Connah's Quay Low Carbon Power

Preliminary Environmental Information Report
Volume II, Chapter 16: Physical Processes

Uniper

The Planning Act 2008
The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017
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Delivering a better world

Prepared for:
Uniper UK Limited

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16. Physical Processes

16.1 Introduction

Overview

16.1.1 This chapter of the Preliminary Environmental Information Report (PEIR) presents a preliminary assessment of the likely significant environmental effects of Connah's Quay Combined Cycle Gas Turbine (CCGT) with Carbon Capture Plant (CCP) (hereafter referred to as the 'Proposed Development') with respect to Physical Processes during the construction, operation (including maintenance), and decommissioning phases of the Proposed Development. This chapter relates primarily to issues associated with the construction / upgrading and operation of the water intake and outfall structures located within the water connection corridor (**Chapter 4: The Proposed Development; Chapter 5: Construction Management and Programme**).

16.1.2 This chapter should be read in conjunction, and supported by information presented within the following Chapters (PEIR Volume II):

- **Chapter 4: The Proposed Development;**
- **Chapter 5: Construction Management and Programme;**
- **Chapter 12: Marine Ecology;**
- **Chapter 13: Water Environment and Flood Risk**; and
- **Chapter 14: Geology and Ground Conditions.**

16.1.3 This chapter is supported by the following appendix in **PEIR Volume IV**:

- **Appendix 7-A: Legislative, Policy and Guidance Framework for Technical Topics**

16.1.4 This chapter is supported by the following figures in Preliminary Environmental Information Report (PEIR) Volume III:

- **Figure 16-1: Designated sites within the Dee Estuary**; and
- **Figure 16-2: Upstream and downstream Zone of Influence (ZOI).**

Legislation, Policy and Guidance

16.1.5 Legislation, planning policy, and guidance relating to Physical Processes and pertinent to the Proposed Development are listed in **Table 16-1**. Further detail regarding these can be found in **Appendix 7-A: Legislative, Policy and Guidance Framework for Technical Topics** (**PEIR Volume IV**).

Table 16-1: Legislation, Planning Policy, and Guidance relating to Physical Processes

Type	Legislation, Policy and Guidance
Legislation	• The Infrastructure Planning (Environmental Impact Assessment (Environmental Impact Assessment)) Regulations 2017 (Ref 16-1); • Marine Coastal Access Act 2009 (Ref 16-2); • The Marine Strategy Regulations 2010 (Ref 16-3); and • The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (Ref 16-4).
National Planning Policy	• The Overarching National Policy Statement (NPS) for Energy (EN-1) (Ref 16-5); • The NPS for Natural Gas Electricity Generating Infrastructure (EN-2) (Ref 16-6); • The NPS for Natural Gas Supply Infrastructure and Gas and Oil Pipelines (EN-4) (Ref 16-7); • The NPS for Electricity Networks Infrastructure (EN-5) (Ref 16-8); • Planning Policy Wales (PPW) (Ref 16-9). • UK Marine Policy Statement (MPS) (Ref 16-10); • The National Planning Policy Framework - NPPF (2018), Section 14 and Section 167. • Welsh National Marine Plan 2019; and • Future Wales: The National Plan 2040
Local Planning Policy	• Flintshire County Council (FCC) Local Development Plan (LDP) (2015-2030) (Ref 16-11). Relevant policies include: – Policy STR13: Natural and Built Environment, Green Networks and Infrastructure; – Policy STR6: Services, Facilities and Infrastructure; – Policy EN2: Green Infrastructure; – Policy EN3: Undeveloped Coast and Dee Estuary Corridor; and – Policy EN6: Sites of Biodiversity Importance. – Policy EN13: Renewable and low carbon energy development; and • Shoreline Management Plans (SMP) (Ref 16-12) – the Proposed Development is located within the North West England and North Wales Coastal Group area called the Great Ormes Head to Solway Firth (SMP22). - Sub Group: Flint Marsh to Chester Weir to Sealand Rifle Range (Inner Dee estuary, both banks) 11A5.3. - For the short (2005-2025), medium (2025-2055) and long term (2055-2105), the management approach for sub-cell 11A5.3 is to hold the line.
National Guidance	• Environment Agency, 2016. Flood risk assessments: climate change allowances, Guidance (Ref 16-28) • Natural Resource Wales (NRW), Guidance Note. Marine Physical Processes Guidance to inform Environmental Impact Assessment (Ref 16-13). • Welsh Government, 2021. Climate change allowances and flood consequence assessments (Ref 16-29); and • Marine sediment quality guidelines - Cefas Guideline Action Levels - Canadian Sediment quality guidelines

16.2 Consultation and Scope of Assessment

Consultation

16.2.1 A request for an Environmental Impact Assessment (EIA) Scoping Opinion was sought from the Secretary of State for Energy Security and Net Zero (SoS) through the Planning Inspectorate (PINS) in February 2024 as part of the EIA Scoping Process. The EIA Scoping Opinion was adopted on 20 March 2024 (**Appendix 1-B: Scoping Opinion Responses PEIR Volume IV**).

16.2.2 Key issues raised in the Scoping Opinion are summarised and responded to in **Appendix 2-B: Matters Raised in the Scoping Opinion** (**PEIR Volume IV**). All issues are being considered during the EIA process.

16.2.3 No further statutory consultation has been undertaken outside of the Scoping Opinion at this stage.

16.2.4 A meeting with NRW was held on 1st July 2024 during which aspects of the scoping opinion were discussed in more detail, including the proposed approach for hydrodynamic and sediment dispersion modelling associated with sediment disturbance as a result of scour due to the presence of a cofferdam during the construction phase. The requirements associated with sediment sampling data needed to carry out the modelling study and sediment contaminant analysis were also discussed. The requirement for thermal plume modelling was confirmed not to be required on the basis that the thermal load from the proposed new power station would not exceed the current permit limits. It was agreed that an assessment of circulation and stratification within the Dee Estuary could be based on available information rather than requiring a 3-dimensional model to investigate these specific issues. It was also agreed that a particle-tracking approach would be suitable for modelling of sediment and contaminant dispersion processes.

Scope of the Assessment

16.2.5 This chapter assesses the potential impacts of the proposed works within the water connection corridor on physical processes.

16.2.6 Following the scoping exercise that has been undertaken, this chapter of the PEIR provides an assessment as outlined below:

16.2.7 Construction phase:

- changes to river/ estuary bed morphology, due to:
  - scour of the river / estuary bed due to the acceleration of flow around the cofferdam; and
  - change or disruption to existing sediment transport and deposition patterns.
- increased water column turbidity due to increased suspended sediment concentration; and
- potential release of contaminants into the water column due to river / estuary bed disturbance.

16.2.8 Operational phase:

- changes to river / estuary bed morphology, due to:
  - scour of the river / estuary bed and associated change in hydrological regimes as cooling water is discharged from the outfall into the estuary.
  - scour of the river/estuary bed associated with the flow around the water outfall and intake structures.
  - maintenance excavation / dredging of the channel and the estuary bed around the eel screens.
- increased water column turbidity / increased suspended sediment concentration (SSC) due to estuary bed scour.
- potential release of contaminants into the water column due to estuary bed disturbance.

16.2.9 Decommissioning phase:

- increased water column turbidity / increased SSC in relation to the temporary works for removal of any infrastructure from the estuary environment.
- potential release of contaminants into the water column due to riverbed / estuary bed disturbance.

16.2.10 For the construction, operational and decommissioning phases, nothing has been scoped out of further assessment at this stage of the appraisal process.

16.3 Assessment Methodology

16.3.1 **Chapter 2: Assessment Methodology and Consultation**, sets out the overarching approach which has been used in developing the PEIR. This section describes the technical methods used to determine the baseline conditions, sensitivity of the receptors and magnitude of effects and sets out the significance criteria that have been used for the preliminary physical environment assessment.

Impact Assessment

Sensitivity

16.3.2 When defining sensitivity, the criteria levels set out in **Chapter 2: Assessment Methodology and Consultation** have been considered. To determine sensitivity of the receptor, the vulnerability of the receptor to the impact and its ability to recover and adapt are assessed. The criteria for assessing the sensitivity of the receptors are defined in **Table 16-2**.

Table 16-2: Sensitivity / Value Criteria for Physical Processes

Sensitivity / Value	Sensitivity / Value Criteria
High	Receptor has little or no ability to absorb change without fundamentally altering its character. For example,

Sensitivity / Value	Sensitivity / Value Criteria
	• The receptor has low / no capacity to return to baseline conditions within project life (10 + years), e.g., low tolerance to change and low recoverability. • The receptor is a designated feature or a protected site, is rare or unique; or economically and or environmentally valuable.
Medium	Receptor has moderate capacity to absorb change without significantly altering its character. For example, • The receptor has a medium capacity to return to baseline condition, i.e. return to baseline between 5 and 10 years; or • The receptor is valued but not protected.
Low	The receptor is tolerant to change without significant detriment to its character. For example, • Disturbance to unconsolidated seabed sediments or sandwaves; or • The receptor has a high capacity to return to baseline conditions, e.g., within 1 year, or up to 5 years; or • The receptor is common and / or widespread.
Very Low / Negligible	The receptor's character, survival or viability has a high tolerance to change.

Magnitude

16.3.3 The magnitude of impact will be considered in terms of the spatial extent, duration, and timing of the impact in question. A summary of the magnitude criteria is detailed in **Table 16-3.**

Table 16-3: Magnitude Criteria for Physical Processes

Magnitude	Magnitude Criteria
High	Adverse: Loss of resource and / or quality and integrity of resource; severe damage to key characteristics, features or elements. Beneficial: Large scale or major improvement of resource quality; extensive restoration; major improvement of attribute quality.
Medium	Adverse: Loss of resource, but not adversely affecting the integrity; partial loss of / damage to key characteristics, features or elements. Beneficial: benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality
Low	Adverse: Some measurable change in attributes, quality or vulnerability; minor loss of, or alteration to, one (maybe more) key characteristics, features or elements. Beneficial: Minor benefit to, or in addition of, one (maybe more) key characteristics, features or elements; some beneficial impact on attribute, or a reduced risk of negative impact occurring.
Very Low / Negligible	Adverse: Very minor loss or detrimental alteration to one or more characteristics, features or elements.

Magnitude	Magnitude Criteria
	Beneficial: Very minor benefit to, or positive addition of one or more characteristics, features or elements.

Significance of effects

16.3.4 As set out in **Chapter 2: Assessment Methodology and Consultation**, the approach taken to determine the significance of effects in this preliminary assessment is only to state the potential significance of effects based on currently available design information. These levels of significance will need to be reassessed at the ES stage if aspects of the design change once more detail is available.

Rochdale Envelope

16.3.5 The setting of design parameters using the 'Rochdale Envelope' approach is described in **Chapter 4: The Proposed Development**, including **Table 4-1** which sets out the maximum parameters currently envisaged for the principal components of the Proposed Development. These parameters, together with assumptions regarding the future plans for the existing Connah's Quay Power Station set out in **Chapter 2: Assessment Methodology and Consultation** have been used to inform the representative worst-case scenario that has been assessed in this chapter, in order to provide a robust assessment of the impacts and likely significance of environmental effects of the Proposed Development at its current stage of design.

16.3.6 In particular, focused use of the Rochdale Envelope has been adopted for the following aspects:

- the maximum extent of the cofferdam within the Water Connection Corridor is not currently known. However, it is expected that with the cofferdam and Jack Up Barge (JUB) in place, less than 50% of the River Dee at low tide will be obstructed;
- cooling water for the Proposed Development will be abstracted from and discharged to the River Dee, in-line with the current process for the existing Connah's Quay Power Station CCGT. Cooling water abstraction and discharge conditions to be assessed will be based on the existing Environmental Permit. The permit requires that abstraction is limited to the period from 1 hour before high tide to two hours after with discharge permitted over the period from 1 to 4 hours after the predicted high tide. Cooling water will be abstracted at a rate of up to 3.04 cubic metres per second (m^3/s) and up to 33 megalitres (ML) per high tide; and
- the Proposed Development may refurbish the existing Connah's Quay Power Station cooling water abstraction and discharge infrastructure or, may replace and install new abstraction and discharge infrastructure. For the purposes of deriving worst-case assessment for this PEIR in terms of physical processes, it is assumed that new cooling water infrastructure will be installed in the Water Connection Corridor

Assessment Assumptions and Limitations

16.3.7 Due to the ongoing iterative design process, there are currently uncertainties around the works proposed and construction methodology to be undertaken within the Water Connection Corridor. The Water Connection Corridor covers the maximum area that would be required for the construction and operation of refurbishing, or fully replacing the cooling water infrastructure (the details of which will be further refined as the design and EIA studies progress). As such, the assessment of Physical Processes is limited to areas situated below the local Mean High Water Springs (MHWS) level.

16.3.8 It is assumed that maintenance dredging will not be required during the operational phase of the Proposed Development, which is consistent with the current situation. Construction phase dredging may be required and so is assumed as a worst case. However, details on this are not yet known and will be available following design of the cooling water infrastructure which is ongoing. Therefore, potential effects on physical processes from construction phase dredging are considered at a high level in this PEIR chapter. An assessment will be undertaken in the ES once details are available.

16.3.9 The outfall and intake structures may be rebuilt elsewhere within the water connection corridor. It is anticipated that the design of the new structures will be similar to the existing power station and in this respect, there will be no change to the current baseline conditions relating to abstraction and discharge rates.

16.3.10 The potential impact of the construction and operation of the extension to the training wall on physical processes has been omitted from the PEIR due to the lack of information available on the installation and design of the structure. Extension of the training wall could alter existing flows within the estuary leading to localized scouring of the channel bed. Once the relevant information has been provided, further assessment will be carried out within the ES.

16.3.11 For the purposes of the assessment, the construction phase includes enabling and demolition works required to facilitate the Proposed Development.

16.3.12 It is assumed that during construction, the contractor will adhere to best practice measures and permit, consent and licensing requirements to minimise the risk of impacts on the physical environment and physical processes.

16.4 Baseline Conditions and Study Area

Data Sources

- BGS Geology Viewer (Ref 16-17)
- Climatology Report, Waters Suspended sediment concentrations (SSC). (Ref 16-19)
- Admiralty Tide Tables (Ref 16-21).
- Renewables Atlas (Ref 16-22).
- SEASTATES (Ref 16-23).

- Awel y Môr Offshore Wind Farm Category 6: Environmental Statement (Ref 16-26).
- Foundation geology of the River Dee estuary cable-stayed bridge, Flintshire, North Wales (Ref 16-16).
- Morphological evolution of the Dee Estuary, Eastern Irish Sea, UK: A tidal asymmetry approach (Ref 16-18).
- North West Estuaries Processes Report, Dee Estuary (Ref 16-14).
- North West England and North Wales Shoreline Management Plan SMP2 (Ref 16-25).
- Measuring suspended sediment and its wave and turbulence forcing in the Dee Estuary (Ref 16-20).
- UK Climate Projections User Interface (Ref 16-27).

Study Area

16.4.1 The study area has been defined to include Physical Processes features likely to be at risk from possible direct and indirect impacts arising from the Proposed Development, as determined by the maximum extent of the Zone of Influence (ZOI) for all receptors. The seaward limit of the ZOI can be estimated using the tidal excursion distance from the Proposed Development for the highest astronomical tide, equivalent to the longitudinal axis of the maximum spring tidal ellipse. The maximum tidal ellipse dimension can be expected to increase from 6.2 km for a mean tide (Ref 16-22) to approximately 10 km for the largest tide in a year. However, the ZOI for the water column has been increased by a further 50% to allow for natural dispersion processes giving a seaward limit that is 15 km to the north-west of Proposed Development (**Figure 16-2 (PEIR Volume III)**).

16.4.2 The upstream limit of the ZOI is based on the normal tidal limit within the river with a 1 km buffer zone (identified by the black dotted line in **Figure 16-2 (PEIR Volume III)**) added to allow for the additional influence of storm surge propagation. To provide an initial estimate of the seaward limit of the ZOI, the length of the longitudinal axis of the mean tidal ellipse has been scaled-up to represent a maximum spring tide (**Figure 16-2 (PEIR Volume III)**).

Existing Baseline

16.4.3 **Table 16-4** lists the key receptors considered in this assessment. It includes the designations associated with the Dee Estuary, however a specific impact assessment is not carried out for each designation, instead key aspects of the physical environment within the Dee Estuary are assessed.

16.4.4 In many cases, there is no defined receptor for the physical environment but instead the physical processes act as a pathway which has the potential to impact other receptors (i.e. increased deposition resulting from the disturbance of seabed material could have an adverse impact on benthic habitats). One exception to this is coastal morphology which will be considered as a receptor in its own right.

Table 16-4: Key Receptors within the Existing Baseline

Sensitive Receptor	Location
The Dee Estuary – Site of Special Scientific Interest	Dee Estuary
The Dee Estuary – Special Protection Area	Dee Estuary
The Dee Estuary – Special Area of Conservation	Dee Estuary
The Dee Estuary – Ramsar site	Dee Estuary
Estuary / river bed morphology	River Dee / Dee Estuary
Water column	River Dee / Dee Estuary
Estuary / river hydrodynamics	River Dee / Dee Estuary

Environmental Overview

16.4.5 The Proposed Development is situated on the southern bank of the upper Dee Estuary close to Connah's Quay. The shape of the estuary is broad and funnel-shaped with a mouth approximately 5.7 km wide spanning between the Point of Ayr spit and Hilbre Point (Ref 16-14). The length of the estuary is 30 km. The inner estuary environment is characterised by several channels, well developed mud and sand flats and extensive saltmarshes (Ref 16-14). The Dee Estuary is designated as a Site of Scientific Interest (SSSI), Special Area of Conservation (SAC), Ramsar site and Special Protection Area (SPA), and contains several nature reserves within these particular designated areas (**Figure 16-1 (PEIR Volume III)**).

16.4.6 The site of the Proposed Development is at the point where the River Dee channel begins to widen into the estuary, from approximately 150 m upstream of the Flintshire Bridge to approximately 350 m (entire channel width) at the Water Connection Corridor.

Geology

16.4.7 The Dee Estuary was formed as an iceway during the last ice age as icesheets moved south-eastwards from the Irish Sea towards the Cheshire Plain (Ref 16-15). The bedrock geology surrounding and underpinning the estuary includes Triassic Sandstone and the Carboniferous bedrock band of Pennine Lower Coal Measures Formation, formed around 318 million years ago. This hard geology acts as a structural control on the estuary morphology (Ref 16-16).

16.4.8 The bedrock geology is overlain by surficial Quaternary formations, including clayey tills laid down during the last glaciation of the Pleistocene. This is followed by tidal flat deposits and alluvial sands, silts and clays deposited by the River Dee (Ref 16-17; Ref 16-16).

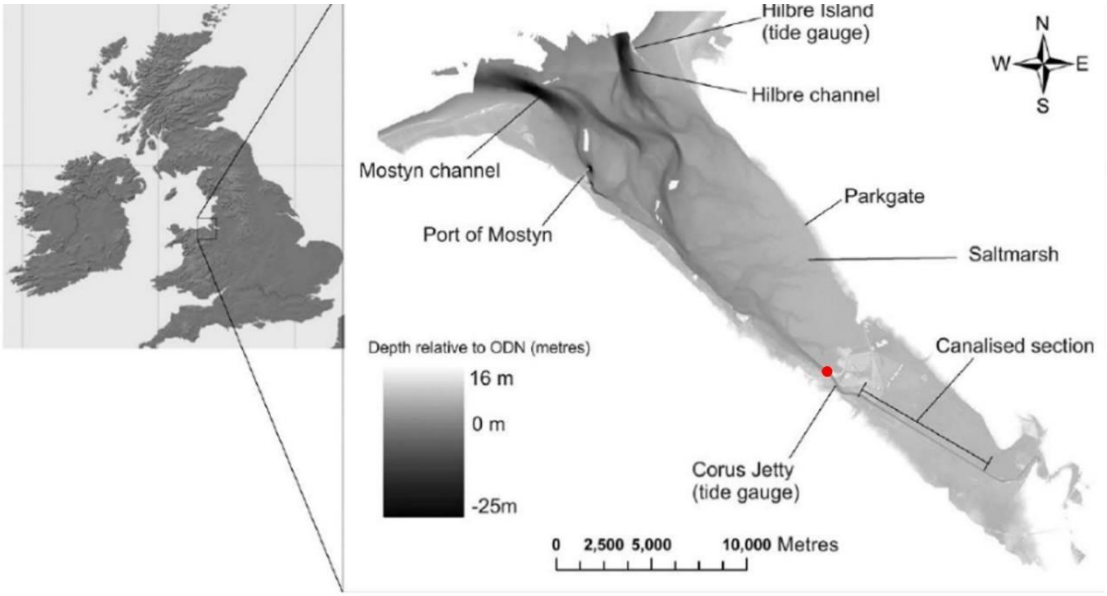
Bathymetry

16.4.9 The overall bathymetry of the Dee Estuary is shown in **Plate 16-1**. The plate depicts the location of The Site (red dot) where the river channel is below Chart Datum (CD) with depths within the wider estuary ranging from 17 m below CD

to 8 m above. Much of the estuary consists of intertidal sand banks with a narrow navigation channel. The canalised section upstream of Connah's Quay is believed to have caused heavy siltation and accretion, allowing the formation of a saltmarsh environment within the wider estuary (Ref 16-18).

16.4.10 A section of training wall adjacent to the existing outfall acts as a guide to currents at this location which was constructed as an aid to navigation. The training wall will be represented in any modelling exercise to ensure local current patterns are accurately simulated.

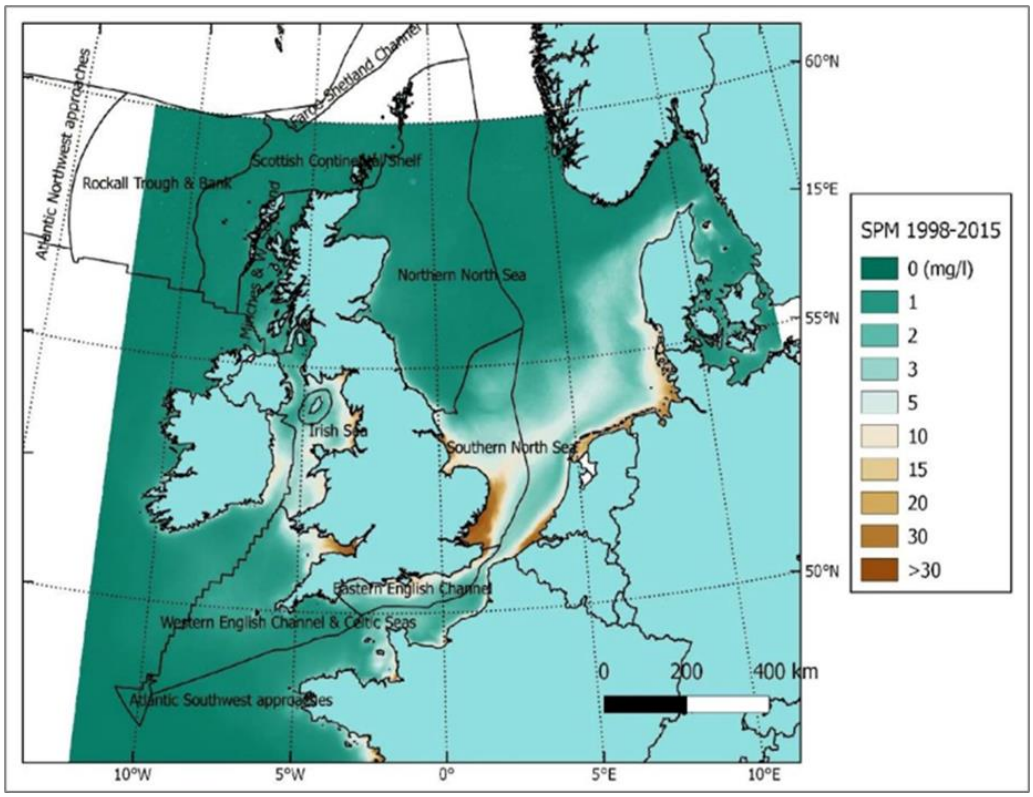
Plate 16-1: Bathymetry of The Site and wider Dee Estuary (Ref 16-18)



Suspended sediment

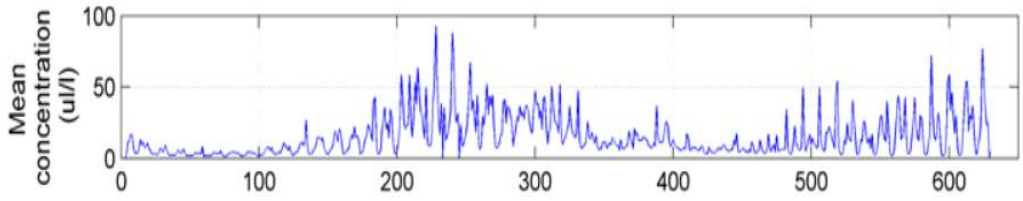
16.4.11 The Centre for Environment and Aquaculture Science (CEFAS) provides the spatial distribution of average non-algal Suspended Particulate Matter (SPM) between 1998 and 2005 for the majority of the UK continental shelf (**Plate 16-2**). The largest plume concentrations are associated with the major estuaries and waterbodies, such as Liverpool Bay off the North Wales Coast, where the mean values of SPM are above 30 mg/l (Ref 16-19).

Plate 16-2: Average Suspended Sediment Around the UK (Ref 16-19)



16.4.12 SPM values for the Dee Estuary are expected to be higher than in Liverpool Bay, which is confirmed by CEFAS in-situ measurements with values near the mouth frequently reaching 60 mg/l or higher, as shown in **Plate 16-3**. The highest concentrations were found to be relatively close to the bed (i.e. bottom 1 m) with peak values occurring in response to the flood and ebb tides as well as well as storm wave conditions (Ref 16-20). The mobile sediment was found to have a mean particle size of 70 µm, representative of silt and fine sand fractions which is consistent with material found within the estuary (Ref 16-20).

Plate 16-3: Measured suspended sediment concentrations (mg/l) plotted against time (hours) from initial deployment in the Hilbre Channel (Ref 16-20)



16.4.13 Although no measured data has been identified for SSC in the upper reaches of the Dee Estuary at The Proposed Development site, it is likely that SSC levels will be elevated further due additional sediment supply from the river.

Tidal Water levels

16.4.14 **Table 16-5** presents tidal levels from the UK Hydrographic Office (UKHO) Admiralty Tide Tables for the Connah's Quay (0463) Secondary Non-Harmonic Port (Ref 16-21). The Dee Estuary is classified as being a semi-diurnal, macro-tidal environment with a mean spring tidal range at Mostyn Docks in the outer estuary of 7.8m. The tidal range reduces from west to east as the tidal wave is attenuated due to the influence of bed friction in the shallow water depths.

Table 16-5: Tidal planes for Connah's Quay and Mostyn Docks (Ref 16-21).

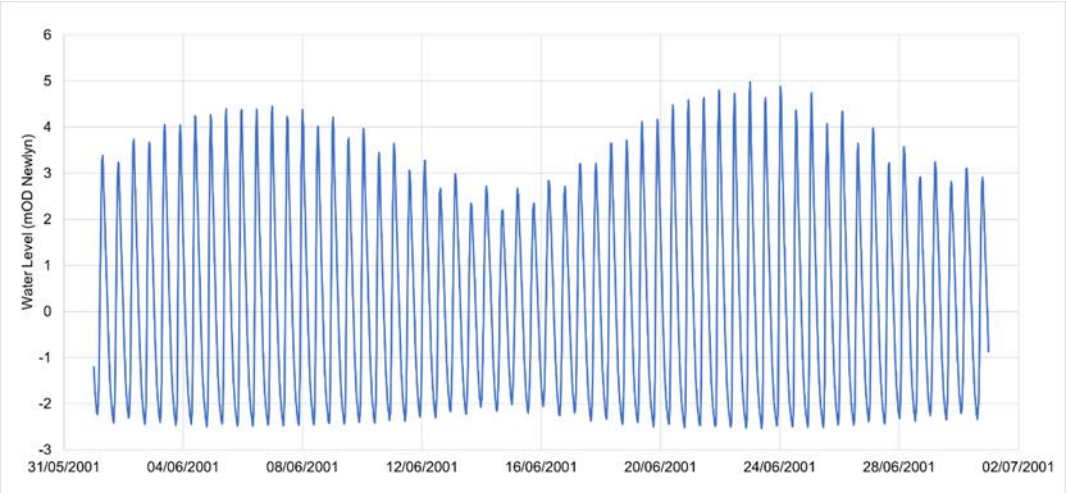
	Connah's Quay		Mostyn Docks	
Description	**Height (m CD[1])**	**Level (m ODN[2,3])**	**Height (m CD)**	**Level (m ODN[4])**
HAT	5.50	+4.75	9.80	+5.30
MHWS	4.70	+3.95	8.90	+4.40
MHWN	3.00	+2.25	7.00	+2.50
MSL	-	-	4.90	+0.40
MLWN	-	-	2.90	-1.60
MLWS	-	-	1.10	-3.40
LAT	-	-	0.20	-4.30

Notes
1. CD = Chart Datum
2. ODN = Ordnance Datum Newlyn
3. ODN is 0.75 m above CD at Connah's Quay
4. ODN is 4.50 m above CD at Mostyn Docks

16.4.15 An AECOM developed hydrodynamic model (Ref 16-30) including Liverpool Bay and the Dee Estuary was configured using the MIKE21 modelling software and was calibrated and validated using available water level and tidal current data (Ref 16-21). Model output data covers the one-month period of June 2001. The location of the model output point relative to Connah's Quay is shown in **Plate 16-4**. Modelled variations in local water levels are also shown in **Plate 16-5** based on results from the 2D depth-averaged model.

Plate 16-4: Location of model output point in the Dee Estuary

Plate 16-5: Water levels (m ODN) at model output point in the upper Dee Estuary



16.4.16 The nearshore tidal ellipse at the entrance to the Dee Estuary is orientated north north-west to south south-east. The major axis of this tidal ellipse is approximately 6.2 km in length (based on a mean tide) with a similar excursion distance likely to be found within the estuary. Further offshore within the Irish Sea the ellipses are orientated west to east and are approximately 10 to 12 km long (based on a mean tide) (Ref 16-22).

16.4.17 The existing hydrodynamic model of the Dee Estuary will be locally refined and extended to include the River Dee upstream as far as the tidal limit. Following calibration using available data, harmonic analysis of modelled currents will be undertaken to provide an estimate of the maximum tidal excursion distance within the Dee Estuary. As a minimum, calibration of the model will be carried out using water levels and tidal currents from the nearest prediction points available from the UKHO's TotalTide software. This will be used to refine the definition of the ZOI for potential physical process related impacts to be presented in the ES.

Waves and wind

16.4.18 The SEASTATES data explorer (Ref 16-23) was used to provide an indication of the wind and wave conditions for the regional area.

16.4.19 The closest available data point is at the entrance of Dee Estuary and has therefore been used to provide indicative local wind and wave conditions.

16.4.20 **Plate 16-6** provides a wave rose for significant wave height which shows that that the dominant direction of waves reaching the estuary mouth is from the north-west. Similarly, **Plate 16-7** provides a summary of wind conditions with the dominant direction from west to south-west (Ref 16-23).

Plate 16-6: Significant wave height at the entrance to the Dee Estuary (Ref 16-23)

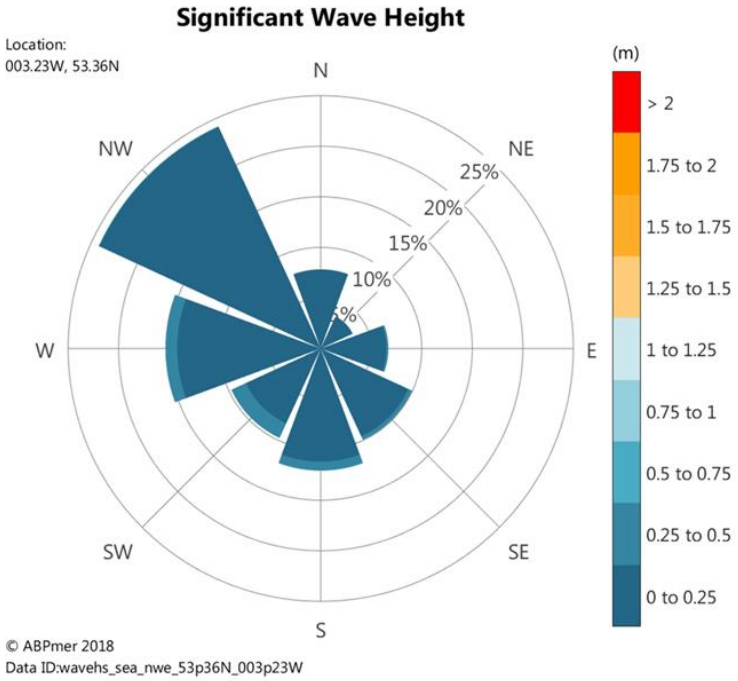
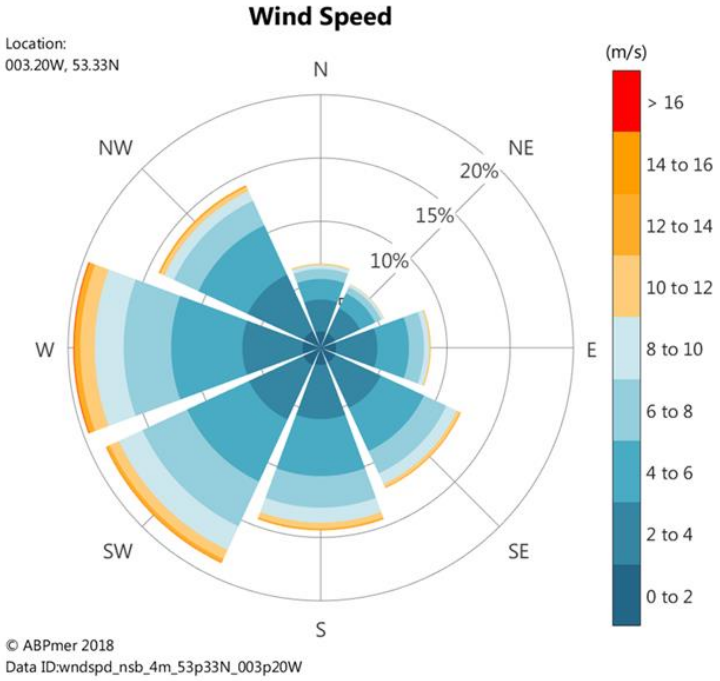


Plate 16-7: Wind speed at the entrance to the Dee Estuary (Ref 16-23)

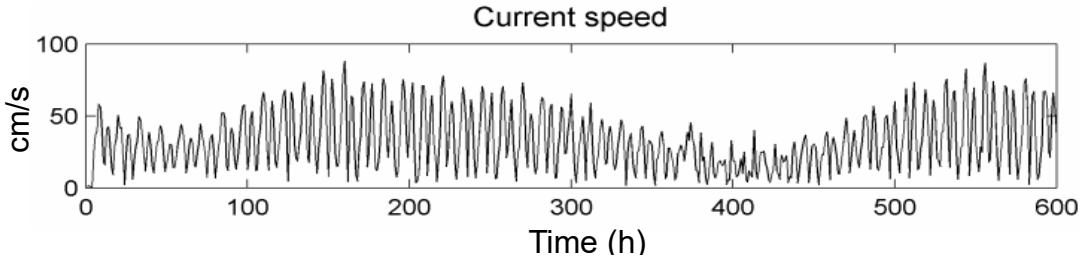


Tidal Currents

16.4.21 Tidal currents are an important component of the physical environment, influencing aspects such as sediment transport and dispersion of suspended sediment.

16.4.22 **Plate 16-8** shows the variation in measured tidal currents in the Hilbre Channel off the Wirral coast near the mouth of the estuary where peak currents over a spring-neap cycle are shown to be approximately 0.8 m/s (or 80 cm/s) (Ref 16-20).

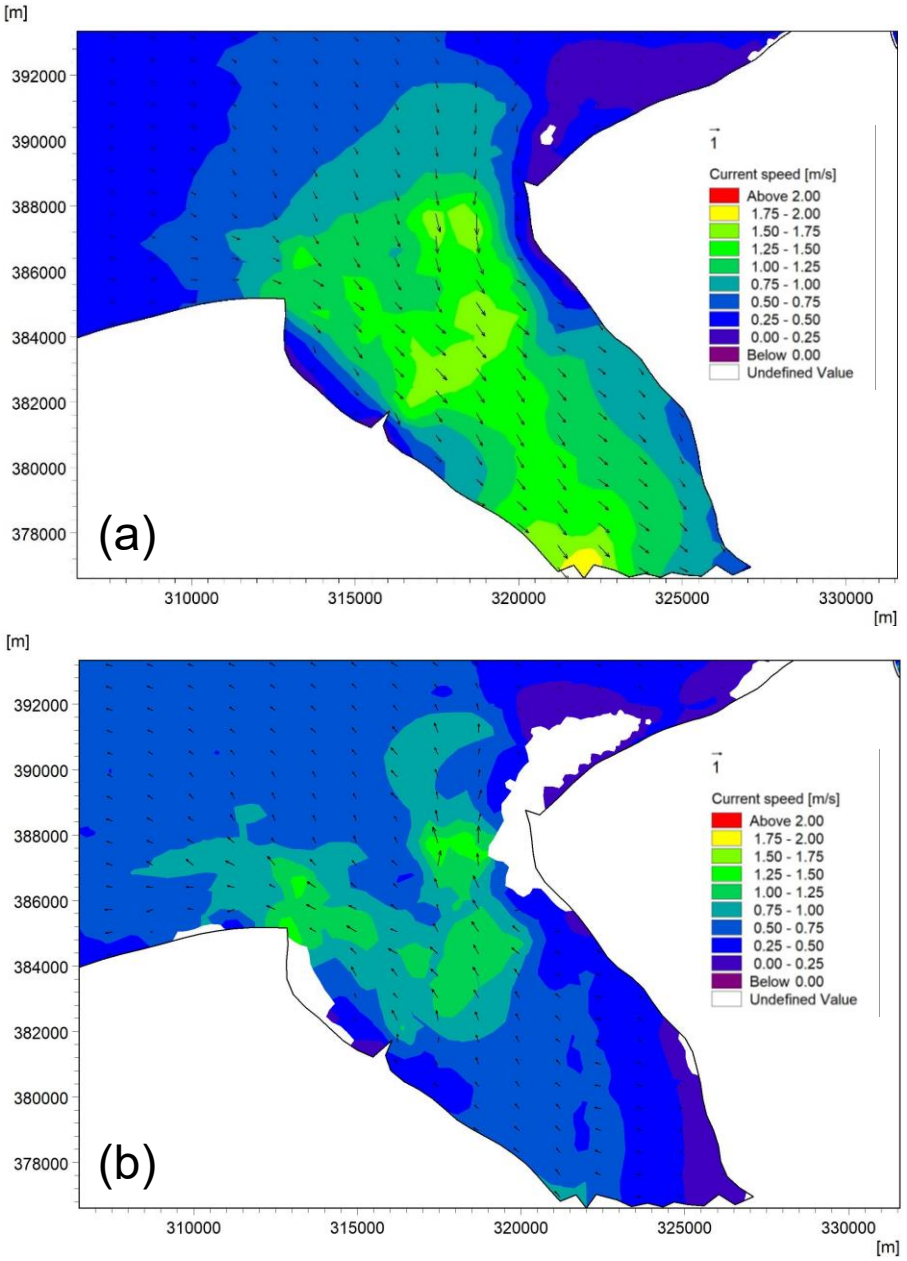
Plate 16-8: Measured current speed (cm/s) plotted against time (h) from initial deployment (Ref 16-20)



16.4.23 Tidal current vectors from the 2D hydrodynamic model are presented in **Plate 16-9** for a spring tide showing peak flow conditions during flood and ebb phases with similar current patterns found for a neap tide, but with a lower magnitude. The model results show how the magnitude of the flood currents are increased within the estuary due to the funneling effect. Enhanced resolution of the main low water channel will be required to ensure that local

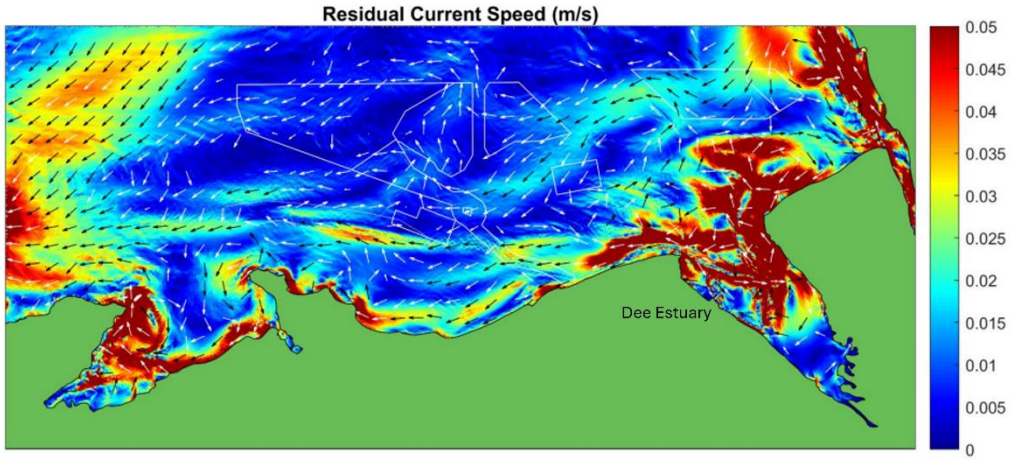
currents are accurately predicted at the location of the Water Connection Corridor. A peak current speed in excess of 1.75 m/s is shown along the southern shoreline with peak tidal currents reducing in magnitude further upstream. This suggests that the upper reaches could be a more depositional environment although river flow conditions are likely to become more influential with distance upstream. The ebb tidal currents are shown to be much weaker than the flood indicating flood dominance, likely to provide a depositional environment for sediment transported from Liverpool Bay. Further analysis of sediment mobility is required to confirm the characteristics of the estuary for both coarse (sand and gravel) and fine-grained material (mud and silt).

Plate 16-9: Modelled Spring tide current vectors in the Dee Estuary for (a) Flood and (b) Ebb tide



16.4.24 **Plate 16-10** shows modelled residual tidal currents prepared for a study of a proposed windfarm development (Awel Y Mor) and shows the variation of these residuals within the Dee Estuary, as derived over a spring-neap tidal cycle (Ref 16-26, Ref 16-24). Tidal residuals represent the net movement of water particles averaged over a period of time and can be used to infer potential sediment transport pathways and, in this case, suggest that tidal-induced sediment transport is significant in the coastal region and extending into the Dee Estuary, but is less influential in the upper reaches, including the study area. This suggests that river flow conditions will have an important influence on physical processes at this location.

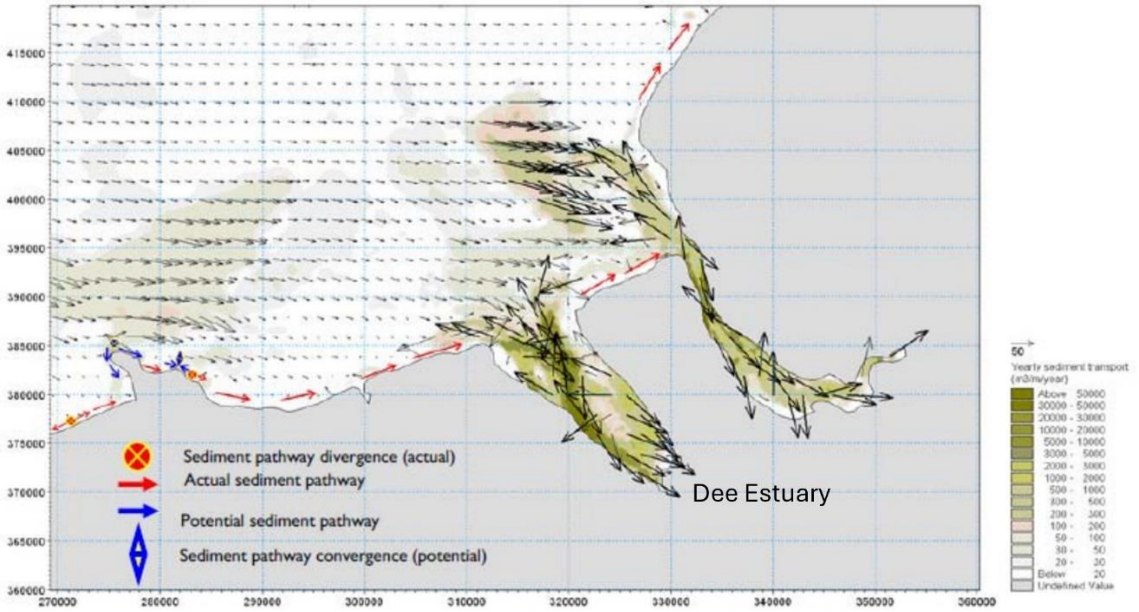
Plate 16-10: Residual current vectors for a spring-neap tidal cycle (Ref 16-26)



Sediment Transport Processes

16.4.25 The Dee Estuary is flood dominant with stronger currents during the flood phase of the tide resulting in the net movement of sediment into the estuary (**Plate 16-11**) (Ref 16-25). The primary sediment source results from the inshore movement of material from the Irish Sea. The black vector arrows show yearly estimated subtidal sand transport under representative tide and wave forcing and the red arrows indicate actual littoral transport pathways with the blue arrows indicating potential littoral transport pathways where sediment is present (Ref 16-25).

Plate 16-11: Estimated annual average littoral and subtidal sediment transport vectors (Ref 16-12)

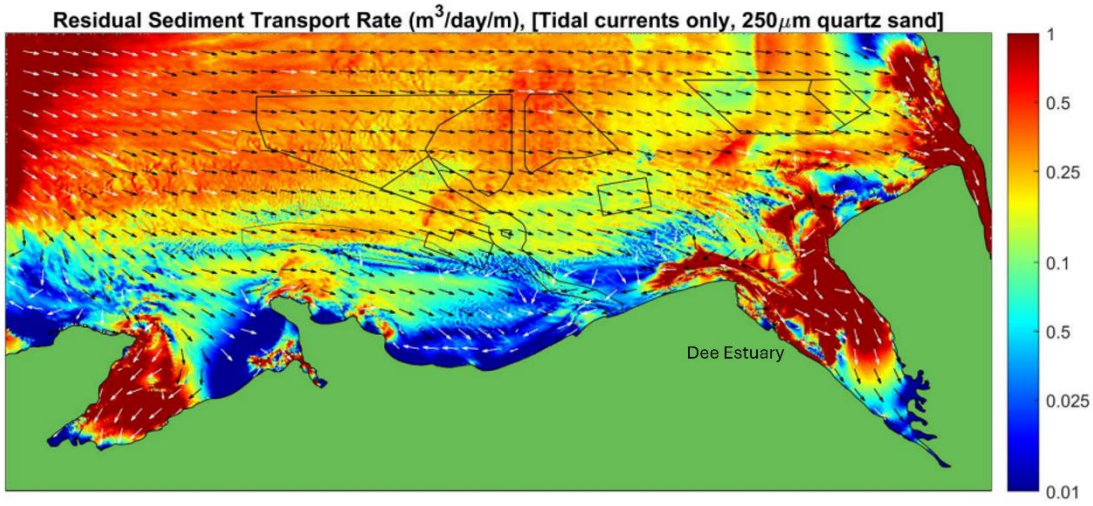


16.4.26 The estuary is a major sink of fine sands which are stored within the sandbanks at the mouth of the estuary, such as the East Hoyle Bank.

16.4.27 Modelling results for the proposed Awel Y Mor offshore wind farm study provide indicative residual sediment transport rates under tidal currents for sand (**Plate 16-12**). These results are particularly relevant given that the wind farm is approximately 20 km from the mouth of the Dee Estuary which is

included in the model extending upstream to the tidal limit. Similar to the pattern of residual currents, the potential for high sediment transport is shown within the outer estuary whereas in the inner estuary transport rates are significantly reduced (Ref 16-24).

Plate 16-12: Modelled residual sediment transport rate within the Dee Estuary (Ref 16-26)



Water Quality

16.4.28 Detailed information on water quality is provided in **Chapter 13: Water Environment and Flood Risk.**

Marine Sediment Quality

16.4.29 The non-technical summary for the Awel Y Mor offshore wind farm (situated approximately 40 km offshore and north west from The Proposed Development) (Ref 16-26), provides offshore marine sediment quality data. However, it is expected that within the Dee Estuary and nearer to The Proposed Development, sediment quality will vary due to the inflow of the River Dee.

16.4.30 The contaminant analysis identified that metal concentrations in sediment samples were below the marine sediment quality guidelines (**Table 16-1**) within the windfarm area, apart from arsenic, whose concentration levels were slightly elevated as a result of geological inputs from the North Wales coastal region.

16.4.31 A sediment sampling study is planned to gather site-specific data for locations in the marine environment where sediments could potentially be disturbed during construction, operation and decommissioning. Results from analysis of the sediment can then be used to inform the assessment of sediment quality for the inner estuary areas, particularly where disturbance of bed material is likely to occur.

Future Baseline

16.4.32 The future baseline scenario, as defined in **Chapter 2: Assessment Methodology and Consultation**, is the set out below for this chapter.

16.4.33 For the assessment of changes to physical processes under a different future climate change scenario, the UK guidance and projection of sea level rise and increased storminess are applied to the baseline (present day) conditions.

16.4.34 Changes in future wind and wave conditions are provided by the Environment Agency's 'Flood Risk Assessments: Climate Change Allowances (Ref 16-28), and Welsh Government guidance (Ref 16-29) (**Table 16-1**). The guidance states that wind speeds and wave height should be increased by 5% between 1990 and 2055 and by 10% for 2056 to 2115.

16.4.35 The latest UK Climate Projections are available from the UKCP18 website (Ref 16-27) which provides the most up-to-date assessment of how the climate may change up to 2100 and post-2100. Sea level rise data for locations around the UK coast are available for the relevant grid square. According to this data, by 2050, sea levels may rise by 0.22 m above 2023 levels in the Dee Estuary. This is estimated for a high emissions Representative Concentration Pathway 8.5 (RCP 8.5) for the 95th percentile value.

16.5 Development Design and Embedded Mitigation

16.5.1 The Proposed Development has been designed, as far as possible, to avoid or minimise impacts and effects on Physical Processes through the process of design development, and by embedding measures into the design of the Proposed Development.

16.5.2 There is currently limited information regarding the design and proposed works that will take place within the Water Connection Corridor. Therefore, as the design continues to develop, embedded mitigation measures will be incorporated into the Proposed Development design, with detailed proposals and locations to be submitted with the Development Consent Order (DCO) application.

16.5.3 The following embedded mitigation measures will be considered (but are not limited to) and will be detailed in the ES:

- a compressed air blast / jet washing system will be used to clear any build-up of silt on the intake screens thus avoiding any requirement for maintenance dredging;
- the outfall could incorporate a multiport diffuser to distribute the flow discharge to reduce flow rates and the amount of scour; and
- during construction a cofferdam could be designed to minimise changes to the estuary bed and minimise bank erosion and toe scour by extending the minimum distance required into the channel. If required, silt curtains could also be used to contain any sediment that becomes suspended.

16.5.4 In addition to the embedded mitigation measures, the following standard construction practices are also relevant to this assessment:

- construction phase impacts will likely be mitigated through the implementation of standard construction techniques and mitigation measures, as are described in a wide range of good practice publications which will be listed in the ES;

- measures during construction, including good practice, will be included and implemented through the Construction Environmental Management Plan (CEMP) and Site Waste Management Plan (SWMP) or permitting regimes including any Deemed Marine Licence (DML) that may form part of the DCO; and
- approaches to mitigating potential significant effects during construction, operational and decommissioning phases have been described with reference to good practice guidance and design.

16.6 Preliminary Assessment of Likely Impacts and Effects

16.6.1 Taking into account the embedded mitigation measures as detailed in Section 16.5 above, the potential impacts and effects of the Proposed Development have been assessed using the methodology as detailed in Section 16.3 of this chapter and **Chapter 2: Assessment Methodology and Consultation**.

16.6.2 Many impacts and changes to the physical environment associated with the construction, operational and decommissioning phases are impact pathways that could give rise to potentially significant effects to other receptors that are not related to physical processes. Where this is the case, the relevant chapter is referenced, and the impact is assessed further.

Construction phase

16.6.3 Impacts on Physical Processes features during construction of the Proposed Development are likely to include:

- changes to river / estuary bed morphology, due to:
  - scour of the river / estuary bed around the cofferdam;
  - change or disruption to existing sediment transport and deposition patterns caused by the presence of the cofferdam and jack-up barge (subject to confirmation of location and leg dimensions) within the waterway; and
  - change or disruption to existing sediment transport and deposition patterns caused by newly built intake and outfall structures elsewhere within the water connection corridor;
- increased water column turbidity / increased SSC (start of an impact pathway); and
- potential release of sediment-bound contaminants into the water column due to river / estuary bed disturbance (start of an impact pathway). Concentrations to be determined from the sediment modelling and assessed separately in **Chapter 13: Water Environment and Flood Risk**.

Changes to river / estuary bed morphology

16.6.4 For the length of time the cofferdam is in place (to be confirmed in the ES), the structure will protrude into the waterway and will locally interfere with the hydrodynamic regime. The maximum duration, extent and location of the

cofferdam within the Water Connection Corridor is not currently known. However, it is expected that with the cofferdam and JUB in place, less than 50% of the River Dee at low tide will be obstructed. This will be assessed in full in the ES.

16.6.5 Increased local flow rates around the sheet piles can lead to changes in estuary bed levels both locally and on a wider scale. The possible extent and rate of local scour is related to the erodibility of the sediment, flow rates within the estuary and the design of the cofferdam. Once this information is available, the impact of local scour (i.e. the potential depth and extent of scour) will be considered in more detail in the ES.

16.6.6 Based on the information currently available, the impact of local scour due to the presence of the cofferdam on the estuary bed morphology, which is of low sensitivity, has been assessed as having a potential magnitude of medium adverse, resulting in a minor adverse effect, which is **not significant**. The presence of the cofferdam is temporary, and the estuary bed will return to equilibrium conditions via natural current-driven sediment transport processes once the cofferdam is removed.

16.6.7 While the size, design and location of the cofferdam are not yet known, for the length of time the cofferdam is in place (details on the duration of the placement of the coffer dam and its impact will be assessed in full within the ES), it will interfere with natural hydrodynamic and associated sediment transport regimes. For example, the protrusion of the cofferdam into the channel of the River Dee may cause a temporary obstruction / restriction of the flow and transportation of suspended sediment from the river channel. This may cause temporary changes to the wider morphology of the estuary bed (beyond the localised occurrence of scour around the structure) as the erosion and depositional patterns within the estuary are altered.

16.6.8 The hydrodynamic model that will be developed for the ES (subject to ongoing discussions with NRW) will estimate where velocities and bed shear stress will increase and decrease within the estuary in association with the cofferdam and therefore where sediment is most likely eroded or deposited.

16.6.9 The wider-scale morphology of the estuary is of low sensitivity. The potential magnitude of the impact associated with bed morphology change has been assessed as medium adverse, resulting in an overall minor adverse effect, which is **not significant**. The presence of the cofferdam is temporary, and the estuary bed can be expected to return to equilibrium conditions as a result of re-working of bed sediments transported by tidal processes after the cofferdam is removed.

Increased suspended sediment concentration (SSC) in the water column

16.6.10 The temporary presence of the cofferdam (for the building of the new intake and outfall structures, or the refurbishment of the existing structures) within the estuary may increase SSC levels within the water column should scour occur around the base of the cofferdam. Scouring is the removal of sediment from the estuary bed which then becomes suspended in the water column and potentially carried in suspension throughout the estuary by river and tidal currents. Where large areas of scour develop and lots of sediment suspended,

a plume of sediment may be generated that can act as an impact pathway to other sensitive receptors, for example sensitive habitats and species which are assessed in **Chapter 12: Marine Ecology**.

16.6.11 To support a more detailed assessment in the ES (once the design information becomes available and subject to ongoing discussions with NRW), a 3D particle-tracking model will be used to assess how sediment disturbed during the scour process will disperse within the estuary. This will help determine the ZOI associated with this impact and identify the sensitive habitats and species at risk of impact due to increased turbidity and / or smothering as sediment eventually settles on the bed. This will be assessed in **Chapter 12: Marine Ecology**.

16.6.12 Construction phase dredging may be required, however, details on this are not yet known and will be available following design of the cooling water infrastructure which is ongoing. A full assessment will be undertaken in the ES once further information is available. As part of the worst-case assessment for the PEIR, it is assumed that dredging of the riverbed will occur within an unimpeded area (rather than within the dry cofferdam area or at low tide). Dredging the estuary bed will release sediment into the water column increasing the SSC and turbidity, as well as potentially release sediment-bonded contaminants. The ES will establish the potential ZOI associated with the impacts of dredging (once dredging details are available) and the potential impact of increased SSC and contaminant release will be assessed in **Chapter 12: Marine Ecology** and **Chapter 13: Water Environment and Flood Risk** (subject to ongoing discussions with NRW).

Release of contaminants in the water column

16.6.13 The suspension of sediment into the water column may also lead to the release of contaminants leading to water quality deterioration. As the type of contaminants present at the Site are currently unknown, a sediment sampling study is planned to acquire this data to carry out a more detailed assessment in the ES. In 2019 waterbodies within the Dee Estuary were found to have a failed chemical status for selected contaminants and any related effects will therefore be discussed in **Chapter 13: Water Environment and Flood Risk**.

16.6.14 The release of contaminants will lead to deterioration in water quality which may act as an impact pathway for sensitive habitats and species which are assessed in **Chapter 12: Marine Ecology**.

Operation phase

16.6.15 The earliest year of operation for the Proposed Development is anticipated to be 2030, under a phased construction approach beginning in 2026 for a period of five years. If construction was to be undertaken in a single phased approach, the earliest year of operation is anticipated to be 2035. If a single phased construction approach was undertaken at the latest possible time, five years after DCO Consent, operation would be anticipated to occur in late 2036.

16.6.16 Impacts on Physical Processes features during the operational phase of the Proposed Development are likely to include:

16.6.17 Changes to river/estuary bed morphology, due to:

- scour of the river / estuary bed and associated change in hydrological regimes as cooling water is extracted from the estuary and discharged from the outfall into the estuary;
- alteration of estuary bed morphology due to new installation of outfall and intake structures elsewhere within the water connection corridor;
- maintenance operations involving use of an air blast, and/or jet washing system to remove accumulated sediment from the intake screens;
- increased water column turbidity / increased SSC due to estuary bed scour (start of an impact pathway); and
- potential release of sediment-bound contaminants into the water column due to estuary bed disturbance (start of an impact pathway).

Changes to river / estuary bed morphology

16.6.18 Cooling water abstraction and discharge will be limited to periods around high water in line with the current abstraction permit. Cooling water will be abstracted at a rate of up to 3.04 cubic metres per second (m^3/s) and up to 33 mega litres (ML) per high tide.

16.6.19 As cooling water is discharged and abstracted it may lead to local scour and erosion of the estuary bed caused by the increased velocity of the discharging / abstracting water.

16.6.20 The possible extent and rate of scour is related to the erodibility of the sediment type at each site, flow rates within the estuary and the rate of the discharge. Once the indicative design of the Proposed Development is known, including the location of the outfall and intake structures, and once erodibility rates have been calculated from the results of the planned sediment sampling study (subject to ongoing discussions with NRW), the impact of scour due to cooling water discharge and abstraction, will be considered in more detail in the ES as appropriate.

16.6.21 For the PEIR assessment it is assumed that the design, i.e. the capacity of the outfall and intake structures, the rate of discharge into the estuary, will be the same design as the existing power station. Therefore, there will be no impact on the estuary bed morphology as there will be no change to the current baseline conditions should the structures be refurbished (rather than rebuilt elsewhere). Further, the estuary is dynamic undergoing natural changes over varying timescales on a local and wider scale. The influence of intake and outfall discharges is likely to be outweighed by the larger-scale natural processes influencing the wider estuary geomorphology.

16.6.22 The impact on estuary bed morphology, which is of low sensitivity, has been assessed as having a potential magnitude of very low adverse, resulting in a negligible effect, which is **not significant**.

16.6.23 Should new intake and outfall structures be rebuilt elsewhere within the water connection corridor, it is assumed that the design parameters will remain the same as at present. The location of the impact on the estuary bed morphology will change, however the estuary bed morphology is considered to be of low

sensitivity. Therefore, the impact on the estuary bed morphology in the new location has been assessed as having a potential magnitude of very low adverse, resulting in a negligible effect, which is **not significant**.

16.6.24 Scour may also occur in association with the outfall and intake structures themselves when water intake and discharge are not taking place. It remains to be confirmed whether the outlet and intake structures will be replaced as part of the new development. Should the design and or the location of the structures change, this may cause a change in the local hydrodynamic patterns about the structure and lead to increased scour at the outfall locations. The impact on estuary bed morphology, which is of low sensitivity, has been assessed as having a potential magnitude of medium adverse. This results in a minor adverse effect, which is **not significant**.

16.6.25 Current operational practice involves the regular use of an air blast system to clear sediment build-up around the intake screen. This process will be intermittent and short-duration and effectively returns sediment back into the estuary thereby minimizing any changes to natural transport processes and the overall estuary sediment budget. The associated impact on bed morphology, which is of low sensitivity, has been assessed as having a potential magnitude of minor adverse. This results in a minor adverse effect, which is **not significant**.

Increased suspended sediment concentration in the water column

16.6.26 As described above, as cooling water is discharged and abstracted into and from the estuary this may lead to local scour and erosion of the estuary bed caused by the increased velocity of the discharging/ abstracting water. Scour may also occur about the outfall and intake structures. The regular removal / scour of sediment from the bed can lead to increased amounts of suspended sediment and increased turbidity of the water column. Plumes of suspended sediment may then be transported about the estuary by currents.

16.6.27 While the water column may experience increased turbidity, there is no impact associated with the water column itself. Instead, increased water column turbidity can act as an impact pathway for other receptors, for example the impact of increased sediment suspension levels on sensitive habitats and species are assessed in **Chapter 12: Marine Ecology**.

Release of contaminants in the water column

16.6.28 As is the case for the construction phase, the suspension of sediment into the water column may also lead to the release of contaminants leading to water quality deterioration. As the type of contaminants present at The Site are currently unknown, a sediment sampling study is planned to acquire this data (subject to ongoing discussions with NRW). In 2019 waterbodies within the Dee Estuary were found to have a failed chemical status for selected contaminants and any related effects will therefore be discussed in **Chapter 13: Water Environment and Flood Risk**. The release of contaminants will lead to deterioration in water quality which may act as an impact pathway for sensitive habitats and species which are assessed in **Chapter 12: Marine Ecology**.

Decommissioning phase

16.6.29 Impacts on Physical Processes during decommissioning of the Proposed Development are likely to include:

- increased water column turbidity / increased SSC in relation to the temporary works for removal any infrastructure from the estuary environment;
- potential release of contaminants into the water column due to river / estuary bed disturbance; and
- changes to river / estuary bed morphology due to the removal of any infrastructure from the estuary environment.

16.6.30 It is assumed that whether the estuary-based structures are removed or left in-situ, the environmental effects associated with the decommissioning phase would be no worse than those experienced during the construction phase. Therefore, decommissioning is not anticipated to present any significant environmental effects beyond those assessed for the construction phase of the Proposed Development.

16.7 Additional Mitigation and Enhancement Measures

16.7.1 The assessment found that the construction, operation and decommissioning phases of the Proposed Development are likely to have no significant effects on physical processes. Therefore, additional mitigation measures and enhancements are not required.

16.7.2 It is noted however, that the preliminary assessment is based on limited information regarding the design and proposed works that will take place within the Water Connection Corridor. The final ES will therefore further assess any potential impacts and re-consider if any further mitigation measures are required.

16.8 Summary of Likely Significant Residual Effects

16.8.1 **Table 16-6** to **Table 16-8** summarise the likely residual significant effects of the Proposed Development on Physical Processes and receptors following implementation of mitigation.

16.8.2 An assessment of cumulative effects with other proposed developments that could interact with the effects of this Proposed Development will be carried out in the final ES, when the short-list of other developments has been finalised, as detailed in **Chapter 24: Cumulative and Combined Effects**. **Chapter 24** will also assess the in-combination effects of multiple impacts occurring on one receptor.

16.8.3 No significant residual effects have been identified.

Table 16-6: Summary of Likely Significant Residual Effects (Construction)

Receptor	Sensitivity (value)	Description of Impact	Classification of Effect (prior to Additional Mitigation)	Additional Mitigation / Enhancement Measure	Magnitude of Impact after Additional Mitigation	Residual Effect after Additional Mitigation
Water column	Low	Increased water column turbidity and increased levels of SSC.	To be assessed at ES stage	To be assessed at ES stage	To be assessed at ES stage	To be assessed at ES stage
Water column	Low	Release of contaminants into the water column due to estuary bed disturbance.	To be assessed at ES stage	To be assessed at ES stage	To be assessed at ES stage	To be assessed at ES stage

Table 16-7: Summary of Significant Residual Effects (Operation)

Receptor	Sensitivity (value)	Description of Impact	Classification of Effect (prior to Additional Mitigation)	Additional Mitigation / Enhancement Measure	Magnitude of Impact after Additional Mitigation	Residual Effect after Additional Mitigation
Water column	Low	Increased water column turbidity / increased SSC due to estuary bed scour	To be assessed at ES stage	To be assessed at ES stage	To be assessed at ES stage	To be assessed at ES stage
Water column	Low	Potential release of sediment-bound contaminants into the water column due to estuary bed disturbance	To be assessed at ES stage	To be assessed at ES stage	To be assessed at ES stage	To be assessed at ES stage

Table 16-8 Summary of Significant Residual Effects (Decommissioning)

Receptor	Sensitivity (value)	Description of Impact	Classification of Effect (prior to Additional Mitigation)	Additional Mitigation / Enhancement Measure	Magnitude of Impact after Additional Mitigation	Residual Effect after Additional Mitigation
Water column	Low	Increased water column turbidity and increased levels of SSC.	To be assessed at ES stage. It is assumed that the environmental effects associated with the decommissioning phase would be no worse than those experienced during the construction phase.	To be assessed at ES stage	N/A	N/A
Water column	Low	Release of contaminants into the water column due to estuary bed disturbance.	To be assessed at ES stage. It is assumed that the environmental effects associated with the decommissioning phase would be no worse than those experienced during the construction phase.	To be assessed at ES stage	N/A	N/A

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