.

13.4.44 No other Annex I habitats were recorded from the Disposal Site benthic surveys. A benthic study by NRW [RD64] covered three sampling locations in the Disposal Site; at three of these sites Sabellariidae reef was recorded. However, based on reef elevations recorded at these sites it is thought that these would represent low and medium reefiness.

13.4.45 Further afield, to the south of the Disposal Site, work by CMACS [RD71] recorded the presence of Sabellariidae reef at three locations, two sites of low reefiness and one of low to medium reefiness. A comprehensive benthic study in this region by Rees [RD69] recorded many sites with biogenic Sabellariidae crusts, but with an apparent reef structure recorded at only a single site. A recent study by NRW [RD64] recorded well developed Sabellariidae reef at a number of sites; however, these were far to the east of the Disposal Site, specifically around Church Bay, north-west Anglesey.

13.4.46 No species listed in accordance with Section 7 of The Environment (Wales) Act 2016 were recorded within the Disposal Site from the benthic surveys or work by NRW [RD64]. Nor did CMACS [RD71] record any from the area adjacent to the Disposal Site. However, several biotopes were recorded from these surveys that sit within the broad Section 7 habitat, 'subtidal sands and gravels'. Subtidal sands and gravel sediments are the most commonly found habitats below the level of the lowest low tide around the coast of the United Kingdom and are widely occurring in this region of the Irish Sea.

13.4.47 The HABMAP project [RD66] predicted that the muddy mixed biotope '*Mysella bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment' to be present and wide ranging within the Disposal Site boundary. However, benthic surveys by Horizon have not recorded the presence of the *Mysella bidenta* and *Thyasira* spp. biotope within the Disposal Site (appendix D13-2, Application Reference Number: 6.4.84).

Non-native species

13.4.48 Neither the Disposal Site benthic surveys (appendix D13-2, Application Reference Number: 6.4.84) nor work commissioned by NRW, with one of the key objectives to record any benthic INNS, recorded the presence of non-native species within or adjacent to the Disposal Site. However, a number of non-native species have been recorded from marine ecology surveys covering the north Anglesey coastline and within Holyhead Harbour. These are considered in detail in paragraphs 13.3.80 to 13.3.89.

13.4.49 Non-native species are not considered receptors in themselves; however, the potential effects associated with non-native species has been discussed, and the potential effects on other receptors considered, as part of the Disposal Site assessment.

Value of receptors

13.4.50 The Habitats Directive Annex I reef is present within the Disposal Site as stony reefs, rocky reefs and biogenic reefs; the latter being represented by Sabellariidae reef (see paragraph 13.4.43). There are no designated sites of national/international importance within, or adjacent to, the boundary of the Disposal Site that have reefs as a qualifying feature. However, recognition is given to reefs being an Annex I habitat and the aim of the Habitats Directive to achieve 'favourable conservation status' to the entire occurrence of a habitat type within its natural range.

13.4.51 Assessments of reefiness (appendix D13-2, Application Reference Number: 6.4.84) found two examples which qualified as reef features; one assigned a medium reefiness score whilst the second was of low reefiness. The reef features, in particular Sabellariidae reef, add to the local biodiversity and support the wider ecosystem. Based on the above the Annex I 'reef' features are assigned a medium value under the receptor group 'subtidal habitats of conservation importance'.

13.4.52 Several biotopes are present within the Disposal Site that fall within the broad habitat 'subtidal sands and gravels' which is listed in accordance with Section 7 of The Environment (Wales) Act 2016. These are commonly found throughout the area. These subtidal habitats are assigned medium value under the receptor group 'subtidal habitats of conservation importance.'

13.4.53 Other subtidal habitats identified throughout the surveys are common in the local area, have some biodiversity characteristics (e.g. naturalness, contribution to diversity) and are of local importance. All invertebrate taxa recorded are considered characteristic and common to this region. Habitats and species that are common and do not have any particular conservation importance are considered as part of the subtidal habitats and communities' receptor group, which is assigned a low value.

Marine fish

13.4.54 Considering the similarities in water quality characteristics, and mobility of fish, the wider study area delineated for the Wylfa Newydd Development Area (see paragraphs 13.3.99 to 13.3.101) which encompasses the eastern Irish Sea and coastal waters around Anglesey, is considered relevant to the Disposal Site.

Ichthyoplankton

13.4.55 The species complement at the Disposal Site will be similar to that recorded around the Wylfa Newydd Development Area. Abundances of some species (e.g. plaice, herring, Dover sole and whiting) may be slightly higher than that observed within the Wylfa Newydd Development Area, although abundances are likely to remain much lower than those recorded in the eastern Irish Sea. Furthermore, given the rapid dispersion of larvae, peak abundances at the Disposal Site are only likely to occur for a short period, coinciding with the timing of peak spawning.

13.4.56 High intensity spawning grounds for a number of fish taxa have been identified in the eastern Irish Sea (e.g. [RD24]); however, like the Wylfa Newydd Development Area, the Disposal Site is to the south-west and hence outside of the areas characterised by high intensity spawning in the Irish Sea.

13.4.57 Demersal species such as cod, plaice, sandeel, Dover sole, anglerfish (*Lophius piscatorius*) and whiting are all known to have low intensity spawning grounds that encompass the Disposal Site [RD24]. While pelagic species, such as mackerel, also have spawning grounds within the Disposal Site, the intensity of spawning within this area is considered to be low [RD24]. There are no known high intensity spawning or nursery grounds within the Disposal Site.

Subtidal fish and shellfish

13.4.58 Of the demersal species listed above, only whiting and anglerfish are known to utilise the Disposal Site as nursery grounds although this is considered to be a low intensity area [RD24]. Nursery grounds are assumed active for much of the year.

13.4.59 Considering the water depth at the Disposal Site, lesser-spotted dogfish, sprat, herring, grey gurnard (*Eutrigla gurnardus*), common dragonet, poor cod and other elasmobranchs are all expected to be present in this area, although in much lower abundances than that observed inshore within coastal waters around the north coast of Anglesey and wider Irish Sea. Although [RD24] classified inshore coastal waters around the north coast of Anglesey as a high intensity nursery ground for Dover sole, subtidal trawl surveys for the Wylfa Newydd Development Area (appendix D13-4, Application Reference Number: 6.4.86) along with evidence from other fish data (e.g. average fish landings into Holyhead, Cemaes Bay and Amlwch, from 2010 to 2014 by all vessels [RD25]; suggest Dover Sole is not a key characterising species of the Wylfa Newydd Development Area and Disposal Site.

13.4.60 Whilst sandeel is undoubtedly a key taxa characterising wider fish communities along the north coast of Anglesey (particularly inshore within sandy bay and inlets), owing to the presence of coarse rocky substrata, it is not considered to represent a key taxa characterising subtidal fish communities within the Disposal Site. Similarly, the dominance of coarse substrata at the Disposal Site would preclude any significant abundance of dab and plaice.

13.4.61 Elasmobranchs such as the basking shark (*Cetorhinus maximus*), nursehound, lesser-spotted dogfish, spotted ray (*Raja montagui*) and tope shark (*Galeorhinus galeus*) are all likely to be present at the Disposal Site [RD73]. There have been ten sightings of basking sharks near the Disposal Site between 1987 and 2006 and therefore, this species could to be present, albeit in low abundance and considered transitory rather than resident. Data from Ellis *et al*., [RD24] indicate that no elasmobranch species spawn near the Disposal Site. Tope shark and spotted ray are known to use the area for nursery but the intensity of use is low [RD24].

13.4.62 Diadromous species may transit the Disposal Site on an occasional basis to reach freshwater habitats on the west coasts of England and Wales. Sea lamprey (*Petromyzon marinus*), allis (*Alosa alosa*) and twaite shad (*Alosa fallax*) have not been encountered in any baseline surveys for the Wylfa Newydd Project, historic monitoring of the Existing Power Station, nor in biological records supplied by NRW and Cofnod. It is therefore unlikely that any of these species would be present at the Disposal Site in any significant numbers. Diadromous species such as river lamprey and sea trout, which are known to be present along the north coast of Anglesey, are also unlikely to be present in any significant numbers at the Disposal Site, as these species prefer inshore coastal waters.

13.4.63 Although European eel and Atlantic salmon has not been recorded in any of the recent marine surveys (since 2010), their presence along the north coast of Anglesey has been recorded historically. European eel is also known to be present in freshwater environments within the Wylfa Newydd Development Area (see appendix D9-16, Application Reference Number: 6.4.49). Whilst these species may be present at the Disposal Site, they are only likely to occur for short periods of time (i.e. migrating through) and in low abundance.

13.4.64 Commercial shellfish species such as edible crab, queen scallop and king scallop are likely to be present at the Disposal Site. There is no commercial fishing for scallops operating in or around the Disposal Site. Commercial potting for whelks, lobster and crab is known to occur at the Disposal Site although the intensity is considered to be low (less than two pots lifted and dropped per hectare per day) [RD28]. However, the recent Disposal Site benthic survey did not record the presence of any of these commercial shellfish (appendix D13-4, Application Reference Number: 6.4.86) nor were they recorded from this area in reports by NRW [RD64] and CMACS [RD71].

13.4.65 Of the Section 7 species recorded during the Wylfa Newydd Development Area subtidal trawl surveys, the following species are likely to occur at the Disposal Site: spurdog (*Squalus acanthias*), tope, cod, whiting, Dover sole, plaice, herring, scad/horse mackerel (*Trachurus trachurus*), mackerel, anglerfish, Raitt's sandeel, blonde ray (*Raja brachyura*) and the thornback ray. Of these species it is considered that the whiting and herring represent key characterising species of the fish communities at the Disposal Site.

13.4.66 No Annex II fish species were recorded from the subtidal trawls (appendix D13-4, Application Reference Number: 6.4.86); however, as noted above, species such as Atlantic salmon and European eel may transit through the Disposal Site.

Value of receptors

13.4.67 A number of individual fish species have no specific conservation value themselves but need to be considered as a community owing to the importance they play in the wider environment. Fish communities are therefore considered as 'ichthyoplankton not of commercial or conservation value' and 'general fish and fisheries (subtidal)', both of which are considered to be of low value.

13.4.68 Given that a similar complement of fish species will be present in the ichthyoplankton from those collected as part of the Wylfa Newydd Development Area ichthyoplankton surveys, it is considered that those species of conservation importance (which are listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016) will be present (see table D13-3).

13.4.69 Any Section 7 fish species likely to be present in the Disposal Site are considered to be important on a regional level and have therefore been assigned a medium value. Similarly, any fish species of commercial importance are also assigned a medium value.

13.4.70 There are two fish species of national/international importance which are likely to be present at the Disposal Site. Atlantic salmon, which is listed on Annex II of the Habitats Directive, and European eel, which is protected by the Eels (England and Wales) Regulations 2009, are both considered high-value receptors. These species are considered as separate receptors and assigned a high value.

Marine mammals

13.4.71 Considering the mobility and home ranges of marine mammals, the baseline for the Wylfa Newydd Development Area is considered to be representative of the Disposal Site. This baseline is made up of survey work, records of casual sightings and desk-based information, which includes taking account of Marine Mammal Management Units and SACs up to 200km from the Wylfa Newydd Development Area. Full details of the baseline information relevant to the Wylfa Newydd Development Area is presented in appendix D13-6 (Application Reference Number: 6.4.88). A desk-based study was also undertaken by Minesto, which assessed the density of marine mammals and sensitivity to potential effects near Holyhead Deep [RD74]. This information is considered applicable to the wider area around the Disposal Site. Baseline information directly relevant to the Disposal Site is summarised in paragraphs 13.4.72 to 13.4.76 below.

13.4.72 Bottlenose dolphin is one of the most common cetacean species recorded in the Irish Sea, accounting for over 50% of individuals sighted between 2004 and 2014 [RD30]. However, during dedicated surveys carried out within the area of the Disposal Site, no bottlenose dolphins were recorded from the entire survey area (375km survey effort) [RD65]. Considering this, it seems unlikely that the Disposal Site represents an area of particular importance to bottlenose dolphins although individuals are known to be present.

13.4.73 Harbour porpoise is the most widely distributed cetacean within the Irish Sea, and the distribution of sightings shows a localised hotspot of abundance around the area of the Disposal Site [RD37]. Harbour porpoise are known to be present year round with seasonal peaks in abundance during the summer months (particularly July and August).

13.4.74 Risso's dolphin has a relatively localised distribution in the Celtic and Irish Sea, covering Pembrokeshire, the western end of the Lleyn Peninsula and Anglesey [RD30]. Although Risso's dolphin are known to be present in the area, neither the Sustainable Expansion of the Applied Coastal and Marione Sectors [RD74] nor Gordon *et al*., [RD75] recorded any observations of Risso's dolphin during their studies of the north Anglesey coast. However, two sightings of Risso's dolphin with an average pod size of two individuals were reported during boat-based transect surveys carried out in 2016. It is therefore unlikely that the Disposal Site is of particular importance to this species, although it is possible that they could use the area on occasion. The seasonal distribution of Risso's dolphin for the Irish Sea Management Unit shows that there is a presence along the north coast of Anglesey throughout the year with an increased abundance during the summer (May to September) and a peak in June.

13.4.75 Grey seals are present in Welsh waters year round with peak sightings occurring between April and May. There are many suitable haul-out locations for grey seal across Anglesey, three of which (North Stack, Carmel Head and The Skerries) are known for grey seal breeding [RD39]; [RD41]. The nearest site to Holyhead North, North Stack, is situated just off Holy Island on the north-west coast of Anglesey and a relatively high proportion of pups have been recorded, signifying that the site is heavily used during the breeding season (August to December) but little outside that time, whilst Carmel Head and The Skerries are utilised year-round as haul-out sites.

13.4.76 The north Wales coast is described as a high-density area for grey seals. [RD76]. Two grey seal sightings in the west Anglesey area, corresponded to a rate of 0.10 sightings per hour [RD74]. Dedicated marine mammal surveys of the sea area surrounding the Disposal Site recorded equally low numbers of grey seals [RD74]. Hence, there is evidence to suggest that both adult and juvenile grey seal use the Disposal Site, although it is considered that the Disposal Site does not represent a particularly important area in the context of the wider Irish Sea.

Value of receptors

13.4.77 As detailed in paragraph 13.3.173, all species of marine mammal discussed above are assigned a high value.

Seabirds

13.4.78 JNCC Seabird Monitoring Program data (see paragraph 13.3.179) has shown that regional breeding population sizes (as defined in 13.3.176) ranged from zero for species known to occur but do not breed in the region (e.g. great skua) up to 173,445 (Manx shearwater). For the Disposal Site zone of effects, notable regional populations were shown for gannet (70,260), guillemot (90,559), fulmar (32,370) and kittiwake (2,738).

13.4.79 Within the Disposal Site zone of effects, there were colonies of four species ranging in numbers from shag (four pairs) to guillemot (196 pairs), with shag being the species with the largest proportion (14.81%) of birds in comparison to the regional population.

13.4.80 A desk-based ornithology study was undertaken by Minesto in 2016, which assessed the density of certain species of diving seabirds (mainly auks and gannet) and their sensitivity to potential effects in their study area near Holyhead Deep [RD65]. This was supported by an offshore ornithology baseline study [RD77] and work by Natural Research (Projects) Ltd on seabird populations and collision risks to diving seabirds [RD78]. This was a broad search, with the inclusion of bird populations of target species across the Irish Sea. Existing boat-based (JNCC ESAS data) and WWT aerial survey data identified relatively low densities of seabirds in the vicinity of Holyhead Deep with many species' presence being limited to the breeding season, especially auks. The desk study data used by Minesto was suitable for the purpose of their sensitivity study, but too old for use in EIA. Consequently, ESAS transect surveys were carried out in the Minesto study area in late 2016 and part of 2017, the results of which are summarised in appendix D13-7, (Application Reference Number: 6.4.89). Auks and Manx shearwater were the species present in highest numbers.

Value of receptors

13.4.81 The seabird species referred to as 'target species' are those which are qualifying features of the Anglesey Terns/Morwenoliaid Ynys Môn SPA, i.e. Arctic tern, common tern, roseate tern and Sandwich tern, and these are assigned a high value. All other seabirds (secondary species) are assigned a value of medium, as this includes secondary species such as regularly occurring migratory species (listed in accordance with the requirements of Section 7 of the Environment (Wales) Act 2016) and some species which are listed on Annex I of the Wild Birds Directive, e.g. black-headed gull, or on Schedule 1 of the Wildlife and Countryside Act 1981, e.g. Mediterranean gull.

Summary of receptors

13.4.82 The receptors relevant to the assessment and their values are presented in table D13-5.

Table D13-5 Summary of marine environment receptor value for Disposal Site

Receptor	Value
All designated sites of nature conservation importance and supporting features (SACs, SPAs and SSSIs, including candidate SACs)	High
Plankton (phytoplankton and zooplankton)	Low
Subtidal habitats and communities of conservation importance	Medium
Subtidal habitats and communities	Low
Ichthyoplankton (not of conservation and/or commercial importance)	Low
Ichthyoplankton (of commercial and/or conservation importance)	Medium
General fish and fisheries (subtidal)	Low
Fish (of conservation and/or commercial importance)	Medium
European eel	High
Atlantic salmon	High
Marine mammals (pinnipeds and cetaceans)	High
Seabirds (target species)	High
Seabirds (secondary species)	Medium

Evolution of the baseline

13.4.83 Acknowledging connectivity between marine receptors, the baseline environment at the Disposal Site and that characterised for the Wylfa Newydd Development Area are considered to be very similar with differences primarily relating to subtidal benthic habitat and species receptors. The evolution of baseline conditions at the Disposal Site is therefore likely to closely resemble that outlined in paragraphs 13.3.240 to 13.3.250 for the Wylfa Newydd Development Area baseline environment, although the effect of climate change will be less.

13.5 Design basis and activities

13.5.1 This section sets out the design basis for this assessment of effects. It sets out where any assumptions have been made to enable the assessment to be carried out at this stage in the evolution of the design. This section also identifies the embedded and good practice mitigation that will be adopted to reduce adverse effects as inherent design features or by implementation of standard industry good working practice.

13.5.2 As described in chapter D1 (proposed development) (Application Reference Number: 6.4.1), the application for development consent and Licensable Marine Activities is based on a parameter approach. The assessment described within this chapter has taken into consideration the flexibility afforded by the parameters. Modelling has included sensitivity testing of the tolerances within the Parameter Plans and Works Plans (Application Reference Number: 2.3), such as changes in positioning of the breakwater and in dredged depth. A worst case scenario has therefore been assessed from a marine environment perspective within the parameters described in chapter D1 (Application Reference Number: 6.4.1).

Construction

13.5.3 During construction the following activities are of particular relevance to the assessment of effects on the marine environment (either directly or through effects to surface water and groundwater, and freshwater environments); listed in order of occurrence:

- tree felling, vegetation clearance and dry stone wall dismantling and storage;
- topsoil clearance and storage;
- installation of drainage;
- removal of rock outcrop(s);
- watercourse diversion;
- construction of haul roads, plant compounds, car parks and offices (described as part of Main Construction);
- bulk earthworks including site levelling and grading to form required building platform levels for Unit 1 and Unit 2, including building platforms and construction and laydown areas;
- construction of haul roads and bridges;
- deep excavation (of Unit 1 and Unit 2);
- excavation of other features such as culverts and building foundations;
- progressive mound creation (through Enabling Works and Main Construction);
- construction and commissioning of concrete batching plant;
- temporary use of a beach landing facility;
- construction of the Cooling Water Systems (CWSs), breakwaters and Marine Off-Loading Facility (MOLF) (bulk material and Roll-on Roll-off (Ro-Ro));
- dry marine excavation, including blasting;
- wet marine excavation, including dredging;
- installation (and removal) of cofferdams for Cooling Water intake and outfall construction;
- excavation and construction of Cooling Water intake and outfall including tunnelling;
- construction of internal roads, car parking, security fencing and permanent lighting;
- operation of the MOLF;
- operation of concrete batching plant;

- Main Plant construction (Unit 1 and Unit 2);
- discharge of sewage; and
- disposal of material (rock and sediment) from marine excavation.

13.5.4 The term ‘inner harbour’ has been used to describe activities inside the temporary cofferdam whilst the term ‘outer harbour’ has been used to refer to activities within the remaining area in Porth-y-pistyll.

13.5.5 The Power Station construction programme is anticipated to commence following grant of development consent. The Main Construction is anticipated to take approximately seven years with the first Unit operational following Main Construction and the second Unit operational approximately two years later.

13.5.6 Activities such as bulk earthworks, deep excavations, rock excavation and MOLF construction would commence in the first year following grant of development consent. Details on the phasing of construction of the Marine Works are provided in appendix D1-1 (Construction Method Statement) (Application Reference Number: 6.4.17).

Drainage network

13.5.7 The drainage within the Wylfa Newydd Development Area would be modified during construction to manage the change in runoff from land drainage. The preliminary design for construction surface water drainage is contained in appendix D8-8 (summary of preliminary design for construction surface water drainage) (Application Reference Number: 6.4.33). The surface water drainage system would be installed prior to any major earthworks (including topsoil stripping) and would remain in place throughout the construction works. To control suspended solid concentrations during the construction of mounds and when they are unvegetated an active treatment system would be installed which, when required, would use a polyelectrolyte to aid settlement. Following construction of the mounds and once they are vegetated the drainage system would remain as a passive system (i.e. the ditches and swales and settlement ponds would remain but the active polyelectrolyte treatment equipment and any additional temporary measures such as silt fences, would be removed).

13.5.8 No process water from the concrete batching plant would enter the marine environment. Runoff from the concrete batching plant would drain into the main site surface water drainage. It would be intercepted within the batching plant site and monitored for pH levels. If the pH is above eight, then it would be treated prior to discharge.

13.5.9 Drainage of the MOLF quay would occur via longitudinal slot drains that would run along the back of the paved areas to collect surface water via an oil separator (to remove oily contaminants) and sediment catch-pit (to removed settled solid materials) before discharge to the sea via the main site drainage outfall. It is anticipated that this outfall would comprise a pipe outlet concrete headwall with a flap valve. The main site drainage outfall would be located within the MOLF’s footprint; for example, in the revetment between the two bulk berths (see figure D8-8, Application Reference Number: 6.4.101).

Dewatering

13.5.10 Dewatering comprises both groundwater (from excavations, and tunnelling) and seawater (from the temporary cofferdams).

13.5.11 Groundwater abstracted for dewatering of the basements and platform area during construction would be discharged to the sea via a system of transverse and perimeter ditches that discharge through two sedimentation ponds. Further treatment will be provided by a polyelectrolyte coagulant dosing system when required. Three discharge points (PA, PB, PC) in Porth-y-pistyll would be used depending on the phase of construction as shown in appendix D8-8 (Application Reference Number: 6.4.33).

13.5.12 Dewatering in the marine environment would be required at the outfall and intake cofferdams and for the inner harbour cofferdam in Porth-y-pistyll. Water would be pumped over the side of the cofferdams into the sea.

13.5.13 Suspended solids concentrations of the groundwater and marine dewatering components (with the exception of the initial dewatering of the inner harbour and outfall area) would be managed to not exceed the permitted level at the discharge points (see paragraphs 13.5.78 and 13.5.78).

Sewage discharge

13.5.14 Construction derived sewage would be treated in a dedicated construction sewage package plant. Following treatment, effluent would be discharged in the north of Porth-y-pistyll, at a location that would become the northern end of the western breakwater. The maximum daily rate of discharge is approximately 1,598m^3 per day.

13.5.15 An extension to the existing Cemaes Welsh Water Treatment Plant, operated by Dŵr Cymru Welsh Water (DCWW), and located to the west of the Site Campus, would treat sewage derived from the Site Campus. This would discharge through the current DCWW outfall or otherwise through the new Cooling Water outfall constructed for the Wylfa Newydd Project. The maximum daily rate of discharge from the Site Campus is approximately 1,598m^3 per day.

Construction, commissioning and operation of the concrete batching plant

13.5.16 The construction of the concrete batching plant and associated infrastructure (e.g. hardstanding, haul roads, conveyor system) is integrated with the construction of the MOLF. Reclamation of land behind of the MOLF would be required for construction of the concrete batching plant. The concrete batching plant would have a total footprint of up to 3.6ha, covering approximately 2ha of the intertidal zone.

Temporary access ramp construction

13.5.17 As one of the initial marine construction activities, a temporary access ramp would be constructed at the southern end of Porth-y-pistyll (see figure D1-9, Application Reference Number: 6.4.101). The ramp would take the form of a slipway and would be constructed from crushed rock either won from the Power Station construction site or imported by road if site-won rock was not available. The ramp would be graded to the required slope by a bulldozer working within the tidal window. The toe of the ramp would be at around Low Water Springs level. For each barge-unloading operation a ramp formed from crushed rock or similar would be reshaped to enable the construction plant to drive off the barge.

13.5.18 Once built, it is anticipated that the ramp would remain in place for a limited period of time (up to one year). It would then be dismantled and removed having served its purpose. The resulting materials would be re-used on-site or off-site (e.g. as aggregate), or in accordance with the Contaminated Land: Applications in Real Environments code of practice.

Temporary barge berth

13.5.19 A temporary berthing and unloading facility would be required to accommodate barges importing construction materials for subsequent Marine Works (e.g. quay wall materials for the MOLF).

13.5.20 The berth would be located to the south of (and adjacent to) the planned site of the eastern breakwater within the area of reclaimed land (see figure D1-9, Application Reference Number: 6.4.101). Its structure would comprise a modular retaining wall constructed using either steel shipping containers filled with crushed rock or other suitable fill, or another suitable modular type retaining wall structure. An area behind the retaining wall would be backfilled to create a working platform for a mobile tracked/crawler crane behind the retaining wall. An area in front of the retaining wall would be filled and levelled with rock to create a platform onto which barges could be grounded as the tidal level falls. An access ramp would be provided from the quay level down to the beach in front of the quay to facilitate plant access for maintenance of the platform.

13.5.21 Once the MOLF is part-constructed and the temporary barge berth is not required, it would be removed. Materials arising from removal of the temporary barge berth would be re-used on-site, off-site or in accordance with the Contaminated Land: Applications in Real Environments code of practice.

Construction of the temporary cofferdam and southern causeway

13.5.22 The temporary cofferdam, approximately 350m long, and a causeway approximately 400m long, would be required to create a watertight seal inside which the inner harbour would be dewatered and excavated in the dry (see figure D1-9, Application Reference Number: 6.4.101). The temporary cofferdams would be constructed by depositing rubble stone and rock armour won from the Power Station Site over the foreshore and seabed to form rubble mound structures. The materials would be transported to the cofferdam using dump trucks or by sea using barges, and would be shaped by tracked excavators either working from land or working from sea on jack-up platforms or barges.

13.5.23 The rubble mound structures would need to be made watertight by integrating a steel pile wall into the centre of the structure. The wall could be constructed by installing steel sheet piles through the middle of the structures and grouting them into a pre-cut trench in the seabed (i.e. trench cut from the seabed prior to the placement of the rubble mound structure) to create an effective seal. Under this option, the piles would be installed using a vibratory piling hammer and, potentially, a hydraulic drop hammer (e.g. Dawson's hydraulic impact hammer) should the piles not reach the required depth through the use of the vibratory piling hammer alone.

13.5.24 Alternatively, the wall could be constructed by installing interlocking steel tubular piles through the middle of the structures and grouting them into the rock below the rubble mound. Under this option, the piles would be installed into holes pre-drilled through the middle of the rubble mound structures and into the bedrock using a vibratory piling hammer and, potentially, a hydraulic drop hammer should the piles not reach the required depth through the use of the vibratory piling hammer alone. Under both options the piles would be installed by construction plant working from the top of the rubble mound structures.

13.5.25 Construction of the temporary cofferdam and temporary causeway (including sheet piling) is expected to take approximately eight months. Once sealed the main dewatering of the inner harbour would take approximately ten days.

13.5.26 To maintain dry conditions within the cofferdam there would be 24-hour use of four dewatering pumps to compensate for water inflow into the basin, for example, through or under the cofferdams, through the ground or by precipitation.

13.5.27 The cofferdam would initially be dewatered using pipes within the cofferdam structure to allow water to flow out at low water. The remaining seawater would subsequently be pumped from the landward to the seaward side. With the exception of the initial dewatering of the inner harbour, the suspended solids of the pumped seawater would be monitored to check that it does not exceed the permitted level and if required, management procedures such as settlement would be provided to meet this limit.

Removal of the Temporary Marine Works (temporary cofferdam and temporary southern causeway)

13.5.28 On completion of the works within the inner harbour, the temporary cofferdam between the temporary causeway and MOLF and the southern causeway would need to be removed. This is expected to extend over a period of 12 months. The temporary structures would be removed in reverse of the installation method. All materials would be re-used on-site, off-site, or in accordance with the Contaminated Land: Applications in Real Environments code of practice.

Dredging and excavation

13.5.29 Superficial soft sediments will be dredged from the outer harbour to provide a solid foundation for the breakwaters and MOLF, and to ready the area for dredging of rock which is required to create sufficient depth for the intake and navigation channel.

13.5.30 The target dredge depth is -10 metres Above Ordnance Datum (mAOD) with a tolerance of a maximum parameter of -11mAOD at the intake channel and -13mAOD at the Berthing Pockets.

Dredging of the outer harbour

Soft sediments

13.5.31 The superficial soft sediment (mainly sands and gravels) would be removed by conventional dredging plant such as a backhoe dredger, cutter suction dredger or trailing suction hopper. For the purpose of the assessment and modelling the worst case upper limit of soft sediment that would be dredged is a bulked volume of 242,000m^3 (equating to a saturated density of approximately 352,000 wet tonnes, based on a specific gravity of 1.6), although the values are likely to be considerably less; see chapter D1 (Application Reference Number: 6.4.1).

Rock

13.5.32 Outside the temporary cofferdam, the bedrock would be initially fractured by peckering with a breaker and then ripped out and dredged with a barge mounted excavator and loaded into barges. The duration of this activity would be about 16 months. For the purposes of the assessment and modelling the worst case upper limit of rock that would be removed from the outer harbour by dredging is a bulked volume of 368,000m^3 (equating to an *in situ* density of 709,714 tonnes, based on a specific gravity of 2.7) (see chapter D1 (Application Reference Number: 6.4.1) for more detail). Dredged bedrock would be re-used for the construction of the cores of the western and eastern breakwaters where appropriate (i.e. geotechnically suitable) and practical (i.e. available when the breakwater construction requires it), or exported off-site for re-use. The remaining dredged bedrock that cannot be re-used would be disposed of at the Disposal Site. Waste material characterisation is outlined in [RD79].

Excavation of the inner harbour

13.5.33 From the existing rock head level, down to around low tide level, and inside the temporary cofferdam, the bedrock would be fractured by blasting (i.e. with explosives in the dry) and then excavated using tracked excavators and dump trucks.

13.5.34 Excavation of the inner harbour would be carried out in the dry and is expected to take around 14 months in total. Preliminary excavation would begin onshore up to 0mAOD and would take around six months. Once the cofferdam around the inner harbour is in place, rock fracturing by blasting in the dry behind the cofferdam would be carried out for approximately seven months. There is likely to be three blasts per day, with operations limited to within 10:00 and 16:00 Monday to Friday, and 10:00 and 13:00 on Saturdays (see appendix B6-2, Application Reference Number: 6.2.21). Drilling activities prior to blasting would be limited to 07:00 to 19:00.

13.5.35 Approximately 500,000m^3 bedrock would be excavated in the dry, including the excavation directly in front of the Cooling Water intake structure.

Re-use and disposal of dredged material

13.5.36 Material arising from works in the inner harbour would be re-used on-site (e.g. for core material in the Cooling Water intake breakwaters).

13.5.37 Disposal of dredged rock and soft sediments from the outer harbour would be carried out at the Disposal Site. The site is located approximately 18km west of the Wylfa Newydd Development Area (see figure D13-21, Application Reference Number: 6.4.101).

13.5.38 For the purposes of this assessment and modelling the worst case volume for material that could require disposal at sea is approximately 610,000m^3. This would comprise approximately 368,000m^3 of bulked rock material and 242,000m^3 of bulked soft sediment.

13.5.39 Assuming a barge with approximate capacity of 3,500m^3, it would take 35 days to dispose of the sediment. However, this assumes a continual series of disposal events without break and is therefore a worst case (see appendix D13-12, Application Reference Number: 6.4.94).

13.5.40 Rock would be disposed of over the duration of the wet excavation works, taking approximately 16 months (chapter D1, Application Reference Number: 6.4.1).

Construction of the breakwaters

13.5.41 There would be two breakwaters extending out into Porth-y-pistyll that would provide protection and create acceptable wave conditions for operation of the CWS; referred to as the western breakwater and the eastern breakwater (see figures D1-2, Application Reference Number: 6.4.101 and D1-9, Application Reference Number: 6.4.101). The breakwaters would also provide sheltered conditions for vessels accessing and berthing at the MOLF.

13.5.42 The western and eastern breakwaters would be approximately 400m and 150m in length, respectively. Both breakwaters would have rock-filled cores covered with pre-cast concrete armour units and, where practical, rock armour. The largest concrete armour units to be used on the ends of the breakwaters are expected to be approximately 38 tonnes in weight, with smaller units being used in less exposed areas. A change to natural rock armour would occur once the block weights are sufficiently reduced to allow economical use of natural rock and where there is sufficient space to accommodate the gentler gradient when using rock armour.

13.5.43 Access for the construction of both breakwaters would be facilitated by the construction of haul roads. A temporary causeway would be constructed to create a haul road (wide enough for two vehicles to pass) between the land and the southern end of the western breakwater.

13.5.44 The western breakwater's core would be constructed by depositing dredged material (i.e. fractured bedrock) and stone and/or rock won from the Power Station Site, with a rock size varying from approximately one kilogramme to one tonne, on top of the prepared seabed to form a mound.

13.5.45 Depending on whether the construction is taking place from the land or the sea, the core material would be transported to site by road using dump trucks or by sea using split hopper barges and/or side stone dumping vessels, and would be trimmed by long-reach tracked excavators working on the breakwaters or from jack-up platforms or barges in the sea.

13.5.46 A rock underlayer with rock size varying from one tonne to six tonnes, depending upon the location along the breakwater, would be placed on top of the core material. Pre-cast concrete armour units (or rock armour, if used; see below) would be placed over the mound. The armour units could vary in size depending upon the location along the breakwater. The further out to sea, the larger the armour unit size. The armour units would be placed in a precise grid pattern to ensure they are interlocked. The rock underlayer and armour units would be transported to site by sea using barges and/or via the haul road using dump trucks, and would be unloaded directly onto the breakwaters using cranes working from the breakwaters.

13.5.47 The eastern breakwater would be constructed from land working seawards using similar methods, materials and plant as described for the western breakwater.

13.5.48 During Power Station operation the breakwaters would be subject to routine visual inspection to check that they were structurally intact, particularly after major storm events. No routine maintenance of breakwaters should be required, but it is possible that the breakwaters could require some occasional maintenance, which is most likely to take the form of the re-positioning and/or replacement of dislodged and/or damaged armour units. In the case of the western breakwater, this would require the use of floating plant; there would be no vehicular access to the breakwater.

Construction of the MOLF

13.5.49 The MOLF is required to facilitate the construction of the Power Station and would therefore be constructed early in the programme and be operational throughout the Power Station construction phase (see figure D1-2, Application Reference Number: 6.4.101). It would provide two quays and a layby berth. The bulk quay (with two berths) for the offloading of bulk materials such as sand, gravel, cement and reinforcement and a Ro-Ro quay. The layby berth is provided as a safe place for ships to berth if the other berths are occupied.

13.5.50 The bulk quay would lie south of the eastern breakwater. It would comprise two berthing platforms providing berthing facilities for bulk vessels and unloading facilities for bulk materials, each with four mooring dolphins (i.e. eight in total). The area between the two platforms would either be a continuous quay wall and for the purposes of modelling and assessment a revetment has been assumed. The bulk quay would provide berthing facilities for bulk materials. The area behind the berthing platforms, dolphins and quay would be reclaimed to form a new land area up to the required platform level of between +5mAOD or +6mAOD, and would be protected by a rock armour revetment.

13.5.51 The Ro-Ro quay would extend eastwards from the southern end of the bulk quay (i.e. towards the shoreline) and comprise a quayside used primarily for Ro-Ro vessels and Lift-on Lift-off vessels, incorporating a ramp for ship to shore transfer of Abnormal Indivisible Loads, and Lift-on Lift-off of equipment and materials by cranes. Its quay wall would be approximately 100m in length and its quay surface would be set at a platform level of between +5mAOD or +6mAOD. The quay wall for the Ro-Ro ramp would be set at the same level as the bulk berth quay surface level with the toe of the sloping ramp used to receive Abnormal Indivisible Loads being at approximately +3.5mAOD, thereby providing a shallow gradient up to the general quay level. The quay wall would continue towards the CWS intake and the base of the wall would match the level required for the CWS intake.

13.5.52 The layby berth would be located at the southern end of the western breakwater and constructed in the dry behind the cofferdam. The berth would consist of a series of berthing and mooring dolphin structures adjacent to a dredged pocket. The berth would be remote from the land and would be accessed by small boats.

13.5.53 The temporary layby berth would be removed once Power Station construction is complete. Removal would involve the use of a floating crane barge or a jack-up crane barge for lifting off the walkways between the dolphins; and demolition of the dolphins. If mass concrete blocks were used for the dolphins, they would be cut into manageable sections using a wire saw or similar and lifted onto a barge for removal and crushing off-site. If steel piles were used to construct the dolphins, these piles would be cut off at seabed level and lifted onto a barge for removal from site and either reuse elsewhere or scrapping. The power cable would be removed from the seabed.

13.5.54 In addition to the various cargo vessel berths, a pontoon would be required for mooring tugboats, pilot vessels, safety boats and other small workboats during the construction of the Power Station. It would be a floating structure located between the Ro-Ro berth and the Cooling Water intake structure.

13.5.55 It is anticipated that the walls of the bulk berthing platforms and the Ro-Ro quay wall would use pre-cast mass concrete blockwork structures built up from the bedrock which would be prepared by rock dredging to the required formation level. The mooring dolphins would either be similarly constructed in pre-cast mass concrete blocks or using large diameter steel mono-piles socketed onto the seabed or multi-pile dolphins similarly socketed into the seabed.

13.5.56 Berthing pockets would be dredged alongside the bulk quay and the layby berth. The proposed depth of the berthing pockets would allow bulk cargo vessels to remain berthed across most states of the tide, but may not be sufficient to allow fully laden vessels to manoeuvre onto the berths across all states of the tide. The berthing pockets would extend approximately 30m from the quay. An indicative bulk berth pocket depth would be approximately -11.9mAOD plus dredging tolerance of approximately 1m.

13.5.57 The berthing platforms, mooring dolphins (if constructed using concrete blockwork) and the Ro-Ro quay wall would be constructed on top of the prepared bed using pre-cast concrete blocks. To facilitate the placing of the blocks, the area immediately behind the quay wall would be partially filled with suitable rock fill material. The pre-cast concrete blocks would be transported to site by barges and would be placed into position by cranes working from the land or from jack-up platforms or barges in the sea. A concrete capping beam would be cast *in situ* along the top of the blockwork to complete the structures.

13.5.58 Aids to navigation would be installed to provide safe navigation for vessels during both construction and operation. During the MOLF construction phase, up to three special marks with yellow lights would be placed at intervals along the north-west of the bay such that they create a safety zone but do not present a navigational hazard for approaching construction vessels. Subject to agreement with the Maritime and Coastguard Agency and Trinity House Lighthouse Service, the aids to navigation for the operational phase would include a set of leading marks with lights to guide vessels between the breakwaters, and marks and lights for breakwaters, the bulk and Ro-Ro berths and the CWS intake. The aids to navigation would be in accordance with the International Association of Lighthouse Authorities' buoyage system.

Operation of the MOLF

13.5.59 It is expected that the MOLF would operate on a 24-hour basis all days of the year, used by bulk Lift-on Lift-off and Ro-Ro vessels. Typically, the bulk vessels would take the form of approximately 8,000 dead weight tonnage aggregate bulk carriers, plus up to approximately 4,000 dead weight tonnage cement bulk carriers, and approximately 1,500 dead weight tonnage general cargo/Lift-on Lift-off ships (for plant, equipment, rebar and cement in tanktainers). Typically, the Ro-Ro vessels would take the form of barges, sized to suit the dimensions of the individual Abnormal Indivisible Loads.

13.5.60 At the bulk quay a range of bulk materials handling and conveyance equipment would be installed including a mobile harbour crane on each berth, height-adjustable receiving hoppers, mechanical conveyors for aggregate transport, and pneumatic pumps and pipelines for cement transport.

Shore protection

13.5.61 Adequate shore protection would be provided where dredging or excavation could lead to shore erosion and/or unacceptable wave overtopping discharges. Locations for shore protection would include:

- between the eastern breakwater and the shoreline (approximately 80m in length); and

- between the two bulk MOLF.

13.5.62 Shore protection would take the form of rock revetments or seawalls and would be tied-in with the adjacent structures (e.g. breakwaters, quay walls and Cooling Water intake channel). The toe of the shore protection would be below Mean Low Water Springs at the dredged seabed depth, which would be approximately -10mAOD. Where there is no requirement to dredge in front of the area of shore protection, the revetment/sea wall would tie in with the existing seabed level.

Cooling Water intake and outfall works

13.5.63 The CWS comprises three individual systems, all of which share a common intake. The CWS requires the construction of the following elements below Mean High Water Springs:

- an intake channel and forebay structure with screening, acoustic deterrents and a skimmer wall within Porth-y-pistyll;
- breakwater structures to offer necessary weather protection to the intakes, including calming the water during stormy conditions (see paragraph 13.5.41);
- outfall structure within Porth Wnal; and
- fish recovery and return discharge structure (see paragraph 13.5.70).

13.5.64 Construction of the intake and outfall would require significant rock excavation which would be completed in the dry behind cofferdams. The Cooling Water intake channel would be excavated to create a –10mAOD formation level. An additional cofferdam is required in front of the intake as the tunnelling works and installation of associated infrastructure are longer in duration than the marine excavation and construction works.

13.5.65 The cofferdams at both the Cooling Water intake and outfall would be constructed using one of three options:

- twin sheet piled wall gravity structures;
- twin tubular pile wall gravity structure; or
- rock bund type cofferdams similar to the semi-dry cofferdam (not considered for the Cooling Water intake structure)

13.5.66 For the two piled options, trenches on the line of the two tubular pile/sheet pile walls would either be blasted into the rock (intake cofferdam constructed in the dry), or cut into the rock where the work is undertaken underwater. The tubes/sheet piles would be stood up in place and concreted into position. In the case of the Cooling Water intake cofferdam this operation would be undertaken in the dry, behind the semi-dry cofferdam. In the case of the Cooling Water outfall cofferdam the operation would be carried out underwater. In both cases, tie rods and steel waling beams would be installed between the two parallel walls and fill material placed inside the cofferdam.

13.5.67 The rock bund type cofferdam being considered as an option for the Cooling Water outfall would be a similar form of construction to the semi-dry cofferdam with a steel sheet pile concreted into a trench cut into the rock, supported on both sides by a rock fill bund, protected on the outer face by rock armour.

13.5.68 The cofferdam structures would remain in place until completion of all of the intake, outfall and tunnel works. The cofferdam removal works would be a reversal of the construction works. The resulting materials would be re-used on-site, off-site, or in accordance with the Contaminated Land: Applications in Real Environments code of practice.

13.5.69 The Cooling Water tunnels are to be primarily excavated by controlled drilling and blasting. The discharge channels at the Cooling Water outfall would be constructed using a cut-and-cover methodology.

Fish protection measures

13.5.70 Fish protection measures including an Acoustic Fish Deterrent (AFD) and fish recovery and return (FRR) system would be installed at the Cooling Water intake structure. The discharge point for the FRR system would be below lowest astronomical tide (LAT) and located to the north of the eastern breakwater in the region of the -6.0mAOD contour. The design of the FRR outfall structure and type of conduit is currently being examined but would follow best practice (e.g. [RD80]). It is likely to involve installation of a conduit below ground level, of sufficient diameter, flow and gradient to reduce risk of blockage, following a route north from the Cooling Water intake screen structure to meet the coastline level with the eastern breakwater and rock armour. The discharge point would be fixed to the northern face of the eastern breakwater and the height and positioning of this structure have been considered in order to permit the best chance of fish survival and reduce the risk of re-impingement (as determined by modelling), respectively.

13.5.71 The AFD would involve mounting an array of underwater sound projectors on the dividing walls of the coarse screens at the face of the Cooling Water intake. This array would provide an adequate sound field to deflect fish hearing specialists and generalists (when coupled with low approach velocities), whilst not spreading beyond the intake embayment (which could cause a disturbance to passing marine mammals).

Marine plant

13.5.72 To excavate and construct the marine elements the following plant are required in addition to conventional site plant:

- jack-up platforms;
- a variety of cranes;
- barges for the transportation of material;
- drilling rigs;
- dredgers;
- rock breaker;
- rock cutter; and

- work boats and safety boats.

13.5.73 There would be a number of small vessels required to transfer workers from land onto marine plant during the two-year period of construction and during operation of the MOLF. These vessels would primarily operate within Porth-y-pistyll and would be subject to strict controls including appropriate speed restrictions. Journeys to and from other ports would not normally be required.

Lighting

13.5.74 Lighting levels would be required to be as uniform as possible, thereby offering an even field of view and the elimination of unnecessary bright spots. The effect of glare is of particular importance for the moving of vehicular and trailer-mounted cargo within the area together with the effect on the approach to the MOLF from the Power Station Site. Lighting levels would vary based on the construction activity with maximum levels of 200Lux associated with dredging operations. Land based operations would have light levels between 2Lux and 120Lux.

13.5.75 Dolphin walkway lighting would typically consist of low-level luminaires mounted in walkway hand-railing. The mobile harbour cranes located on each platform would feature on-board lighting for the purpose of providing specific supplementary lighting, task lighting, and for operational purposes to supplement the berth platform vulnerable areas (i.e. remove shadows created when the crane moves on the platform).

Embedded mitigation

13.5.76 As set out in the Phasing Strategy (Application Reference Number: 8.29), Horizon will install appropriate drainage on-site prior to main construction. This would include sediment settlement ponds, appropriate treatment to manage flows and meet agreed water quality thresholds. An application would be made for an Environmental Permit which would set limits on the concentrations of substances which could be discharged to protect the receiving surface water.

13.5.77 As set out in the Wylfa Newydd Code of Construction Practice (CoCP) (Application Reference Number: 8.6), surface water runoff from exposed topsoil during construction and later from the newly formed landscape mounds would be managed by a treatment train of sustainable drainage system (SuDS) features, as detailed in appendix D8-8 (Application Reference Number: 6.4.33). Sediment settlement ponds would be used in conjunction with other measures including silt traps, silt curtains, silt fences and vegetated channels. Ditches would be constructed around the base of the landscape mounds to allow flows to be captured and discharged to the drainage system. The discharge limit for suspended solids for each discharge point would be set in the construction Environmental Permit with the limit set based on baseline conditions so that there would be no significant effect on the receiving water. The design has been prepared to meet a minimum treatment standard of between 40mg/l and 70mg/l total suspended solids (depending upon the background concentration in the receiving watercourse) during normal rainfall conditions. Chemical dosing may be required during the construction stage of the mounds and when they are unvegetated if there is insufficient settlement of solids in the settlement ponds (e.g. due to high flow rates). Details are provided in appendix D8-8 (Application Reference Number: 6.4.33).

13.5.78 As set out in the Marine Works sub-CoCP (Application Reference Number: 8.8) dredging of soft sediments in Porth-y-pistyll will be restricted to the area identified in the dredging plan and the duration will be shortened as far as practicable, in order to reduce suspended solids concentrations and the release of sediment-bound contaminants.

13.5.79 As set out in the Marine Works sub-CoCP (Application Reference Number: 8.8) where possible excavated rock material would be used in the construction of marine structures to reduce the volume of material imported to site and the amount requiring marine disposal. This would reduce the possibility of transmitting INNS via excavated materials.

13.5.80 As set out in the Marine Works sub-CoCP (Application Reference Number: 8.8) and the Marine Licence application, where practicable, disposal of sediment would take place within the central area of the Disposal Site to mitigate any effects beyond the Disposal Site boundary. Rock material would also be deposited within a micro-sited area of the Disposal Site.

13.5.81 As set out in volume 2 of the Design and Access Statement (Power Station Site, Application Reference Number: 8.2.2) the design and positon of the western breakwater would ensure that a sufficient gap exists at the landward end, post construction of the Marine Works. This would be designed to maintain appropriate hydrodynamic flows and allow mixing within Porth-y-pistyll and prevent long-term physical disturbance to habitats located to the west of the breakwater structures around Cerrig Brith during the remainder of the construction phase of the Wylfa Newydd Project. The design would also consider wave refraction to reduce changes to hydrodynamics (bed shear stress and scour) and wave climate from the presence of the breakwaters and MOLF.

13.5.82 As set out in volume 2 of the Design and Access Statement (Application Reference Number: 8.2.2) the footprint of the breakwaters, Cooling Water intake and outfall structures, temporary causeway, including dredging activities would be designed to be as small as practicable (whilst meeting operational requirements). This would ensure migratory fish species such as European eel and sea trout are not prevented from entering and leaving freshwater habitat in the Afon Cafnan during the construction phase.

13.5.83 As set out in the Phasing Strategy (Application Reference Number: 8.29) the design of the breakwater structures will introduce new hard surfaces which could potentially have the capacity to function as an artificial rocky reef, providing new colonisation opportunities for species dependent on hard substrate [RD81].

13.5.84 As set out in the Phasing Strategy (Application Reference Number: 8.29) the design of the permanent breakwaters will provide intertidal areas for grey seals to haul out. The development of habitats and species on the breakwater structures could also potentially provide habitat, food and refuge resources for seabirds.

13.5.85 As stated in the Landscape and Habitat Management Strategy (Application Reference Number: 8.16) the sediment control design element of the construction drainage system would reduce mobilisation and transport of fine suspended sediment. Methods would be applied to manage the discharge of sediment (as outlined in the Main Power Station Site sub-CoCP, Application Reference Number: 8.7). At the Nant Cemlyn (which drains to the Cemlyn Lagoon) specific measures would be undertaken during construction of Mound E. Flow would be diverted into the Afon Cafnan until vegetation becomes established and risk of high sediment solid discharge is reduced.

13.5.86 In accordance with the strategy set out in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7), methods would be applied to manage the discharge of suspended sediments to Cemlyn Lagoon. These include:

- No polyelectrolyte dosing would be employed for discharge E1.
- From the point of commencement of earthworks on the west of Mound E onwards, no water would be discharged into Nant Cemlyn via discharge E1 until vegetation has re-established and risk of increased sediment run off is low.
- After establishment of vegetation, if there are any additional bulk earthworks on the west of Mound E resulting in a risk of sediment discharge, no water would be discharged into Nant Cemlyn via discharge E1 until re-establishment has again occurred.
- During the above period(s) all water would be diverted and discharged into the Afon Cafnan via discharge E2 or further down the catchment. This discharge would require an Environmental Permit from NRW.

Good practice mitigation

13.5.87 An overarching Wylfa Newydd CoCP (Application Reference Number: 8.6) and relevant sub-CoCPs (Main Power Station Site and Marine Works, Application Reference Numbers: 8.7 to 8.8) set out environmental management requirements to mitigate construction activities. These documents include best practice, where practicable, such as environmental emergency management as well as dust and sediment management strategies. Pollution prevention strategies are also set out to reduce the potential for, and the scale of, any accidental leaks and spills during the proposed activities. All bulk fuel storage would be within engineered containment facilities including suitably bunded tanks.

13.5.88 As set out in the Marine Works sub-CoCP (Application Reference Number: 8.8) a suitably qualified and experienced person would be employed during the construction phase to monitor the environmental aspects of the Wylfa Newydd Project. For example, where activities necessitate an Ecological Clerk of Works/environmental liaison officer will be present to ensure the works proceed in accordance with best practice guidance and adhere to the mitigation measures as outlined here. This person would work with the appointed construction contractors with regard to implementation of the environmental mitigation measures.

13.5.89 As set out in the Wylfa Newydd CoCP (Application Reference Number: 8.6) marine and land-based plant would be used in line with best practice construction methods, for example machinery would be switched off when not in use and drip trays would be placed under plant and appropriate bunding will be in place where necessary.

13.5.90 In accordance with the management strategy set out in the Wylfa Newydd CoCP (Application Reference Number: 8.6) and relevant sub-CoCPs (Main Power Station Site and Marine Works, Application Reference Numbers: 8.7 to 8.8), methods would be applied to all works to control noise and vibration.

13.5.91 The management strategy set out in the Wylfa Newydd CoCP (Application Reference Number: 8.6) and relevant sub-CoCPs (Main Power Station Site and Marine Works, Application Reference Numbers: 8.7 to 8.8), will include monitoring locations within the Wylfa Newydd Development Area including locations close to Cemlyn Bay. The scope of the monitoring, including the locations, would be discussed and agreed with NRW.

13.5.92 In accordance with the Marine Works sub-CoCP (Application Reference Number: 8.8) Horizon will produce and adhere to a Biosecurity Risk Assessment and Method Statement based on industry standards.

Operation

13.5.93 The operation of the Power Station includes the following components which are relevant to the marine environment and assessed within this chapter:

- abstraction and discharge of cooling and service water;
- control of biofouling;
- emissions of nitrogen and sulphur dioxide from operational combustion plant;
- the presence of the breakwater throughout operation;
- vessel movements associated with the MOLF;
- maintenance dredging; and
- general operational activities including alarm testing, intake and exhaust fans, steam venting, use of generators and pumps.

13.5.94 The activities that would be carried out during operation are described in chapter D1 (Application Reference Number: 6.4.1). At this stage of the Wylfa Newydd Project it has been necessary to make a number of assumptions to facilitate assessment; the assumed scenario for operations relevant to the marine environment is provided below and the worst case is provided where applicable.

Abstraction and discharge of Cooling Water

13.5.95 The Cooling Water intake would be located in the south-east corner of Porth-y-pistyll (see figure D1-2 (Application Reference Number: 6.4.101) and D1-9 (Application Reference Number: 6.4.101). The Cooling Water outfall would be located adjacent to the outfall of the Existing Power Station (chapter D1, Application Reference Number: 6.4.1).

13.5.96 The Cooling Water System would be designed to limit the entrapment of marine organisms and includes the following measures:

- A maximum intake velocity of 0.3m/s in front of the intake opening at LAT.
- Screening in the form of coarse raked bars located in front of fine mesh drum screens (for the main Cooling Water intake) and band screens (for the service water intake). The proposed fine mesh screen size is 5mm. There are likely to be a minimum of four main screens at the Cooling Water intake and two service water (reactor service water and turbine service water) intake screens per unit; this would incorporate redundancy to allow maintenance and biocide treatment of screens and adequate and effective fish handling capacity.
- An AFD in front of the Cooling Water intake, designed in line with Best Available Technique [RD80]. The sound field would be located in the most appropriate location within the intake entrance; it would be specified to allow redundancy in the system and would be supported by modelling to demonstrate a uniform sound field. It would also be designed to avoid effects on marine mammals.
- An effective FRR system, discharge point located below LAT, designed in line with the Best Available Technique that would remove fish impinged on all screens and return them to sea.
- To control biofouling, treatment of the CWS is required. Sodium hypochlorite or appropriate alternatives would be used for this purpose. Management of the biocide dosing regime, while preventing harm to fish impinged on screens, will be in line with best practise. Continuous dosing will be applied during a higher fouling risk period. The biocide dosing regime would be designed to reduce biofouling risk, normally between April and December, when sea temperatures are above 10°C. Typically, biocide dosing would be applied to all areas of the CWS except around the fine mesh screens to prevent harm to fish impinged upon them. It is assumed that the water source for any on-site generation of hypochlorite does not change water balance and if seawater is used, then the abstraction point will be downstream of the fine mesh screens.

13.5.97 Circulating and service water flows would vary according to the state of the tide. At highest astronomical tide the flow would increase by approximately 12% compared with the flow at LAT as a result of a reduced pumping head. The flows at LAT and highest astronomical tide are shown in table D13-6. It is acknowledged that there may be marginal differences between predicted and actual pump efficiencies; furthermore, over the operational lifetime of the Power Station, there could be variations in the performance of the different pumps constituting the CWS and inefficiencies due to biofouling. A precautionary approach has therefore been taken with an additional 5% contingency added to the tidal average of 119.6m^3/s, equating to 125.5m^3/s. For modelling purposes this was rounded up to 126m^3/s.

Table D13-6 CWS abstraction rates

	Maximum at LAT		Maximum at highest astronomical tide		Tidal average (two reactors)		Tidal average plus 5% contingency	
	Vol.	Units	Vol.	Units	Vol.	Units	Vol.	Units
Cooling Water	184,800	m^3/hr	206,976	m^3/hr				
Turbine service water	7,400	m^3/hr	8,288	m^3/hr				
Reactor service water	10,800	m^3/hr	12,096	m^3/hr				
Subtotal per reactor (m^3/hr)	203,000	m^3/hr	227,360	m^3/hr				
Subtotal per reactor (m^3/s)	56.39	m^3/s	63.16	m^3/s				
Total for two reactors	112.78	m^3/s	126.31	m^3/s	119.55	m^3/s	125.52	m^3/s

13.5.98 The temperature of the Cooling Water discharge water will also vary with the tide; the larger the volume of abstracted water the lower the temperature will be at the point of discharge. At LAT, the temperature increase at the point of discharge will be:

- 12°C (98 percentile) above ambient for the Cooling Water discharge;
- 5°C above ambient for the turbine service water; and
- 5.4°C above ambient for the reactor service water.

13.5.99 The service water intakes are independent from the main Cooling Water intake but they have a common discharge.

13.5.100 The ultimate heat sink is the Irish Sea using this once-through cooling system. Should this system become impaired, a reserve ultimate heat sink facility, based on forced draft wet cell cooling towers, would be called into service as described in chapter D1 (Application Reference Number: 6.4.1).

There is no additional discharge from the reserve ultimate heat sink into the marine environment.

13.5.101 The Cooling Water abstraction and associated discharge could vary during the lifetime of the Power Station as a result of different operational modes, resulting in variation of the discharge flow and temperature. These modes include commissioning, routine operation, outages, turbine trips and start-up/shut-down. In addition, there are two modes which are governed by National Grid in relation to balancing demand and total generation; these are known as 'frequency responsive' and 'island mode' operation. Many of these modes are either unplanned, infrequent and/or regarded as abnormal or emergency modes.

13.5.102 The assessment is based on the routine operation mode and assumes 100% reactor load with no steam bypass, which is the most representative scenario during operation. During commissioning, outages, turbine trips and start-up/shut-down modes there would be no increase in abstraction or thermal discharge above routine operation. If an abnormal or emergency mode is entered there may be an increase in the temperature of the Cooling Water discharge for a very short duration, but this would not exceed 12°C as a 98 percentile.

Commissioning and maintenance

13.5.103 There are three phases of commissioning; construction testing, pre-operational testing and start-up testing. Construction testing involves testing the components of the Power Station and would not have any effects on the marine environment.

13.5.104 During pre-operational testing (also known as cold commissioning) it may be necessary to discharge some water to the environment to support required plant testing. The amount of water abstracted would be increased in stages but would not exceed the maximum volumes for the Cooling Water and service water intakes. During this period the discharge water would be approximately the same temperature as the abstracted water, i.e. ambient temperature.

13.5.105 Start-up testing (also known as hot commissioning) is the final phase of commissioning. Water would be abstracted up to the maximum permitted volumes for the Cooling Water and service water systems. During this period, warm water would be discharged from the outfall at temperatures up to 12°C above ambient.

13.5.106 The chemicals discharged during commissioning would be similar or less than those used during the operational phase.

13.5.107 The Power Station is planned to operate on an 18-month fuel cycle; 17 months at high power operation and one month shutdown.

Drainage and other discharges

13.5.108 During operation, all sewage would be treated at a Welsh Water sewage treatment works (under Dwr Cymru Welsh Water operations) and would be discharged to the sea in the same (or similar) location as the Cooling Water outfall as occurred at the Existing Power Station.

MOLF and breakwater during operation

13.5.109 All or part of the MOLF may be retained for use during Power Station operation. Whilst the bulk quay is expected not to be required, the Ro-Ro quay may be used for delivery of replacement parts which are Abnormal Indivisible Loads (to avoid road transport). It is currently assumed that only one vessel per year would use the MOLF during operation.

13.5.110 Dredging is likely to be required to maintain sufficient depth in front of the intake and to allow continued access to the MOLF. The dredged material would be deposited at the Disposal Site. The volume of dredged material (sediment) would be significantly smaller than that for the capital dredging programme and consist largely of dispersive material. Any material requiring disposal through maintenance will be subject to a separate Marine Licence application.

13.5.111 During operation the western breakwater would be a standalone structure with no connection between the breakwater and the land to allow through flow of water.

Embedded mitigation

13.5.112 Measures to prevent the entrapment of marine organisms are set out in volume 2 of the Design and Access Statement (Application Reference Number: 8.2.2) and have been described in paragraph 13.5.96. The control of biofouling through the use of biocide is set out in the Wylfa Newydd Code of Operational Practice (CoOP) (Application Reference Number: 8.13). The majority of these measures are intended to reduce the risk of impingement and increase the return and survival of marine organisms that would be impinged. However, the reduced mesh size (5mm) and biocide dosing regime are also intended to reduce the risk of entrainment and increase survival through the CWS of entrained marine organisms.

13.5.113 As set out in volume 2 of the Design and Access Statement (Application Reference Number: 8.2.2) the Cooling Water outfall would be designed to increase the momentum of the discharge, to help propel the thermal plume, and promote mixing and dispersal of associated biocide products to the north of Wylfa Head where the offshore currents will aid dispersion and decay, and reduce the risk of recirculation.

Good practice mitigation

13.5.114 The Wylfa Newydd CoOP (Application Reference Number: 8.13) sets out mitigation measures for operational activities with the potential to cause significant effects (for example, in relation to air, noise, traffic, water quality etc.).

Decommissioning

13.5.115 Activities associated with decommissioning are outlined in chapter D1 (Application Reference Number: 6.4.1). The activities of particular relevance to the marine environment are:

- the shutdown of reactors and the reduction and eventual cessation of abstraction and discharge of Cooling Water;
- changes in the quantity and quality of liquid effluent discharge; and
- the removal of structures including the intake, outfall and MOLF, but not the breakwaters.

13.5.116 The details of decommissioning are not known at this time and to facilitate the assessment a number of assumptions have been made:

- the Power Station would operate for 60 years;
- both reactors would be decommissioned simultaneously;
- the pumps required to abstract Cooling Water would continue for a period of 100 days after cessation of generation;
- there would be some residual abstraction and discharges during the decommissioning period;
- all plant and equipment would be removed prior to demolition and all structures down to 1m below ground level would be removed;
- civil structures greater than 1m depth would be left *in situ* and backfilled or grout-filled, including the discharge water channel and the discharge water tunnels; and
- the removal of structures would be carried out using similar equipment as for construction.

Embedded mitigation

13.5.117 No embedded mitigation in relation to decommissioning has been identified at this stage.

Good practice mitigation

13.5.118 No good practice mitigation in relation to decommissioning has been identified at this stage.

13.6 Assessment of effects for Wylfa Newydd Development Area

13.6.1 This section presents the findings of the assessment of effects associated with the construction, operation and decommissioning of the Wylfa Newydd Development Area. Assessments of cumulative effects are provided in chapter I4 (intra-project cumulative effects) (Application Reference Number: 6.9.4) and chapter I5 (inter-project cumulative effects) (Application Reference Number: 6.9.5).

Table D13-7 Signposting table to receptors

Receptor	Changes to marine water quality from land drainage, dewatering and sewage discharge	Changes to water quality from dredging (suspended sediment and release of contaminants)	Direct footprint of the works leading to mortality and habitat loss	Physical disturbance of habitats	Introduction of non-native species	Underwater noise	Airborne noise	Changes in visual stimuli	Physical injury of marine mammals from vessel strikes	Impingement of marine organisms	Entrainment of marine organisms	Thermal effects	Thermal effects on spread of non-native species	Thermal effects on dissolved oxygen	Thermal effects on pH pm the ratio of ionised to unionised ammonia	Total Residual Oxidant (TRO)	Chemical changes in discharge water	Airborne noise
All designated sites of nature conservation importance and supporting features	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			✓	✓	✓		
EU-designated WFD water bodies	✓	✓										✓		✓	✓	✓	✓	
EU-designated bathing water	✓	✓																
Plankton	✓	✓			✓						✓	✓	✓	✓	✓	✓	✓	
Subtidal and intertidal habitats of conservation importance	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	
Intertidal habitats and communities	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	
Subtidal habitats and communities	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓	✓	✓	
Invertebrates (of conservation and commercial importance)	✓	✓	✓	✓	✓					✓	✓	✓		✓	✓	✓	✓	
Ichthyoplankton (of conservation and commercial importance)	✓	✓									✓	✓		✓	✓	✓	✓	
Ichthyoplankton	✓	✓									✓	✓		✓	✓	✓	✓	
River lamprey	✓	✓	✓	✓		✓		✓		✓	✓	✓		✓	✓	✓	✓	
European eel	✓	✓	✓	✓		✓		✓		✓	✓	✓		✓	✓	✓	✓	
Fish (of conservation and/or commercial importance)	✓	✓	✓	✓		✓		✓		✓	✓	✓		✓	✓	✓	✓	
General fish and fisheries	✓	✓	✓	✓		✓		✓		✓	✓	✓		✓	✓	✓	✓	
Marine mammals	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓		✓	✓			
Seabirds (target species)	✓	✓	✓	✓			✓	✓		✓	✓	✓		✓	✓			✓
Seabirds (secondary species)	✓	✓	✓	✓			✓	✓		✓	✓	✓		✓	✓			✓

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Construction

Impact pathway: changes to marine water quality from land drainage, dewatering and sewage discharge

13.6.2 This pathway covers the potential changes in water quality relating to physico-chemical, biological and chemical parameters during construction from all discharges including land drainage, dewatering and sewage. The deposition of sediment from these sources and associated effects is considered in paragraph 13.6.181.

13.6.3 The drainage design for construction, which is a key embedded mitigation measure (see paragraph 13.5.76) has identified seven discharge points into the marine environment in the following locations (from west to east):

- Cemlyn Lagoon via the Nant Cemlyn;
- Cemlyn Bay;
- Porth-y-pistyll via the Afon Cafnan and directly at points PA, PB and PC;
- Porth Wnal;
- Porth y Wylfa; and
- Cemaes Bay via a location east of Porth y Wylfa, and the Nant Cemaes (see appendix D8-8, Application Reference Number: 6.4.33 for the location of these areas).

13.6.4 The construction drainage system will alter the flows in terms of the volume and timing of discharges from fluvial catchments into the marine environment. The discharge quality could also be modified in terms of the chemical and physico-chemical parameters (e.g. water chemistry and suspended solids).

Basis of modelling and a worst case

13.6.5 Horizon's marine hydrodynamic model was used to assess the effects of all sources of suspended solids (drainage, dewatering, and sewage). The modelling methodology, details of the input parameters and results are described in appendix D13-8 (Application Reference Number: 6.4.90). A worst case has been modelled where water discharges incorporate a storm event and includes all land drainage, sewage (from both main construction and Site Campus), and dewatering from the deep excavations, tunnelling and from cofferdams. The model has also taken into consideration the particle size distribution to take account of fine clay particles as these have a lower settling velocity and could therefore travel further.

13.6.6 To assess the effects on specific pollutants and priority substances an assessment was carried out using the Environment Agency's H1 software tool to calculate the chemical composition of discharges from all sources and to compare the predicted quality of the discharges to EQSs. The modelling methodology, details of the input parameters and results are described in appendix D13-14 (marine modelling of the construction discharge)

(Application Reference Number: 6.4.96). The H1 assessment represents a worst case scenario as the screening phase uses raw data from leaching tests and it assumes that the surfaces of mounds are bare soil.

Effects on marine water quality

Changes to freshwater flows

13.6.7 Surface water modelling has predicted that there would be changes to freshwater flows into marine waters over the duration of the construction phase (see appendix D8-7 (surface water and groundwater modelling results) (Application Reference Number: 6.4.32). The changes to flows relating to the construction drainage design are outlined in chapter D8 (Application Reference Number: 6.4.8). The predicted rates of discharge from land drainage are set out in appendix D8-7 (Application Reference Number: 6.4.32) and are all within +/- 10% of the Q_{95}.

13.6.8 There will also be a change in the delivery of freshwater flows into coastal waters (excluding Cemlyn Lagoon) from dewatering. The dewatering component of deep excavations would comprise rainfall and groundwater seepage with a predicted upper estimate of 9,500m^3/day in a 1 in 30 year rainfall event. Discharge would be a phased at three different locations within Porth-y-pistyll during construction (at PA, PB and PC – see appendix D8-8, Application Reference Number: 6.4.33), with PC being the final dewatering discharge location.

13.6.9 During construction sewage would be discharged in the north of Porth-y-pistyll at a rate of approximately 1,598m^3/day. This discharge water would be buoyant and would be quickly dispersed and diluted by the strong tidal currents.

13.6.10 Hydrological modelling (excluding the temporary diversion of flow from the western side of Mound E to the Afon Cafnan) has quantified the change in water availability to the Cemlyn catchment (appendix D8-7, Application Reference Number: 6.4.32). Results show that the mean change in flow duration at the downstream point of the catchment is an increase of 51m^3/day, representing a temporary change equivalent to +/- 10% of the Q_{95}. The mean change in flow duration at the discharge point from Nant Cemlyn into Cemlyn Lagoon is an increase of 20m^3/day representing a small change (chapter D8, Application Reference Number: 6.4.8). The magnitude of this effect would be reduced by operation of the pumping infrastructure during construction to convey runoff from Mound E to discharge point E2 to the Afon Cafnan. Freshwater flows being discharged into Cemlyn Lagoon from Nant Cemlyn would only be 10% different to the existing regime. The lagoon already has wide fluctuations in salinity with low salinity values (as low as 10) in the winter (corresponding with increased precipitation and freshwater inflow), and high values (30) in the summer when the lagoon is managed. The small change in freshwater flow is not likely to result in changes that would be detectable above background variation in salinities.

13.6.11 Although there is a predicted change in the rate of freshwater flows being discharged into the marine environment, the volumes are small in comparison to the size of the WFD coastal water bodies. The coastal waters are characterised by strong tidal flows which provide rapid dispersion. The changes in freshwater flows would not lead to any change in the physico-chemical or chemical characteristics of marine waters. The change in freshwater input into Cemlyn Lagoon is very small and given that baseline salinities are so variable within the lagoon; this change is not likely to be detectable above the naturally variable baseline conditions.

13.6.12 The magnitude of change is therefore predicted to be negligible and the effects on coastal WFD water bodies as a result of changes to freshwater flows are predicted to be negligible.

Changes to suspended solids

13.6.13 The discharge of suspended solids from the drainage system at all discharge points would be limited to the concentrations proposed in the construction Environmental Permit (i.e. 40mg/L to 70mg/L during normal rainfall events, and higher levels during storm events). Worst case assessments on the marine environment have been based on modelling suspended solid concentrations predicted during a spring – neap tidal cycle for a 1 in 2 year flow with a 1 in 30 year storm event, with no wind or waves as presented in appendix D13-8 (Application Reference Number: 6.4.90). The modelling of drainage discharges to the marine environment includes all surface water runoff with landscaping mounds un-vegetated, including runoff from the platform and the concrete batching plant. There would be no other discharges relating to the concrete batching plant other than drainage of surface water as any excess process water would be tankered off site.

13.6.14 The discharge of suspended solids from dewatering (from deep excavations and from cofferdams) would be limited to 70mg/L suspended solids under normal rainfall conditions, whilst sewage discharge would be limited to 30mg/L suspended solids.

13.6.15 One other potential source of suspended solids is the channel realignment works on the Caerdegog Isaf, however as these are 2km upstream any sediment would fall out of suspension over this distance before reaching the marine environment. Geomorphological assessments are made in chapter D13-8 (Application Reference Number: 6.4.8).

13.6.16 The dispersion of suspended sediment in The Skerries and Anglesey North WFD water bodies has been modelled and the concentrations at the seabed resulting from fugitive spill from dredging activities are shown in figure D13-22 (Application Reference Number: 6.4.101). During the dredging operation there is an area of approximately 18ha to 25ha, varying with the depth in the water column, which has an increment in concentration of 6.1mg/L (equal to the low end of observed ambient concentrations). Between the dredge events this area reduces as the material is flushed out of the bays.

13.6.17 The suspended solid concentrations from the surface water drainage system, dewatering and sewage discharge with the absence of dredging are shown in figure D13-23 (Application Reference Number: 6.4.101). The modelling undertaken assumes no wind and wave in the receiving environment and concentrations reach levels similar to background (less than 6mg/L) within 4.16ha from the discharge point in Port-y-pistyll.

Following a 1 in 30 year storm event there is an increase in the extent and concentration of suspended solids. The maximum concentration (115mg/l) following the storm event falls within the lower end of the turbid waters classification for WFD of 100 – 300mg/L and is restricted to within 0.05ha of the discharge point in Porth-y-pistyll (see appendix D13-8, Application Reference Number: 6.4.90). The highest concentration occurs at the discharge point of the Afon Cafnan as shown in figure D13-23 (Application Reference Number: 6.4.101).

13.6.18 For the majority of time it is likely that the suspended solids concentrations will be broadly similar to baseline conditions, with peaks occurring during rainfall events in line with the existing regime.

13.6.19 The Skerries and Anglesey North WFD water bodies are characterised by strong tidal flows and the receiving coastal waters have a high capacity for mixing and dilution. Upon entering the coastal water bodies suspended solids would be rapidly dispersed.

13.6.20 There will be no effects of suspended solids in the Nant Cemlyn and therefore Cemlyn lagoon as a result of the operation of the pumping infrastructure to the Afon Cafnan during construction of mound E and while it is un-vegetated.

13.6.21 The magnitude of change in suspended solids in coastal waters is predicted to be negligible and there would be no effect on coastal WFD water bodies from changes to suspended solid concentrations.

Changes in water chemistry

13.6.22 During construction there is potential for changes to water chemistry from discharges into the marine environment including land drainage, dewatering and sewage. As rain falls onto exposed bare earth surfaces this could result in the leaching of substances from soil strip and topsoil mounds, resulting in elevated concentrations of substances in receiving water bodies (both fluvial and marine).

13.6.23 An assessment using the Environment Agency's H1 software tool and associated guidance has been carried out to calculate the chemical composition of the discharges from all sources and compare the predicted quality of the discharges to EQSs (see appendix D13-14, Application Reference Number: 6.4.96). The modelling methodology, details of the input parameters and results are described in appendix D13-14 (Application Reference Number: 6.4.96). The H1 assessment represents a worst case scenario as the screening phase uses raw data from leaching tests and it assumes that the surfaces of mounds are bare soil. This is considered worst case as the mounds will be seeded.

13.6.24 The substances discharged during construction have been determined as part of an H1 screening assessment. The results indicate that three substances (dissolved copper, dissolved zinc and dissolved lead) would be discharged at levels above their respective relevant EQS from land drainage discharge. The relevant EQSs and predicted discharge concentrations are presented in table D13-8.

Table D13-8 Predicted concentrations at point of discharge from land drainage (surface water and groundwater)

Marine discharge point and receiving water	Outfall number and pathway to discharge point	Copper (dissolved) (µg/L)	Lead (dissolved) (µg/L)	Zinc (dissolved) (µg/L)	Nickel (dissolved) (µg/L)
EQS (AA)	-	3.76	1.3	7.9	8.6
EQS (Maximum Allowable Concentration)	-	n/a	14	n/a	34
Surface water discharges					
Cemaes Bay (1S)	A3 via Nant Cemaes	4.54	1.98	Not exceeded	Not exceeded
Cemaes Bay (A2)	A2 direct to sea	9.3	6.45	11.4	Not exceeded
Porth y Wylfa (2S)	A1 and B1 via Tre'r Gof outfall channel	9.26	6.45	11.4	Not exceeded
Porth-y-pistyll (direct to sea) (PA, PB and PC)	PA, PB and PC locations direct to sea	9.3	6.45	11.4	Not exceeded
Porth-y-pistyll (3S)	C1, D1, D2 and E1 via Afon Cafnan	8.57	5.91	11.09	Not exceeded
Groundwater discharge					
Porth-y-pistyll (direct to sea) (PA, PB and PC)	PA, PB and PC locations direct to sea	Not exceeded	Not exceeded	37.8	16.5

13.6.25 For the land drainage discharge the substance requiring the greatest dilution to achieve the EQS is dissolved lead, where the maximum concentration in the predicted discharge is 6.45µg/L compared to the AA EQS of 1.3µg/L, therefore requiring a dilution factor of 10.

13.6.26 For the groundwater dewatering discharge the substance requiring the greatest dilution to achieve the EQS is dissolved zinc, and the dilution factor is calculated to be 4.78.

13.6.27 Modelling was carried out using Delft3D to understand how both the surface water and groundwater discharges would disperse and dilute upon entering the marine environment at the marine discharge points within the Wylfa Newydd Development Area. Model runs emulated one complete spring-neap tidal cycle and as worst case, assumed the temporary cofferdam and causeway were in place. To represent the discharge locations PA, PB and PC within the model one location was modelled at discharge point PC.

13.6.28 The predicted discharge concentrations in surface water and groundwater from table D13-8 were combined, taking into account the flows from each discharge point to derive a maximum concentration once the discharge entered the marine environment. Once the flows from each discharge point were taken into account the maximum concentrations within the marine environment predicted by the Delft3D model differed from the original concentration in the predicted discharge. These results were processed for each substance in turn and the model indicated that for all substances, the mixing zones would occur within close proximity to the discharge points.

13.6.29 For dissolved zinc the predicted maximum concentration within the marine environment occurred in proximity to discharge point 2S, downstream of the Afon Cafnan, and the zinc AA EQS exceedance would be limited to within an overall area of 2ha in the model (figure D13-24, Application Reference Number: 6.4.101).

13.6.30 For dissolved lead the predicted maximum concentration within the marine environment occurred in proximity to discharge point 2S and the dissolved lead AA EQS exceedance would be limited to within an overall area of 31ha in the model (figure D13-25, Application Reference Number: 6.4.101).

13.6.31 For dissolved copper the predicted maximum concentration in the marine environment occurred in proximity to discharge point 2S and the dissolved copper AA EQS exceedance would be limited to within an overall area of 11.95ha in the model (figure D13-26, Application Reference Number: 6.4.101).

13.6.32 For dissolved nickel the predicted maximum concentration within the marine environment would be well below the AA EQS of 8.6µg/L and the dispersion occurs in very close proximity (within a few metres) of the discharge.

13.6.33 Given the predicted small extent of mixing zones, there would be no effect on the water chemistry within The Skerries or Anglesey North water bodies. If the discharge at PC were to be located at PA or PB during different phases of construction (chapter D1, Application Reference Number: 6.4.1, for locations) this could result in a slight increase in the extents of the mixing zones in Porth-y-pistyll. However, the relevant EQS for each substance would still be reached within close proximity to the discharge points and there would be no effect on the water chemistry within The Skerries or Anglesey North water bodies.

13.6.34 There would be no discharge from Mound E to the Nant Cemlyn until all topsoil movement and placement is complete and the mound is vegetated therefore no risk of EQS exceedance. Also there would be no treated water discharged to Nant Cemlyn so there is no potential for carry over of polyelectrolytes into Nant Cemlyn or Cemlyn Lagoon.

13.6.35 The magnitude of change is therefore predicted to be negligible and the effects on coastal WFD water bodies as a result of changes to water chemistry are predicted to be negligible.

13.6.36 No process water would be discharged from the concrete batching into the marine environment. Surface water drainage from the concrete batching plant would be monitored to assess pH levels and if necessary it would be treated prior to discharge to neutralise the water. Therefore, no effects on coastal WFD water bodies are predicted relating to discharge from the concrete batching plant.

Changes to nutrient conditions

13.6.37 Sewage with conventional treatment would be discharged in the north of Porth-y-pistyll. The wastewater treatment works maximum flow will be $900m^3$/d with a 10% allowance for nitrification. It is assumed that the plant will be operational for 12 hours a day, and that balancing tanks are included, therefore the maximum daily flow over 24 hours would be 11.5L/s. Modelling has been undertaken assuming a worst case flow of 18.5L/s.

13.6.38 Unionised ammonia concentrations depend on the equilibrium between the ammonium ion (NH_{4+}) and unionised ammonia (NH_3). The position of the equilibrium is affected by temperature, pH and salinity. The value for ammoniacal nitrogen would always be greater than the unionised ammonia fraction. The ammoniacal nitrogen concentrations following conventional treatment and after initial dilution are 0.016mg/L (as N) as an AA and represent worst case. This falls well below the long-term (mean) EQS for coastal waters (21µg/L), meets the required standards and therefore would not affect water quality in coastal WFD water bodies. Assuming a worst case temperature (maximum from baseline was 16.7ºC), maximum pH (8.25) and salinity (34) the combined total ammonia concentration (baseline of <0.021mg/L plus the process contribution of 0.016mg/L as worst case) would result in a non-ionised ammonia concentration after initial dilution of <1.57µg/L which is well inside the EQS for coastal waters (21µg/L).

13.6.39 The key nutrients in soils which could contribute to enrichment of freshwaters, and subsequently marine waters, are nitrates and phosphates which are present in the topsoil that would be removed during construction. Dissolved inorganic nitrogen is the key growth-limiting nutrient in marine waters and is therefore a key indicator for which standards are set in coastal waters.

13.6.40 The Wylfa Newydd Development Area is predominantly used as pastureland for grazing (chapter D7, soils and geology, Application Reference Number: 6.4.7) with only a small fraction of the land used for crop agriculture, which is assumed to be on the Best and Most Versatile land (Agricultural Land Classification Grade 2 and 3a), of which 23ha would be removed. Fertilisers or manures would not have been intensively applied to the majority of the land in the last few years as the land is mainly used as pasture for low-density grazing, therefore the levels of nitrates in soils are likely to be low. It is anticipated that there would be no change to the nutrient concentrations in the runoff reaching the marine environment. The magnitude of change is predicted to be negligible and it is considered that there would be no significant effects on water quality in coastal WFD water bodies as a result of increased nutrient levels.

Changes to oxygenation conditions

13.6.41 Depletion of dissolved oxygen can occur in surface waters, due to an increase in biological productivity (e.g. from respiration of plankton), as a result of elevated nutrient concentrations. However nutrient concentrations are not predicted to increase as a result of a discharge and stratification owing to the high dilution in the receiving waters. The magnitude of change is predicted to be negligible and it is considered that there would be no significant effects on water quality in coastal WFD water bodies from a change in oxygenation conditions.

Changes to bacteriological water quality

13.6.42 Changes to bacteriological water quality could result from the mobilisation of soil during topsoil clearance and storage. In addition, sewage would be discharged in the north of Porth-y-pistyll. The estimates of worst case 95th percentile contributions of faecal coliforms would be a mean of $3x10^6$CFU/100ml at a continuous discharge of 18.5L/s from conventional treatment process (without disinfection).

13.6.43 The sensitive receptor in terms of bacteriological water quality is the EU-designated bathing water at Cemaes. Cemaes bathing water receives discharge from Nant Cemaes which meets the sea at the west of Cemaes Bay. The Cemaes catchment drains an area of 300ha that is mostly situated to the east and south-east of the Wylfa Newydd Development Area.

13.6.44 Only a small part of the Wylfa Newydd Development Area extends into the Cemaes catchment, approximately 15ha (5% of the total Cemaes catchment). The land within the catchment is currently used for pastureland for grazing (chapter D7, Application Reference Number: 6.4.7). During construction the vegetation would be cleared and topsoil removed from this area. Where practicable, a 15m buffer would be retained around Nant Cemaes and any runoff would be directed towards a sediment settlement pond.

13.6.45 A source of bathing water pollution is water draining from farmland and in particular from manure, livestock or poorly stored slurry that can wash into rivers and result in faecal material (*E. coli* and intestinal enterococci) entering the sea [RD7]. Fertilisers or manures would not have been intensively applied to the majority of the land in the last few years as the land is mainly used as pasture for low-density grazing. Prior to the start of works, grazing would be excluded from this area for four weeks which would allow sufficient time for animal faeces to biodegrade naturally, and reduce the risk of runoff containing *E.coli* and intestinal enterococci.

13.6.46 Modelling has been carried out to predict how sewage effluent will disperse within the marine environment. Modelling showed that the sewage discharged in the north of Porth-y-pistyll would be quickly dispersed. Under the Bathing Water Directive, to achieve good classification the intestinal enterococci concentration must not exceed 200CFU/100ml in 80% of samples. In a worst case scenario, the modelled concentration of faecal coliforms reaching the bathing water at Cemaes would result in an increase in 29.3CFU/100ml (11.8CFU/100ml from the Breakwater north outfall and 17.5CFU/100ml from the Site Campus outfall). This contribution is likely to occur infrequently as it is based on a modelled continuous discharge of 18.5L/s, when in reality the discharge would be batched and would occur only over a 12- or 15-hour period. Furthermore, the small addition is well below the maximum concentration required to achieve good classification.

Changes to marine water quality from the use of polyelectrolyte coagulants in water treatment

13.6.47 Polyelectrolytes, which are commonly used in water treatment to control and enhance the coagulation and flocculation of suspended particulate matter, would be used infrequently to respond to anticipated and rapid responses to increased suspended solid concentrations resulting from storm events (see paragraph 13.5.11).

13.6.48 Flow proportional dosing is proposed and, therefore, it is very unlikely that there will be any notable concentrations of polyelectrolytes being discharged from the drainage system. Dosing is expected to be in the range of 0.1mg/L to 1mg/L, thus any accidental releases or over-dosing of the polyelectrolyte would be in concentrations less than 1mg/L [RD82].

13.6.49 A review of polyelectrolytes undertaken for the Environment Agency [RD83] found that the impact of polyelectrolytes on the aquatic environment (including brackish waters) is low due to the following:

- the strong and irreversible sorption (or binding) to suspended and dissolved organic matter;
- losses due to hydrolysis and biodegradation; and
- a low potential to bioaccumulate.

13.6.50 Jar testing of various ionic strengths has shown polyelectrolytes to have no effect on the following parameters:

- alkalinity;
- biological oxygen demand;
- chloride;
- nitrate;
- potassium;
- sulphate;
- electrical conductivity; and
- pH.

Slight effects to calcium, magnesium, dissolved organic carbon and total organic carbon were identified but these were minimal [RD82].

13.6.51 Considering this, there is considered to be a negligible effect to marine water quality (and subsequent ecological receptors) from the discharge of polyelectrolytes during the construction phase.

Summary on effects on EU-designated water bodies and EU-designated bathing waters

13.6.52 Considering the embedded and good practice mitigation proposed (see paragraphs 13.5.76, 13.5.87 and 13.5.88), changes to water quality from land drainage, dewatering and sewage discharge is not considered to result in detectable changes in the marine environment. Changes to freshwater flows, suspended solids, nutrient concentrations and oxygenation conditions are not considered to vary outside of baseline conditions and therefore the magnitude of change is predicted to be negligible. Therefore, the effect on EU-designated water bodies through changes in water quality from drainage, dewatering and sewage is predicted to be negligible.

13.6.53 Modelling of the sewage effluent has indicated that it will quickly disperse to background levels within the marine environment. Given the embedded and good practice mitigation proposed (see paragraphs 13.5.76, 13.5.87 and 13.5.88), the magnitude of change is therefore predicted to be negligible as the works would not result in a significant increase in E. coli and intestinal enterococci reaching Cemaes bathing water. Therefore, it is considered that there would be a negligible effect on EU-designated bathing waters through changes in water quality from drainage, dewatering and sewage.

Effects on phytoplankton and zooplankton

13.6.54 In coastal waters phytoplankton and zooplankton could be affected by freshwater flows through changes in salinity, changes to suspended solids and changes to water chemistry; principally nutrients (see paragraphs 13.6.37 to 13.6.40). These effects would be restricted to the immediate areas around the discharge points. Within these very small areas there could be some inhibition of phytoplankton and zooplankton growth. However, this would not have any effect on the abundance and diversity of phytoplankton or zooplankton within the water bodies as a whole. Any effects would be very small scale and are unlikely to be detectable above the ranges of natural variability.

13.6.55 Within Cemlyn Lagoon the changes in salinity, suspended solids concentrations and water chemistry are not likely to be detectable and there would be no change to the conditions that phytoplankton or zooplankton are exposed to.

13.6.56 The magnitude of change in phytoplankton and zooplankton communities is predicted to be negligible and the effect from land drainage, dewatering and sewage discharge on this receptor is considered to be negligible.

Effects on intertidal and subtidal habitats and communities

Changes to freshwater flows

13.6.57 There are a number of discharge points to the marine environment (see table D13-8 and appendix D8-8, Application Reference Number: 6.4.33).

Freshwater would be quickly dispersed by the strong tidal currents in the adjacent coastal waters and as it is more buoyant than seawater, any effects to subtidal habitats would be limited to the immediate vicinity of the outfall. In Cemlyn Lagoon there is predicted to be a negligible change in freshwater flows and the benthic lagoon habitats already experience large fluctuations in salinity and therefore there would be no detectable change.

13.6.58 The magnitude of change is predicted to be negligible and it is considered that there would be negligible effects on intertidal and subtidal habitats, species and communities (including those of conservation importance) as a result of changes to freshwater flows.

Changes to suspended solids

13.6.59 Intertidal and subtidal habitats and species could be affected by an increase in suspended solids concentrations which may reduce feeding efficiency and subsequently growth rates of filter feeders if suspended solids result in the clogging of feeding structures. The effects relating to smothering are discussed in paragraphs 13.6.216 to 13.6.228.

13.6.60 In coastal water bodies the maximum area that would be affected by suspended solids concentrations above background is approximately 25ha at mid-depth, spread over the discharge points. The extent of a plume that would occur in a 1 in 30 rainfall event is within the immediate vicinity of the discharge locations. As noted in paragraph 13.6.17 for the majority of the time suspended solids concentrations would be within the existing variability of the baseline.

13.6.61 The habitats and species present are already adapted to fluctuating suspended solids from the existing catchments, and there may be effects on some more sensitive species although they are already habituated to fluctuations in suspended solids.

13.6.62 There would be rapid dispersion of suspended solids in coastal waters therefore any impact on benthic species would be localised to the discharge. The magnitude of change is therefore to be negligible and the effects on intertidal and subtidal habitats from an increase in suspended sediment are considered to be negligible.

Changes in water chemistry

13.6.63 The change in water quality due to the discharge of dissolved metal concentrations above the EQS is not predicted to have any detectable effect on intertidal or subtidal habitats or species. The mixing zones are very small, particularly on the seabed as the discharged water would be buoyant and would rise to the surface.

13.6.64 The magnitude of change is predicted to be negligible and it is considered that there would be no significant effects on intertidal and subtidal habitats as a result of changes to water chemistry.

Summary of effects on subtidal and intertidal habitats and communities

13.6.65 Based on the assessments provided in the previous sections (paragraphs 13.6.57 to 13.6.64) the changes to freshwater flows, introduction of suspended solids and changes to water chemistry are considered to result in a negligible magnitude of change. It is therefore considered there would be a negligible effect for subtidal and intertidal habitats of conservation importance, 'intertidal habitats and communities', subtidal habitats and communities, and invertebrates (of conservation and commercial importance).

Effects on fish

Changes to freshwater flows

13.6.66 The predicted change in delivery of freshwater flows into coastal waters is unlikely to affect marine fish as firstly the majority of the discharge locations into coastal waters are existing watercourses and secondly marine fish can avoid these locations if required. The areas which would be affected are very small compared to the available habitat for fish and these areas do not represent key refuge or foraging habitat.

13.6.67 An increase in freshwater flows would mean that during high rainfall events there would be a stronger cue for fish seeking to migrate upstream. The changes to flow rates in the watercourses would not affect fish migration from the sea into watercourses and for the majority of time would be similar to the existing baseline.

13.6.68 The magnitude of change is predicted to be negligible and it is considered that there would be negligible effects on fish as a result of changes to freshwater flows.

Changes to suspended solids

13.6.69 High turbidity or suspended solids levels can diminish visibility, affect feeding behaviours as well as migration, and potentially cause physical harm to fish. Fish that rely on sight and speed to catch their prey are especially affected by high turbidity levels and may choose to avoid these areas. For the fish that remain in the turbid environment, suspended sediment can begin to physically affect the fish, for example by clogging of gills. In general, fish are more likely to undergo sub-lethal stress from suspended sediments rather than lethality because of their ability to move away from or out of an area of higher concentrations [RD89].

13.6.70 Suspended solids levels are above background concentrations over an area of approximately 18ha at the surface. As noted in paragraph 13.6.66 this area is small compared to the available habitat for fish and these areas do not represent key refuge or foraging habitat. It is possible that during heavy rain events when suspended solids concentrations are highest, some migratory fish species that are more sensitive to suspended sediments (e.g. sea trout) may choose to wait until levels have reduced prior to entering freshwater catchments. This may already occur however as suspended solids concentrations in catchments across the Wylfa Newydd Development

Area are very variable. For example, the range of suspended sediment concentration (SSC) recorded in the Afon Cafnan was between 2.5mg/L and 2,580mg/L (mean of 129mg/L) (see appendix D8-1, Application Reference Number: 6.4.26). Other species (e.g. European eel and river lamprey) which are accustomed to living on the river bed in silty environments are not likely to be affected.

13.6.71 The magnitude of change is predicted to be negligible and the effect on fish from an increase in suspended sediment is considered to be negligible.

Changes in water chemistry

13.6.72 Any exceedance of the EQSs would be restricted to the confines of small mixing zones. Any discharge of dissolved metals above the EQSs would be intermittent and driven by rainfall, and would readily dissipate once in the marine environment.

13.6.73 The magnitude of change is predicted to be negligible and it is considered that there would be negligible effects on fish and ichthyoplankton (including commercial fisheries and spawning grounds) from changes in marine water quality.

Summary of effects on fish

13.6.74 The changes to freshwater flows, introduction of suspended solids and changes to water chemistry are considered to result in a negligible magnitude of change and therefore a negligible effect for all fish receptors (including those of conservation and/or commercial importance).

Effects on marine mammals

13.6.75 There are predicted to be no significant effects on marine water quality from changes relating to freshwater flows, suspended sediment and water chemistry. It is considered very unlikely that an individual marine mammal would enter a mixing zone due to the very small area affected and the shallow depth of water where the discharges are located. Water depth at the discharge points ranges from zero (water running across the foreshore in two locations) to a few metres at high water. There are no effects from changes in marine water quality on their prey sources (fish and invertebrates).

13.6.76 Owing to there being no effect on marine water quality or to prey source the magnitude of change is predicted to be negligible and it is considered that there would be negligible effects on marine mammals (pinnipeds and cetaceans) from changes in marine water quality.

Effects on seabirds

13.6.77 The potential changes to suspended solids are discussed in paragraphs 13.6.13 to 13.6.21. The magnitude of change in suspended solids in coastal waters is predicted to be negligible, and there would be no effect on marine water quality from changes to suspended solids. Therefore, it is predicted that there would be negligible effects on the prey sources (fish and invertebrates) and ultimately on seabirds, from changes to suspended solids.

Effects on designated sites

13.6.78 As described in the preceding sections on seabirds and marine mammals, the magnitude of change on the features of the sites are predicted to be negligible and therefore there are predicted to be negligible effects on the Anglesey Terns/Morwenoliaid Ynys Môn SPA, the Bae Cemlyn/Cemlyn Bay SAC/SSSI and the North Anglesey Marine cSAC.

Impact pathway: changes to water quality from dredging (suspended sediment and release of contaminants)

General context

13.6.79 Dredging in Porth-y-pistyll will result in an increase in suspended solids concentrations as soft sediment is removed from the seabed. Mobilisation of sediment may release sediment-bound contaminants into the water column with potential indirect effects on marine organisms. The deposition of sediment from these sources and associated effects is considered in paragraph 13.6.181.

13.6.80 The maximum soft sediment to be dredged is 242,000m^3 (bulked volume) and will take approximately 35 days to complete. This activity would take place at the same time as land drainage, dewatering and sewage discharge. Embedded and good practice mitigation proposed to reduce any effects to water quality from dredging is outlined in paragraphs 13.5.78, 13.5.87 and 13.5.88.

Modelling and partition coefficient analysis

13.6.81 Dredging has been modelled using the marine hydrodynamic model to predict the dispersion of sediment within the water column and to provide estimates of concentrations of suspended sediments around the dredged area. The modelling methodology is described in appendix D13-8 (Application Reference Number: 6.4.90).

13.6.82 In order to determine the potential for contamination of the water column as a result of sediment disturbance, an assessment was undertaken based on the metal concentrations reported from the water and sediment quality monitoring in and around the Wylfa Newydd Development Area. The assessment involved the following steps:

- estimating the maximum incremental suspended solids concentration in the dredge area;
- multiplying the maximum concentration of metal contaminants in sediments with the maximum incremental suspended solids concentration to derive the maximum concentrations of sediment-bound contaminants suspended in the water column;
- dividing the maximum suspended concentrations of sediment-bound contaminants by individual partition coefficients to derive the maximum concentration of each contaminant likely to enter the dissolved phase;

- adding the maximum dissolved concentration for each contaminant to the ambient levels recorded in the area to derive the total dissolved concentration; and
- comparing the estimated maximum concentrations of dissolved contaminants as a result of dredging activities with marine EQSs.

Effects on marine water quality

Changes to suspended solids

13.6.83 The dispersion of suspended sediment in coastal waters within The Skerries coastal WFD water body has been modelled and the concentrations at the seabed are shown in figure D13-22 (Application Reference Number: 6.4.101). The extent of the suspended sediment plume at the surface is localised to dredging operations. Suspended solids concentrations within the plume are predicted to be above background levels (approximately 6.1mg/L) over 24.5ha (mid-depth).

13.6.84 The marine environment is characterised by strong tidal flows and the receiving marine waters have a high capacity for mixing and dilution. Upon entering the marine environment suspended solids would be rapidly dispersed.

13.6.85 Dredging of soft-sediments would last for approximately 35 days and given the temporary nature of the effect, and the limited extent of the effect, the magnitude of change in suspended solids in coastal waters is predicted to be negligible and there would be no effect on marine water quality from changes to suspended solids.

Changes in water chemistry

13.6.86 Metal concentrations from water and sediment quality baseline monitoring in the Wylfa Newydd Development Area are described in paragraph 13.3.17. Overall the quality of sediment is not considered to be contaminated.

13.6.87 As a worst case scenario for the modelling, the maximum incremental SSC in the dredge area was assumed to be 1,000mg/L. The maximum concentrations of metal contaminants in sediments from the Wylfa Newydd Development Area (collected in 2016) are shown in table D13-9.

13.6.88 Due to the variability in environmental conditions, a wide range of partition coefficients are reported in the literature. The partition coefficient values used here for metals have been taken from documents used to derive the EQS for priority (hazardous) substances and specific pollutants (arsenic and chromium, [RD90]; [RD91]), as well as Crommentuijn *et al*., [RD92]. It should be noted that environmental conditions (such as salinity) can influence the desorption rates of contaminants from suspended sediments into the water column and thus use of such partition coefficients is indicative only.

13.6.89 As a conservative approach the lowest sediment-water partition coefficient value reported from the literature was used for each contaminant, i.e. the value resulting in the highest proportion of contaminant released into the water column.

13.6.90 The estimated maximum concentrations of sediment-bound metal contaminants in suspension, the partition coefficients used and the resulting maximum concentrations of the contaminants entering the dissolved phase are shown in table D13-9.

Table D13-9 Estimated maximum concentrations of metals entering the water column and the dissolved phase as a result of sediment dredging activities at the Wylfa Newydd Development Area.

Contaminant	Maximum concentration in sediment (mg/kg)	Maximum concentration in suspension (sediment-bound) (μg/L)	Partition coefficient	Maximum concentration entering dissolved phase (μg/L)
Arsenic	11.9	11.9	6,607[a]	1.8×10^{-3}
Cadmium	0.43	0.43	20,417[b]	2.1×10^{-5}
Chromium	52.6	52.6	191,000[a]	2.8×10^{-4}
Copper	102.5	102.5	22,909[b]	4.5×10^{-3}
Lead	39.6	39.6	35,481[a]	1.1×10^{-3}
Mercury	0.18	0.18	44,668[b]	4.0×10^{-6}
Nickel	32.2	32.2	2,138[a]	1.5×10^{-2}
Zinc	163.9	163.9	72,444[c]	2.3×10^{-3}

[a] [RD90]; [RD91]

[b] [RD92] – monitoring

[c] [RD92] – estimated

13.6.91 The maximum dissolved concentration for each contaminant resulting from dredging is several orders of magnitude below the available EQS, suggesting that the potential for dredging activity within the Wylfa Newydd Development Area to affect water quality from contaminants in sediments is minimal. Both the AA-EQS and MAC-EQS are relevant as the proposed dredging and disposal activities will occur over an extended period (more than one year).

13.6.92 While the potential change in the dissolved concentration of contaminants due to dredging activities within the Wylfa Newydd Development Area suggests very small increases may occur in isolation, it is necessary to consider the resultant concentration in addition to ambient levels. Table D13-10 presents maximum dissolved concentrations (for individual samples and AA) for metals measured in water samples collected from the Wylfa Newydd Development Area between May 2010 and November 2014, along with the maximum dissolved concentration attributed to dredging activity.

13.6.93 The maximum ambient water quality measurements collected between 2010 and 2014 indicate a few samples for chromium and mercury which exceeded the MAC-EQS (i.e. individual samples). Therefore, as sediment resuspended during dredging activities contains small quantities of contaminants, and assuming a proportion of this material should transfer into the dissolved phase, then it is possible to result in a further small temporary uplift in concentration if the dredging activity occurred at the same time as these elevated ambient concentrations. However, this short-term (localised) increase in concentration is less than 0.1% compared to maximum ambient levels for all metals, with the exception of nickel (1.2%). By using the maximum annual ambient metal concentration, it can be seen that the AA-EQS thresholds are not exceeded for all metals (table D13-10).

13.6.94 Similar short-term, small-scale increases in concentration could be expected for other contaminants found within sediments at the Wylfa Newydd Development Area, including organotins, PCBs and PAHs, with any small uplift in concentration returning to ambient levels very quickly.

13.6.95 While the SSC will be extremely high immediately after release from the dredger hopper, sediment will naturally disperse and subsequently deposit on the seabed. It is anticipated that incremental concentrations calculated for dredging activity as described above provide a worst case scenario (based on 1,000mg/L). Therefore, it is unlikely that significant increases in metal concentrations will occur at the disposal site which would lead to EQS values being exceeded.

Table D13-10 Combined dredging and ambient metal concentrations

Contaminant	Maximum dissolved concentration for individual samples (maximum AA)				EQS[a]
	Ambient (µg/L)	Dredging (µg/L)	Ambient plus dredging (µg/L)	Percentage increase Ambient (%)	
Arsenic	1.9 (1.530)	1.8×10^{-3}	1.90 (1.532)	0.09 (0.12)	25 (AA)
Cadmium	0.128 (0.045)	2.1×10^{-5}	0.128 (0.045)	0.02 (0.05)	0.2 (AA)
Chromium	43.6 (0.865)	2.8×10^{-4}	43.6 (0.865)	- 0.001 - (0.03)	0.6 (AA); 32 (MAC)
Copper	20.9 (0.862)	4.5×10^{-3}	20.9 (0.867)	0.02 (0.52)	3.76 (AA)*
Lead	1.57 (0.350)	1.1×10^{-3}	1.571 (0.351)	0.07 (0.32)	1.3 (AA), 14 (MAC)
Mercury	0.086 (0.011)	4.0×10^{-6}	0.086 (0.011)	0.005 (0.04)	0.07 (MAC)
Nickel	1.29 (0.446)	1.5×10^{-2}	1.305 (0.461)	1.17 (3.37)	8.6 (AA), 34 (MAC)
Zinc	26.3 (7.129)	2.3×10^{-3}	26.3 (7.131)	0.01 (0.03)	7.9 (AA)**

[a] As described under the WFD (Standards and Classification) Directions (England and Wales) 2015. EQS values refer to dissolved concentrations. *Copper EQS based on dissolved organic carbon

concentration of <1mg/L. **Zinc EQS includes ambient background concentration for saltwater (1.1µg/L).

13.6.96 It is considered that any potential increase in dissolved concentrations of metals in the water column as a result of dredging activities will be minimal. The magnitude of change is therefore predicted to be negligible and the effects on coastal WFD water bodies as a result of changes to water chemistry are predicted to be negligible.

Effects on phytoplankton and zooplankton

13.6.97 The effects of suspended solids are temporary and are restricted to the vicinity of the dredging. The magnitude of change in phytoplankton and zooplankton is therefore predicted to be negligible and the effect from changes to water quality from dredging are considered to be negligible.

Effects on intertidal and subtidal habitats

13.6.98 Intertidal and subtidal habitats could potentially be affected by an increase in suspended solids concentrations which reduce light levels and may inhibit feeding for some species (as discussed in paragraphs 13.6.59 to 13.6.62). However, the effects on suspended solids are temporary and are restricted to the vicinity of the dredging. Therefore, the magnitude of change in intertidal and subtidal habitats and communities (including those of conservation importance and invertebrates of conservation and/or commercial importance) is predicted to be negligible and the effect from changes to water quality is considered to be negligible.

Effects on fish

13.6.99 The potential effects on fish are described in paragraph 13.6.69. The effects from suspended solids from dredging would be temporary (approximately 35 days) and the area affected is small in relation to the available refuge and foraging habitat. The magnitude of change is predicted to be negligible and the effect on all fish receptors from an increase in suspended sediment is considered to be negligible.

Effects on marine mammals

13.6.100 As stated in paragraph 13.6.75, it is unlikely that marine mammals would enter the area where suspended solids concentrations are above background and there is no predicted change to prey sources. The magnitude of change is predicted to be negligible and it is considered that there would be negligible effects on marine mammals from changes in marine water quality.

Effects on seabirds

13.6.101 The potential changes to suspended solids are discussed in paragraphs 13.6.13 to 13.6.21. The magnitude of change in suspended solids in coastal waters is predicted to be negligible, and there would be no effect on marine water quality from changes to suspended solids. Therefore, it is predicted that there would be negligible effects on the prey sources (fish and invertebrates) and ultimately on seabirds, from changes to suspended solids.

13.6.102 The potential changes in marine water chemistry are discussed in paragraphs 13.6.22 to 13.6.31. This would not affect seabirds directly, and negligible effects are predicted from changes in marine water chemistry on their prey sources (fish and invertebrates). Therefore, it is predicted that there would be negligible effects on seabirds from changes in water chemistry.

Effects on designated sites

13.6.103 As described in the preceding sections on seabirds and marine mammals, the magnitude of change is predicted to be negligible and the effects on the Anglesey Terns/Morwenoliaid Ynys Môn SPA and the North Anglesey Marine cSAC, are considered to be negligible.

Impact pathway: changes to hydrodynamics from construction of Marine Works

General context

13.6.104 The temporary causeway to the western breakwater would restrict water circulation within the area inside of the breakwaters by blocking off water moving into this area from the west. The temporary causeway would be constructed first and would remain in place for a total of approximately five years. Following completion of the causeway the construction of the breakwaters and temporary cofferdam would commence. The temporary cofferdam would be in place for approximately two years during which the dewatering and excavation of the inner harbour will take place. The area inside the breakwaters would be approximately 30ha with 18ha comprising the inner harbour. For the two years during which the temporary cofferdam would be in place, seawater would only be present in the outer harbour (approximately 12ha). After excavation of the inner harbour the temporary cofferdam would be removed; this will allow seawater to flood back into the dewatered area.

Effects on marine water quality

Changes to water circulation

13.6.105 It is unlikely that water circulation within the outer harbour would be significantly affected while the temporary causeway is present, as water exchange through tidal movements between the eastern and western breakwater would still take place.

13.6.106 Whilst the tidal and wave driven flows around the southern tip of the western breakwater will be absent during construction due to the temporary causeway there will still be an exchange of water from within the harbour and the sea because of tidal forcing. On the ebb tide as levels fall water will leave the harbour whilst on the flood the rising water level will be associated with a flow south into the harbour. The tidal range at the Wylfa site varies between 2m and over 6m and hence a large volume of water will enter on the flood and exit on the ebb with more exchange on a spring compared to a neap tide. The flow field outside the harbour set up by the east to west tidal flow north of Wylfa Head should ensure mixing of the water flushed out of the harbour with the wider sea. Within the harbour itself there can be expected to be vertical and transverse mixing of water due to the tidal forcing and from wind and wave action (the latter depending on the wave direction offshore).

13.6.107 The inner harbour will be dry for two years and therefore not subject to changes in hydrodynamics during this time. For the remaining three years, water circulation within the inner harbour would be restricted. It is likely that water exchange through tidal movements and mixing of the water column would be reduced compared to the outer harbour. Ongoing construction activities, however, such as dredging and piling would continually cause disturbance to the water column.

13.6.108 After the temporary causeway is removed water circulation in the area inside the breakwaters would be restored.

13.6.109 Construction of the temporary causeway would result in changes to water circulation particularly within the inner harbour for approximately three years. Given the limited extent and the temporary nature of the effect, the magnitude of change in water circulation of coastal waters is considered to be negligible and there would be no effect on marine water quality from changes to water circulation within the inner harbour.

Changes to temperature, underwater light regime and nutrient conditions

13.6.110 Reduced water circulation within the inner harbour could result in increased stratification of the water column. Particularly during the summer months increased solar radiation would increase the temperature of surface waters, promoting further thermal stratification.

13.6.111 Increased stratification of the water column within the inner harbour is likely to increase light availability in the surface waters. Ongoing construction activities, however, such as dredging and piling would continually cause disturbance to the water column with suspended material countering some of the effects of increased stratification on light availability.

13.6.112 Nutrient concentrations in the Wylfa Newydd Development Area are low (see paragraph 13.3.19) and nutrient conditions in Porth-y-pistyll are not predicted to change during construction (see paragraphs 13.6.9 to 13.6.41). Reduced water circulation within the inner harbour is therefore not expected to have an effect on nutrient conditions.

13.6.113 Reduced water circulation within the inner harbour could result in increased stratification and increased temperature and light availability in the surface waters; no effect is expected on nutrient conditions. Given the limited extent and the temporary nature of the effect, the magnitude of change in temperature, underwater light regime and nutrient conditions in coastal waters is considered to be negligible and there would be no effect on marine water quality from changes in these variables within the inner harbour.

Effects on phytoplankton

13.6.114 The increased temperature and light availability within the inner harbour as a result of reduced water circulation could promote phytoplankton growth and particularly that of harmful and/or toxic algae. A number of harmful/toxic algae are present within the Wylfa Newydd Development Area but their densities are considered to be very low compared to the number at which an individual taxon is considered to reach bloom densities (see paragraph 13.3.44). Overall phytoplankton densities are also considered to be low in the area (see paragraphs 13.3.41 and 13.3.42).

13.6.115 Increased light and nutrient availability as well as increased temperature are all considered to promote phytoplankton growth. While anthropogenic nutrient enrichment has been proposed as a principal causative factor of harmful algal blooms it is often the hydrodynamic processes that determine whether the blooms occur [RD93]. Porth-y-pistyll and the rest of the Wylfa Newydd Development Area are not subject to anthropogenic nutrient enrichment, though the temporary reduced water circulation in the inner harbour could promote algal growth including harmful algal blooms. The naturally low nutrient concentrations in the area, however, are not expected to change during construction and are unlikely to support extensive algal blooms in the inner harbour, if any.

13.6.116 Reduced water circulation could promote phytoplankton growth including harmful algal blooms within the inner harbour; however, extensive blooms, if any, are unlikely to be supported considering the low nutrient concentrations in the area. Given the limited extent and the temporary nature of the effect, the magnitude of change in phytoplankton densities including harmful algal blooms in coastal waters is considered to be negligible and there would be no effect on phytoplankton from changes to hydrodynamics within the inner harbour.

Impact pathway: direct footprint of the Marine Works leading to mortality of species and loss of habitats and the resource provided by these habitats

General context

13.6.117 Direct loss of intertidal and subtidal habitats and species would occur from construction activities such as excavation, dredging, dewatering and land reclamation; and from the construction of temporary and permanent marine structures as described in section 13.5. Embedded mitigation measures proposed to reduce direct loss of habitats and species are outlined in paragraphs 13.5.82, 13.5.83 and 13.5.113.

13.6.118 The MOLF would be constructed within the intertidal area south-west of the Existing Power Station (see chapter D1, Application Reference Number: 6.4.1). This structure (including any reclaimed land below Mean High Water Springs) would result in a loss of approximately 5ha. The Cooling Water intake would be constructed on the shore in Porth-y-pistyll bay, adjacent to the Ro-Ro MOLF. The main part of this structure would be positioned on land above Mean High Water Springs, but would extend vertically down through the tidal range, resulting in a loss of approximately 5ha of intertidal habitats. Two permanent breakwaters would also be built, and the combined footprint of these permanent structures would result in the loss of approximately 4ha of intertidal and subtidal habitats. Temporary marine structures, including a causeway and temporary cofferdam, would result in the loss of intertidal and subtidal habitats (chapter D1, Application Reference Number: 6.4.1).

13.6.119 Excavation and dredging activities would be required to form the inlet navigation channel along with the Cooling Water channel and intake facility. This would result in the direct loss of approximately 17ha of intertidal and subtidal habitats and species. Total habitat loss due to the Marine Works in Porth-y-pistyll is estimated to be 30.5ha (figure D13-27, Application Reference Number: 6.4.101).

13.6.120 The Cooling Water outfall represents an additional permanent structure that would result in the loss of both intertidal and subtidal habitats. A temporary cofferdam would be required in front of the Cooling Water outfall to enable construction in dry conditions, resulting in further losses within the subtidal zone. The footprint of the Marine Works in the vicinity of the Cooling Water outfall represents an approximate area of 0.6ha.

13.6.121 Once constructed, the area inside the temporary cofferdams would be dewatered to permit dry marine excavation (see paragraph 13.5.10). Any fish drawn into the dewatering pumps would be vulnerable to direct mortality. The effect of dewatering on other marine organisms is considered to be negligible and has not been considered further in the assessment.

13.6.122 Following cessation of Cooling Water discharge at the Existing Power Station and prior to the construction phase commencing, baseline conditions within the vicinity of the Cooling Water outfall are likely to have changed. As it is not possible to reliably predict what these changes might be, a precautionary approach has been taken which assumes that habitats and communities at this location would have fully recovered and would therefore be of a value consistent with baseline conditions found elsewhere along the north coast of Anglesey.

13.6.123 The building of permanent and temporary structures will lead to the direct loss of habitats and mortality of associated communities within the construction footprint. Fragmentation of habitats and isolation of species and communities within the remaining areas would also occur. Core and beneficial ecosystem processes provided by intertidal and subtidal habitats, including nutrient cycling, primary production and regulation of water quality, would be lost within the footprint, with possible disruption to the functioning of adjacent habitats. Species which rely on these habitats for food or refuge would also be affected, leading to potential indirect effects on survival, growth, reproduction or displacement of individuals.

Effects on habitats and communities from direct loss

13.6.124 A total of 30.5ha of habitat would be lost under the footprint of the Marine Works in Porth-y-pistyll (figure D13-27, Application Reference Number: 6.4.101). Of this, 22ha has been classified into biotopes according to the

JNCC habitat classification system [RD12]. Effects to these specific habitats and communities have been considered in further detail below.

13.6.125 The remaining 8ha which falls under the footprint of the Marine Works in Porth-y-pistyll and a further 0.6ha under the construction footprint of the Cooling Water outfall (including temporary cofferdam) has not been assigned a biotope. Data from drop-down camera, dive and grabbing surveys (see appendix D13-3, Application Reference Number: 6.4.85) suggests that the remaining area under the western breakwater and to the north represents sublittoral sediments (see paragraph 13.3.68), whilst the area to the east of the eastern breakwater and around the Cooling Water outfall is comprised of predominately high and moderate energy littoral rock habitats (LR.HLR and LR.MLR).

13.6.126 For the purpose of this assessment, areas which have not been assigned a formal biotope but which are considered to represent littoral or sublittoral rock, have been considered under the receptor 'subtidal and intertidal habitats of conservation importance', as examples of Annex I 'rocky reef' (see figure D13-27, Application Reference Number: 6.4.101). Littoral and sublittoral sediments, are not considered to be of conservation importance (see paragraph 13.6.142 for further justification) and have been considered under the receptors intertidal habitats and communities or subtidal habitats and communities, respectively.

Intertidal habitats and communities

13.6.127 A total 7.6ha of intertidal habitats falls under the footprint of the Marine Works, of this 6.9ha have been assigned a biotope and would be lost in Porth-y-pistyll. These primarily represent littoral rock (LR) (5.9ha) with some littoral sediment (LS) (0.9ha) habitats (figure D13-27, Application Reference Number: 6.4.101). Approximately 55% of intertidal habitats within the footprint fall into two biotope complexes; 'Fucoids on sheltered marine shores' (LR.LLR.F) and 'Barnacles and fucoids on moderately exposed shores' (LR.MLR.BF) (table D13-11).

13.6.128 Habitats within the biotope complexes 'Lichens or small green algae on supralittoral and littoral fringe rock' (LR.FLR.Lic) and 'Mussel and/or barnacle communities' (LR.HLR.MusB) comprise a further 29% of the intertidal area that would be lost in Porth-y-pistyll whilst littoral sediment (LS) biotope complexes contribute 14%. The remaining area is characterised by 'ephemeral green or red seaweed communities' (LR.FLR.Eph) and 'robust fucoid and/or red seaweed communities' (LR.HLR.FR), contributing 2% and 1%, respectively.

Table D13-11 The approximate area (ha) of intertidal biotope complexes present within the footprint of the Marine Works (excludes the Cooling Water outfall construction footprint)

Biotope complex code	Biotope description	Approximate area of habitat in the footprint of the works (ha)
LR.LLR.F	Fucoids on sheltered marine shores	1.95
LR.MLR.BF	Barnacles and fucoids on moderately exposed shores	1.81
LR.FLR.Lic	Lichens or small green algae on supralittoral and littoral fringe rock	1.00
LR.HLR.MusB	Mussel and/or barnacle communities	0.97
LS.LCS.Sh	Shingle (pebble) and gravel shores	0.54
LS.LSa.FiSa	Polychaete/amphipod-dominated fine sand shores	0.18
LR.FLR.Eph	Ephemeral green or red seaweed communities (freshwater or sand-influenced)	0.13
LS.LSa.MoSa	Barren or amphipod-dominated mobile sand shores	0.12
LS.LSa.St	Strandline	0.08
LR.HLR.FR	Robust fucoid and/or red seaweed communities	0.08
LS.LSa.MuSa	Polychaete/bivalve-dominated muddy sand shores	0.01

13.6.129 Intertidal habitats present within the construction footprint are typically characterised by dense fucoid seaweed species and invertebrates including molluscs and crustaceans. No species considered to be of conservation importance were recorded within the footprint of the Marine Works during intertidal benthic surveys.

13.6.130 Construction within the intertidal zone in Porth-y-pistyll would result in the loss of approximately 20 rock pools greater than 1m^2 that are characterised by a number of biotopes. 'Seaweed and sediment-floored rock pools' (LR.FLR.Rkp.SwSed) are the most common, representing 11 of the total number of rock pools present within the footprint of the Marine Works (see appendix D13-3, Application Reference Number: 6.4.85).

13.6.131 Several intertidal biotopes within the footprint of the Marine Works in Porth-y-pistyll are considered to be examples of rocky reef habitat (see paragraph 13.3.60) and in accordance with Section 7 of The Environment (Wales) Act 2016, although they are not qualifying features of any nearby designated site (see appendix D13-3, Application Reference Number: 6.4.85). Of these, the localised extents of four fall entirely within the footprint of the Marine Works in Porth-y-pistyll. These include:

- *Porphyra purpurea* and *Enteromorpha* spp. on sand-scoured mid or lower eulittoral rock (LR.FLR.Eph.EntPor);
- *Mastocarpus stellatus* and *Chondrus crispus* on very exposed to moderately exposed lower eulittoral rock (LR.HLR.FR.Mas);
- *Fucus serratus* on full salinity sheltered lower eulittoral rock (LR.LLR.F.Fserr.FS); and
- *Fucus serratus* on moderately exposed lower eulittoral rock (LR.MLR.BF.Fser).

13.6.132 Of the total 7.6ha of intertidal habitats that falls under the footprint of the marine works, approximately 6.7ha are considered to be rocky reef Annex I habitat. The remaining intertidal habitats (0.9ha) represent littoral sediments and are not considered to be of conservation importance (figure D13-27, Application Reference Number: 6.4.101).

13.6.133 Although the intertidal habitat within the footprint of the Marine Works is common round the north coast of Anglesey, the permanent loss of 7.6ha would result in fragmentation of intertidal habitat around the coastline. Recovery would not be possible in the long-term as conditions within Porth-y-pistyll and around the Cooling Water outfall will be permanently altered. It is recognised however, that the structures would introduce permanent hard surfaces providing new colonisation surface for species dependent on hard substrate [RD81].

Subtidal habitats and communities

13.6.134 A total of 23.5ha of subtidal habitats falls under the footprint of the Marine Works, of this 15.6ha have been assigned a biotope and would be lost in Porth-y-pistyll. These primarily represent infralittoral rock (IR) (11.1ha) with some sublittoral sediment (SS) (4.1ha) and circalittoral rock (CR) (0.4ha) habitats (figure D13-27, Application Reference Number: 6.4.101).

13.6.135 Approximately 60% of this area is characterised by habitats within the biotope complex Kelp and red seaweeds (moderate energy infralittoral rock) (IR.MIR.KR). Circalittoral muddy sand (SS.SSa.CMuSa), which includes the biotope *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment (SS.SSa.CMuSa.AalbNUC), contributes a further 18% (table D13-12). Of the remaining area, 14% represents the biotope complexes Silted kelp communities (sheltered infralittoral rock) (IR.LIR.K), Kelp with cushion fauna and/or foliose red seaweeds (IR.HIR.KFaR) and Mixed faunal turf communities (CR.HCR.XFa), whilst 9% represents sublittoral sediments (SS.SCS and SS.SSa).

Table D13-12 The approximate area (ha) of subtidal biotope complexes present within the footprint of the Marine Works (excludes the Cooling Water outfall construction footprint)

Biotope complex code	Biotope description	Approximate area of habitat in the footprint of the works (ha)
IR.MIR.KR	Kelp and red seaweeds (moderate energy infralittoral rock)	9.33
SS.SSa.CMuSa	Circalittoral muddy sand	2.76
SS.SSa.IMuSa	Infralittoral muddy sand	1.34
IR.LIR.K	Silted kelp communities (sheltered infralittoral rock)	1.06
IR.HIR.KFaR	Kelp with cushion fauna and/or foliose red seaweeds	0.70
CR.HCR.XFa	Mixed faunal turf communities	0.35
SS.SCS.ICS	Infralittoral coarse sediment	0.02
SS.SMu.ISaMu	Infralittoral sandy mud	0.02

13.6.136 The biotope complex IR.MIR.KR, one of the largest biotopes present within the footprint, is characterised by a variety of red, brown and green algal species which support epilithic seaweeds, encrusting sponges and epifaunal colonial organisms such as the bryozoan *Alcyonidium diaphanum* and *Flustra foliacea*, the cnidarian *Alcyonium digitatum*, the hydroid *Tubularia indivisa*, and the polychaete *S.spinulosa*.

13.6.137 No significant biogenic reef structures, classified as low to high reefiness according to Gubbay [RD14], have been recorded within the Wylfa Newydd Development Area during baseline surveys (see appendix D13-2, Application Reference Number: 6.4.84). Within the footprint of the Marine Works, sparse individuals and thin/sparse crusts of tube structures have been recorded although Sabellaridae does not represent a classifying feature of any of the biotopes present.

13.6.138 The biotope complex Bryozoan turf and erect sponges on tideswept circalittoral rock (CR.HCR.XFa.ByErSp) is present in Porth-y-pistyll. This is recognised as part of the broader Section 7 habitat ‘Fragile Sponge and Anthozoan Communities on Rocky Habitats’ of The Environment (Wales) Act 2016 as well as being an Annex I habitat under rocky reefs. This biotope covers an approximate area of 0.6ha, with 0.4ha falling within the footprint of the Marine Works. The extent of this habitat in Porth-y-pistyll is considered to represent a relatively small area compared to its wider distribution along the north Anglesey coastline, with better examples in terms of species richness observed to the east of Porth-y-pistyll (see appendix D13-3, Application Reference Number: 6.4.85).

13.6.139 Several subtidal biotopes within the footprint of the Marine Works are considered to be examples of rocky reef habitat listed on Annex I of the Habitats Directive and in accordance with Section 7 of The Environment (Wales) Act 2016, although they are not qualifying features of any nearby designated site (see appendix D13-3, Application Reference Number: 6.4.85). The localised extent of two of these falls entirely within the footprint of the Marine Works in Porth-y-pistyll and will therefore be lost from the immediate area. These include:

- *Laminaria saccharina* and *L.digitata* on sheltered sublittoral fringe rock (IR.LIR.K.Lsac.Ldig); and
- *Laminaria hyperborea* and foliose red seaweeds on moderately exposed infralittoral rock (IR.MIR.KR.Lhyp).

13.6.140 Of the total 23.5ha of subtidal habitats that falls under the footprint of the Marine Works, approximately 13.3ha are considered to be rocky reef' Annex I habitat. Recovery of subtidal rocky reef habitat within the footprint would not be possible in the long-term as conditions within Porth-y-pistyll and around the Cooling Water outfall will be permanently altered.

13.6.141 The remaining subtidal area under the footprint of the Marine Works in Porth-y-pistyll (10.2ha) represents predominately muddy sand sediments with smaller areas of coarse sediments and sandy mud. These habitats support a number of burrowing infaunal species (e.g. *Abra alba*, *Nicula nitidosa* and *Arenicola marina*) which are considered bioturbators, influencing the cycling of nutrients and oxygen as well as the structure of surface sediments.

13.6.142 Muddy sand sediments is recognised under the Annex I habitat 'Sandbanks which are slightly covered by seawater all the time', and a number of sublittoral sediment biotopes identified are also recognised as part of the broader Section 7 habitat 'Subtidal sands and gravels of The Environment (Wales) Act 2016. Although designated, these habitats are not qualifying features of any nearby designated sites and are considered to represent very large habitat resources at the local and regional scale. In light of this, these biotopes are not considered to be of conservation importance. The loss of sublittoral sediment habitat is small, and although permanent, it is not considered to affect the integrity of this receptor, which is very common around the north coast of Anglesey and the UK.

Colonisation of new substrate

13.6.143 Direct habitat and species loss within the footprint of the Marine Works has been assessed as a permanent effect, however following construction, new substrate and hard structures within Porth-y-pistyll will be available for colonisation within the intertidal and subtidal zone (see paragraph 13.5.82).

13.6.144 The early stages of recolonisation will occur quickly and in the intertidal area this is likely to involve green algae and *Porphyra* spp., followed by barnacles, and potentially mussels, depending on the nature of the surrounding environment [RD94]. Once habitats have become established, invertebrate fauna would be expected to move into the area rapidly from adjacent habitats.

13.6.145 Most subtidal, stable rock substrata within the photic zone are likely to be colonised by kelp. Rapid recolonisation of *L.hyperborea* has been demonstrated by Kitching [RD95] and Kain [RD96]. The latter study found that *L.hyperborea* forest regenerated within two years of the initial disturbance in shallow sublittoral waters. The establishment of new kelp fronds can be considered an important initial driver of community recovery and recolonisation which is only likely to facilitate the establishment of many other associated species.

13.6.146 For hard surfaces, recolonisation rates and the succession of species depends greatly on the physical conditions of new substrates, influenced by position within the tidal frame, gradient, exposure and surface and structural heterogeneity. The breakwater structures would represent a range of exposure conditions which would provide conditions suited to a range of macroalgae, invertebrate and fish species. However, it is not possible to accurately predict the new habitats that would colonise new structures. The presence of the structures alone (i.e. without incorporation of specific enhancement measures), does not reduce the magnitude of change relating to the loss of intertidal and subtidal habitats and species.

Summary of effects on habitats and communities from direct loss

13.6.147 Off the 7.6ha and 23.5ha of intertidal habitats and communities and subtidal habitats and communities that would be lost under the footprint of the Marine Works, 6.7ha and 13.3ha are considered to be of conservation importance, being examples of Annex I rocky reef.

13.6.148 Although the scale of rocky reef habitat loss is small in comparison to the availability of this habitat on a regional scale, the level of degradation and fragmentation means that the magnitude of change is considered to be medium. Whilst hard substrate on the breakwater structures could function as an artificial rocky reef, it is considered that there would be a medium magnitude of change and a moderate adverse effect from the direct loss of subtidal and intertidal habitats of conservation importance under the footprint of the Marine Works.

13.6.149 The remaining intertidal habitats (0.9ha) represent littoral sediments which fall under the receptor intertidal habitats and communities. Considering the extent of these habitats on a local and regional scale, the magnitude of change is predicted to be small and there would be a negligible effect from the direct loss of intertidal habitats and communities under the footprint of the Marine Works.

13.6.150 The remaining subtidal habitats (10.2ha) represent sublittoral sediments which fall under the receptor, ‘subtidal habitat and communities’. Considering the extent of these habitats on a local and regional scale, the magnitude of change is predicted to be small and there would be a negligible effect from the direct loss of subtidal habitats and communities under the footprint of the Marine Works.

Effects on invertebrates of conservation and commercial importance

13.6.151 The permanent loss of subtidal and intertidal habitat would have a direct effect on invertebrates of conservation and commercial importance from mortality under the footprint of the Marine Works.

13.6.152 Ocean quahog and spiny lobster are the only two invertebrate species of conservation importance that have been identified within the vicinity of the Wylfa Newydd Development Area. Both are listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016.

13.6.153 A single individual ocean quahog was recorded in Porth-y-pistyll and would fall under the footprint of the western breakwater (see appendix D13-2, Application Reference Number: 6.4.84). This species is found around all British and Irish coasts as well as offshore, with a global distribution extending from Iceland to the Bay of Biscay [RD97]. This species is commonly found on firm sublittoral sediments, buried or partially buried in sand and muddy sand. In the North Sea, reported average densities of the ocean quahog range from 0.7 individuals/m^2 in southern areas to 2.1 individuals/m^2 in central regions [RD98]. Juveniles are found in the northern North Sea in densities of up to 286 individuals/m^2 [RD98]. The densest population around Anglesey was found to the south in Caernarfon Bay with 66 individuals/km dredged. A small population (1.6 individuals/km dredged) has been observed in Red Wharf Bay inhabiting a patch of muddy sand surrounded by coarser sands. Small isolated populations ranging from 1.0 to 4.2 individuals/km dredged have also been recorded in Cardigan Bay [RD99].

13.6.154 Records of ocean quahog around the north Wales coast and the eastern Irish Sea are sparse, an indication that it is rare in these areas [RD99]. This is further evidenced by the absence of this species in subtidal benthic surveys carried out around the north Anglesey coastline (see appendix D13-2, Application Reference Number: 6.4.84). It is therefore considered that loss of individuals from the footprint of the works would not affect the integrity of the wider population.

13.6.155 A single record of the European spiny lobster was recorded at Llanbadrig Head, outside the Wylfa Newydd Development Area. Although this species is mobile, therefore the potential for direct mortality is low.

13.6.156 Within the Wylfa Newydd Development Area there is limited commercial potting activity which suggests a low abundance of commercial invertebrate species including scallop, whelk, lobster and edible crab. Potting for prawns is believed to occur in the area although the intensity of this commercial fishery is unknown [RD25]. These commercial invertebrate species are mobile and therefore the potential for direct mortality is low.

13.6.157 For invertebrate species of conservation and/or commercial importance, notably the ocean quahog, the magnitude of change is predicted to be small as the potential for and extent of the loss is small. Therefore, it is considered that there would be a minor adverse effect from the direct loss of either individuals or habitat under the footprint of the Marine Works.

Effects on marine fish from the direct loss of individuals, habitats and the resource provided by these habitats

13.6.158 Fish would be vulnerable to direct mortality from initial dewatering activities. As fish are highly mobile, direct mortality is unlikely to occur within the remainder of the marine construction footprint; the magnitude of change is considered to be negligible and the effect in this area, negligible.

13.6.159 The permanent loss of subtidal and intertidal habitat would have an indirect effect on marine fish receptors due to the loss of habitat, feeding resource and refuge, resulting in displacement. The effects of underwater noise have been assessed from paragraph 13.6.263.

13.6.160 Fish assemblages in Porth-y-pistyll are reflective of a typical inshore community. Being a rocky bay, lower abundances of sandeel (Ammodytidae) and plaice, which live in association with softer sediments, are generally observed in Porth-y-pistyll, compared to other sites along the coastline which are characterised by sandy substrates. Conversely, species such as sand smelt, 15-spined stickleback (*Spinachia spinachia*), long-spined sea scorpion (*Taurulus bubalis*) and mullet (Muglidae), which rely on algae and detritus for shelter and food, are generally found in higher abundances (see appendix D13-4, Application Reference Number: 6.4.86). Juvenile clupeids (sprat and herring) are also known to use shallow intertidal areas as nursery grounds. Based on the abundance of these species in Porth-y-pistyll and the wide availability of food resource outside this area, the magnitude of change is predicted to be small. Therefore, it is considered that there would be a negligible effect on general fish and fisheries from the direct loss of either individuals or habitats under the footprint of the Marine Works.

13.6.161 Fish of conservation and/or commercial importance recorded in Porth-y-pistyll include herring, sea trout, sandeel (specifically Raitt's sandeel) and nursehound. Herring and sandeel are common to the wider sea area with abundances in Porth-y-pistyll considered to represent a small proportion of the overall population along the north Anglesey coastline. Therefore, given the low numbers of fish that are likely to be affected, the magnitude of change is predicted to be negligible and the effect on fish of commercial and/or conservation importance from the direct loss of either individuals or habitat under the footprint of the Marine Works is considered to be negligible.

13.6.162 Considering the embedded mitigation outlined in paragraph 13.5.82, freshwater habitats in the Afon Cafnan would remain accessible to migratory fish. Diadromous species such as European eel, river lamprey and Atlantic salmon are not known to utilise the habitats within Porth-y-pistyll but may transit through during migrations to and from the sea. Owing to the low abundance of these species recorded within Porth-y-pistyll and their mobility, the magnitude of change is predicted to be negligible and the effect on migratory species from the direct loss of habitats under the footprint of the Marine Works is considered to be negligible.

13.6.163 Although unlikely, there is a risk that European eel, river lamprey and Atlantic salmon may be present within the area behind the temporary cofferdams and would be vulnerable to mortality during initial dewatering activities. The magnitude of change is predicted to be small and the effect on these species from the direct loss of individuals during dewatering is considered to be minor adverse.

Effects on marine mammals from the direct loss of individuals, habitats and the resource provided by these habitats

13.6.164 The permanent loss of intertidal and subtidal habitats and displacement of fish could have an indirect effect on marine mammals due to a loss of feeding resource (e.g. invertebrates and fish). The loss of intertidal areas under the footprint of the Marine Works may displace grey seals if suitable haul-out sites are lost. Marine mammals are highly mobile and the risk of direct mortality within the marine construction footprint is considered to be very low.

13.6.165 Marine mammal species most commonly recorded along the north Anglesey coastline and within the vicinity of Porth-y-pistyll (harbour porpoise, bottlenose dolphin and grey seal), exhibit similar food preferences. Gadoids are the dominant prey of harbour porpoise, bottlenose dolphin and grey seal representing 60%, 77% and 38% of their diet, respectively [RD100]. Species targeted include, but are not limited to, whiting, haddock (*Melanogrammus aeglefinus*), pollack (*Pollachius pollachius*), saithe (*Pollachius virens*), blue whiting (*Micromesistius poutassou*), *Trisopterus* sp. and common ling (*Molva molva*). Harbour porpoise also target clupeids (namely herring, *Clupea harengus*) and to a lesser extent Atlantic mackerel (*Scomber scombrus*), whilst bottlenose dolphin target Anguilliformes (namely conger eel) and scad/horse mackerel. Within the Irish Sea, sandeel is not considered to be an important prey species to either harbour porpoise or bottlenose dolphin [RD100].

13.6.166 Grey seal are considered to be a more generalist feeder; salmonids, flatfish (namely lemon sole; *Microstomus kitt*; plaice; Dover sole; and dab), Anguilliformes, sandeel, dragonets, sea scorpions, eelpout, wrasse and sea lamprey, all form important components of their diet [RD101]; [RD100].

13.6.167 Porth-y-pistyll is not considered to represent an important area for gadoids with very few individuals recorded in the area from intertidal surveys and subtidal surveys compared to elsewhere along the coastline. Species known to be present include pollack, poor cod and rockling. Higher abundances of whiting, cod and poor cod have been found in the subtidal area, particularly to the east of the Wylfa Newydd Development Area (see appendix D13-4, Application Reference Number: 6.4.86). As outlined in paragraph 13.6.160, few flatfish and sandeel are present in Porth-y-pistyll owing to the nature of substrates. Although clupeids have been recorded in the bay, they do not exhibit consistent seasonal presence, nor are they present in particularly high abundances (see appendix D13-4, Application Reference Number: 6.4.86). Higher clupeid abundances have generally been observed to the east in Cemaes Bay and Red Wharf Bay (see appendix D13-4, Application Reference Number: 6.4.86).

13.6.168 Given information regarding the diet of marine mammals and an understanding of fish communities within Porth-y-pistyll, the bay is unlikely to represent a key foraging area. Displacement of marine mammals due to a loss of food resource is considered to be negligible and therefore the magnitude of change is predicted to be negligible. The indirect effect on marine mammals from the direct loss of habitats and species in the footprint of the Marine Works is considered to be negligible.

13.6.169 The grey seal relies on intertidal habitat for breeding and resting (hauling-out). There are no primary or secondary breeding haul-out sites for grey seal recognised along the north Anglesey coastline. The nearest site is located on The Skerries, which is over 7km from the Wylfa Newydd Development Area [RD41]; [RD102]. Sightings of grey seals in the vicinity of Porth-y-pistyll are typically of individuals or small groups in the water (see appendix D13-6, Application Reference Number: 6.4.88). The baseline surveys did not record any sightings of breeding seals or pups within the vicinity of the Wylfa Newydd Development Area, although incidental sightings have been reported along the wider north Anglesey coastline.

13.6.170 Whilst the loss of intertidal habitat has the potential to affect grey seal, the breakwater structure itself would provide suitable areas for seals to haul-out (see paragraph 13.5.82). It is therefore considered that the magnitude of change is negligible and the direct effect on grey seals from the direct loss of intertidal habitats would be negligible.

Effects on seabirds from the direct loss of habitats and the resource provided by these habitats

13.6.171 The permanent loss of intertidal and subtidal habitats and species could have an indirect effect on seabirds due to a loss of habitat, refuge and food resource (e.g. fish and invertebrates).

13.6.172 Porth-y-pistyll is not considered to be a key foraging area for target seabird species, for which the Anglesey Terns/Morwenoliaid Ynys Môn SPA is designated (i.e. Arctic tern, common tern, roseate tern and Sandwich tern). The tern tracking surveys did not record any terns feeding within Porth-y-pistyll and less that 2% of terns recorded in the bay in the VP surveys were actively feeding (appendix D13-7, Application Reference Number: 6.4.89). This suggests that Porth-y-pistyll is characterised by low value food resources with respect to the dietary preference of terns.

13.6.173 Sandwich terns from the Cemlyn Lagoon colony exhibit a preference for sandeel and clupeids [RD50]. It is likely that gadoids (namely rockling) as well as invertebrates and cephalopods make up the remaining diet although the relative contribution of these prey types is unknown. Arctic/common terns are believed to exhibit a broadly similar diet [RD50].

13.6.174 Tracking studies have shown terns fly from the breeding colony in Cemlyn Lagoon to feeding grounds primarily to the east in the case of Sandwich tern, and fanning out in a more northerly direction in the case of both common and Arctic tern (see appendix D13-7, Application Reference Number: 6.4.89). The tracking studies from 2009, 2016 and 2017 do not show any evidence of significant feeding activity in Porth-y-pistyll by any of the three tern species; feeding activity takes place in areas further out to sea, beyond the inshore bays surrounding the Wylfa Newydd Development Area.

13.6.175 Large areas of the north and eastern Irish Sea are characterised as spawning and nursery grounds for sandeel and herring as well as gadoid species such as whiting and cod [RD24]. Whilst sandeel and clupeid are known to be present in Porth-y-pistyll, their abundance relative to the highly productive areas in the eastern Irish Sea is considered to be low. The loss of food resource within Porth-y-pistyll is considered to be negligible for target seabird species, considering the limited use of this area by feeding birds and the availability and preference for food resources farther afield and therefore the magnitude of change is predicted to be negligible. The indirect effect on target seabirds from the direct loss of habitats and species in the footprint of the Marine Works is considered to be negligible.

13.6.176 Surveys have shown that a total of 30 secondary seabird species utilise the intertidal zone in Porth-y-pistyll for loafing and/or foraging. Herring gull and black-headed gull were present in the greatest numbers, with common gull and lesser black-back gull also recorded in high numbers. Great black-backed gull, cormorant and shag were also present, but in lower abundance (appendix D13-7, Application Reference Number: 6.4.89).

13.6.177 Displacement of secondary seabirds from Porth-y-pistyll due to the direct loss of intertidal habitats and species within the footprint is likely; however, owing to the low abundance of birds present in the area, there would not be an effect on the integrity of wider populations and therefore the magnitude of change is predicted to be negligible. It is considered that there would be a negligible indirect effect on secondary seabirds from the direct loss of habitats and species in the footprint of the Marine Works. It is also recognised that the development of intertidal habitats and species on the breakwaters could represent additional habitat, refuge and food resource for secondary seabird species.

13.6.178 The direct loss of terrestrial and intertidal habitats and species may affect local populations of black-headed gull. However, the various seabird surveys undertaken have indicated that this species is widely distributed in the area and, with the exception of Cemlyn Lagoon and Bay, tends to be found in small numbers. This species also uses a wide variety of habitats for foraging and loafing. As such, they are not considered to be reliant on intertidal habitats; therefore, the loss of intertidal habitats and species is considered to be negligible.

Effects on designated sites from the direct loss of habitats and the resource provided by these habitats

13.6.179 The permanent loss of terrestrial, intertidal and subtidal habitats and communities (including those of conservation importance) would have an indirect effect on designated sites, through loss of habitat, feeding resource and refuge for species, which are qualifying features.

13.6.180 None of the terrestrial, intertidal and subtidal habitats, associated invertebrate or fish species identified as being either directly or indirectly affected by the footprint of the Marine Works are qualifying features of any nearby designated sites. Furthermore, the magnitude of effects on receptors which are qualifying features of designated sites are considered to be negligible (see paragraphs 13.6.164 to 13.6.177). It is therefore considered that there would be a negligible magnitude of change and effect on current and proposed designated sites from the direct loss of habitats and species in the footprint of the Marine Works.

Impact pathway: disturbance of habitats and species including from wave action, scour, smothering (from dredging and land-based sources) and deposition of dust and air pollutants

General context

13.6.181 Increased wave action could cause disturbance to coastal habitats from increased salt spray and erosion, resulting in changes to community assemblages or changes in the overall extent of habitats. However, hydrodynamic modelling has demonstrated that changes in wave height resulting from the operation of the Power Station would be small and therefore the potential for increased wave action and the associated risk of overtopping is considered to be within the range of natural variation (see chapter D12, Coastal processes and coastal geomorphology, Application Reference Number: 6.4.12). The magnitude of change and effect on Cemlyn Lagoon from disturbance arising from changes in wave action is therefore considered to be negligible and has not been considered further in the assessment.

13.6.182 Air pollutants released from construction plant machinery and marine vessels can be deposited into the marine environment either by dry or wet deposition processes. Deposition of air pollutants, particularly nitrogen and sulphur compounds can cause disturbance to marine habitats and species through acidification. An assessment of air quality effects on designated sites of nature conservation importance and supporting features is presented within chapter D5 (air quality) (Application Reference Number: 6.4.5). Considering the embedded and good practice mitigation proposed (see section 5.4 in chapter D5, Application Reference Number: 6.4.5), this assessment concluded that there would be a negligible magnitude of change and effect to designated sites of nature conservation importance due to emissions from construction plant, machinery and marine vessels. Consequently, there is considered to be no effect to habitats and species, or any other marine environment receptors (e.g. water quality, fish, marine mammals and seabirds), due to emission of air pollutants.

13.6.183 The release of suspended solids, either from marine sources, namely dredging, or land sources such as drainage, dewatering and sewerage release, can lead to subsequent sediment deposition on the seabed and therefore physical disturbance. Similarly, the release and subsequent deposition of dust from both land-based construction (e.g. demolition, land excavation and vehicle movements) and marine-based construction (e.g. construction of the MOLF and breakwaters, dredging) may also cause physical disturbance to intertidal habitats and species.

13.6.184 The deposition of suspended solids can smother the seabed potentially resulting in changes to seabed geomorphology, sediment structure and habitats. This would have effects on species that currently rely on these habitats for food or refuge, leading to potential indirect effects on survival, growth, reproduction or displacement of individuals. In shallow habitats smothering may also prevent photosynthesis, leading to lower growth rates of flora and potentially mortality if conditions persist.

13.6.185 Dust deposition would be limited to intertidal habitats as material would be dispersed rapidly within the wider marine environment with a negligible magnitude of effect on subtidal habitats. The potential effects on the marine benthos would be as described in paragraph 13.6.184 with a physical disturbance occurring as a result of smothering.

13.6.186 The effects of water quality deterioration arising from sediment dispersion (including the indirect effects of high turbidity on light levels and water chemistry) on habitats and species have been considered in paragraph 13.6.2.

13.6.187 Changes in hydrodynamic conditions (i.e. waves and currents) can lead to changes in bed shear stress; this, depending on the substratum has the potential to cause physical disturbance (scour) of the seabed if the changes in bed shear stress manifest as increases from baseline conditions. Conversely, a decrease in bed shear stress could lead to less disturbance of the substratum, depending on the nature of the sediment affected. Scour effects arising from changes in bed shear stress may cause physical disturbance to habitats and species through abrasive action.

13.6.188 While physical disturbance from deposition or scour has the potential to effect the benthic habitats and communities it is acknowledged that in high energy systems, where the quantity and changes to physical disturbance may not differ greatly from natural processes, the effects of scour are likely to be relatively small, as the community will consist of species with high tolerance to abrasion. Within sedimentary habitats many of the motile species present are able to vertically migrate through deposited sediments [RD103]; [RD104]; [RD105].

13.6.189 The effects from the potential impacts arising from smothering and dust deposition on marine benthic receptors are specifically considered in relation to the relevant key construction activities that can lead to sediment dispersion and/or dust deposition. The potential effects of scour, as a consequence of changes to bed shear stress from the presence of the marine structures, specifically the western and eastern breakwaters, are considered separately. Subsequent consideration is then given to the overall effects of physical disturbance on benthic habitats and communities (see paragraph 13.6.230*).*

13.6.190 The assessment uses the conclusions of chapter D12 (Application Reference Number: 6.4.12) and focussed modelling work (see below) and these are referred to as appropriate, while consideration is given to the embedded and best practice mitigation measures that have been proposed to reduce physical disturbance of habitats (see paragraphs 13.5.81 and 13.5.91).

13.6.191 It is recognised that physical disturbance could facilitate the introduction and spread of INNS and the associated effects have been assessed separately within paragraphs 13.6.239 to 13.6.262.

Modelling

Scour

13.6.192 Changes to coastal processes associated with construction at the Power Station Site, and how these changes could lead to alteration of bed shear stress have been identified through hydrodynamic (Delft3D) and wave (Simulating WAves Nearshore, SWAN) modelling investigations.

13.6.193 Hydrodynamic modelling of baseline conditions has demonstrated a wide range of bed shear stress both spatially and temporally. The highest seabed shear stress levels occur slightly offshore and around Trwyn Cemlyn, Cerrig Brith and Wylfa Head, with lower values found within coastal embayments. During the summer, wave energy from comparatively small waves does not penetrate to the seabed within the embayments. However, during winter the bed shear stresses, due to the occurrence of larger waves, increase across these inshore areas in particular, when the wave direction is from the north.

13.6.194 Based upon the results of the modelling studies, overall changes in maximum bed shear stress have been found to range mostly between -0.1N/m^2 and +0.1N/m^2 (figure D12-15, Application Reference Number: 6.4.101). Changes in bed shear stress ranging from -0.1N/m^2 and +0.1N/m^2 are judged to generate no more than minor differences in terms of the transportable sediment fraction for both sands and gravels (see chapter D12, Application Reference Number: 6.4.12).

13.6.195 However, a number of areas, specifically adjacent to the breakwaters and also around Cerrig Brith, Trwyn Cemlyn and Wylfa Head were predicted to experience changes in bed shear stress between -0.5N/m^2 and +0.5N/m^2 during spring tide conditions. From the modelling, these changes were generally shown to manifest as an increase in bed shear stress at localised areas around Cerrig Brith, Trwyn Cemlyn and Wylfa Head, and a decrease in those areas adjacent to the breakwaters. Adjacent to the breakwaters, the decrease was sometimes predicted to be between -0.5N/m^2 and -1.0N/m^2.

13.6.196 Only under certain wave and tide conditions would any of these changes manifest in Cemlyn Bay and then these would be highly localised, ranging from -0.5N/m^2 to +0.5N/m^2 changes in bed shear stress. The western breakwater does reflect waves from the west and northwest causing some minor refocussing of energy but only from relatively small waves. This refocussing (reflected in a minor increase of bed shear) affects the Cemlyn Bay seabed close to the most western part of the Esgair Gemlyn in an area of relatively hard bedrock. The levels of wave height increase remain lower than the baseline wave heights from the northeast (a direction unaffected by the breakwater).

13.6.197 The greatest increases in bed shear stress from baseline occurred in extremely localised areas of seabed dominated by bedrock and were almost all confined to either the winter, but more usually, the high north wave conditions modelled.

13.6.198 As noted in chapter D12 (Application Reference Number: 6.4.12), the generally small changes in bed shear stress predicted by the modelling are judged to generate no more than minor differences in terms of the transportable sediment fraction for both sands and gravels. Far larger differences in bed shear stress are required to generate significant changes to mobilisation of these grain sizes. Furthermore, in chapter D12 (Application Reference Number: 6.4.12), based on the potential changes in bed shear stress modelled (spatial distribution, magnitude and extent) and acknowledging the type of substrata present, the significance of the effect on the seabed from bed shear stress was assessed as negligible.

13.6.199 To summarise, the levels of bed shear stress predicted are broadly comparable to baseline and where changes do occur they generally manifest as small differences and a reduction in bed shear stress. While increases of greater than 1.0N/m^2 from baseline are almost completely confined to bedrock dominated habitat.

Smothering – deposition of suspended sediments

13.6.200 Delft3D [RD106] was used to model the deposition of suspended solids discharged from the drainage system (i.e. drainage, dewatering and sewage effluent outfalls) around the Wylfa Newydd Development Area and fugitive sediments released during the dredging operations.

13.6.201 The dredge model simulation was set up to run from 1 July 2011 to 17 July 2011 as a spin up period. During this period the baseline fluvial discharges were in operation, but the wave model was not coupled to the hydrodynamics nor was the dredge spill included. The dredge activities were simulated for the period between 17 July and 21 August. After the 21 August, there was a six-day post dredge period with the baseline fluvial discharges still in operation. The fugitive spill from dredging activities was included at five locations, three along the western breakwater axis and two within the harbour area. The wave model was run coupled to the hydrodynamics hourly starting on the 17 July until the end of the simulation.

13.6.202 The drainage discharges simulation included a spring-neap-spring cycle as a spin up. During the spin up, the drainage discharges were in operation and hence the spin up allowed both the hydrodynamics and suspended solids concentrations to settle. The flows used in the scenario were the 1 in 2 year flows with the suspended solids concentrations ranging from 30 to 70 mg/L. The model ran from 17 June 2011 to 28 August 2011, with the discharges in operation from the outset (a total of 72 days). A 24 hour storm event (1 in 30 year flow) with elevated suspended solid concentrations was introduced on the 19 August.

13.6.203 During both simulations, the wave model was coupled to the hydrodynamics to allow the maximum sediment deposition to be demonstrated as a worst case scenario.

13.6.204 For both the dredge and drainage scenarios, it was assumed that the cofferdam and temporary causeway were in place.

13.6.205 Details of the drainage system modelled can be found in 13.5.7 to 13.5.9, with further information regarding the model assumptions presented in appendix D13-8 (Application Reference Number: 6.4.90).

13.6.206 A summary of the information relating to the fugitive spills from the dredging operations can be found in paragraphs 13.5.38 to 13.5.40.

Smothering – deposition of dust

13.6.207 A construction dust assessment has been carried out to assess the levels of dust likely to be generated by construction activities (see appendix D5-1, Construction Dust assessment – Main Construction, Application Reference Number: 6.4.20). This has identified the level of dust mitigation (i.e. adoption of industry standard air quality and dust management procedures) required (see chapter D5, Application Reference Number: 6.4.5).

Effects on habitats and communities from physical disturbance

Scour

13.6.208 Scour effects, as a result of increases in bed shear stress, could potentially result in changes to seabed geomorphology, sediment structure and habitats.

13.6.209 The potential effects on soft sediment habitats, those that can be mobilised by hydrodynamic processes, and their associated communities would be greater than those on rocky habitats, with interfaces between different substrata, for example, at the base of fixed structures such as the breakwaters and the MOLF, being particularly vulnerable [RD107].

13.6.210 Modelling of bed shear stress has predicted comparatively small changes from the baseline environment (see above), and in the context of these changes, the greatest increases were generally shown to occur in areas dominated by bedrock tide-swept communities e.g. Cerrig Brith and Trwyn Cemlyn. Where sedimentary habitats were predicted to experience an increase, the change in bed shear stress was usually less than $0.5N/m^2$.

13.6.211 Where sedimentary habitat is located within areas of increased bed shear stress, it is characterised by tide-swept communities indicative of the high tidal energy of the local environment (appendices D13-2, Application Reference Number: 6.4.84 and D13-3, Application Reference Number: 6.4.85). From drop-down camera surveys in 2010 and 2011 (appendix D13-2, Application Reference Number: 6.4.84) the seabed immediately to the north of the western breakwater and between the western breakwater and Wylfa Head is known to be dominated by brittle star beds (‘*Ophiothrix fragilis* and/or *Ophiocomina nigra* brittle star beds on sublittoral mixed sediments’). This habitat, coincident with the areas of increased bed shear stress on sediments, is found in a range of water flows, from weak to strong. Consequently, this brittle star bed biotope is not considered sensitive to the Marine Evidence based Sensitivity Assessment (MarESA) benchmark for change to mean spring bed flow velocity [RD108]. Using the same MarESA approach, a medium sensitivity is assigned against abrasion on this biotope; however, given the very small increases predicted by the modelling (usually less than 0.5N/m^2) in an area already characterised by strong tidal flows it is not considered that the changes in bed shear stress would result in any detectable effect from scour.

13.6.212 Although beyond the predicted extent of much of the changes (as increases) in bed shear stress modelled, there may also be some overlap with the widely occurring biotope *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand. Dominated by bivalve and polychaete infauna this biotope is not considered sensitive to the MarESA benchmark changes in water flows and, by virtue of its resistance and resilience, has a low sensitivity to abrasive activities such as scour [RD109].

13.6.213 The rocky habitats that overlap with the predicted changes in bed shear stress are characterised by communities well adapted to strong tidal flows and reasonably tolerant of sediment scour. Bearing in mind the comparatively small increases to bed shear stress predicted even at the rocky headlands i.e. Trwyn Cemlyn, Cerrig Brith and, to a lesser extent, Wylfa Head; it is not considered that the changes in bed shear stress would result in any detectable effect from scour.

13.6.214 Within the bays (Cemlyn, Porth-y-pistyll and Cemaes) the changes to bed shear stress, on subtidal and intertidal habitats, are minimal and, with the exception of Porth-y-pistyll, highly localised. Such small changes in Cemaes and Cemlyn leads to the conclusion that scour would not have any detectable effect on habitats in these bays. Within Porth-y-pistyll the changes are clearly dominated by a reduction in bed shear stress (figure D12-15, Application Reference Number: 6.4.101) with the only increases occurring to the north of the bay, between the breakwaters, and then only during the infrequent high north wave scenario. Hence the effects of scour are not considered further for Porth-y-pistyll.

13.6.215 Acknowledging the small changes in tidal flows and therefore bed shear stress predicted by the modelling, the spatial distribution of these changes, the types of communities present within the extent of the changes and the wide occurrence of these communities along the north Anglesey coastline the magnitude of change for habitats and communities (including habitats and communities of conservation importance) from scour is negligible. Therefore, there would be a negligible effect on intertidal and subtidal habitats and communities from scour.

Smothering – deposition of suspended sediments on subtidal and intertidal habitats and communities

13.6.216 According to the MarLIN MarESA criteria, deposition of up to 5cm in a single event is classified as light smothering with heavy smothering being up to 30cm in a single discrete event [RD110]; [RD111]; [RD112]. Deposition of up to 1cm in a single event is assumed to represent smothering comparable to natural events and is therefore considered to be of negligible magnitude. This assumption is based on extensive literature which contains studies relating to natural sedimentation processes and ecological effects [RD113].

13.6.217 For the assessment of the dredge scenario, the total duration of dredging activity (35 days) was assumed to represent a ‘single event’. Figure D13-28

(Application Reference Number: 6.4.101) shows the thickness of sediment deposited on the bed an hour after the last dredge activity; this delay allows time for the deposition of suspended sediments released near the surface. The majority of the area predicted to experience heavy smothering falls under the direct footprint of the Marine Works. This area has been assessed through direct loss and has therefore been excluded from the assessment of physical disturbance.

13.6.218 Outwith the direct footprint of the Marine Works, the highest levels of deposition are predicted to occur in subtidal areas adjacent to the western breakwater (figure D13-28, Application Reference Number: 6.4.101). Here, smothering from the deposition of sediment is predicted to range from negligible (<1cm) to light (up to 5cm).

13.6.219 With the exception of a localised area immediately to the west of the western breakwater, deposition of dredged material was less than 1cm, thus representing a negligible effect on habitats and species from smothering (i.e. <1cm in a single event). This included the intertidal environment and the subtidal areas within Cemlyn Bay, Porth-y-pistyll and Cemaes Bay.

13.6.220 Under the worst case drainage discharges scenario, the deposition of sediment on the seabed is predicted to be up to 6cm in a highly localised area from the Afon Cafnan (see appendix D13-8, Application Reference number: 6.4.90). This is based on no wind or wave effects which in reality would occur during a 1 in 30 year storm event; the effect of waves would be to reduce deposition in this area further. The area of seabed classified as heavy deposition (according to the MarLIN MarESA criteria) is restricted to 0.93ha in Porth-y-pistyll. In all other areas deposition is predicted to be less than 1cm (classified as light smothering) under the worst case modelling scenario (see figure D13-29, Application Reference Number 6.4.101) thus representing a negligible effect on habitats and species from smothering.

13.6.221 From analysis of survey data, in the areas of deposition (figures D13-28 and D13-29, Application Reference Number: 6.4.101) (see appendices D13-2, Application Reference Number: 6.4.84, and D13-3, Application Reference Number: 6.4.85), the habitats present are considered a combination of infralittoral rock, muddy sands and mixed sediments. Constituent biotopes of these habitats in the area such as ‘dense foliose red seaweeds on silty moderately exposed infralittoral rock’ *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand; *Ophiothrix fragilis* and/or *Ophiocomina nigra* brittle star beds on sublittoral mixed sediments vary in their sensitivity to smothering. The biotope dense foliose red seaweeds on silty moderately exposed infralittoral rock has high resilience to both light and heavy smothering [RD114] and therefore it is not considered further in this assessment. Both the other biotopes (see above) have a medium resilience even to heavy smothering based on the ability of the characteristic species to move through sediment or away from the deposition.

13.6.222 In the case of bivalves, the MarESA notes how the character of the overburden is an important factor determining the degree of vertical migration i.e. individuals are more likely to escape from a covering similar to the sediments in which the species is found than a different type [RD109].

This is acknowledged in the context of the dredging and drainage as the material deposited will be broadly similar to the substrata receiving the deposition.

13.6.223 In relation to the effects of light smothering on brittle star beds MarESA states that ‘in areas of high water flow dispersion of fine sediments may be rapid and this could mitigate the magnitude of this pressure by reducing the time exposed, where ‘light’ deposition of sediments is likely to be cleared in a few tidal cycles’ [RD108].

13.6.224 The worst case modelling scenarios for dredging and drainage discharge assume no wind or waves which would aid dispersion and reduce overall sediment deposition. In the majority of areas where higher rates of deposition are predicted to occur, the bed shear stress is also increased therefore sediments are likely to be dispersed. An indication of this is shown in figure D12-15, (Application Reference Number 6.4.101) where a typical wave, winter wave and north wind wave all increase shear stress in areas of greatest sediment deposition. Therefore, any potential smothering effects within this area post dredging or from the land drainage discharge is likely to be short-term.

13.6.225 Some build-up of sediment is predicted to occur in areas of Cemlyn Bay, Porth-y-pistyll and Cemaes Bay from dredging and drainage discharge although maximum deposition is predicted to be <0.2cm and therefore the scale of the effect from smothering would be negligible.

13.6.226 Excavation of the seabed at the Cooling Water outfall would be carried out in the dry behind a cofferdam; suspended sediments would be released from dewatering, with possible resuspension of sediments during dredging. No modelling was carried out to assess sediment dispersion in this location; however, due to the very limited spatial extent of the works and the exposed nature of this area of coastline; any release of suspended solids would be rapidly dispersed.

13.6.227 Considering the small extent of intertidal and subtidal habitats of conservation importance that would be affected by smothering and the short-term nature of effects, the magnitude of change is predicted to be small and the effect negligible.

13.6.228 Subtidal habitat and communities affected are considered tolerant to sediment deposition. The likely remobilisation of deposited sediments over several tidal cycles, the highly localised area affected by deposition >1cm and recognition that those habitats potentially affected are widely occurring and extensive along the north Anglesey coastline; the magnitude of change is predicted to be small. Therefore, there would be a negligible effect on subtidal habitats and communities from smothering.

Smothering – deposition of dust on intertidal habitats and communities

13.6.229 With the incorporation of embedded mitigation (see paragraph 13.5.91), there would not be a noticeable change in baseline conditions and therefore the magnitude of change is predicted to be negligible. The indirect effect on intertidal habitats from the deposition of dust during construction is therefore considered to be negligible and is not considered further in this assessment.

Summary of effects on intertidal and subtidal habitats and communities from physical disturbance

13.6.230 The effects on intertidal and subtidal habitats and communities, including those of conservation importance, from scour and smothering were assessed as negligible. Therefore, it is considered that the overall effect of physical disturbance is negligible.

Effects on invertebrates of conservation and commercial importance

13.6.231 Commercial species including scallop, whelk, lobster, prawn and edible crab may be affected by smothering during the early construction phase. These species are generally considered to be tolerant of smothering to a depth of 5cm over a period of a month [RD115]; [RD116] and being mobile, are able to move away from the affected area.

13.6.232 The ocean quahog is considered to have medium sensitivity to smothering [RD97] whilst no comparative assessment is available for spiny lobster. However, given that this species is relatively large and mobile, it is unlikely to be significantly affected by smothering. The effects of smothering on invertebrates of conservation and/or commercial importance is therefore likely to be limited and therefore the magnitude of change is negligible and the effect is considered to be negligible.

Effects on marine fish from disturbance to habitat and loss of resource

13.6.233 The physical disturbance of subtidal habitats and species would have an indirect effect on marine fish receptors due to the loss of habitat, refuge and feeding resource (e.g. invertebrates and detritus) resulting in displacement. Fish are highly mobile and therefore direct effects of smothering on demersal species are predicted to be negligible.

13.6.234 The sensitivity of most habitats and species to physical disturbance ranges from zero (not sensitive) to moderate. This level of disturbance is not considered to result in a marked decline in biomass of either algae or species present in Porth-y-pistyll. The disturbance is therefore unlikely to represent a decline in food resource for marine fish which would be temporarily displaced from the area. Few fish species of conservation and/or commercial importance are present in significant numbers within Porth-y-pistyll (see paragraph 13.3.114). Therefore, it is considered that the magnitude of change is negligible and the indirect effect on marine fish receptors from physical disturbance of habitats and species is negligible.

13.6.235 Migratory species such as river lamprey, European eel, sea trout and Atlantic salmon typically follow the coastline. The presence of the Marine Works in Porth-y-pistyll therefore has the potential to affect those routes, although access would not be prevented and fish would find alternative routes. The numbers of river lamprey, European eel and sea trout in the vicinity of Porth-y-pistyll is low in comparison to wider populations and disturbance would not affect feeding or spawning. Therefore, the magnitude of change is predicted to be negligible and the effect on fish of conservation importance is negligible.

Effects on marine mammals from disturbance to habitat and loss of resource

13.6.236 Marine mammals feed on invertebrates and fish and therefore there is potential for indirect effects on marine mammals from the loss of food resource. As the effect on fish and invertebrates from disturbance is negligible, the effects on marine mammals are also considered to be negligible.

Effects on seabirds from disturbance to habitat and loss of resource

13.6.237 Seabirds feed on invertebrates and fish and there is potential for indirect effects on seabirds from the loss of food resource. As the effect on fish and invertebrates from disturbance is negligible, the effects on seabirds are also considered to be negligible.

Effects on designated sites from disturbance to habitat and loss of resource

13.6.238 The indirect effects on marine mammals and seabirds, which are qualifying features of sites of national/international importance, are considered to be negligible and therefore the effects on designated sites are considered to be negligible.

Impact pathway: introduction of non-native species during Main Construction

General context

13.6.239 Invasive, non-native, alien or exotic species are those that have been released into an environment beyond their native bio-geographic range or habitat, either by accident or intentionally [RD117]. On release into a new environment, a non-native species may or may not become established depending on its tolerances of the prevailing conditions or other random events such as predation.

13.6.240 A species is classed as ‘invasive’ when it establishes in the new environment and out-competes native species resulting in a detrimental impact on native habitats. The Great Britain Non-Native Species Secretariat defines INNS as *“any non-native animal or plant that has the ability to spread causing damage to the environment, the economy, our health and the way we live”* [RD118].

13.6.241 The most likely pathway for non-natives to be introduced to the Wylfa Newydd Development Area is from marine plant and vessels which can transport invasive non-natives, as fouling on hulls and in ballast waters. This is evidenced by the presence of hotspots for INNS in areas of high shipping traffic [RD119]; [RD120]; [RD121]. Non-native species can also be introduced in construction materials imported as a result of the Wylfa Newydd Project. General marine traffic associated with the marine construction works also has the potential to transfer INNS that are currently present within the Wylfa Newydd Development Area to other areas.

13.6.242 Although INNS could be introduced via activities not directly associated with the Wylfa Newydd Project (e.g. commercial fishing and recreational sports), the probability of transmission is low.

13.6.243 New substrates and artificial structures are often colonised by INNS owing to the absence of competition and predation; their presence can facilitate the establishment and spread of newly introduced INNS [RD122]. New substrates can also serve as ‘stepping stones’ in an otherwise unhospitable area (e.g. hard structures placed on soft sediment habitats can support the establishment of species associated with hard substrates), which can assist with the expansion of a species distribution [RD123]; [RD124].

13.6.244 There are several pathways by which conditions could alter during construction in favour of non-native species which include the following.

- Changes to the physical conditions (e.g. hydrodynamics) which can disrupt native species therefore allowing potential establishment of INNS.
- Disturbance of established communities containing INNS increasing the risk of releasing fragments into the marine environment which may then spread on currents or attach to vessels and establish elsewhere.

13.6.245 Increased water temperatures which could facilitate the establishment and spread of invasive non-natives adapted to warmer waters [RD125] and the effects of Cooling Water discharge have been assessed within paragraphs 13.6.720 to 13.6.724.

13.6.246 Embedded mitigation has been proposed to reduce the likelihood of transmitting non-native species during the construction phase (see paragraph 13.5.92).

Effects on phytoplankton and zooplankton from the introduction of non-native species

13.6.247 The introduction of INNS has the potential to displace native plankton species through competition for resources. Of the non-native plankton species listed under [RD19], only one has known environmental impacts: the diatom *C.wailesii* [RD20]. Blooms of this species are reported to form up to 90% of total phytoplankton biomass in the German Bight and may displace native phytoplankton species both physically and by stripping nutrients from the water [RD20]. These cells are so large that they are not easily grazed by zooplankton which as a result could become food deprived [RD20].

13.6.248 *C.wailesii* has been recorded from the Wylfa Newydd Development Area during baseline surveys. Over the monitoring period 2010 to 2014 only one cell of this species was recorded in December 2010. This indicates that despite being present *C.wailesii* has not established in the area and is not causing any adverse effects to local plankton populations. *C.wailesii* is widely distributed around British waters and is an established member of the phytoplankton community with the highest abundances occurring in the North Sea. It is able to grow in a wide range of environmental conditions including temperatures from 0°C to 20°C and salinities from 24 to 35 [RD18].

13.6.249 Only one other non-native plankton species was recorded from the baseline surveys, the diatom *O.sinensis* which was recorded at low abundances. It is widely distributed in British coastal waters and has no known environmental impacts [RD20]. No holoplanktonic (spending their entire life in the plankton) zooplankton non-native species were recorded during the baseline surveys.

13.6.250 By adhering to legislation and good practice guidance, as detailed in chapter B13 (Application Reference Number: 6.2.13) and paragraph 13.5.92, the introduction and spread of other invasive non-native plankton species through ballast water exchange would be reduced and therefore the probability of transmission is low. Based on the presence of non-native plankton species in the area and their wider distribution, the magnitude of change is predicted to be negligible. Therefore, it is considered there would be a negligible effect on the phytoplankton and zooplankton from the introduction and spread of INNS.

Effects on intertidal and subtidal habitats and communities (including invertebrates of conservation and/or commercial importance) from the introduction of non-native species

13.6.251 The introduction of INNS has the potential to alter interactions within existing ecological assemblages. Potential effects on native species include competition for space and resources; alteration of substrata and water conditions; predation and depletion of native species; smothering of native species; consumption of pelagic larvae and loss of prey and refuge [RD126].

13.6.252 All INNS outlined in paragraph 13.3.80 represent benthic species, the introduction and spread of which would have a direct effect on intertidal and subtidal habitats and species.

13.6.253 The sensitivity of intertidal habitats and species to non-native introductions varies from low to moderate depending on the potential for non-native species to compete with native species for space and food. INNS already known to be present within intertidal areas of the Wylfa Newydd Development Area do not represent a significant risk, although the introduction of new substrate could allow these species to proliferate within the area. Consequently, vulnerability is considered to range from low (where already present) to moderate (where the Wylfa Newydd Project might allow colonisation or expansion of species already present). Of particular consideration are two species of invasive non-native algae, *S.muticum* and *C.fragile* sub sp. *t*. *S.muticum* was recorded at five intertidal locations in Porth-y-pistyll in 2014; four in the south-east corner of the bay under the footprint of the Marine Works and one in a rock pool on Cerrig Brith (see appendix D13-3, Application Reference Number: 6.4.85). It is associated with sheltered environments; being fast growing and able to reproduce within the first year of life and fertilise itself, this species can increase its extent rapidly outcompeting local species [RD127].

13.6.254 In 2015, *C.fragile* was recorded within the infralittoral zone in the vicinity of the Cooling Water outfall (see appendix D13-5, Application Reference Number: 6.4.87). This species grows on hard substrate in shallow sheltered waters [RD128] and is known to be better adapted to warmer waters with its spread limited by cooler temperatures [RD125].

13.6.255 The sensitivity of subtidal habitats and species to non-native introductions is considered to range from low to high due to the potential introduction of high risk species such as *D.vexillum* and *U.pinnatifida* which are known to be present in Holyhead Harbour although absent from the Wylfa Newydd Development Area presently.

13.6.256 Recreational boating is considered the main source of transfer of *D.vexillum*. Significant movement of *D.vexillum* is not expected from commercial shipping due to antifouling coatings and ballast water procedures [RD129], although transfer may occur in water abstracted and discharged by the vessel for cooling or other uses [RD130]. Smaller vessels and equipment docking in Holyhead Harbour could provide a vector for transfer of *D.vexillum*. If introduced to the Wylfa Newydd Development Area, there would be a high probability of the species becoming established owing to the presence of suitable conditions and substrates. *D.vexillum* has the potential to cause major biofouling problems of marine structures and could have a significant effect on the abundance and diversity of benthic species leading to the degradation of subtidal habitats.

13.6.257 Large swathes of the subtidal area within the Wylfa Newydd Development Area are characterised by dense kelp forests or parks (see appendix D13-3, Application Reference Number: 6.4.85). Introduction of the kelp species (*U.pinnatifida*), which has morphological and reproductive traits that makes it a highly successful invasive species, could result in a decline in biomass of native species such as *L.hyperborea* and abundance of supporting species.

13.6.258 Other subtidal INNS, which are considered to represent a high or medium risk of introduction and establishment, include *S.clava*, *F.enigmaticus* and *C.fornicata*. All three species could be transferred via fouling of vessels and equipment and via ballast water. They have the potential to outcompete native species through competition and food.

13.6.259 INNS already present in the Wylfa Newydd Development Area or on the north Anglesey coastline could facilitate the spread of newly introduced non-natives. For example, the Japanese skeleton shrimp (*C.mutica*) is commonly found in association with *S.muticum* [RD128]. Similarly, the colonial sea squirt (*B.violaceus*) is often found attached to other unitary sea squirts such as *S.clava* [RD131].

13.6.260 By adhering to legislation and good practice guidance, as detailed in chapter B13 (Application Reference Number: 6.2.13) and paragraph 13.5.92, the introduction and spread of INNS through ballast water exchange and on ships' hulls would be reduced and therefore the probability of transmission is low. However, the physical presence of the artificial structures (e.g. breakwaters, MOLF, Cooling Water intake and outfall) would create potential colonising space for non-native species. Changes in existing habitat would also influence the introduction and spread of non-native species, for example the carpet sea squirt (*D.vexillum*) which thrive in relatively sheltered environments on the inside of breakwater structures and shallow subtidal areas. Dredging may remove non-native species present in the Wylfa Newydd Development Area (e.g. *S.muticum*) and translocate them to other areas. However, for most INNS the risk of translocation is considered low, as those species at risk of introduction and spread are not adapted to deeper site conditions and are therefore unlikely to survive at disposal sites.

13.6.261 Even with good practice mitigation in place (see paragraph 13.5.92), intertidal and subtidal habitats of conservation importance and invertebrates of conservation and/or commercial importance would be at risk from the introduction and spread of INNS. Based on the presence of non-native species and the potential for transfer and establishment of non-native species, the magnitude of change is predicted to be medium. Therefore, it is considered that there would be a moderate adverse effect on these receptors from the introduction and spread of invasive non-natives during construction.

13.6.262 Intertidal and subtidal habitats not considered to be of conservation importance would also be at risk from the introduction and spread of INNS for the reasons listed above. The magnitude of change is also predicted to be medium, and it is considered that there would be a minor adverse effect on intertidal and subtidal habitats and communities from the spread of invasive non-natives during construction.

Impact pathway: underwater noise from Main Construction activities

General context

13.6.263 Over the past 20 years it has become increasingly evident that noise from human activities in and around underwater environments can have an impact on the marine species in the area. The extent to which intense underwater sound might have an adverse environmental impact on a particular species is dependent upon the incident sound level, frequency, duration, and/or repetition rate of the sound wave.

13.6.264 The impacts of underwater sound can be broadly summarised into three categories:

- physical traumatic injury or fatality;
- auditory damage (either permanent or temporary); and
- behavioural disturbance.

13.6.265 Underwater noise generated during marine construction has the potential to impact upon fish and marine mammals. In terms of the Marine Works, the following construction activities are considered as sources of noise and vibration:

- dredging;
- rock breaking;
- rock cutting;
- drilling; and

- vessels.

13.6.266 For the purpose of this assessment each of these activities is assessed separately for each of the receptors taking into consideration good practice mitigation (see paragraphs 13.5.85 and 13.5.91).

13.6.267 Sound or vibration are defined in terms of their frequency (pitch) and amplitude (level or loudness). Frequency is measured in Hertz (Hz) (1Hz = 1 cycle per second), amplitude is measured in units of velocity, e.g. millimetres per second (mm/s), but is often expressed in decibels (dB) in biological applications. Sound pressure level is usually reported in decibels (dB) which is a logarithmic scale that compresses the wide ranging potential source pressures to ease description.

13.6.268 An animal's sensitivity to sound varies according to the sound frequency. The response to sound depends on the presence and levels of noise within the range of frequencies to which an animal is sensitive. For most fish, sound above 1kHz is not audible. Marine mammals such as pinnipeds and cetaceans typically hear best between 1kHz and 100kHz [RD132].

13.6.269 Sound may be expressed in many different ways depending on the particular type of noise, and the parameters of the noise that will allow it to be evaluated in terms of a biological effect.

13.6.270 The attenuation of sound in the water as it propagates from the noise source must be considered in an impact assessment. As the measurement or receiver point moves away from the source, the sound pressure measured will decrease due to spreading. To standardise all source levels, regardless of where they are measured, they are referred back to a conceptual point 1m away from the point of origin of the noise. Consequently, source levels should and will be presented with units of 'dB re 1μPa @ 1m'.

13.6.271 The sound pressure level (SPL) is normally used to characterise noise and vibration of a continuous nature such as drilling, boring, or background sea levels. To calculate the SPL, the variation in sound pressure is measured over a specific time period to determine the root mean square (RMS) level of the time varying acoustic pressure. The SPL_{RMS} can therefore be considered to be a measure of the average unweighted level of the sound over the measurement period.

13.6.272 The peak sound pressure level (SPL_{peak}) is the maximum level of sound. This form of measurement is often used to characterise underwater blasts where there is a clear positive peak following the detonation of explosives.

13.6.273 The sound exposure level (SEL) is used when assessing the noise from transient sources such as impact piling. The SEL sums the acoustic energy over a measurement period, and effectively takes account of both the SPL of the sound source and the duration for which the sound is present in the acoustic environment.

Modelling of noise sources

13.6.274 To assess the potential effects from marine construction, underwater noise modelling was completed for all planned elements of construction. Modelling was undertaken using the RAMSGeo software package which is designed to model any noise source where it is reasonable to assume it is a point source (appendix D13-9, Underwater Noise Baseline and Modelling, Application Reference Number: 6.4.91). The model allows for the incorporation of variable bathymetry and a complex seabed and therefore provides an accurate representation of noise propagation.

13.6.275 A point at a depth of -10m above ordnance datum was selected for the modelling as it represents the deepest point for marine operations. Therefore, this acts as a worst case for noise propagation; noise attenuation will be greater in shallow waters and therefore noise will propagate shorter distances. Three transects were chosen for the modelling to illustrate the propagation of noise; one to the north-east (038º), one to the north-northwest (332º) and one to the south-southeast (156º) (appendix D13-9, Application Reference Number: 6.4.91).

Dredging

13.6.276 Dredging would be used to prepare the seabed for marine construction. The dredge method would use either a backhoe dredger or a cutter-suction dredger; the choice of plant would depend upon detailed information on sediments from the detailed offshore geotechnical investigations, as described in paragraph 13.5.29.

13.6.277 Cutter-suction dredging uses a rotating cutter head to loosen material and a suction inlet to bring the material onto the vessel. Backhoe dredging removes material from the seabed with a boat-mounted excavator which lifts material onto the vessel.

13.6.278 The noise generated during dredging depends on the method, with cutter-suction dredging resulting in short pulses of noise caused by the cutter tool (appendix D13-9, Application Reference Number: 6.4.91), and backhoe dredging creating a more variable noise corresponding with the processes taking place (appendix D13-9, Application Reference Number: 6.4.91). Noise levels modelled for dredging operations at similar ranges indicated that cutter-suction dredging operations produce more noise than backhoe. Therefore, modelling of dredging has been undertaken based on cutter-suction dredging as it is considered worst case.

Drilling

13.6.279 Drilling operations are required to install pre-bored piles for the MOLF and cofferdam construction. Modelling has been undertaken for the following.

- Rotary drilling of two diametres whereby a rotating head is forced into the ground. The source levels for the modelling have been extrapolated from measurements taken at close range to drilling operations in Strangford Lough, Northern Ireland (appendix D13-9, Application Reference Number: 6.4.91).
- Percussive drilling whereby there is a hammer action to the drilling head. The source levels for modelling has been based on measurements from Orkney.

- Concurrent drilling whereby two drilling rigs may be in operation at the site.

Rock breaking

13.6.280 During construction, rock within the outer harbour will be fractured and removed using a rock breaker (see section 13.5) with work scheduled to extend for up to 16 months.

13.6.281 The process of rock breaking involves using a thin head that rapidly strikes the seabed to break up the rock (much like a jack-hammer). The plant used to do this has not yet been finalised. Modelling has been based on option using a hammer with a diameter of 50cm, with a blow energy of 70kJ and a strike rate of 43 strikes/minute to represent the worst case noise levels for rock breaking.

13.6.282 For the purposes of modelling rock breaking, it has been assumed that the noise source will be similar to small-scale tubular piling operations, owing to the similar motion of metal hitting the bedrock. However, it is expected that this represents a worst case noise level (appendix D13-9, Application Reference Number: 6.4.91).

Rock cutting

13.6.283 During the construction of the semi-dry cofferdam a rock cutter will be used to cut a trench along the seabed prior to the placement of rock. This trench will improve the footing of the sheet piles that will be driven through the breakwater to form a seal.

13.6.284 A rock cutter is similar in design to the cutting head of a cutter suction dredger, with teeth designed to grind the rock in order to remove it. The rock cutting equipment is expected to be a Rockwheel G55 hydraulic cutting wheel. Due to the similarity in design, the levels from the cutter suction dredger have been scaled based on the power of the device.

Vessels

13.6.285 There will be increased vessel movement around the site during construction, with vessels being used to bring equipment to the site and to dispose of excavated material. In addition, there would be a number of small support vessels used for staff transfers. The peak number of vessels on-site is predicted to average approximately 15 per week over a three month period.

13.6.286 Vessel noise contributes to overall background noise and has the potential to cause disturbance and is therefore included in the assessment. For the purposes of modelling, vessels have been divided into two categories, medium sized and large sized. Medium vessels include smaller support boats such as tugs and workboats and the large vessels include the dredgers and vessels transporting equipment.

13.6.287 For the modelling it is also assumed that the vessels are travelling at a speed of approximately 10 knots; the speed of the vessel will alter the sound level, with faster moving vessels generally creating more noise. The dredging vessels and jack-up barges required for construction activities are assessed as part of the noise source for those activities, and are not included under the vessel noise assessment.

13.6.288 Full details of the modelling work are available in appendix D13-9 (Application Reference Number: 6.4.91).

The effect of underwater noise on marine fish

13.6.289 Fish responses to noise are in part related to the anatomy of their hearing mechanisms. The presence of a swim bladder enhances hearing sensitivity as the bladder acts as a pressure transducer, converting sound pressure to particle velocity. Those species where the swim bladder is near to or connected to the ear have increased hearing sensitivity [RD133]. The hearing range of fish varies extensively amongst species, and it is not only related to anatomy; cod and Atlantic salmon both have a swim bladder, yet cod is sensitive to pressure at higher frequencies [RD133].

13.6.290 Hearing sensitivity in larval fish and eggs is poorly researched. However, evidence suggests that the hearing frequency range in larvae is similar to that of adults with similar startle thresholds [RD133].

Thresholds and criteria used for marine fish

13.6.291 A review of hearing sensitivity in fish, developed categories that can be used when assessing the effects of sound [RD133]. The categories are based on the presence or absence of a swim bladder and the potential for the swim bladder to enhance hearing sensitivity. The relevant categories are listed below.

- Fishes with no swim bladder or other gas chamber – e.g. flatfish. These species generally only detect particle motion and are less sensitive to sound pressure.
- Fishes with swim bladders in which hearing does not involve the swim bladder or other gas volume – e.g. Atlantic salmon. These species hear through particle motion.
- Fishes in which hearing involves a swim bladder or other gas volume – e.g. herring and cod. These species detect sound pressure and particle velocity.
- Fish eggs and larvae.

13.6.292 The presence of a swim bladder makes these species more susceptible to pressure related injury (such as rupture of the swim bladder) associated with sudden changes in hydrostatic pressure (water depth) or sound pressure. Those species lacking a swim bladder (elasmobranchs, flatfish etc.) are less vulnerable to pressure changes.

13.6.293 Guideline criteria have been established by Popper *et al*., [RD133] for the assessment of underwater noise on fish, based on extensive literature review, and are provided based on the type of noise source (e.g. explosives, piling, continuous noise source). The criteria adopted in this assessment are shown in table D13-13. Where actual data are not available, criteria have been set based on the risk to species at different distances from the source (near is tens of metres, intermediate is hundreds of metres and far is thousands of metres).

Table D13-13 Summary of criteria used in the assessment of underwater noise on fish [RD133] relating to shipping and continuous noise sources

Effect	Criteria	Metric	Species
Mortality and potential mortal injury	Low risk at near, intermediate and far field	n/a	All adult fish categories larvae and eggs
Recoverable injury	170dB re 1µPa for 48 hours	Unweighted SPL_{RMS}	Fish with swim bladder associated with hearing
	Low risk at near, intermediate and far field	n/a	Fish with no swim bladder Fish with swim bladder not involved in hearing Larvae and eggs
Temporary Threshold Shift (TTS)	158dB re 1µPa for 12 hours	Unweighted SPL_{RMS}	Fish with swim bladder associated with hearing
	Moderate risk at near source and low risk at intermediate and far from source	n/a	Fish with no swim bladder Fish with swim bladder not involved in hearing Larvae and eggs
	Low risk at near, intermediate and far field	n/a	larvae and eggs
Behaviour	Moderate risk at near and intermediate to source and low risk at far from source	n/a	Fish with no swim bladder Fish with swim bladder not involved in hearing Larvae and eggs
	High risk at near source and moderate risk at intermediate to	n/a	Fish with swim bladder

Effect	Criteria	Metric	Species
	source and low risk at far from source		associated with hearing

13.6.294 The fish in the vicinity of the Wylfa Newydd Development Area are a mixed community with species of conservation and/or commercial importance, and other more common species. The dominant species varies seasonally but whiting and dab are consistently abundant in subtidal areas.

13.6.295 Intertidal fish surveys within Porth-y-pistyll have indicated that catches are low across the board with limited species diversity. Dominant species include sand smelt, clupeids and sandeel as well as species common to rich habitats e.g. gobies, rockling, wrasse, and dogfish (appendix D13-4, Application Reference Number: 6.4.86). These results show that the fish community within Porth-y-pistyll is characterised by species with hearing sensitivities ranging from high (clupeids) to low (dogfish and gobies).

13.6.296 Several species of conservation interest were identified, including sea trout, river lamprey and European eel. Sea trout are considered to have hearing abilities similar to the Atlantic salmon and are assessed as being generalists (fish with swim bladder not associated with hearing).

13.6.297 River lamprey and European eel are considered to be, at the most, hearing generalists, with little in the way of anatomical adaptation to assist hearing [RD134]. There has been no research to date on the response of lamprey to sound, and Popper [RD134] presented that sound may not be biologically important for lamprey. Owing to the lack of research into the hearing of lamprey, the criteria from Popper [RD133] for fish with no swim bladders has been adopted for the assessment.

13.6.298 The hearing ability of European eel is also poorly documented with only one known study that looked specifically at hearing in the eel [RD135]. The anatomy of the eel is such that the swim bladder is positioned some distance from the ear. Therefore, for the purposes of this assessment eel are considered to be hearing generalists and the criteria from Popper *et al*., [RD133] for fish with no swim bladders has been adopted.

13.6.299 The marine construction methods of dredging, drilling, rock cutting and vessel movements are continuous sounds and therefore the criteria defined by Popper *et al*., [RD133] can be used for the assessment of effect.

13.6.300 Those fish with swim bladders that are associated with hearing are considered specialists in terms of hearing ability and are therefore at higher risk of injury resulting from sound pressure. This includes species such as herring and sprat.

13.6.301 For this group there are only defined sound levels for effects of Temporary Threshold Shift (TTS and recoverable injury (table D13-13) based on research on the goldfish (*Carassius auratus*) [RD133]. For other species the assessment is based on the risk of effect rather than a defined sound level (table D13-13). The ranges of effect for fish with swim bladders associated with hearing for each of the continuous noise sources are provided in table D13-14.

Table D13-14 Summary of modelled impact ranges for fish with swim bladders involved in hearing [RD132] to sound pressure levels (SPL_{RMS}) for cutter-suction dredging, rock cutting and drilling

Activity	Range to effect	
	Recoverable injury (48 h) 170 dB re 1 µPa (SPL_{RMS})	TTS (12 h) 158 dB re 1 µPa (SPL_{RMS})
Cutter-suction dredger	2m	13m
Rock cutting	<1m	3m
Rotary drilling (242kW)	<1m	2m
Rotary drilling (570kW)	<1m	3m
Percussive drilling	7m	67m

13.6.302 Sound levels known to cause TTS in hearing specialists are in the region of 158dB re 1µPa (SPL_{RMS}), and for recoverable injury are in the region of 170dB re 1µPa (SPL_{RMS}). Modelling results for dredging, rock cutting and drilling have shown that sound levels of this magnitude are limited to close proximity of the works with recoverable injury at and within 7m and TTS within 67m. Recoverable injury includes damage to sensory hair cells or minor internal/external injury, whilst TTS is defined as any change in hearing of 6dB or greater that persists [RD133].

13.6.303 Modelling has also been undertaken to examine the potential impact with concurrent drilling rigs. Assuming there would be two drilling rigs working concurrently, the range of effect for TTS would not change for the 242kW rig and would increase from 3m to 5m for the 570kW drilling rig. For percussive drilling, the range of effect for concurrent rigs would increase from 67m to 100m for TTS and from 7m to 13m for recoverable injury. These ranges are again very localised to the area and as such effects will be limited with fish moving away from the sound source.

13.6.304 Rock breaking is considered a multiple pulse sound and as such different criteria apply. The range of effects from noise generated from rock breaking are shown in table D13-15. Modelling of rock breaking has been undertaken using piling operations as a proxy as it is assumed that the method of impact pulse would be similar.

Table D13-15 Summary of modelled impact ranges for fish with swim bladders involved in hearing ([RD133] to sound levels for rock breaking

Activity	Range to effect		
	Mortality and potential mortal injury >207 dB re 1 µPa (SPL_{peak})	Recoverable injury 203 dB re 1 µPa^{2}s (SEL_{cum})	TTS (12 h) 186 dB re 1 µPa^{2}s (SEL_{cum})
Rock breaking	1m	10m	180m

13.6.305 Sound levels known to cause mortality and recoverable injury in hearing specialists from noise sources such as piling are greater than 207dB re 1µPa (SPL_{peak}). Modelling results have shown that sound levels of this magnitude are limited to within 1m of the source.

13.6.306 Criteria for TTS resulting from pile driving is 186dB re 1µPa^2 (SEL_{cum}) for all fish and is modelled to extend out to 180m from the source. This indicates that fish are at moderate risk of TTS within these ranges.

13.6.307 The risk of mortality resulting from dredging, rock cutting and drilling is considered low, with potential effects of recoverable injury being restricted to within 2m of the works (using hearing specialists as a worst case). For rock breaking, the risk is also considered low with potential effects of recoverable injury being restricted to within 10m of the works (using hearing specialists as a worst case).

13.6.308 There are no defined sound levels for which behavioural affects are likely in marine fish; instead this is based on the risk to fish at arbitrary distances. For hearing sensitive species, the risk of behavioural effects from continuous noise sources is considered high when close to the source (within tens of metres), reducing to medium at distances of hundreds of metres and then low at ranges in the kilometres [RD133]. Behavioural effects include long-term changes in behaviour such as moving away from areas of feeding refuge or alteration of migration patterns [RD133].

13.6.309 For multiple pulse sounds, the risk of behavioural effects for hearing sensitive species is considered high when close to the source (within tens of metres), high at distances of hundreds of metres and then moderate at ranges in the kilometres [RD133]. The risk of behavioural effects to generalists is considered high risk near to the source, moderate in the intermediate (hundreds of metres) and low risk at distance.

13.6.310 Intertidal fish surveys within Porth-y-pistyll have indicated that catches are generally low with peaks in the abundance of sprat, herring and sand smelt in the summer months (appendix D13-4, Application Reference Number: 6.4.86). Despite the increased abundance of clupeids, the noise levels generated during the Marine Works are considered low, and the ranges to which behavioural effects are high risk are local to the works. In addition, the north Anglesey coast is typically rocky in nature with numerous inlets and bays and therefore fish displaced from within Porth-y-pistyll would have access to other similar habitats.

13.6.311 Sea trout, river lamprey and European eel identified from the baseline programme to date have been recorded in very low numbers. Effects on these species are considered highly unlikely as a result of the low level of noise generated by dredging and their limited presence in the area.

13.6.312 The larval fish community in the vicinity of the Power Station was characterised through dedicated ichthyoplankton surveys, and was dominated by sandeel, flatfish (pleuronectidae), clupeids and gobies, with inshore reef species also present (dragonets, blennies, wrasse etc.).

13.6.313 Modelling results for vessel movements have been based on large and medium vessels travelling at a speed of 10 knots and have not accounted for bathymetry. This can therefore be considered representative of ships travelling to site, and a worst case scenario, as ships within Porth-y-pistyll will be moving considerably slower, and therefore are assumed to be quieter.

13.6.314 The modelling has shown that noise levels are low with sound pressure levels of 160dB re 1µPa (SPL_{RMS}) being limited to within 4m for large vessels and 1m for medium vessels (appendix D13-9, Application Reference Number: 6.4.91). Existing natural background noise levels for the wider area were recorded to be between 111.4dB re 1µPa (SPL_{RMS}) and 120.9dB re 1µPa (SPL_{RMS}) (based on all transects measured) (appendix D13-9, Application Reference Number: 6.4.91). This indicates that the noise levels generated from vessel movements will not be discernible above background noise after approximately 4.4km for large vessels and 2.4km for medium vessels.

13.6.315 The modelled ranges of effect for fish that are considered hearing specialists (those with a swim bladder involved in hearing) are shown in table D13-16. The ranges of effect for fish are localised with auditory injury being limited to within a meter of the vessels, and TTS occurring for large vessels within 4m. This is considered a worst case distance of effect as the vessels within Porth-y-pistyll and those involved in the construction activities will be small and slow moving.

Table D13-16 Summary of modelled ranges to effect for fish with a swim bladder involved in hearing [RD133] for vessel movements

SPL_{RMS}	Large vessels	Medium vessels
Recoverable injury (48h) 170dB re 1 µPa (SPL_{RMS})	<1m	<1m
TTS (12h) 158 dB re 1 µPa (SPL_{RMS})	4m	<1m

13.6.316 The modelling of marine construction activities has shown that the potential for mortal injury, recoverable injury and TTS are limited to within close proximity of the works. The duration of these activities extends over a number of months, although it is unlikely that all activities would occur simultaneously as they would require sequential elements. In addition to this, the Marine Works construction would not be undertaken continuously for the whole duration and therefore their use would be intermittent. Behavioural effects are more likely, with the range of avoidance extending out to kilometres from the source. It is likely this would result in temporary displacement of fish species away from the area, although there are numerous other similar habitats of high quality within the vicinity that could support fish communities throughout the duration of the works.

13.6.317 It is considered that the magnitude of change to fish populations is negligible as it constitutes a temporary, localised effect. Therefore, the effect of underwater noise from construction is considered to be negligible for all fish receptors.

The effect of underwater noise on marine mammals

Marine mammal hearing

13.6.318 The auditory system in marine mammals is similar to that in terrestrial mammals, in that hearing apparatus can be divided into the outer ear, an air-filled middle ear and a liquid filled inner ear. In odontocetes (toothed cetaceans), sound is channelled to the middle ear through the lower jaw [RD136], whilst in mysticetes (baleen whales) sound is channelled in two ways, either through the soft tissue or through the skull itself [RD137].

13.6.319 Pinnipeds' hearing capabilities both in air and water have been reviewed by the Department of Commerce [RD138] who stated that the hearing range for this group is greatly reduced in air to 1kHz to 22kHz with sensitivity at 12kHz, compared to 1kHz to 180kHz in water with peak sensitivity at around 32kHz. Phocinid seals have a hearing range from 1kHz to 60kHz [RD139] with sensitivity between 8kHz and 35kHz.

13.6.320 The absolute hearing threshold is the minimum sound level at a specific frequency that can be heard in the absence of any other sounds. In mammals, exposure to sound levels above absolute hearing thresholds can result in either a TTS, when hearing sensitivity returns to normal after temporary loss, or a permanent threshold shift (PTS) when hearing is lost permanently. In the past, reliable information on the levels of sound that cause damage in marine mammals was not available and therefore common practice was to apply human damage risk criteria [RD139].

13.6.321 Applying damage risk criteria to marine mammals, it would be predicted that at low frequencies (<500Hz), TTS would occur at around 165dB re 1µPa to 180dB re 1µPa in seals, and at around 180dB re 1µPa to 210dB re 1µPa in small dolphins [RD140].

Thresholds and criteria used for marine mammals

13.6.322 There have been various studies looking at the effects of noise on marine mammals from which criteria have been established that set noise levels at which PTS and TTS are likely to occur. Southall *et al*., [RD141] presented a set of interim criteria for noise levels that may result in PTS or TTS for marine mammals. The Southall *et al*., [RD141] criteria are generally based on marine mammals grouped by their hearing sensitivity, based on frequency ranges, as follows:

- low-frequency cetaceans (7Hz to 22kHz);
- mid-frequency cetaceans (150Hz to 160kHz);

- high-frequency cetaceans (200Hz to 180kHz);
- pinnipeds in water (75Hz to 75kHz); and
- pinnipeds in air (75Hz to 30kHz).

13.6.323 More recent studies for harbour porpoise have indicated that this species is potentially more sensitive than as generalised in the study by Southall *et al*., [RD141]. Stricter criteria have therefore been developed by Nehls *et al*., [RD142] based on work by Lucke *et al*., [RD143] and Kastelein *et al*., [RD144] which looks at the SEL. In addition, the work by Lucke *et al*., [RD143] also sets levels where a minor behavioural effect may occur in harbour porpoise.

13.6.324 The auditory injury criteria based on unweighted metrics and sources used in this assessment are shown in table D13-17.

Table D13-17 Summary of criteria used in the assessment of underwater noise on marine mammals

Effect	Criteria	Weighting	Species	Reference
Lethal effect	240dB re 1µPa	Unweighted SPL_{peak}	All	[RD144]
Physical injury	220dB re 1µPa	Unweighted SPL_{peak}	All	
PTS	230dB re 1µPa	Unweighted SPL_{peak}	Low, Mid, High-frequency cetaceans.	[RD140]
TTS	22 dB re 1µPa	Unweighted SPL_{peak}		
PTS	218dB re 1µPa	Unweighted SPL_{peak}	Pinnipeds (in water)	
TTS	212dB re 1µPa	Unweighted SPL_{peak}		
PTS	180dB re 1µPa^2 s	Single strike unweighted Sound Exposure Level (SEL)	Harbour porpoise	[RD141]
TTS	165dB re 1µPa^2 s	Single strike unweighted SEL		
Behavioural effect	145dB re 1µPa^2 s	Single strike unweighted SEL		[RD142]

13.6.325 Additional criteria based on an individual's hearing ability have also been used in the assessment (M-weighted criteria). M-weighted SELs from Hammond and Harris [RD140] have been used for the four groups of cetaceans as described in paragraph 13.6.322. The M-weighted criteria are based on PTS and TTS and depend on the noise source; pulsed (single/multiple) or non-pulsed (continuous) and are presented in table D13-18.

Table D13-18 M-weighted criteria for PTS and TTS from [RD141]

Criteria	Effect	Species	Source
198dB re 1μPa^{2}s (M)	PTS	Cetaceans	Single and multiple pulsed over a 24-hour period
186dB re 1μPa^{2}s (M)		Pinnipeds	
215dB re 1μPa^{2}s (M)		Cetaceans	Non-pulsed (continuous) over a 24-hour period
203dB re 1μPa^{2}s (M)		Pinnipeds	
183dB re 1μPa^{2}s (M)	TTS	Cetaceans	Single pulse sounds
171dB re 1μPa^{2}s (M)		Pinnipeds	

13.6.326 Behavioural responses of marine mammals to noise are highly variable and dependent on a suite of internal and external factors [RD139]. Behavioural responses can include changes in surfacing patterns, cessation of vocalisations, active avoidance of or exit from the area [RD139]. It is likely that responses are context-specific, and internal factors include:

- individual hearing sensitivity and tolerance;
- activity pattern;
- motivational and behavioural state at the time of exposure;
- past exposure of the animal to the noise (which may have led to habituation or sensitisation);
- predation risk; and
- demographic factors such as age, sex and presence of dependent offspring.

13.6.327 External factors that influence behavioural responses of marine mammals can include the size of the sound source and whether the sound source is stationary or moving (e.g. a vessel). Physical habitat characteristics can also influence sound transmission, such as being in a confined location or in proximity to a shoreline.

13.6.328 To assess the behavioural avoidance of marine mammals, criteria from Finneran and Jenkins [RD146] have been used (appendix D13-9, Application Reference Number: 6.4.91). These criteria use several different weightings listed as ‘Type I’, which is the same as M-Weighting from Southall *et al.*, [RD141] and ‘Type II’, which is a modified version of the filter based on an alternative weighting function.

13.6.329 This criterion is based on blasting operations however provides a criterion against which behaviour can be assessed. Finneran and Jenkins [RD146] state that, for single detonations, behavioural disturbance is likely to be limited to a short-lived startle reaction; therefore Finneran and Jenkins [RD146] do not suggest any unique behavioural disturbance thresholds for marine mammals exposed to single explosive events. The criteria for multiple successive detonations are set 5dB below the SEL based on the level at which TTS occurs. These would represent a worst case and are used for rock breaking activates in lieu of further information on behavioural avoidance in marine mammals.

13.6.330 These criteria are presented in table D13-19 and have been based on a modelled stationary animal subject to multiple explosions over a 24 hour period. As a result of this, the criteria is only used in the assessment of rock breaking as it is not representative for continuous noise sources such as drilling and dredging.

Table D13-19 Behavioural avoidance criteria after [RD150]

Criteria	Weighting	Species
167dB re 1µPa^{2}s SEL	Type II Weighting	Mid-frequency cetacean
141dB re 1µPa^{2}s SEL	Type II Weighting	High-frequency cetacean
172dB re 1µPa^{2}s SEL	Type I Weighting	Pinnipeds (in water)

13.6.331 Of the three cetacean species frequently observed, the harbour porpoise is considered a high-frequency species, and both the bottlenose dolphin and Risso's dolphin are considered mid-frequency species [RD141].

Dredging and drilling operations

13.6.332 The modelling results for high-frequency cetaceans (harbour porpoise) uses the criteria of Nehls *et al*., [RD142] and Lucke *et al*., [RD143] and are summarised in table D13-20.

Table D13-20 Summary of modelled impact ranges for harbour porpoise from cutter-suction dredging, rock cutting, rotary drilling and percussive drilling based on criteria set by [RD142] (PTS and TTS) and [RD143] (behavioural). *Unit ss represents single strike

Activity	Range to effect		
	Range to PTS in harbour porpoise 180dB re 1µPa^{2}s (SELss*)	Range to TTS in harbour porpoise 165dB re 1µPa^{2}s (SELss*)	Range to behavioural effect in harbour porpoise 145dB re 1µPa^{2}s (SELss*)
Cutter-suction dredger	<1m	4m	99m
Rock cutting	<1m	<1m	15m
Rotary drilling (242kW)	<1m	<1m	9m
Rotary drilling (570kW)	<1m	<1m	18m
Percussive drilling	2m	17m	390m

Activity	Range to effect		
	Range to PTS in harbour porpoise 180dB re 1μPa²s (SELss*)	Range to TTS in harbour porpoise 165dB re 1μPa²s (SELss*)	Range to behavioural effect in harbour porpoise 145dB re 1μPa²s (SELss*)
Concurrent rotary drilling rigs	<1m	1m	28m
Concurrent percussive drilling rigs	3m	36m	530m

13.6.333 For mid-frequency cetaceans (bottlenose dolphin) the modelling uses the criteria of Southall *et al*., [RD141] and Finneran and Jenkins [RD146] with summary results in table D13-21. There are no M-weighted criteria for TTS given by Southall *et al*., [RD141] for non-pulsed continuous sound, and therefore no range to TTS is presented. In the absence of other criteria for behavioural avoidance of bottlenose dolphin the cumulative criteria of Finneran and Jenkins [RD146] is used. This is based on a worst case situation with noise exposure on a stationary animal over 24 hours of operation. This is precautionary as it is a highly unlikely scenario; if an animal moves away from the noise source the effect will be greatly reduced to a negligible range.

Table D13-21 Summary of modelled impact ranges for bottlenose dolphin from cutter-suction dredging, rock cutting, rotary drilling and percussive drilling based on criteria set by Southall *et al*., [RD141] (PTS and TTS) and Finneran and Jenkins [RD146] (behavioural). *Unit Mmf represents M-weighting for mid-frequency cetacean

Activity	Range to PTS in bottlenose dolphin 215dB re 1μPa²s (Mmf*)	Range to behavioural effect in bottlenose dolphin 167dB re 1μPa²s (Type II)
Cutter-suction dredger	<1m	130m
Rock cutting	<1m	88m
Rotary drilling (242kW)	<1m	7m
Rotary drilling (570kW)	<1m	16m
Percussive drilling	3m	480m
Concurrent rotary drilling rigs	<1m	26m
Concurrent percussive drilling rigs	4m	620m

13.6.334 During drilling, cutting and dredging operations there is no potential risk of physical injury for marine mammals from underwater noise as the noise levels generated are below those required to cause physical injury.

13.6.335 It is apparent that, for these works, the risks of PTS and TTS are localised to the noise source and are therefore very unlikely to result in injury. Modelling results for dredging and drilling show that PTS would within 4m of the source for concurrent percussive drilling on bottlenose dolphin, and within 3m of the source for harbour porpoise.

13.6.336 Baseline surveys and available literature have shown that sightings of harbour porpoise within the shallow bays of Porth-y-pistyll and Cemaes are generally low, with higher numbers observed around Wylfa Head (appendix D13-6, Application Reference Number: 6.4.88). In addition, incidental sightings collected during the detailed offshore geotechnical investigations within Porth-y-pistyll have shown that between 7 July and 14 August 2016, no harbour porpoise were seen within a zone of 150m radius.

13.6.337 The range to PTS in harbour porpoise is shown to be a maximum of 3m from the source. Using the Wylfa Newydd Development Area densities it is estimated that considerably less than one harbour porpoise (0.00004) would be affected by PTS as a result of the dredging and drilling operations. This represents a very small proportion (0.00001%) of the estimated population of 104,695 (CV=0.32) individuals within the Celtic and Irish Sea Management Unit [RD151].

13.6.338 Behavioural effects in harbour porpoise have been modelled using criteria set by Finneran and Jenkins [RD143]. Using the ranges of effect from the works, and assuming that they are constant around the source (worst case), it shows that dredging and drilling could cause behavioural avoidance within a maximum area of approximately 83ha (based on concurrent percussive drilling). Using harbour porpoise densities determined within the Wylfa Newydd Development Area (126ha) it is estimated that less than two harbour porpoise (1.05) would show behavioural avoidance.

13.6.339 Existing records show that the distribution of bottlenose dolphin tends to be concentrated to the east of Anglesey between Bull Bay and Llandudno [RD37]. Very few sightings have been recorded from the Wylfa Newydd Development Area (appendix D13-6, Application Reference Number: 6.4.88). The nearest population estimates for bottlenose dolphin are those within the Irish Sea (SCANS II, survey block O) and are reported to be in the region of 235 individuals (CV = 0.75) with a density equivalent of 0.0052 individuals/km^2 ([RD33] cited in [RD147]).

13.6.340 The range to PTS in bottlenose dolphin is shown to be a maximum of 4m from the source. Using the Wylfa Newydd Development Area densities it is estimated that considerably less than one bottlenose dolphin (0.000017) would be affected by PTS as a result of the dredging and drilling operations. This represents a very small proportion (<0.00001%) of the reference population of 235 individuals ([RD33] cited in [RD147]).

13.6.341 Behavioural effects in bottlenose dolphin have been modelled using criteria set by Finneran and Jenkins [RD146]. Using the ranges of effect from the works, and assuming that they are constant around the source (worst case), it shows that dredging and drilling could cause behavioural avoidance within a maximum area of approximately 111ha (based on concurrent percussive drilling). Using the bottlenose dolphin densities determined within the Wylfa

Newydd Development Area (0.34/km^2) it is estimated that less than one bottlenose dolphin (0.38) would show behavioural avoidance.

13.6.342 Like the bottlenose dolphin, Risso's dolphin is considered to be a mid-frequency species which suggests that the effects on these two species from dredging and drilling operations could be broadly similar. Although existing records show that the distribution of Risso's dolphin tends to be concentrated around the north and west Lleyn Peninsula, east Anglesey and the Isle of Man (appendix D13-6, Application Reference Number: 6.4.88), this species is much less common in the area than harbour porpoise and bottlenose dolphin. There are currently no population estimates for the Risso's dolphin.

13.6.343 Considering the low abundance of Risso's dolphin in the area and the effects of underwater noise disturbance on bottlenose dolphin which is assumed to be a proxy, it is unlikely that dredging and drilling operations will have an effect on this species.

13.6.344 The modelling results for pinnipeds in water uses the criteria of Southall et al., [RD141] and Finneran and Jenkins [RD146] and are summarised in table D13-22.

Table D13-22 Summary of modelled impact ranges for pinnipeds in water from cutter-suction dredging, rock cutting, rotary drilling and percussive drilling based on criteria set by Southall *et al*., [RD141] (PTS) and Finneran and Jenkins [RD146] (behavioural). *Unit Mpw represents M-weighting for pinnipeds in water.

Activity	Range to PTS 186dB re 1µPa^{2}s (Mpw*) (pulsed)	Range to PTS 203dB re 1µPa^{2}s (Mpw*) (non-pulsed)	Range to behavioural effect 127dB re 1µPa^{2}s (Type II)
Cutter-suction dredger	n/a	5m	500m
Rock cutting	n/a	4m	320m
Rotary drilling (242kW)	n/a	1m	130m
Rotary drilling (570kW)	n/a	1m	230m
Percussive drilling	n/a	41m	4.1km
Concurrent rotary drilling rigs	n/a	3m	300m
Concurrent percussive drilling rigs	n/a	71m	5.9km

13.6.345 Modelling results using the M-weighted criteria of Southall *et al*., [RD141], for continuous sounds, show that in pinnipeds, PTS would be experienced within 5m from the source. Based on drilling rigs running concurrently and side by side (an unlikely scenario), PTS would be experienced within 71m of the sound source. Using cumulative SELs and criteria set by Finneran and Jenkins [RD146], behavioural avoidance would be expected to distances of up to 500m, for dredging, though for concurrent drilling this would extend out to 5.9km.

13.6.346 Based on the range to PTS of 71m, and assuming that this distance is taken from the furthest seaward point of the dredge and drilling operations, the area in which PTS could occur for pinnipeds in water would be approximately 1.6ha. For behavioural effects the area of effect would be approximately 6054ha.

13.6.347 Grey seal are present along the north Anglesey coast throughout the year. The relative density of grey seal in the vicinity of the Wylfa Newydd Development Area is estimated to be 0.24 individuals/km^2. Observations made during the detailed offshore geotechnical investigations within Porth-y-pistyll have shown that between 7 July and 14 August 2016, only three seals were seen within a mitigation zone of a 150m radius; an additional two were seen outside. Using these densities PTS is predicted to affect less than one (0.004) grey seal, representing 0.00006% of the reference population of 6,000 individuals.

13.6.348 The modelling has indicated that the effects associated with PTS and TTS are within close proximity to the works, and behavioural avoidance could extend out to approximately 530m, 620m and 4.1km for harbour porpoise, bottlenose dolphin and grey seal, respectively. Dredging and drilling operations are programmed to extend over several months, although the work will not be continuous for the whole period. It is therefore assumed that behavioural effects are likely to result in temporary displacement of marine mammals from the area around the works, with avoidance occurring before any mortality or physical damage would occur.

Rock breaking and cutting

13.6.349 The modelling results for high-frequency cetaceans (harbour porpoise) uses the criteria of Nehls *et al*., [RD142] and Lucke *et al*., [RD143] and are summarised in table D13-23.

Table D13-23 Summary of modelled impact ranges for harbour porpoise from rock breaking based on criteria set by Nehls *et al*., [RD142] (PTS and TTS) and Lucke *et al*., [RD143] (behavioural). *Unit ss represents single strike

Activity	Range to effect		
	Range to PTS in harbour porpoise 180dB re 1μPa²s (SELss*)	Range to TTS in harbour porpoise 165dB re 1μPa²s (SELss*)	Range to behavioural effect in harbour porpoise 145dB re 1μPa²s (SELss*)
Rock breaking	3m	25m	490m

13.6.350 For mid-frequency cetaceans (bottlenose dolphin) the modelling uses the criteria of Southall *et al*., [RD141] and Finneran and Jenkins [RD146] with summary results in table D13-24.

Table D13-24 Summary of modelled impact ranges for bottlenose dolphin from rock breaking based on criteria set by Southall et al., [RD141] (PTS and TTS) and Finneran and Jenkins [RD146] (behavioural). *Unit Mmf represents M-weighting for mid-frequency cetacean

Activity	Range to PTS in bottlenose dolphin 198dB re 1μPa²s (Mmf*)	Range to behavioural effect in bottlenose dolphin 167dB re 1μPa²s (Type II)
Rock breaking	36m	600m

13.6.351 The modelling results for pinnipeds in water uses the criteria of Southall *et al*., [RD141] and Finneran and Jenkins [RD146] and are summarised in table D13-25.

Table D13-25 Summary of modelled impact ranges for pinnipeds in water from rock breaking based on criteria set by Southall *et al.*, [RD141] (PTS) and Finneran and Jenkins [RD146] (behavioural). *Unit Mpw represents M-weighting for pinnipeds in water.

Activity	Range to PTS 186dB re 1μPa²s (Mpw*) (Pulsed)	Range to PTS 203dB re 1μPa²s (Mpw*) (non-pulsed)	Range to behavioural effect 127dB re 1μPa²s (Type II)
Rock breaking	450m	n/a	3.3km

13.6.352 During rock breaking and cutting operations there is no potential risk of physical injury for marine mammals from underwater noise as the noise levels generated are below those required to cause physical injury.

13.6.353 Modelled results (table D13-23) for rock breaking show that for harbour porpoise, PTS would be experienced up to 3m from the source (an approximate area of 0.003ha). Behavioural avoidance would be limited to within 490m using the unweighted criteria set by Lucke *et al.*, [RD143] which is approximately 72ha.

13.6.354 Observations of harbour porpoise numbers within the direct footprint of the works are low. Using the harbour porpoise densities for the Wylfa Newydd Development Area rock breaking activities would affect considerably less that one (0.00004) harbour porpoise. This represents a very small proportion (<0.00001%) of the reference population [RD147]. Damage resulting from PTS is therefore considered unlikely. Likewise, rock breaking has the potential to only affect less than one (0.91) harbour porpoise through behavioural avoidance.

13.6.355 Modelling results (13.6.350) of rock breaking in mid-frequency cetaceans (bottlenose dolphin and Risso's dolphin), shows that PTS would be experienced within approximately 36m of the source. Using cumulative SELs and criteria set by Finneran and Jenkins [RD146], behavioural avoidance would be expected to distances of up to 600m.

13.6.356 Based on the modelled range to PTS of 36m, and assuming that this distance is taken from the furthest seaward point of dredge operations, an approximate area of 104ha would be the area of behavioural effect for bottlenose dolphin and Risso's dolphin.

13.6.357 Using the bottlenose dolphin densities for the Wylfa Newydd Development Area, it is considered unlikely that bottlenose dolphin will be affected by the rock breaking operations. Owing to Risso's dolphin being less common in the area, a similar assumption could be made in that it is unlikely that dredging operations would affect this species.

13.6.358 For rock breaking the modelling results (table D13-25) show that in pinnipeds, PTS would extend out to 450m from the source. Using cumulative SELs and criteria set by Finneran and Jenkins [RD146], behavioural avoidance would be expected to distances of up to 3.3km.

13.6.359 Based on the range to PTS for rock breaking and assuming that this distance is taken from the furthest seaward point of dredge operations, the area of effect for pinnipeds in water would be approximately 61ha. Using grey seal densities for the Wylfa Newydd Development Area, PTS is predicted to affect less than one (0.15) grey seal, representing 0.0025% of the reference population.

Vessel movements

13.6.360 The predicted noise levels for vessels when compared with other construction methods are low, with cumulative noise exposure from large vessels being comparable to that of dredging. The predicted noise levels from vessel movements is not discernible above measured background noise levels at distances of 2.4km for medium vessels and 4.4km for large vessels.

13.6.361 The impact ranges based on criteria from Nehls *et al*., [RD142], and Lucke *et al*., [RD143] show that PTS and TTS from vessel movements is considered unlikely (table D13-26). The ranges to behavioural effects are limited to within 60m of large vessels and 10m of medium vessels. These ranges are localised to the vessels and as such no impacts to marine mammals are predicted, with only localised avoidance.

Table D13-26 Summary of modelled impact ranges for harbour porpoise from vessel movements based on criteria set by Nehls *et al*., [RD142] (PTS and TTS) and Lucke *et al*., [RD143] (behavioural)

Activity	Range to effect		
	Range to PTS in Harbour porpoise 180dB re 1μPa^{2}s (SELss)	Range to TTS in Harbour porpoise 165dB re 1μPa^{2}s (SELss)	Range to behavioural effect in Harbour porpoise 145dB re 1μPa$_2$s (SELss)
Large vessels	<1m	<1m	60m
Medium vessels	<1m	<1m	10m

13.6.362 The modelling results for pinnipeds in water uses the criteria of Southall et al., [RD141] and Finneran and Jenkins [RD146] and are summarised in table D13-27.

Table D13-27 Summary of modelled impact ranges for pinnipeds in water from vessel movements based on criteria set by Southall *et al*., [RD141] (PTS) and Finneran and Jenkins [RD146] (behavioural). *Unit Mpw represents M-weighting for pinnipeds in water.

Activity	Range to PTS 186dB re 1μPa^{2}s (Mpw*) (pulsed)	Range to PTS 203dB re 1μPa^{2}s (Mpw*) (non-pulsed)	Range to behavioural effect 127dB re 1μPa^{2}s (Type II)
Large vessels	n/a	<1m	<1m
Medium vessels	n/a	<1m	<1m

13.6.363 It has been suggested that the primary effect of vessel movements is the masking of biologically important sounds [RD148]. However, most shipping generates low frequency sound below 1kHz and is therefore outside of the auditory range for most cetaceans and it is likely to be only detectable to pinnipeds [RD149]. The effect to cetaceans is considered to be negligible and has not been considered further in the assessment.

Summary of effects to marine mammals

13.6.364 Modelling results for underwater noise during construction have shown that marine mammals would not be at risk of physical injury or fatality from underwater noise generated by any of the construction activities.

13.6.365 There is potential for PTS and TTS effects although these would be localised (≤71m). Considering marine mammal densities within the vicinity of the Wylfa Newydd Development Area, the number of individuals and the proportion of marine mammal populations potentially at risk of PTS or TTS is considered to be small, with avoidance expected to occur before any auditory damage (temporary or permanent). In addition, as good practice mitigation, the Wylfa Newydd CoCP (Application Reference Number: 8.6) and relevant sub-CoCPs (Main Power Station Site and Marine Works, Application Reference Numbers: 8.7 to 8.8) sets out best practice guidance (i.e. JNCC guidance) to reduce the risk of PTS and TTS effects to marine mammals.

13.6.366 Modelling results of underwater noise during construction have shown that behavioural disturbance could occur over a larger area (pinnipeds could be affected up to 5.9km away as a result of underwater noise disturbance generated from concurrent percussive drilling rigs). However, considering marine mammal densities within the vicinity of the Wylfa Newydd Development Area, the number of individuals and the proportion of marine mammal populations potentially at risk of behavioural disturbance is considered to be low. Nonetheless, the marine construction works are likely to result in displacement of individuals from the area around the works.

13.6.367 The total duration of the Marine Works is expected to be 32 months; rock breaking would occur for 16 months whilst all other activities (e.g. dredging, drilling and rock cutting) are each expected to occur for only a few months. Generally, these construction activities are not expected to occur concurrently as they will require sequential elements. In addition, they would not be undertaken continuously for the whole duration of the works and therefore underwater noise disturbance over the two years would be intermittent. Any displacement of marine mammals is likely to be temporary with the area around the works available to marine mammals outside the periods of construction activity.

13.6.368 Considering the information presented above and the good practice mitigation proposed, the magnitude of change is considered to be small resulting in a minor adverse effect from underwater noise on marine mammals.

The effects of underwater noise on designated sites

13.6.369 Of the marine construction activities assessed above, rock breaking is the only one that has the potential to result in a significant effect on the harbour porpoise and therefore has the potential to affect the North Anglesey Marine cSAC. Based on the modelled range to PTS of 3m from the source, and assuming that this distance is taken from the furthest seaward point of rock breaking operations, the area of effect for harbour porpoise would be approximately 0.003ha. Using the densities for harbour porpoise presented by Shucksmith *et al*., [RD35], PTS could affect considerably less than one (0.00004) harbour porpoise.

13.6.370 No population estimate has been defined for harbour porpoise within the SAC but a value of 1,084 individuals is provided within the SAC selection assessment document [RD150]. It is noted that this figure is only indicative as it is based on a single month's survey in a single year, but can be used to provide an indication of numbers within the SAC. It is also recognised that harbour porpoise are most prevalent in the SAC during the summer months [RD150].

13.6.371 The reference populations used for the harbour porpoise are therefore the estimated abundance of 104,695 (CV=0.32) individuals within the Celtic and Irish Sea Management Unit [RD151], of which the effect of PTS is a very small proportion (less than 1%).

13.6.372 A potential minor adverse effect on the harbour porpoise has been identified owing to a temporary displacement effect, and therefore there is potential for a minor adverse effect on the North Anglesey Marine cSAC.

Impact pathway: airborne noise from Main Construction activities leading to species disturbance

General context

13.6.373 An increase in noise may lead to avoidance behaviour and could potentially affect breeding or foraging activities which may have wider implications for populations. This pathway considers noise transmitted via the air; the effects on marine receptors from underwater noise are considered above. During construction the main sources of airborne noise generation are likely to be:

- stripping of topsoil and placing stripped topsoil in storage mounds with installation of associated drainage;
- demolition of existing buildings to ground level;
- rock excavation by blasting;
- piling, including sheet piling, to construct a temporary cofferdam and reinforce the southern causeway;
- rock cutting, to excavate the core of the temporary cofferdam and reinforce the southern causeway;
- dewatering, which would require generators for pumps;
- soil clearance and mound creation; and
- construction of haul roads, platforms and laydown areas.

13.6.374 The total construction period is seven years, and in the first two years there would be both marine-based and land-based construction. Noise modelling of the construction works has been carried out for four periods during the construction period and the results compared to the existing baseline conditions (see chapter D6, noise and vibration, Application Reference Number: 6.4.6). Additional noise predictions have been undertaken specifically to assess the bounding-case for marine ecological receptors (see appendix D13-13, Noise at Marine Ecological Receptors, Application Reference Number: 6.4.95).

13.6.375 The construction activities on-site are inherently dynamic. The noise levels that a receptor would experience at a particular point in time will depend on the nature of the activities being undertaken at that moment, and the location of the activities in relation to the receptor. It is not possible to predict the noise level that a receptor would experience at a particular time of day. Instead the prediction of noise from the construction works aims to represent typical noise levels that would be expected at a location over a three month period.

13.6.376 A number of good practice mitigation measures are proposed to reduce the effects of airborne noise during the construction phase (see paragraphs 13.5.90 and 13.5.91).

Effects on marine mammals

13.6.377 Rock fracturing work would be carried out in line with the relevant guidelines, which ensures the protection of human receptors. Vibration effects decay quickly with distance and would not lead to an effect on sound underwater. As such, a pathway arising from airborne noise or vibration disturbance to cetaceans has been ruled out.

13.6.378 Pinnipeds (e.g. grey seals) that have surfaced or have hauled out could be affected by airborne noise from land-based and marine-based construction activities. Disturbance from noise could potentially cause grey seals to stop feeding, resting, travelling and/or socialising, with possible long-term effects of repeated disturbance including permanent displacement and/or a decline in fitness and productivity.

13.6.379 There are no primary or secondary breeding haul-out sites for grey seal along the north Anglesey coastline, with the nearest one located on The Skerries, which is over 7km from the Wylfa Newydd Development Area [RD41]; [RD102]. Sightings of grey seals in the vicinity of Porth-y-pistyll are typically of individuals or small groups in the water (see appendix D13-6, Application Reference Number: 6.4.88). Throughout the marine environment baseline survey period, there have been no sightings of breeding seals or pups within the vicinity of the Wylfa Newydd Development Area, although incidental sightings have been reported along the broader north Anglesey coastline.

13.6.380 Based on the predicted noise modelling described in appendix D13-13 (Application Reference Number: 6.4.95) it is predicted that the A-weighted maximum sound ($L_{AF,max}$) levels to be generated within Porth-y-pistyll result from rock breaking within the intertidal area where the Cooling Water intake would be (66.7dB $L_{AF,max}$). Works within Porth-y-pistyll may require impact piling through the temporary causeway and cofferdam should vibratory piling not be sufficient. In this instance, noise levels within the Porth-y-pistyll would reach a maximum of 80.3dB $L_{AF\ max}$, and levels in Cemlyn Bay would reach a maximum of 63.4dB $L_{AF\ max}$.

13.6.381 There is little best practice guidance relating to the review of airborne noise disturbance on hauled-out seals directly. The sensitivity of grey seals to airborne noise is thought to be similar to human sensitivity [RD151]. General industry best practice is to establish a 500m exclusion zone around seal haul-out sites located within the vicinity of a development [RD152]. There are no primary or secondary grey seal haul-out sites along the North Anglesey coast and although the haul-out of individuals or small groups of grey seals would be expected along the coastline, the likelihood of this occurring within 500m of the Marine Works in Porth-y-pistyll is extremely low.

13.6.382 If grey seals were to haul-out within 500m of the Marine Works, temporary or permanent physical damage to these individuals as a result of airborne noise disturbance is highly unlikely; an avoidance response would be the most likely pathway of effect. There is wide availability of habitats known to be used as haul-out sites (intertidal rocky outcrops, beaches and sea caves that are tidally exposed) along the north Anglesey coastline [RD153]. Therefore, the effects of airborne noise on hauled-out seals would not have an effect on the integrity of the wider population.

13.6.383 As very few individual grey seals are likely to be affected and there would be no wider effects on populations, the magnitude of change is predicted to be negligible and the effect on grey seals from airborne noise is considered to be negligible.

Effects on seabirds

13.6.384 An increase in airborne noise can mask biologically useful sounds (i.e. 'signals' e.g. birds' contact calls from predators) or impair hearing of seabirds. This could result in the range and distribution of seabirds being constrained, and the potential for decreased fitness and productivity if breeding birds are disturbed by noise. Nesting birds can also be vulnerable to human-induced disturbance from noise and or visual sources that can directly affect reproductive success or survival, with effects including reduction in daytime nest attentiveness and reduction in time spent incubating eggs (potentially leading to a reduction in hatch rates and an increased risk of egg and chick predation), smaller proportions of collected food being allocated to chicks, and energetic costs to birds engaged in avoidance behaviours [RD158].

13.6.385 Airborne noise disturbance effects could also lead to abandonment of the tern colony, if sufficiently high in magnitude and frequency of the effect. Tern colony abandonment normally occurs after eggs and or chicks are lost to predators or flood events, or when levels of disturbance (human or otherwise) are sufficiently high as to present an imminent and repeated danger to adult birds or their eggs and chicks. Disturbance effects which do not pose an obvious danger to the birds can elicit a reaction from the birds, e.g. a fly up of adults from the colony, but are not likely to result in colony abandonment. Noise effects alone, with no associated visual threat of danger, are unlikely to lead to colony abandonment.

13.6.386 Flying or actively feeding seabirds may react to unexpected noise disturbance by diverting their flight or avoiding an affected area; this could affect seabirds by reducing access to feeding resources if present within noisy areas and/or increasing energy demands due to flight deviation, thus affecting breeding success and population sustainability.

13.6.387 Garthe and Hüppop [RD155] produced a sensitivity index to measure the potential vulnerability of seabirds to marine wind farms. The sensitivity index was informed by nine different factors, including the species vulnerability to disturbance by ship and helicopter traffic as this was believed to give an indication of the general behaviour of birds towards disturbances (albeit noise and visual combined). The study concluded that Sandwich tern, common tern and Arctic tern are relatively tolerant of disturbance, with each species being scored a '2', on a scale from '1' (hardly any escape/avoidance behaviour and/or none/very low fleeing distance) to '5' (strong escape/avoidance behaviour and/or large fleeing distance). Gulls (herring, lesser black-backed, common and black-headed) and great-crested grebe were also deemed to be relatively tolerant of disturbance, with each species being scored a '2'. Guillemot and razorbill (*Alca torda*) were deemed less tolerant with a score of '3'. Cormorant (*Phalacrocorax carbo*) displayed stronger escape/avoidance behaviour and/or with a larger fleeing distance and were given a score of ‘4’.

13.6.388 For the purpose of this assessment, seabirds are differentiated into target species (i.e. qualifying species of the Anglesey Terns/Morwenoliaid Ynys Môn SPA: Arctic tern, common tern, roseate tern and Sandwich tern) and secondary species (i.e. those species other than terns, which are specially protected or are of conservation concern). Black-headed gull is assessed as a secondary species, but is also considered within the assessment of effects on target species during the breeding season due to its commensal relationship with Sandwich terns

13.6.389 The construction activities from which disturbance to seabirds can potentially arise can be differentiated into two categories. These categories comprise regular construction activities that produce noise levels which can be modelled such as piling, drilling and the use of machinery and those activities that produce airborne pressure waves over frequencies that are made up of audible sound, and concussion.

Construction noise

13.6.390 Worst case noise levels generated by the construction works have been modelled for four periods, each with a three-month duration, during the construction period (see chapter B6, Application Reference Number: 6.2.6) for detail on the noise modelling methodology employed). The assessment of noise effects is partly based on these modelled noise levels (see chapter D6, Application Reference Number: 6.4.6) for a description of the construction scenarios and effects on humans). Additional bounding-case noise modelling (with one or more inputs set to their limit values) has also been undertaken for marine receptors. This assumes that all construction plant would be close to the sea and that all construction plant would be operating at under full load simultaneously (see appendix D13-13, Application Reference Number: 6.4.95). It is not expected that the bounding-case conditions will occur in practice, but if a similar situation was to occur, then it would only be for a very short time. The results of the bounding-case noise modelling are therefore considered to be representative a short period of time, and are presented in terms of the A-weighted equivalent continuous noise level over five minutes ($L_{Aeq,5min}$).

13.6.391 Based on construction noise modelling described in chapter D6 (Application Reference Number: 6.4.6), i.e. without blasting taken into account, it is predicted that the highest noise level (presented in terms of a typical equivalent continuous noise level over one hour, $L_{Aeq,1\text{-}hour}$) during construction at the tern breeding colony at Cemlyn Lagoon would be 60dB $L_{Aeq,1\text{-}hour}$, whereas for the majority of Porth-y-pistyll it would be between 70 and 80dB $L_{Aeq,1\text{-}hour}$, with a very small area at the south-east of the bay at 80-85dB $L_{Aeq,1\text{-}hour}$ (see chapter D6, Application Reference Number: 6.4.6). The bounding-case construction scenario predicts highest noise levels of 55dB $L_{Aeq,5min}$ to 65dB $L_{Aeq,5min}$ (averaged over five minutes) at the tern breeding colony and 75dB $L_{Aeq,5min}$ to 80dB $L_{Aeq,5min}$ over the majority of Porth-y-pistyll, with 80dB $L_{Aeq,5min}$ to 85dB $L_{Aeq,5min}$ and greater than 85dB $L_{Aeq,5min}$ within very small areas.

13.6.392 Although wind direction and strength can affect how noise attenuates with distance, the construction noise models do not take into account wind conditions. This is because the code of practice which sets out the method for predicting noise from construction sites in the UK (BS 5228-1:2009+A1:2014 [RD156]) does not include the effects of wind direction, the effects of atmospheric attenuation or several other attenuation effects. However, comparison with more sophisticated noise modelling methodologies (e.g. ISO9613-2 [RD157]) show that BS 5228-1 [RD156] provides higher estimates of noise at distance even when downwind conditions are specified in the more sophisticated noise model.

13.6.393 The baseline noise levels at the tern colony at Cemlyn Bay have been monitored and are very variable, including many impulsive noise events above 70dB $L_{AF,max}$. Baseline noise is dependent on factors such as wind conditions, the state of the tide and the number of terns present. Baseline noise levels can vary in any particular hour between 35dB and 45dB on a quiet day, to between 60dB and 68dB on a noisier day. There are however many noisier events, from known sources such as low flying jet aircraft and unknown sources (see appendix D13-7, Application Reference Number: 6.4.89 and D13-12, Application Reference Number: 6.4.94). The highest noise event which was identified was that caused by a low flying RAF jet of 88.8dB $L_{AF,max}$.

13.6.394 Seventy-six hours of monitoring identified 179 events of potentially disturbing occurrences and/or reactions from the terns. From these 179 events, 121 reactions from terns were recorded. Approximately two thirds (66%) of these reactions (80 reactions) have no obvious attributable cause detected by the surveyors, and for which no noise stimulus was recorded by the microphone. On these occasions, the terns were potentially reacting to a stimulus missed/ not detected by the surveyors and microphone. It is also possible that not all tern fly ups at a colony happen in reaction to a disturbing stimulus, and that a proportion of fly ups are attributable to social behaviour of the colony. Of the reactions from terns where a cause was detected by the surveyors, 18% were caused by predators; 5% caused by non-predator species (e.g. geese); and 10% by human-induced causes (including aircraft, vehicles, people and dogs).

13.6.395 Fifty-eight disturbance events were recorded that did not lead to any reaction from the terns, with an average associated noise level of 72.6dB $L_{AF,max}$ and the highest being 87.6dB $L_{AF,max}$. There were 13 instances where the terns flew up in reaction to anthropogenic disturbance sources (visual and noise), with an average level of 77.5dB $L_{AF,max}$ and a minimum level of 69.7dB $L_{AF,max}$. These events included jets flying overhead, with noise levels of 78.2dB(A) and 88.8dB $L_{AF,max}$.

13.6.396 For the thirteen anthropogenic events resulting in a reaction from the terns described above, the disturbance sources were a combination of visual and noise. There were 10 noise-only events recorded during the disturbance monitoring surveys, none of which elicited a response from the terns. Decibel values ranged from 46.8dB to 76.6dB, average 66.5dB.

13.6.397 Three of the disturbance events were from sources giving impulsive noise with a sharp attack/rise-up time, the loudest of which was a tractor door slamming shut at 75.6dB. The other sources were a distant gunshot and a grain container slamming closed. None of these impulsive noise events caused a reaction from the terns.

Blasting noise

13.6.398 Blasting operations are required in a number of locations across the site to facilitate excavation. The nearest blasting activities to seabird receptors would be located within the marine environment in Porth-y-pistyll (dry blasting) and on land at approximately 1.5km from the islands in Cemlyn Lagoon which support terns in the breeding season. Blasting activities could occur up to six times per day during construction.

13.6.399 When blasting is carried out, energy is transmitted from the blast site in the form of airborne pressure waves. The effects of blasting have the potential to disturb nesting, roosting, foraging and flying seabirds, depending on factors such as:

- the source-receiver distance (i.e. the distance between blasting and sensitive areas);
- the maximum instantaneous charge weights used (which is related to the magnitude of air overpressure/ground-borne vibration generated at source);
- the frequency of blasting (how many times per day); and
- the blast design (for example, good blast design can reduce the magnitude of air overpressure generated for a given maximum instantaneous charge weight).

13.6.400 For highly confined blasts conducted for the deep excavations, which would be the large majority of blasting operations, the maximum sound levels are predicted to be 60dB $L_{AF,max}$ at the tern and black-headed gull breeding colony.

13.6.401 Proposed blast sites are also located within Porth-y-pistyll. At the tern and black-headed gull breeding colony, this would lead to noise levels of 62.9dB $L_{AF,max}$. At the gull colony at Porth Wnal, approximately 450m from the blasts, noise levels would be between 70.4dB $L_{AF,max}$ to 72.6dB $L_{AF,max}$. At 100m (i.e. distance from blast site to the closest typical flying route of terns as they fly between the colony and feeding grounds to the east), the noise levels are predicted to be 85.8dB.

13.6.402 The prevailing wind conditions in the Wylfa Newydd Development Area (south westerlies) mean that on most commonly the tern and black-headed gull colony is likely to be upwind of the sites where blasting may occur. However, when downwind conditions exist (as defined by wind coming from a direction of 50º to 130º) the noise levels experienced at the tern colony would be increased, potentially to above 80dB.

Effects on target species – construction noise

13.6.403 During the breeding season, common, roseate, Sandwich and Arctic terns are all sensitive to disturbance through effects on foraging and breeding behaviour [RD158]. The black-headed gull colony at Cemlyn comprises a large proportion of the population in Wales and it is recognised that any effects on black-headed gull could have implications for Sandwich terns owing to the commensal relationship between these two species.

13.6.404 Disturbance monitoring (see appendix D13-7, Application Reference Number: 6.4.89) showed the background noise level recorded at the shingle ridge adjacent to the breeding colony varied dependent on weather and tide conditions and gradually declined as the season progressed. Regular peaks over 70dB and occasional peaks of over 80dB have been recorded at the colony, some of which had known sources such as Royal Air Force jets and some of which had no apparent source.

13.6.405 Of the 13 potential anthropogenic disturbance events associated with a marked increase in noise, two were associated with responses by the terns with loud noise levels of 78dB(A) and 89dB(A) (overflying jets). The mean noise level for the remaining 11 noise events that produced no tern response was 65.5dB(A), with values ranging from 47dB(A) to 78dB(A) and being 65dB(A) or above in 10 of these events.

13.6.406 Based on the lack of response of the birds at the colony to noisy events and the predicted noise levels being below thresholds that disturb the colony, the effects of disturbance to target and secondary seabirds at the breeding colony from noise generated during construction are considered to represent a small magnitude of change and therefore result in a minor adverse effect.

13.6.407 Terns in flight could potentially divert away from noise generated by construction activities, which could lead to an increased energetic burden and affect fitness. As Arctic/common terns were generally observed to fly northwards from the colony and out to sea, terns using this route are likely to not come in to contact with areas that are predicted to have a significant increase in noise levels.

13.6.408 Sandwich terns were generally observed to fly along the coast through Porth-y-pistyll and around Wylfa Head to favoured feeding grounds to the east (see appendix D13-7, Application Reference Number: 6.4.89). Tern species are considered to be highly manoeuvrable in flight [RD155]. This suggests that they would be able to respond to any sudden noise disturbance encountered whilst in flight or actively feeding by diverting rapidly and efficiently and without experiencing a significant energetic burden.

13.6.409 Results from additional VP surveys during offshore ground investigation works in Porth-y-pistyll in 2016 indicate that terns flying in the vicinity of unusual stimuli (which included the presence of noisy marine machinery) either did not deviate or deviated only slightly and returned to their general flight direction shortly afterwards.

13.6.410 It is considered likely that birds flying through Porth-y-pistyll would habituate to construction noise as they learn that no danger would accompany the noise.

13.6.411 Seabird surveys undertaken from 2010 to 2017 revealed very low use of Porth-y-pistyll and the adjacent bay by actively feeding Sandwich terns, common terns and Arctic terns (appendix D13-7, Application Reference Number: 6.4.89). The vast majority of Arctic/common tern recorded were observed flying from the breeding colony northward and out to sea. Most Sandwich terns recorded were observed flying from the colony to feeding grounds to the east, including waters around Middle Mouse and Point Lynas (approximately 5.8km and 15.3km away respectively) [RD151]; [RD159]; appendix D13-7 (Application Reference Number: 6.4.89).

13.6.412 Boat-based transect surveys and visual tern tracking surveys have been undertaken in 2016 and 2017. Results from these surveys corroborate previous findings from tracking surveys undertaken in 2009. Tracked Sandwich terns did not feed in Cemaes Bay, Porth Wnal or Porth-y-pistyll. Arctic terns and common terns were not recorded diving in Cemaes Bay, Porth Wnal, Porth-y-pistyll or Cemlyn Bay. The nearest clusters of data indicative of active feeding (by the three species) are greater than 1km from the Wylfa Newydd Development Area. Cemlyn Bay was the only inshore area where any of the tern species were observed in predictably significant numbers during tracking surveys, as they flew to and from the colony. Small numbers of Sandwich terns were observed diving within 500m of Wylfa Head (see appendix D13-7, Application Reference Number: 6.4.89).

13.6.413 The bounding-case noise levels during construction over the majority of Porth-y-pistyll are predicted to be 75dB $L_{Aeq,5min}$ to 80dB $L_{Aeq,5min}$ with 80dB $L_{Aeq,5min}$ to 85dB $L_{Aeq,5min}$ and greater than 85dB $L_{Aeq,5min}$ within very small areas. Although these noise levels may result in some temporary displacement, it is likely that the birds would habituate to the noise as they learn that no danger would accompany the noise.

13.6.414 Based on the above, the effect of disturbance to flying and actively feeding terns in the marine environment due to construction noise is considered to have a negligible magnitude. The effect on target species from construction noise is therefore considered to be negligible.

Effects on target species - blasting noise

13.6.415 Noise levels for the majority of blasting operations due to well confined blasting for the deep excavations is predicted to be 60dB $L_{AF,max}$ at the tern and black-headed gull breeding colony during favourable (i.e. outwith a 50° to 130° direction range) wind conditions. Noise levels for blasting within Porth-y-Pistyll are predicted to be 62.9dB $L_{AF,max}$. The background noise level recorded at the shingle ridge adjacent to the breeding colony in May and June 2017 was between 39dB $L_{Aeq,2\text{-}hours}$ and 65dB $L_{Aeq,2\text{-}hours}$, with regular peaks over 70dB $L_{AF,max}$ and occasional peaks of over 80dB $L_{AF,max}$. Terns and black-headed gulls did not generally react to instances of RAF jets flying nearby, even when noise levels were up to 83.5dB $L_{AF,max}$, but were observed to fly up twice during 76 hours of monitoring, when jets flew directly over at low altitude and produced noise levels of 73.4dB $L_{AF,max}$ and 88.8dB $L_{AF,max}$. Additionally, non-breeding black-headed gulls monitored during trial blasts in March 2017 (see appendix D13-7, Application Reference Number:

6.4.89) did not react to blasting generated noise until a level of 68.2dB $L_{AF,max}$ was exceeded.

13.6.416 The maximum noise level at Porth-y-pistyll during blasting is predicted to be over 85.8dB $L_{AF,max}$ (for a highly confined construction blast). This could result in terns avoiding this area when actively feeding. However, the various seabird surveys have shown that there is very little use of Porth-y-pistyll by actively feeding terns of any species (see appendix D13-7, Application Reference Number: 6.4.89).

13.6.417 The maximum noise level at the closest commuting route of terns to the blast site (i.e. an essentially direct line from the coast at Trwyn Pencarreg to Porth y Gwartheg) is predicted to be 85.8dB $L_{AF,max}$, decreasing to 75.3dB $L_{AF,max}$ at a distance of approximately 300m.

13.6.418 It is considered that flying terns are unlikely to significantly deviate from flight paths. Terns flying in the vicinity of unusual stimuli (presence of noisy marine machinery) during the offshore Ground Investigation VP surveys either did not deviate or deviated only slightly and returned to their general flight direction shortly afterwards. The disturbance monitoring has indicated that these species are habituated to sudden typical anthropogenic noise levels of up to 83.5dB $L_{AF,max}$ at the breeding colony (e.g. low flying jets, slamming vehicle doors), where they are likely to be most sensitive to disturbance due to potential threat to their eggs or chicks. Whilst in flight between the colony and at-sea feeding areas, terns are likely to be less sensitive to noise disturbance than when at the colony.

13.6.419 The disturbance monitoring surveys showed no reaction of terns either to noise-only events or to impulsive noises. Terns only reacted to known disturbance sources with a visual, as well as noise, component. When the terns did react to a sudden disturbance, they displayed the same behaviour regardless of the nature of the disturbance (other than the NWWT wardens' visit), and quickly settled back to the colony when no obvious sign of danger was apparent.

13.6.420 Based on the above, the effects of disturbance from blasting in typical conditions on target species of seabirds are considered to be of small magnitude and therefore are considered to be minor adverse. However, during downwind conditions, the noise levels could rise potentially to over 80dB as described previously, causing birds to fly up. In this worst case circumstance, the terns could be subject to additional fly ups from the colony in response to loud noises from blasting operations. The disturbance monitoring surveys show an average number of fly-ups per day of c. 25, and for less than a minute each time. A small number of extra fly-ups in response to loud noise from blasting during times of unfavourable wind conditions is not likely to represent a level of disturbance sufficient to lead to colony abandonment as the noises will not be accompanied by an obvious threat of danger to the birds, their eggs or chicks. Previous abandonments of the Cemlyn tern colony have all been in response to predation pressures. Extra time spent by adult birds off the nests during fly-ups could lead to reduced productivity via reduced egg hatching rates or increased predation of eggs or chicks. The small proportion of extra time spent off nests due to a potential increase in the number of fly-ups during blasting operations under unfavourable wind conditions is not likely to lead to a significant decrease in colony productivity. During the 121 fly-up events observed during the disturbance monitoring surveys, predation occurred in only one instance. It is considered that in the worst case scenario the magnitude of change would be small and that such a change would result in minor adverse effects on the nesting birds. Additional mitigation is presented in paragraphs 13.8.15, 13.8.16 and 13.8.17.

Effects on secondary species – construction and blasting noise

13.6.421 There is potential for disturbance of secondary seabirds that may be nesting, loafing, foraging or flying in the waters around the Wylfa Newydd Development Area, particularly within Porth-y-pistyll. Noise associated with construction works could cause birds to be flushed and avoid certain areas.

13.6.422 If disturbance is continuous and intense, and combined with louder, irregular noises such as blasting, it could result in increased stress levels and costs to birds in expending more energy if birds make unnecessary movements or have to fly an increased distance to alternative nests and feeding sites. This could impair the birds' condition and potentially increase their susceptibility to predation, which could affect the breeding success of populations.

13.6.423 A total of 19 secondary seabird species were recorded using (i.e. roosting, loafing and/or foraging) VP1 (the survey area in which Porth-y-pistyll is located) during the VP surveys. Seven secondary seabird species were recorded using the intertidal zone at Porth-y-pistyll. The majority of the species recorded in high numbers in this location use the bay during winter for roosting and loafing due to its sheltered location (see appendix D13-7, Application Reference Number: 6.4.89).

13.6.424 Similar habitats exist in the vicinity, including Cemlyn Bay and Lagoon, Porth y Wylfa and Cemaes Bay, and Hen Borth and Porth Wen further afield. Although these birds may regularly move between these areas (due to different tidal states and disturbance levels) it is considered likely that adequate roosting and loafing places are available for any displaced individuals.

13.6.425 Secondary seabird species that regularly use Porth-y-pistyll for foraging, such as gulls, cormorants and common auks (defined as guillemots/razorbills not identified to species level during surveys), may also be displaced by construction and blasting noise. However, low numbers of these species have been recorded using Porth-y-pistyll for foraging when compared to the wider area (peak counts of 56 herring gulls, 20 lesser black backed gull, seven great black-back gulls, 40 common gulls, 50 black-headed gulls, three cormorants, six shags and eight common auks recorded during foraging in Porth-y-pistyll during the VP surveys (see appendix D13-7, Application Reference Number: 6.4.89).

13.6.426 The bounding-case noise level during construction over the majority of Porth-y-pistyll is predicted to be 70dB $L_{Aeq,5min}$ to 80dB $L_{Aeq,5min}$ without blasting. Although these noise levels may result in some temporary displacement, it is likely that the less sensitive species such as gulls would habituate to the noise as they learn that no danger would accompany the noise. Additionally, the noise levels during construction would be present when birds that breed in the area arrive, and therefore these birds would not be exposed to new noise levels during the active breeding period.

13.6.427 More sensitive species that use Porth-y-pistyll for roosting and loafing, such as cormorant and auks, may be displaced due to an increase in noise levels, but again, it is considered likely that adequate roosting and loafing places are available for any displaced individuals.

13.6.428 Blasting noise within Porth-y-pistyll is predicted to be between 67.2dB $L_{AF,max}$ and 85.8dB $L_{AF,max}$, which could result in secondary species being displaced from this area as a foraging resource. However, it is considered that adequate foraging resources are also available in the wider area for any displaced individuals.

13.6.429 Cemlyn Lagoon regularly supports high numbers of birds, with black-headed gull recorded in the greatest numbers with a peak count of 812 taken during April 2013. Herring gull was also recorded in relatively high numbers with a peak count of 364 (appendix D13-7, Application Reference Number: 6.4.89). The highest average noise level during construction at islands in Cemlyn Lagoon is predicted to be 60dB(A) with favourable wind conditions. These noise levels would not be expected to result in displacement, as monitoring has shown black-headed gulls are habituated to this level of noise.

13.6.430 Although the noise levels from blasting may result in some temporary displacement from Porth-y-pistyll, it is likely that the birds would habituate to the noise as they learn that no danger would accompany it.

13.6.431 There is potential for the gull colony (herring gull, lesser black-backed gull and great black-backed gull) at Porth Wnal to be disturbed by excavation and construction of the temporary cofferdam and Cooling Water outfall structures and by blasting. Disturbance during the breeding season (March to August inclusive) could cause gulls to be flushed from their nests resulting in stress and potential affects to foraging routines. Acute disturbance could affect breeding if the works were carried out when gulls are beginning to lay/incubate eggs [RD160]. The breeding success of the gull species present could be affected if brooding adults are flushed from eggs or chicks, or adults bringing food items are delayed from returning.

13.6.432 The gulls may become habituated to regular noise disturbance within Porth Wnal, however any loud, intermittent construction activities, including blasting, within the immediate vicinity of the colony would be expected to potentially result in a flyup type response.

13.6.433 The bounding-case noise levels during construction at the gull colony is predicted to be 70dB $L_{Aeq,5min}$ to 85dB $L_{Aeq,5min}$ and the maximum noise level during blasting is predicted to be between 70.4dB $L_{AF,max}$ and 72.6dB $L_{AF,max}$.

13.6.434 Although these noise levels may result in some temporary displacement, it is likely that the birds would habituate to the regular noise disturbance as they learn that no danger would accompany the noise. Additionally, the noise levels during construction would be present when the birds arrive in the area, and therefore these birds would not be exposed to new noise levels during the active breeding period.

13.6.435 Based on the above, the magnitude of effects of disturbance from construction noise and blasting is considered to be small. Therefore, the effect on secondary species of seabirds is considered to be minor adverse.

Impact pathway: changes in visual stimuli during Main Construction leading to species disturbance

General context

13.6.436 The land-based and marine-based construction activities that would lead to an increase in visual stimuli are outlined in paragraph 13.5.72. As with noise, a change in visual stimuli could potentially lead to avoidance behaviour and could affect breeding or foraging activities, which could have wider implications for populations.

Effects on fish

13.6.437 Marine-based construction activities and the presence of humans, vessels, construction plant and artificial lighting, would result in direct visual disturbance to marine fish receptors. This could lead to a variety of behavioural responses, including displacement and/or disruption to feeding and reproduction, leading to a decline in fitness and productivity.

13.6.438 Most fish species are photoreceptive, with key activity rhythms and behavioural patterns (e.g. feeding) stimulated by light. Daytime feeders, which are typically planktivorous, detritivorous or grazers, are generally attracted to light [RD161]. Conversely, nocturnal species, which are typically carnivores, would show a strong avoidance of light. Crepuscular species that show peaks of activity during the twilight periods are likely to exhibit a varied behavioural response [RD161].

13.6.439 For species that are deterred from the area due to the presence of a visual disturbance, displacement is unlikely to affect the integrity of populations (i.e. reduction in fitness and productivity through effects on reproduction and feeding) given the availability of alternative habitats along the north Anglesey coastline.

13.6.440 The distribution of fish species attracted to artificial lighting is also likely to be influenced by other factors such as the availability of resources (e.g. food and refuge). It is unlikely that species typically attracted to artificial lighting (e.g. mullet) [RD161] will significantly increase in abundance within the vicinity of the Marine Works. Any localised increase is unlikely to affect the integrity of wider populations.

13.6.441 Whilst some sources of artificial lighting might be permanently in place during the construction phase, the majority of lighting (designed to reduce light spill), plant and personnel would be mobile. Visual disturbance effects would therefore be intermittent and localised. As construction of the Marine Works progress, the loss and decline in suitable habitats within the Wylfa Newydd Development Area is likely to result in displacement of fish receptors (this effect has been assessed within paragraphs 13.6.158 and 13.6.163) which would reduce the possible effect of visual disturbance during the construction phase. Visual disturbance is therefore considered to have a negligible magnitude of change on fish receptors, including fish of conservation and/or commercial importance and general fish and fisheries. Therefore, the effect on marine fish receptors from visual disturbance during the construction phase is considered to be negligible.

Effects on marine mammals

13.6.442 Pinnipeds (e.g. grey seals) that have surfaced or have hauled-out could be affected by changes to visual stimuli from marine-based construction activities. Visual disturbance could potentially cause grey seals to stop feeding, resting, travelling and/or socialising, with possible long-term effects of repeated disturbance including permanent displacement and/or a decline in fitness and productivity.

13.6.443 Seals that are hauled out on land, either resting or breeding, may be particularly sensitive to visual disturbance [RD162]. In general, shipping traffic more than 1,500m away from a haul-out site is unlikely to evoke any reaction; between 900m and 1,500m, grey seals could be expected to detect the presence of vessels; and at closer than 900m, a flight reaction could be expected [RD163]. However, the level of response is dependent on a range of factors, such as the species at risk, age, weather conditions and the degree of habituation to the source of disturbance. Jansen *et al*., [RD164] studied the effects of approaching vessels on harbour seals and found that hauled-out seals 100m away from the ship were 25 times more likely to enter the water compared to seals that were located 500m away. Other studies have recorded a flight response in harbour seals by boats at a distance of around 500m [RD165].

13.6.444 As described in paragraph 13.3.169, there are no primary or secondary breeding haul-out sites for grey seal along the north Anglesey coastline, and sightings within the Wylfa Newydd Development Area generally represent sporadic individuals or small groups which are either in the water or hauled-out (see appendix D13-6, Application Reference Number: 6.4.88).

13.6.445 The likelihood of grey seals hauling-out within the immediate vicinity of the Wylfa Newydd Development Area (i.e. within 500m) is considered extremely low. Visual disturbance due to the presence of human activity is therefore considered to be of negligible magnitude. Therefore, the effect on grey seals from visual disturbance during the construction phase, is also negligible.

Effects on seabirds

13.6.446 Land-based activities and marine developments during construction could potentially affect target and secondary seabirds, due to an increase in visual and light disturbance. Potential sources of visual stimuli include: construction activities for the breakwater, MOLF, temporary cofferdam and subsequent CWS intake and outfall works; increased barge/vessels in construction areas; lighting for offshore ground works; ground works and construction activities, and increased presence of human activity.

13.6.447 Responses from seabirds could potentially occur if there are lines of sight to construction activities whilst birds are nesting, loafing, actively feeding or in flight between breeding sites and feeding grounds. The minimum response to a visual stimulus is head turning or scanning behaviour. A more severe response could be the initiation of flight, the deviation from a flight path or avoiding a certain area.

13.6.448 The effect on seabirds refers to visual stimuli that may result in species disturbance, leading to changes in normal behaviour, including avoiding or being attracted to certain areas that otherwise would not occur. This could result in the range and distribution of seabirds being constrained and the potential for decreased fitness and productivity. Potential effects could range from temporary disturbance to brooding or foraging adults being regularly delayed from returning to eggs or chicks.

13.6.449 The scale of effect of visual disturbance on seabirds can vary between species and stimuli, and some species appear to become habituated to regular disturbance [RD166]. As discussed in paragraph 13.6.387, Garth and Hüppop [RD155] concluded that Sandwich tern, common tern and Arctic tern are relatively tolerant of disturbance when in flight at sea.

Effects on target species

13.6.450 At nest sites, terns can be susceptible to visual disturbance, notably in the form of human presence in close proximity to nest sites [RD154] and unaccustomed movement along the skyline (when viewed from nest sites). Common terns frequently make mass out-flights when a threat is perceived, especially early in the process of settlement at a breeding site [RD167].

13.6.451 There are a number of studies that provide information on the thresholds at which tern species would start to exhibit behaviour associated with visual disturbance. Erwin [RD168] described how nesting colonies of least terns (*Sternula antillarum*) were found to exhibit a flight response when people were 70m away and recommended 100m buffer zones to offset disturbance to least terns and royal terns (*Thalasseus maximus*), and 200m for common terns. Other studies on terns have identified a flight response at distances of 20m [RD169] and 28m [RD170] for least terns, 31m for Caspian terns (*Hydroprogne caspia*) and 24m for Forster's tern (*Sterna forsteri*) [RD170]. [RD154] advised that 'larger' parties of people should be restricted to 300m to avoid disturbance to the most sensitive species of birds at sensitive times of year. These studies are of similar species but not specifically of Sandwich terns; also these studies primarily consider the effect of the presence of people, which represent a predatory threat to terns, as opposed to large-scale machinery. Therefore, a precautionary factor of safety has been applied to these published disturbance buffers and a value of 500m has been adopted as the distance beyond which it is considered unlikely that changes in visual stimuli during construction would affect target species of seabirds.

13.6.452 Activity associated with the construction works would extend into the Anglesey Terns/Morwenoliaid Ynys Môn SPA, but it would not encroach the breeding colony at Cemlyn Lagoon. The nearest point to the nesting islands at which works could take place is approximately 520m away. There is potential for the operation of machinery and personnel to disturb breeding terns if present within 500m of the colony, or if sightlines exist between the breeding colony and the proposed working areas.

13.6.453 The breeding terns at Cemlyn Bay attract daily visitors throughout the months of April to July, for example in 2016 approximately 3,064 people visited the site during this period [RD54]. Although visitor numbers were down by 32%, compared with 2015 [RD54], it is clear that the April to July period represents the annual peak in visitor numbers to the site, due to the terns' presence. In monitoring of baseline disturbance in May and June 2017, an average of 12 visitors an hour was recorded over 76 hours of monitoring, with a peak of 18 per hour. During this, no disturbance was caused to the birds during normal visiting behaviour i.e. staying behind the shingle ridge at approximately 50m from the tern and black-headed gull colony. Visitors park either side of the lagoon and walk along the shingle ridge that runs across the northern boundary of the lagoon, with some visitors staying overnight in the car parks. At its closest point the ridge is approximately 40m from the breeding islands. People and dogs approaching the colony closer than the top of the ridge did however cause fly up reactions from the colony.

13.6.454 The proposed construction works will bring a high number of visual changes to the area. The extent of visual change with potential to affect the terns (either at the colony or at sea) is not likely to generate levels of visual disturbance significantly above existing background levels (i.e. in terms of potential disturbance to terns, they would be consistent with disturbance generated by other industrial, agricultural and recreational activities that are routinely undertaken in the local landscape, and would be unlikely to be greater than visual disturbance generated by e.g. visitors and walkers utilising public rights of way and accessing the shingle ridge).

13.6.455 Terns and breeding black-headed gulls may also be sensitive to the use of lighting at night. With the exception of the main site compound and marine developments, work areas would not be required to be illuminated at night. The proposed MOLF and breakwaters are located over 1km from the breeding colony. As such, the effects of lighting on terns and breeding black-headed gulls, which do not normally fly or actively feed at night, are not considered likely to result in anything more than negligible change and are therefore negligible.

13.6.456 There is also potential to disturb terns that are actively feeding or in flight within and immediately adjacent to the construction site, with unobstructed views of construction activities. These terns may react to unexpected visual stimuli by diverting their flight or avoiding an affected area. Despite the ability of terns to deviate without significant energetic costs, the duration of the works in Porth-y-pistyll (two years) would increase the overall distance of flight paths between the colony and feeding grounds. This could lead to increasing energy demands which could affect individual fitness and breeding success of terns.

13.6.457 Both land-based and boat-based baseline surveys of terns from the Cemlyn Bay colony revealed insignificant use of Porth-y-pistyll for feeding. This work also showed that the majority of Arctic and common terns fly northwards and out to sea, whereas Sandwich terns fly along the coast to preferred foraging grounds to the east (see appendix D13-7, Application Reference Number: 6.4.89).

13.6.458 In July 2016, tern behaviour was monitored during the offshore ground investigation works in Porth-y-pistyll (see appendix D13-7, Application Reference Number: 6.4.89). These works required the use of two jack-up rigs, one smaller rig within the intertidal area and a larger rig within the subtidal area. Sandwich tern was the only tern species observed during the surveys and approximately 300 flights were recorded involving approximately 500 birds. Results indicate that birds whose chosen flight path would have taken them straight at/over a rig tended to deviate either horizontally by up to approximately 200m, or vertically by up to approximately 30m, to bypass the rig. Some birds showed no deviation at all and flew immediately adjacent to or directly over the rig. Birds whose flightpath did not take them directly to or close to the rig showed no obvious deviations (see appendix D13-7, Application Reference Number: 6.4.89). These observations indicate that terns can easily deviate from their flight path in response to a sudden disturbance without experiencing a significant energetic burden; this is unsurprising given the high manoeuvrability of terns and their propensity to actively feed, fly and forage across considerable areas.

13.6.459 It is considered that the proposed works would be extremely unlikely to significantly disturb birds flying over the sea, especially when considered in context of the size of the SPA (101,931ha) and the propensity of terns to make use of this entire resource. Therefore, the magnitude of change is predicted to be negligible and the effect on target seabird species from changes in visual stimuli during the construction phase, also negligible.

Effects on secondary species

13.6.460 A total of 19 secondary seabird species were recorded using (i.e. roosting, loafing and/or foraging) VP1 (the survey area in which Porth-y-pistyll is located) during the VP surveys. Seven secondary seabird species were recorded using the intertidal zone surveys at Porth-y-pistyll. The majority of the species recorded in high numbers in this location use the bay during winter for roosting and loafing due to its sheltered location (see appendix D13-7, Application Reference Number: 6.4.89). Seabirds that regularly use Porth-y-pistyll for foraging, such as gulls, cormorants and common auks, were generally recorded in lower numbers.

13.6.461 The majority of seabird species that were recorded regularly using Porth-y-pistyll for roosting and loafing (i.e. herring gull, lesser black-backed gull, common gull, black-headed gull and great black-backed gull) are considered to be relatively tolerant of disturbance, as according to Garth and Hüppop [RD155] these species have a low sensitivity value.

13.6.462 Sensitive species that use Porth-y-pistyll for roosting and loafing, such as cormorant and auks, may be displaced due to an increase in visual stimuli. However, similar relatively undisturbed, habitats are available for any displaced individuals.

13.6.463 The vegetated cliffs at Porth Wnal to the north of the Wylfa Newydd Development Area support a breeding gull colony of herring gull, lesser black-backed gull and great black-backed gull. Visual disturbance of the gull colony is likely to be limited to construction activities associated with the excavation and construction of the cofferdam and Cooling Water outfall structures although flying and actively searching adults may also be disturbed by construction activities in Porth-y-pistyll. These species are considered to be relatively tolerant of disturbance and are therefore likely to habituate to the disturbance.

13.6.464 Secondary species of seabirds that can be active at night (as well as by day), such as shearwaters and storm-petrels could potentially be affected by the use of lighting at night. Of these species, only Manx shearwater has been regularly recorded within the VP survey areas, although no nocturnal surveys have been conducted. Juvenile Manx shearwaters (and storm-petrels) can be attracted to strong light sources during their first flight away from the natal colony, usually only during bad weather [RD172]. Light sources (e.g. lighthouses, coastal town lights) near shearwater/storm-petrel colonies can disorientate juvenile birds, attracting them towards the light source and put them at risk of collision with nearby buildings or the light source itself. Sources of light further away (>20km) from shearwater/storm-petrel colonies do not normally effect birds in the same way as light sources closer to the colonies - the effect is localised to some extent. The only UK colonies from which juvenile birds are likely to migrate past the Wylfa area are the Copeland Islands (off the east coast of Northern Ireland) and the Calf of Man (the south of the Isle of Man). These colonies are situated approximately 150km and 70km from the construction site. Young Manx shearwaters from the Scottish colonies (primarily on Rhum and St. Kilda) normally migrate down the west coast of Ireland and not through the Irish Sea. By the time juvenile birds from the Copeland Islands and Calf of Man colonies have reached the Wylfa area, their migration flight will be well underway and the birds will typically be past the stage of being vulnerable to disorientation effects of artificial light sources.

13.6.465 Visual disturbance during construction would be noticeable but would occur intermittently and therefore the magnitude of change is predicted to be small. It is likely that most species will habituate to the majority of disturbances and adequate resources are available for any displaced individuals in the vicinity of the construction site. As such it is considered that the magnitude of change is predicted to be negligible and the effect on secondary seabird species from changes in visual stimuli during the construction phase, also negligible.

Effects on designated sites

13.6.466 The effects of visual disturbance have been considered in relation to terns, which are features of the Anglesey Terns/Morwenoliaid Ynys Môn SPA. The assessment determined that there would be a negligible effect on terns as a result of visual disturbance during the construction phase and therefore there is a negligible effect on the Anglesey Terns/Morwenoliaid Ynys Môn SPA and Cemlyn Bay/Bae Cemlyn SAC/SSSI.

Impact pathway: physical injury of marine mammals from vessel strikes

General context

13.6.467 Moving marine plant and vessels could strike marine mammals, resulting in physical injury (e.g. corkscrew injuries) and, in the worst case, mortality [RD173].

13.6.468 Marine construction would require plant (e.g. drilling rigs, cranes and dredgers), barges, work boats and safety boats to be brought to site with movement occurring within the Wylfa Newydd Development Area during the construction phase. Once the Marine Works are complete and the MOLF is operational, there would be continued marine traffic from vessels transporting materials, equipment and parts required for the construction of the Power Station.

13.6.469 Marine mammals are considered to be agile species possessing quick reflexes, good sensory capabilities and fast swimming abilities (over 6m/s for harbour porpoise) [RD174]; [RD175]. However, there have been a number of reported incidents of mortality or injury of cetaceans from vessel strikes in UK waters [RD176]. In addition, several cases of seal injury, thought to be caused by propellers and thrusters (used for the dynamic positioning of vessels), have also been reported in recent years [RD177]; [RD178].

13.6.470 Marine mammals are relatively robust to potential strikes as they have a thick subdermal layer of blubber which would protect their vital organs from minor strikes or collisions [RD179]. Consequently, incidents of mortality or injury of marine mammals caused by vessels are recognised as being a very rare occurrence in UK waters [RD180]; [RD181]. However, a direct strike from a sharp object such as a moving blade would have significant potential to cause injury to marine mammals. Juvenile grey seal pups, which are inexperienced in the water, are likely to be particularly vulnerable to vessel strikes. Inquisitive species such as bottlenose dolphins would also be vulnerable. Marine mammals distracted by activities such as foraging and social interactions may not perceive the threat of moving vessels and could therefore be vulnerable to vessel strikes [RD179].

13.6.471 Although all types of vessels may collide with marine mammals, the most lethal and serious injuries are caused by large ships (e.g. 80m or longer) and vessels travelling at speeds faster than 14 knots [RD182].

Effects on marine mammals from vessel strikes

13.6.472 Prior to construction and on completion of the Marine Works, marine plant and vessels would be required to transit to/from the Wylfa Newydd Development Area. The numbers of vessel are small in comparison to the vessel density in the wider area of up to 25 vessels per week [RD183]. Once on-site, much of the marine plant would be stationary for long periods of time or travelling at relatively slow speeds. Work boats and safety boats may travel at faster speeds but movement would generally be limited to the Wylfa Newydd Development Area. Marine mammals have been recorded in low abundance here and given the likely occurrence of other disturbance effects (e.g. underwater noise), displacement of individuals from the area is probable. The risk of vessel strikes from marine plant and vessels transiting to site and once on-site is therefore considered to be negligible.

13.6.473 During operation of the MOLF, vessel movement within the area would be expected to occur on average twice a day although, for most of the time, there would be fewer movements than this. Marine traffic would be comprised of primarily large slow moving vessels required to transport general equipment, cement and aggregate. Considering the slow travelling speeds of these vessels, the likelihood of marine mammal strikes is considered to be low and therefore the magnitude of change is predicted to be negligible and the effect on marine mammals from vessel strikes is negligible.

Effects on designated sites due to the physical injury of marine mammals from vessel strikes

13.6.474 As outlined in paragraph 13.6.472, the effect on marine mammals from vessel strikes is considered to be negligible. There would also be a negligible effect on designated sites for which marine mammals are a qualifying feature.

Operation

Impact pathway: impingement of marine organisms

General context

13.6.475 During operation, Cooling Water would be abstracted from the sea, and biota such as fish and invertebrates would be at risk of being drawn into the CWS. The CWS design incorporates fish protection measures, including deterrents, coarse and fine screens on the intake, and a fish and invertebrate recovery and return system (see 13.5.96 for a detailed description of these measures). Fish and invertebrates small enough to pass through the CWS coarse screens, but large enough to be impinged on the fine screens, would be taken through the recovery and return system before being discharged back to the sea. It is during these stages of impingement and subsequent handling that fish and invertebrates would be most vulnerable to mortality.

13.6.476 The impingement process exposes biota to a range of stresses including mechanical effects (such as impacts from falling onto hard structures and abrasion), increased predation risk and emersion. On return to ambient conditions (i.e. once discharged from the recovery and return system), damaged and disorientated organisms may also be vulnerable to predation [RD184]. It has long been recognised that large numbers of organisms are impinged by power plants and that the mortalities incurred might cause ecological harm over wide temporal or spatial scales [RD184].

13.6.477 The susceptibility of biota to impingement on Cooling Water intake screens depends on factors such as water temperature, the life stage of the organism, species-specific hearing ability and swimming ability. Once impinged, the subsequent survival of biota depends on the life stage and their tolerance of stressors experienced and the effectiveness of the return and recovery system. Early life stages of fish and invertebrates and other small planktonic organisms are unable to swim against the intake currents and are therefore particularly at risk of being drawn into the CWS. Owing to their small body size they would pass through the fine screen mesh to form the entrained component (see paragraph 13.6.544).

Impingement at the Existing Power Station

13.6.478 Fish and invertebrate impingement data are available for the Existing Power Station, from both historical (i.e. from 1985 to 1987, [RD26] and recent surveys (see appendix D13-10, Application Reference Number: 6.4.92). These data have been used alongside fish and invertebrate population data from the surrounding waters (where necessary, e.g. for less common species that may not have been present in the impingement survey data) to produce annual impingement predictions for the Power Station.

13.6.479 The CWS intake will be in a more sheltered location further south along the coastline, compared to the Existing Power Station intake. It is acknowledged that communities may differ between the two localities and therefore the abundance, biomass and species complement impinged may differ from that predicted. It is not possible to quantify or predict exactly what these differences might be, if any, and therefore impingement predictions have been based on existing data for the area. The assessment of impingement effect does however consider qualitatively, possible differences between the two localities and how these may influence impingement predictions.

13.6.480 The construction works would alter the habitat within Porth-y-pistyll (e.g. from habitat loss and physical disturbance), which may affect the communities present and therefore the species vulnerable to impingement. Furthermore, fish and invertebrate communities may change over the operational lifetime of the Power Station in response to climate change. It is not possible to quantify or predict exactly if or how communities might change and therefore impingement predictions are based on existing data for the area. The assessment of impingement effect does however consider qualitatively, possible community changes within Porth-y-pistyll and how these may influence impingement predictions.

Predictions

13.6.481 Impingement results from the most recent 2011 to 2012 impingement surveys on the Existing Power Station have been scaled up to a tidally averaged abstraction rate of 126m^3/s. This value includes 5% contingency and represents the most realistic worst case. Fish and invertebrate abundances have been extrapolated from numbers of individuals per m^3 sampled in the impingement surveys during each month and then summed to give an annual prediction, allowing for changes in abundances owing to seasonality. It is noted that these numbers are indicative and are presented to support the assessment.

13.6.482 It is recognised that the intake design of the Existing Power Station does not meet current best practice; therefore, predictions are likely to be worst case. The new intake at the Power Station would be designed to reduce impingement of fish and invertebrates (see paragraph 13.5.70) and increase survival through the recovery and return system.

13.6.483 Whilst studies have been undertaken at other power stations to investigate the efficiency of AFD and fish and invertebrate recovery and return systems, the design of the CWS (including these mitigation measures) is ongoing and therefore efficiencies for the Power Station can only be inferred. In the absence of this information, the assessment has taken a precautionary approach assuming 100% mortality. However, estimated efficiencies associated with low approach velocities, the AFD and the fish and invertebrate recovery and return system, have been applied where applicable, in order to demonstrate how these embedded mitigation measures could lower annual impingement predictions and mortality of fish and invertebrates.

Effects of impingement on intertidal and subtidal habitats and communities (including invertebrates of conservation and commercial importance)

13.6.484 Impingement of benthic invertebrates may result in mortality as a result of mechanical damage and abrasion. Emersion may also be a factor, however many species, such as those that inhabit the intertidal zone, are robust and adapted to survive out of water for short periods of time.

13.6.485 Estimated losses of benthic invertebrates have been quantified, although owing to the practicalities of enumerating some individuals (e.g. colonial organisms or those that are very small) the invertebrate data used refer to crustaceans and molluscs only. Obtaining fully quantitative data for some species of crustacean and mollusc was also not possible; therefore, the lists of taxa presented here are not exhaustive. Fauna from the other groups (e.g. sponges, polychaete worms) also likely to be impinged are summarised in appendix D13-10 (Application Reference Number: 6.4.92).

13.6.486 In terms of crustaceans, pink shrimp (*Pandalus montagui*) and edible crab (*Cancer pagurus*) are predicted to be impinged in the highest abundances each year (based on abundance in existing data). For molluscs, the most abundant species impinged are likely to be edible mussel (*M. edulis*) and little cuttle (*Sepiola atlantica*). Around 40 to 50 species of each phyla (crustaceans and molluscs) are likely to be impinged at the CWS intake annually (Table D13-28).

Table D13-28 Estimated numbers of crustaceans and molluscs impinged per year, extrapolated to 126m^3/s. Numbers over 100 are presented to two significant figures. Species shaded grey represent 95% of the catch by number

Crustaceans	Total	Molluscs	Total
Pandalus montagui	880,000	*Mytilus edulis*	680,000
Cancer pagurus	220,000	*Sepiola atlantica*	35,000
Palaemon serratus	98,000	*Musculus* sp.	6,400
Mysidae	49,000	*Eledone cirrhosa*	5,600
Pasiphaea sivado	26,000	Anomiidae sp.	5,600

Crustaceans	Total	Molluscs	Total
Necora puber	23,000	*Loligo* sp.	4,100
Pilumnus hirtellus	21,000	*Nucella lapillus*	3,600
Liocarcinus sp.	17,000	Pleurobranchaeidae	2,600
Macropodia sp.	13,000	*Helcion pellucidum*	1,900
Liocarcinus holsatus	10,000	*Nassarius reticulatus*	1,200
Inachus sp.	9,700	Gibbula sp.	1,200
Processidae sp.	8,300	Patellidae sp.	1,000
Pandalina brevirostris	7,000	*Pecten maximus* (juv.)	960
Gammarellus sp.	5,300	*Trivia arctica*	720
Carcinus maenas	5,000	*Archidoris pseudoargus*	710
Pisidia longicornis	3,300	*Aequipecten opercularis*	620
Crangon crangon	3,300	*Onchidoris bilamellata*	590
Liocarcinus depurator	1,600	*Buccinum undatum*	590
Isopoda indeterminate	1,500	Nudibranch indeterminate	520
Pinnotheridae	670	Pectinidae	500
Hyas sp.	640	*Trivia monacha*	230
Galathea sp.	600	*Littorina littorea*	150
Paguridae sp.	490	*Gastropoda* sp.	130
Shrimp indeterminate	440	*Flabellina* sp.	120
Corophiidae	330	Bivalvia indeterminate	94
Crab indeterminate	260	*Aplysia punctata*	77
Porcellana platycheles	230	Aeolidia sp.	46
Pagurus bernhardus	210	Trivia sp.	37
Hippolytidae	200	*Janolus cristatus*	30
Processa edulis edulis	190	*Aeolidia papillosa*	28
Hyperia galba	180	*Patella vulgata*	17
Pycnogonida	150	Tellinoidea	15
Crangon allmanni	130	*Velutina velutina*	15
Homarus gammarus	120	*Dendronotus frondosus*	15
Galathea squamifera	110	*Facelina* sp.	12
Pisinae sp.	100	Opisthobranchia	12
Gammaridae	94	*Philine aperta*	12
Hyas coarctatus	92	*Polycera quadrilineata*	12
Maja squinado	86		
Hyas araneus	77		
Pirimela denticulate	75		
Caprellidae	74		
Hippolyte varians	68		
Megalopa	58		

Crustaceans	Total	Molluscs	Total
Palaemon elegans	47		
Galathea strigose	35		
Caprella linearis	30		
Dromiidae	24		
Eualus occultus	23		
TOTAL	1,400,000	TOTAL	760,000

13.6.487 Taking into consideration the life history characteristics of the crustacean and mollusc species listed in Table D13-28 (i.e. short-lived and high fecundity) and their widespread abundance, the number predicted to be impinged annually (assuming an unmitigated system) is considered low in comparison to experience from other stations.

13.6.488 There is no significant commercial fishery for pink shrimp around the coast of Anglesey (ICES rectangle 35E5) [RD25] although this species is an important target species for fisherman operating in Cardigan Bay. Fishing pressure on shrimp and prawn populations within the Irish Sea is generally low [RD25] and therefore impingement at the Power Station is unlikely to affect local populations and wider commercial fisheries.

13.6.489 Edible crab was commonly impinged at the Existing Power Station and therefore annual impingement predictions for the Power Station are reasonably high. A commercial fishery for edible crab is present around the coast of Anglesey (ICES, rectangle 35E5), although within the vicinity of the Wylfa Newydd Development Area, this is classified as low intensity (less than two pots lifted and dropped per hectare per day), with higher intensity areas identified to the east [RD28]. Around six tonnes of edible crab are reported to be landed from coastal waters around Anglesey annually (2010-2014 average) [RD25]. Edible crab is known to be highly abundant; low commercial landings are likely to reflect the poor retail price of this species and are not indicative of local population sizes.

13.6.490 Annual impingement predictions based on data from the Existing Power Station are believed to overestimate impingement of edible crab at the new Power Station as abundances within Porth-y-pistyll are anticipated to be lower than those observed along regions of more exposed rocky coastline. Considering this and the low commercial fishing pressure operating in the area, it is unlikely that impingement would affect populations and wider commercial fisheries.

13.6.491 Scallop, whelk and lobster are also targeted by commercial and recreational fishing around the coast of Anglesey, although the intensity of activities within the vicinity of the Wylfa Newydd Development Area is low [RD28]. Impingement of these taxa at the Power Station is predicted to be low (<1,000 of each taxa per year).

13.6.492 The high abundance of edible mussel within impingement samples at the Existing Power Station has been attributed to the settlement of young juveniles (spat) within the CWS which became dislodged either by operations or by natural process such as storms or waves, and subsequently impinged.

The predicted impingement of *M.edulis* should therefore be interpreted with caution as this is not considered to represent a true effect on natural populations. The biofouling regime at the Power Station is likely to influence the settlement of spat and vulnerability of this species to impingement.

13.6.493 It is possible that species characteristic of the lower intertidal zone such as common shore crab (*Carcinus maenas*) may be more prevalent in impingement catches than predicted. Gastropod molluscs (e.g. *Patella vulgata* and *Gibbula umbilicalis*), which are currently at the northern limit of their extent on the west coast of Anglesey, may also become more prevalent due to climate change. Slightly higher possible impingement rates for some species will likely be offset by lower than predicted impingement of other species (e.g. edible crab). Any changes are therefore unlikely to alter the overall magnitude of impingement predicted for benthic invertebrates.

13.6.494 Based on the numbers presented here for an unmitigated system, effects of impingement on benthic invertebrates including commercial catches (e.g. scallop, whelk and lobster), would be minimal. The predicted impingement of edible crab (based on survey data from the Existing Power Station) whilst reasonably high, is considered to overestimate the impact on this species. Considering this and the low commercial fishing pressure operating in the area, it is unlikely that impingement would affect populations and wider commercial fisheries. The magnitude of change is therefore predicted to be small and the effect of impingement on subtidal and intertidal habitats and communities, including invertebrates of conservation and commercial importance, is predicted to be negligible.

13.6.495 In terms of mortality through the impingement process, survival rates for crustaceans are good (>80%) [RD80]. Studies undertaken at Pembroke Power Station have shown that prawns and shrimps exhibit 86% and 99% survival 24 hours post-capture respectively, and crabs and spider crabs exhibit 81% and 100% survival, respectively [RD189]. It is expected that many molluscs will also exhibit high survival rates as most have the protection of a shell and many are able to close their shells (bivalves) or operculum (gastropods) to survive emersion.

13.6.496 Once invertebrates have been returned to the sea, they could be at risk of predation from predatory fish and seabirds attracted to the area around the discharge of the recovery and return system due to an artificially increased abundance of (possibly compromised) prey. However, if the invertebrates are in a viable condition, many would have a good chance of survival.

Effects of impingement on marine fish

13.6.497 During the impingement process, fish are vulnerable to mortality through mechanical effects (such as impacts from falling onto hard structures and abrasion), increased predation risk (e.g. from crabs once in constricted areas) and emersion.

13.6.498 Over 60 species of fish from all habitat guilds (pelagic, proximo-benthic and benthic) are at risk of impingement at the CWS intake. Pelagic species such as sprat, sand smelt and herring are predicted to be impinged in the highest abundances each year (see 13.6.498). Impingement of fish would be expected to peak during the winter when it is likely higher numbers of sprat, herring, dragonets, scorpion fish and lesser-spotted dogfish would be impinged.

Table D13-29 Annual fish impingement catches extrapolated to 126m^3/s. Abundances/biomass over 100 are displayed to two significant figures. Species shaded grey represent 95% of the catch by number

Common name	Number	Biomass (kg)	Common name	Number	Biomass (kg)
Sprat	54,000	77	Butterfish	150	1
Sand smelt	18,000	51	Short-spined sea scorpion	140	4
Herring	7,600	43	Grey gurnard	140	0.2
Long-spined sea scorpion	6,200	98	Leopard-spotted goby	130	0.2
Whiting	5,700	34	Thornback ray	130	1
Five-bearded rockling	5,400	110	Tadpole fish	120	10
Common dragonet	5,300	26	John Dory	120	1
Pogge	4,500	52	Two-spot goby	94	0.1
Pollack	4,200	290	Bass	80	54
Lesser-spotted dogfish	3,400	1,400	Northern rockling	64	0.3
Lesser weever	3,000	14	Solenette	49	0.1
Dragonet	2,800	3	Tompot blenny	48	1
Fifteen-spined stickleback	2,700	8	Striped sea snail	47	0.3
Greater pipefish	1,900	9	Sea snail family	41	0.2
Lesser sandeel	1,800	12	Ling	41	0.04
Poor cod	1,800	22	Topknot family	41	0.2
Dab	1,600	41	Montagu's sea snail	40	0.2
Cod family (Gadoid indeterminate)	1,100	2	Spotted dragonet	35	0.2
Corkwing wrasse	1,000	28	Red gurnard	35	1

Common name	Number	Biomass (kg)	Common name	Number	Biomass (kg)
Ballan wrasse	960	150	Dover sole	35	6
Plaice	730	28	Common goby	35	0
Shanny	680	4	Conger eel	32	53
Sandeel	680	12	Blenny family	29	0.03
Herring family	640	1	Flounder	28	6
Indeterminates	420	1	Sea scorpion family	28	0.03
Pouting	410	7	River lamprey	23	1
Cod	400	70	Pearlside	17	0.02
Scaldfish	340	3	Horse mackerel	17	0.1
Snake pipefish	340	4	Haddock	15	0.05
Pipefish family	330	0.4	Grey mullet family	15	22
Goby family (Gobiidae)	320	0.3	Three-spined stickleback	15	0.03
Reticulated dragonet	320	2	Cuckoo wrasse	15	1
Lumpsucker	300	37	Spotted ray	15	15
Saithe	280	26	Golden grey mullet	12	11
Rock goby	280	1	Gurnard family	12	0.01
Nursehound	260	92	Poor cod family	12	0.02
Three-bearded rockling	260	24	Transparent goby	12	0.01
Rock cook	250	1	Wrasse family	12	0.01
Sand goby	240	0.4	Dogfish family	12	0.02
Thick-lipped grey mullet	220	240	Nilsson's pipefish	12	0.01
Goby sp. (*Pomatoschistus* sp.)	200	0.2	Total abundance	143,000	

Common name	Number	Biomass (kg)	Common name	Number	Biomass (kg)
Goldsinny wrasse	200	3	Total biomass		3,200

13.6.499 Species of conservation concern are known to be present in the area and are vulnerable to impingement. Of these, only three species (nursehound, thornback ray and cod) are expected to be impinged in low numbers based on data from the Existing Power Station. River lamprey and European eel have both been recorded historically within impingement catches at the Existing Power Station [RD26] whilst sea trout is known to be present in the vicinity of the Wylfa Newydd Development Area. These species are considered at very low risk of impingement, with a likely abundance in the order of tens per year. All other species of conservation importance (including Atlantic salmon) are expected to have a very low rate of impingement.

13.6.500 In terms of commercial species, in addition to sprat and herring described earlier the following are at risk of impingement:

- plaice;
- Dover sole;
- whiting;
- cod;
- haddock; and
- bass.

13.6.501 Haddock, Dover sole and bass would likely be impinged in very low numbers (less than 100 per year), even without embedded mitigation. Sprat, herring and whiting could be caught in numbers of around 54,000, 7,600 and 5,700 per year, respectively.

13.6.502 Approximately 87% of all fish species impinged during the surveys at the Existing Power Station were 11cm or below (standard length) which is the smallest minimum landing size for a fish species, based on pilchard (*Sardina pilchardus*) as stipulated by the Council Regulation (EC) No. 850/98. Historically, impingement of fish at the Existing Power Station has been assessed as very low; it remains lower than at other UK power stations and has been assessed as not posing a threat to commercial stocks [RD26].

13.6.503 To allow impingement predictions (based on an unmitigated system) to be contextualised against commercial fish landings they can be converted to potential equivalent adult values (EAVs) (see paragraph 13.6.569). Table D13-30 presents the equivalent number of the following predicted to be impinged annually as a proportion of the most recent international landing estimates:

- adult whiting;
- plaice;
- Dover sole;

- herring;
- sprat; and
- bass.

13.6.504 Information on commercial fishing efforts for whiting, plaice and Dover sole within the Irish Sea (ICES assessment division VIIa) is provided by the ICES Working Group for the Celtic Sea Ecoregion [RD186] whilst the ICES Herring Assessment Working Group [RD187] provide landing statistics for herring in the northern Irish Sea (ICES assessment division VIIaN). Limited commercial fishing for sprat occurs in the Irish Sea; the nearest and most reliable sprat landing statistics are reported for the English Channel (ICES assessment division VIId-e). ICES does not publish commercial landing statistics for Irish Sea bass stocks specifically [RD186] although Welsh landings for 2015 have been reported [RD188]. Whilst it is acknowledged that coastal waters around the north coast of Anglesey are important for recreational fishing of bass, reliable estimates of recreational landings are not available and therefore no quantitative comparison to impingement predictions has been made.

Table D13-30 Predicted impingement EAVs as proportion of commercial landings.

Species	Weight at 50% maturity	Stock	Condition of stock	Latest landings (tonnes)	Proportion of landings
Whiting	[RD189] [RD190]	Irish Sea (VIIa)	Undefined	73 (2014)	0.07%
Plaice	131g [RD191] [RD190]	Irish Sea (VIIa)	Stock size increasing	1,005 (2015)	0.01%
Dover sole	211g [RD192] [RD190]	Irish Sea (VIIa)	Below reproductive capacity	76 (2015)	0.003%
Herring	109g [RD193]	North Irish Sea (VIIaN)	Full reproductive capacity	4,900 (2015)	0.003%
All clupeids as herring					0.0001%
Sprat	7g [RD194] [RD190]	English Channel (VIId-e)	Undefined	3,003 (2015)	0.01%
All clupeids as sprat					0.0001%
Bass	519g [RD195]	Welsh waters	Reduced reproductive capacity	61 (2015)	0.07%

13.6.505 For all species listed in table D13-30, the numbers of equivalent adults predicted to be impinged annually represent a tiny fraction (<0.1%) of those being removed by commercial fishing activities within the Irish Sea (and the English Channel in the case of sprat). Stocks of herring and plaice in the

Irish Sea and northern Irish Sea respectively are in good condition and therefore the biomass of equivalent adults predicted to be lost annually due to impingement (0.2 tonnes and 0.1 tonnes of herring and plaice, respectively) is unlikely to have a significant effect on wider stocks.

13.6.506 Stocks of Dover sole, whiting and sea bass within the Irish Sea are considered to be in poor condition. The biomass of Dover sole in the Irish Sea has shown a declining trend since the mid 1980s; the 2011 to 2014 recruitment was the lowest in the time series. Although a slight increase in recruitment was observed in 2015, populations remain below reproductive capacity. Although the Irish Sea whiting stock and exploitation pressure is currently undefined, the recent decline in fishery landings has been interpreted by ICES as a collapse in biomass. This has been attributed to poor recruitment and high discards (1,894 tonnes in 2014). The biomass of bass in the North Sea, English Channel, Celtic Sea and Irish Sea has also exhibited a decline caused by poor recruitment and continued high levels of fishing. Given that the biomass of equivalent adult Dover sole, whiting and bass predicted to be lost annually is very low (0.003 tonnes, 0.05 tonnes and 0.04 tonnes, respectively), impingement is unlikely to have a significant effect on the condition of these stocks.

13.6.507 The biomass of equivalent adult sprat predicted to be impinged annually represents the highest estimate of any species. The condition of stocks within the Irish Sea, Celtic Sea and English Channel is currently unknown. No significant commercial fishery for sprat exists within the Irish Sea and given the apparent abundance of this species, the biomass of equivalent adults predicted to be lost annually due to impingement (0.3 tonnes plus 0.003 tonnes assuming all clupeids are sprat) is unlikely to have a significant effect on wider stocks.

13.6.508 Other population metrics can also be used to contextualise impingement catches for species such as dab. Selsay [RD196] examined the population ecology of dab in the eastern Irish Sea, off the coast of north Wales. The survey area included Red Wharf Bay, Conwy Bay and the offshore grounds on the north Wales coast. The total survey area was $656km^2$, and the population of dab within this area was estimated to be $2.34x10^6$ individuals. The estimated number of equivalent adult dab potentially impinged annually at the Existing Power Station represented 0.02% of the local population.

13.6.509 Considering the design (i.e. onshore) and locality of the Cooling Water intake in Porth-y-pistyll (i.e. in a heavily modified, sheltered rocky bay), it is possible that fewer gadoids will be impinged than predicted based on entrapment surveys at the Existing Power Station. Taxa typically associated with soft sediments (e.g. flatfish, weeverfish and sandeel) may also be less prevalent in impingement catches than predicted. Conversely, species affiliated with inshore rocky habitats such as the following might be more prevalent within impingement catches than predicted:

- gobies;
- scorpionfish;
- sea snails;

- blennies;
- sticklebacks; and
- wrasse.

13.6.510 Once habitats and associated fish communities become re-established within the area following disturbance during the construction phase, species such as sprat, herring, sand smelt, rockling and lesser-spotted dogfish are likely to be a core component of impingement catches as predicted. The accuracy of impingement predictions for pelagic species such as sprat, herring and sand smelt however, is highly dependent. This can depend on recruitment success and the frequency of shoals within the vicinity of the Power Station intake can be driven by weather conditions (seeking shelter) or the presence of predators.

13.6.511 Over the operational lifetime of the Power Station, the distribution of Lusitanian species may shift northwards in response to increased sea temperatures due to climate change. It is therefore possible that species such as sprat, Dover sole and horse mackerel may become more prevalent in impingement catches than predicted whilst pilchard and anchovies, which are currently not predicted to be impinged, may also be present. A decline in the abundance of boreal species (e.g. herring, cod and plaice) impinged may also be observed as their distribution moves northwards or into deeper waters.

13.6.512 It is not possible to reliably quantify these potential temporal or spatial changes in fish communities and therefore the assessment of impingement effect has been based on existing data for the area. Slightly higher possible impingement of some species will likely be offset by lower than predicted impingement of other species and therefore any changes are unlikely to alter the overall magnitude of predicted impingement of fish.

13.6.513 With the inclusion of embedded mitigation, the number and biomass of fish impinged would be lower than predicted for an unmitigated system. The mortality of individuals that do become impinged would also be reduced.

13.6.514 The embedded mitigation includes:

- a low approach velocity (less than 0.3m/s) allowing fish to actively avoid impingement;
- the use of AFDs to deter fish from the area; and
- a fish and invertebrate recovery and return system.

13.6.515 Efficiency data for working examples of these protection systems are available (obtained from available literature and the survivability studies undertaken in 2015 and 2016 [RD185]. These efficiencies have been applied to impingement predictions to demonstrate how overall impingement effects on fish could be reduced.

13.6.516 The method used to determine those fish that will be able to swim away is based on size-class information and swimming performance at different water temperatures [RD197] and is based on the 'Fish Escape Model' [RD198]. The lengths of the individual fish impinged on the screens at the

Existing Power Station were used to estimate the efficiency of the low design approach velocity. In doing this consideration was given to the length of fish, and the water temperature at the time of impingement. The Fish Escape Model was then used to estimate whether the fish would be able to swim away from an approach velocity of 0.3m/s and therefore avoid impingement. The estimated efficiencies are shown in Table D13-31. It must be noted that these efficiencies are based on the size classes of fish observed through the entrapment monitoring at the Existing Power Station, and are not applicable for smaller individuals.

13.6.517 The efficiencies for acoustic deterrents are based on trials undertaken at operational power stations; Hartlepool [RD199]; [RD80] and Doel [RD200]. AFDs are most effective for pelagic species (that are hearing specialists as they possess a swim bladder e.g. herring) and least effective for benthic species (hearing non-specialists with reduced or no swim bladder e.g. flatfish).

13.6.518 The FRR system would be most effective for reducing mortality of benthic species such as flatfish, gobies, rocklings and dragonets (typically >80% survivability), whereas more delicate pelagic species would exhibit lower survivability (typically less than 10%); species such as sprat and herring normally suffer 100% mortality. However, the most recent studies at Pembroke Power Station showed the pelagic sand smelt to exhibit 30% survival through the screen handling and FRR [RD185]. Proximo-benthic species such as cod, whiting and gurnard would likely exhibit survival rates of between 50% and 80% [RD80].

Table D13-31 The estimated efficiency of low approach velocities in reducing impingement at the Existing Power Station, the efficiency of AFDs, and the efficacy of fish and invertebrate return and recovery systems

Species	Length range (mm)	Low velocity efficiency	AFD efficiency	Source of AFD trial data	Survival through return and recovery systems
Cod	60 – 390	>95%	55%	Hartlepool	65%
Poor cod	45 – 205	86%	55%	Hartlepool	65%
Pouting	55 – 140	>95%	55%	Hartlepool	65%
Whiting	20 – 275	53%	54%	Hartlepool	65%
Clupeid	20 – 105	73%	92%	Doel (avg.)	0%
Herring	30 – 230	>95%	95%	Doel	0%
Sprat	20 – 115	>95%	88%	Doel	0%
Dab	25 – 215	71%	16%	Hartlepool	80%
Flounder	235 – 270	>95%	38%	Doel	80%
Plaice	25 – 475	77%	16%	Hartlepool	80%
Grey mullet	310 – 540	>95%	76%	Doel	65%

Species	Length range (mm)	Low velocity efficiency	AFD efficiency	Source of AFD trial data	Survival through return and recovery systems
Sand smelt	30 – 140	90%	55%	Hartlepool	30%

Note: Sand smelt AFD efficiency based on Hartlepool gadoid data, as considered to be a hearing generalist; fish return efficiencies from percent survival figures and data from Jacobs 2016 [RD80].

13.6.519 The efficiencies of these measures when installed together, i.e. low approach velocity, acoustic deterrent and FRR, have been taken into consideration when assessing the effects of impingement on fish populations in the area.

13.6.520 A reduction in catch of greater than 76% of the original annual impingement total may be possible. As an approximation, if this reduction factor was applied to the extrapolated catch, this could potentially reduce the impingement mortality rate from around 143,000 (3.2 tonnes) to around 34,320 (0.8 tonnes) per year. The relatively high numbers of species such as sprat and sand smelt impinged will therefore be reduced considerably. Similarly, the mortality of commercial species would potentially be reduced. It is likely that the level of impingement will vary through the year reflecting the different life stages of fish and winter storm events, although this variability is accounted for within the assessment as the surveys were carried out throughout the year. As with invertebrates, once impinged fish have been returned back to the sea, there is a risk of predation e.g. from predatory fish and seabirds around the outfall. However, if they are in a viable condition, many would have an increased rate of survival.

13.6.521 Based on an understanding of the scale of loss of fish from impingement in relation to fish populations, the overall magnitude of change is predicted to be small on all marine fish receptors. The impingement of all fish receptors, including those of conservation and/or commercial importance is considered to be negligible.

Effects of impingement on marine mammals

13.6.522 Marine mammals are very unlikely to be at risk of impingement owing to the low approach velocities embedded into the design of the intake. In addition, coarse bar screens positioned upstream of the fine mesh screens would prevent marine mammals from entering the CWS.

13.6.523 Impingement of fish and invertebrates may have an indirect effect on marine mammals in the area through a reduction in their prey populations. Harbour porpoise and grey seal are the most common marine mammal species around the north coast of Anglesey and would likely be most affected. Dietary equivalent modelling (using weight composition data) has been carried out to quantify the potential loss of food resources to harbour porpoise and grey seal as a result of fish impingement. Minke whale and bottlenose dolphin are also present but in much lower abundances and not all year round; impingement is unlikely to affect the wider food resources available to these marine mammals.

13.6.524 In the Irish Sea, harbour porpoise predominately prey upon gadoids (namely whiting and haddock) and herring [RD100]. Although sprat, blue whiting, cod, *Pollachius* sp., sandeel, horse mackerel, and Atlantic mackerel are also consumed, these are not considered to be key prey taxa (each contributing <2% to the overall weight of prey consumed). Harbour porpoise in the Irish Sea are not known to prey upon gobies and sand smelt although elsewhere these species are an important dietary component [RD201]; [RD202] [RD203]. The majority of fish targeted by harbour porpoise represent juveniles (<10cm) [RD100].

13.6.525 Grey seal feed on available inshore fish, cephalopods and crustaceans. In the Irish Sea, grey seal target a wide range of fish taxa including gadoids (namely whiting, *Trisopterus* sp., cod, rockling and *Pollachius* sp.), clupeids (i.e. sprat and herring), dragonet, sandeel, wrasse (*Labrus* sp.), flatfish (namely sole, plaice and dab), gurnards and rays [RD45]; [RD100]; [RD202]. Although other taxa including salmonids, conger eel, haddock, tadpole fish (*Raniceps raninus*), Atlantic mackerel, sandeel, goby, sea bass, sea bream (Sparidae), mullet (Mugilidae), as well as a number of other flatfish species (e.g. Lemon sole and long rough dab; *Hippoglossoides platessoides*) are also consumed, these are not considered key prey species (each contributing <2% to the overall weight of prey consumed). The majority of fish targeted by grey seal represent juveniles (<17cm) [RD100].

13.6.526 The dietary equivalents assessment for harbour porpoise includes all fish classified as Clupeiformes, Gadiformes and Perciformes. The dietary equivalents assessment for grey seal also considers Pleuronectiformes, Scorpaeniformes, Anguilliformes, Salmoniformes and Rajiformes. This broad taxonomic approach is considered precautionary, taking into consideration the degree of uncertainty associated with dietary analysis as well as possible geographical and seasonal variations in dietary composition.

13.6.527 A single harbour porpoise consumes between 4% and 9.5% of its body weight daily [RD204]; [RD205]. Assuming an average adult weight of 45kg to 60kg [RD206], harbour porpoise are predicted to consume between 1.8kg and 5.7kg per day. This is equivalent 657 kg to 2,081 kg per year. Of the overall weight of fish predicted to be impinged annually (based on an unmitigated system), 40% represents fish belonging to the three taxonomic orders outlined above and would therefore represent a possible food resource for harbour porpoise. This would feed the equivalent of one to two harbour porpoise per year.

13.6.528 Based on a mean adult weight of 194kg, a grey seal will consume approximately 4.6kg per day [RD100]. This is equivalent to 1.7 tonnes per year. Of the overall weight of fish predicted to be impinged annually (based on an unmitigated system), 51% represents fish belonging to the eight taxonomic orders outlined above and would therefore represent a possible food resource for grey seal. This would feed the equivalent of one to two seals per year.

13.6.529 Embedded mitigation would reduce the impingement and possible mortality of fish prey species, thereby reducing the indirect effect on marine mammals.

13.6.530 Considering the quantity of food resource lost in relation to the food requirements of harbour porpoise and grey seal populations, the magnitude of change is predicted to be negligible and it is therefore considered that the effect on marine mammals from impingement would be negligible.

Effects of impingement on seabirds

13.6.531 The impingement of fish could have an indirect effect on seabirds through a loss of food resource. Dietary equivalents modelling (using bioenergetic data) has been carried out to quantify the potential loss of food resources to terns, which are features of the Anglesey Terns/Morwenoliaid Ynys Môn SPA. Dietary equivalents modelling (using generic bioenergetic data) has also been used to quantify the potential loss of food resources to other seabirds. The indirect food resource loss to primary and secondary seabird receptors has been considered collectively and assigned a value of high.

13.6.532 Clupeids and sandeel are known to be the principal prey species of terns, representing between 78% and 95% of the overall diet of adults and chicks [RD207]; [RD50]; [RD208]; [RD209]. The majority of individuals consumed represent juveniles [RD50]. It is likely that gadoids (e.g. rockling) as well as invertebrates and cephalopods make up the remaining diet of terns although the relative contribution of these prey types is uncertain. For the purpose of the assessment, only sandeel and clupeids have been considered.

13.6.533 Using information regarding feeding ecology and energy requirements [RD210]; [RD211]; [RD50]; [RD54], it is estimated that during the breeding season (April-July), each adult Arctic, common and Sandwich tern needs to consume 9kg, 8kg and 9kg of sandeel and clupeids combined to meets its own energetic demands, respectively. Based on this, the estimated number of clupeid and sandeel predicted to be impinged during the breeding season would support 0.21, 0.24 or 0.22 adult Arctic, common or Sandwich terns, respectively.

13.6.534 A total of 1.9kg of sandeel and clupeids is predicted to be impinged during the tern breeding season (based on an unmitigated system). This equates to 0.01% of the diet of the tern populations of the Anglesey Terns/Morwenoliaid Ynys Môn SPA (calculations assume a five year mean population size: 1992–1996 for Arctic and common terns and 1993-1997 for Sandwich terns) during the breeding season. This figure is likely to be reduced owing to the presence of embedded mitigation measures.

13.6.535 In terms of secondary seabird species, the effects of impingement on their food source can be quantified in terms of total fish biomass removed by the Power Station. This is presented as a worst case (i.e. based on an unmitigated system and assuming all fish species are preyed upon by seabirds).

13.6.536 Camphuysen *et al.*, [RD212] undertook a study to investigate the number of seabirds that would be supported by fish discards from fishing vessels. Their figures (i.e. 4.5kJ/g as an average value for fish and a 1kg seabird basal rate requirement of 6.57×10^5kJ/y) provide a basis for assessing the number of seabirds that would be supported by the fish impinged at the Power Station. By applying these values to the potential annual impingement catch biomass of 3.2 tonnes, the potential loss of food resource from impingement equates to around 22 seabird equivalents per year. In reality this figure would be much lower, as a large proportion of the fish caught would either avoid impingement or would be returned alive, through the recovery and return system.

13.6.537 The biomass of clupeids and sandeel potentially impinged at the Power Station represents only 0.01% of that required to support the tern population of the Anglesey Terns/Morwenoliaid Ynys Môn SPA annually. In addition, the weight of fish predicted to be impinged would equate to the annual diet of 22 seabirds. Whilst fish impingement predictions assume 100% loss from the system, with embedded mitigation measures in place, a large proportion of fish are likely to either avoid or be deterred from the intake. Furthermore, a large proportion of those that are impinged are likely to be returned to the sea via the return and recovery system, becoming available prey again for seabirds. The magnitude of change is therefore predicted to be small and the effect on seabirds from impingement negligible.

Effects of impingement on designated sites

13.6.538 The indirect loss of food resource to marine mammals and seabirds due to impingement would have a further indirect effect on current and proposed designated sites for which they are qualifying features.

13.6.539 As described in the preceding sections on marine mammals and seabirds, impingement catches are only likely to represent a small proportion of the food requirements of the populations of terns of the currently newly designated Anglesey Terns/Morwenoliaid Ynys Môn SPA. Similarly, the fish biomass potentially impinged each year would equate to the annual diet of up to two harbour porpoises (within the North Anglesey Marine cSAC). As already stated, with embedded mitigation in place this impingement biomass is likely to be reduced further still with mortality of impinged fish predicted to be less than 8%.

13.6.540 The magnitude of effect on receptors which are qualifying features of designated sites is considered to be negligible. It is therefore considered that there would be a negligible magnitude of change and effect on current and proposed designated sites from impingement.

Impact pathway: entrainment of marine organisms

General context

13.6.541 During operation, Cooling Water would be abstracted from the sea, and fish, invertebrates and plankton would also be drawn (entrained) into the CWS. The CWS design incorporates fish protection measures, including fine mesh screens. However, ichthyoplankton (larval fish), phytoplankton (microscopic plants) and zooplankton (including partly planktonic animals such as invertebrate larvae and truly planktonic animals such as copepods) are small enough to pass through these screens. Once entrained, they would transit the entire CWS during which they would be vulnerable to mortality. Any marine organisms entrained would be returned to the sea via the Cooling Water discharge.

13.6.542 Passing through a CWS exposes planktonic organisms to a range of stressors, including pressure and temperature differentials, mechanical effect and abrasion, hydraulic shear stress and biocide toxicity (chlorine and its derivatives). On return to ambient conditions of temperature and pressure, damaged and disorientated organisms may also be at an increased risk of predation [RD213]. It has long been recognised that large numbers of organisms are entrained by power plants and that the mortalities incurred might cause ecological harm over wide temporal or spatial scales [RD213].

13.6.543 Survival of planktonic organisms through the CWS depends on species-specific tolerance to the stressors experienced during cooling system passage. Planktonic organisms are incapable of avoiding entrainment due to their inability to swim against the intake currents and therefore typical mitigation measures used for juvenile and adult fish species are not effective.

Entrainment at the Existing Power Station

13.6.544 Fish entrainment data are available from surveys carried out at the Existing Power Station (see appendix D13-10, Application Reference Number: 6.4.92). These data have been used to produce annual entrainment predictions for the Wylfa Newydd Power Station.

Predictions

13.6.545 Entrainment results from the 2011 to 2012 entrainment surveys on the Existing Power Station have been scaled to a constant tidally averaged abstraction rate of 126m^3/s. This value includes 5% contingency and represents the worst case. Ichthyoplankton abundances (eggs and larvae) have been extrapolated from numbers of individuals per m^3 sampled in the entrainment surveys at the Existing Power Station during each month and then summed to give an annual prediction, allowing for changes in abundances owing to seasonality. It is noted that these numbers are indicative and are presented to support the assessment.

13.6.546 It is recognised that the intake design of the Existing Power Station does not meet current best practice. The new intake at the Wylfa Newydd Power Station would be designed to reduce the mortality of marine organisms. However, the design of the CWS (including these mitigation measures) is ongoing and therefore efficiencies for the Power Station are not known. In the absence of this information, the assessment has taken a precautionary approach assuming 100% mortality. However, predicted survival rates have been presented, where available, in order to demonstrate how the mortality of marine organisms entrained could be reduced.

Effect on phytoplankton and zooplankton of entrainment

13.6.547 Phytoplankton communities in the area are dominated by diatoms (phylum Ochrophyta), with dinoflagellates (phylum Myzozoa) being the second most abundant group. These important groups of the phytoplankton community would not be able to avoid entrainment through the CWS.

13.6.548 The zooplankton community is dominated by Copepoda (e.g. Harpacticoida, Calanoida and Cyclopoida) and Thecostraca (Sessilia) which would also not be able to avoid entrainment through the CWS. Both phytoplankton and zooplankton would be vulnerable to mortality, the degree of which would depend on the individual species, developmental stage, size and condition. The distribution of zooplankton (i.e. patchiness and stratification) would also play a role in determining the magnitude of losses.

13.6.549 When examining the effects of entrainment on particular species, simulation studies in controlled conditions, such as the entrainment mimic unit (EMU), provide more robust data compared to entrainment survivorship studies on operational power stations. This is firstly because entrainment of individual species is very intermittent and it has proved difficult to obtain sufficiently large sample sizes for statistical analysis, and secondly, because it is hard to distinguish damage caused by collection in plankton nets from CWS passage injuries [RD213].

13.6.550 The EMU was first designed in the late 1970s and was based on the design of Sizewell B Nuclear Power Station, Suffolk. The EMU aimed to assess the effect of entrainment on various planktonic species. The unit was designed to mimic and assess the individual and combined effects of temperature, physical stress and biocide dosing.

13.6.551 Effects on the planktonic stages of Pacific oyster, common shrimp, lobster and copepods were investigated by Bamber and Seaby [RD214]; [RD215]; [RD216]; [RD217]; and Turnpenny and Taylor [RD218]. Mortality of the organisms passing through the EMU was found to vary according to the type and strength of stressors encountered. Evidence from studies such as these suggests that a large proportion of entrained plankton is able to survive passage through the CWS. In general, the results of experiments suggest that crustacean larvae are more tolerant than fish or mollusc larvae (table D13-34).

13.6.552 Mortality and injury to organisms occur due to mechanical damage, pressure-related effects, thermal shock and toxic biofouling-control agents. The magnitude of each effect varies according to each individual power station's operating regime and the time of year, the latter dictating the degree of thermal shock and use of biofouling control.

Table D13-32 Survival rates of entrained species from CWS passage simulation [RD218]

Species	Life stage	Entrainment survival rate	Prime causes of mortality
Shrimp (Crangon crangon)	Larvae	60% – 70%	Chlorine toxicity
Lobster (*H.gammarus*)		92%	Mechanical stress
Pacific oyster (*Megallana gigas*)	Embryo	0%	Chlorine toxicity and pressure stress

Species	Life stage	Entrainment survival rate	Prime causes of mortality
Copepod (Acartia tonsa)	Adult	80%	Chlorine toxicity and pressure stress

13.6.553 A study at Fawley Power Station found that phytoplankton productivity fell by 50% to 60% once it had passed through the circulating water system under routine conditions (ΔT 8°C to 10°C, 0.2mg/L chlorine at outfall) [RD219]. The main cause, however, was considered to be chlorine rather than temperature. In an experiment focused on the effects of water temperature, it was found that productivity increased by 15% with temperatures up to 23°C but then decreased by up to 11% when temperatures exceeded 23°C [RD220].

13.6.554 A study which considered the effects of temperature on zooplankton determined survival to be around 90% up to a temperature of 29.5°C and that the change in temperature did not have any effect [RD221]. In another study, thermal shocks with an increase of 10°C, 12°C, 15°C and 17°C were applied to diatom populations for durations of five to 40 minutes under various temperatures (12°C, 16°C, 20°C and 24°C). The effects of thermal shock were assessed by analysing the percentage growth after seven days in relation to a control. Two species, *Phaeodactylum tricornutum* and *Gyrosigma spenceri*, were not significantly adversely affected by the thermal shock when grown at temperatures of 12°C and 16°C [RD222]; [RD223]. The cultures were destroyed under a temperature increase of 15°C and 17°C, while their growth was inhibited with temperature increases of 10°C and 12°C [RD222]; [RD223]. The two species behaved differently in extreme temperature conditions; *G.spenceri* showed similar growth to control cultures up to a temperature of 35°C whilst *P.tricornutum* was more affected.

13.6.555 Responses to increased temperature exposure during entrainment may be seen in phytoplankton community composition, e.g. changes in the relative proportions of component species. However, changes to communities as a whole are not likely to be significant because of the very small percentage of the overall community being entrained and high productivity of such groups.

13.6.556 Subsequent effects may be seen in zooplankton, with populations changing in extent or phenology in response to prey abundance. Direct effects on zooplankton species may also occur resulting in changes in population composition, although this is likely to affect only a very small proportion of species. The literature suggests that it is likely that the most abundant components of the zooplankton communities, i.e. Crustacea, would exhibit a large degree of survivability (e.g. around 80%, with mortalities mostly from biocide or pressure stress) and therefore zooplankton would have a better potential for survival through the CWS than phytoplankton.

13.6.557 For the purposes of this assessment, 100% mortality of phytoplankton and zooplankton through the CWS has been considered. There could be reduced productivity in the immediate waters receiving the discharge, perhaps by up to 60%, mainly owing to biocide effect rather than temperature. It is expected that any reduced phytoplankton abundance as a result of entrainment through the CWS would be short-term as the water body is well mixed.

13.6.558 Although replenishment from the wider area is likely, the reduced productivity may have a subsequent effect on zooplankton which would have, in effect, less prey. The complex dynamics of phytoplankton and zooplankton interactions mean that species-specific effects are difficult to predict and may be masked by other variables. For example, in theory, changes in water temperature, e.g. a permanent uplift, may also affect primary production such as increasing growth rate, changing the kinetics of nutrient recycling and causing an earlier start to the plankton spring bloom. In UK waters, light rather than temperature appears to be the limiting factor in primary production [RD224]. Subsequent effects may be seen in zooplankton wider communities, with populations changing in extent or phenology in response to prey abundance.

13.6.559 Overall, the magnitude of change to wider phytoplankton and zooplankton populations present off Wylfa Head is predicted to be small and the effects on phytoplankton and zooplankton from entrainment through the CWS is considered to be negligible.

Effects of entrainment on intertidal and subtidal habitats and communities (including invertebrates of conservation and commercial importance)

13.6.560 The plankton populations entrained through the CWS would likely contain meroplanktonic life stages (i.e. eggs and/or larval stages) of benthic invertebrates present in the wider area (e.g. barnacles, brittlestars, shrimps, crabs, bivalves and polychaete worms). As described in paragraph 13.6.551, it is likely the mortality rates would be relatively greater for mollusc larvae compared to crustaceans. There is therefore the potential effect of a reduction in density of early life stages of molluscs available for recruitment to the benthic communities. Although it is difficult to quantify this effect, recruitment from the wider environment would likely offset any losses owing to entrainment mortality.

13.6.561 There may also be a reduction in food resource if plankton densities are reduced. Filter feeders such as bivalves and barnacles, particularly populations closest to the outfall, would be most affected. Plankton suffering mortality would still be a viable resource as it would not be lost from the ecosystem. However, again it is difficult to quantify this effect.

13.6.562 Although the effects on benthic invertebrate communities are difficult to quantify, the magnitude of change is predicted to be small and it is considered that there would be a negligible effect on benthic invertebrates from entrainment.

Effects of entrainment on ichthyoplankton and marine fish

13.6.563 Based on survey data from the Existing Power Station, a total of 151 million fish larvae and 1.6 billion eggs are predicted to be entrained at the Power

Station per year. It is predicted that the following species would be entrained in the highest abundances (each in the order of tens of millions per year):

- gobies;
- dragonet;
- right-eyed flatfish (namely dab);
- blenny;
- scorpionfish; and
- sandeel (namely *Ammodytes* sp.) larvae.

13.6.564 Annual entrainment predictions of larvae belonging to each of the remaining taxonomic families are in the order of millions or less per year (see appendix D13-4, Application Reference Number: 6.4.86).

13.6.565 In terms of abundance of species of conservation importance, it is likely that Raitt's sandeel and gobies (sand and common goby) would be entrained in the greatest numbers (each in the order of millions per year). A proportion of species that are likely to be entrained are also of commercial importance. The key commercial species include plaice, Dover sole, sprat, whiting and herring. With the exception of Dover sole, each of these species will be entrained in the order of less than a million per year; less than two million Dover sole larvae are predicted to be entrained each year.

13.6.566 Whilst intuitively the potential loss of ichthyoplankton from entrainment seems high, it is important to consider annual entrainment estimates in the context of ichthyoplankton abundances within the source water body. Densities of eggs and fish larvae predicted to be entrained represent a maximum of 32% and 20% of that recorded from coastal plankton samples during the corresponding months, respectively. The highest densities of fish larvae and eggs around the north coast of Anglesey have been found offshore and to the east, in proximity of known spawning grounds [RD24]. Inshore waters support comparatively lower abundances of ichthyoplankton.

13.6.567 It is also important to consider the life history characteristics of fish. With little or no parental care, fish eggs and larvae experience extremely high rates of natural mortality. For small, short lived species such as sprat and sand smelt, mortality following recruitment can reach 50% to 90%, whilst large, long lived fishes (e.g. bass) typically experience lower natural mortality rates, i.e. 10% per year or less [RD225]. To ensure population persistence, an individual fish will spawn thousands to millions of eggs each year on the basis that over its reproductive lifetime, only two offspring need to survive to adulthood to replace the parents within the population. Owing to natural mortality factors such as predation, starvation, disease and hydrodynamic processes, very few eggs and larvae would likely survive through to adulthood.

13.6.568 Whilst annual entrainment estimates appear high, these values represent a small fraction of ichthyoplankton abundances known to be present within the eastern Irish Sea. Furthermore, the life history strategy of fishes takes account of high natural mortality during early life stages. Mortality of ichthyoplankton due to entrainment is therefore unlikely to have a significant effect on wider abundances and the success of adult populations.

13.6.569 To give an indication of the relevant value of early life stages to adult populations, extrapolated entrainment catches have been converted into EAVs. This approach takes into consideration species-specific reproductive and mortality rates (where available) to calculate the estimated numbers of adult fish lost from the ecosystem based on larval numbers entrained through a CWS.

13.6.570 Annual abundances of larvae predicted to be entrained and their EAV are presented in table D13-33. The predicted number of adult equivalents lost is reduced considerably compared with raw annual abundances of larvae; in most cases by up to four orders of magnitude. For example, the 14 million sandeel (*Ammodytes* sp.) larvae predicted to be entrained over the course of the year equate to less than 5,000 adult equivalents (table D13-33).

Table D13-33 Predicted annual abundance of larvae entrained and their EAVs for species where data are available (numbers over 100 to two significant figures), for an abstraction rate of 126m^3/s

Common name	Annual raw abundance	Annual EAV
Sprat	260,000	46,000
All clupeids as sprat	280,000	32,000
Goby family	24,000,000	24,000
Sandeel (*Ammodytes* sp.)	14,000,000	4,600
Dragonet	21,000,000	3,700
Plaice	84,000	1,200
Whiting	23,000	690
Solenette	2,700,000	270
Dover sole	650,000	210
Dab	9,700,000	100
Corkwing wrasse	1,100,000	100
Goldsinny wrasse	480,000	85
All clupeids as herring	280,000	36
Herring	110,761	27
Total[3]	74,000,000	81,000-110,000

[3] The reported total assumes individuals recorded as Clupeidae represent either sprat or herring.

13.6.571 Eggs experience the highest rates of natural mortality of any life stage with more than 99.9% of those predicted to be entrained annually, unlikely to survive through to adulthood. In the absence of speciation, an approximate EAV can be assigned to the annual egg entrainment estimate assuming they represent the species listed in Table D13-33. The 1.6 billion eggs predicted to be entrained annually equates to an average of 97,000 adult equivalents. The EAV-at-hatching has been assumed within the calculations and therefore this estimate represents a worst case approximation.

13.6.572 In terms of the numbers of fish larvae abstracted, the effect of entrainment has been considered from both the Existing Power Station and any subsequent station running concurrently, as having no significant adverse effect on fish populations of the species entrained [RD226]. Although the Power Station would have a larger abstraction compared with the Existing Power Station, the numbers of fish entrained are small in relation to the wider populations. Therefore, the magnitude of change is predicted to be small and there is considered to be a negligible effect on ichthyoplankton including those of conservation and/or commercial importance, from entrainment.

13.6.573 As with phytoplankton and zooplankton, evidence from previous studies suggests that a proportion of entrained ichthyoplankton are able to survive passage through circulating water systems (Table D13-34). As for phytoplankton and zooplankton, mortality and injury occurs due to mechanical damage, pressure-related effects, thermal shock, toxic antifouling agents and Total Residual Oxidant (TRO). The magnitude of each effect varies according to each individual power station’s operating regime and time of year, the latter dictating the degree of thermal shock and use of biofouling control.

13.6.574 Effects on the planktonic stages of Dover sole, turbot, and bass were investigated using the EMU as described in paragraph 13.6.550 above [RD214]; [RD215]; [RD213]; [RD216]; [RD227]; [RD228]; [RD218]. Mortality through the EMU was found to vary according to the type and strength of stressors encountered.

Table D13-34 Survival rates of entrained fish from CWS passage simulation [RD218]

Species	Lifestage	Entrainment survival rate	Prime causes of mortality
Dover sole (*Solea solea*)	Eggs and post-larvae	65%	Thermal stress and chlorine toxicity
Turbot (Psetta maxima)	Eggs and post-larvae	15%–30%	Thermal, mechanical and pressure stress
Bass (Dicentrarchus labrax)	Fry	54%–60%	Thermal stress and chlorine toxicity

13.6.575 In a study of fish egg survivability, the majority of species did not seem to be affected by the rapid change in temperature. The results for Dover sole showed that as long as the maximum temperature was less than 29°C, no significant effects were noted [RD229]. The results for turbot showed that significant effects were only noted when the absolute temperature reached 32°C, whereas for bass, at an absolute temperature of 27°C degrees, 20% egg mortality was recorded [RD229].

13.6.576 Assuming 12°C uplift, ichthyoplankton passaging the CWS will be subject to an absolute temperature of 29°C during the late summer and therefore a degree of survival is probable. Peak entrainment would occur during the late spring and early summer when ambient temperatures would be lower; survival rates are therefore likely to be higher during this period of the year.

13.6.577 In the absence of survivability data specific to the Power Station thermal and biofouling regime, the assessment has taken a precautionary approach assuming 100% mortality. However, consideration of survival rates would likely reduce the magnitude of ichthyoplankton mortality. This information provides further support to the conclusion that entrainment would have a negligible effect on ichthyoplankton.

13.6.578 The effects of entrainment on wider marine fish populations has been assessed by comparing EAV losses to commercial fish landings data or other quantifiable population data.

13.6.579 The losses to entrainment as a proportion of commercial landings are provided in table D13-35. Using information on commercial fishing efforts as presented in paragraph 13.6.505 above.

Table D13-35 Predicted equivalent adult fish entrained annually as a proportion of commercial landings

Species	Weight at 50% maturity (g)	Stock	Condition of stock	Latest landings (tonnes)	Proportion of landings
Whiting	89 [RD189]; [RD190]	Irish Sea (VIIa)	Undefined	73 (2014)	0.08%
Plaice	131 [RD191]; [RD190]	Irish Sea (VIIa)	Stock size increasing	1,005 (2015)	0.02%
Dover sole	211 [RD192]; [RD190]	Irish Sea (VIIa)	Below reproductive capacity	76 (2015)	0.06%
Sprat	7 [RD194]; [RD190]	North Irish Sea (VIIaN)	Full reproductive capacity	4,900 (2015)	0.01%
All clupeids as sprat					additional 0.01%
Herring	109 [RD193]	English Channel (VIId-e)	Undefined	3,003 (2015)	0.0001%
All clupeids as herring					additional 0.0001%

13.6.580 Other population metrics can also be used to contextualise entrainment catches for species such as dab. Using the population information presented by Selsay [RD196] (see paragraph 13.6.508), the estimated number of equivalent adult dab potentially entrained annually at the Existing Power Station represented 0.004% of the local population.

13.6.581 Of those species that are likely to be entrained and that are subject to conservation designation(s), Raitt's sandeel is the only species which would be entrained in relatively large numbers. Assuming all sandeel larvae were Raitt's sandeel (i.e. worst case), numbers would equate to a loss of 4,600 equivalent adults. Supposing each equivalent adult weighed 8g (i.e. typical weight at 50% maturity) [RD230]; [RD190], this number would represent a weight of 0.04 tonnes. Abundances of sandeel on the west coast of the United Kingdom are too low to sustain a commercial fishery and therefore no direct comparison can be made to fishing pressure. Nonetheless, a loss of this size is unlikely to affect the integrity of wider populations and therefore the magnitude of change is predicted to be negligible and the effect is negligible.

13.6.582 The plankton (including ichthyoplankton) entrained through the CWS is potentially a food source for marine fish (or their prey). Therefore, losses may cause indirect effects on this receptor in the wider population. Although it is difficult to quantify this effect, as each fish species has different prey preferences (species, size, etc.) at different life stages, it is likely that the effect would be small as the planktonic prey would still be available within the system (and may also survive entrainment), as well as be replenished via tidal exchange. Fish are also highly mobile species and are likely to have large foraging areas, and as such are unlikely to restrict their feeding to the immediate area of the CWS discharge.

13.6.583 In terms of commercial species, it is likely that sprat and herring would be entrained in the greatest numbers. Calculated as EAVs, the numbers of commercial fish potentially entrained correspond to less than 0.02% of their respective commercial catch within the northern Irish Sea and English Channel, respectively. The reduction in food resource for some marine fish species in the wider population (directly and indirectly) owing to entrainment losses, as already stated, is difficult to quantify, but is predicted to be small.

13.6.584 Although no glass eels are predicted to be entrained at the Power Station, it is acknowledged that adult life stages are present in freshwater habitats within the Wylfa Newydd Development Area; albeit in low abundance. It is therefore possible that glass eels would be vulnerable to entrainment, although the probability of this occurring is considered to be low. Entrainment of glass eel would result in small magnitude of change therefore the effect to European eel populations from entrainment is considered to be negligible.

13.6.585 The loss of all other fish species is very small in comparison to wider populations. Therefore, the magnitude of change to general fish and fisheries and all remaining fish of conservation and/or commercial importance, as a result of ichthyoplankton entrainment is small and the effect on marine fish populations is considered to be negligible.

Effects of entrainment on marine mammals

13.6.586 The entrainment of fish and invertebrates may have an indirect effect on marine mammals in the area through a reduction in their prey populations. Harbour porpoise and grey seal are the most common species present around the north coast of Anglesey and would likely be most affected. Dietary equivalents modelling (using weight composition data) has been undertaken to quantify the potential loss of food resources to these marine mammal species. Minke whale and bottlenose dolphin are also present but in much lower abundances and not all year round; entrainment is unlikely to affect the wider food resources available to these species.

13.6.587 The dominant prey of harbour porpoise in the Irish Sea are known to be gadoids (namely whiting and haddock) and clupeids (namely herring) [RD100]. Grey seal target a wide range of fish taxa within the Irish Sea; these include the majority of those predicted to be entrained [RD45]; [RD100]. Although sprat has not been identified as prey species of grey seal within the Irish Sea, this species has been included within the dietary equivalents assessment owing to the degree of uncertainty associated with dietary analysis and the possible confusion with herring larvae.

13.6.588 The approach used to assess the loss of food resources to harbour porpoise and grey seal due to entrainment is consistent with that used to assess the effects of impingement. A detailed description of this approach is outlined in paragraph 13.6.525. The only difference is that EAVs have been used rather than raw extrapolated numbers; this is considered more accurate as harbour porpoise and grey seal do not consume larval fish, preferring to target juveniles, and to a lesser extent, adults.

13.6.589 Of the fish predicted to be entrained annually, 59% and 89% are considered to represent a possible food resource to harbour porpoise and grey seal, respectively. Assuming an average adult weight of 45kg to 60kg [RD206], the estimated equivalent adult biomass of prey species potentially entrained each year equates to the annual diet of one to three harbour porpoise. The upper estimate corresponds to the smaller average adult weight and assumes that all fish recorded as clupeids were sprat which have a higher EAV at a given age compared to herring. Assuming an average adult weight of 194kg [RD100], the estimated equivalent adult biomass of known prey species potentially entrained per year equates to the annual diet of two to four grey seals.

13.6.590 Considering the loss of food resource in relation to the size of the population and availability of alternative food sources, the magnitude of change is predicted to be small and the effect on marine mammals from entrainment of food resource is negligible.

Effects of entrainment on seabirds

Target species

13.6.591 The entrainment of fish could have an indirect effect on seabirds through a loss of food resource. Dietary equivalents modelling (using bioenergetic data) has been carried out to quantify the potential loss of food resources to terns, which are features of the Anglesey Terns/Morwenoliaid Ynys Môn SPA.

13.6.592 The approach taken is consistent with that used to assess the indirect effects of fish impingement; a detailed description can be found in paragraph 13.6.525. The only difference is that EAVs have been used rather than raw extrapolated numbers; this is considered more accurate as terns preferentially target juvenile and to a lesser extent adult fish.

13.6.593 The dietary equivalents assessment has only considered sandeel and clupeids as these are the main food resource to terns, representing between 78% and 95% of the overall diet of adults and chicks [RD207]; [RD50]; [RD208]. The estimated number of clupeid and sandeel adult equivalents entrained during the breeding season (April to July) can be examined in the context of the typical dietary intake of terns, which are a target species owing to their designation within the Anglesey Terns/Morwenoliaid Ynys Môn SPA.

13.6.594 Based on the bioenergetics information presented in paragraph 13.6.528, it is estimated that the number of clupeid and sandeel adult equivalents entrained during the breeding season would support up to 55, 62 or 57 adult Arctic, common or Sandwich terns, respectively.

13.6.595 Whilst intuitively the potential loss of food resource to these target species seems large, it is important to consider entrainment effects in the context of the SPA population. Approximately 1,290, 189 and 460 breeding pairs of Arctic, common and Sandwich terns are supported by the SPA (five year mean population size: 1992 to 1996 for Arctic and common terns and 1993 to 1997 for Sandwich terns). Multiplying per capita consumption by these population estimates, the predicted weight of equivalent adult sandeel and clupeid entrained between April and July would represent between 0.8% and 1.5% of that required to sustain the SPA population during the corresponding period (i.e. the breeding season).

13.6.596 Considering the loss of local food resource in relation to the size of the wider foraging area known to be utilised by terns, the magnitude of change is predicted to be small and the effect on target seabirds from entrainment of food resource is negligible.

Secondary species

13.6.597 In terms of secondary species, the effect of entrainment on their food source is less quantifiable (as opposed to an impingement catch where actual biomass is easily obtainable). It is difficult to obtain and apply an accurate EAV value to the potential total entrainment loss through the Power Station (or to only those species that would be targeted by seabirds).

13.6.598 To quantify the potential loss of food resources to other seabirds, dietary equivalents modelling using generic bioenergetic data [RD212] has also been used. This approach is consistent with that used to assess the indirect effects of fish impingement; a detailed description can be found in paragraph 13.6.536.

13.6.599 The estimated equivalent adult weight of whiting, plaice, dab, Dover sole, sandeel, herring and sprat entrained annually would equate to the annual diet of between three and five seabird equivalents. Although it is recognised that this does not include all potentially targeted species, it is indicative of the magnitude as some of these species are among those potentially entrained in the highest numbers (and/or EAVs).

13.6.600 Considering the loss of food resource in relation to the size of the population and availability of alternative food sources, the magnitude of change is predicted to be small and the effect on secondary seabirds from entrainment of food resource is considered to be negligible.

Effects of entrainment on designated sites

13.6.601 The indirect loss of food resource to marine mammals and seabirds due to entrainment would have a further indirect effect on current and proposed designated sites for which they are qualifying features.

13.6.602 As described in the preceding sections on marine mammals and seabirds, the magnitude of change is predicted to be small and the effects on the Anglesey Terns/Morwenoliaid Ynys Môn SPA from entrainment, as well as the North Anglesey Marine cSAC, are considered to be negligible. It is therefore considered that there would be a negligible magnitude of change and effect on current and proposed designated sites, from entrainment.

Impact pathway: underwater noise from AFDs during operation

General context

13.6.603 An AFD system will be installed on the front face of the intake (paragraph 13.5.70) to reduce the effect of impingement on marine fish. The AFD system is designed to emit sound signals in the frequency range of 25Hz to 400Hz at a source level of 160dB re 1µPa. The operation of the AFD system will result in a continuous noise source at the intake to deflect fish away from the area and thereby avoiding entrapment.

Effects of underwater noise generated through operation on marine mammals

13.6.604 An overview of marine mammal hearing is provided in paragraphs 13.6.318 to 13.6.321. This shows that the frequency range at which the AFD operates within the auditory range of marine mammals and pinnipeds.

13.6.605 The largest overlap is for low-frequency cetaceans which include the baleen whales such as the minke whale. Baleen whales are more commonly found offshore and in the southern Celtic and Irish Sea (appendix D13-6, Application Reference Number: 6.4.86). Baseline surveys undertaken have reported two sightings of baleen whales (possibly minke) outside of the survey area (appendix D13-6, Application Reference Number: 6.4.86).

13.6.606 Of the cetacean species likely to be within the Wylfa Newydd Development Area, the hearing ranges of the bottlenose dolphin and harbour porpoise will have some overlap with the AFD system. The underwater noise generated by the system is not of a level that would result in PTS or TTS for both species and it is highly unlikely that any disturbance would result.

13.6.607 Pinnipeds in water also have a hearing range that overlaps with the sound signal for the AFD. Like the harbour porpoise and bottlenose dolphin there is not potential for PTS or TTS in seals from the AFD and disturbance is unlikely.

13.6.608 Modelling of the AFD system has shown that the sound signal is localised to the intake and assuming a precautionary range of 500m within which disturbance could occur this would not have an effect on the species. The records of all cetaceans and pinnipeds within Porth-y-pistyll are sparse with only rare sighting of grey seal within the bay. The effect of underwater noise on marine mammals is considered to be of negligible magnitude and therefore negligible effect.

Impact pathway: discharge of Cooling Water – thermal effects

General context

13.6.609 The Cooling Water discharge for the Power Station would be located at Porth Wnal, adjacent to the outfall of the Existing Power Station. The discharge water would be approximately 12°C (98 percentile) warmer than the water being abstracted. The volume of water discharged would vary over the tidal cycle from 113m^3/s at LAT to 126m^3/s at highest astronomical tide. Hydrodynamic modelling has been based on a tidal average value with an allowance made for potential inefficiencies over the lifetime of the CWS. The modelling is therefore based on Cooling Water being discharged at a rate of 126m^3/s (tidal average plus 5%).

13.6.610 The Cooling Water outfall would be located within the Anglesey North WFD coastal water body. The discharge would also influence the adjacent Skerries WFD coastal water body.

13.6.611 Factors that influence the thermal tolerances of marine organisms include environmental aspects such as latitude, habitat, exposure and seasonality as well as biological factors such as mobility mechanisms, feeding, foraging and reproductive strategies.

13.6.612 The effect on each marine receptor from an increase in temperature would be determined by their exposure to the warmer water both spatially and temporally. As warmer water is more buoyant than cooler water, the area of the seabed that is warmed is relatively small in comparison to the surface. The effects on receptors are evaluated based on the modelling results, the characteristics of the receptor and the sensitivity of a receptor to temperature (as indicated by thresholds where data are available).

Thermal standards

13.6.613 Temperature limits are placed on Cooling Water discharges for a number of reasons, including:

- elevated water temperatures experienced during transit through a CWS can be fatal to fish and other organisms;
- aquatic organisms have thermal preferences and raising the water temperature may preclude certain species from an area;

- increased temperatures can reduce the dissolved oxygen concentration and/or promote algal blooms; and
- the potential for in-combination stresses on aquatic organisms, such as those associated with both temperature and biocide use.

13.6.614 The difference in temperature between the water abstracted and the water discharged (also referred to as the temperature rise) is a balance between the requirement to limit potential effects related to both discharge temperature and levels of entrapment of marine organisms into the CWS. For an equivalent power output, a lower discharge temperature would require a higher abstraction rate, which would increase entrapment effects, whilst reducing temperature related effects. Conversely, a lower abstraction rate would result in fewer entrapment effects but a higher temperature discharge and the associated issues of the thermal plume.

13.6.615 In the UK, thermal discharges are consented by applying temperature limits to the thermal mixing zone [RD219]. Temperature and other water quality parameters are allowed to exceed defined acceptable limits within the mixing zone, but the extent of the zone and the distance at which levels must have returned to below the limits, are set by the statutory authority based on the relevant regulations, available data and modelling output.

13.6.616 There are no legal standards for limits on thermal discharges into coastal water bodies. The most recent guidance available was developed by the British Energy Estuarine & Marine Studies Expert Panel who produced a report: Thermal standards for Cooling Water from new build nuclear power stations, which summarises existing temperature standards and provides evidence on the effects of thermal discharges [RD224]. This work was expanded by Wither *et al*., [RD231] in a review of the thermal tolerances of fish and marine biota and recommended thresholds in relation to WFD status boundaries (high, good, moderate, poor, bad, where the aim is for all water bodies to achieve good). The temperature boundaries for transitional and coastal water bodies proposed by the British Energy, Estuarine and Marine Studies [RD224] are shown in Table D13-36.

Table D13-36 Proposed temperature boundary values for all transitional and coastal waters outside the mixing zone in relation to WFD status [RD226]

Typology	Normative definition boundary positions (as annual 98 percentile) (°C)			
	High/good	Good/ moderate	Moderate/ poor	Poor/bad
Maximum allowable temperature	23	23	28	30
Maximum allowable temperature uplift	+2	+3	+3	+3

13.6.617 The assessment considers the locations of the 2°C and 3°C temperature boundaries. This provides an indication of the proportion of the WFD water bodies that are influenced by the Cooling Water discharge. It is recognised that temperature influences other WFD quality elements (e.g. benthic invertebrates) and that the effects of temperature should be assessed in relation to known thresholds of effect for these quality elements. Therefore, where appropriate, consideration has also been given to receptors which may be more sensitive to temperature rise and in respect of absolute temperature.

Modelling: simulations

13.6.618 Horizon has developed a marine hydrodynamic model and carried out simulations of the Cooling Water discharge using the excess temperature surface heat exchange sub model within Delft3D [RD106]. The modelling methodology is described in appendix D13-8 (Application Reference Number: 6.4.90).

13.6.619 The model uses an excess temperature surface heat transfer model to simulate the heat loss from the surface. This requires some assumptions to be made about the average sea temperature, wind speed and an effective area (see appendix D13-8, Application Reference Number: 6.4.90).

13.6.620 The base case simulations used a fixed discharge condition of 126m^3/s and a temperature rise of 12°C (98 percentile). Four base case simulations were modelled covering summer, autumn, winter and spring seasons. These simulations used seasonally appropriate surface heat loss rates and TRO decay rates, and were undertaken without the influence of wind or wave stress on the water surface.

13.6.621 Sensitivity studies were then completed using the average observed wind speed from the north, east, south and west and also a variable wind case. The influence of waves and sensitivity to surface heat loss were also investigated.

13.6.622 The results of the sensitivity studies are summarised here as they provide an indication of how the thermal plume is likely to be affected in reality. For the purposes of assessment, two scenarios have been used to illustrate the effects of the Cooling Water discharge:

- a ‘worst case’ scenario using an annual base case with a continuous discharge of 126m^3/s and no wind stress; and
- a summer base case with a continuous discharge of 126m^3/s with the inclusion of a variable wind.

Modelling: results

Variation of the thermal plume over a tidal cycle

13.6.623 The Cooling Water discharge is buoyant and will form a plume at the surface, which will be advected by the tide and influenced by wind and waves, and will therefore remain in a constant state of flux. The buoyancy limits the exposure of the bed to elevated temperatures.

13.6.624 The tidal flow north of Wylfa Head is relatively simple, with an essentially east to west tidal current (see chapter D12, Application Reference Number: 6.4.12). However, the presence of the headland results in complex flow region in the bays either side, and the evolution of the plume differs on a neap and spring tide.

13.6.625 At high water on a neap tide, the plume is beginning to be advected to the west as the tide begins to ebb (figure D13-30). At mid ebb on a neap tide, the plume at the surface has been advected to the west of the outfall. Compared to the high water case the plume is smaller. At low water on a neap tide, the plume still extends to the west of the outfall. However, at mid flood, the surface temperature rise shows the plume being advected to the east past Wylfa Head (figure D13-31).

13.6.626 The trends are similar for both neap and spring tides, with the plume being advected to the west on the ebb and east on the flood tide. There is a difference between the evolution of the plume at high tide, with the plume having a greater extent at the surface on a neap tide compared to a spring tide. At mid ebb, the extent is also greater on a neap than a spring tide. At low water neap, the plume extends further than on a spring tide. These differences can be explained by the higher current magnitudes on a spring compared to a neap tide. The higher currents increase shear stress and result in greater mixing of the Cooling Water discharge.

13.6.627 To further explore the evolution of the thermal plume, a series of vertical profiles were plotted around the outfall at different states of the tide using a neap tide for the summer base case (a worst case scenario).

13.6.628 For the vertical profile along a north-south axis near the outfall at low water, there is a rise of around 9°C close to the outfall (figure D13-32). Further offshore, temperature rises of 4°C to 5°C are predicted within the upper 4m to 5m of the water column. For the other tidal states, the predicted temperature rise is similar although with less offshore penetration of the plume than at low water (figure D13-32). These plots show that the plume is limited to the upper layers of the water column, except in the vicinity of the outfall where the seabed is exposed to higher temperatures.

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Figure D13-30 Rise in surface temperature at high water on a neap tide (dotted line indicates cross section locations) [RD232]

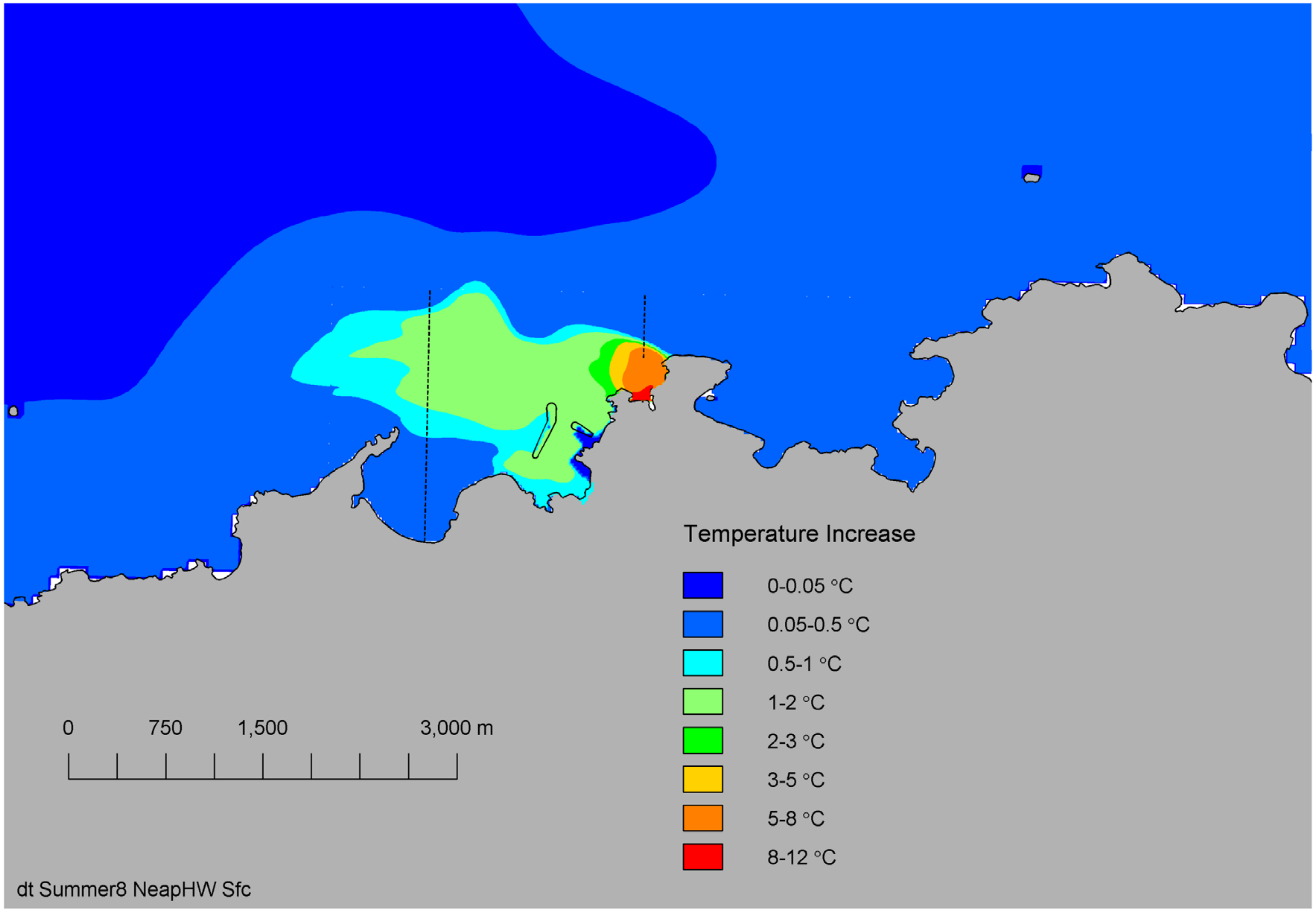


Figure D13-31 Rise in surface temperature at mid flood on a neap tide (dotted line indicates cross section locations) [RD232]

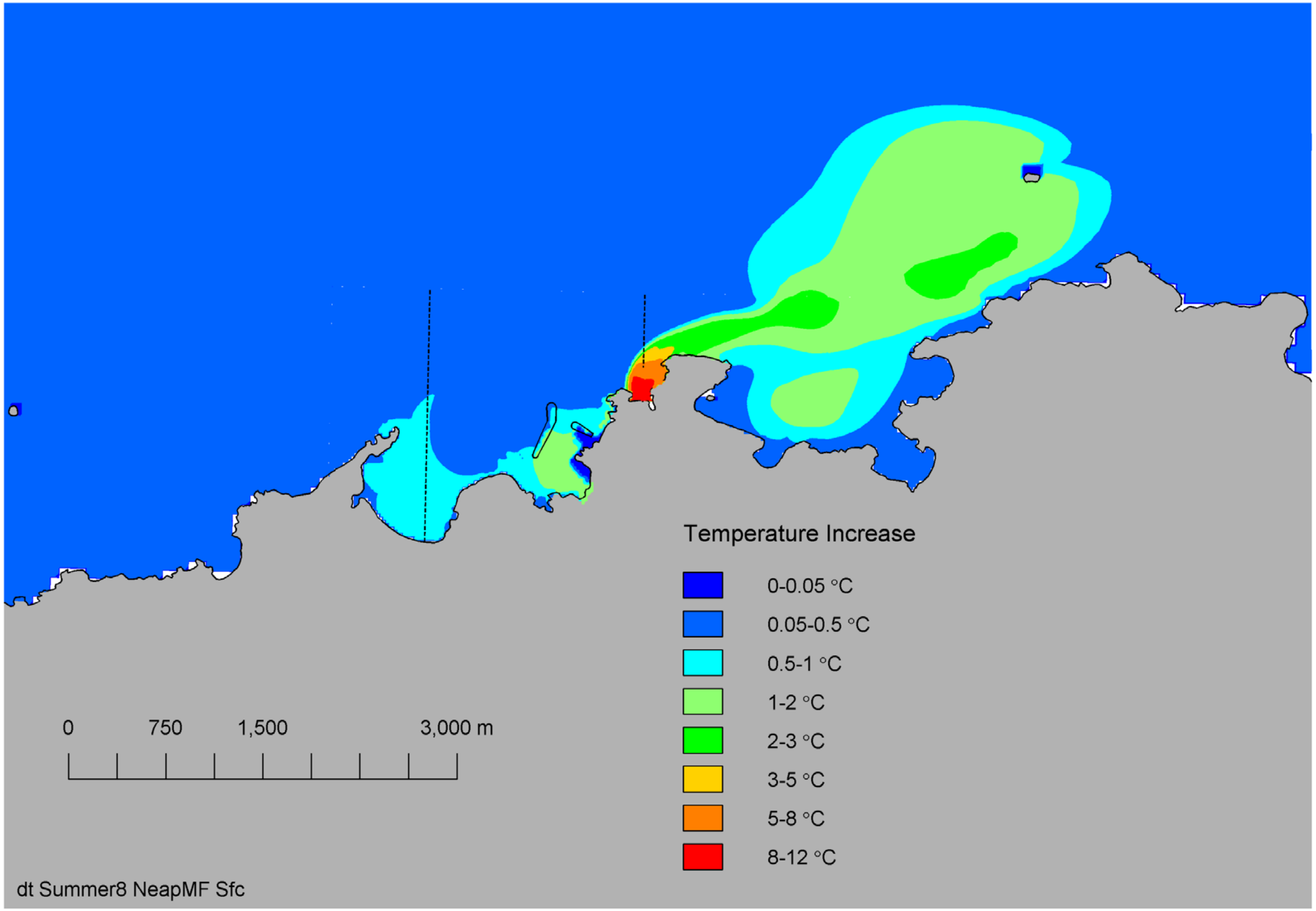
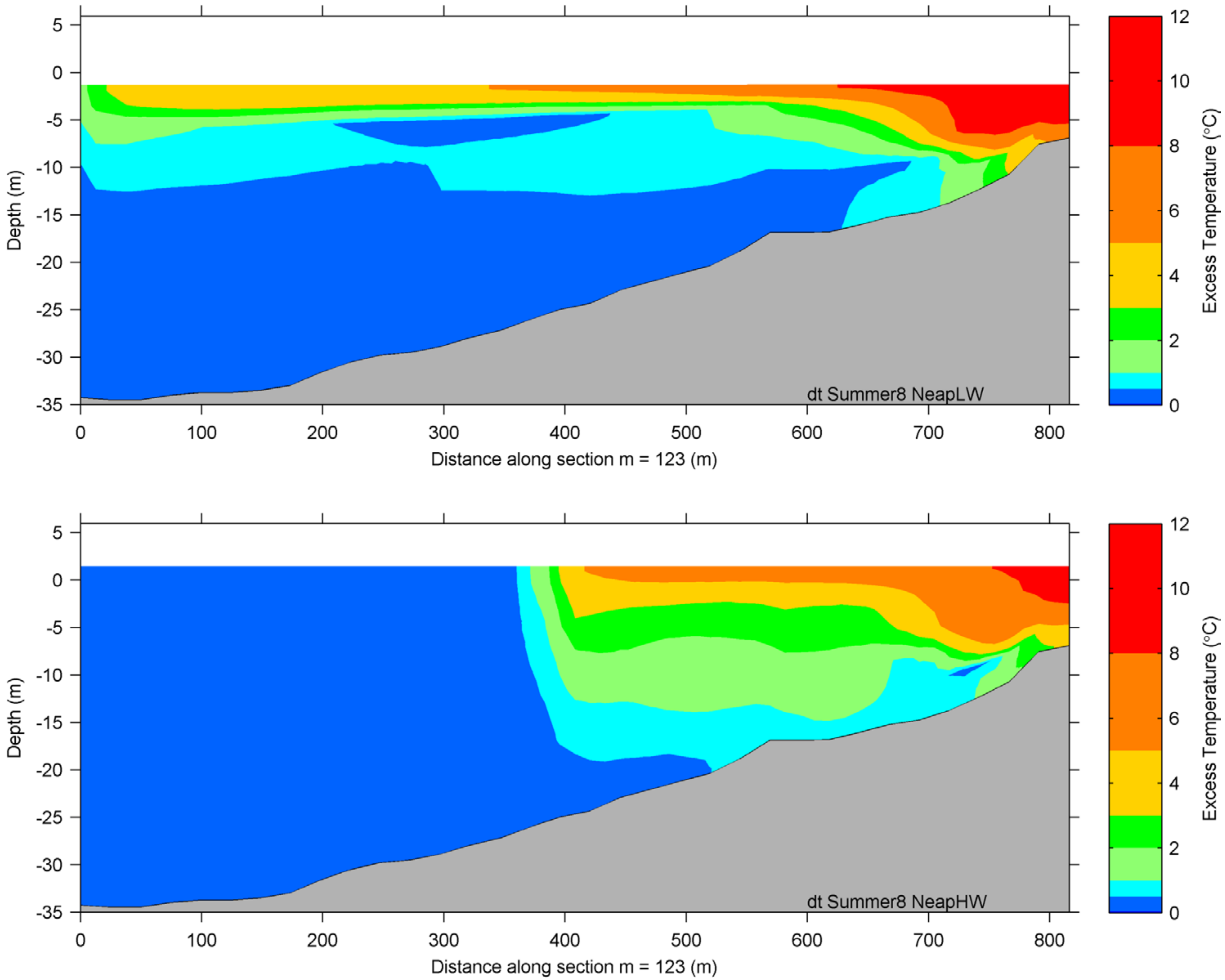


Figure D13-32 Vertical profiles at the outfall on a neap tide at low water (above) and high water (below) [RD232]; note the discharge is to the right of the figure.



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Sensitivity study: surface heat flux

13.6.629 A sensitivity study was carried out to consider the influence of the surface heat flux on mixing zones. The simulations repeated those of the summer base case but with a surface heat loss rate equal to the summer average $\pm 10Wm^2/K$. Model simulations were undertaken with both low and high surface heat exchange coefficients.

13.6.630 The difference between a low surface heat flux and the summer base case was small. In Cemlyn Bay, the mean difference between the two cases was around 0.03°C. The difference between a high surface heat flux and summer base case was also small. The small differences between the cases were considered to be indicative of the relative importance of the mixing processes compared to the surface heat loss in the waters around the Wylfa Newydd Development Area (see appendix D13-8, Application Reference Number: 6.4.90).

Sensitivity study: influence of wind

13.6.631 Both wind speed and direction have the potential to influence mixing of the Cooling Water discharge. The wind speed will influence both the stress imposed on the water and the surface heat flux. The wind stress will influence the hydrodynamics, while the surface heat flux affects the rate of heat loss and hence the mixing.

13.6.632 The base case simulations were all modelled without the influence of wind stress on the water surface. Sensitivity studies were then completed using the summer base case to explore the influence of wind from the north, south, east and west.

13.6.633 The greatest influence on the mixing zone is constant winds from the north and south. A southerly wind tended to push the plume out into the faster currents north of Wylfa Head, where mixing is greater, whilst a wind from the north tended to push the plume back towards the shore.

13.6.634 While long duration winds from any direction are relatively rare, the sensitivity studies provided confidence that excluding wind stress in the base case simulations was unlikely to have resulted in the under-prediction of the size and temperatures of the mixing zone. A no-wind stress assumption is likely to result in conservative modelling outputs. For the purposes of assessment, the summer base case with variable wind (derived from a long-term average of wind speed and direction) was used to represent a more realistic longer-term scenario.

Assessment scenarios

13.6.635 The areas of the mixing zones of the 2°C and 3°C (98 percentile) rise at the surface and seabed are presented in table D13-37 for both the annual base case and the summer base case with variable wind. The mixing zones are shown in figures D13-33 to D13-35 (Application Reference Number: 6.4.101).

Table D13-37 Area of the thermal plume in relation to 2° and 3°C (98 percentile) boundaries

Scenario	Area of the surface exceeding temperature boundaries (ha)		Area at the seabed exceeding temperature boundaries (ha)	
	>2°C	>3°C	>2°C	>3°C
Annual base case (126m^3/s at +12°C) – no wind	209	88	4.2	3.2
Summer base case (126m^3/s at +12°C) – with variable wind	97	49.8	4.1	3.1

Sensitivity study: influence of waves

13.6.636 Compared to the annual base case, the 2°C (98 percentile) mixing zone for the summer base case with waves was 29.2% smaller at the surface. The 2°C (98 percentile) mixing zone at the seabed was 5.0ha with waves compared to 5.2ha for the annual base case (19.6% larger) as a result of increased vertical mixing.

Annual base case (no wind)

13.6.637 For the annual base case the model predicted the following sea surface temperature rise:

- a greater than 3°C 98 percentile rise over a zone extending approximately 1.04km north and 1.37km from east to west; and
- a greater than 2°C 98 percentile rise over a zone extending approximately 1.52km north and 2.71km from east to west (figure D13-33, Application Reference Number: 6.4.101).

13.6.638 For the annual base case the model predicted the following temperature rise at the seabed:

- a greater than 3°C 98 percentile rise over a zone extending approximately 0.14km north and 0.38km from north-east to south-west, restricted to Port Wnal (orange zone); and
- a greater than 2°C 98 percentile rise over a zone extending approximately 0.17km north and 0.38km from north-east to south-west (figure D13-34, Application Reference Number: 6.4.101).

Summer base case with variable wind

13.6.639 For a summer base case with variable wind the model predicted the following sea surface temperature rise:

- a greater than 3°C 98 percentile rise over a zone extending approximately 0.86km north and 0.95km from east to west; and

- a greater than 2°C 98 percentile rise over a zone extending approximately 1km north and 1.86km from east to west (figure D13-35, Application Reference Number: 6.4.101).

13.6.640 A reduction in the mixing zone areas at the surface would be expected with the inclusion of wind, because the wind increases mixing and increases the surface heat flux. There is a small increase in the mixing zone at the seabed as the wind increases the vertical mixing of the thermal plume down towards the seabed, although the increases are relatively small.

Recirculation

13.6.641 A continuous supply of cool water is required for safe operation of the Power Station. The position of the intake and outfall has been carefully considered to avoid recirculation of warm water. The potential for recirculation was investigated by modelling over a range of conditions. A cell located approximately within the forebay was chosen and the depth-averaged temperature was determined over a spring neap tidal cycle under both the base case and tidally varying case. The results for the summer base case are presented in table D13-38.

Table D13-38 Temperature rise above ambient at the intake

Scenario	Temperature rise above ambient (°C)		
	Average	98 percentile	Maximum
Summer base case ($126m^3$/s at +12°C)	0.46	0.78	0.84

13.6.642 With a constant wind from the north, the mixing zone was slightly larger when compared to the base case. The degree of recirculation increased slightly with a constant wind from the north (an average of 0.1°C increase over the summer base case of 0.46°C). For all other directions the influence of wind either reduced or did not change the average temperature rise.

Absolute temperatures

13.6.643 The predicted maximum water temperature with the long-term operation of the Cooling Water discharge have been produced by combining the ambient temperature (maximum) with the maximum rise from the Cooling Water discharge over the year.

13.6.644 For the annual base case, the surface area with a temperature greater than 23°C (maxima) is approximately 14.6ha compared to 14.2ha in the summer base case with variable wind. In both scenarios the area of the 23°C (98 percentile) mixing zone at the seabed is limited to the immediate vicinity of the outfall in Porth Wnal.

Commissioning and non-standard operation conditions

13.6.645 During commissioning, it is possible that certain scenarios may lead to short-term temperature excursions whereby the Cooling Water discharge temperature will be elevated more than 12°C above ambient. However, the maximum temperature rise at the point of discharge will not exceed 12°C above ambient as a 98 percentile.

13.6.646 For the majority of time the Power Station will operate under normal conditions. However, over the lifetime of the Power Station a number of scenarios may occur that differ from standard operating conditions. These include planned events such as outages which are required for maintenance, as well as unplanned events such as pump or turbine trips and turbine bypass.

13.6.647 At some point during operation, the Power Station could be required by National Grid to operate in ‘frequency sensitive mode’. National Grid are responsible for balancing grid ‘frequency’[4], which is achieved by controlling the outputs from large power generators to alter their output continuously to keep the frequency near 50Hz. There are a number of options that can be employed to achieve this, and the worst case scenario in terms of discharge temperature is whereby the station operates a 32% turbines bypass whilst operating at 100% reactor power. This would result in a discharge temperature uplift of up to 15°C above ambient for 100 seconds. This situation is unlikely to occur more than a few times over the lifetime of the Power Station.

13.6.648 During commissioning and non-standard operational conditions, there may be a rise in the temperature of the discharge of more than 12°C above ambient (98 percentile), but any exceedance would be balanced out over the discharge consent averaging period by varying reactor load to ensure that temperature thresholds (98 percentile) are met within the agreed mixing zone.

Effects of thermal discharge on marine water quality

13.6.649 To determine the magnitude of effect on the receiving waters, a comparison is made of the areas of mixing zones, in relation to the area of the receiving water bodies. This can be used to consider whether the mixing zones are proportionate and whether there could be any related effects on other receptors.

13.6.650 The Skerries and Anglesey North WFD water bodies are 4,723ha and 12,600ha respectively. The thermal plume would be dispersed over both water bodies. The thermal plume will be in a constant state of flux and the proportion of the plume within the water bodies will change with the tide. For the purposes of assessment, the area of the thermal plume that falls within each water body has been calculated and the proportion of the mixing zone in comparison to the water body has been derived (table D13-39).

13.6.651 The Skerries water body is achieving high status and therefore the 2°C boundary is relevant, whereas the Anglesey North water body is currently at

[4] System frequency is a continuously changing variable that is determined and controlled by the second-by-second (real time) balance between system demand and total generation. If demand is greater than generation- the frequency falls, while if generation is greater than demand the frequency rises (National Grid, 2016).

moderate status and therefore the exceedance should be considered in relation to a 3°C boundary, although the 2°C has also been considered.

13.6.652 This shows that in the worst case scenario the 2°C (98 percentile) mixing zone in the Anglesey North water body would be 0.97% of the water body area at the surface. The 2°C (98 percentile) mixing zone in The Skerries water body would be 1.69% of the water body area at the surface.

Table D13-39 Proportion of WFD water bodies exceeding 2°C and 3°C boundaries (98 percentile)

Scenario	WFD water body	Proportion of the water body exceeding boundaries (98 percentile) at the surface (%)		Proportion of the water body exceeding boundaries (98 percentile) at the seabed (%)	
		>2°C	>3°C	>2°C	>3°C
Annual base case ($126m^3/s$ at +12°C (98 percentile)) – no wind	Anglesey North	0.97	0.27	0.03	0.02
	The Skerries	1.69	1.09	0.04	0.03
Summer base case ($126m^3/s$ at +12°C (98 percentile)) – with variable wind	Anglesey North	0.32	0.11	0.02	0.01
	The Skerries	1.11	0.75	0.05	0.03

13.6.653 The total area of the 23°C (maximum) mixing zone at the surface is 14.6ha. The proportion of the mixing zone within the two water bodies is shown in table D13-40. The largest mixing zone occurs in The Skerries water body where, in the annual base case and the summer base case with variable wind, the 23°C (maxima) boundary would be exceeded at the surface over an area equivalent to 0.3% of the water body.

Table D13-40 Proportion of WFD water bodies exceeding the 23°C boundary

Scenario	WFD water body	Proportion of the water body exceeding the 23°C boundary (98 percentile) at the surface (%)
Annual base case ($126m^3/s$ at +12°C (98 percentile)) – no wind	Anglesey North	0.1
	The Skerries	0.3
Summer base case ($126m^3/s$ at +12°C (98 percentile)) – with variable wind	Anglesey North	0.1
	The Skerries	0.3

13.6.654 Given the large area of the water bodies and the comparatively small area of the thermal plume at the surface and seabed, the magnitude of change is predicted to be small and the effects on WFD water bodies from the thermal discharge is considered to be negligible.

Effects of thermal discharge on phytoplankton and zooplankton communities

13.6.655 Plankton have limited motility and their distribution is governed by external factors including the hydrodynamic regime and degree of vertical mixing. Localised effects are therefore usually hard to detect in coastal waters owing to the patchiness of plankton concentrations. Separating the effects of entrainment and temperature is difficult and therefore consideration has been given to thermal effects within the assessment of effects of entrainment (see paragraphs 13.6.547 to 13.6.559).

13.6.656 An increase in water temperature can directly affect planktonic species as metabolic rates are linked to temperature. The temperature tolerances of any organism are complex and tolerance will vary both within individuals and within the lifetime of any one individual [RD233]. All species will have an upper limit which, if exceeded, will have adverse effects ranging from a reduction in productivity to mortality [RD234]. Where a thermal discharge raises water temperature above the optimum range of plankton, this can have a negative effect on the survival and growth of plankton and thus the wider community. Such changes in community structure may lead to lower abundance of benthos and fish [RD235].

13.6.657 Effects on individual species can, in turn, potentially lead to changes in species' community composition and distribution. This results from some species being more (or less) successful at coping with environmental change, conferring competitive advantage (or disadvantage) to certain species over others. This can lead to a change in the assemblage, which currently constitutes the 'characteristic' species complement for the area.

13.6.658 Primarily, it is the degree of change in temperature from the ambient temperatures, to which the organism is adapted, which will dictate the response. Competitive advantage or disadvantage to planktonic species resulting from increased temperatures can lead to an increase in the occurrence of Lusitanian species and a decrease in the occurrence of cold boreal species. For example, Southward *et al*., [RD236] noted the observed latitudinal shifts in planktonic communities coinciding with climate shifts over the twentieth century. Additionally, an increase in water temperature may increase the possibility of the successful establishment of self-sustaining populations of exotic plankton species, and exotic species having planktonic life stages, released into the area from, for example, ballast water. However, Naylor [RD237] reported that although there were instances where introductions of 'southern' immigrant species had been recorded, there was little evidence of such establishments replacing indigenous species.

13.6.659 Phytoplankton respond rapidly to changes in environmental factors. Baseline surveys have demonstrated that seasonal patterns in abundance and community composition are driven by changes in light and nutrients.

Whilst temperature affects rates of growth and reproduction, other factors may have a greater influence on productivity including the availability of nutrients [RD235] and light [RD238].

13.6.660 A study on the effects of high temperature on marine phytoplankton undertaken by Hirayama and Hirano [RD239] reported that Cooling Water discharges from power stations rarely adversely affect marine plankton even in the immediate vicinity of the discharge. This study investigated potential harmful effects on plankton from heated effluents, focusing on direct inhibitory influences of high temperature (in conjunction with residual chlorine) on growth, and photosynthesis of marine phytoplankton. For the phytoplankton species studied, adverse effects were not apparent until significant temperatures had been reached (>35°C, a temperature rise of 15°C relative to the 'ambient' temperature of the experimental media used at 20°C), far in excess of temperatures (or temperature rise) that would be experienced at the Cooling Water outfall.

13.6.661 Zooplankton abundance was dominated by Arthropoda (specifically Copepoda) and exhibited a lag response to the seasonal peaks in phytoplankton abundance. Metabolic rates in zooplankton are dependent on temperature [RD240] as seen in the copepod (*Pseudodiaptomus hessei*) which showed exponentially increasing metabolic rates with increasing temperature [RD241].

13.6.662 In terms of zooplankton, copepods, such as *Acartia tonsa,* have been found to tolerate temperatures of between –1ºC and 32ºC [RD242]. *Temora longicornis* has been found to be able to adjust to changing environmental temperatures. This species tolerates an increase in temperature above its normal range, (with test conditions of up to 24ºC) and the response to temperature rise is an increase in swimming activity [RD243].

13.6.663 One study at a power station considered the entrainment of the planktonic stage of three crustacean species, *A.tonsa, C.crangon* and *H.gammarus*, and found that on its own, elevated temperature did not have a significant effect on these species, although it was noted that at temperatures above 8ºC *C.crangon* had a greater sensitivity to TRO [RD244].

13.6.664 The modelling shows that exposure to temperatures in excess of 2°C (98 percentile) above ambient, up to a maximum of 12°C (98 percentile), is restricted to locations in the immediate vicinity of the outfall. Within this body of water, plankton is likely to be exposed to temperatures that would affect their metabolic function and could even result in mortality.

13.6.665 Beyond the immediate vicinity of the outfall, modelling showed that in the worst case scenario, temperatures at the surface would increase by up to 2°C (98 percentile) above ambient over an area of approximately 209ha. This increase is restricted to the surface layer. At the seabed, the 2°C (98 percentile) temperature rise affects only around 4ha. In terms of absolute temperature, at the surface there would be an increase above 23°C (98 percentile) over an area of approximately 14ha.

13.6.666 Within the water column, peak phytoplankton abundance occurs within 5m or 10m of the water surface; zooplankton are also known to exhibit diel vertical migrations to even greater depths. Therefore, the majority of the planktonic community would not be exposed to a temperature increase that would affect their metabolic rate, with the exception of the communities in the vicinity of the outfall. The effects are not considered likely to have any wider implications for the abundance and diversity of plankton communities. Therefore, the magnitude of change is predicted to be negligible and the effect on plankton communities from the thermal discharge is considered to be negligible.

Effects of thermal discharge on intertidal and subtidal habitats and communities

Thermal tolerances of habitats and species

13.6.667 In their natural environment, marine organisms, of a given species and life stage, occupy areas with water temperatures that best suit their genetic predisposition and their state of physiological adaptation, described as the thermal optima. This is the temperature condition which a species finds the most favourable for growth and reproduction. Each species has a thermal tolerance range which can be demarcated by its lower critical and upper critical limits [RD245].

13.6.668 There are three key factors relating to a thermal discharge from an outfall which determine the biota that may be exposed and the degree of physiological stress:

- the rise in mean ambient temperatures (e.g. the ΔT +°C values);
- the absolute temperature, where the maximum temperatures are sufficiently high to interfere with biological processes and approach an organism’s lethal limits; and
- the warm water fronts from the discharge and plume, which shift tidally causing a localised increase in the short-term fluctuations in temperatures across the seabed [RD246]; [RD219].

Consideration of a recovered baseline

13.6.669 It is recognised that the current baseline environment in the vicinity of the outfall is likely to change following the cessation of the discharge from the Existing Power Station on 30 December 2015. Recolonisation of this area is currently at an early stage and it is likely to be some years before the habitats reach a stable state where species abundance and diversity is similar to the surrounding habitats.

13.6.670 As a precautionary approach, the assessment considers that, by the start of the operational phase, the habitats in close proximity to the outfall will have recovered and would be similar to those in the surrounding area.

Intertidal habitats and communities

13.6.671 Intertidal habitats and species are naturally exposed to a greater degree of thermal stress than subtidal species, as they are periodically exposed to elevated temperature and desiccation when immersed during low tide. For example, on uncovered sandflats of Milford Haven (south Wales) temperature rises of 0.2°C/min were recorded in the summer and, during early autumn, temperatures ranged between 15°C and 26°C on the shore [RD247]. Beyond these seasonal fluxes in temperature are short-term diurnal and tidal shifts in temperature with organisms subjected to rapid changes in temperature. Under such fluctuating thermal conditions, behavioural responses, physiological acclimation and evolutionary adaptation of these intertidal populations will be important [RD248]; [RD249]. A review of thermal impacts from discharges [RD224] identified shifting temperature interfaces as being one of the main negative impacts on flora and fauna. The report concluded that most fauna should be able to tolerate tidal temperature shifts of up to 3°C.

13.6.672 Most intertidal macroalgae species generally live close to their upper thermal tolerance limits and have a lower ability to respond to further rising temperatures [RD250]; [RD251]. Some algal species are particularly sensitive to elevated temperature; a study by Howalls and Langford [RD252] found that *Ascophyllum* sp. and *Fucus* spp. were eliminated from a rocky shore in Maine, USA where a power station had raised the temperature to between 27°C and 30°C. These species were both replaced by *Ulva intestinalis*. The replacement of fucoids and other macroalgae by ephemeral species such as *Cladophora* and *Ulva* seems to be a typical community response to pressure.

13.6.673 Available scientific literature, the MarLIN MarESA and professional judgement has been used to determine if a community is stenothermal (able to tolerate only a small range of temperature conditions). Table D13-41 is closely derived from that provided by MarLIN for the hydrological pressure temperature increase. The criteria for this pressure are an increase in water temperature of 5°C for one month, or 2°C for one year, excluding temperature changes from global warming (climate change).

13.6.674 MarLIN has carried out a MarESA based on resistance, resilience and sensitivity to a pressure. Resistance indicates whether a receptor can absorb disturbance or stress without changing character. Resilience is the ability of a receptor to recover from a given pressure, and sensitivity is a function of the ability of the feature to tolerate or resist change (resistance) and its ability to recover from an impact (resilience) [RD253].

13.6.675 All assessment against resilience was either high (full recovery in two years) or medium (full recovery in two to 10 years). Information on the resistance, resilience and sensitivity, as well as whether a species is stenothermal, can be found in table D13-41.

Table D13-41 Resistance, resilience and sensitivity of intertidal biotopes at the outfall to an increase in temperature

Biotope complex code	Biotope description	Resistance	Resilience	Sensitivity	Stenothermal
LR.MLR.BF.PelB	*Pelvetia canaliculata* and barnacles on moderately exposed littoral fringe rock	Medium	Medium	Medium	No
LR.MLR.BF.Fser.R	*Fucus serratus* and red seaweeds on moderately exposed lower eulittoral rock	High	High	Not sensitive	No
LR.MLR.BF.FspiB	*Fucus spiralis* on exposed to moderately exposed upper eulittoral rock	High	High	Not sensitive	No
LR.HLR.FR.Coff	*Corallina officinalis* on exposed to moderately exposed lower eulittoral rock	High	High	Not sensitive	No

Note: All sensitivities listed are based on a decrease or increase in temperature of 5°C over one month, or 2°C for one year.

13.6.676 The influence of the Cooling Water discharge at the Existing Power Station on communities is described in paragraph 13.3.90. The effects recorded from the outfall surveys show similar patterns to those described in the literature and can be used to provide an indication of the distance from the outfall at which communities could be affected.

13.6.677 Both intertidal and shallow subtidal surveys from the late 1980s [RD23]; [RD254] and from the present day have shown that the existing discharge causes a gradient of impoverished fauna and flora on the rocky reef communities. Within the intertidal zone, the effects of the discharge were recorded up to 250m. The Existing Power Station operated at 70m^3/s with a temperature rise of 10.3°C. Bamber considered this impoverishment to be related to thermal stress rather than the influence of scour or the effects of antifouling agents in the Cooling Water, and discussed similar effects recorded at other power stations such as Hinkley Point, Somerset [RD255].

13.6.678 Based on modelling and on studies of the Existing Power Station Cooling Water outfall, it is predicted that within a few hundred metres there would be very low species diversity, representing a marked change to the baseline natural composition of intertidal habitats and species.

13.6.679 The intertidal habitats that would be affected are considered to be rocky reef Annex I habitat (0.3ha) and are assigned a medium value. The effects of the thermal plume on intertidal habitats are likely to result in a reduction in abundance of some species and degradation of intertidal habitat. However, as with the Existing Power Station, this would occur over a small area of the intertidal shore and would not affect the wider integrity of this receptor. Therefore, the magnitude of change is predicted to be small and it is considered that there would be a minor adverse effect on intertidal habitats and communities (including those of conservation importance) from thermal discharge.

Subtidal habitats and communities

13.6.680 Subtidal organisms are naturally less adapted to wide fluctuations or increases in temperature than those in intertidal communities, and as a result could be more susceptible to the effects of thermal stress.

13.6.681 There is an absence of thermal tolerance data for the majority of the sessile, sublittoral reef organisms such as sponges, tunicates, cnidarians and bryozoans. However, it is expected that an increase in temperature could affect reproduction and therefore could affect an organism's ability to colonise new areas. Other potential effects from exposure to high temperatures include, for example, bleaching in cnidarians.

13.6.682 Two key macroalgae species are considered to be stenothermal, *Alaria esculenta* and *L.hyperborea.* None of the benthic invertebrate species recorded in the Wylfa Newydd Development Area are considered stenothermal.

13.6.683 The habitats (biotopes) within Porth Wnal were recorded during the outfall surveys and the MarLIN MarESA have been used to consider the effects on the subtidal communities recorded around Porth Wnal (Table D13-42). Based on scientific literature and the MarLIN MarESA, an indication has been given as to whether a community is likely to be stenothermal.

13.6.684 The outfall surveys did not record any priority habitats listed in accordance with the requirements of Section 7 of The Environment (Wales) Act 2016.

13.6.685 The Cooling Water outfall is designed to direct the plume away from the seabed, and the buoyancy of the plume is demonstrated in the vertical profiles in figure D13-32. Modelling predicted that the area of seabed exposed to temperatures in excess of 2°C (98 percentile) above ambient would be restricted to the immediate vicinity of the outfall, over an area of 4.2ha in the worst case scenario (table D13-37). Within this area, temperatures will fluctuate, and habitat in the immediate vicinity of the outfall would be exposed to temperatures up to a maximum of 12°C above ambient (98 percentile).

Table D13-42 Resistance, resilience and sensitivity of subtidal biotopes at the outfall to an increase in temperature

Biotope complex code	Biotope description	Resistance	Resilience	Sensitivity	Stenothermal
IR.HIR.KFaR.FoR	Foliose red seaweeds on exposed lower infralittoral rock	High	High	Not sensitive	No
IR.MIR.KR.Lhyp.Ft	*Laminaria hyperborea* forest and foliose red seaweeds on moderately exposed upper infralittoral rock	Medium	Medium	Medium	No
IR.MIR.KR.Lhyp.Pk	*Laminaria hyperborea* park and foliose red seaweeds on moderately exposed lower infralittoral rock	Medium	Medium	Medium	No
IR.MIR.KR.LhypT (derived from the assessment of IR.MIR.KR.LhypT.Ft and IR.MIR.KR.LhypT.Pk)	*Laminaria hyperborea* on tide-swept, infralittoral rock	Medium	Medium	Medium	No
IR.MIR.KR.XFoR	Dense foliose red seaweeds on silty moderately exposed infralittoral rock	High	High	Not sensitive	No

Note: All sensitivities listed are based on a decrease or increase in temperature of 5°C over one month, or 2°C for one year.

13.6.686 At the Existing Power Station, the subtidal outfall surveys recorded a clear, acute effect on the infralittoral rocky reef communities within 100m of the outfall, with kelp notably absent from this area. There were clear shifts in the dominant taxa within 150m to 200m of the outfall and subtler effects were recorded out to 300m. Beyond 300m from the outfall there were no significant differences in the subtidal communities observed (appendix D13-5, Application Reference Number: 6.4.87).

13.6.687 The Existing Power Station operated at 70m^3/s with a temperature rise of 10.3°C, and the observed effects cannot be directly related to the influence of temperature alone. However, it does provide some indication of the likely scale of effects on benthic communities.

13.6.688 Within a few hundred metres of the outfall, it is likely that there would be a loss of key characterising species, particularly *L.hyperborea*, that has an upper lethal limit of around 23°C (which in summer is approximately 7°C above ambient) (see appendix D13-5, Application Reference Number: 6.4.87). Diversity is likely to be affected within a few hundred metres of the outfall and the effects would extend further than those observed at the Existing Power Station. Based on the outfall surveys, it is likely that there would be a decrease in densities of brown algae and red algae close to the Cooling Water outfall, and an increase in densities of green algae.

13.6.689 An area of 4.2ha of subtidal habitats and species not considered to be of conservation importance would be exposed to temperatures up to 2°C above ambient, which includes subtidal habitat within Porth Wnal and to the west of Wylfa Head. The main effects are likely to occur within a few hundred metres of the outfall. There would be a permanent reduction in the abundances of some species and degradation of subtidal habitat, with the severity of the effect declining with increasing distance from the outfall. The subtidal habitats affected by the thermal plume are common along the coastline and the loss would not result in wider effects on the structure and function of subtidal habitats. Mobile benthic species would move away from the outfall to a location that would be more favourable for growth and reproduction.

13.6.690 Considering the extent of the effect on subtidal habitats and communities (including those of conservation importance) the magnitude of change is predicted to be medium and it is considered that there would be a minor adverse effect on subtidal habitats and communities from thermal discharge.

Invertebrates of conservation importance

13.6.691 There are no records of the spiny lobster within the vicinity of the outfall, however, if it were present, it is a mobile species and therefore has the ability to move away from warmer water. Therefore, the magnitude of change is negligible and the effect is negligible.

Effects of thermal discharge on marine fish

13.6.692 In terms of more mobile species, Magnuson *et al*., [RD256] proposed the concept of fish occupying a ‘thermal niche’, i.e. a range of temperatures in which fish prefer to live. They found that most fish spent two-thirds of their time within 2ºC of their temperature preferendum and all of their time within 5ºC. Fish choose to spend as much time as possible in their preferred temperature range but will venture into sub-optimal conditions to exploit resources such as food. However, in doing so they compromise their growth rate. The ability of fish to seek areas out of their preferred temperatures can therefore be seen as critical to their ecological performance, and explains shifting distributions of species in response to climatic changes [RD257]; [RD258].

Ichthyoplankton

13.6.693 Ichthyoplankton distribution is largely dependent on external factors especially in earlier life stages, and populations are patchy in nature. As juveniles mature, their swimming ability increases and there will be some degree of selectivity in their location in areas of weaker currents. Separating the effects of entrainment and temperature is difficult and therefore consideration has been given to thermal effects within the assessment of effects of entrainment (see paragraphs 13.6.563 to 13.6.584). There is a paucity of data on the effects of temperature alone on fish larvae and especially on the effects on recruitment.

13.6.694 A study on the effect of water temperature on ichthyoplankton concluded that the highest temperature increase that most eggs can tolerate is 6ºC from the centre of their optimum temperature range [RD259]. Marine fish will spawn within a few degrees of the optimum temperature to produce the maximum number of viable eggs.

13.6.695 Sandeel eggs are demersal, and are spawned directly within the adult habitat where they adhere to sand grains and remain until hatching [RD260]; [RD261]. Following hatching, larvae become pelagic and enter the water column. Following metamorphosis, juveniles exhibit burrowing behaviour from September until spring (March to April) [RD262]; [RD261]; [RD263]. The hydrodynamic modelling predicts that a bed temperature rise of over 2°C (98 percentile) is restricted to Port Wnal and just west of Wylfa Head. The subtidal habitat in this location is silt overlying bedrock which is not suitable sandeel habitat and therefore no effect on sandeel eggs is predicted.

13.6.696 Once operation is established, the ichthyoplankton communities adjacent to the outfall are likely to comprise those which have been entrained within the CWS. The loss of ichthyoplankton from entrainment is assessed in paragraphs 13.6.563 to 13.6.584.

13.6.697 Fish larvae may be transported by currents from spawning grounds (plaice, Dover sole and whiting) around Anglesey to the waters in proximity to the outfall that are influenced by the thermal discharge. The modelling shows that exposure to temperatures in excess of 8°C (98 percentile) above ambient, up to a maximum of 12°C (98 percentile), is restricted to Porth Wnal and to the west of Wylfa Head. Within this body of water, ichthyoplankton are likely to be exposed to temperatures that would affect their metabolic function and could even result in mortality.

13.6.698 Beyond the immediate vicinity of the outfall, the modelling showed that in the worst case scenario, temperatures at the surface would increase by up to 2°C (98 percentile) above ambient over an area of approximately 200ha. At the seabed, the 2°C (98 percentile) temperature rise is predicted to affect 4.2ha. Ichthyoplankton are distributed throughout the water column and the highest temperature increases are restricted to the surface layer, so only a small proportion of the ichthyoplankton would be subjected to the highest temperature increases.

13.6.699 The peak in sandeel larvae occurs in February and March (see appendix D13-4, Application Reference Number: 6.4.86). With the exception of the surface waters immediately adjacent to the outfall, the increase in temperature would not expose sandeel larvae to absolute temperatures outside of their known tolerance. In addition, the highest abundances of sandeel larvae were recorded at the sites furthest offshore where the temperature rise would be reduced compared to the rise in the vicinity of the outfall.

13.6.700 The exposure of ichthyoplankton to the thermal plume is not considered likely to result in changes to communities in terms of abundance and diversity. The duration that individual larvae would be exposed to high temperatures would be short given the momentum of the Cooling Water discharge and the rapid mixing processes in the coastal waters. Therefore, the magnitude of change is predicted to be negligible and the effect on ichthyoplankton from thermal discharge is considered to be negligible.

Fish (of conservation and/or commercial importance)

13.6.701 Depending on the species, temperature may have a positive, negative or neutral effect on subtidal fish populations. Langford [RD233] examined data from power plant studies around the world and found no instance of direct fish mortalities associated with a power plant outfall. The main effects to consider are therefore sub-lethal effects such as active thermal avoidance or attraction, changes in growth rate or the modification of community structure resulting from warm-water species being favoured over cold-water species.

13.6.702 The fish species recorded in baseline surveys of conservation and/or commercial importance are listed in table D13-3. Of these, sandeel, plaice and herring were the most abundant with other notable species being mackerel, cod, Dover sole and sea trout (medium importance). Eel and river lamprey (high importance) are also considered as these species have been recorded in entrapment surveys. The thermal tolerances of the majority of these species were considered within the BEEMS [RD224] and Wither *et al.*, [RD231] studies, which derived thresholds based on the most sensitive cold-water fish species.

13.6.703 Baseline surveys recorded sandeel in all seasons in both intertidal and subtidal surveys. Densities of adult sandeel were much higher at sites east of Wylfa Head which is likely to be related to the presence of suitable sandy substrate (see appendix D13-4, Application Reference Number: 6.4.86). Sandeel alternate between burrowing in sand and feeding in the water column. The subtidal habitat in the immediate vicinity of the outfall is silt overlying bedrock which is not suitable sandeel habitat, although this area may be used for feeding.

13.6.704 A spawning ground for plaice is located on the east of Anglesey and baseline surveys recorded plaice in consistently high numbers at sites east of Wylfa Head at the wide sandy beaches (see appendix D13-4, Application Reference Number: 6.4.86). However, there is an absence of suitable substrate for plaice in the vicinity of the outfall.

13.6.705 In both the intertidal and subtidal fish surveys, herring were recorded in particularly high numbers at sites on the east coast of Anglesey compared to sites on the west and north coasts. Whiting was the most abundant species in the subtidal fish surveys and again peak numbers were observed at sites on the east coast of Anglesey (appendix D13-4, Application Reference Number: 6.4.86). Sea trout were recorded in seine nets in Cemaes Bay and very occasionally in Porth-y-pistyll. European eel, river lamprey and Atlantic salmon, if present, would be migrating to or from freshwater habitat. These species navigate by following the seabed and may be exposed to higher temperatures for a short duration when navigating around Porth Wnal.

13.6.706 Some fish species currently utilise the waters around the outfall for feeding. For species where the habitat type is not suitable, fish may visit the area infrequently before returning to more favoured habitat (e.g. sandeel). During operation some species may choose not to utilise the area in the immediate vicinity of the outfall where temperatures are noticeably warmer. The area that fish may avoid would depend on the species. It is likely that there would only be a noticeable change in behaviour at temperatures of 2°C or higher for the majority of species present. The waters and habitats adjacent to the outfall are not considered to provide a vital food source or refuge for fish species of conservation and/or commercial importance. Although fish will navigate along the coastline, they are able to drop down to near the seabed for a short duration to avoid the warmer water if preferred. It is possible that some species, e.g. sandeel, may alter their feeding behaviour to avoid warmer water at the surface, although again effects are not likely to be noticeable below 2°C and would only result in localised displacement, rather than effects on fish communities.

13.6.707 A rise in water temperature is unlikely to adversely affect bass as they are known to associate with warmer water, particularly in their juvenile stages [RD264].

13.6.708 It is likely that most fish would avoid the waters with the highest temperatures in close proximity to the Cooling Water outfall. The thermal plume would not affect the breeding success of fish species of conservation and/or commercial importance and therefore would not affect wider fisheries. The magnitude of change is predicted to be negligible and the effect on fish of conservation and/or commercial importance from thermal discharge is considered to be negligible.

General fish and fisheries

13.6.709 A total of 42 fish species were recorded in the baseline surveys and, of the other species not of commercial or conservation importance, the most abundant were Gobiidae and sand smelt. Some species, such as Gobiidae, are likely to actively move away from the immediate vicinity of the outfall where the greatest fluctuations in temperature would be experienced. The optimum growth temperature of common goby, *Pomatoschistus minutus* was found to be between 17ºC and 22.6ºC with a thermal preference of 17.3ºC and an upper lethal temperature of 31ºC [RD265]. Subtidal habitats, which provide a food resource and refuge, would be altered and may no longer provide these services. However, similar habitats are abundant along the coastline and the loss of this area for fish is not considered likely to affect recruitment or wider fish populations.

13.6.710 The thermal plume would not affect the breeding success of fish and therefore would not affect wider fisheries. The magnitude of change is predicted to be negligible and the effect on general fish and fisheries from thermal discharge is considered to be negligible.

Effects of thermal discharge on marine mammals

13.6.711 Marine mammals are physiologically adapted to regulate their body temperature. Although the increase in temperature in the vicinity of the discharge may be noticeable to marine mammals, it would be within the natural temperature range that would be experienced by these species (e.g. when diving and moving between coastal and estuarine waters or when hauling-out as in the case of grey seals). Therefore, the magnitude of change is predicted to be negligible and the effect on marine mammals from the thermal discharge is considered to be negligible.

Effects of thermal discharge on seabirds

13.6.712 There is no direct pathway from an increase in water temperature to effects on seabirds. There is a negligible effect on the fish species that provide a food source for seabirds. Baseline surveys show that terns do not significantly utilise the area around the outfall to actively feed (see appendix D13-7, Application Reference Number: 6.4.89), so the foraging in this area is not considered to be a significant resource.

13.6.713 It is possible that some fish prey species may be less available to terns if fish choose to feed deeper within the water column, potentially outside the hunting range of terns. Considering the thermal tolerances of fish, there may be a noticeable effect at temperatures above 2°C, which would equate to an area of 201.6ha where feeding may be affected.

13.6.714 In relation to the feeding grounds that are available to terns, this is a very small area and considered to be insignificant as similar habitats are abundant along the coastline.

13.6.715 The food resource is not likely to be lost, rather it would be displaced. During feeding, sandeel are likely to tolerate sub-optimal temperatures for short periods of time to utilise the food resources in the upper water column. In addition, the Irish Sea is known to support several species of sandeel, with those species preferring colder waters and those preferring warmer waters, present. It is therefore likely that should boreal species be displaced from the area to different feeding grounds, the Lusitanian species are more than likely to exploit the areas left.

13.6.716 Therefore, the magnitude of change is predicted to be negligible and the effect on seabirds from the thermal discharge is considered to be negligible.

Effects of thermal discharge on designated sites

13.6.717 The extent of the thermal plume has been considered in relation to the North Anglesey Marine/Gogledd Môn Forol cSAC, Anglesey Terns/Morwenoliaid Ynys Môn SPA), and indirect effects of thermal changes on the Cemlyn Bay SSSI via potential effects on the seabird assemblage (table D13-43).

Table D13-43 Proportion of the North Anglesey Marine/Gogledd Môn Forol cSAC and Anglesey Terns/Morwenoliaid Ynys Môn SPA exceeding a 2°C boundary

Scenario	Designated nature conservation site	Proportion of the site exceeding 2°C (98 percentile) at the surface (%)	Proportion of the site exceeding 2°C (98 percentile) at the seabed (%)
Annual base case ($126m^3/s$ at +12°C (98 percentile)) – no wind	North Anglesey Marine/ Gogledd Môn Forol cSAC	0.06	0.001
	Anglesey Terns/ Morwenoliaid Ynys Môn SPA	0.21	0.004
	Cemlyn Bay SSSI	N/A	N/A
Summer base case ($126m^3/s$ at +12°C (98 percentile)) – with variable wind	North Anglesey Marine/ Gogledd Môn Forol cSAC	0.03	0.001
	Anglesey Terns/ Morwenoliaid Ynys Môn SPA	0.10	0.004
	Cemlyn Bay SSSI	N/A	N/A

13.6.718 There are no effects predicted on the features of the designated sites either directly or indirectly and therefore the magnitude of change is predicted to be negligible and the effect on designated sites from the thermal discharge is negligible.

Impact pathway: discharge of Cooling Water – thermal effects on spread of non-native species

General context

13.6.719 The Cooling Water discharge for the Power Station would be located at Porth Wnal, adjacent to the outfall of the Existing Power Station. The discharge water would be approximately 12°C (98 percentile) warmer than the water being abstracted. The volume of water discharged would vary over the tidal cycle from $113m^3/s$ at LAT to $126m^3/s$ at highest astronomical tide. Hydrodynamic modelling has been based on a tidal average value with an allowance made for potential inefficiencies over the lifetime of the CWS. The modelling is therefore based on Cooling Water being discharged at a rate of $126m^3/s$ (tidal average plus 5%).

Non-native species

13.6.720 The risk of introduction of non-native species would be very low during the operational phase as there would be limited pathways for introduction. During operation, the MOLF would only be used very infrequently for occasional deliveries.

13.6.721 Prior to operation, marine life would have become established on areas of new substrate (e.g. the breakwaters and MOLF) over a period of around six years following the completion of the Marine Works.

13.6.722 If non-native species are present in the surrounding waters, then based on evidence from the Existing Power Station it is possible that some species adapted to warmer water could become established in the Cooling Water outfall channel. The baseline for non-native species will continue to evolve during the construction phase and therefore it is not possible to accurately predict the species that could become established. The species observed in the outfall at the Existing Power Station included *C.fragile, A.armata* and *D.japonica*. It was noted that the Cooling Water outfall did not support an unusual abundance of non-native species. *A.armata* and *D.japonica* continued to be present at other sites, further afield, in comparable abundances. *C.fragile* was not recorded at survey sites outside of the outfall channel and this species is better adapted to warmer waters, with its spread limited by cooler temperatures [RD124]. It is possible that *C.fragile* would become established in the Cooling Water outfall of the Power Station, but its distribution would be confined to the area of warmer water in proximity to the outfall.

13.6.723 The risk of introduction and colonisation of non-native species during operation is considered to be low and therefore the magnitude of change is predicted to be negligible. The effect on native habitats and species (including invertebrates of conservation and commercial importance) from the establishment of non-native species linked to the thermal plume is predicted to be negligible.

Effects on zooplankton and phytoplankton

13.6.724 There is a small risk that some southern species, including harmful/toxic species, could be favoured within the vicinity of the outfall, but these communities would not be sustained beyond Porth Wnal where temperatures return close to ambient, and therefore this would not affect wider communities. The non-native diatom *C.wailesii*, which is already present in the area and has known ecological impacts (see paragraph 13.6.247), is known to grow well in a wide range of temperatures from 0°C to 20°C; therefore, it is unlikely that increased surface temperatures will favour its growth.

Impact pathway: discharge of Cooling Water – thermal effects on dissolved oxygen

General context

13.6.725 An increase in temperature decreases the solubility of gases in water and therefore could affect the dissolved oxygen concentration in the water column.

Dissolved oxygen standards

13.6.726 The standards for dissolved oxygen are outlined in the WFD (Standards and Classification) Directions (England and Wales) 2015. Salinity in the coastal waters ranged between 32.80 and 35.29. The standards for dissolved oxygen concentrations are defined in relation to salinity and the most conservative values have been used in the assessment, as outlined in Table D13-44.

Table D13-44 Dissolved oxygen standards for coastal water bodies (normalised to salinity 35)

Status	Dissolved oxygen concentration (mg/L) as 5 percentile values
High	5.7
Good	4.0
Moderate	2.4
Poor	1.6

Modelling

13.6.727 The dissolved oxygen saturation concentration, as a function of temperature and salinity, was calculated using a formula by Benson and Krause [RD266]. Based on the assumption that the water is saturated at the existing ambient temperature, the hydrodynamic model can then be used to calculate the dissolved oxygen concentration at a particular temperature.

13.6.728 The calculations assumed a constant salinity of 33.6 (the average measured at mooring S9 from February to December 2011), a temperature equal to the 95 percentile ambient plus the maximum predicted temperature rise.

Thermal effects on dissolved oxygen and the effects on marine water quality

13.6.729 The average dissolved oxygen saturation levels recorded at the two monitoring buoys closest to the outfall was 99.4% at S9 and 94.8% at S2 (further offshore) (see appendix D12-2, Sediment Regime, Application Reference Number: 6.4.81).

13.6.730 The minimum predicted dissolved oxygen concentration, assuming average salinity of 33.6 and a maximum temperature rise, is greater than the high status boundary value of 5.7mg/L. The minimum saturated dissolved oxygen concentration occurs at the discharge, where the temperature increase is greatest.

13.6.731 As the predicted dissolved oxygen concentration remains well above the concentration required to achieve high status, the magnitude of change is predicted to be negligible. It is therefore considered that there would be no effect on water quality from changes to dissolved oxygen as a result of the thermal discharge.

13.6.732 Based on the high status of the predicted dissolved oxygen concentration, it is considered that there would be no effect on biological receptors from changes to dissolved oxygen concentrations as a result of the thermal discharge.

Impact pathway: discharge of Cooling Water – thermal effects on pH and on the ratio of ionised to unionised ammonia

General context

13.6.733 Ammonia in water can exist in either an ionised or unionised form. The unionised form is typically more toxic to aquatic life. The ratio of ionised to unionised ammonia varies with temperature and pH; the concentration of unionised ammonia increases as the temperature increases. The temperature increase from the operation of the Cooling Water discharge could therefore alter the natural ratio.

Unionised ammonia standards

13.6.734 The standard for unionised ammonia is given as a long-term EQS of 21µg/L. The equilibrium of the ionised to unionised ammonia is particularly sensitive to changes in pH. At pH 8.5, the proportion of unionised ammonia is approximately 10 times that at pH 7.5 and, for every 9°C increase in temperature, the proportion of unionised ammonia approximately doubles [RD267].

Effects on marine water quality

13.6.735 Baseline data collected for the Wylfa Newydd Project indicate that the average concentration of ammonia is 0.0293mg/L as nitrogen (N) and for unionised ammonia it is 0.58µg/L as N (see appendix D13-1, Application Reference Number: 6.4.83). The average concentrations of ammonia to unionised ammonia show approximately 2% of the ammonia was in the unionised form.

13.6.736 The observed unionised ammonia ratio is similar to that calculated using the United States Environment Protection Agency [RD268] formula [RD269]. This formula has been used to calculate the unionised ammonia concentration for a range of temperature increases up to the maximum temperature rise of 12°C (Table D13-45).

Table D13-45 Predicted unionised ammonia concentration as a function of temperature at salinity 34.3 and pH 8.07

Condition	Temperature (°C)	Ratio	Unionised ammonia (µg/L)
Average ambient	11.78	0.020	0.60
Average + 12°C	23.78	0.048	1.42
Max ambient	16.00	0.028	0.81
Max ambient + 12°C	28.00	0.065	1.91

13.6.737 For all conditions considered, the unionised ammonia remains well below the EQS and therefore the magnitude of change is predicted to be negligible. It is considered that there would be no effect on water quality from changes in pH and on the ratio of ionised to unionised ammonia as a result of the thermal discharge.

13.6.738 Based on the negligible magnitude of change on water quality, it is considered that there would be a negligible effect on biological receptors from thermal effects on pH and on the ratio of ionised to unionised ammonia.

Impact pathway: discharge of Cooling Water – TRO

General context

13.6.739 Biofouling is an almost universal problem at power stations and requires operators to implement measures for its control. The exclusion of larval and juvenile fish at intakes is becoming increasingly important, necessitating finer (smaller) screen mesh. However, this is not sufficient to prevent ingress of the <1mm planktonic larval stages of most fouling organisms, nor some of the secondary settlement stages of mussels (1mm to 5mm).

13.6.740 Small ‘hard fouling’ organisms, (young mussels, tubeworms and barnacles) together with ‘soft fouling’ (hydroids and sponges) can completely cover submerged surfaces, increasing roughness and decreasing flow, particularly in smaller-diameter ancillary cooling circuits.

13.6.741 The most common method of biofouling control (antifouling) is by chlorination. It is proposed that sodium hypochlorite would be used to control biofouling and the typical dosing regime is described in paragraph 13.5.96. Any residual biocide that is discharged with the Cooling Water is referred to as the TRO. TRO is the sum of the following oxidants:

- free (available) chlorine which is that present as an equilibrium mixture of hypochlorous acid (HClO) and hypochlorite ions (OCl-); and
- combined (available) chlorine which is available in (mainly) inorganic chloramines and in other compounds having a nitrogen-carbon link.

13.6.742 Natural waters have a ‘chlorine demand’ consisting primarily of oxidisable material – organic and non-organic, living and dead – that rapidly reduces the applied biocide concentration. Following discharge, the concentration of TRO will diminish through dilution, additional demand introduced by the receiving water and by continuing decay reactions. The biocidal potential of discharged TRO concentrations therefore depends on the chlorine demand of the water. Decay/demand would likely be greatest in late spring and summer when productivity and water temperatures are at their highest. However, relative dilution and dispersal may be greatest during autumn and winter when the coastal waters are subject to greater mixing from wind and wave action.

13.6.743 TRO reacts with virtually any oxidisable material in the water to produce compounds referred to as chlorine (produced) by-products or chlorination by-products (CBPs). Bromoform is the principle CBP generated in saline waters owing to the prevalence of bromide which provides a rapid reaction pathway to bromoform. However, exactly what CBPs are formed depends upon what is present in the water. There are known to be a great number of brominated and chlorinated chemical species that could be formed [RD270].

13.6.744 Many CBPs are known to persist in the marine environment and have been proved or suspected to be toxic, mutagenic or carcinogenic to marine organisms when subject to long-term exposure [RD271]. CBPs can also bioaccumulate in sediments, organic detritus and biota, although this has generally been found to be restricted by the concentration of bromide in seawater.

13.6.745 As the production of CBPs is dependent on the chemical characteristics of the seawater at a given point in time (most notably the concentration of bromide), it is extremely difficult to reliably predict the speciation and concentration of CBPs that could arise in the marine environment from Cooling Water discharge. However, the concentration of TRO, a component of CBPs, at the point of discharge is known and therefore dispersion can be reliably modelled. Consequently, for the purpose of this assessment, chemical and any subsequent ecological effects of Cooling Water discharge have been considered in the context of TRO. This assessment is considered to provide a reliable indication of potential effects from CBP production.

13.6.746 Acute toxic effects (mortality) of TRO would primarily be experienced by organisms entrained through the CWS. Once discharged, TRO still has the potential to affect ecological receptors, although the extent and scale of effects are less easy to predict than for entrainment, and would likely be sub-lethal. In terms of the sub-lethal effects of TRO, these could include inhibition of growth, changes in molluscan shell deposition and changes in adenosine triphosphate. The effects of TRO on receptors have been evaluated based on published data (e.g. relating to thresholds) of representative taxa, which may have similar responses or sensitivities to those inhabiting the receiving waters of the Cooling Water discharge. These evaluations are also further guided by the TRO modelling outputs, in terms of spatial extent.

TRO standards

13.6.747 There is a statutory EQS relating to the discharge of biocide products (in this case TRO) into coastal waters. The WFD (Standards and Classification) Directions (England and Wales) 2015 (Part 2, Article 1) sets the ‘end of pipe’ EQS for TRO as 0.01mg/L, as a 95 percentile. Part 2, Article 17 of the WFD (Standards and Classification) Directions (England and Wales) 2015 allows this standard to be exceeded within a designated area, a ‘mixing zone’ around the point of discharge and offers some technical guidelines for identifying a mixing zone. However, this is at the discretion of the regulator and is considered on a case-by-case basis.

13.6.748 As outlined in the WFD Directions [RD272] “The Appropriate Agency may designate mixing zones adjacent to points of discharge in surface water bodies. In mixing zones designated under sub-paragraph (1) [RD272], concentrations of one or more substances listed in table 1 may exceed the relevant EQS if those concentrations do not affect the compliance of the rest of the water body with those standards”.

Modelling parameters

13.6.749 Modelling of TRO is based on a first order decay process, both as a function of water temperature and season. The simulations used a fixed discharge condition of 126m^3/s and fixed TRO discharge concentration at the point of discharge of 0.1mg/L.

13.6.750 The Cooling Water discharge is influenced by tidal conditions, and by wind and waves, and therefore as with the thermal plume, TRO concentrations in the Cooling Water discharge would remain in a constant state of flux.

13.6.751 For the purposes of assessment, two scenarios have been used to illustrate the effects of the Cooling Water discharge. These are the same scenarios as used for the assessment of the effects of temperature from the Cooling Water discharge:

- a worst case scenario using an annual base case with a continuous discharge of 126m^3/s and no wind stress; and
- a summer base case with a continuous discharge of 126m^3/s and application of a variable wind.

Modelling results

13.6.752 The areas of the 0.01mg/L mixing zones (95 percentile) rise at the surface and seabed are presented in Table D13-46 for both the annual base case and the summer base case with variable wind. The mixing zone is shown in figures D13-36 to D13-38 (Application Reference Number: 6.4.101). Compared to the annual base case, the TRO mixing zone for the summer base case with variable wind is 48% smaller at the surface and 2% larger at the seabed.

Table D13-46 Area of the 0.01mg/L TRO (95 percentile) mixing zone

Scenario	Area at the surface exceeding 0.01mg/L TRO (95 percentile) (ha)	Area at the seabed exceeding 0.01mg/L TRO (95 percentile) (ha)
Annual base case ($126m^3/s$ at +12°C and TRO 0.1mg/L) – no wind	248	5.6
Summer base case ($126m^3/s$ at +12°C and TRO 0.1mg/L) – with variable wind	128.5	5.7

13.6.753 For the annual base case, the model predicted the following in relation to a TRO concentration of 0.01mg/L (95 percentile):

- a mixing zone at the surface extending approximately 1.1km north and 3.5km from east to west (figure D13-36, Application Reference Number: 6.4.101); and
- a mixing zone at the seabed extending 0.4km north but limited to the Port Wnal area and along the western coast of Wylfa Head (figure D13-37, Application Reference Number: 6.4.101).

13.6.754 For a summer base case with variable wind, the model predicted the following in relation to a TRO concentration of 0.01mg/L (95 percentile):

- a mixing zone at the surface extending approximately 0.9km north and 2.3km from east to west (figure D13-38, Application Reference Number: 6.4.101); and
- a mixing zone at the seabed extending 0.4km north but limited to the Port Wnal area and along the western coast of Wylfa Head.

13.6.755 A reduction in the mixing zone at the surface would be expected with the inclusion of wind due to increased vertical mixing of the TRO down towards the seabed. However, the mixing zone at the seabed is still restricted to a similar area to that seen under the annual base case.

Effects of TRO on marine water quality

13.6.756 To determine the magnitude of change on water quality, a comparison was made between the size of the TRO mixing zones and that of the receiving water bodies. This was used to consider whether the mixing zones are proportionate and whether there could be any related effects on other receptors.

13.6.757 The Skerries and Anglesey North water bodies are 4,723ha and 12,600ha respectively. The TRO mixing zone will be dispersed over both water bodies. For the purposes of assessment, the area of the TRO mixing zone that falls within each water body has been calculated and the proportion of the mixing zone in comparison to the water body has been derived.

13.6.758 Table D13-47 compares the proportion of the mixing zone to the area of each water body. This shows that in the worst case scenario the mixing zone in The Skerries water body would be 3.4% of the water body area at the surface. The mixing zone in the Anglesey North water body would be 0.6% of the water body area at the surface.

Table D13-47 Proportion of WFD water bodies exceeding 0.01mg/L TRO (95 percentile) (ha)

Scenario	WFD water body	Proportion of the water body exceeding 0.01mg/L TRO (95 percentile) at the surface (%)	Proportion of the water body exceeding 0.01mg/L TRO (95 percentile) at the surface (%)
Annual base case ($126m^3/s$ at +12°C) – no wind	Anglesey North	0.6	0.03
	The Skerries	3.4	0.08
Summer base case ($126m^3/s$ at +12°C) – with variable wind	Anglesey North	0.4	0.03
	The Skerries	1.7	0.08

13.6.759 Given the large area of the water bodies and the comparatively small area of the TRO mixing zones at the surface and seabed, the magnitude of change is predicted to be small and the effects on WFD water bodies from discharge of TRO is considered to be negligible.

Effects of TRO on phytoplankton and zooplankton communities

13.6.760 Plankton have limited motility and their distribution is governed by external factors including the hydrodynamic regime. Localised effects are therefore usually difficult to detect in coastal waters owing to patchiness of plankton concentrations. It is also difficult to separate the effects of TRO on planktonic communities at power stations from the combined effects of exposure to thermal discharges and entrainment (particularly in close proximity to the outfall).

13.6.761 TRO inputs can directly affect planktonic species, and different life stages to varying extents, for example by reducing adenosine triphosphate (the molecule providing energy to cells) in phytoplankton [RD273].

13.6.762 Short-term studies on various species of phytoplankton gave a 24h EC_{50} (effective concentration) of 0.075 mg/L for the diatom *Thalassiosira pseudonana*. This was a static test system in which the exposure concentration was estimated from dilution of a concentrated stock solution [RD274]. The recent Risk Assessment Report [RD275] regarded these results as a very likely underestimate of the toxicity following a continuous exposure. The majority of the other short-term algal toxicity results are an order of magnitude higher than this value.

13.6.763 Long-term exposure to concentrations as low as 0.001mg/L to 0.01mg/L Total Residual Chlorine (which is equivalent to TRO) were reported to reduce phytoplankton cell numbers, with a 21 day EC_{50} (effective concentration)

[RD276]. Continuous (one year) exposure of mixed estuarine phytoplankton to TRO in indoor and outdoor microcosms resulted in a 13%–58% reduction in adenosine triphosphate (ATP). Chlorination appeared to have been intermittent, with additions ranging from 0.125mg/L – 1.441mg/L. However, the measured concentration in the system was continually below the detection limit of 0.01mg/L [RD273]. This is an abnormally high chlorine demand and casts doubt on the method. This information was used as supportive information for the Risk Assessment Report [RD275].

13.6.764 Phytoplankton responds rapidly to changes in environmental factors. Effects on individual species can, in turn, potentially lead to changes in species community composition and distribution. This results from some species being more (or less) successful at coping with environmental alteration, conferring competitive advantage (or disadvantage) to certain species over others. This can lead to a change in the assemblage which currently constitutes the 'characteristic' species complement for the area. The modelling results show that the long-term exposure levels of 0.001mg/L – 0.01mg/L Total Residual Chlorine from Sanders *et al*., [RD276] would be exceeded by the expected concentrations at the surface over a considerable area. However, it must be borne in mind that below the immediate surface layer, TRO concentrations would rapidly diminish to a much smaller footprint and therefore any effects would not be detectable.

13.6.765 The copepod *Acartia tonsa* has been found to exhibit 22% mortality at TRO concentrations of 0.14mg/L to 0.56mg/L [RD217]. The copepod *Eurytemora affinis* had an LC_{50} (lethal concentration) of 1mg/L TRO when exposed for five hours. These levels are higher than the concentrations proposed at the point of discharge. The zooplankton community is dominated by copepods, and whilst they may not exhibit toxicological effects over a wide area they may exhibit sub-lethal effects within the surface waters that are subject to higher concentrations (e.g. 0.08mg/L to 0.11mg/L).

13.6.766 The modelling output for the summer base case with variable wind showed that exposure to TRO concentrations (95 percentile) between 0.08mg/L and 0.1mg/L are restricted to locations in the immediate vicinity of the outfall. Within this body of water, plankton is likely to be exposed to TRO (and temperature) that would affect their metabolic function and could even result in mortality. Once operation is established, the planktonic communities adjacent to the outfall are likely to comprise those which have been entrained within the CWS (see paragraphs 13.6.548 to 13.6.562).

13.6.767 Beyond the immediate vicinity of the outfall the modelling showed that in the worst case scenario, TRO at the surface would reduce to 0.05mg/L at approximately 500m offshore. This level of TRO would be restricted to the surface layer, and there would be no detectable increase in the TRO concentration at the seabed at this distance.

13.6.768 The peak in plankton abundance occurs just below the surface and the proportion of the plankton community exposed to TRO concentrations that would affect metabolic rates is very small compared to the size of the community. The effects are not considered likely to have any wider implications for the abundance and diversity of plankton communities.

13.6.769 Only a very small proportion of the plankton community would be affected and therefore the magnitude of change is predicted to be negligible and the effects on phytoplankton and zooplankton communities from the TRO discharge are predicted to be negligible.

Effects of TRO on intertidal and subtidal habitats and communities

Tolerances of habitats and species

13.6.770 The TRO in the Cooling Water discharge has the potential to affect individual benthic species either through lethal or sub-lethal effects. Sub-lethal effects include changes in swimming and crawling behaviour of molluscan larvae and changes in shell growth rate of adults [RD277]. Sessile species are at particular risk once settled as they are unable to move away from the stressor.

13.6.771 The lowest reliable short-term data point for marine invertebrates that can be identified was a 48h LC_{50} of 0.026mg/L chlorinated polyolefin for the larvae of the American oyster *Crassostrea virginica* [RD278]. A 15 day field study on *C.virginica* (a cultured UK species) yielded an inferred no observed effect concentration of 0.007mg/L TRO for shell deposition and a lowest observed no-effect concentration of 0.014mg/L TRO [RD279]. In molluscs, effect concentrations range from approximately 0.01mg/L to 5mg/L.

13.6.772 The effects on an individual species may vary according to the life stage. Early-stage larvae of the American clam *Mercenaria mercenaria* (a cultured UK species) had a 48h LC_{50} of 0.001mg/L Total Residual Chlorine although the reliability of this study is in question and it may overestimate toxicity [RD280]. Nevertheless, *Mercenaria* larvae managed to settle and grow to maturity in the chlorinated outfall channel of the previous power station at Marchwood on Southampton Water [RD219]. The *M.mercenaria* results were used as supportive information in the Risk Assessment Report.

13.6.773 The effects of sodium hypochlorite on bivalves such as mussels *Mercenaria* and *Crassostrea* have been found to be greater in larvae compared to juveniles [RD280]; [RD277].

13.6.774 Tolerance data from literature is likely to be more useful in terms of assessing effects outside the zone closest to the outfall (e.g. 100m or further offshore), owing to the potential combined effects of temperature. However, the presentation of the effects of TRO in terms of lethal concentrations and sub-lethal physiological responses or behaviour varies and comparative assessments across the majority of species receptors are therefore not possible.

13.6.775 Lethal concentrations of TRO have been measured for a number of crustacean species with LC_{50} of 0.09mg/L recorded for *Pandalus goniurus* [RD281] and an LC_{100} of 2.5mg/L for *Melita nitida* [RD282] and [RD283] in BEEMS [RD284]. Although these are higher than, or within the upper contour range concentration close to the outfall, there could still be sub-lethal effects at the concentrations experienced in the surface waters of the wider TRO plume.

13.6.776 Other crustacean species that are also known to be present in the area include the brown shrimp (*C.crangon*) and European lobster. TRO concentrations of 0.53mg/L have caused responses in approximately 38% of *C.crangon* after 48 hours and concentrations of between 0.24mg/L and 1.0mg/L have been found to cause 2.7% mortality in European lobster [RD213]; [RD216]. Again, these responses have occurred at concentrations higher than that at point of discharge, but this does not preclude other effects occurring in waters particularly within 250m of the outfall. *Corophium volutator* has been found to exhibit lethal responses at much lower concentrations, with a LC_{10} of 0.032mg/L to 0.039mg/L [RD285]. Sensitive crustacean species such as this would likely be sub-lethally affected within approximately 200m of the outfall.

13.6.777 In terms of molluscs, TRO sensitivities have been found to cause a decrease in survival from concentration of around 0.1mg/L for *Megallina gigas* (reducing to 0% survival at 0.15mg/L) [RD214]. The LC_{50} for *C.virginica* has been found to be much lower at 0.026mg/L TRO [RD278]; [RD286]. *M.edulis* has shown similar sensitivities to *M.gigas*, with complete inactivity in larvae occurring at concentrations between 0mg/L and 0.13mg/L and 95% inactivity of larvae between 0.14 and 0.8mg/L [RD228]. Sensitivity was found to be reduced in older (spat) life stages. *Macoma balthica* was found to exhibit sub-lethal effects at 0.037mg/L and 0.124mg/L TRO with the occurrence of burial activity [RD285]. Sub-lethal effects would therefore inhibit individuals' ability to thrive in an environment through reducing feeding activities, for example.

13.6.778 The available literature indicates that most of the benthic invertebrate species would not experience lethal effects from TRO at the highest concentrations (i.e. 0.1mg/L) modelled close to the outfall.

Considerations of a recovered baseline

13.6.779 There have been no direct observations of the effects of TRO on marine invertebrates at the Existing Power Station. As with macroalgae there was a change in species composition within the area of influence of the discharge. Invertebrates appearing to be most adversely affected by the CWS discharge (at around 150m to 200m) were sponges, algae and sea squirts. As there are several environmental factors acting in combination, it is unclear the extent to which the existing TRO alone is affecting these organisms.

13.6.780 The assessment of the effects of TRO has followed the same approach as described in paragraph 13.6.669.

Intertidal habitat and communities

13.6.781 An understanding of the sensitivity of habitats has been derived from MarLIN MarESA. None of the intertidal biotopes recorded in baseline surveys were found to be sensitive to 'synthetic compound contamination', although it is noted that this may not specifically refer to TRO.

13.6.782 Intertidal habitats and species would only be exposed to TRO when inundated and therefore those highest up the shore would be least affected.

The effects from exposure to TRO may be masked by those caused by the effects of the thermal discharge.

13.6.783 At the Existing Power Station, the effects of Cooling Water discharge on intertidal habitats and species were recorded from 200m to 250m. Based on modelling and on studies at the Existing Power Station Cooling Water outfall it is predicted that the effects on intertidal habitats would result in low diversity and abundance of some species within a few hundred metres from the outfall, although it is not possible to attribute this to the effects of TRO or thermal discharge alone.

13.6.784 The effects on this intertidal habitats and communities would occur over a small area of the intertidal shore and this would not affect the wider integrity of the receptor. Therefore, the magnitude of change is predicted to be negligible and there would be a negligible effect on intertidal habitats and communities from TRO discharge.

Subtidal habitat and communities

13.6.785 Subtidal habitats and species that are continually submerged would be susceptible to the effects of TRO discharge.

13.6.786 An understanding of the sensitivity of habitats has been derived from MarLIN MarESA. None of the subtidal biotopes recorded in baseline surveys were found to be sensitive to ‘synthetic compound contamination’, although it is noted that this may not specifically refer to TRO.

13.6.787 Modelling results predicted that the area of seabed exposed to TRO in excess of 0.01mg/L (95 percentile) would be restricted to the immediate vicinity of the outfall, over an area of 5.7ha in the worst case scenario (see Table D13-46). Within this area the TRO would fluctuate and some intertidal habitat adjacent to the outfall would be exposed to concentrations up to a maximum of 0.1mg/L.

13.6.788 At the Existing Power Station, the effects of Cooling Water discharge on subtidal habitats and species were recorded up to 300m. Based on modelling and on studies at the Existing Power Station Cooling Water outfall, it is predicted that the effects on subtidal habitats would result in low diversity and abundance of some species within a few hundred metres from the outfall, although it is not possible to attribute this to the effects of TRO or thermal discharge alone. It is likely that effects would be sub-lethal in the majority of subtidal benthic species outside the immediate zone of discharge (i.e. beyond 100m from the outfall).

13.6.789 Based on the extent of subtidal habitat that would be affected, the magnitude of change is predicted to be small and there would be minor adverse effect on subtidal habitats and communities from TRO discharge.

Intertidal and subtidal habitat of conservation importance

13.6.790 Considering the presence of the Annex I rocky reef habitat in the intertidal subtidal areas and the presence of other biotopes that form Section 7 habitats and species of The Environment (Wales) Act 2016, the magnitude of change is predicted to be small. Therefore, there would be a minor adverse effect on intertidal and subtidal habitats of conservation importance from TRO discharge.

Effects of TRO on marine fish

13.6.791 TRO in the Cooling Water discharge has the potential to affect fish in the area, with smaller benthic species inhabiting the biotopes close to the outfall (e.g. blennies) being most at risk of exposure. As all adult fish are mobile, they are able to move away from the source. However, the egg and early planktonic stages have a higher risk as they have no/limited motility.

Ichthyoplankton

13.6.792 The distribution of ichthyoplankton is patchy and it is clear that separating the effects of entrainment, temperature and TRO is difficult. Therefore, consideration has been given to TRO effects within the assessment of effects of entrainment (see paragraphs 13.6.563 to 13.6.572).

13.6.793 The larvae of several species found in the area have been studied with respect to their tolerance of TRO. In terms of flatfish larvae, the LC_{50} for plaice and Dover sole was found to be 0.028mg/L [RD287]. In another experiment using the EMU, Dover sole exhibited approximately 17% mortality after 24 hours at TRO concentrations of 0.13mg/L to 0.2mg/L [RD227]. Turbot eggs and larvae were tested at concentrations of 0.2mg/L and around three quarters of larvae were found to be damaged and the rest viable, but none suffered mortality. At the same concentrations, around 95% of turbot eggs were found to be viable and hatching, and none were dead [RD215]. In terms of other species, TRO concentrations of 0.08mg/L were found not to induce mortality in bass after 24 hours, although concentrations of 0.2mg/L to 0.32mg/L increased mortality to around 50% of larvae. The LC_{50} of herring larvae was found by McLean [RD282] to be 0.065mg/L.

13.6.794 Taking these observations into account it is considered that the larval stages of some of these species would not suffer mortality as a result of the TRO discharge. One exception may be Dover sole and herring, which may be vulnerable to effects of concentrations greater than 0.06mg/L and 0.03mg/L, respectively, although this would only affect larvae in the surface layer, up to approximately 900m from the point of discharge. However, the majority of the water column in this zone would have much lower TRO concentrations, decreasing to zero at the bed.

13.6.795 A small proportion of the ichthyoplankton community would be affected and therefore the magnitude of change is predicted to be negligible and the effect on ichthyoplankton from TRO discharge is negligible.

All fish receptors (excluding ichthyoplankton)

13.6.796 Most of the relevant data available to fish species in this area of coast are pertinent to the egg and larval stages. Langford [RD233] examined data from power plant studies around the world and found no instance of direct fish mortalities associated with a power plant outfall. As fish are mobile species and can avoid sub-optimal habitat conditions, the main effects to consider are therefore sub-lethal. This may include change in local distribution and reduction in feeding opportunities in areas affected.

13.6.797 Bellanca and Bailey [RD288] found adult ocean spot (*Leiostomus xanthurus*) had a 96 hour LC_{50} of 0.09mg/L TRO in a through flow experiment [RD275]. Although not found in UK waters, it provides an example of an adult fish tolerance.

13.6.798 European eel elvers exposed to TRO concentrations of 0.102mg/L for seven days at 22ºC exhibited 100% mortality [RD289]. This concentration is just above that at the point of discharge, therefore if elvers remained in areas subject to maximum concentration (which is highly unlikely) then mortalities could, in theory, occur. In reality, fish would be able to avoid areas of increased TRO, therefore mortalities are unlikely.

13.6.799 Areas close to the outfall experiencing the highest TRO (and temperature) would likely be inhabited by proximo-benthic species which are able to take advantage of food resources in sub-optimal areas of habitat. Benthic species would likely be reduced in abundance compared to seabed habitats outside the influence of the plume. This effect would only be likely at a distance of up to a few hundred metres from the outfall.

13.6.800 As fish are able to move away from the source of the effect and given the extent of the effect, the magnitude of change is predicted to be negligible. Therefore, the effect on fish receptors (including those of conservation and/or commercial importance and general fish and fisheries) from TRO discharge is predicted to be negligible.

Effects of TRO on marine mammals and seabirds

13.6.801 The discharge of TRO would not affect marine mammals or seabirds directly and there is no pathway for TRO through the food chain. There would be no effect on marine mammals and seabirds from TRO discharge.

Effects of TRO on designated sites

13.6.802 The extent of the TRO mixing zone has been considered in relation to the North Anglesey Marine/Gogledd Môn Forol cSAC and Anglesey Terns/Morwenoliaid Ynys Môn SPA.

Table D13-48 Proportion of the North Anglesey Marine/Gogledd Môn Forol cSAC and Anglesey Terns/Morwenoliaid Ynys Môn SPA exceeding 0.01mg/L TRO (95 percentile) boundary

Scenario	Designated nature conservation site	Area (ha)at the surface exceeding 0.01mg/L TRO (95 percentile) as % proportion of the site	Area (ha) at the seabed exceeding 0.01mg/L TRO (95 percentile) as a % proportion of the site
Annual base case ($126m^3/s$ at +12°C (98 percentile)) – no wind	North Anglesey Marine/ Gogledd Môn Forol cSAC	0.08	0.002
	Anglesey Terns/ Morwenoliaid Ynys Môn SPA	0.24	0.005
Summer base case ($126m^3/s$ at +12°C (98 percentile)) – with variable wind	North Anglesey Marine/ Gogledd Môn Forol cSAC	0.04	0.002
	Anglesey Terns/ Morwenoliaid Ynys Môn SPA	0.13	0.006

13.6.803 There are no effects predicted on the features of the designated sites either directly or indirectly and therefore the magnitude of change is predicted to be negligible and the effect on designated sites from the TRO is negligible.

Impact pathway: discharge of Cooling Water – chemical changes in discharge water

General context

13.6.804 The Cooling Water will be abstracted from Porth-y-pistyll through the Cooling Water intake structure, passed through the Power Station's CWS and returned to the Irish Sea at the Cooling Water discharge structure. The conventional discharge from the Power Station is subject to H1 screening with respect to the marine environment. The H1 process enables calculation of the impact of substances likely to be released to various media. In this instance, the H1 screens out the need for detailed assessment of those discharges to liquid effluent streams described as insignificant in comparison to the relevant EQS.

13.6.805 The Environment Agency provides a methodology for the H1 process based on risk assessment of discharges to surface water. The risk assessments enable operators to demonstrate how their activities will be managed so that the impact on their local environment is acceptable. NRW has stated its intention to accept the H1 screening process for regulated activities in Wales.

13.6.806 The effects of radionuclides to marine environment receptors (including phytoplankton and zooplankton, marine benthic habitats and species, marine fish, seabirds as well as relevant designated and candidate conservation sites) have been assessed within chapter D14 (radiological effects) (Application Reference Number: 6.4.12) of this Environmental Statement. This assessment concluded a negligible magnitude of change and effect on marine environment receptors from the release of radionuclides in the Cooling Water plume and from disturbance to marine sediments.

Modelling: parameters

13.6.807 Horizon has undertaken water quality monitoring in the vicinity of the Existing Power Station since 2010, the results of which have been used to provide ambient water quality data for this assessment.

13.6.808 The screening process compares the predicted concentrations of the discharge constituents to water quality standards. Where available, the EQS provided by the Environment Agency have been used. For those constituents for which an EQS is not available, alternative standards have been used (appendix D13-14, Application Reference Number: 6.4.96). The preference in selecting these screening criteria has been to use a predicted no-effects concentration.

13.6.809 The H1 assessment has been undertaken based on four discharge points for liquid effluent from the Power Station with both continuous and non-continuous (batch) discharges. These discharges will be to:

- sea (Cooling Water outfall), via the seal pit;
- sea (Porth-y-pistyll) – Cooling Water intake and discharge point for the fish recovery and return system;
- Welsh Water wastewater treatment works (under Dŵr Cymru Welsh Water operations); and
- surface waters.

13.6.810 The expected chemical discharges from the Power Station during operation and outage (appendix D13-11, Marine Modelling of the Operational Discharge, Application Reference Number: 6.4.93) have been considered separately as the chemical discharges will differ considerably between the two periods.

Modelling: outputs

13.6.811 Of the chemical discharges expected to arise from Wylfa Newydd Power Station (appendix D13-1, Application Reference Number: 6.4.83) that have been subject to an H1 assessment, one was not immediately screened out of the need for further assessment. This was sodium nitrite. All other chemicals were screened out as not being of potential concern.

13.6.812 Sodium nitrite is used as a corrosion inhibitor in closed loop systems. This will result in sodium nitrite being present in the maintenance batch discharges, as a product of the drain down of the closed-loop systems. Following drain down, sodium nitrite will enter the marine environment via the main CWS outfall. The maximum concentration in the CWS effluent at the point of discharge (i.e. before any mixing taking place) will be 24.8 µg/L. Sodium nitrite concentrations would be lower at drain down than that stated in the maximum concentration, owing to degradation within the system during operation.

13.6.813 The following section presents further information on the effects of sodium nitrite in the marine environment, and assesses whether there would likely be any effects resulting from its discharge.

Sodium nitrite standards

13.6.814 There is no defined EQS for sodium nitrite therefore the predicted no-effect concentration value of 6µg/L has been used in the H1 assessment for a preliminary assessment of potential effects on the marine environment.

13.6.815 Sodium nitrite is listed in the OSPAR List of Substances Used and Discharged Offshore which Are Considered to Pose Little or No Risk to the Environment [RD290].

Effects of nitrite

13.6.816 Nitrite is an intermediate product and is converted to nitrate in the aquatic environment by nitrite-oxidizing bacteria, e.g. of the genera *Nitrospira*, *Nitrospina*, *Nitrobacter*, and *Nitrococcus* [RD291].

13.6.817 Once discharged, sodium nitrite has the potential to affect ecological receptors. Given sufficient concentrations and specific conditions, nitrite is a toxic substance to aquatic organisms. Nitrite poisoning in fish, for example, manifests itself in the presence of high levels of blood methaemoglobin, whereby nitrite reacts with haemoglobin and oxidises ferrous iron into ferric iron, producing methaemoglobin, which will not bind or transport oxygen, causing tissue hypoxia [RD292]; [RD293].

13.6.818 The effects of sodium nitrite on receptors has been evaluated partly based on published data relating to 96h LC_{50} thresholds, (i.e. the concentration at which 50% of the test sample suffer mortality after 96 hours) of broadly representative taxa to those inhabiting the receiving waters of the Cooling Water discharge (e.g. fish and crustaceans).

13.6.819 Boyd [RD294] states that nitrite-nitrogen 96h LC_{50}s for marine organisms generally range from 10 mg/L to 300 mg/L for invertebrates and 100mg/L to 1,000mg/L for fish.

13.6.820 The 48h LC_{50} for penaeid shrimps was found to be 170mg/L for nitrite –N (nitrite as nitrogen) [RD295]. The 24h LC_{50} value of nitrite –N was 13.20 mg/L for (larval development stage) [RD295].

13.6.821 In terms of marine fish, red drum (*Sciaenops ocellatus*) larvae have been found to tolerate nitrite concentrations of up to 100mg/L for two weeks, with no effects on growth [RD296].

13.6.822 Lewis and Morris [RD297] collated 96h LC_{50} for nitrite information relating to various (mainly freshwater) fish species. A summary of the lowest concentration reported for each species (note environmental variables vary depending on the experiment) is presented in table D13-49.

13.6.823 Boyd [RD294] presented similar published information relating to marine species, some of which may be present in the receiving waters of the Wylfa Newydd Cooling Water discharge (i.e. sea bass (*Dicentrarchus labrax*), European eel (*Anguilla anguilla*) and sea trout) (table D13-50). Those species had 96h LC_{50}s broadly in the range of 80mg/L to 980mg/L nitrite.

Table D13-49 96h LC_{50} for fish (mainly freshwater) species (lowest concentration recorded) [RD297]

Species	Nitrite concentration (mg/L)
Rainbow trout	0.15
Chinook salmon	0.88
Cutthroat trout	0.52
Channel catfish	7.1
Black bullhead	>32
Fathead minnow	7.1
European minnow	28
Creek chub	>41
Common carp	>32
White sucker	>80
Quillback	>80
Largemouth bass	140
Bluegill	2.4
Mosquitofish	1.5
Blue tilapia	16
Logperch	<3
Brook stickleback	<3
Mottled sculpin	>67

Table D13-50 96h LC_{50} for marine species [RD294]

Species	Nitrite concentration (mg/L)
Mud crab	41.6 to 69.9
Sea bass	154.0 to 274.0
European eel	84.0 to 974.0
Pacific white shrimp	9.0 to 322.0
Black tiger prawn	13.6
Sea trout	980.0

Factors influencing nitrite toxicity

13.6.824 The presence of chloride in marine waters can reduce or inhibit the toxic effects of nitrite [RD296]. The key factor is the attenuating effect of monovalent ions such as Cl- [RD292], which is a competitive inhibitor of the uptake of nitrite [RD292]; [RD298]. As the concentration of Cl- increases, the capacity of nitrite ions to enter the blood stream decreases [RD297]; [RD298]. Fish tolerance to nitrite exposure may therefore increase in environments with greater salinity [RD292]; [RD297]; [RD299]. In terms of other monovalent ions, the presence of Br- (80mg/L) has been found to almost fully offset the presence of nitrite (at a concentration of 32mg/L) for Atlantic salmon [RD300].

13.6.825 Owing to the fact that nitrite reduces the oxygen-carrying capacity of blood, lower levels of oxygen will exacerbate the toxicological effects. A higher amount of oxygen coupled with lower metabolic rates of fish at lower temperatures might render nitrite a less potent toxin. However, lower temperatures reduce the efficiency of any detoxification mechanisms [RD297].

13.6.826 The duration of exposure is also an important factor in terms of toxicity; a 24 hour to 48-hour exposure period was found to be required for maximum accumulation of nitrite in fish [RD301]; [RD300]; [RD302].

13.6.827 Studies have shown that recovery from nitrite exposure can be rapid. Eddy *et al*., [RD300] found that most rainbow trout (*Oncorhynchus mykiss*) that had been exposed to LC_{50} concentrations for 20 hours recovered rapidly once placed in nitrite-free water.

Effects of sodium nitrite on marine receptors

13.6.828 By comparison of published data with the anticipated operational conditions at the Power Station, the maximum concentration of sodium nitrite within the Cooling Water discharge would be over six times lower than the most sensitive example of a fish species' 96h LC_{50} (Rainbow trout, table D13-49). Furthermore, the concentration would be over 500 times lower than published 24h LC_{50}s for penaeid shrimps. It is therefore concluded that toxic effects on marine organisms would be extremely unlikely.

13.6.829 Following discharge, the concentration of nitrite will diminish through dilution and additional demand introduced by the receiving water, e.g. by continuing oxidisation of nitrite to nitrate via nitrite-oxidising bacteria. The final product, nitrate, is less toxic to organisms such as fish. Demand through oxidisation would likely be greatest in late spring and summer when bacterial activity and water temperatures are at their highest.

13.6.830 In addition, both the temporary nature of the discharge (in allowing individuals to recover on cessation) and the toxicity-reducing effects of the saline receiving waters (in blocking the nitrite uptake by organisms) would ensure that sub-lethal effects on marine biota would also be unlikely. The same conclusion is drawn for potential effects of sodium nitrite on features of designated sites (i.e. terns and harbour porpoise), as there are no pathways for this discharge component to affect the designated receptors or their prey.

13.6.831 Given the fact that sub-lethal effects on marine biota are considered unlikely, the magnitude of any change is predicted to be negligible therefore the overall effects of the sodium nitrite discharge on the marine environment would be negligible.

Impact pathway: airborne noise during operation leading to disturbance of seabirds

Context

13.6.832 Activities during operation would potentially affect target and secondary seabirds, due to an increase in airborne noise. The main sources of plant noise during operations would be from engines/generators, heating ventilation and air condition intake and exhaust fans, steam venting, pumps and transformers, alarm testing and marine vessels. In the context of the Power Station Site and the nearest receptors, it is unlikely that other noise sources such as traffic, or noise from overhead transmission lines, would be of concern.

Effect of airborne noise during operation on seabirds

13.6.833 In respect of the operation of the Power Station, tolerance of seabirds to noise disturbance is predicted to be high, as all seabird species using the marine environment adjacent to the Existing Power Station have been habituated to noise associated with its operation.

13.6.834 Based on the predicted noise contour modelling during operation with mitigation described in chapter D6 (Application Reference Number: 6.4.6), it is predicted that there would be no increase in noise levels at the tern colony at Cemlyn Lagoon, whereas at Porth-y-pistyll the maximum noise level would be 35dB(A) to 40dB(A) (see chapter D6, Application Reference Number: 6.4.6).

13.6.835 During worst case scenarios when all emergency equipment would be in operation, noise levels at the tern colony at Cemlyn Lagoon would be at less than 35dB(A), however this situation would be rare. Noise levels at Cemlyn Bay, Cemaes Bay, Porth Wnal and the gull colony are predicted to be temporarily up to 40dB. Porth-y-pistyll is predicted to experience temporary worst case noise levels of 50dB during very rare events. These noise levels would represent a negligible magnitude of change and would result in negligible effects on seabirds.

Decommissioning

13.6.836 Activities associated with decommissioning are described in chapter D1 (Application Reference Number: 6.4.1). The activities of particular relevance to the marine environment are:

- the shutdown of reactors and the reduction and eventual cessation of abstraction and discharge of Cooling Water;

- changes in the quantity and quality of liquid effluent discharge; and
- the removal of structures including the intake and outfall and MOLF.

13.6.837 Decommissioning of the Power Station would be subject to a separate Environmental Impact Assessment which would assess in detail the effects against the baseline conditions at that time. A preliminary indication of the likely effects during decommissioning is outlined below considering the current baseline.

13.6.838 A number of details relating to decommissioning are not known at this time and therefore, a number of assumptions have been made, as shown in paragraphs 13.5.115 and 13.5.116.

13.6.839 The marine receptors that would potentially be directly or indirectly affected by decommissioning are considered the same as those outlined in table D13-4 for the Wylfa Newydd Development Area.

13.6.840 A reduction in Cooling Water abstraction and discharge and eventual cessation during the decommissioning phase would represent an opportunity for the potential thermal effects identified in paragraphs 13.6.649 to 13.6.718 to be reversed. This would allow intertidal and subtidal species with lower thermal tolerances that had previously been displaced from the area around the Cooling Water outfall, to return. Species which are adapted to warmer temperatures may be affected by cessation of the Cooling Water discharge resulting in a decrease in feeding and reproduction rates, growth and potential displacement or mortality.

13.6.841 With a reduction in Cooling Water abstraction and discharge and eventual cessation, the total amount of biocide discharged would reduce and following shutdown, TRO would no longer be released into the marine environment. Habitats and species sensitive to TRO would be able to recolonise the area within the TRO footprint with potential reversal of the TRO effects identified in paragraphs 13.6.749 to 13.6.831.

13.6.842 The removal of the MOLF, and intake and outfall structures could lead to localised losses of marine habitats and species on and around the structures. The majority of structures that would be removed represent vertical surfaces which are known to support fewer marine organisms compared to surfaces with shallow gradients owing to the limited extent of habitat available within each tidal zone. Mobile species commonly found on surfaces with shallow gradients are often unable to survive on vertical slopes, especially when the effect of wave action is significant [RD303]; [RD304]. Therefore, although marine habitats present on hard structures at the time of decommissioning are likely to support fully established habitats and communities, these would probably be of lower quality (i.e. lower species diversity) than comparative communities on surfaces with shallow gradients. The intertidal and subtidal areas which will remain following removal of the MOLF, and intake and outfall structures will represent more natural rocky habitats characterised by a greater degree of structural heterogeneity. It is likely that these habitats would support a more diverse species complement in the long-term.

13.6.843 Information regarding the likely succession of intertidal and subtidal communities following the cessation of physical disturbance is outlined in paragraphs 13.6.143 to 13.6.146. This should be borne in mind when considering the effects of decommissioning on intertidal and subtidal habitats and species.

13.6.844 During decommissioning there would be a number of vessels and marine plant entering the area which may originate from national or international destinations. This could lead to non-native species being introduced to the area. Following removal of structures and cessation of Cooling Water discharge, new substrate would also present an opportunity for non-natives to become established which may facilitate their spread and increase the risk to native species. An assessment of the effects associated with the introduction of non-native species is outlined in paragraphs 13.6.247 to 13.6.262; this is considered to represent a reliable indication of the likely effects during the decommissioning phase.

13.6.845 During decommissioning there would be temporary disturbance to marine receptors (e.g. fish, marine mammals and seabirds) from an increase in underwater and airborne noise and vibration, artificial lighting and visual disturbance during removal of structures. An assessment of the effects associated with underwater and airborne noise and vibration, artificial lighting and visual disturbance is outlined in paragraphs 13.6.263 to 13.6.466; these are considered to represent a reliable indication of the likely effects during the decommissioning phase.

13.6.846 Land-based and marine-based demolition works associated with decommissioning could affect marine water quality. An assessment of the effects associated with surface water and groundwater discharge is outlined in paragraphs 13.6.2 to 13.6.103; these are considered to represent a reliable indication of the likely effects during the decommissioning phase.

13.6.847 It is recognised that given the duration of the operation phase (60 years), the abundance and distribution of marine species present in the vicinity of the Power Station may change owing to the effects of climate change. Legislation and conservation designations are also likely to adapt to changes in the marine environment to ensure continued protection of vulnerable species and habitats. These factors would all influence the assessment of key ecological receptors. Any future assessment should review the baseline conditions at that time and redefine key ecological receptors if necessary.

13.6.848 A more detailed indication of effects is not possible at this time; however, future assessments would be expected to consider the following beneficial changes:

- no further abstraction and therefore no further loss of plankton, ichthyoplankton, invertebrates or fish;
- cessation of the maintenance dredging programme which would allow recovery of habitats in the approach channel; and
- the ecological value of the breakwaters at the end of the operational phase.

13.7 Assessment of effects for the Disposal Site

13.7.1 This section presents the findings of the assessment of effects associated with the Disposal Site.

Construction

Impact pathway: changes to marine water quality from proposed dredging disposal (suspended sediment and release of contaminants)

General context

13.7.2 Disposal of sediment would result in an increase in SSCs at and beyond the point of disposal. Sediment dispersion will be subject to the hydrodynamic processes of the Disposal Site.

13.7.3 Increases in SSCs can lead to high turbidity in the water column, with the potential to affect phytoplankton through light reduction and thus indirectly the primary consumers (zooplankton). High turbidity levels may result in displacement of fish, marine mammals and seabirds if the changes reduce prey availability. Increased suspended sediments can affect filter feeding organisms, such as shellfish [RD305] and young fish may also be affected if suspended sediments become trapped in their gills [RD306].

13.7.4 Mobilisation of sediment at the point of disposal may also result in the release of sediment-bound contaminants into the water column with potential indirect effects on marine organisms.

13.7.5 The maximum volume of soft sediment that would be disposed is 242,000m^3 (bulked volume) with sediment disposal operations estimated to take 35 days to complete. This period assumes that disposal of sediment is continuous and without break in operations, i.e. the worst case.

Modelling

13.7.6 Plume dispersion modelling has been carried out using a range of model scenarios (see appendix D13-12, Application Reference Number: 6.4.94). The model outputs predict the fate of the disposed material in terms of increases to SSCs beyond background levels and also sediment deposition rates.

13.7.7 A number of conservative assumptions have been made including the following.

- Modelling of disposal events every 12 hours, continuously for 35 days.
- The volume of sediment disposed of will be 242,000m^3 (bulked volume).
- There are no waves during the 35-day disposal period. The model predicted that the addition of waves would result in a more rapid dispersion of dredged material; therefore, a more conservative scenario

was to model without waves (appendix D13-12, Application Reference Number: 6.4.94).

13.7.8 A number of SSC model outputs are presented in the modelling report based on the different sediment partitioning (coarse sand, medium sand, fine sand and fines fractions) and time after disposal event(s) (appendix D13-12, Application Reference Number: 6.4.94). As the SSCs generated by coarse and medium sand fractions were not visible from the outputs these are not discussed further in relation to SSCs; however, these are discussed later in relation to potential effect of deposition.

13.7.9 The modelling outputs (appendix D13-12, Application Reference Number: 6.4.94) following a disposal event showed that the plume (mostly represented by SSCs that exceed typical background levels by no more than 10mg/L) disperses to baseline background SSCs (see section 13.4) after approximately three hours.

13.7.10 Figure D13-39 to figure D13-42 (Application Reference Number: 6.4.101), show the SSC outputs from the modelled surface layer (approximately 7m thick), where the highest SSCs are predicted, for fine sand and fines fractions, each after a single disposal event (+3hrs after event) and the final disposal event (+35 days after initial disposal event). The model outputs showed that the SSC of fine sands is well within the range of typical background concentrations in both outputs (+3hrs after single disposal event, +35 days after initial disposal (end of disposal programme)); therefore, the effects from fine sands are not considered further.

From the plume generated by the fines it is predicted that SSCs would disperse to typical background concentrations after approximately three hours following a single disposal event. Figure D13-43 (Application Reference Number: 6.4.101), showing the residual fines plume 48hrs after the final disposal event of the programme, indicates that SSCs will be within typical background concentrations, evidencing the highly dispersive nature of the area.

Effects on marine water quality

Changes in SSCs

13.7.11 Modelling of the SSCs from disposal events has evidenced the highly dispersive nature of the receiving water (see figure D13-39 to figure D13-42, Application Reference Number: 6.4.101). Increases in SSCs beyond typical background concentrations are highly transitory. More than three hours following a single disposal event all sediment would have dispersed to such a degree that SSCs would be within typical background concentrations (paragraphs 13.4.18 to 13.4.21). Furthermore, at 48 hours after the final disposal event it is considered that the SSCs generated by the sediment plume would not be discernible from the background environment.

Changes in water chemistry

13.7.12 Chemical analyses of sediment collected from Porth-y-pistyll and the adjacent area, recorded comparatively few exceedances of the Cefas Action

Level 1 for metals and PAHs (appendix D13-2, Application Reference Number: 6.4.84). The sum concentration of ICES-7 PCB congeners did not exceed Cefas Action Level 1. None of the determinands analysed exceeded Cefas Action Level 2 from any of the locations within or adjacent to Porth-y-pistyll.

13.7.13 The Cefas Action Level 1 has been set as criteria below which the material is unlikely to pose a significant chemical risk to the marine environment and as such disposal at sea would be considered acceptable.

13.7.14 Although there is potential for some of the sediment-bound determinands to dissolve in the water consideration is given to the large volume of water and hence considerable diluting properties, along with the high dispersive nature of the environment in this area, as evidenced in appendix D13-12 (Application Reference Number: 6.4.94).

13.7.15 In order to determine the potential for contamination of the water column as a result of sediment disturbance from dredging and excavation, an assessment was carried out to determine the effect on marine water quality from the potential mobilisation of sediment-bound contaminants (see paragraphs 13.6.86 to 13.6.96). The assessment derived the maximum dissolved concentration for each contaminant and added this to the ambient levels to derive a total dissolved concentration.

13.7.16 The assessment concluded that the maximum dissolved concentration for each contaminant resulting from dredging and excavation is several orders of magnitude below the available EQS, suggesting that the potential for dredging activity within the Wylfa Newydd Development Area to affect water quality from contaminants in sediments is minimal. Further assessment considered the potential for any small uplifts in contaminant concentrations (see paragraphs 13.6.86 to 13.6.96); however, it was found that these would not result in any AA-EQS exceedances.

13.7.17 The study is considered relevant to changes in sediment chemistry at the Disposal Site as it presents a worst case scenario based on an increase from typical background SSCs to 1000mg/L. At the point of disposal, at zero hours, an increase from typical background SSCs to 1600mg/L has been assumed for the modelling study (appendix D13-12, Application Reference Number: 6.4.94) based on the sediment density within the hopper. Although the disposal increase in SSCs is higher than that modelled for the excavation, as the dissolved concentration for each contaminant from the sediment is several orders of magnitude below the available EQS, the effect on water quality from contaminants in sediments is similarly minimal.

Effects on phytoplankton and zooplankton

Changes to SSCs

13.7.18 Modelling outputs of the SSCs (figure D13-39 to figure D13-43, Application Reference Number: 6.4.101) and appendix D13-12, Application Reference Number: 6.4.94) indicated that changes beyond typical background concentrations would be minimal and highly transitory.

13.7.19 Within the comparatively small areas of the receiving water that would show a detectable increase in SSCs, phytoplankton and zooplankton growth may be inhibited. However, this would not have any effect on the abundance and diversity of phytoplankton or zooplankton within the wider environment.

13.7.20 The value of this receptor is low. Any effects on the phytoplankton and zooplankton would be minimal and not be detectable within the wider populations or beyond the range of natural variability. Hence the magnitude of change on phytoplankton and zooplankton is predicted to be negligible and the effect on this receptor from changes to suspended sediments is considered negligible.

Changes in water chemistry

13.7.21 The potential effect on coastal water from changes in water chemistry from the release of contaminants has been assessed as negligible (see paragraph 13.7.20). Consequently, it is considered that there would be no noticeable effect on phytoplankton and zooplankton populations from changes in water chemistry and the magnitude of change is predicted to be negligible. The value of this receptor is low. Hence the effect on this receptor from changes to water chemistry is considered negligible.

Summary of effects on phytoplankton and zooplankton

13.7.22 The effects of SSCs and water chemistry would occur simultaneously for the first two years of the construction phase. The effects on phytoplankton and zooplankton from changes to SSCs and water chemistry separately were considered to be negligible. It is considered that the overall effect of changes to marine water quality to phytoplankton and zooplankton is negligible.

Effects on marine fish

Changes to SSCs

13.7.23 Modelling outputs of the SSCs (figure D13-39 to figure D13-43, Application Reference Number: 6.4.101) and appendix D13-12, Application Reference Number: 6.4.94) indicated that changes beyond typical background concentrations would be minimal and highly transitory.

13.7.24 The magnitude of change is predicted to be negligible for fish receptors given there would be no noticeable effect above typical background concentrations, to which fish are already tolerant. Fish are also mobile species so would be able to avoid these minimal and temporary changes in SSCs. Hence the effects on all marine fish receptors (including ichthyoplankton receptors) from changes to SSCs are considered negligible.

Changes in water chemistry

13.7.25 The potential effect on water chemistry from the release of contaminants has been assessed as negligible (paragraph 13.7.21). Consequently, it is considered that there would be no noticeable effect on larval, juvenile or adult fish populations from changes in water chemistry and the magnitude of change is predicted to be negligible on all fish and shellfish receptors.

Hence, the effect on all marine fish receptors (including ichthyoplankton receptors) from changes to water chemistry is considered negligible.

Summary of effects on marine fish

13.7.26 The effects of SSCs and water chemistry would occur simultaneously for the first two years of the construction phase. The effects on marine fish from changes to SSCs and water chemistry separately were considered to be negligible. It is considered that the overall effect of changes to marine water quality to all marine fish receptors (including ichthyoplankton receptors) is negligible.

Effects on marine mammals

Changes to SSCs

13.7.27 Modelling outputs of the SSCs (figure D13-39 to figure D13-43, Application Reference Number: 6.4.101; appendix D13-12, Application Reference Number: 6.4.94) indicated that changes beyond typical background concentrations would be minimal and highly transitory.

13.7.28 Effects on fish from changes to SSCs, some of which will be prey items for marine mammals, were assessed as negligible (see paragraph 13.7.24).

13.7.29 The magnitude of change is predicted to be negligible given there would be no noticeable effect on marine mammal populations from these minimal and temporary changes in SSCs. Hence, the effect on highly mobile marine mammal receptors from changes to SSCs is considered negligible.

Changes in water chemistry

13.7.30 The potential effect on water chemistry from the release of contaminants has been assessed as negligible (paragraph 13.7.21) as is the effect on fish receptors (paragraph 13.7.25). Consequently, it is considered that there would be no noticeable effect on marine mammals and the magnitude of change is predicted to be negligible. Hence, the effect on highly mobile marine mammal receptors from changes to water chemistry is considered negligible.

Summary of effects on marine mammals

13.7.31 The effects of SSCs and water chemistry would occur simultaneously for the first two years of the construction phase. The effects on marine mammals from changes to SSCs and water chemistry separately were considered to be negligible. It is considered that the overall effect of changes to marine water quality to marine mammals is negligible.

Effects on target and secondary seabirds

13.7.32 The effects of SSCs and water chemistry would occur simultaneously for the first two years of the construction phase. The effects on seabirds from changes to SSCs and water chemistry separately were considered to be negligible. It is considered that the overall effect of changes to marine water quality to target and secondary seabirds is negligible.

Effects on designated sites

13.7.33 As described in the preceding sections on seabirds and marine mammals, the magnitude of change from potential effects on marine water quality is predicted to be negligible. It is therefore considered that any effects on the terns, as the qualifying feature for the Anglesey Terns/Morwenoliaid Ynys Môn SPA and the Cemlyn Bay SSSI, or harbour porpoise as the qualifying feature for the North Anglesey Marine cSAC, would be negligible.

Impact pathway: direct footprint of the works leading to mortality of species, loss of subtidal habitat and loss of resource (food and refuge)

General context

13.7.34 Direct loss of subtidal habitats and benthic species would occur from the disposal of rock and sediment at the Disposal Site.

13.7.35 As part of the embedded mitigation, rock material will be deposited within a micro-sited area of the Disposal Site (paragraph 13.5.80). Rock will be deposited over a period of approximately 16 months following commencement of dredging in the outer harbour.

13.7.36 Based on benthic survey data (appendix D13-2, Application Reference Number: 6.4.84); [RD64] the position of the micro-sited area within the Disposal Site is such that it is >0.25km from any known Sabellariidae reef (see figure D13-20, Application Reference Number: 6.4.101).

13.7.37 Assuming that a bulked volume of rock equal to 368,000m^3 (this being a worst case volume) is disposed at the micro-sited area would result in raising the seabed by approximately 1m (less than 1.5% of the baseline depth).

13.7.38 Direct loss of subtidal habitat will also occur as a result of sediment disposal and consequent deposition of material. The effect on benthic communities and sessile species is dependent on their sensitivity to sedimentation and the level of deposition.

13.7.39 Broad partitioning of the sediment fractions divides the sediment into coarse sand, medium sand, fine sand and fines (see appendix D13-12, Application Reference Number: 6.4.94). As part of the embedded mitigation, where practicable the sediment will be disposed within the central area of the Disposal Site thus constraining the effects of sediment dispersion, specifically deposition, as much as possible, to within the Disposal Site boundary.

13.7.40 Multibeam data collected by a SEACAMS research project in 2013 and 2014 and interpreted by Potter [RD67] indicates that depths in the middle region of the Disposal Site exceed 70m. BGS data (BGS DigSBS250) records the seabed in this area as comprising a mix of sandy gravels. The general community type characterising this area is predicted as '*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment' (SS.SMx.CMx.FluHyd) [RD8].

Modelling

13.7.41 For rock disposal, modelling was carried out to assess the potential for changes to hydrodynamics and therefore any changes to sediment processes that the disposed rock would have on the seabed following the immediate completion of the disposal activities. This was achieved by reducing model depth locally by 1m, and locally increasing bed roughness to simulate the increased roughness length of the disposal area due to the presence of the rock.

13.7.42 For sediment disposal, plume dispersion modelling looked at rates of sediment deposition at the Disposal Site following disposal of dredged sediment (see paragraphs 13.7.6 to 13.7.11).

13.7.43 Modelling outputs showed minimal deposition after seven days in a highly localised area (see appendix D13-12, Application Reference Number: 6.4.94). The model showed that deposition of sediment is restricted to certain states of the tide i.e. deposition did not occur for sustained periods in the full tidal cycle.

13.7.44 After a single disposal event the model predicted that no area of the seabed receives a deposition of 1cm or more.

13.7.45 On completion of the sediment disposal programme (after 35 days) the areal extent of 1cm or more of deposition was 180ha (appendix D13-12, Application Reference Number: 6.4.94). This was depicted by a patch of sediment extending 2.8km along its major axis and 0.9km along it minor axis in a broadly oval shape (figure D13-44, Application Reference Number: 6.4.101). Therefore, deposition of 1cm or more did not occur beyond the Disposal Site boundary.

13.7.46 By the end of the disposal programme the model outputs showed that a deposition depth of 5cm or more covered an area of 50ha; and that a deposition depth of 30cm or more covered an area of 7ha. The maximum depth predicted was 43cm, covering an area of <1.6ha.

Effects on subtidal habitats and communities (including those of conservation importance)

13.7.47 The direct footprint of the disposal activities is considered as those areas directly impacted from the disposal of rock and the disposal of sediment. These areas are geographically distinct and are discussed separately with an overall assessment based on the considerations.

Rock disposal

13.7.48 From survey work carried out around the micro-sited rock disposal area (appendix D13-2, Application Reference Number: 6.4.84) and acknowledging BGS data (BGS DigSBS250), it is considered that the seabed encompassed by the rock disposal footprint is a mix of circalittoral rock and coarse gravels, interspersed with boulders.

13.7.49 The Disposal Site benthic survey (appendix D13-2, Application Reference Number: 6.4.84) recorded the presence of the rocky biotope '*Urticina felina* and sand-tolerant fauna on sand-scoured or covered circalittoral rock'

(CR.MCR.EcCr.UrtScr) immediately within the footprint of the micro-sited area and the biotope ‘very tide-swept faunal communities’ (CR.HCR.FaT) just to the north-east. Further to the west and south were ‘circalittoral mixed sediment’ (SS.SMx.CMx) and ‘*Balanus crenatus* and *Tubularia indivisa* on extremely tide-swept circalittoral rock’ (CR.HCR.FaT.BalTub) biotopes, respectively. Sabellariidae reef were not recorded at any of these locations and no extensive reef formations are thought to be present within the footprint; however, as a worst case it has been assumed that pockets of this Annex I feature may be present.

13.7.50 It is therefore considered that circalittoral rock habitat, some mixed rock coarse sediment habitat and potentially Sabellariidae reef will be lost. The circalittoral rock and Sabellariidae reef habitat clearly represents part of the Annex I reef feature and are therefore assigned a medium value. As a worst case, it has been assumed that the entirety of the rock disposal footprint is represented by this Annex I reef feature and thus encompassed by the receptor group ‘subtidal habitats and communities of conservation value.’

13.7.51 Consideration is given to the wider rocky reef environment. Survey data has indicated that rather than continuous bedrock it is a mix of bedrock, boulders and stony reef. These rocky reef environments are extensive within this region of the Irish Sea, covering approximately 1233ha in the Disposal Site alone. Beyond the Disposal Site, recognising the data by BGS and also HABMAP [RD8], it is acknowledged that these rocky reef features extend many kilometres to the north and east of the rock disposal footprint.

13.7.52 Owing to the rocky nature of the disposed material recolonisation by a similar community is likely within the short-term, the sessile species lost being common to the general area. Furthermore, the scale of habitat loss is very small in comparison to the availability of rocky reef in the wider region. Such a small loss would not have a noticeable effect on the connectivity or ecological function of the wider communities nor reduce the overall biodiversity of the region. Consideration is also given to the incremental changes to the seabed within the rock disposal footprint. These would occur over the estimated 16-month duration and therefore it is considered that some recolonisation may occur soon after the first disposal event, rather than at the end of the 16 months.

13.7.53 The loss of resource would be unnoticeable when considered in terms of the extensive rocky habitat adjacent to the footprint. In the short-term the development of a similar community on the disposed rocky material will also provide resources to benthic species.

13.7.54 As with the rocky reef habitat, Sabellariidae aggregations are present throughout the wider area with crusts and, less commonly, reef being recorded at a number of sites during the benthic surveys of the Disposal Site (appendix D13-2, Application Reference Number: 6.4.84). Sabellariidae aggregations, specifically crusts and reefs, are often representative of a regularly changing community, i.e. they are just one step in a cyclical succession, representing an ephemeral rather than particularly stable community (e.g. [RD307].

13.7.55 For the physical pressure 'habitat structure changes – removal of substratum' the MarLIN MarESA for *S.spinulosa* habitat is relevant. Since rocky seabed lost would be replaced by disposed rock, the resulting substratum would be similar. On this basis, the MarLIN MarESA concludes that the sensitivity of the Sabellaria community to this physical pressure is medium [RD308].

13.7.56 As a reasonable larval supply of Sabellaria is thought to exist in the region, evidenced by the presence of Sabellariidae crusts, and the surrounding environmental conditions would remain the same, then recolonisation of seabed could take place in the short-term to medium-term [RD308].

13.7.57 Furthermore, considering that any pockets of Sabellariidae reef, if present within the rock disposal footprint, would not represent an isolated feature in this region, it is not thought that the short-term to medium-term loss of this habitat would have a noticeable effect on the integrity of this receptor over the wider area.

Sediment disposal

13.7.58 The model predicted that an area of 180ha will receive a deposition depth of 1cm or more over the complete sediment disposal programme (figure D13-44, Application Reference Number: 6.4.101).

13.7.59 The whole of the 180ha area lies within an area predicted by HABMAP as the community *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment [RD8]. Presence of the broad habitat type 'circalittoral mixed sediment' (SS.SMx.CMx) in this region was also confirmed from some of the nearest benthic survey sampling sites (HHD_8; HHD_12; HHD_19) (appendix D13-2, Application Reference Number: 6.4.84) to the 180ha area. However, as a worst case it has been assumed that the more sensitive feature (*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment) dominates the 180ha area. To the north-west of the 180ha area the site HHD_16 recorded the biotope '*Sabellaria spinulosa* on stable circalittoral mixed sediment' (SS.SBR). PoR.SspiMx; however, applying the criteria for assessment of reefiness [RD14] this community was not considered a reef (appendix D13-2, Application Reference Number: 6.4.84).

13.7.60 Despite no record of Sabellariidae reef from the sampling sites nearest to the area of sediment deposition; as a worst case it has been assumed that pockets of this Annex I feature may be present within the footprint of the sediment disposal.

13.7.61 As the MarLIN MaeESA has concluded that the habitats *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment and 'Sabellaria *spinulosa* on stable circalittoral mixed sediment' are 'not sensitive' to smothering up to 5cm, it is more appropriate to consider the area affected by a sediment deposition of 5cm or more (50ha) [RD308]; [RD309]. Although many of the species would tolerate deposition of 5cm, especially since sedimentation will occur over a 35-day period, as the deposition approaches 30cm or more it is assumed that most characterising species would be buried

[RD308]; [RD309]. However, as a worst case it has been assumed that the habitat that experiences 5cm or more sediment deposition will be lost (50ha).

13.7.62 Utilising the HABMAP predictive model [RD8], it is suggested that approximately 60% of the Disposal Site (1727ha) is covered by the habitat *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment (see [RD70]). This feature extends way beyond the Disposal Site, extending a number of kilometres to the north, south and east. The benthic survey (appendix D13-2, Application Reference Number: 6.4.84) also confirmed the presence of this feature at several sites in the Disposal Site along with the broad habitat type 'circalittoral mixed sediment' (SS.SMx.CMx).

13.7.63 The characterising species of the *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment biotope and the habitat itself are widespread throughout this region. No benthic species of conservation designation were recorded from within the Disposal Site.

13.7.64 As discussed above (paragraphs 13.7.54 to 13.7.57) Sabellariidae crusts and, to a lesser extent, reefs are found throughout the region. From consideration of the MarLIN MarESA of physical pressure 'habitat structure changes – removal of substratum', the sensitivity of the *Sabellaria* community to this physical pressure is medium [RD308].

13.7.65 In terms of the *Flustra* community the loss of resource would be unnoticeable when considered in terms of the extent of the same or very similar habitat occurring adjacent to the footprint and far beyond this area.

13.7.66 Considering that Sabellariidae reef, if present within the sediment disposal footprint, would not represent an isolated feature in the wider region it is not thought that the short-term to medium-term loss of this habitat would have a noticeable effect on the integrity of this receptor.

13.7.67 From consideration of the habitats' resilience it is determined that recovery of the *Flustra* community would occur in the short-term and the *Sabellaria* community in the short-term to medium-term.

Overall assessment of effect on subtidal habitats and communities (including those of conservation importance)

13.7.68 The assessment has considered loss of Annex I reef (rocky and biogenic) from the rock and sediment disposal. Loss of the habitat *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment from sediment disposal has also been considered.

13.7.69 Assuming the worst case scenario, a total area of 87.5ha will be lost during the disposal events. The directly impacted habitat will largely be made up of rocky reef (up to 37.5ha) and *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment (up to 50ha). Within these areas it has been assumed that pockets of Sabellariidae reef may also exist; however, it is also recognised that *Sabellaria* communities are widespread throughout the region.

13.7.70 Acknowledging that loss of any of these features from the disposal footprints would not lead to a permanent effect on the integrity or ecological function within the wider area, and that recovery within the footprint would occur in the short-term to medium-term, the magnitude of change is predicted to be small.

13.7.71 The *Flustra* habitat falls under the receptor group subtidal habitats and communities and is assigned a low value. The magnitude of change is small and the effect on subtidal habitats and communities from direct loss under the footprint of disposal is therefore assessed as minor adverse.

13.7.72 The Annex I reef feature falls under the receptor group 'subtidal habitats and communities of conservation importance' and are assigned a medium value. Given consideration of all of the above, the magnitude of change is small and the effects on subtidal habitats of conservation importance from direct loss under the footprint of disposal is assessed as minor adverse.

Effects on marine fish

13.7.73 While the mechanism of rock disposal may result in some shellfish mortalities as a direct effect; these infrequent and very limited mortalities would have no noticeable effect on their populations. Some benthic fish species may suffer mortalities; however, as most fish are highly mobile, the effect of direct mortality on fish populations within the disposal footprint (rock or sediment) is considered to be negligible.

13.7.74 Indirectly, the loss of habitat feeding resource and refuge would result in some displacement of fish and shellfish. However, as outlined above (paragraph 13.7.52), recolonisation of rock material will occur in the short-term, taking place after each disposal event; and recovery of the dominant habitat within the footprint of the sediment disposal (*Flustra* community) would occur in less than two years. Therefore, any loss in the dominant habitats is transitory, occurring over a short-term duration. Considering that those habitats directly affected by the disposal are extensive within this area any displacement of fish would be minimal and short-term, with suitable and considerable resource and refuge available in the surrounding area.

13.7.75 Given the above, the magnitude of change to all marine fish receptors (including shellfish) from mortality or displacement is predicted to be negligible, with no noticeable effects on populations of fish or fisheries. Hence the effect is assessed as negligible on all marine fish receptors.

Impact pathway: physical effects on subtidal habitats and communities from sand-scour and smothering (sediment disposal)

General context

13.7.76 Dredged material will be disposed as rock and as sediments. These disposals will vary temporally and spatially with the disposal of sediment taking place initially, followed by rock. It is assumed that, so far as possible, sediments be deposited approximately within the central area of the Disposal Site.

13.7.77 For the purposes of this assessment, and with consideration of a worst case effect, it has been assumed that sediment deposition of 5cm or more would effectively result in the loss of subtidal habitat (paragraphs 13.7.44 to 13.7.67). As discussed, deposition of up to 1cm in a single event is assumed to represent smothering comparable to natural events and is therefore considered to represent a negligible magnitude of change, as it is within the range of natural variability within the short-term. This assumption is based on extensive literature which contains studies relating to natural sedimentation processes and ecological effects e.g. [RD113].

13.7.78 Therefore, the effect of physical disturbance from smothering by sediment, is that which receives between 1cm and 5cm of deposition; which, from the modelling (paragraphs 13.7.41 and 13.7.46), equates to 130ha. This area is fully encompassed by the Disposal Site and is considered coincident with the habitat *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment (see paragraph 13.7.59). Acknowledging that the MarLIN MarESA definition for 'light' deposition is up to 5cm of fine material added to the habitat in a single, discrete event. This is considered valid for the assessment of smothering effects from sediment at the Disposal Site.

13.7.79 Once the sedimentary material settles, it can potentially cover benthic organisms through the increase of sedimentation and result in deterioration of the benthic community. Although mobile organisms such as fish and marine mammals would not be directly impacted by the light deposition, it may affect food resource and lead to displacement.

Effects on subtidal habitats and communities

13.7.80 Within the MarLIN MarESA of light deposition to *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment, the resistance and resilience of this community is assessed as high leading to an assessment of not sensitive [RD309].

13.7.81 Acknowledgment is also given to the JNCC description of the *Flustra habitat* as 'sand-scoured', this physical factor being an important structuring component of the biotope [RD310]. The characterising species of this habitat, *F.folicacea* and *H.falcata* are both tolerant of sediment abrasion and sand-scouring [RD310]; [RD311]

13.7.82 Given the above the magnitude of change is predicted to be negligible on the group receptor subtidal habitats and communities, which represents *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment (low value). Hence, the potential effect of sand-scouring and smothering is assessed as negligible.

13.7.83 Benthic surveys within the Disposal Site have recorded the presence of Sabellariidae reef, albeit infrequently, at several locations within the Disposal Site (appendix D13-2, Application Reference Number: 6.4.84), and [RD64]. However, Sabellariidae reef has not been recorded within or adjacent to the area of seabed that is predicted to receive between 1cm and 5cm of sediment deposition as shown in figure D13-44, (Application Reference Number: 6.4.101) and appendix D13-12 (Application Reference Number: 6.4.94).

13.7.84 Acknowledged as an r-strategist (a life strategy which allows a species to deal with the general variations of climate and food supply with a high rate of reproduction), *S. spinulosa* is considered fairly tolerant of disturbance with high rates of recovery [RD312]. The species and associated structures are considered fairly resilient to increased sediment loads, even being able to tolerate smothering for a number of weeks [RD312].

13.7.85 On the MarLIN website, [RD312] also state how it is likely that *S.spinulosa* could tolerate sediment deposition of 5cm or more for several weeks and hence assesses *S.spinulosa* as not sensitive to smothering, increases in turbidity or suspended sediment.

13.7.86 Given the above the magnitude of change is predicted to be negligible on the group receptor subtidal habitats and communities of conservation value which represents Sabellariidae reefs (medium value). Hence, the potential effect of sand-scouring and smothering is assessed as negligible.

Effects on marine fish

13.7.87 Indirectly, the modification of habitat feeding resource and refuge through light sediment deposition may result in some displacement of fish and shellfish. However, as outlined above (paragraphs 13.7.61 to 13.7.63), the dominant habitat *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment is assessed by MarLIN [RD309] as not sensitive to light smothering, with a high resilience to this effect.

13.7.88 Considering that the magnitude of change from light deposition is predicted to be negligible on the dominant habitat (*Flustra* community), it is considered that any effect on fish that utilise this area of seabed would not be noticeable, beyond that which would be experienced within the range of natural variability in the short-term. Light deposition of the dominant habitat, which is considered not sensitive to this physical factor [RD309], is unlikely to result in a detectable indirect effect on fish that utilise the area for foraging.

13.7.89 Given the above, the magnitude of change to all marine fish receptors (including shellfish) from disturbance of subtidal habitats and communities is predicted to be negligible, with no noticeable effects on populations of fish or fisheries. Hence the effect is assessed as negligible on all marine fish receptors.

Impact pathway: physical effects on subtidal habitats and communities from changes to hydrodynamics and bathymetry

General context

13.7.90 It is assumed that the disposal of dredged sedimentary material will be over an area represented by coarse sediments (central area of the Disposal Site) and rock material will be micro-sited in an area characterised by rocky substrata, these locations thus representing a similar substratum type to their respective disposal locations.

13.7.91 The deposit of material on the seabed has the potential to affect hydrodynamics. Within the Disposal Site, particularly at the depths of the target disposal locations, studies have shown that the bed shear stress is dominated by tidal processes (see chapter D12, Application Reference Number: 6.4.12). Consideration was given to the potential changes that the dredge material (sediment and rock) could elicit on these processes. However, acknowledging that the deposition of the sedimentary material is dominated by a sediment thickness of 5cm or less (paragraph 13.7.46) and the material is mobile, the potential effect on marine receptors from changes to hydrodynamics as a result of sediment deposition is not considered further.

13.7.92 Assuming a bulked volume of 368,000m^3 of rock material is disposed across the entirety of the micro-sited area (paragraph 13.5.80); the seabed will be raised by approximately 1m or less. The placement of this rock on the seabed will create a permanent change to the topography at the micro-site and will result in changes to coastal processes, which may indirectly affect subtidal communities.

13.7.93 Consideration of these changes on coastal processes was specifically addressed through modelling.

13.7.94 As the micro-site location considered for rock disposal is outside the predicted area of influence for the sediment deposition, no interaction between the rock and sediment disposal would be anticipated.

Modelling

13.7.95 A model simulation was used to understand and quantify the potential effects of the rock disposal on hydrodynamics, specifically tidal flow and therefore sediment transport.

13.7.96 This was achieved by reducing model depth locally by 1m, and locally increasing bed roughness to simulate the increased roughness of the disposal area due to the presence of the rock.

13.7.97 At the rock disposal location depths range from 60m to 70m. It is considered that at the depth of the rock disposal, there would be no measurable change on wave climate from increasing the height of the seabed by 1m or less. Therefore, the changes on wave climate would not be detectable from baseline variability.

13.7.98 The outputs showed that in all instances, water velocity over the rock disposal area itself is reduced, as would be expected. There is evidence of a slight wake (approximately 10% reduction in speed) on the flood tide, although this is limited to the immediate lee of the disposal area, and recovers within 50m from the micro-site. On the ebb, a wake of approximately 20% velocity deficit is apparent over a larger area, recovering within 150m from the micro-site.

13.7.99 In the context of the existing bed processes in this area these highly localised and small changes are considered minimal. The modelling showed that the changes extend to 150m from the micro-site, and then only during a short window of the tidal cycle on a spring ebb tide. However, over the course of a full tidal cycle (neap to flood) these changes would be realised by considerably smaller reductions in velocity (both in magnitude and extent) than that predicted on a spring ebb tide.

13.7.100 Acknowledging the limited and highly localised changes to the tidal regime, in addition to the unbounded area around the disposed rocks, any changes to sediment transport would be highly localised and not measurable beyond the immediate vicinity of the rock disposal area.

Effects on subtidal habitats and communities

13.7.101 Considering the comparatively small changes to tidal velocity predicted by the modelling, following rock disposal, it is acknowledged that within any given two-week period the changes to current speed would be greatest during the spring ebb and spring flood tide. These changes would extend 150m to the south-west on the spring ebb, and 50m to the north-east on the spring flood.

13.7.102 However, over the majority of the tidal cycle these changes would be experienced over a much smaller extent of the seabed.

13.7.103 The seabed adjacent to the rock disposal site is considered a mix of rocky and stony reef (paragraphs 13.7.48 and 13.7.50) with some coarse sediment. As a worst case it has been assumed that this area represents the Annex I rocky reef with no pathway to effect on subtidal habitats and communities not considered to be of conservation importance. The communities in the area include the biotopes *Balanus crenatus* and *Tubularia indivisa* on extremely tide-swept circalittoral rock (CR.HCR.FaT.BalTub) and '*Urticina felina* and sand-tolerant fauna on sand-scoured or covered circalittoral rock' (CR.MCR.EcCr.UrtScr) (appendix D13-2, Application Reference Number: 6.4.84).

13.7.104 The MarLIN MarESA of these two communities assesses the effect of a change in the water flow. The benchmark criteria for this change described as a change in peak mean spring bed flow velocity of between 0.1m/s and 0.2m/s for more than a year. It is considered that the benchmark criteria are broadly representative of the predicted changes from the modelling study (appendix D13-12, Application Reference Number: 6.4.94). The MarLIN MarESA for both these communities from changes to water flow, at this benchmark criteria, is not sensitive.

13.7.105 As a result, the magnitude of change is predicted to be negligible for the medium value group receptor subtidal habitats and communities of conservation value which encompasses the Annex I reef communities. Hence, the effect from changes to water flow is assessed as negligible.

Impact pathway: changes to marine water quality from proposed dredging sediment disposal (suspended sediment) if coincident with existing maintenance dredging operations

General context

13.7.106 There is one active marine licence to dispose of dredged material at the Disposal Site. This is for Stena Line Ports to dispose of up to 99,000 tonnes per year of maintenance dredged material from Holyhead Port. This material comprises fine silts which would disperse rapidly at the Disposal Site [RD63].

13.7.107 Disposal of maintenance dredgings at the Disposal Site has been ongoing for a number of years [RD67] and are therefore considered part of the baseline. There are no other active disposal licences for this site.

13.7.108 In the unlikely event that the proposed disposal of sediment could overlap with the annual maintenance dredging works, consideration is given to whether there would be any additional change to water quality from cumulative SSCs from both operations that would result in a different effect from that already assessed for the proposed capital dredging disposal (paragraphs 13.7.2 to 13.7.33).

13.7.109 Acknowledging that the annual maintenance dredging of Holyhead Port has been ongoing for many years and dredged sediments are tested on a regular basis and only permitted by NRW for disposal at sea if levels of contamination are acceptable, there would be no impact pathway for changes in water chemistry resulting from release of sediment-bound contaminants with that of the proposed capital dredging disposal. Therefore, changes in water chemistry are not considered beyond that previously assessed (paragraphs 13.7.2 to 13.7.33).

13.7.110 Acknowledging modelling work specific to predicting the increase in SSCs over the duration of the proposed capital dredged sediment disposal only (appendix D13-12, Application Reference Number: 6.4.94); the effects for all relevant marine receptors were assessed as negligible or minor adverse (paragraphs 13.7.2 to 13.7.33).

Modelling

13.7.111 To assess the potential coincidence of the proposed sediment disposal with ongoing maintenance dredging a scenario was modelled based on the proposed release of 1,568m^3 of fines per day, and the release of 15,000m^3 of fines per day (2,500m^3 per release) from the Holyhead Port maintenance dredging operation. The latter simulation was run for 21 consecutive disposal releases, all of which were modelled as occurring within the same timeframe as the proposed capital dredged sediment disposal events i.e. a worst case scenario was assumed.

13.7.112 The cumulative effect from the addition of the proposed sediment disposal was not readily discernible from that of the much larger port releases. Therefore, it is not considered that the proposed disposal of material would result in a readily detectable increase in SSCs from that already generated through baseline disposal operations (appendix D13-12, Application Reference Number: 6.4.94).

Effects on marine receptors

13.7.113 In the unlikely event that both disposal operations would be coincident, given that the increase in SSCs from the proposed sediment disposal would not result in a readily noticeable change from the increase in SSCs predicted for the baseline maintenance dredging disposal, no significant additional effect is predicted (paragraphs 13.7.2 to 13.7.33).

Impact pathway: introduction of non-native species from proposed dredging disposal (Main Construction)

General context

13.7.114 No non-native benthic species have been recorded within or adjacent to the Disposal Site (paragraphs 13.4.48 and 13.4.49).

13.7.115 The most likely pathway for non-native species to be introduced to the Disposal Site is via transport of the dredged materials from the Wylfa Newydd Development Area. Non-native species can also be introduced through biofouling on ships' hulls and in ballast waters during disposal events.

13.7.116 Disposal of materials at a location outside the range of conditions to which non-native species are adapted would reduce the risk of their transfer and establishment. The proximity of the Disposal Site to the source environment of marine non-native species already present in the Wylfa Newydd Development Area (approximately 18km from Porth-y-pistyll) but at a greater depth than that of the species range (more than 50m for the majority of the Disposal Site compared to no more than 7m in Porth-y-pistyll) would reduce the risk of transfer and establishment of non-native species.

Effects on phytoplankton and zooplankton

13.7.117 The phytoplankton and zooplankton communities present at the Disposal Site are considered to be similar to the ones recorded in and around the Wylfa Newydd Development Area during baseline surveys (paragraphs 13.3.40 to 13.3.52). *C.wailesii* and *O.sinensis* recorded from the Wylfa Newydd Development Area are also likely to be present at the Disposal Site, at equally low abundances. Both of these species are widely distributed in coastal waters therefore transfer to the Disposal Site through currents and general water movements is also likely.

13.7.118 Considering the similarities in water quality characteristics between the Disposal Site and Wylfa Newydd Development Area, there are unlikely to be any changes in conditions at the Disposal Site that would further favour the growth and establishment of these non-native diatom species.

13.7.119 By following the guidance and legislation, as detailed in chapter B13 (Application Reference Number: 6.2.13) the introduction and spread of other invasive non-native plankton species through ballast water exchange would be reduced and therefore the probability of transmission is low. Based on the likely presence of non-native plankton species in the area and their wider distribution, the magnitude of change is predicted to be negligible. Therefore, it is considered there would be a negligible effect on phytoplankton and zooplankton from the introduction and spread of INNS.

Effects on subtidal habitats and communities (including those of conservation importance)

13.7.120 The non-native benthic species already present within the Wylfa Newydd Development Area include red algae (*A.armata, A.furcellatum* and *D japonica*); a green alga (*C.fragile* sub sp. *tomentosoides*); a brown alga (*S.muticum*); and the barnacle *A.modestus* (see paragraphs 13.3.80 and

13.3.89). All of these species are classified as low or unknown impact for the purposes of WFD assessment (Application Reference Number: 8.26). *S.muticum* is listed as a strategic priority species by the NWWT.

13.7.121 The five non-native algal species listed above require sufficient light for their photosynthetic processes and as such their distribution ranges from the mid-shore to shallow subtidal areas. The deep waters found at the Disposal Site of over 50m would exclude their growth due to light limitation.

13.7.122 The barnacle *A.modestus* is most common from mid-shore to shallow subtidal areas of estuarine and sheltered marine habitats. Again, the deep waters and exposed conditions would inhibit growth of this non-native species at the Disposal Site.

13.7.123 By following the guidance and legislation, as detailed in chapter B13 (Application Reference Number: 6.2.13), the introduction and spread of INNS through ballast water exchange and biofouling would be reduced and therefore the probability of transmission is low. If species already present within the Wylfa Newydd Development Area were to be transmitted to the Disposal Site, it is unlikely they would establish due to lack of suitable habitat. Therefore, based on the potential for transfer and establishment of non-native species, the magnitude of change is predicted to be negligible. Hence, there would be a negligible effect on subtidal habitats and communities (including those of conservation importance) from the introduction and spread of INNS.

Impact pathway: underwater noise from disposal of excavated material

General context

13.7.124 Underwater noise generated during the disposal of excavated rock and soft sediments has the potential to impact upon fish and marine mammals. The following activities associated with dredge disposal are considered as sources of noise and vibration:

- dredge disposal; and
- vessels.

Dredge disposal

13.7.125 For the purposes of this assessment the maximum amount of excavated material requiring disposal would be up to 368,000m^3 of rock and 242,000m^3 of soft material (bulked volumes).

Vessels

13.7.126 There will be an increase in the number of vessels at the Disposal Site and vessel movements between the Wylfa Newydd Development Area and the Disposal Site. The underwater noise assessment has been based on large vessels and has assumed that the vessels are travelling at a speed of approximately 10 knots. It is assumed that two disposal events will occur in each 24-hour period.

13.7.127 The dredging works are predicted to last for a duration of 16 months. There will be a predicted peak of 60 vessels per month for disposal of soft sediments and a peak of 10 vessels per month for disposal of rock.

Modelling

13.7.128 Details of the underwater noise modelling undertaken for the assessment are provided in paragraph 13.6.263 above. For the purpose of assessing the potential impact of underwater noise generated through the disposal of excavated material, model outputs for vessel movements and cutter suction dredging have been used.

13.7.129 Underwater noise generated from the disposal of dredged material is difficult to predict and therefore, as a precautionary approach, the maximum modelled impact range for cutter suction dredging has been used as a proxy.

Effects on marine fish

13.7.130 As presented in appendix D13-6 (Application Reference Number: 6.4.88) modelling results for vessel movements have been based on large and medium vessels travelling at a speed of 10 knots, which is considered representative of ships travelling to the Disposal Site.

13.7.131 The number of vessels moving between the Wylfa Newydd Development Area and the Disposal Site is small in comparison to the vessel density in the wider area of up to 25 vessels per week [RD183]. Therefore, it is highly likely that fish are already habituated to noise generated from vessels.

Table D13-51 Summary of modelled impact ranges for fish with swim bladders involved in hearing for vessel movements

SPL_{RMS}	Large vessels (m)	Medium vessels (m)
Recoverable injury (48h) 170dB re 1µPa (SPL_{RMS})	<1	<1
TTS (12h) 158dB re 1µPa (SPL_{RMS})	4	<1

13.7.132 Modelling has shown that noise levels generated by vessels are low with sound pressure levels of 160dB re 1µPa (SPL_{RMS}) being limited to within 4m for large vessels and 1m for medium vessels (appendix D13-6, Application Reference Number: 6.4.88). The modelled ranges of effect generated by disposal vessels does not have the potential to result in injury to fish, with TTS in fish being limited to within 4m of the vessel itself (Table D13-51).

13.7.133 It is likely that vessel movements would result in temporary localised displacement of fish species away from the area, although there are numerous other similar habitats of high quality within the vicinity that could support fish communities throughout the duration of the works.

13.7.134 It is considered that the magnitude of change to fish populations is negligible as it constitutes a temporary, localised effect. Therefore, the effect of underwater noise from vessel movements is considered to be negligible for all fish receptors.

Effects on marine mammals

13.7.135 As presented in appendix D13-6 (Application Reference Number: 6.4.88), modelling results for vessel movements have been based on large and medium vessels travelling at a speed of 10 knots which is considered representative of ships travelling to the Disposal Site. The Disposal Site is also located in an area of heavier shipping where the vessel density in the wider area is up to 25 vessels per week [RD183]. The number of vessels using the site for disposal would be expected to be in the range of 60 vessels per month.

13.7.136 The impact ranges based on criteria from Nehls *et al*., [RD142] and Lucke *et al*., [RD143] show that PTS and TTS from vessel movements is considered unlikely (table D13-51). The ranges to behavioural effects are limited to within 60m of large vessels and 10m of medium vessels. These ranges are localised to the vessels with at most, localised avoidance. Marine mammals are highly mobile species and baseline results have indicated that their distribution is more concentrated to the east of the Wylfa Newydd Development Area.

13.7.137 The assessment of cutter-suction dredging on cetaceans and pinnipeds is provided in paragraphs 13.6.332 to 13.6.343. The conclusion made there of no potential for injury to cetaceans and pinnipeds and only displacement of a small number of individuals is also relevant here.

13.7.138 The magnitude of effect is considered to be negligible as a result of the localised nature of any effect and the lower abundance in the area. The effect on marine mammals is therefore considered negligible.

Effects on designated sites

13.7.139 As outlined in paragraph 13.7.135, the effect of underwater noise from vessel movements is considered to be negligible. There would also be a negligible effect on designated sites for which marine mammals are a qualifying feature.

Impact pathway: physical injury of marine mammals from vessel strikes

General context

13.7.140 Marine vessels used for the disposal of excavated rock and soft sediments could strike marine mammals, resulting in physical injury (e.g. corkscrew injuries) and, in the worst case, mortality [RD173].

13.7.141 The risk to marine mammals from vessel strikes and their response is discussed above in paragraphs 13.6.467 to 13.6.471.

Effects on marine mammals from vessel strikes

13.7.142 The number of vessels moving between the Wylfa Newydd Development Area and the Disposal Site are small in comparison to the vessel density in the wider area of up to 25 vessels per week [RD183]. Marine mammals have been recorded in low abundance around the Disposal Site with the highest densities observed to the east of the Wylfa Newydd Development Area. The risk of vessel strikes from marine plant and vessels transiting to and from the Disposal Site is therefore considered to be of negligible magnitude and therefore negligible effect.

Effects on designated sites due to the physical injury of marine mammals from vessel strikes

13.7.143 As outlined in paragraph 13.7.142, the effect on marine mammals from vessel strikes is considered to be negligible. There would also be a negligible effect on designated sites for which marine mammals are a qualifying feature.

Operation

Impact pathway: changes to marine water quality from proposed maintenance dredging disposal (suspended sediment and release of contaminants) during operation of the MOLF and of the Power Station

General context

13.7.144 During the operational phase of the Power Station, and the operational phase of the MOLF there will be a limited requirement for removal of fine sediment to maintain sufficient depth in front of the Cooling Water intake and to allow continued access to the MOLF.

13.7.145 Following consideration of sediment transport mechanisms in this region and the nature of the substrata, the requirement for maintenance dredging would be minimal.

13.7.146 The volume of the material required to be removed would be considerably lower than that for the capital dredging work, possibly representing an order of magnitude less.

13.7.147 The dredged material will be predominantly fines, these being highly dispersive in nature.

Effects on marine receptors

Changes to SSCs

13.7.148 The Disposal Site (IS043) is licensed as a dispersive site, regularly receiving maintenance disposals from Holyhead Port. It is considered that the infrequent maintenance dredging disposals required during operation of the MOLF and the Power Station would represent smaller volumes than are required for Holyhead Port.

13.7.149 The volume of the maintenance disposal will also be considerably less than that assessed for the capital dredging works (242,000m^3 of bulked sediment) and will therefore be shorter in duration. Moreover, unlike the capital dredgings, which will comprise a large proportion of coarse sediment, the maintenance dredgings will be predominantly dispersive.

13.7.150 From consideration of the above and acknowledging the dispersive nature of the Disposal Site, it is predicted that the magnitude of change on all receptors previously assessed (paragraphs 13.7.2 to 13.7.33) would be the same or, more likely, less.

13.7.151 Consequently, the effects on all marine receptors from changes to SSCs would be negligible with the exception of coastal water, which is minor adverse. Although the magnitude of change from maintenance disposal is predicted to be less on coastal water than assessed for capital dredging disposal, a conservative approach has been taken and the same effect is assessed.

Changes in water chemistry

13.7.152 It is anticipated that maintenance dredging during the operations of the MOLF and the Power Station would take place between three and five years after the capital dredging programme.

13.7.153 Prior to capital dredging, analyses of sediment chemistry adjacent to the Wylfa Newydd Development Area recorded relatively few exceedances of Cefas Action Level 1 (see paragraph 13.7.12).

13.7.154 Following excavation of this material by capital dredging, there would be a three-year to five-year period before maintenance dredging is required. Therefore, the risk of a significant build-up of contaminants within the approach channel sediments during this time, or the time between subsequent maintenance dredging operations, is highly unlikely.

13.7.155 From consideration of the above and acknowledging the dispersive nature of the Disposal Site it is predicted that the magnitude of change on all receptors would be negligible, as previously assessed for capital dredging (paragraphs 13.7.2 to 13.7.33). Consequently, the effects on all marine receptors from changes in water chemistry would be negligible.

Summary of effects on marine receptors

13.7.156 The effects on all marine receptors from changes to SSCs and water chemistry separately were considered to be negligible. It is considered that the overall effect of changes to marine water quality to all marine receptors is negligible.

Impact pathway: introduction of non-native species from disposal events during operation of the Power Station

General context

13.7.157 The details regarding the context to the introduction of non-native species is provided in paragraphs 13.7.114 to 13.7.116.

13.7.158 It is acknowledged that the requirement for disposal during the operation phase will be considerably less than during construction (paragraph 13.5.110). It is also considered that environmental conditions within the area encompassed by the proposed harbour will have changed.

Effects on phytoplankton and zooplankton

13.7.159 Following from the considerations made in paragraphs 13.7.117 to 13.7.119, acknowledgment is also given to the reduced volume of the sediment disposal programme compared to the construction phase.

13.7.160 It is recognised that post-construction, changes in the environment within the dredged area may provide suitable habitat for establishment of non-native species; however, with adherence to legislation and good practice guidance, as detailed in chapter B13 (Application Reference Number: 6.2.13) and section 13.5, and in consideration of the low level of requirement for maintenance disposal the potential effect on phytoplankton and zooplankton remains as assessed in the construction phase (paragraph 13.7.119) i.e. the effect is negligible.

Effects on subtidal habitats and communities (including those of conservation importance)

13.7.161 With consideration of paragraphs 13.7.120 to 13.7.123 and also paragraph 13.7.160, the potential effect on subtidal habitats remains as assessed in the construction phase (paragraph 13.7.123) i.e. the effect is negligible.

Decommissioning

13.7.162 See paragraph 13.6.836. At this time there is no requirement for marine disposal activities as a result of the decommissioning phase.

Transboundary effects

13.7.163 During the planning process a recommendation was made in the scoping opinion that "…consideration should be given in the Environmental Statement to any likely significant effects on the environment of another Member State of the European Economic Area. In particular, the [IPC] recommends consideration should be given to discharges to the air and sea and to potential impacts on migratory species. This is particularly relevant in terms of the likely impacts on the Irish Sea."

13.7.164 With respect to the marine environment, the pathway for transboundary effects would be through potential effects to the following receptors:

- marine mammals (cetaceans and pinnipeds);
- European eel, river lamprey, Atlantic salmon;
- fish of commercial importance; and
- seabirds.

Marine mammals

13.7.165 Marine mammals are very mobile with large home ranges and can travel large distances for feeding and foraging. Owing to the mobility of marine mammals it is possible that individuals associated with populations from international waters could potentially be affected by the construction, operation and decommissioning of the Wylfa Newydd Project.

13.7.166 Effects from construction have largely been assessed as negligible with localised effects from loss of food resource, habitat and airborne noise disturbance. There is the potential for minor adverse effects from underwater noise generated through marine construction. These effects will likely result in temporary displacement of species from the immediate vicinity of the works therefore it is not considered that these have the potential to result in significant transboundary effects on other EEA states.

European eel, river lamprey, Atlantic salmon

13.7.167 European eel, river lamprey and Atlantic salmon are migratory fish that move between the freshwater and marine environment as part of their life-cycles. The construction and operation of the Power Station poses potential risks to migratory life stages of these species. European eel, river lamprey, Atlantic salmon and sea trout are common to European waters and effects on individuals could potentially affect wider populations.

13.7.168 The numbers of European eel, river lamprey, Atlantic salmon and sea trout that are expected to be impinged annually at the Power Station during the operational phase are very low and impingement effects have been assessed as negligible. Entrainment would present a risk only to the glass eel stages of European eel (owing to this life stage being present in coastal waters), although again the magnitude of any effect is expected to be negligible. Further operational effects such as from thermal and TRO inputs are all assessed as negligible to fish. As a result, it is considered that there is no potential to result in significant transboundary effects on other European Economic Area (EEA) states.

Fish of commercial importance

13.7.169 Some marine fish species undertake migrations from deep water offshore to shallow waters near shore with the migrations being both species-specific and seasonally dependent. The construction and operation of the Power Station poses potential risks to fish of commercial importance.

13.7.170 Embedded and good practice mitigation would reduce any construction effects on these species, e.g. from noise and visual disturbance during construction, placement of temporary structures and habitat loss, to negligible.

13.7.171 The numbers of individuals of commercial species that are expected to be impinged and entrained annually at the Power Station during the operational phase have been assessed in terms of their adult equivalents and are not expected to have a detectable effect on wider populations of fish or marine birds and mammals. Furthermore, they constitute a very small fraction (<0.1%) of commercial landings in the Irish Sea. Subsequently the operational effects of entrapment on commercial fish species have been assessed as negligible. Further operational effects such as from thermal and TRO inputs are all assessed as negligible to fish. As a result, there are not expected to be any significant transboundary effects on other EEA states.

Seabirds

13.7.172 Elements of the Wylfa Newydd Project have the potential to cause disturbance to seabirds through direct effects such as airborne noise. Some seabird species are designated under EU legislation and undertake international migrations (e.g. terns), and therefore effects on seabirds as a result of the Wylfa Newydd Project could have wider implications for populations.

13.7.173 During the construction and operation of the Power Station, there are predicted to be negligible effects to breeding seabirds through the loss of habitat, physical disturbance, loss of food resource or disturbance from changes in airborne noise or visual stimuli. The majority of seabird species recorded in Porth-y-pistyll during winter use the bay for roosting and loafing due to the sheltered location and protection. Although some individuals are likely to be displaced from Porth-y-pistyll, many would become habituated to the disturbance. Furthermore, extensive similar habitats exist along the north coast of Anglesey and it is considered likely that adequate resource is available for any displaced individuals. It is therefore considered that with mitigation in place, there are not expected to be any significant transboundary effects on other EEA states.

13.8 Additional mitigation

13.8.1 In accordance with chapter B1 (introduction to the assessment process) (Application Reference Number: 6.2.1), embedded and good practice mitigation measures relevant to the marine environment were taken into account when determining the ‘pre-mitigation’ significance of effects. These are detailed in the design basis and activities section of this chapter.

13.8.2 Additional mitigation measures would be implemented to address potential significant effects and some of the minor effects identified in the assessment of effects section.

Construction

13.8.3 Additional mitigation measures for construction are summarised in table D13-52. Further information is provided below.

Wylfa Newydd Development Area

13.8.4 Two significant adverse effects were identified in the Wylfa Newydd Development Area from the assessment of the construction phase which includes embedded and good practice mitigation; both comprised a potentially moderate adverse effect.

13.8.5 The first significant effect related to the introduction and spread of INNS and the potential effect on subtidal and intertidal habitats of conservation importance and invertebrates of conservation and commercial importance.

13.8.6 Good practice mitigation for the production of a biosecurity risk assessment and method statement is presented in paragraph 13.5.92. As additional mitigation a monitoring programme for non-native species would be implemented (as outlined in the Marine Works sub-CoCP, Application

Reference Number 8.8) to include observational surveys on structures that may provide substrate for non-native species. Surveys would record presence/abundance of non-native species with reporting in agreement with NRW. An initial pre-construction survey would be undertaken and regular surveys would begin once construction of the breakwaters and MOLF is completed. The frequency and extent of monitoring would reduce over time, particularly once the MOLF is no longer operational. The ongoing requirement for monitoring would be regularly reviewed and agreed with NRW.

13.8.7 This additional mitigation is likely to significantly increase the probability of detecting the introduction and/or spread of non-native species which has potentially occurred as a result of construction, allowing time and opportunity for additional action to be taken if necessary. This additional mitigation is considered to reduce the magnitude of change from medium to small and therefore the significance of effect on subtidal and intertidal habitats and communities (including those of conservation importance) and invertebrates (of conservation and commercial importance), from the introduction and spread of non-native species would be reduced from moderate to minor adverse.

13.8.8 The second significant effect relates to the direct loss of subtidal and intertidal habitats of conservation importance under the footprint of the Marine Works. Embedded mitigation has been considered through the presence of the breakwater structures potentially having the capacity to function as an artificial rocky reef (paragraph 13.5.83). As additional mitigation (stated in the Marine works sub-CoCP), it is proposed that marine ecological enhancement measures will also be provided in suitable locations by engineering design and functionality, to include pre-cast ecological units (e.g. features similar to bio-blocks) and modification of the permanent artificial structures (e.g. construction material, surface roughness or the addition of surface features). The purpose of marine ecological enhancement measures would be to increase surface and structural heterogeneity, encouraging the colonisation by native marine species and the establishment of diverse and productive intertidal and subtidal habitats within the footprint of the Marine Works.

13.8.9 Horizon will implement a monitoring programme (as stated in the Wylfa Newydd CoOP, Application Reference Number: 8.13) for the marine ecological enhancement measures and permanent structures, developed in consultation with NRW. The aim will be to determine the success of habitat enhancement by monitoring the colonisation of new structures, allowing adaptive management. The monitoring data will be used to inform the decision to implement further ecological enhancement if necessary.

13.8.10 The details relating to marine ecological enhancement have been developed in consultation with NRW. With inclusion of this additional mitigation, the magnitude of change would be reduced to small and the significance of effect on subtidal and intertidal habitats of conservation importance from direct loss under the footprint of the Marine Works would be reduced from moderate to minor adverse.

13.8.11 A number of minor adverse effects to marine receptors in the Wylfa Newydd Development Area were identified during the assessment of the construction phase. Whilst these are not significant effects, additional mitigation relevant to some of these effects has been proposed.

13.8.12 Initial dewatering inside the cofferdams during the construction phase would potentially result in the direct mortality of marine fish drawn into the dewatering pumps; this has been assessed as a minor adverse effect on all fish receptors.

13.8.13 As additional mitigation (as set out in the Marine Works sub-CoCP, Application Reference Number: 8.8), 'fish-friendly' pumps would be used for dewatering. Eel and Fish Transfer Pumps are used by contractors who have to dewater assets/structures that might contain eels or live fish. The purpose is to transfer/ pump fish into other waters without causing damage to the fish.

13.8.14 Use of fish-friendly pumps is likely to significantly reduce direct loss (i.e. mortality) of marine fish (and possibly other marine organisms) enclosed inside the cofferdams. The magnitude of change and significance of effect on European eel and river lamprey from dewatering would therefore be reduced from small and minor adverse, respectively to negligible.

13.8.15 Airborne noise and vibrations generated from blasting activities has been assessed as having a potentially minor adverse effect on the tern colony in Cemlyn Lagoon. Additional mitigation is set out in the Marine Works sub-CoCP (Application Reference Number: 8.8) and is shown below.

13.8.16 As additional mitigation, between 15 April and 15 August, Horizon would commit to undertake regular monitoring of terns throughout the nesting period. If the colony exhibits fly-up disturbance reactions [to be quantified] as a direct result of attributable noise events or shows a measurable increase in the incidence of disturbance events above those recorded during baseline observation works, then alternative methods of working or additional constraint would be applied. Details of the monitoring and controls are detailed in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7) and in the Marine Works sub-CoCP (Application Reference Number: 8.8).

13.8.17 As additional mitigation, in order to allow for additional sensitivities of terns arriving and establishing their nesting colony, additional construction controls would be applied during the 'establishment period', for the remaining period of the tern nesting season post establishment and in all subsequent tern nesting seasons. The details of these construction controls are provided in the Main Power Station Site sub-CoCP (Application Reference Number: 8.7) and in the Marine Works sub-CoCP (Application Reference Number: 8.8).

13.8.18 Considering the dynamic nature of this approach, the magnitude of the effects on the terns in Cemlyn Lagoon from airborne noise and vibrations due to blasting would be reduced to small. This additional mitigation would therefore reduce the effect on the terns in Cemlyn Lagoon to negligible.

13.8.19 Underwater noise has been assessed as being not significant for marine mammals and fish, however in undertaking piling activities, best practice will be followed including Joint Nature Conservation Committee, 2010, Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise (as stated in the Marine Works sub-CoCP, Application Reference Number: 8.8).

Disposal Site

13.8.20 No significant effects at the Disposal Site have been identified from the assessment of the construction phase and therefore no additional mitigation is proposed.

Table D13-52 Mitigation during the construction phase relevant to the marine environment

Proposed mitigation measure	Objective	Achievement criteria and reporting requirements
Implementation of a monitoring programme for non-native species.	To record the introduction and spread of non-native species to allow an opportunity to take corrective action if necessary.	Monitoring of new substrate. Record presence/abundance of non-native species. Reporting in agreement with NRW.
Provision of marine ecological habitat enhancements in suitable locations, to include ecological units.	To enhance the development of biodiversity and biomass on artificial structures.	The assessment criteria have been developed in agreement with NRW.
Use of fish-friendly pumps for dewatering	To reduce loss and damage to fish during dewatering activities.	The assessment criteria would be to reduce fish mortality as far as practicable.
Between 15 April and 15 August, Horizon would commit to undertake regular monitoring of terns throughout the nesting period. If the colony exhibits fly-up disturbance reactions [to be quantified] as a direct result of attributable noise events or shows a measurable increase in the incidence of disturbance events above those recorded during baseline observation works, then alternative methods of working or additional constraint would be applied.	To reduce disturbance on the terns in Cemlyn Lagoon from airborne noise and vibrations due to blasting.	Only undertaking blasting that conforms with model predictions. Appointing of qualified observers for the tern colony.

Proposed mitigation measure	Objective	Achievement criteria and reporting requirements
In order to allow for additional sensitivities of terns arriving and establishing their nesting colony, additional construction controls would be applied during the 'establishment period', for the remaining period of the tern nesting season post establishment and in all subsequent tern nesting seasons.	To reduce disturbance on the nesting terns in Cemlyn Lagoon from construction plant.	Establishment of buffer zones during the nest establishment season.

Operation

13.8.21 Additional mitigation measures for the operational phase are summarised in table D13-53. Further information is provided below.

Wylfa Newydd Development Area

13.8.22 No significant effects in the Wylfa Newydd Development Area have been identified from the assessment of the operation phase however; a number of minor adverse effects to marine receptors were identified. Whilst these are not significant effects, additional mitigation relevant to some of these effects have been proposed.

13.8.23 Impingement within the Cooling Water intake system is assessed as having a potentially minor adverse effect on river lamprey, European eel and Atlantic salmon. This assessment is primarily driven by the high value of these receptors, although the magnitude of impingement is predicted to be small. In addition, entrainment within the CWS may also have a minor adverse effect on ichthyoplankton of conservation and commercial importance.

13.8.24 No additional mitigation has been identified to directly reduce the effects of entrapment (impingement and entrainment), although as a form of additional mitigation, (as stated in the Wylfa Newydd CoOP, Application Reference Number: 8.13) Horizon will implement a monitoring programme for entrapment (impingement and entrainment) associated with the cooling water intake system. This will assess the effectiveness of fish protection measures embedded in the system during the operation of the Power Station, through a programme agreed with NRW, and enable any improvements to mitigation measures to be made where necessary. This additional mitigation is not considered to reduce the magnitude of change or significance of effect on river lamprey, European eel and Atlantic salmon however; further mitigating actions can be considered, in consultation with NRW, should monitoring identify potential issues.

Disposal Site

13.8.25 No significant effects at the Disposal Site have been identified from the assessment of the operation phase and therefore no additional mitigation is proposed.

Table D13-53 Mitigation during the operational phase relevant to the marine environment

Proposed mitigation measure	Objective	Achievement criteria and reporting requirements
Implementation of an entrapment monitoring programme	To monitor fish protection measures.	Monitoring and reporting in agreement with NRW.

Decommissioning

13.8.26 No additional mitigation is proposed for marine environment receptors during decommissioning. Decommissioning of the Power Station would be subject to a separate Environmental Impact Assessment which would assess in detail the effects against the baseline conditions at that time.

13.9 Residual effects

13.9.1 This section describes the residual effects on the marine environment having taken into account the embedded, good practice and additional mitigation described above. Table D13-54 provides a summary of significant residual effects identified either prior to or post application of additional mitigation for the construction phase.

13.9.2 No significant adverse effects were identified for the operational and decommissioning phases.

13.9.3 Additional minor residual effects identified in the assessment of effects section are summarised in appendix I3-1 (master residual effects table) (Application Reference Number: 6.9.8).

13.9.4 Combined topic effects (also known as intra-development effects), occur when a single receptor is affected by more than one way by the same development. These has been assessed within chapter D16 (combined topic effects) (Application Reference Number: 6.4.16). Intra-project (resulting from the various developments that comprise the Wylfa Newydd Development Project) and inter-project (resulting from the Wylfa Newydd Project together with external projects) effects have been assessed within volume I of the Environmental Statement.

Table D13-54 Summary of residual effects at the Wylfa Newydd Development Area during construction

Receptor (or group of receptors)	Value of receptor(s)	Description of potential effect(s)	Nature of effect(s)	Magnitude of change	Significance of potential effect	Additional mitigation	Post-mitigation magnitude of change	Significance of residual effects
Subtidal and intertidal habitats of conservation importance	Medium	Direct loss of habitat under the footprint of the Marine Works.	Adverse Local Permanent Long-term	Medium	Moderate adverse	Provision of marine ecological habitat enhancements in suitable locations, to include ecological units.	Small	Minor adverse
		The risks posed by the introduction of non-native species (outcompeting native species).	Adverse Regional Permanent Long-term	Medium	Moderate adverse	Implementation of a monitoring programme for non-native species.	Small	Minor adverse
Invertebrates (of conservation and/or commercial importance)	Medium	The risks posed by the introduction of non-native species (outcompeting native species).	Adverse Regional Permanent Long-term	Medium	Moderate adverse	Implementation of a monitoring programme for non-native species.	Small	Minor adverse

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13.10 References

Table D13-55 Schedule of references

ID	Reference
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