# LLŶR FLOATING OFFSHORE WIND PROJECT

## Llŷr 1 Floating Offshore Wind Farm

## Environmental Statement

## Volume 6: Appendix 11A - Phase 1 Geo-environmental Desk Study Report

## August 2024

Prepared by: Llŷr Floating Wind Ltd

FLOVENTIS ENERGY

## Document Status

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## Approval for Issue

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## Acronyms and abbreviations

| Acronym or Abbreviation | Definition | Acronym or Abbreviation | Definition |
|---|---|---|---|
| BGS | British Geological Survey | PCB | Polychlorinated Biphenyls |
| CIEH | Chartered Institute of Environmental Health | PDSA | Pre-Desk Study Risk Assessment |
| CSAI | Cranfield Soil and AgriFood Institute | PHE | Public Health England |
| EA | Environment Agency | RIGS | Regionally Important Geological and Geomorphological Sites |
| ES | Environmental Statement | SAC | Special Areas of Conservation |
| GCR | Geological Conservation Review | SPA | Special Protection Areas |
| LGS | Local Geodiversity Sites | SPZ | Source Protection Zone |
| LFW | Llŷr Floating Wind Ltd | SSSI | Sites of Special Scientific Interest |
| NHBC | National House Building Council | TPH | Total Petroleum Hydrocarbons |
| NRW | Natural Resources Wales | UXO | Unexploded Ordnance |
| NVZ | Nitrate Vulnerable Zone | WFD | Water Framework Directive |
| PAH | Polycyclic Aromatic Hydrocarbons | | |

## Glossary of project terms

| Term | Definition |
|---|---|
| The Applicant | The developer of the Project, Llŷr Floating Wind Limited. |
| Array | All wind turbine generators, inter array cables, mooring lines, floating sub-structures and supporting subsea infrastructure within the Array Area, as defined, when considered collectively, excluding the offshore export cable(s). |
| Array Area | The area within which the wind turbine generators, inter array cables, mooring lines, floating sub-structures and supporting subsea infrastructure will be located. |
| Floventis Energy | A joint venture company between Cierco Ltd and SBM Offshore Ltd of which Llŷr Floating Wind Limited is a wholly owned subsidiary. |
| Landfall | The location where the offshore export cable(s) from the Array Area, as defined, are brought onshore and connected to the onshore export cables (as defined) via the transition joint bays. |
| Llŷr 1 | The proposed Project, for which the Applicant is applying for Section 36 and Marine Licence consents. Including all offshore and onshore infrastructure and activities, and all project phases. |
| Marine Licence | A licence required under the Marine and Coastal Access Act 2009 for marine works which is administered by Natural Resources Wales (NRW) Marine Licensing Team on behalf of the Welsh Ministers. |
| Offshore Development Area | The footprint of the offshore infrastructure and associated temporary works, comprised of the Array Area and the Offshore Export Cable Corridor, as defined, that forms the offshore boundary for the S36 Consent and Marine Licence application. |
| Offshore Export Cable | The cable(s) that transmit electricity produced by the WTGs to landfall. |

| Term | Definition |
|---|---|
| Offshore Export Cable Corridor (OfECC) | The area within which the offshore export cable circuit(s) will be located, from the Array Area to the Landfall. |
| Onshore Development Area | The footprint of the onshore infrastructure and associated temporary works, comprised of the Onshore Export Cable Corridor and the Onshore Substation, as defined, and including new access routes and visibility splays, that forms the onshore boundary for the planning application. |
| Onshore Export Cable(s) | The cable(s) that transmit electricity from the landfall to the onshore substation. |
| Onshore Export Cable Corridor (OnECC) | The area within which the onshore export cable circuit(s) will be located. |
| proposed Project | All aspects of the Llŷr 1 development (i.e. the onshore and offshore components). |
| Onshore Substation | Located within the Onshore Development Area, converts high voltage generated electricity into low voltage electricity that can be used for the grid and domestic consumption. |
| Section 36 consent | Consent to construct and operate an offshore generating station, under Section 36 (S.36) of the Electricity Act 1989. This includes deemed planning permission for onshore works. |

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## 11.1 Introduction

### *11.1.1. Overview*

1. This report presents a Phase 1 Geo-environmental Desk Study (hereafter referred to as 'Desk Study') for the onshore areas of the proposed Project, hereafter referred to as the 'Onshore Development Area'.

### *11.1.2. Report Objectives*

2. This report aims to establish the baseline ground conditions within the Onshore Development Area using available published geological and geo-environmental information sources, together with reference to third party data and a site inspection.
3. This report is a necessary precursor to any ground investigation that may be required prior to development, that may be required in support of the design development.
4. Current industry guidance supports the preparation of a development-specific desk study as a necessary precursor to any intrusive works. The desk study defines the plausible risks that may be present on a site, and hence the need for any further remediation or investigation.
5. The following represents the scope of this report:

- Review the Onshore Development Area's geological, hydrological and hydrogeological setting, and other geo-environmental and ground condition information obtained from Groundsure GIS data (June 2023) and other published sources to build up an understanding of the ground model, environmental setting and sensitivity;
- Review the historical development and land use at the Onshore Development Area and in the surrounding area, with an emphasis on identifying any potential on-site and / or off-site contamination sources;
- Carry out a site inspection of selected areas of the Onshore Development Area defined from the historical development review to help inform assessment of features giving rise to potential hazards and related risks or constraints in these areas;
- Develop an initial Conceptual Site Model (iCSM) to describe potential source-pathway-receptor linkages followed by undertaking a preliminary risk assessment;
- Develop a ground model and review of outline geotechnical hazards; and
- Outline the scope of any further investigation or remediation, as required.

### *11.1.3. Sources of Information*

6. The following sources of information have been referenced in preparing this report:

- Historical mapping included as part of a Groundsure Insights Report provided by Groundsure (June 2023) presented in **Annex 11A-A**;
- Information provided by Groundsure (in GIS data format – June 2023);
- British Geological Survey (BGS) geological mapping and memoirs (British Geological Survey, n.d.);
- Natural Resources Wales (NRW) Interactive Map Viewer Geocortex Viewer for HTML5 (cyfoethnaturiolcymru.gov.uk);
- Welsh Government, Data Map Wales (Welsh Government, n.d.); https://datamap.gov.wales/maps/new#/);
- BGS Geoindex website (British Geological Survey (BGS), n.d.);

- Cranfield Soil and AgriFood Institute (CSAI) Soilscapes website (Cranfield Soil and AgriFood Institute, n.d.); and
- UK Radon maps by UK Health Security Agency (UK Health Security Agency, n.d.).

*11.1.4. Study Area*

7. For the purposes of this Desk Study, a Study Area extending 250 m from the Onshore Development Area has been adopted. This is extended for hydrogeological receptors to 1 km from the boundary of the Onshore Development Area. This is appropriate to assess the local geological and hydrogeological setting, and the plausible influence that potential contaminated land might have on the Onshore Development Area or local receptors. A site location plan of the Onshore Development Area, along with the Study Area is presented as **Volume 5: Figure 11A.1**. Note that the Study Area terminates at the coastline irrespective of whether this is 250m or less from the Onshore Development Area.

## 11.2 Site Description and Setting

*11.2.1. Site Setting and Surrounding Land Use*

8. The Onshore Development Area is in a predominantly agricultural setting in Pembrokeshire. The below features can be identified on **Volume 5: Figure 11A.1.**
9. The Onshore Development Area extends approximately west-to-east from the Mean Low Water Springs (MLWS) and landfall location in Freshwater West, to Pembroke Power Station and comprises agricultural and undeveloped land with a very small parking area near Freshwater West Beach.
10. The surroundings of the Onshore Development Area mostly comprise grassland, agricultural land, woodlands, undeveloped land, farms, and solar farms. The Celtic Sea bounds the Onshore Development Area to the west.
11. Only sporadic settlements are located along the Onshore Development Area / Study Area, notably Newton (central area) and Wallaston Green (eastern area). Pembroke Power Station is located at the eastern extent of the Study Area.
12. Pembroke Refinery is located approximately 1 km north of the Onshore Development Area (at its closest point), east of Angle Bay; a former tank farm (Angle Bay Oil Terminal (disused)) is located adjacent to the Onshore Development Area to the north, immediately south-east of Angle Bay.
13. The mouth of the Pembroke River (otherwise known as Milford Haven Inner transitional waterbody) is located to the east of the Onshore Development Area and at its closest point, is located approximately 130 m north-east of the easternmost spur of the Onshore Development Area.

## 11.3 Site Inspection

14. A site inspection was completed from roads and public rights of way along the Onshore Development Area by a qualified AECOM engineer on 31st May 2022. The drive-by confirmed the land uses along the length of the Onshore Development Area.
15. The drive-by confirmed that the majority of the Onshore Development Area is occupied by agricultural land (predominantly pastoral), with several farms noted along the length of the Onshore Development Area. The site inspection also noted the Wogaston Service Reservoir approximately 200 m south of the central area of the Onshore Development Area (1km east of Newton) (this reservoir is indicated on **Volume 5: Figure 11A.1**) and the Pembroke Power Station at the far eastern end, however it was not possible to view the power station in any

detail from public access roads. The Pembroke Refinery (Valero) was also observed approximately 1 km to the north of the Onshore Development Area.

## 11.4 Environmental Setting

### *11.4.1. Introduction*

16. The environmental setting including the soil classification, geology, hydrogeology, and hydrology are the key factors that influence the way in which potential contaminants in the soil and / or groundwater can be transported on, or off-site, and the way in which contamination can impact users of the Onshore Development Area.

17. The environmental setting of the Onshore Development Area has been assessed by referring to the information sources detailed in **Section 11.1.3.**

### *11.4.2. Soil Classification*

18. Information obtained from the CSAI Soilscapes website (Cranfield Soil and AgriFood Institute, n.d.) (accessed December 2023) describes the soils underlying the Onshore Development Area as indicated in **Table 11A-1.**

*Table 11A-1. CSAI soil classification*

| Soilscape classifications | Descriptions of the Soilscape classifications | Extent |
|---|---|---|
| Soilscape 7 | Freely draining slightly acid but base-rich soils. | Pembroke Power Station (eastern-most extent of the Onshore Development Area). |
| Soilscape 4 | Sand dune soils. | Portion of land from Angle Bay, south-west of the Pembroke Refinery, to Freshwater West Beach (western part of the Onshore Development Area). |
| Soilscape 17 | Slowly permeable seasonally wet acid loamy and clayey soils. | Portion of land in the central-southern area of the Onshore Development Area, in proximity of Newton, east of Soilscape 4. |
| Soilscape 6 | Freely draining slightly acid loamy soils. | Remainder of Onshore Development Area, comprising the central area to Pembroke Power Station. |

### *11.4.3. Geology*

19. The BGS Geoindex website (British Geological Survey (BGS), n.d.) has been reviewed, alongside BGS geological map sheets 244 and 245 (Pembroke and Linney Head), solid and drift edition (1:50,000) (British Geological Survey, n.d.). **Table 11A-2 and Table 11A-3** outline the anticipated geological succession underlying the Onshore Development Area and Study Area.

**Made Ground**

20. BGS mapping does not indicate the presence of Made Ground / artificial ground within the Study Area. However, it is expected to be present in areas around more developed areas such as the Pembroke Power Station.

**Superficial Deposits**

21. The extent of mapped superficial deposits across the Onshore Development Area is limited, with the following present:

- Across the western portion of the Onshore Development Area, south of Angle Bay and the area surrounding Freshwater West Beach (mostly blown sand, with marine beach deposits in the Study Area along Freshwater West Beach, and small areas of alluvium in the Study Area around Neath Farm (north of the western section of Onshore Development Area); and
- On the eastern-most spur of the Onshore Development Area, close to the Pembroke Power Station (alluvium) and small areas in the south-east and east of the Study Area (till and tidal flat deposits).

A more detailed description of superficial deposits in the Study Area, together with the BGS descriptions, is reported in **Table 11A-2. Volume 5: Figure 11A.2** shows the distribution of the superficial geology within the Study Area.

*Table 11A-2. Superficial deposits*

| Name | Location | **BGS description** (British Geological Survey, n.d.) |
|---|---|---|
| Marine beach deposits - sand | Freshwater West Beach. | Shingle, sand, silt and clay. |
| Blown sand | Located in the western portion of the Onshore Development Area and Study Area. | Sand that has been transported by wind, or sand consisting predominantly of wind-blown particles. |
| Alluvium | Mapped underneath and to the south-east of the Pembroke Power Station and in a small strip south-east of Angle Bay, extending within the Study Area around Neath (north of the western section of the Onshore Development Area). | Clay, silt, sand and gravel. It is the unconsolidated detrital material deposited by a river, stream or other body of running water. |
| Till, Mid Pleistocene | Small strip in the south-easternmost extent of the Study Area. | Not available. |
| Tidal flat deposits – sand, silt and clay | Along the coastline east of the Pembroke Power Station, with very limited overlap into the eastern-most extent of the Study Area. | Mud flat and sand flat deposits, deposited on extensive nearly horizontal marshy land in the intertidal zone that is alternately covered and uncovered by the rise and fall of the tide. |

**Bedrock**

22. The mapped bedrock underneath the Study Area consists of a complex sequence of strata.

23. The Pembrokeshire peninsula is mostly comprised of sedimentary rocks of the Devonian and Carboniferous Periods (sandstone and limestone) with outcrops of Silurian and Ordovician rocks (shales and sandstones). Sequences of limestones interbedded with mudstones (Avon Group) outcrop in parts of the Onshore Development Area and are part of the Pembroke Limestone Group, which in turn are part of the Carboniferous Limestone Supergroup. There are two axial plane traces of major anticline / syncline located in the western extent of the Onshore Development Area and Study Area. A few faults and folds trending approximately in a north to south direction are located across the Study Area; due to the folding and faulting,

depth and direction of strata is expected to vary significantly across the Study Area. The bedrock geology and morphological features can be seen on **Volume 5: Figure 11A.3.**

24. For the purposes of this section, the Onshore Development Area has been divided into two areas (shown on **Volume 5: Figure 11A.3**):

- From Freshwater West Beach to Wallaston Green village (western portion of the Onshore Development Area); and
- From Wallaston Green village to Pembroke Power Station (eastern portion of the Onshore Development Area).

***From Freshwater West Beach to Wallaston Green village***

25. This area is predominantly underlain by the Milford Haven Group along the Orielton Anticline, except for an area in the south-western spur, where the Ludlow Rocks and Aber Mawr Shale formations outcrop. A fault extends from Freshwater West Beach to Angle Bay Beach, in a southwest-northeast direction; the geological units either side of the fault dip roughly north at steep angles (around 60 ° – 65°), there is no information regarding dip or strike of the fault itself on the BGS geological map sheets reviewed (BGS, n.d.).

***From Wallaston Green village to Pembroke Power Station***

26. This area's bedrock geology comprises mostly the Milford Haven Group and outcrops of the Ridgeway Conglomerates, Skrinkle Sandstone, and the Avon Group. The Black Rock Subgroup and Gully Oolite Formation, forming the core of the Pembroke syncline, is not mapped below the Onshore Development Area, but is likely to be present immediately north, within the Pembroke Power Station footprint (as indicated on the BGS geological map sheets (BGS, n.d.)).

27. The above geology is summarised below in **Table 11A-3,** reported roughly from south to north. **Volume 5: Figure 11A.3** shows the distribution of the bedrock geology and morphological features within the Study Area.

*Table 11A-3. Bedrock geology*

| Name | Location | Described by the BGS as… |
|---|---|---|
| Aber Mawr Shale Formation – mudstone. | Slight overlap into the south-western portion of the Onshore Development Area. | Dark grey mudstones locally with interbedded tuffs. |
| Ludlow Rocks (undifferentiated) – sandstone. | South-western portion of the Study Area (north of the Aber Mawr Shale Formation). | Not available. |
| Milford Haven Group – argillaceous rocks and sandstone interbedded. | Majority of the Onshore Development Area and Study Area, except the north-eastern areas and a limited area in the southern-most portions of the Study Area. | Hard, red calcareous marls with sporadic red and green sandstones. Basal beds of green marl, conglomerate and breccia are also present. |
| Ridgeway Conglomerate Formation – conglomerate. | Along a band outcropping east west and crossing the Onshore Development Area and Study Area north of the Milford Haven Group. | Interbedded conglomerates and red mudstones. |
| Skrinkle Sandstone Formation – sandstone. | Along a band outcropping east west and crossing the Onshore Development Area and Study Area north of the Ridgeway Conglomerate Formation. | Interbedded grey quartzitic and red lithic sandstones, conglomerates, red mudstones and siltstones. |
| Avon Group – limestone and mudstone, interbedded. | Along two bands outcropping east west and crossing the Onshore Development Area and Study Area north of the Skrinkle Sandstone Formation. | Interbedded grey mudstones and thin- to medium-bedded skeletal packstones with one to several thick units of ooidal and skeletal grainstones. Thin units of calcite mudstone and mudstone locally present. Sparse thin ironstones. Represents mid to inner shelf / ramp deposits with coeval barrier, back barrier and coastal plain sediments. |
| Black Rock Subgroup and Gully Oolite Formation (undifferentiated) – limestone. | Located within the north-easternmost extent of the Onshore Development Area and Study Area, along a band outcropping east west between the two Avon Group bands. | Not available. |

**Historical Borehole Records**

28. No historical boreholes records are publicly available for the Onshore Development Area or Study Area. The closest historical boreholes from the Onshore Development Area are located at least 1.2 km away and therefore not considered to be relevant.

*11.4.4. Hydrogeology*

**Aquifer Classification**

29. NRW aligns with the Environment Agency's (EA) Groundwater Protection Policy (EA, 2018) which adopts aquifer designations that are consistent with the Water Framework Directive (WFD) (WFD 2000/60/EC).

30. NRW have adopted the EA definitions for the aquifer designations, which are listed as follows:

- Principal aquifer: 'layers of rock or drift deposits that have high intergranular and / or fracture permeability – meaning they usually provide a high level of water storage. They may support water supply and / or river base flow on a strategic scale.'
- Secondary A aquifer: 'permeable layers that can support local water supplies and may form an important source of base flow to rivers.'
- Secondary B aquifer: 'lower permeability layers that may store and yield limited amounts of groundwater through characteristics like thin cracks (called fissures) and openings or eroded layers.'
- Secondary undifferentiated aquifer: 'Secondary undifferentiated are aquifers where it is not possible to apply either a Secondary A or B definition because of the variable characteristics of the rock type.'

31. The superficial deposits in the Study Area, when present, are classified as follows:

- The tidal flat deposits and till deposits are classified as Secondary undifferentiated aquifers; and
- The marine beach deposits, alluvium, and blown sand deposits are classified as Secondary A aquifers.

32. The bedrock formations underlying the Study Area are classified as follows:

- The Black Rock Subgroup and Gully Oolite Formation is classified as Principal aquifer;
- The Ludlow Rocks and the Aber Mawl Shale Formation, are classified as Secondary B aquifers; and
- The remaining bedrock designations are classified as Secondary A aquifers.

**Groundwater Vulnerability**

33. Groundsure data outlines the vulnerability of groundwater to pollution. The definition of the groundwater vulnerability to pollution is as follows;

- High: 'Areas able to easily transmit pollution to groundwater. They are characterised by high leaching soils and the absence of low permeability superficial deposits'.
- Medium: 'Areas that offer some groundwater protection. Intermediate between high and low vulnerability'.
- Low: 'Areas that provide the greatest protection to groundwater from pollution. They are likely to be characterised by low leaching soils and / or the presence of low permeability superficial deposits'.

34. The groundwater vulnerability map obtained as part of the Groundsure data, indicates that the combined groundwater vulnerability is classified as High for the whole Onshore Development Area and 250m Study Area, except for an area of limited extent within the western Onshore Development Area boundary north of Angle Road. The High vulnerability classification applies to the Secondary superficial aquifers, Principal bedrock aquifers and Secondary bedrock aquifers (i.e., across the Onshore Development Area and Study Area).

**Source Protection Zones**

35. NRW mapping (Welsh Government and Natural Resources Wales, n.d.) and the Groundsure data indicate that no Source Protection Zones are located within the Onshore Development Area or within a 1 km radius from its boundary.

**Groundwater Quality**

36. The Study Area overlies the Pembrokeshire Carboniferous Limestone WFD groundwater body, which was classified as being of 'good' overall quality in 2017; this is indicated in **Volume 5: Figure 10-1** of **Chapter 10: Water Environmen**t. It should be noted that the route intersects limestone formations for a limited extent only.

**Groundwater Abstractions**

37. Details of groundwater abstractions were requested from NRW who indicated that the information would be available online from Data Map Wales (Welsh Government, n.d.). This indicates that there are no groundwater abstractions present within the 1km Study Area.

38. Details of registered Private Water Supplies (PWS) were requested from the local authority, Pembrokeshire County Council and also gleaned from the Project Erebus ES Chapter 19 (Onshore Geology, Hydrogeology and Hydrology) Appendix 19.1 Private Water Supply Assessment (Blue Gem Wind, 2021); the Study Area of Project Erebus overlaps in part with the Onshore Development Area. These are listed in **Table 11A-4.**

39. The PWS data from Appendix 19.1 (Blue Gem Wind, 2021), has been revaluated and updated following some discrepancies in the data between the NGR's of the PWS and the names identified in Table 1 of Appendix 19.1. The re-evaluated data from Appendix 19.1 has been combined with the data received from PCC and a list of PWS with updated references and correct names is provided in **Table 11A-4.**

40. PWS7 has been sampled historically but PCC could not confirm if these single domestic supplies are still in use or not.

41. The planned water feature survey will be undertaken to identify, confirm or deny the presence of any PWS in the Study Area, the results of which will be included below and in a technical appendix to the impact assessment chapter.

42. As water extracted from wells and springs is derived from groundwater, these have been considered as groundwater abstractions for domestic / potable use. This is considered to be a precautionary approach.

43. Note that the information presented in Table **11A-4** may be different to that presented in **Chapter 10: Water Environment** as different Study Areas are used.

*Table 11A-4. Groundwater abstractions (including PWS) within the Study Area*

| PWS ID | Name | Type | Use | Location | Data source |
|---|---|---|---|---|---|
| PWS03a | Broomhill (i) | Borehole | Assumed domestic / potable | Approximately 70m north of the Onshore Development Area, southeast of the tank farm | Project Erebus ES |
| PWS03b | Broomhill (ii) | Well | Assumed domestic / potable | Western portion of the Onshore Development Area | |
| PWS04 | Cheveralton | Spring | Assumed domestic / potable | Approximately 630m northeast of the Onshore Development Area, south of Valero Refinery | |
| PWS05 | Coreside Nursery | Spring | Assumed domestic / potable | Approximately 300m south of the Onshore Development Area, southeast of Newton Farm | |
| PWS06a | Moreston (i) | Borehole | Assumed domestic / potable | Approximately 470m south of the eastern portion of the Onshore Development Area | |
| PWS06b | Moreston (ii) | Borehole | Assumed domestic / potable | Approximately 530m south of the eastern portion of the Onshore Development Area | |
| PWS7 | Moreston Cottage | Spring | Assumed domestic / potable | Approximately 320m south of the eastern portion of the Onshore Development Area | Project Erebus ES and PCC |
| PWS12 | Goldborough | Unconfirmed | Assumed domestic / potable | Approximately 590m southeast of the eastern portion of the Onshore Development Area | PCC |

### *11.4.5. Hydrology*

44. **Table 11A-5** outlines the surface watercourses located within 250 m of the Onshore Development Area, at their closest point. There are no rivers, lakes or canals managed under the WFD mapped within 250 m of the Onshore Development Area. Most of the Study Area is not part of a river catchment and drains into coastal or estuarine waters, except for the southern-most area, which is part of a river catchment (Castlemartin Corse).

*Table 11A-5. Surface water features*

| Surface water feature name | Category | Closest distance to the Onshore Development Area and direction | River quality |
|---|---|---|---|
| Milford Haven Inner (mouth of the Pembroke River towards the Pennar Mouth) | Transitional (estuary)/ coastal waters | Approximately 170m east of the northeastern-most spur at its closest point. | Overall quality: moderate (2016). |
| Pembrokeshire South Coast | Coastal water | Adjacent to the west of the Onshore Development Area. | Overall quality: good (2016). |
| Green Hill Reservoir | Inland surface waters | Approximately 25m north of the Onshore Development Area (eastern area). | Not applicable |
| Goldborough Pill | Inland surface waters | Approximately 90m southeast, flowing towards Milford Haven | Not applicable |
| Unnamed streams, ponds and reservoirs | Inland surface waters | On-site and in the Study Area. | Not applicable |

**Surface Water Abstractions**

45. The following surface water abstractions, listed in **Table 11A-6,** have been identified within the Study Area. These are licenced water abstractions available on the Data Map Wales website (Welsh Government, n.d.). The surface water abstractions are reported in **Volume 5: Figure 10-1** within **Chapter 10: Water Environment**.

*Table 11A-6. Surface water abstractions within the Study Area*

| ID | Permit no. | Name | Type | Use | Location |
|---|---|---|---|---|---|
| 32593 | 22/61/6/0014 | Reservoir 'c' - fed by unnamed tributary of Daucleddau River. | Surface Water | Agriculture | 70m north of the western portion of the Onshore Development Area |
| 32592 | 22/61/6/0014 | Reservoir 'b' - fed by unnamed tributary of Daucleddau River. | Surface Water | Agriculture | 140m north of the western portion of the Onshore Development Area |
| 32650 | 22/61/6/0113 | Inland water unnamed tributary at Kilpaison Farm. | Surface Water | Impounding | 60m north of the western portion of the Onshore Development Area |
| 32651 | 22/61/6/0014 | Inland water unnamed tributary at Kilpaison Farm. | Surface Water | Agriculture | 60m north of the western portion of the Onshore Development Area |
| 32657 | 22/61/6/0120 | Impounding of un-named tributary of Daucleddau at Angle. | Surface Water | Agriculture | 110m north of the central portion of the Onshore Development Area |
| 32659 | 22/61/6/0122 | Impounding of un-named tributary of Daucleddau at Angle. | Surface Water | Impounding | 110m north of the central portion of the Onshore Development Area |

| ID | Permit no. | Name | Type | Use | Location |
|---|---|---|---|---|---|
| 32597 | 22/61/6/0021 | Unnamed stream in field 154 at Neath Farm, Angle. | Surface Water | Agriculture | 110m north of the central portion of the Onshore Development Area |
| 789 | 22/61/6/0156 | Cleddau and Pembrokeshire Coastal Rivers | Surface Water | Non-evaporative cooling | East of Pembroke Power Station, 220m north of the eastern portion of the Onshore Development Area |
| 32660 | 22/61/6/0123 | Unnamed tributary of the Daucleddau River | Surface Water | Agriculture | 300m north of the Onshore Development Area, west of the tank farm[1] |
| 32642 | 22/61/6/0105 | Reservoir fed by land drains in Rhoscrowther | Surface Water | Agriculture | 280m west of the Onshore Development Area, east of the tank farm[1] |

[1] These abstractions are located out of the Study Area for hydrology; however, these are within 250 m from contaminated land sites and have therefore been included in this table for reference.

**Nitrate Vulnerable Zones**

46. According to the Groundsure data, there are no nitrate vulnerable zones (NVZ) in the Study Area.

*11.4.6. Radon*

47. The UK Radon website (UK Health Security Agency, n.d.) provides details of radon risk. The radon potential of the majority of the Onshore Development Area and Study Area is 'medium', with between 5 to 10% of homes at, or above, the action level. There are some areas in the central and eastern extents where the radon potential is 'high', with between 10 to 30% of homes at, or above, the action level. Where the Onshore Substation building is proposed, basic building mitigation measures are required as it has been identified as a 'medium' area.

*11.4.7. Unexploded Ordnance*

48. According to the Pre-Desk Study Risk Assessment (PDSA) provided by Zetica UXO in **Annex 11A-B**, several defences were established at the Onshore Development Area; in addition, several strategic targets were located in the vicinity of the Onshore Development Area. Although no readily available records have been found to indicate that the Onshore Development Area was bombed, Zetica UXO recommends a detailed desk study to assess the hazard level.

## 11.5 Regulated Activities

*11.5.1. Introduction*

49. The key relevant features that characterise the Onshore Development Area and the surrounding area are summarised within this section, along with an indication of the risk to land quality. Information detailed in the following section has been taken from the Groundsure data obtained for the Onshore Development Area.

50. Information on groundwater and surface water abstractions are detailed in Sections 11.4.4 and 11.4.5 and are not repeated here.

51. Generally, any regulated processes, registered radioactive substances, licensed waste management facilities and landfills, hazardous substances, any other industrial or commercial activities within 250m of the Onshore Development Area could, depending upon the nature of their activities, represent potential sources of contamination.

### *11.5.2. Regulated Processes*

**Discharge Consents and Pollutant Release**

52. **Table 11A-7** summarises information on licensed discharges to controlled waters within the Study Area. These are presented on **Volume 5: Figure 11A.4**.

*Table 11A-7. Summary of discharge consents*

| Location | Status | Description | Receiving waters |
|---|---|---|---|
| Pembroke Power Station, 20m north of the north-easternmost spur of the Onshore Development Area (two entries). | Effective | Oil interceptor at Pembroke Power Station – trade discharges (process effluent). | Drain leading to Pennar Gut. |
| Pembroke Power Station, within the north-easternmost spur of the Onshore Development Area (two entries). | Revoked | Treated sewage discharges from Pembroke Power Station. | Unnamed tributary of Pembroke River. |
| Greenhill Farm and Pembroke Power Station, 160m east of the north-easternmost spur of the Onshore Development Area. | Revoked | Sewage discharges – sewer storm overflow. | Pennar Gut. |
| The Burrows (residential), in the western area of the Onshore Development Area, 1km south of Angle Bay. | Effective | Treated sewage discharges. | Unnamed ditch flowing towards Angle Bay. |
| Wollaston Green (presumably residential), 150m south-east of the eastern area of the Onshore Development Area. | New consent | Treated sewage discharges. | Groundwater, via soakaway. |

53. There are no List 1 or List 2 dangerous substances entries in the Study Area. However, there is a point mapped outside of the Study Area (450m west of the north-easternmost spur) listed for Pembroke Power Station Site Drainage to Milford Haven; List 1 includes mercury and cadmium, and List 2 includes arsenic, copper, lead, nickel, pH, vanadium and zinc. This is presented on **Volume 5: Figure 11A.4**.

**Waste Management Facilities**

54. There are no active or recent landfills, historical landfills or historical waste sites, pollution inventory substances, pollution inventory waste transfers, or pollution inventory radioactive waste entries within the Study Area.

**Hazardous Substances and Contaminated Land**

55. An entry related to the storage / usage of hazardous substances is associated with Pembroke Power Station, for the chemical cleaning of boilers on site for commissioning (application 10/0373/HS, status 'approved'). This is presented on **Volume 5: Figure 11A.4**.

56. There are no Radioactive Substance Authorisations, Control of Major Accident Hazards Sites (COMAH), or Regulated Explosive Sites entries within the Study Area.

57. According to the Groundsure data, no sites were determined as Contaminated Land by the Local Authority within the Study Area.

**Historical Tanks**

58. The Groundsure report indicates that there are a number of known historical tanks indicated within the Study Area of the Onshore Development Area; their contents are not known. Other tanks, not reported within the Groundsure report, may be present in the Study Area.

59. The known historical tanks within 250m from the Onshore Development Area are indicated below. These are presented on **Volume 5: Figure 11A.4**;

- Within the Pembroke Power Station footprint; adjacent to the north-east of the north-easternmost boundary of the Onshore Development Area;
- At Lambeeth Farm, 50 m south-east of the easternmost boundary of the Onshore Development Area; and
- Within and around the former tank farm located at Angle Bay; adjacent to the north of the western boundary of the Onshore Development Area.

**Current, Recent and Historical Commercial and Industrial Activities**

60. There are a number of current, recent and historical commercial and industrial activities within the Study Area of the Onshore Development Area. **Table 11A-8** provides a summary of those present up to 250 m, with more focus placed on those located within 50m from the Onshore Development Area boundary.

*Table 11A-8. Summary of commercial and industrial activities entries*

| Category | Location | Description |
|---|---|---|
| Historical | Pembroke Power Station | Adjacent to the north-easternmost spur of the Onshore Development Area. |
| Historical | Sewage works | Adjacent to the north-easternmost spur of the Onshore Development Area. |
| Historical | Unspecified quarries / ground workings / pts. | Off-site, multiple locations across the Onshore Development Area Study Area. |
| Historical | Burial chamber[1] | On-site, approximately 600m north-east of Freshwater West Beach. |
| Recent | Pylons and wind turbines | On-site, and in multiple locations off-site. |
| Recent | Solar farms | On-site for a limited extent, and adjacent to the Onshore Development Area. |
| Historical | Smithies | Adjacent to and 150m north and east of the Onshore Development Area boundary. |
| Recent | Dairy farming | 250m south-west of the Onshore Development Area boundary. |

[1] Not considered to be a significant source of contamination.

| Category | Location | Description |
|---|---|---|
| Recent | Slurry bed | 250m north-east of the Onshore Development Area boundary. |
| Historical | Refuse heaps | 120m south-east of the Onshore Development Area boundary. |
| Historical | Disused gun emplacement | 50m north-west of the Onshore Development Area boundary, approximately 330m northeast of Freshwater West beach. |
| Historical | Unspecified tanks | Adjacent to the north of the Onshore Development Area boundary, between the Onshore Development Area and Angle Bay. |

61. There are no recorded historical military land entries, historical licensed industrial activities (IPC) or licensed industrial activities (Part A(1)) entries within the Study Area.

62. No historical or current fuel stations were identified within the Onshore Development Area or in the Study Area according to the Groundsure data and Google Maps (Google, n.d.).

**Pollution Incidents**

63. There are two Pollution Incidents located within the Study Area for the Onshore Development Area. These are presented on **Volume 5: Figure 11A.4**. Details are as follows;

- One pollution incident located 180m south of the western area of the Onshore Development Area, relating to pollution by 'inert materials and wastes (soils and clay)'. This was a minor (category 3) impact to air and no impact (category 4) to land and occurred in 2015; and
- One pollution incident located adjacent to the westernmost area of the Onshore Development Area, relating to pollution by 'oils and fuels (unidentified oil)'. This was a minor (category 3) impact to air and no impact (category 4) to land and occurred in 2015.

64. There are no listed pollutant releases to surface water (Red List), pollutant releases to public sewer, or licensed pollutant releases (Part A(2)/B) within the Study Area of the Onshore Development Area.

## 11.6 Sensitive Land Uses

65. **Table 11A-9** summarises the sensitive land uses, including national parks, Sites of Special Scientific Interest (SSSI), Special Areas of Conservation (SAC), Special Protection Areas (SPA), ancient woodlands and National Parks located within the proposed Study Area. These are presented on **Volume 5: Figures 8.2 and 8.3.**

*Table 11A-9. Summary of sensitive land uses*

| Area | Distance / direction from Onshore Development Area |
|---|---|
| SSSI – Milford Haven Waterway | 190m east of the north-easternmost spur of the Onshore Development Area (at its closest point). |
| SSSI – Broomhill Burrows | Within the south-western spur of the Onshore Development Area, extending inland from Freshwater West Beach. |
| SAC – Pembrokeshire Marine / Sir Benfro Forol | Adjacent to the west, extending from Freshwater West Beach northwards. |

| Area | Distance / direction from Onshore Development Area |
|---|---|
| | 190m east of the north-easternmost spur of the Onshore Development Area (at its closest point). |
| SAC – Limestone Coast of South West Wales / Arfordir Calchfaen De Orllewin Cymru | Within the south-western spur of the Onshore Development Area, extending inland from Freshwater West Beach. |
| SPA – Castlemartin Coast | Within the south-western spur of the Onshore Development Area at its closest point, extending inland from Freshwater West Beach. |
| Ancient woodlands | Adjacent to the north of the western Onshore Development Area. |
| National Parks – Pembrokeshire Coast National Park | The western portion of the Onshore Development Area is located within the National Park. |

66. There are no Conserved Wetland Sites (Ramsar sites), National Nature Reserves, Local Nature Reserves, Biosphere Reserves, Forest Parks, Marine Conservation Zones, Green Belt, proposed Ramsar Sites, possible Special Areas of Conservation, potential Special Protection Areas, Areas of Outstanding Natural Beauty or Conservation Areas in the Study Area.

67. The Castlemartin Corse SSSI is located approximately 500m south-east of the Onshore Development Area, east of Freshwater West beach. As reported in **Chapter 10: Water Environment,** it is not believed to be hydrologically connected to the Onshore Development Area. Furthermore, it is outside the Study Area and has therefore not been included in the assessment for land contamination. **Chapter 10: Water Environment** have assessed this receptor for impacts from runoff.

## 11.7 Historical Development

68. Historical mapping has been reviewed to evaluate the potential for past activities, both on and adjacent to, the Onshore Development Area to have impacted upon its environment and land quality. Historical Ordnance Survey (OS) maps of the Onshore Development Area were obtained from Groundsure and are presented in **Annex 11A-A**. The available mapping dates were between 1864 - 2021. Where dates are given in the text, these refer to dates of maps on which the features appear, and do not necessarily refer to exact dates of construction, or operation of any facility.

69. For the purposes of this section, the Onshore Development Area has been divided into two areas as described in Paragraph 24.

70. The Onshore Development Area and its surroundings have undergone limited development, with predominantly agricultural areas and sporadic settlements. Several farms, a reservoir and old quarries were identified within 250 m from the Onshore Development Area.

71. The most significant development is the Pembroke Power Station, immediately adjacent to the north-easternmost spur of the Onshore Development Area: the current combined-cycle gas turbine station has operated since 2012, replacing the former oil-fired power station which was decommissioned in 1999 (RWE.com, n.d.). Immediately north of the Onshore Development Area, between the Onshore Development Area and Angle Bay is the former BP Angle Bay Oil terminal, now demolished.

72. Relevant historic features within 250m of the Onshore Development Area are described in **Table 11A-10.**

*Table 11A-10. Historical development*

| Area | Location, including distance / direction from section |
|---|---|
| From north of Freshwater West Beach to Wallaston Green village. | 1864-1866: Several 'old quarries' mapped within 250m from the Onshore Development Area.<br><br>1864-1866: Smithy[2] located within the Newton Cottage area, approximately 150m southwest of the Onshore Development Area boundary.<br><br>1971-1972: Disused gun emplacement north of Freshwater Beach. Smithy no longer present.<br><br>1972: Tank farm located adjacent to the north of the western portion of the Onshore Development Area. A reservoir labelled as 'covered' is located immediately south of the tank farm.<br><br>2001: Tank farm no longer visible on mapping. |
| From Wallaston Green village to Pembroke Power Station | 1864: Smithy north of Wallaston Green, on-site.<br><br>1864: A lime kiln and sporadic settlements are mapped to the north of the north-eastern spur of the Onshore Development Area.<br><br>1864: Farm named 'Lambeeth' is located in proximity of the easternmost spur of the Onshore Development Area.<br><br>1906: The lime kiln is no longer present.<br><br>1962: A reservoir, named Green Hill Reservoir, is located 25m north of the Onshore Development Area.<br><br>1972-1976: The smithy north of Wallaston Green is no longer present.<br><br>1972-1976: The Pembroke Power Station has been constructed, with significant modifications of the coastline: multiple buildings, sewage works, a chimney, and jetties are visible on the 1976 mapping.<br><br>1972-1976: Lambeeth farm now includes tanks.<br><br>1989-1993: A sludge lagoon is visible immediately south-east of the Pembroke Power Station.<br><br>2010: The footprint of the Pembroke Power Station appears to have been significantly reduced, with the demolition of buildings and tanks in the northern area. This is presumably due to the decommissioning of the oil-fired station.<br><br>2022: Pembroke Power Station appears to have been expanded to the west, with the construction of new infrastructure. |

[2] Blacksmith

## 11.8 Initial Conceptual Site Model

### *11.8.1. Introduction*

73. This section is aimed at identifying possible risks, if any, arising from substances used or deposited on the Onshore Development Area, or from other sources of land contamination. Both past and current potentially contaminative land uses have been considered. It is based on the Onshore Development Area involving the construction of onshore cabling between the landfall and the grid connection, and an Onshore Substation near to the grid connection point. The risk assessment process for environmental contaminants is based on a source-pathway-receptor analysis. These terms can be defined as follows:

- **Source:** a contaminant or pollutant that is in, on or under the land, and that has the potential to cause harm or pollution;
- **Pathway:** a route by which a receptor is, or could be, affected by a contaminant: examples include ingestion of contaminated soil and leaching of contaminants from soil into watercourses; and
- **Receptor:** something that could be adversely affected by a contaminant: examples include human occupants / users of the Onshore Development Area, water resources (surface waters or groundwater), or structures.

74. For a risk to be present, there must be a relevant / viable contaminant linkage; i.e., a mechanism whereby a source can reasonably impact on a sensitive receptor via a pathway.

75. The following sections detail the initial CSM which has been developed for the Onshore Development Area with a view to assessing the potential risks / liabilities and constraints associated with the Onshore Development Area in its current condition prior to the Onshore Development Area works taking place. Risks associated with the Onshore Development Area have also been assessed based on a commercial / industrial future land use scenario, including any potential sources of contamination, potential receptors and potential contaminant pathways identified during this desk-based assessment.

### *11.8.2. Sources of Potential Contamination*

76. This section highlights those former and current on-site and off-site activities that have been identified as potential sources of contamination for the Onshore Development Area. These activities may have in turn impacted on soil, soil leachate and groundwater.

77. **Table 11A-11** indicates potential on-site and off-site sources of contamination identified from this Phase 1 desk-based assessment. With reference to the Construction Industry Research and Information Association (CIRIA) Guidance for the Safe Development of Housing on Land Affected by Contamination: R&D Publication 66 (National House Building Council (NHBC) / Chartered Institute of Environmental Health (CIEH) / EA) 2008 (NHBC, CIEH and EA, 2008), **Table 11A-11** also indicates the potential contaminants that may be associated with the potential sources identified.

*Table 11A-11. Potential sources of contamination*

| Feature | Associated Contaminants of Potential Concern (CoPC) |
|---|---|
| Pembroke Power Station, including sewage works, sludge lagoon, and historical tanks (adjacent). | Potential for: metals and semi-metals; inorganic (sulphate, sulphide, asbestos, pH); oil / fuel hydrocarbons, polycyclic aromatic hydrocarbons (PAH), chlorinated aliphatic hydrocarbons, polychlorinated biphenyls (PCB). |

| Feature | Associated Contaminants of Potential Concern (CoPC) |
|---|---|
| Former tank farm (disused Angle Bay Oil Terminal). (adjacent) | Potential for: metals and semi-metals; inorganic (sulphate, sulphide, asbestos, pH); oil / fuel hydrocarbons, PAH, chlorinated aliphatic hydrocarbons, PCB. |
| Historical tanks (off-site) | Potential for: total petroleum hydrocarbons (TPH); PAH; hydrocarbons. |
| Farms (off-site) | Potential for metals; pesticides and herbicides; inorganic compounds; oil / fuel hydrocarbons. |
| Old quarries, potentially infilled land, historical refuse heaps (on-site and off-site) | Unknown. Potential for: metals; inorganics; organics including PAH and TPH. Potential for methane ($CH_4$), carbon dioxide ($CO_2$) and hydrogen sulphide ($H_2S$) |
| Former gun emplacement (off-site) | Potential for metals; inorganics; organics including PAH and TPH. |
| High-pressure oil pipeline (on-site)[3] | Potential for: TPH; PAH; hydrocarbons. |

### *11.8.3. Potential pathways*

78. **Table 11A-12** provides a summary of the potential pathways associated with the Onshore Development Area.

*Table 11A-12. Potential pathways*

| Date | Feature |
|---|---|
| P1 | Direct contact / ingestion of contaminants within Made Ground / natural soils, in addition to soil derived dust, and groundwater. |
| P2 | Inhalation of organic vapours from Made Ground / natural soils, soil derived dust and groundwater. |
| P3 | Inhalation of asbestos fibres. |
| P4 | Leaching of soluble contaminants and migration of mobile contaminants into shallow groundwater. |
| P5 | Vertical migration of groundwater through Made Ground and superficial deposits into underlying bedrock aquifer. |
| P6 | Lateral groundwater migration and direct run-off to nearby surface waters. |
| P7 | Vertical migration of ground gases to indoor and outdoor air and migration of ground gases into enclosed spaces (inhalation / asphyxiation / explosion). |
| P8 | Direct contact of buried infrastructure with contaminated Made Ground / natural soils and aggressive ground conditions (pH and sulphate) / direct contact of services and supply pipes (Onshore Export Cables) with contaminated soils. |
| P9 | Indirect pathway: migration of hazardous gases / vapours via permeable strata into enclosed spaces and service / utility trenches and potential explosion risk. |

### *11.8.4. Potential receptors*

79. **Table 11A-13** provides a summary of the potential receptors associated with the Onshore Development Area, which could be impacted upon by the contamination sources outlined in **Table 11A-11.**

[3] Inferred from Project Erebus Environmental Statement (Blue Gem Wind, ITP Energise, OWC, MarineSpace, 2021).

*Table 11A-13. Potential receptors*

| Date | Feature |
|---|---|
| R1 | Current Human Health (on-site users): commercial users (agriculture workers). Road users, public open space users (open areas). |
| R2 | Future Human Health (on-site users): commercial users (agriculture workers and workers within proposed buildings at the Onshore Development Area). Road users, public open space users (open areas). |
| R3 | Human Health (off-site users): current and future residential, commercial (farms and power station workers) and public open space users (surrounding). |
| R4 | Groundwater:<br>• Secondary undifferentiated aquifers (tidal flat deposits and till deposits)<br>• Secondary A aquifer (marine beach deposits, alluvium and blown sand)<br>• Secondary B aquifers (Ludlow Rocks, and the Aber Mawl Shale Formation);<br>• Secondary A aquifers (remaining bedrock designations) |
| R5 | Groundwater:<br>• Principal aquifer (Black Rock Subgroup and Gully Oolite Formation);<br>• Groundwater abstractions. |
| R6 | Surface waters: various unnamed streams and ponds (both on and off-site), Green Hill Reservoir, Milford Haven Inner, and the Celtic Sea.<br>Surface water abstractions. |
| R7 | Buildings and infrastructure: existing buildings and below ground infrastructure on-site and off-site; proposed Onshore Substation, Onshore Export Cables: infrastructure at risk from ignition following potential accumulation of ground gas within confined spaces, below ground infrastructure at risk from potentially aggressive ground conditions. |
| R8 | Ecological / geological sites: SSSI (Broomhill Burrows), SAC (Limestone Coast of South West Wales / Arfordir Calchfaen De Orllewin Cymru), SPA (Castlemartin Coast), National Parks (Pembrokeshire Coast), Geological Conservation Review (GCR) site (Freshwater West (North)). |

## 11.9 Environmental Risk Assessment

### *11.9.1. Risk Assessment Principles*

80. Current best practice recommends that the determination of hazards due to contaminated land is based on the principle of risk assessment, as outlined in the EA's published online guidance for the management of land contamination 'land contamination: risk management (LCRM)' (EA, 2021) (gov.uk, n.d.). This was adopted by NRW in 2021. For a risk to be present, there must be a viable contaminant linkage; i.e., a mechanism whereby a source impacts on a sensitive receptor via a pathway.

81. Assessment of risks associated with each of these potential contaminant linkages are discussed in the following sections.

82. Using criteria broadly based on those presented in the NHBC/CIEH/EA publication R&D 66 (NHBC, CIEH and EA, 2008) the magnitude of the risk associated with potential contamination at the Onshore Development Area has been assessed. To do this, an estimate is made of:

- The magnitude of the potential consequence (i.e., severity); and
- The magnitude of probability (i.e., likelihood).

83. The severity of the risk is classified according to the criteria in **Table 11A-14** which has been summarised from the R&D 66 guidance.

*Table 11A-14. Description of severity of risk*

| Term | Description |
|---|---|
| Severe | • Highly elevated concentrations likely to result in significant harm to human health.<br>• Catastrophic damage to crops, buildings or property (e.g., by explosion).<br>• Equivalent to EA Category 1 pollution incident including persistent and / or extensive effects of water quality.<br>• Major damage to aquatic or other ecosystems. |
| Medium | • Elevated concentrations which could result in significant harm to human health.<br>• Significant damage to crops, buildings or property (e.g., damage to building rendering it unsafe).<br>• Equivalent to EA Category 2 pollution incident including significant effect on water quality.<br>• Significant damage to aquatic or other ecosystems. |
| Mild | • Exposure to human health unlikely to lead to significant harm.<br>• Minor damage to crops, buildings or property (e.g., surface spalling to concrete).<br>• Equivalent to EA Category 3 pollution incident including minimal or short-lived effect on water quality.<br>• Minor or short-lived damage to aquatic or other ecosystems. |
| Minor | • No measurable effect on humans.<br>• Repairable effects of damage to buildings, structures and services.<br>• Equivalent to insubstantial pollution incident with no observed effect on water quality of ecosystems. |

84. The probability of the risk occurring is classified according to the criteria in **Table 11A-15** which has been summarised from the R&D 66 guidance.

*Table 11A-15. Likelihood of risk occurrence*

| Term | Description |
|---|---|
| High likelihood | There is a pollutant linkage, and an event would appear very likely in the short-term and almost inevitable over the long-term, or there is evidence at the receptor of harm or pollution. |
| Likely | There is a pollutant linkage, and all the elements are present and in the right place which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short-term and likely over the long-term. |
| Low likelihood | There is a pollutant linkage and circumstance are possible under which an event could occur. However, it is by no means certain that even over a long period such an event would take place and is less likely in the shorter term. |
| Unlikely | There is a pollutant linkage, but circumstances are such that it is improbable that an event would occur even in the very long-term. |

85. An overall evaluation of the level of risk is gained from a comparison of the severity and probability, as shown in **Table 11A-16.**

*Table 11A-16. Risk based on comparison of likelihood and severity*

| | | Severity | | | |
|---|---|---|---|---|---|
| | | Severe | Medium | Mild | Minor |
| Likelihood | High likelihood | Very high | High | Moderate | Moderate / low |
| | Likely | High | Moderate | Moderate / low | Low |
| | Low likelihood | Moderate | Moderate / low | Low | Very Low |
| | Unlikely | Moderate / low | Low | Very Low | Very Low |

### *11.9.2. Preliminary Risk Assessment*

86. In accordance with the risk assessment principles outlined above, a preliminary evaluation of the potential risks associated with all the identified sources at the Onshore Development Area, through the potential pathways (P1 to P9) to the various potential receptors (R1 to R8) is discussed and presented in **Table 11A-17**, below. The level of risk is determined based on the current condition of the Onshore Development Area (i.e., the effects of mitigation measures are not included). In some cases, a degree of mitigation is assumed as part of legislative requirements or standard construction practice. This is acknowledged where these assumptions are made.

87. The preliminary risk assessment undertaken within this section does not consider acute linkages for construction and maintenance workers. It is anticipated that these acute linkages will be managed by appropriate health and safety measures. These are discussed further in **Section 11.9.3.**

*Table 11A-17. Preliminary risk assessment*

| Receptor | Pathway | Potential severity | Likelihood of occurrence | Potential risk | Linkage reference | Justification |
|---|---|---|---|---|---|---|
| R1: Current Human Health (on-site users): commercial users (agriculture workers); road users, public open space users (open areas). | P1: Direct contact / ingestion of contaminants within Made Ground / soils, together with soil derived dust and groundwater | Medium | Unlikely | Low | L1 | L1, L2: There is a generally very low potential for soil contamination deriving from on-site sources, and very limited potential for Made Ground (if present – namely around the Pembroke Power Station, the former tank farm, and the high-pressure oil pipeline). The potential for direct contact / ingestion of contaminants or inhalation of organic vapours on-site is considered to be low given the nature of the identified sources, with the exception of the high-pressure oil pipeline.<br>L3: There is potential for asbestos to be present in any Made Ground (if / where encountered). The presence of significant amounts of Made Ground is not expected on-site (if present – namely around the Pembroke Power Station, the former tank farm, and the high-pressure oil pipeline), and there are no buildings to be disturbed during the works. Any Made Ground found to be contaminated with asbestos will require suitable management if it is to be retained / re-used.<br>L4: Ground gases are unlikely to be present at the Onshore Development Area due to the low potential for significant Made Ground and absence of ground gas sources. The risks to road, public open space and agricultural land users are considered to be low as they will not be accessing confined environments. The risks are considered to be low for the existing site users. |
| | P2: Inhalation of organic vapours from Made Ground / soils, soil derived dust and groundwater | Medium | Unlikely | Low | L2 | |
| | P3: Inhalation of asbestos | Severe | Unlikely | Moderate / low | L3 | |
| | P7: Vertical migration of ground gases to indoor and outdoor air and migration of ground gases into enclosed spaces (inhalation / asphyxiation / explosion) | Medium | Unlikely | Low | L4 | |
| R2: Future Human Health (on-site users): Residential and commercial users | P1: Direct contact / ingestion of contaminants within Made Ground / soils, together with soil derived dust and groundwater | Medium | Unlikely | Low | L5 | L5: Once the Onshore Export Cables have been installed, the Onshore Development Area is anticipated to be restored to open land (mostly) or hardstanding. The potential risk to future commercial users (workers at the proposed Onshore Substation) from direct contact / ingestion of contaminants has been assessed as low due to proposed hardstanding and buildings limiting the potential exposure to Contaminants of |

| Receptor | Pathway | Potential severity | Likelihood of occurrence | Potential risk | Linkage reference | Justification |
|---|---|---|---|---|---|---|
| (agriculture workers and workers at the Onshore Substation). Road users, public open space users (open areas). | P2: Inhalation of organic vapours from Made Ground / soils, soil derived dust and groundwater | Medium | Unlikely | Low | L6 | Potential Concern (CoPC) and hence reducing exposure risk. The potential risk to future road, public open space and agricultural land users is also considered to be low as they are temporary site users and the road users' time on-site will be transient.<br>L6: The risk from vapours emanating from within Made Ground is considered to be low. Hardstanding (where proposed) will reduce the likelihood of risk being realised to a degree.<br>L7: There is potential for asbestos to be present in any Made Ground (if / where encountered). The presence of significant amounts of Made Ground is not expected on-site (if present – namely around the Pembroke Power Station, the former tank farm, and the high-pressure oil pipeline), and there are no buildings to be disturbed during the works. Any Made Ground found to be contaminated with asbestos will require suitable management if it is to be retained / reused.<br>L8: Ground gases are unlikely to be present at the Onshore Development Area due to the low potential for significant Made Ground and absence of ground gas sources. The risks to road, public open space and agricultural land users are considered to be low as they will not be accessing confined environments. The risks are considered to be low for the future site users (including workers at the Onshore Substation). |
| | P3: Inhalation of asbestos | Severe | Unlikely | Moderate / low | L7 | |
| | P7: Vertical migration of ground gases to indoor and outdoor air and migration of ground gases into enclosed spaces (inhalation / asphyxiation / explosion) | Medium | Unlikely | Low | L8 | |
| R3: Human Health (off-site users): current and future | P1: Direct contact / ingestion of contaminants within Made Ground / soils, together with soil derived dust and groundwater | Mild | Unlikely | Very low | L9 | L9, L10: There is a generally very low potential for soil contamination deriving from on-site sources, to affect off-site users and there is a very limited potential for Made Ground (if present – namely around the Pembroke Power Station, the |

| Receptor | Pathway | Potential severity | Likelihood of occurrence | Potential risk | Linkage reference | Justification |
|---|---|---|---|---|---|---|
| residential, commercial (farms and power station workers) and public open space users (surrounding). | P2: Inhalation of organic vapours from Made Ground / soils, soil derived dust, and groundwater | Mild | Unlikely | Very low | L10 | former tank farm, and the high-pressure oil pipeline). The potential for direct contact / ingestion of contaminants through dust or inhalation of organic vapours is considered to be very low given the nature of the identified sources and the low pathway certainty.<br>L11: Ground gases are unlikely to be present at the existing Onshore Development Area due to the low potential for any significant Made Ground or ground gas sources. The risks to off-site public open space and agricultural land users are considered to be very low as they will not be accessing confined environments. If significant Made Ground is present on-site (albeit unlikely), there is the potential for ground gas to migrate off-site and affect nearby properties although there is no evidence this is happening currently or would in the future. |
| | P7: Vertical migration of ground gases to indoor and outdoor air and migration of ground gases into enclosed spaces (inhalation / asphyxiation / explosion) | Mild | Unlikely | Very low | L11 | |
| R4 Groundwater: Secondary A, Secondary B and Secondary undifferentiated aquifers (superficial and bedrock) | P4: Leaching of soluble contaminants and migration of mobile contaminants into shallow groundwater | Medium | Low | Moderate / low | L12 | L12: Data related to groundwater depth and flow is not available for the Onshore Development Area. Lateral and vertical migration through preferential pathways within Made Ground (if present – namely around the Pembroke Power Station, the former tank farm, and the high-pressure oil pipeline) may facilitate infiltration to the underlying superficial Secondary A and undifferentiated aquifers. The extent to which the groundwater in the superficial deposits is connected to groundwater in the underlying bedrock (Secondary A and B aquifers) is not confirmed. It is considered that there is a moderate / low risk for contamination to impact the groundwater (Secondary A and undifferentiated aquifers) within the superficial deposits and potentially bedrock. It is also likely that the proximity to tidal / coastal waters strongly influences groundwater level encouraging the mobilisation of contaminants into groundwater. Monitoring |

| Receptor | Pathway | Potential severity | Likelihood of occurrence | Potential risk | Linkage reference | Justification |
|---|---|---|---|---|---|---|
| | | | | | | would be required to confirm the current groundwater quality regime. |
| R5: Groundwater: Principal aquifer (within the Black Rock Subgroup and Gully Oolite Formation) Groundwater abstractions | P5: Vertical groundwater flow through Made Ground and superficial deposits to underlying bedrock aquifer | Severe | Low | Moderate | L13 | L13: Data related to groundwater depth and flow is not available for the Onshore Development Area. The Principal aquifers are generally present across areas of limited extent; however, they are located in proximity of potential sources of contamination, namely the Pembroke Power Station and the former tank farm (both located adjacent to the Onshore Development Area). Lateral and vertical migration through preferential pathways within the Made Ground may facilitate infiltration to the underlying superficial Secondary A aquifers, which, in addition, are not mapped above the whole extent of the Principal aquifer. The extent to which the groundwater in the superficial deposits is connected to groundwater in the underlying bedrock is not confirmed. It is also likely that the proximity to tidal / coastal waters strongly influences groundwater levels which may encourage the mobilisation of contaminants into groundwater. It is considered that there is a moderate risk for contamination to impact the groundwater (Principal aquifers) within the bedrock. Investigation and monitoring would be required to confirm the current groundwater quality regime.<br>Migration of contamination in groundwater may also impact existing groundwater abstractions, some of which may be potable. |
| R6: Surface waters: located on-site and off-site. Surface water abstractions | P6: Lateral groundwater flow and direct run-off to surface waters | Mild to medium | Low | Low to moderate / low | L14 | L14: The proximity of potential contamination sources to transitional and coastal waters can lead to an increased risk to surface water. The extent to which groundwater, inland surface water and coastal / transitional waters are interconnected is not known at this stage. It is likely that the proximity to tidal / coastal waters strongly influence |

| Receptor | Pathway | Potential severity | Likelihood of occurrence | Potential risk | Linkage reference | Justification |
|---|---|---|---|---|---|---|
| | | | | | | groundwater levels, encouraging the mobilisation of contaminants into groundwater and seawater.<br>A particular location of concern could be the former tank farm located 20m onshore at the most south-easterly point of Angle Bay.<br>Migration may also impact upon existing surface water abstractions and unnamed streams and ponds within the Study Area. |
| R7: Building and infrastructure: located on-site and off-site | P8: Aggressive attack through direct contact with natural ground or contaminants within Made Ground / soils, leachate and groundwater | Mild | Low | Low | L15 | L15: The risk to foundations and services is considered to be low based on the potential for on-site contamination within the Made Ground / soils, leachate and groundwater across the Onshore Development Area.<br>L16: There may be a risk from ground gas should significant Made Ground be present (on-site or off-site). If present, there may be the potential for ground gas migration and build-up in confined spaces (such as the Onshore Substation). Where methane is identified at certain levels, there is the potential for explosion to occur, albeit unlikely. If ground gases are found to be present, these will need to be mitigated as part of the future Onshore Development Area design. |
| | P9: Ground gas accumulation and potential explosion risk | Medium | Unlikely | Low | L16 | |
| R8: SSSI, SAC, SPA, ancient woodlands, National Parks and conservation areas | P1: Direct contact / uptake of contaminants within Made Ground / soils, leachate and groundwater | Mild to medium | Low | Low to moderate / low | L17 | L17: The risk to the identified ecological sites is considered to be low to moderate / low based on the sensitivity and proximity to areas of potential contamination. |

*11.9.3. Discussion of Risks to Construction Workers and Off-site Receptors During Construction Works*

88. As described in **Chapter 04: Project Description**, the Onshore Development Area works will be undertaken in compliance with Construction Design and Management Regulations 2015 (CDM).

89. Prior to work commencing, a health and safety risk assessment will be carried out by the appointed Principal Contractor as part of their Construction Phase Plan, and this will be developed in accordance with current health and safety regulations. This assessment should cover potential risks to construction staff, permanent site staff and the local surrounding population. Based on the findings of this risk assessment, appropriate mitigation measures should be implemented during the construction period.

90. The greatest potential for generation of dust will be during the enabling and construction works. Dust generation will be minimised using measures which will be outlined in the Construction Environmental Management Plan (CEMP). This will consider relevant best practice, for example, 'Environmental Good Practice on Site', CIRIA Publication C741 to reduce this risk to acceptable levels.

91. The risk to future construction workers is low; however, this assumes the preparation of a construction management and health and safety plan including the use of personal protective equipment (PPE) in accordance with statutory health and safety requirements. The potential for ground gas risks should be considered when developing Health and Safety Plans for works at the Onshore Development Area and a monitoring programme for occupational exposure risk should be considered.

## 11.10 Preliminary Assessment of Ground Hazards

92. A summary of the ground-related risks identified in this report is given in **Table 11A-18.** The risks identified as being potentially present on the Onshore Development Area could have potential implications on both ground engineering and foundation design.

*Table 11A-18. Preliminary ground hazard assessment*

| Hazard | Source | Risk potential (where the hazard is present)[4] | Engineering implication | Mitigation methods |
|---|---|---|---|---|
| Soft / compressible deposits (low bearing capacity and high settlement) | The published geology indicates a sporadic presence of superficial deposits including marine beach deposits, blown sand, alluvium, tidal flat deposits, and till. Their presence is limited to eastern-most spurs (mapped adjacent to the Onshore Development Area, within the Study Area) and within the western area of the Onshore Development Area (area east of Freshwater West Beach). Areas of soft / compressible deposits, in particular the tidal flat deposits and alluvium might cause local areas of settlement. Tidal flat deposits and alluvium are not located within the Onshore Development Area (only in the Study Area).<br><br>Groundsure data confirms that compressible strata are not thought to occur across the whole | Medium for proposed buildings<br><br>(Low for the Onshore Export Cables with the exception of cable joint bays (Medium)) | Potential for settlement and differential settlement is a main consideration for any proposed buildings, including the Onshore Substation.<br><br>Not considered as a potential risk for the permanent works of the Onshore Export Cables, with the exception of cable joint bays, but could affect the stability of temporary excavations.<br><br>If soft / compressible deposits are encountered, the permanent works foundation design for the Onshore Substation, the cable joint bays design, and the temporary | Ground investigation with appropriate testing to understand the compressibility of the deposits, to determine the ground conditions and ensure a safe design. |

[4] Defined as follows;

| | |
|---|---|
| **High** | Unacceptable risk. Re-examine approach to provide a lower risk. Further investigation and / or mitigation measures and / or method of work alterations required. Seek approval from all stakeholders if risk cannot be reduced. |
| **Medium** | Requires further investigation. Mitigation measures and / or method of work alteration may be required. Seek approval from all stakeholders if risk cannot be reduced to consider risk is tolerable if further mitigation is not reasonably practical and there is need to continue activity with identified controls. |
| **Low** | Broadly acceptable with currently available information if all reasonably practicable control measures in place where necessary. |

| Hazard | Source | Risk potential (where the hazard is present)[4] | Engineering implication | Mitigation methods |
|---|---|---|---|---|
| | Study Area, except for areas of mapped alluvium and tidal flat deposits, where compressibility and uneven settlement hazards are probably present. As indicated previously, these are not located within the Onshore Development Area, they are present only in the western Study Area (to the south-east of Angle Bay, north of the western area of the Onshore Development Area) and adjacent to the eastern-most spur of the Onshore Development Area. | | works design of excavations for foundation and cable trenches should consider specifically the strength, compressibility and variability of the ground. | |
| Made Ground | Made Ground is anticipated to be limited across the Onshore Development Area, with the main area for potential Made Ground being within the Study Area in vicinity of the Pembroke Power Station and the former tank farm. | Medium for proposed buildings and cable joint bays<br>(Low for the Onshore Export Cables with the exception of cable joint bays (Medium)) | Made Ground, given its general vertical and lateral variability, is unsuitable as a founding stratum for any proposed buildings (Onshore Substation), unless re-engineered.<br>Not considered as a potential risk for the Onshore Export Cables, with the exception of cable joint bays. | The extent of any Made Ground will need to be confirmed through ground investigation.<br>Dependent on depth / thicknesses and material types, ground improvement or piling to competent founding levels can be considered in areas proposed for buildings. Removal / replacement of the Made Ground may also be considered as an option. |
| Lateral changes in ground conditions | The published geology indicates that there could be lateral variation in the unit thicknesses and geotechnical properties across the Onshore Development Area. | Medium for proposed buildings and cable joint bays<br>(Low for the Onshore Export Cables with the exception of | Variable ground conditions in vicinity of the proposed buildings (Onshore Substation) may need consideration.<br>Not considered to be a potential risk for the Onshore Export Cables | Ground investigation would reduce the uncertainty in the variable ground conditions; however, it is unlikely to completely eliminate the risk. |

| Hazard | Source | Risk potential (where the hazard is present)[4] | Engineering implication | Mitigation methods |
|---|---|---|---|---|
| | | cable joint bays (Medium)) | permanent works, with the exception of cable joint bays, but may affect temporary excavations. | |
| Excessive depth to bearing strata (if shallow foundations are used) | The published geology indicates some superficial deposits across some areas of the Onshore Development Area, potential for Made Ground also in some areas. Also limited information on the extent of any weathering zones. | Medium for proposed buildings and joint bays for linking up Onshore Export Cables<br>(Low for the Onshore Export Cables with the exception of cable joint bays (Medium)) | Excessive depth (over 2.5m) to bearing strata could increase construction costs, excavation quantities, require dewatering and shoring, or require alternative foundation techniques to be adopted.<br>Not considered as a potential risk for the Onshore Export Cables permanent works but may affect temporary excavations. | Ground investigation to determine ground composition. |
| Saturated (running) sands | Groundsure data confirms that running sand conditions are not thought to occur, or are unlikely, across the majority of the Onshore Development Area and Study Area.<br>However, running sand conditions may be present in the western portion of the site, and in proximity of the Power Station. | High | Excavation instability during construction. Requirement for additional excavation supports or the removal of water during construction, increasing construction costs and causing delays. | Ground investigation to determine ground composition. |
| Groundwater vulnerability – soluble rock risk | Groundsure data confirms that across the southern area of the Onshore Development Area and Study Area, soluble rocks are either not thought to be present within the ground, or not prone to dissolution. Dissolution features are unlikely to be present. | High | The presence of infilled or open dissolution cavities may affect the excavation profile and stability. | A geophysical survey needs to be undertaken to investigate the potential for sinkholes.<br>Identification of Karst features in the bedrock may require grout injection to fill voids prior to |

| Hazard | Source | Risk potential (where the hazard is present)[4] | Engineering implication | Mitigation methods |
|---|---|---|---|---|
| | Across the northern area of the Onshore Development Area, soluble rocks are likely to be present within the ground. Across most of this area, the Groundsure data indicates that problems are unlikely except with considerable surface or subsurface water flow. In the eastern-most extent, including in vicinity of Pembroke Power Station and to the south of this area, the Groundsure data indicates a low possibility of localised subsidence or dissolution-related degradation of bedrock occurring naturally, but may be possible in adverse conditions such as high surface or subsurface water flow.<br><br>The potential for difficult ground conditions are at a level where they may need to be considered, localised subsidence may not be considered except in exceptional circumstances. | | | construction, particularly at locations of buildings and joint bays.<br><br>Care should be taken during any dewatering process that any discharged water does not create any sinkholes within the limestone formations. |
| Presence of historical coal / non-coal mine workings | The published geology and Coal Authority mapping (The Coal Authority) indicates that the Onshore Development Area is not located in an area affected by coal mining.<br><br>Groundsure data confirms that across most of the Onshore Development Area and Study Area, localised underground non-coal mining may have occurred for 'vein mineral'. The potential for difficult ground conditions are unlikely or localised and are at a level where they need not be considered. | Low | Engineering implications unlikely. | No mitigation methods required. |

| Hazard | Source | Risk potential (where the hazard is present)[4] | Engineering implication | Mitigation methods |
|---|---|---|---|---|
| Landslides | Groundsure data for the Onshore Development Area indicates the majority of the Onshore Development Area is located in an area where slope instability problems may be present or anticipated. In some areas, slope instability problems are not likely to occur but consideration to potential problems of adjacent areas impacting on the Onshore Development Area should always be considered. | High | Excavation instability, slope failure. Benching of slopes for temporary works. | Ground investigation to determine soil shear strength parameters and subsequent assessment of slope stability.<br>Trenches for Onshore Export Cables with vertical sides will be supported by trench boxes or sheet piling as necessary.<br>Stability assessments may be required. |
| Faults | The published geology indicates the presence of fault lines. | Medium for proposed buildings<br>(Low for the Onshore Export Cables) | Increase in permeability in the underlying rock mass creating a pathway for groundwater flow. Deterioration of rock strength due to presence of faulted rock. Potential for differential settlement over the fault lines.<br>Not considered as a potential risk for the Onshore Export Cables. | Ground investigation to determine strength of bearing strata and groundwater regime. |
| High groundwater table (including waterlogged ground) | Groundwater depth across the Onshore Development Area is unknown at this stage due to the absence of historical borehole data. | Medium | High groundwater levels (if encountered) lead to the flooding of excavations, which can make any excavations for foundations or cables unstable. It can also impact the stability of strata below the groundwater table and cause uplift. | Groundwater monitoring as part of the ground investigation to confirm the site-specific groundwater levels and seasonal variations. If a high groundwater table is confirmed, suitable dewatering and / or temporary supports may be required. |

| Hazard | Source | Risk potential (where the hazard is present)[4] | Engineering implication | Mitigation methods |
|---|---|---|---|---|
| | | | | Trenches for Onshore Export Cables with vertical sides will be supported by trench boxes or sheet piling as necessary. |
| Shallow bedrock | The published geology indicates an absence of superficial deposits across some areas of the Onshore Development Area, or shallow depth to bedrock. | Medium | Hard strata may be encountered near surface leading to difficult excavation and potential for overbreak. | Ground investigation to determine depth to and strength of bearing strata. |
| Aggressive ground (e.g., expansive slags, weathering of sulphides to sulphates) | Potential Made Ground (albeit limited) and potentially naturally elevated sulphate concentrations in bedrock. | Low | Concrete attack on the building foundations and Onshore Export Cables. | Concrete foundations, service ducts and Onshore Export Cables are likely to need to be designed against natural chemical attack from aggressive ground conditions. |
| Existing sub-structures (e.g., foundations, basements, and adjacent sub-structures) | For some areas of the Onshore Development Area, such as the more rural areas, it is unlikely that buried structures will be encountered. However, there is the potential for existing sub-structures to be present within the more developed areas of the Onshore Development Area, including around the Pembroke Power Station area. | Medium | Delays in ground investigation and construction works due to obstructions. | Ground investigation will reduce the uncertainty of the ground conditions but may not eliminate the risk. |
| Utilities | Utilities are likely to be present within and adjacent to the Onshore Development Area (all areas). This includes the high-pressure oil pipeline. | High | Design to avoid utilities or reroute utilities as necessary. Potential to strike utilities as part of design or construction works. | Use of Ground Penetrating Radar and CAT scan before breaking ground to avoid utility strikes. Detailed survey of utilities is required for design. |

| Hazard | Source | Risk potential (where the hazard is present)[4] | Engineering implication | Mitigation methods |
|---|---|---|---|---|
| | | | | Possible consultation with utility companies regarding diversions. |
| UXO | The Zetica PDSA indicates that several defences were established at the Onshore Development Area; in addition, a number of strategic targets were located in the vicinity of the Onshore Development Area. | Medium | Potential to encounter UXO during ground investigation and earthworks. | It is recommended that a detailed desk study is commissioned for the Onshore Development Area. |

## 11.11 Conclusions

93. The Onshore Development Area is underlain by a complex geological sequence characterised by heavily folded bedrock geology. In terms of superficial deposits, when present, these comprise marine beach deposits, blown sand, alluvium, tidal flat deposits, and till.

94. The underlying bedrock underneath the Study Area and surrounding areas consists of a complex sequence of strata; the majority of the Onshore Development Area and Study Area is underlain by the Milford Haven Group, with outcrops of Aber Mawr Shale Formation, Ludlow Rocks, Ridgeway Conglomerate Formation, Skrinkle Sandstone Formation, Avon Group, and Black Rock Subgroup and Gully Oolite Formation (undifferentiated) mapped in the northern-most and southern-most portions of the Onshore Development Area.

95. The superficial deposits in the Study Area, when present, are classified as follows:

- The tidal flat deposits and till deposits are classified as Secondary undifferentiated aquifers; and
- The marine beach deposits, alluvium, and blown sand are classified as Secondary A aquifers.

96. The bedrock formations underlying the Study Area are classified as follows:

- The Black Rock Subgroup and Gully Oolite Formation is classified as Principal aquifer;
- The Ludlow Rocks, and the Aber Mawl Shale Formation, are classified as Secondary B aquifers; and
- The remaining bedrock designations are classified as Secondary A aquifers.

97. There are numerous surface watercourses, both within the Onshore Development Area and the Study Area; transitional water of the Milford Haven Inner is classified as moderate quality. Further details are included in **Table 11A-5.**

98. Based on the initial CSM and preliminary risk assessment, the Onshore Development Area represents a generally low to moderate / low risk in terms of risk to the human health of current and future on-site users, and a very low risk to off-site users, in the absence of mitigation. The moderate /low risk is limited to the potential for exposure to asbestos which may be present in Made Ground in more built-up areas of the Onshore Development Area, and this is driven by the severity of impact to health should exposure happen whilst acknowledging that the potential for exposure is unlikely. The risk to future construction workers is low; however, this assumes the preparation of a construction management and health and safety plan including the use of PPE in accordance with statutory health and safety requirements.

99. The risk to Secondary aquifers (both superficial and bedrock units) has been assessed as moderate / low; the risk for the Principal aquifer within the bedrock has been assessed as moderate which reflects that Principal aquifers have a higher sensitivity and are more likely to support potable water. The risk to surface waters both on-site and off-site from contamination is low to moderate / low. Investigation and monitoring would be required to confirm the risk.

100. In terms of ground engineering risks, saturated (running) sands, groundwater vulnerability (soluble rock risk), landslides and utilities (if / where present) are considered to pose a high risk for the Onshore Development Area. A medium risk is present at the Onshore Development

Area for the following (if / where present); high groundwater table (including waterlogged ground), shallow bedrock, aggressive ground and existing sub-structures.

101. Made Ground and faults (if / when present) are considered to pose a medium risk for the proposed buildings. However, these are considered to pose a low risk for the Onshore Export Cables.

102. Soft / compressible deposits (low bearing capacity and high settlement), lateral changes in ground conditions, excessive depth to bearing strata (if shallow foundations are used), are also assessed to pose a medium risk; they are not considered to be a potential risk for the Onshore Export Cables permanent works but may affect temporary excavations.

103. UXO is considered to pose a medium risk; therefore, it is recommended that a detailed desk study is commissioned for the Onshore Development Area.

104. The potential and known risks defined in this assessment can be better understood and refined further through intrusive ground investigation and risk assessment which is expected as the Onshore Development Area progresses to support design development.

## 11.12 Recommendations

105. To characterise the quantify the risks identified and allow for the refinement of the initial CSM, it is recommended that an intrusive ground investigation is carried out. From this, the composition, extent and depth of Made Ground, the natural superficial deposits and the bedrock across the Onshore Development Area can be confirmed. This will determine the underlying stratigraphy to inform further risk assessment, the need for any more detailed or targeted ground investigation, any future preliminary and detailed design.

106. During any future intrusive investigation, it is recommended that representative soil samples are taken to determine the chemical status of Made Ground and natural soils both in areas close to identified sources and to provide a baseline level of information which may support the scheme in terms of how excavated materials are managed during construction. Samples should also be taken to determine the ground strength and compressibility parameters to inform the geotechnical design. Thermal resistivity testing is likely to also be required. Groundwater monitoring and sampling and ground gas monitoring may also need to be undertaken at the Onshore Development Area.

107. The site investigation should be designed with due consideration of the requirements of BS 5930:2015+A1:2020 Code of Practice for Ground Investigation; BS 10175: 2011+A2:2017 Investigation of potentially contaminated sites – Code of Practice; the UK Specification for Ground Investigation (2nd Edition) published by ICE Publishing; and Eurocodes BS EN 1990 to BS EN 1999.

108. After completion of intrusive works and monitoring, the geo-environmental condition of the Made Ground and underlying superficial deposits should be assessed. The soil, soil leachate and groundwater samples and ground gas readings should be analysed for the purpose of risk assessment to human health, controlled waters and other key receptors. Identification of geotechnical design parameters for earthworks and preliminary foundation design should also be undertaken.

109. A ground investigation report should be produced for interpretation of the ground conditions, geo-environmental and geotechnical hazard identification, risk estimation and evaluation, and an outline of proposed mitigation measures where appropriate.

110. The investigation will allow a quantitative assessment as to whether any of the potential risks identified in this Appendix are present and are of material concern to the Onshore Development Area.

## 11.13 References


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