12 Geology, Peat, Hydrology & Hydrogeology

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12.1 Executive Summary

12.1.1 This Chapter considers the potential effects of the Proposed Development on hydrological, hydrogeological and geological resources.

12.1.2 A combination of desk study and field survey work was undertaken to identify and characterise the geological, hydrological and hydrogeological receptors which could be subject to impacts from construction, operation and decommissioning of the Proposed Development.

12.1.3 No significant effects are predicted on hydrological, hydrological and geological receptors, from construction, operation and decommission of the Proposed Development.

12.2 Introduction

12.2.1 This Chapter provides an assessment of the effects of the Proposed Development on hydrological, hydrogeological and geological receptors.

12.2.2 The Proposed Development involves the construction and operation of a four turbine wind energy development, with associated crane hardstandings, access tracks, underground cabling, an electricity substation, borrow pit search area, and two temporary construction compounds. An assessment of potential effects associated with the construction works has been undertaken, together with assessment of the potential for any long-term or permanent alterations to the hydrological and hydrogeological regime.

12.2.3 For the purposes of this assessment, watercourses have been identified as those which appear on 1:50,000 scale Ordnance Survey mapping. However, site survey work has been undertaken in order to supplement mapping data, and observations of watercourses and field drains have been made and taken into account in the design and mitigation measures.

12.2.4 The internal tracks leading from the site access to each turbine will require crossing minor watercourses (field drains) at three locations; outline design options for water crossings and an assessment of associated environmental effects are provided in this chapter.

12.2.5 The assessment was led by David Nisbet, Head of Geology & Peat at ITPEnergised. David has a BSc in Earth Science and 10 years' experience in environmental consultancy. David has led geology, peat, hydrology and hydrogeology assessments on many renewable energy projects across the United Kingdom and Ireland. David was supported by a number of members of the wider Environmental Planning Team at ITPEnergised.

12.3 Legislation, Policy and Guidelines

Legislation

12.3.1 The key pieces of legislation relevant to hydrology, hydrogeology and geology, which have been considered and taken into account in this assessment, are noted below.

Water Quality

- The European Water Framework Directive (WFD): Designed to improve and integrate the way bodies of water (including groundwater) are managed throughout Europe. It is designed to: enhance the status and prevent further deterioration of aquatic ecosystems and associated wetlands, which depend on the aquatic ecosystems; promote the sustainable use of water; reduce pollution of water, especially by 'priority' and 'priority hazardous' substances; and ensure progressive reduction of groundwater pollution. The basis of the WFD remains

applicable in the UK following its departure from the European Union, having been implemented through domestic legislation (see below).

- The European Groundwater Directive: Requires member states to establish registers of protected areas within each river basin district, for those groundwater areas or habitats and species directly dependent on water. As above, the basis of the Groundwater Directive remains applicable through domestic legislation, despite the UK having left the European Union.
- The Water Environment and Water Services (Scotland) Act 2003: This Act implements the WFD in Scotland. It introduces a regulatory system for the water environment with the Scottish Environment Protection Agency (SEPA) as the lead authority working with the public, private and voluntary sectors.
- The Water Resources Act (Scotland) Act 2013: This seeks to provide protection and improvement to the quality of the water environment through controls on abstraction, impounding and discharges.
- The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended): These Regulations provide the main controls for protecting the water environment from harm and the main regulatory tools to deliver the objectives of the Water Framework and Groundwater Directives. SEPA is responsible for implementing the Regulations, which introduce specific controls for activities affecting watercourses and water bodies, including discharges to wetlands, surface waters and groundwater, and engineering works in inland waters and wetlands.
- The Private Water Supplies (Scotland) Regulations 2006 regulate private water supply in Scotland, aiming to ensure the provision of clean and wholesome drinking water and deliver significant health benefits to those using such supplies.

Flooding

- The Flood Risk Management (Scotland) Act 2009 is the key piece of legislation relating to flood risk management, having replaced the Flood Prevention (Scotland) Act 1961 (as amended).

Site Investigation and Contamination

- Environmental Protection Act (EPA) 1990: This legislation endorses the principle of a 'suitable for use' approach to contaminated land, where remedial action is only required if there are unacceptable risks to health or the environment, considering the use of the land and its environmental setting.
- Environment Act 1995: This Act requires local authorities to identify and, if necessary, ensure the remediation of contaminated sites. The provisions are set out in Section 57, which inserts Part IIA into the EPA 1990.
- Contaminated Land (Scotland) Regulations 2005: These Regulations provide a definition of what constitutes Contaminated Land and sets out the responsibilities of the local authority and SEPA in the identification and management of Contaminated Land.
- The Contaminated Land (Scotland) Regulations 2000 (as amended) sets out the responsibilities of the local authority and SEPA in the identification and management of contaminated land.

Planning Policy

12.3.2 National and local planning policy relevant to this assessment is summarised briefly below.

Scottish Planning Policy 2014: Scottish Planning Policy (SPP) includes several policies relevant to hydrology, hydrogeology and geology.

- Policy 29, which relates to sustainable development, states that policies and decisions should be guided by principles including "protecting the amenity of new and existing development and considering the implications of development for water, air and soil quality."
- Policy 169 relates to proposals for energy infrastructure developments, and requires consideration of impacts on carbon rich soils, and effects on hydrology, the water environment and flood risk.
- Policy 194 notes that the planning system should "promote protection and improvement of the water environment, including rivers, lochs, estuaries, wetlands, coastal waters and groundwater, in a sustainable and co-ordinated way". It also should "seek to protect soils from damage such as erosion or compaction."
- Policy 255 promotes a precautionary approach to flood risk from all sources and requires assessment of flood risk and, where appropriate, undertaking flood management measures. It states that the planning system should prevent development which would have a significant probability of being affected by flooding or would increase the probability of flooding elsewhere.
- Policy 264 sets out aspects to be taken account for development management, in respect of flood risk. This includes consideration of the design and use of the proposed development.
- Policy 266 notes that Flood Risk Assessments should be required for development in the medium to high category of flood risk (annual probability of coastal or watercourse flooding is greater than 0.5% or 1:200 years).

The Orkney Local Development Plan (Orkney Islands Council, 2017) includes three policies of particular relevance.

- Policy 9, D The Water Environment: States that development proposals should seek to protect and, where possible, improve the water environment. Where this is not possible, it must be clearly demonstrated that the development: will avoid causing deterioration in the water quality or overall status of water bodies; includes habitat management and enhancement; and will not significantly affect water quality, flows and sediment transport either during construction or after completion. The policy refers to inclusion of an appropriate buffer zone between the development and water bodies. There is a presumption against unnecessary culverting and engineering activities in the water environment.
- Policy 9, E Peat and Soils: States that development on areas of peat or carbon-rich soils will only be permitted where it has been clearly demonstrated that there is no viable alternative, that the effects of carbon emissions have been assessed, and that economic and social benefits of the development clearly outweigh potential detrimental effects. Where development on peat or carbon-rich soil is permitted, the Council may ask for a peatland management plan to be submitted which is supported by an appropriate peat survey.
- Policy 13, A Flood Risk: States that a Flood Risk Assessment must be undertaken in accordance with SEPA technical guidance where development proposals are in areas identified as being of medium to high risk of flooding and, in certain circumstances, may also be required in the low to medium risk category. It also states that development will not be permitted in locations where it would increase the probability of flooding elsewhere.

Guidance

12.3.3 The guidance documents noted below have been taken into account in this assessment, in particular informing site layout and design and deriving appropriate mitigation measures.

- SEPA Land Use Planning System Guidance Note 4: Planning Guidance on Onshore Windfarm Developments.
- SEPA Land Use Planning System Guidance Note 7: Guidance on the Water Framework Directive including river basin planning.
- SEPA Land Use Planning System Guidance Note 31: Guidance on Assessing the Impacts of Windfarm Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems.
- Planning Advice Note (PAN) 51 Planning, Environmental Protection and Regulation (2006).
- BS5930:2015 (2020 amendment) - Code of Practice for Site Investigation.
- Guidelines for Pollution Prevention (GPPs) and Pollution Prevention Guidelines (PPGs): GPP1 Understanding Your Environmental Responsibilities – Good Environmental Practices (2020); GPP2 Above Ground Oil Storage Tanks (2018); GPP5 Works and Maintenance in or Near Water (2018); and PPG6 Working at Construction and Demolition Sites (2012).
- Additional SEPA guidance including 'Special Requirements for Civil Engineering Contracts for the Prevention of Pollution v2' (2006) and 'Guidance on the Special Requirements v2' (2006).
- Groundwater Protection Policy for Scotland V3 (2009).
- Good Practice during Wind Farm Construction (Version 4, October 2019), produced by Scottish Renewables, Scottish Natural Heritage (SNH, now NatureScot), SEPA and Forestry Commission Scotland.
- CIRIA C532 'Control of Water Pollution from Construction Sites - Guidance for Consultants and Contractors' (CIRIA, 2001).
- Developments on Peatland: Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and the Minimisation of Waste (2012), a joint publication by Scottish Renewables and SEPA.
- Guidance on Developments on Peatland – Peatland Survey (2017), a joint publication by the Scottish Government, SNH and SEPA.
- Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Electricity Generation Developments (2nd Edition, 2017), Scottish Government.

12.4 Consultation

12.4.1 Table 12.1 details consultations that have been undertaken with relevant regulators, together with action undertaken by the Applicant in response to consultation feedback.

Table 12.1 – Consultation

Consultee	Consultation Response	Applicant Action/Response
SEPA (31/03/2022)	SEPA's EIA Scoping Response noted the following key information must be provided in the EIA:	

Consultee	Consultation Response	Applicant Action/Response
	• Map and assessment of any engineering activities in or impacting on the water environment including proposed buffers and details of any related CAR applications. • Map and assessment of impacts upon Groundwater Dependent Terrestrial Ecosystems (GWDTE) and buffers. • Map and assessment of impacts upon groundwater abstractions and buffers. • Peat depth survey and table detailing re-use proposals. • Map and site layout of borrow pits. • Schedule of mitigation including pollution prevention measures. • Map of proposed surface water drainage layout. • Map of proposed water abstractions including details of the proposed operating regime. • Decommissioning statement. • SEPA confirms that they agree with the receptors to be scoped in and out of the assessment, including a detailed flood risk assessment.	• Potential effects on the water environment resulting from construction and engineering activities are described in Section 12.9. • An NVC survey has been carried out, and mapping has been provided showing potential GWDTE overlain with infrastructure (**Appendix 7.2**, **Figure 7.3** and **Figure 7.5**). • No impacts upon groundwater abstractions have been identified, with no abstractions within influencing distance of the Proposed Development. • An Outline Peat Management Plan has been undertaken, including peat depths and reuse proposals (**Appendix 12.2**). • A borrow pit search area (extension of existing borrow pit) has been identified, with detailed design to follow ground investigation. The proposed borrow pit location is shown in **Figure 1.2**. • Mitigation including pollution prevention measures and development of a Construction Environmental Management Plan, are discussed in Sections

Consultee	Consultation Response	Applicant Action/Response
		12.7, 12.10 and **Chapter 16**. • The detailed design of site drainage and watercourse/ditch crossings will take account of relevant guidance and best practice and will be confirmed with SEPA prior to commencement of construction. • No water abstractions are proposed. • A broad Decommissioning statement is detailed within **Chapter 3**, Section 3.7. Prior to decommissioning, a Decommissioning Environmental Management Plan (DEMP) will be produced to reflect the current legislation and policy and will be agreed with the relevant statutory authorities. • SEPA have confirmed that a detailed Flood Risk Assessment is not required.
Orkney Islands Council (30/05/22)	In relation to the water environment, the Policy Officer (Environment) requests that the potential effects of all stages of the development on the water environment should be assessed and addressed, in line with the requirements of the relevant policies of the Orkney Local Development Plan 2017. Careful consideration should be given to any planned	Impacts from excavated peat have been assessed through peat probing and the development of an Outline Peat Management Plan (**Appendix 12.2**).

Consultee	Consultation Response	Applicant Action/Response
	onsite storage of excavated peat and soil, as stockpiles are vulnerable to erosion, particularly during wet weather. Poorly sited stockpiles may pose a risk to watercourses in this area, including the Loch of Swannay and the Loch of Hundland.	
Orkney Islands Council (06/06/22)	Orkney Islands Council provided details of known private water supplies (PWS) within 5 km of the Proposed Development.	No PWS were identified within potential influencing distance of the Proposed Development. Further information is provided in Section 12.6.

12.5 Assessment Methodology and Significance Criteria

12.5.1 The following section describes the methodology used for collecting baseline information, determining sensitivity of receptors and magnitude of impacts, and assessing the significance of effects.

Study Area

12.5.2 The study area for geology comprises the development boundary. The hydrology (surface water) study area incorporates the development boundary, as well as considering hydrological effects up to 1 km downstream of the site. The study area for hydrogeology (groundwater resources) incorporates the development boundary and a 250 m buffer. **Figure 12.1** identifies these study areas.

12.5.3 The criteria for defining the study areas have been established based on the professional judgement and experience of the technical authors regarding likely access and working areas, and with consideration of the relevant guidance noted above.

Desk Study

12.5.4 Baseline conditions have been established primarily through desk-based research, including:

- consultation with SEPA as described in Table 12.1;
- identification of the locations and characteristics of catchments and principal watercourses and waterbodies which may be affected by construction activities, taken to be those watercourses shown on 1:50,000 scale OS mapping and others observed during site survey work (minor field drains have been identified and taken into account where appropriate but are not considered to be principal watercourses);
- identification of SEPA watercourse and waterbody classifications under the WFD;
- review and collation of pertinent information on surface hydrology, flooding and climate;
- review of published OS and topographic mapping of the area – Explorer Series, Sheet 463 Orkney – West Mainland, 1:25,000;
- review of published British Geological Survey (BGS) mapping of the area – Orkney Special Sheet S118, 1:100,000, solid and drift geology edition (published 2000) and online web mapping services;

- review of drainage/surface water and hydrogeological characteristics and groundwater resource; and,
- review of PWS records held by Orkney Islands Council.

Survey

12.5.5 A stage 1 Peat Survey, in line with relevant guidance (Scottish Government, Scottish Natural Heritage, SEPA, 2017) was undertaken on the site in January 2022. The Survey involved completion of a 100 m grid of peat probe points (or as near as possible to this survey density subject to access).

12.5.6 Information has been obtained from Orkney Islands Council regarding the presence and location of PWS in the vicinity of the site. This confirmed the absence of any recorded PWS within the close vicinity of the site, therefore no on-site survey works relating to PWS were undertaken.

12.5.7 A National Vegetation Classification (NVC) Survey were undertaken in April 2022, which involved identification of NVC communities considered to be potentially groundwater dependent, based on Appendix 4 of SEPA Land Use Planning System Guidance Note 31. The NVC Survey report can be found in **Appendix 7.2**. **Figure 12.6** provides a summary illustration of the identified areas of potentially groundwater dependent habitats, based on the NVC survey.

12.5.8 In June 2022, the site was visited by the infrastructure engineers responsible for providing outline designs for access tracks, water crossings and hardstandings. Findings from that site visit and associated desk studies were taken into account in the turbine layout iteration process, and in determining the proposed infrastructure layout and design.

Assessment of Potential Effect Significance

12.5.9 The sensitivity characteristics of hydrological, hydrogeological and geological receptors have been guided by the matrix presented in Table 12.2, which lists indicative criteria.

Table 12.2 – Sensitivity of Receptors (Geology, Peat, Hydrology & Hydrogeology)

Sensitivity	Description
High	Areas containing geological, geomorphological or hydrological features considered to be of national interest, for example, Aquatic Natura 2000 sites, Special Areas of Conservation (SACs), Sites of Special Scientific Interest (SSSIs). Highly permeable superficial deposits allowing free transport of contaminants to groundwater and surrounding surface waters. Wetland/watercourse of High or Good Ecological Potential. Raised or blanket bog. High risk of flooding.
Medium	Areas containing features of designated regional importance, for example, Regionally Important Geological and Geomorphological Sites (RIGS) considered worthy of protection for their educational, research, historic or aesthetic importance. Moderately permeable superficial deposits allowing some limited transport of contaminants to groundwater and surrounding surface waters. Wetland/watercourse of Moderate Ecological Potential. Significant peat deposits. Moderate risk of flooding.
Low	Geological features not currently protected and not considered worthy of protection.

Sensitivity	Description
	Low permeability superficial deposits likely to inhibit the transport of contaminants. Wetland/watercourse of Poor or Bad Ecological Potential or no WFD classification. Thin superficial peat deposits. Low risk of flooding.

12.5.10 The above sensitivity criteria have been developed based on a hierarchy of factors relating to quality of the aquatic and geological environment, including international and national designations, water and soil quality information, water body status from SEPA's WFD review work, consultations, site visits, and the professional judgement of the assessment team.

12.5.11 Various potential impacts on hydrological, hydrogeological and geological receptors have been identified, resulting from aspects of the construction and operation phases. The predicted magnitude of impacts has been based on the guidance criteria for impact magnitudes set out in Table 12.3. These criteria have been developed based on professional experience, in accordance with relevant EIA guidance (IEMA, 2006 and SNH, 2013).

Table 12.3 – Magnitude of Impacts (Geology, Peat, Hydrology & Hydrogeology)

Impact Magnitude	Guidance Criteria
High	Total loss of, or alteration to, key features of the baseline resource such that post development characterises or quality would be fundamentally and irreversibly changed, for example, extensive excavation of peatland or watercourse realignment.
Medium	Loss of, or alteration to, key features of the baseline resource such that post development characteristics or quality would be particularly changed, for example, in-stream permanent bridge supports or partial excavation of peatland.
Low	Small changes to the baseline resource, which are detectable, but the underlying characteristics or quality of the baseline situation would be similar to pre-development conditions e.g., culverting of very small watercourses/ drains.

12.5.12 Using these criteria, potential effects resulting from the Proposed Development have been assessed. These potential effects are presented in Section 12.9. Details of generic and site-specific mitigation measures are given in Sections 12.7 and 12.10, with the residual effects, taking account of mitigation measures, detailed in Section 12.11.

12.5.13 The significance of the predicted effects has been assessed in relation to the sensitivities of the baseline resource. A matrix of significance, based on the combination of magnitude of change and sensitivity of receptor, was developed to provide a consistent framework for evaluation. This is shown in Table 4.1 in **Chapter 4**.

The guideline criteria for the various categories of effect are provided in Table 12.4. These criteria have been developed based on professional experience, in accordance with relevant EIA guidance (IEMA, 2006).

Table 12.4 – Significance Criteria (Geology, Peat, Hydrology & Hydrogeology)

Significance	Definition	Guideline Criteria
Major	A fundamental change to the environment.	Changes in water quality or quantity affecting widespread catchments or groundwater reserves of strategic significance, or changes resulting in substantial loss of conservation value to geological or aquatic habitats and designations.
Moderate	A larger, but non-fundamental change to the environment.	Changes in water quality or quantity affecting part of a catchment or groundwaters of moderate vulnerability, or changes resulting in loss of conservation values to geological or aquatic habitats or designated areas.
Minor	A small but detectable change to the environment.	Localised changes resulting in minor and reversible effects on soils, surface and groundwater quality or habitats.
Negligible	No detectable change to the environment.	No effects on geological resources, drainage patterns, surface and groundwater quality or aquatic habitat.

12.5.14 In the above classification, fundamental changes are those which are permanent, either detrimental or beneficial, and would result in widespread change to the baseline environment. For the purposes of this assessment, those effects identified as being major or moderate have been evaluated as significant environmental effects.

Requirements for Mitigation

12.5.15 Committed mitigation measures are presented within this chapter where the potential to affect sensitive geological, hydrological or hydrogeological receptors have been predicted. These may include temporary effects from construction or long-term/permanent effects associated with the operational phase of the Proposed Development and its associated infrastructure. Standard, embedded mitigation measures (refer to Section 12.7) include changes to layout and design which have been incorporated into the final development proposals, as well as general good construction practice measures to be implemented before or during construction. Where additional, specific mitigation measures are considered to be warranted to further reduce the significance of effects resulting from construction or during the operational and decommissioning phases, these have been identified and set out in Section 12.10.

Assessment of Residual Effect Significance

12.5.16 An assessment of any predicted significant residual effects on sensitive geological, hydrological or hydrogeological receptors, taking account of committed mitigation measures, is presented in Section 12.11.

Assessment of Cumulative Effects

12.5.17 Cumulative effects have been accounted for through the prediction and evaluation of effects at a catchment-wide level.

Limitations to Assessment

12.5.18 Apart from phase 1 peat probing, no intrusive site investigation works have been undertaken. Given the limited extent of peat identified, and avoidance by design, Phase 2 probing was not deemed necessary, and therefore is not considered a limitation to assessment of effects and production of a suitable peat management plan. Additionally, no water quality or flow monitoring has been undertaken at this stage. Intrusive investigations and water quality monitoring would be undertaken pre-construction, as part of the detailed design process and construction environmental management measures.

12.6 Baseline Conditions

Current and Historic Land Use

12.6.1 The site is located between Loch of Swannay to the east, and Loch of Hundland to the west, in the north-east part of mainland Orkney.

12.6.2 The topography of the site rises from approximately 50 m above Ordnance Datum (AOD) on the shore of Loch of Swannay at the eastern site boundary, to a high point of 107 m AOD at Hundland Hill in the west of the site. Hundland Hill is the main topographical feature, with the land sloping down in all directions from that high point. The site is mainly agricultural pastureland, with the upper slopes of Hundland Hill and the eastern area nearest Loch of Swannay having more of a moorland character.

12.6.3 Freely available historic OS mapping dating back to first edition (1843 to 1882) show that the site has remained largely unchanged since that time, being predominately undeveloped agricultural land. Two small quarries were located on the site, immediately west of T2 and at the proposed borrow pit location in the east.

12.6.4 A 1931-1935 Land Utilisation Survey map of the area shows the majority of the site to comprise heathland and moorland or rough hill pasture.

Geology

Superficial Geology

12.6.5 British Geological Survey (BGS) mapping at 1:50,000 scale (**Figure 12.3**) indicates that much of the site has little or no superficial geology, i.e., bedrock is anticipated to be at the surface or overlain by thin soils. The north-central and eastern parts of the site are indicated to have peat deposits overlying bedrock, with more extensive peat recorded off-site to the south-east. Till deposits (typically a clay matrix with variable sand, gravel, cobbles and boulders) are recorded in the far south of the site. An area of alluvial deposits (clay, silt, sand and gravel), is located at the far north-west edge of the site, extending to the north-west along the low ground north of Loch of Hundland.

Bedrock Geology

12.6.6 Bedrock is indicated on BGS mapping to comprise the Upper Stromness Flagstone Formation (siltstone, mudstone and sandstone) across the entire site (**Figure 12.4**).

Designations

12.6.7 There are no SSSIs designated for geological interests, nor Geological Conservation Review (GCR) sites within the site boundary or the close vicinity. The nearest such sites are more than 7 km from the site boundary and would not be expected to be directly or indirectly impacted by the Proposed Development. Therefore, geological designated sites are not considered further in this assessment.

12.6.8 The West Mainland Moorlands SSSI is adjacent to the south-east site boundary (refer to Figure 12.1). This is a biological rather than geological SSSI, designated for its assemblage of upland breeding birds. However, it is relevant to note because the heath and bog habitat supporting the bird species

may be hydrologically connected to the Proposed Development. As a nationally designated site, the sensitivity of the SSSI is assessed as High.

12.6.9 It is noted that no watercourses on the site drain or flow to or through the SSSI. The SSSI does have potential to be impacted by construction activities on site, should excavation lead to dewatering of peat deposits, though the distance from any turbine excavations is a mitigating factor (>60 m). With the limited thicknesses of peat in the south of the site (0.17 m at T4, the nearest infrastructure location to the SSSI boundary), it is unlikely that there is significant groundwater present that would be hydrologically connected to the bog habitat adjacent. In addition, groundwater is expected to be perched within permeable horizons within the glacial deposits.

Soils & Peat

12.6.10 The SNH Carbon and Peatlands Map 2016 shows does not identify any Class 1 or Class 2 peat (both classifications considered to be nationally important) within the site boundary, with the exception of the furthest south-east corner**.** Most of the site is classified as Class 4 (unlikely associated with peatland habitats, unlikely to include carbon-rich soils) and the western site area is identified as being underlain by mineral soils.

12.6.11 A peat survey (100 m grid) was undertaken to gather site specific information of the presence and condition of peat soils and/or peat. Peat is defined as an organic soil in excess of 0.5 m thick, if the soil is less than 0.5 m, then it is considered a peaty soil.

12.6.12 Peat was found to be limited across the Proposed Development with the majority of probes identifying peaty soils less than 0.5 m thick. There were localised areas of thin peat (<1 m) with only three probes recording peat depth in excess of 1 m. Each proposed turbine is located within areas comprising soil/peat depth <0.5 m.

12.6.13 An interpolation of the peat thicknesses identified is presented within **Figure 12.5**. A peat landslide hazard and risk assessment has been undertaken and is presented as **Appendix 12.1**, and an outline peat management plan is given in **Appendix 12.2**.

12.6.14 There are no historical BGS borehole records available for the site.

12.6.15 Given the absence of any onsite or nearby geological or geomorphological features of national or regional interest, and the generally thin peat/peaty soil deposits, the sensitivity of the site geology as a receptor is assessed as Low.

Mining

12.6.16 The site is not located within a historical mining area. There is evidence of small-scale historical stone quarries/borrow pits, but no reason to expect any larger-scale excavation has taken place.

Local Climate

12.6.17 The nearest Met Office weather station to the Proposed Development site is approximately 1 km south-west at Loch of Hundland (National Grid Reference 329780 1025774). The annual average maximum temperature is 11.19°C and the average annual minimum temperature is 5.35°C, both very slightly higher than the Scotland North and the Scotland-wide averages.

12.6.18 Monthly maximum temperatures range from 6.6°C in January to 16.57°C in July, and monthly minimum temperatures range from 1.54°C in February to 10.1°C in July and August.

12.6.19 The average annual rainfall is 1056.01 mm, which is 38 % less than the Scotland North regional average, and 33 % less than the Scotland-wide average.

12.6.20 Monthly rainfall averages at Loch of Hundland range from 53 mm in June to 127.58 mm in November. The wettest months are October, November and January.

Surface Water

12.6.21 The Loch of Swannay is located immediately east of the site. The Loch of Hundland is located 50m west of the site boundary at its nearest point. Apart from the two lochs there are no major surface water features on the site or within 1 km of the site boundary.

12.6.22 The northern and western parts of the Proposed Development (T1, T2, associated tracks and hardstandings, and the substation) drain towards the Loch of Hundland, while the southern and eastern parts (T3, T4, associated tracks and hardstandings, and the borrow pit) drain towards the Loch of Swannay.

12.6.23 Loch of Swannay was classified by SEPA in 2009 as having an overall status of Bad. The 2020 classification update shows the overall status as Moderate, indicating an improvement considerably exceeding the 2009 RBMP targets. Pressures identified on this water body in 2009 included livestock farming and recreational activities. The Loch of Swannay previously maintained good classification from 2012 to 2014 and 2016 to 2018, with the reduction to Moderate relating to water quality.

12.6.24 The Loch of Hundland was classified by SEPA in 2020 as having an overall status of Good, having maintained this status since 2008, prior to which it was classified as Moderate.

12.6.25 Given that the Loch of Swannay and Loch of Hundland have recent WFD classifications of Good and Moderate, the sensitivity of these receptors is assessed as High.

12.6.26 There are additionally multiple field drains and ditches across the site. Traversing the north-western part of the site a drain bounds the field where the construction compound and hardstanding for T1 is located and will require diversion and/or incorporation into the drainage measures serving the T1 hardstanding. North and west of T4 drains flows east, perpendicular to the existing track, towards the Loch of Swannay.

12.6.27 None of these field drains or ditches have been given WFD classifications, and their receptor sensitivity is therefore assessed as Low.

Flood Risk

12.6.28 A review of SEPA's online flood mapping indicates that no areas of the site are expected to be at risk of river, coastal, or surface water flooding. The 'future flood maps' similarly do not show any anticipated flood risk affecting the site, by the 2080s.

12.6.29 No significant areas of potential flood risk are indicated to be present around Loch of Swannay or Loch of Hundland, which are considered to be potentially exacerbated by the Proposed Development. Although the Proposed Development will introduce areas of hardstanding, this will represent a small proportion of the total site area, and suitable drainage provision will seek to maintain greenfield flow conditions.

12.6.30 The overall receptor sensitivity of the site and local area with respect to flooding is therefore assessed as Low.

Hydrogeology

Groundwater Body and Hydrogeology Mapping

12.6.31 The groundwater body at this location is the Orkney Groundwater, classified by SEPA as having an overall status of Good and a quantitative status of Good. The Hydrogeology Map of Scotland identifies the site as being in the category headed "Middle Old Red Sandstone – Aquifers in which flow is dominantly in fractures and other discontinuities". The map provides some additional information on the hydrogeology in Caithness, likely to be similar to that found in the Nisthill area, given proximity and similar rock type (sandstone and flagstone formations within Middle Old Red Sandstone). It states, "In Caithness, groundwater is largely confined to a shallow zone of weathered rock, and borehole yields are limited". This information, together with site observations, suggest that there is low potential for significant groundwater within the bedrock underlying the site.

12.6.32 It is inferred that groundwater may be present as perched groundwater in permeable horizons (sand and gravel) within the thin superficial deposits and/or the upper weathered bedrock, however given the nature of the bedrock it is unlikely that there is any more substantial aquifer.

Groundwater Dependent Terrestrial Ecosystems

12.6.33 The Phase 1 Habitat and NVC Survey results identified several areas of potential GWDTE, based on Appendix 4 of SEPA Land Use Planning System Guidance Note 31. The Ecological National Vegetation Classification Survey report (**Appendix 7.2**) concluded that although a number of potential GWDTE communities were recorded within the survey, none are considered to be truly groundwater dependent and do not require any specific mitigation during either the constructional or operational phases.

12.6.34 **Figure 12.6** shows the identified potential GWDTE areas, with the proposed turbine and infrastructure layout.

12.6.35 The sensitivity of habitats from a biodiversity and nature conservation perspective is discussed in **Chapter 7**. With respect to groundwater sensitivity, despite the identification of areas of potential GWDTE on site, further analysis of the hydrogeological regime has identified no major aquifer, with only potential for localised perched groundwater within superficial materials or upper weathered bedrock.

Private Water Supplies

12.6.36 Consultation was undertaken with Orkney Islands Council, to seek records of any known PWS within the vicinity of the Proposed Development. Data on recorded PWS within 5 km of the site were provided by OIC in June 2022, including National Grid References. This information was reviewed, and it was established that no PWS were recorded within influencing distance of any proposed turbine locations or other Proposed Development infrastructure. The nearest PWS recorded by OIC is over 800 m from the Proposed Development, on the opposite shore of Loch of Swannay (not within the same hydrological catchment). The next nearest PWS are over 3 km away, also in different hydrological catchments.

12.6.37 A well is marked on OS mapping, within the site near the north-west boundary. Another well is marked on OS mapping approximately 60 m north of the central part of the site. No further information is known about these wells, although as noted above, no active PWS have been identified in the area by Orkney Islands Council. Additionally, the landowner has not indicated that there are any wells in active use at or adjacent to the site. It is therefore reasonable to assume that these wells are historical and are not in current use.

12.6.38 Based on the above information, PWS are not assessed further.

Hydrogeology Summary

12.6.39 Based on the analysis described above (absence of an identified substantial bedrock aquifer, moderate permeability and thin/discontinuous nature of superficial deposits, absence of true GWDTE, and absence of PWS in the vicinity), the sensitivity of the groundwater resource is assessed as Low.

12.7 Standard Mitigation

12.7.1 The Proposed Development design iteration process, described in **Chapter 2**, has taken hydrological and hydrogeological receptors into account in order to minimise effects as far as possible. This has included locating all turbines and infrastructure outside identified potential GWDTE areas and areas of deeper peat, wherever possible, taking into account other environmental and technical constraints. No proposed infrastructure is sited within 50 m of a major watercourse or water body, nor within 50 m of the nearby West Mainland Moors SSSI. Proposed tracks have been designed to minimise the length of new track required, taking account of topography and other constraints. Existing access tracks have been incorporated into the site design where possible.

12.7.2 As described in **Chapter 3**, access tracks will be constructed with appropriate drainage provision, including drainage ditches or swales on one or both sides of the track, and cross carriage drainage pipes laid at appropriate intervals within the newly laid material, to allow for the flow of shallow groundwater.

12.7.3 The detailed design of watercourse (drainage ditch) crossings will take account of the guidance contained within Engineering in the Water Environment Good Practice Guide: River Crossings (SEPA, 2010). All crossings will be designed to accommodate 1 in 200-year storm event (including climate change allowance) to reduce the risk of flooding. Depending on the findings of intrusive investigations (see below) and resultant micro-siting, existing field drains may be culverted or re-routed. Given the small scale of the drains and their shallow side slopes, this is not anticipated to be a substantial undertaking, but would involve localised earthworks to dig out a ditch and backfill the existing ditches. The detailed designs will be agreed with SEPA prior to construction.

12.7.4 The existing drainage ditch at the proposed T1 location will be diverted/incorporated into the drainage provision serving the T1 hardstanding and turbine base.

12.7.5 A Construction Environmental Management Plan (CEMP) will be developed, agreed with SEPA and OIC prior to commencement of construction, and implemented by the lead contractor. This will be developed in line with the guidance documents noted in Paragraph 12.3.3, and will cover aspects such as: timing and phasing of construction works; delineating working areas; control of surface runoff; storage of oils and chemicals; protection of watercourse banks during construction; appropriate methods for stockpiling soils; dewatering of excavations; concrete delivery and washing out of vehicles; contingency planning; emergency procedures; and monitoring of construction procedures to ensure risks are minimised. An outline CEMP is provided in **Appendix 3.1**, to be developed further in liaison with SEPA and OIC, when the lead contractor is appointed.

12.7.6 Pre-construction intrusive site investigation works will be undertaken, to confirm ground and groundwater conditions at the proposed turbine and infrastructure locations, and to aid in detailed design and micro-siting. The investigations would include targeted monitoring and assessment of groundwater levels and flows beneath the site. The requirement for any additional specific mitigation resulting from the findings of these investigations would be agreed with SEPA in advance of construction.

12.7.7 All earth moving works or similar operations will be carried out in accordance with the British Standards Institute Code of Practice for Earth Works BS6031:2009.

12.7.8 Tracks will be constructed by stripping topsoil and subsoil from the full width of the road corridor, to a substrate of firm till or rock. Stripped soils will be stored in temporary windrows on either side of the road, to be used in forming soft verges to roads.

12.7.9 The watercourse/ditch crossings and any site discharges will be regulated under the Controlled Activities Regulations (CAR) licensing regime and all necessary licences will be obtained from SEPA prior to the commencement of construction.

12.7.10 The requirement for dewatering of excavations will be minimised by timely and efficient excavation of the foundation voids and subsequent concrete pouring and backfilling.

12.7.11 Site management will check the local weather forecast daily and will prime all site staff to ensure that everyone is aware of their responsibilities to maintain the pollution control system during wet weather. When extremely wet conditions are forecast, sensitive construction operations will be suspended.

12.7.12 Where topography dictates that working platforms are needed, these will be formed to ensure that surface water drains away from watercourses/lochs.

12.7.13 All construction activities will be supervised by a suitably qualified Environmental Clerk of Works (ECoW).

12.8 Receptors Brought Forward for Assessment

12.8.1 Private Water Supplies have not been brought forward for assessment due to no PWS being present on site or within influencing distance of the site.

12.8.2 Potential effects on bedrock geology are not considered further, as a low sensitivity receptor with little potential to be impacted by the Proposed Development.

12.8.3 No significant sources of potential historical contamination have been identified, therefore effects associated with contaminated land are not considered further.

12.8.4 As discussed in Paragraphs 12.6.29 to 12.6.31, no areas of significant flood risk have been identified within the site and there is little potential for the Proposed Development to exacerbate any off-site flood risk. Therefore, flood risk has not been considered further in the assessment of effects.

12.8.5 The assessment of effects on receptors that have been considered further are detailed in the following sections. These include: surface water; groundwater; superficial geology (peat); and the adjacent West Mainland Moors SSSI.

12.9 Potential Effects

12.9.1 The potential effects resulting from the Proposed Development on geology, hydrology and hydrogeology receptors are detailed in this section. A distinction is made between predicted effects during the construction and operational phases. Effects during the decommissioning phase are predicted to be similar to construction phase effects, although shorter in duration.

Pollution/Sedimentation of Watercourses during Construction

12.9.2 There is potential for surface runoff containing silt and other sediments to enter the watercourses/ ditches on-site (and ultimately the Loch of Hundland and/or Loch of Swannay), particularly during and after rainfall events. Surface runoff containing silt and sediments is predicted to arise from excavations, exposed ground and any temporary soil stockpiles. Sediment-laden runoff has the potential to affect the water quality and the hydrological and ecological function of the receiving watercourses at the Proposed Development site and downstream.

12.9.3 There is also potential for pollutants such as oils, fuels and cement to enter surface watercourses as a result of mechanical leaks or spills, directly into watercourses or carried in surface runoff. This can affect surface water quality and ecological value.

12.9.4 The sensitivity of the Loch of Swannay and Loch of Hundland has been assessed as high. The nearest proposed infrastructure to the Loch of Swannay is the proposed hardstanding and access track associated with T1, which is approximately 120 m west of Loch of Swannay. The nearest proposed infrastructure to the Loch of Hundland is the track near the site entrance, which is over 200 m from the loch. The potential for construction-related, sediment-laden runoff to directly enter these water bodies is therefore limited due to their distance from proposed construction works.

12.9.5 However, the field drain in the north-east flows directly into the Loch of Swannay. The proposed access track crosses the drain between the proposed borrow pit, construction compound and T2. The field drains on site are not classified by SEPA. There is potential for construction-related sediment-laden runoff to directly enter this water body and provide a pathway to the Loch of Swannay.

12.9.6 The sensitivity of the field drains is low. Taking account of embedded mitigation, including implementation of good construction practice set out in a CEMP, and the magnitude of change is low, resulting in an effect of **negligible to minor** significance (not significant). The sensitivity of the Loch of Swannay is high and the magnitude of change is negligible to low, taking account of embedded mitigation. Therefore, overall, there is likely to be an indirect, temporary, short-term effect of **minor** adverse significance (not significant) on surface watercourses, prior to the implementation of any additional mitigation.

Soil Compaction during Construction

12.9.7 There is potential for construction of permanent tracks and movement of construction vehicles and plant to result in soil compaction, reducing the ability of water to permeate the ground and increasing the potential for contaminated or sediment-laden surface runoff. Reduced permeability in soils also reduces the site's flood storage capacity, which could increase the potential for localised flooding incidents. The sensitivity of the Loch of Swannay is high and the magnitude of change is negligible to low, taking account of embedded mitigation, including implementation of good construction practice set out in a CEMP. Therefore, overall, there is likely to be an indirect, temporary, short-term effect of **minor** adverse significance (not significant) on surface watercourses, prior to the implementation of any additional mitigation.

Impact on the Integrity of Banking during Construction

12.9.8 Construction activities on or near the edges of watercourses can impact the structural integrity of the banks of watercourses, either through direct damage to bankside material or indirect loosening of soil structure, affecting localised watercourse morphology and water quality through erosion or even collapse of the banking.

12.9.9 Three minor watercourse crossings are proposed, to allow access for construction and maintenance vehicles. Crossing WC1 and WC2 in the north-west of the site comprise field drains, which will require upgrading to the specification required for construction vehicles. Neither drain flows into the Loch of Swannay, nor directly into the Loch of Hundland. Crossing WC3 is located on the track south of the eastern construction compound and comprises a field drain which is approximately 300 m upstream of the Loch of Swannay. The detailed design of watercourse crossings will take account of the guidance contained within Engineering in the Water Environment Good Practice Guide: River Crossings (SEPA, 2010). All crossings will be designed to accommodate 1 in 200-year storm event (including climate change allowance) to reduce the risk of flooding. The detailed designs will be agreed with SEPA prior to construction.

12.9.10 It is anticipated that the crossings will comprise suitably sized pipe culverts (depending on the findings of detailed site investigation work and micro-siting), and in the case of the drainage ditch at proposed T4, this will be diverted/incorporated into the drainage provision serving the T4 hardstanding and turbine base.

12.9.11 The banks of the field drains where water crossings are proposed are generally low-gradient and shallow, thereby reducing the potential for bank collapse.

12.9.12 The sensitivity of the field drains is low and the magnitude of change taking account of embedded mitigation is low. There is therefore potential for a direct, medium-term effect of **minor** adverse significance (not significant), prior to the implementation of mitigation.

Impact on Groundwater Quality and Flow Regime during Construction

12.9.13 The introduction of four turbine foundations (each approximately 22 m diameter and 4 m depth) has the potential to divert groundwater flows within superficial geology, and to impact groundwater quality as a result of alkaline leachate from concrete foundations.

12.9.14 The potential requirement for dewatering of excavations during construction could locally reduce groundwater quantity. The construction of associated crane hardstandings and laydown areas (each approximately 6,744 m^2 and new (2,550 m) and upgraded (650 m) access tracks will reduce the infiltration of rainwater, also affecting localised groundwater flows.

12.9.15 There is considered to be potential for perched, localised groundwater within the thin superficial materials at the site, with low potential for any more substantial groundwater resource within the bedrock. The sensitivity of groundwater is therefore low. The magnitude of change, taking account of embedded mitigation (including implementation of a CEMP and suitable drainage design) is low, resulting in a direct, long-term effect of **negligible to minor** adverse significance (not significant), prior to the implementation of any additional mitigation.

Impact on the Drainage and Groundwater Flow during Operation

12.9.16 As noted above, the proposed turbine foundations have the potential to divert groundwater flows within superficial geology, and hard surfaces will affect the natural drainage regime, potentially creating preferential pathways for runoff and reducing rainwater infiltration (although embedded mitigation includes suitable drainage design aiming to mimic the greenfield flow regime).

12.9.17 The sensitivity of the on-site field drains and the groundwater is low. Taking account of embedded mitigation, and the magnitude of change is low. There is therefore likely to be a direct, long-term effect of **negligible to minor** adverse significance (not significant), prior to the implementation of any additional mitigation.

12.9.18 Impacts on groundwater flows also have the potential to affect the bog habitats within the nearby SSSI, for example by lowering groundwater levels or diverting flows from the SSSI. However, superficial geological deposits at the proposed infrastructure locations nearest the SSSI were identified as being thin, and unlikely to contain substantial groundwater. The SSSI is more than 60 m from the nearest proposed infrastructure. The sensitivity of the SSSI is high, however taking account of embedded mitigation the magnitude of change is negligible. There is therefore likely to be an indirect, long-term effect of **negligible** adverse significance (not significant).

Excavation/Removal of Peat During Construction

12.9.19 Although no proposed infrastructure is sited on deep peat, there would be a requirement for excavation of shallow peat/peaty soils at the two eastern turbines, the borrow pit, and some stretches of track. Further detail on the estimated volume of peat to be excavated, and the management of excavated peat, is given in **Appendix 12.2**.

12.9.20 The excavation of localised peat deposits to allow construction of the Proposed Development is assessed as an impact of negligible to low magnitude (taking account of embedded mitigation), on a low sensitivity receptor. There is therefore likely to be a direct, permanent effect of **negligible to minor** adverse significance (not significant) prior to the implementation of any additional mitigation measures.

Potential Effects During Decommissioning

12.9.21 Effects arising from decommissioning would be anticipated to be no greater than for construction.

12.10 Additional Mitigation and Enhancement

12.10.1 Although no significant potential effects have been identified, taking account of embedded mitigation measures, some additional mitigation measures have been identified to further reduce the potential for adverse effects. These are noted below.

Peat Reuse and Management during Construction

12.10.2 Where peat is required to be excavated, it will be reused and managed in line with the guidance document, 'Developments on Peatland: Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and the Minimisation of Waste' (a joint publication by Scottish Renewables and SEPA, 2012).

12.10.3 It is proposed that peat which has been excavated for construction of the Proposed Development will be reused on site, with no requirement for soils to be disposed offsite.

12.10.4 An Outline Peat Management Plan (PMP) is presented in **Appendix 12.2**. If considered necessary, following site investigation, a detailed Peat Management Plan will be prepared prior to construction. This will follow the principals set out in the Scottish Renewables/SEPA 2012 guidance and provided to OIC, SEPA and NatureScot for comment and approval prior to works beginning.

Peat Landslide during Construction

12.10.5 The likelihood of a peat landslide has been identified as negligible or low across the entire site. **Appendix 12.1** outlines a number of mitigation measures which will be implemented in order to minimise the risk of peat instability during construction of the Proposed Development. Measures include the introduction of a 'Peat Hazard Emergency Plan' to instruct Contractors of response procedures in the event of a peat slide, and the further refinement of layout design through detailed pre-construction ground investigations. The construction process will be undertaken using a detailed Geotechnical Risk Register and under the supervision of a resident Geotechnical Engineer.

Effects on Soils, Peat and Groundwater during Construction

12.10.6 At all construction work areas, clean runoff (i.e., non-silty surface water flow) would be kept separate from potentially contaminated water from construction areas as far as possible. Where required, interceptor ditches and other drainage diversion measures would be installed immediately in advance of any excavation works in order to collect and divert clean runoff away from construction disturbed areas.

12.10.7 The borrow pit would feature a perimeter surface drain, which would aim to prevent water in-flow into the borrow pit. The water collected within the surface drains would be discharged either into the surrounding vegetation, or into a suitably located sediment lagoon. Where necessary, surface settlement lagoons would be constructed within the borrow pit. These would be constructed with the aim of containing surface water collection within the excavation voids, and from collection of water from the perimeter surface drains. The lagoons would be contained within a bunded area at the base of the borrow pit, with suitable pumping systems installed, allowing water to be pumped to soakaways, as required.

12.10.8 Discharge of diverted clean runoff would be into an area of vegetation for dispersion or infiltration and would occur as close as possible to the location of interception in order to ensure that there is no effect on soil moisture regimes downstream of the works.

12.10.9 Mitigation will be incorporated into the CEMP to minimise potential problems relating to dewatering such as:

- Dewatering progressively in cells;
- Reduce the inflow of water by sealing worked surfaces;
- Managing temporary soil storage mounds and slope stability in line with industry best practice;
- Avoiding seepage of contaminated run-off through floor of borrow pit; and
- Ensuring inert fill is used for backfilling purposes.

Effects on Surface Waters during Construction

12.10.10 Where watercourse crossings are being installed or upgraded, best practice construction measures would be adopted to prevent contamination through the use appropriate sediment isolation techniques.

12.10.11 In addition, the use of SuDS, petrol interceptors and spill kits will be utilised where chemical spillage, for example as a result of refuelling, is a possibility. Site personnel will be trained in river and stream protection measures to ensure a quick response to any accidental spillages or contamination.

12.11 Residual Effects

12.11.1 The following paragraphs provide an assessment of residual effects on geology, hydrology and hydrogeology receptors, taking account of the additional mitigation measures described in Section 12.10.

Pollution/Sedimentation and Chemical Contamination Runoff to Watercourses during Construction

12.11.2 The committed mitigation measures will reduce the magnitude of change to negligible. Therefore, overall, there is likely to be an indirect, temporary, short-term residual effect of **negligible** significance (not significant) on surface watercourses.

Soil Compaction during Construction

12.11.3 The additional mitigation measures are unlikely to affect the magnitude of change, which would remain negligible to low. Therefore, overall, there is likely to be an indirect, temporary, short-term residual effect of **minor** significance (not significant) on surface watercourses.

Impact on the Integrity of Banking during Construction

12.11.4 The additional mitigation measures are unlikely to affect the magnitude of change, which would remain low. There is therefore potential for a direct, medium-term residual effect of **minor** significance (not significant) on the on-site field drains.

Impact on Groundwater Quality and Flow Regime during Construction

12.11.5 The committed mitigation measures will reduce the magnitude of change to negligible to low. There is therefore potential for a direct, long-term residual effect of **negligible** significance (not significant) on local groundwater.

Excavation/Removal of Peat during Construction

12.11.6 The committed mitigation measures detailed in this chapter and within **Appendix 12.2** are unlikely to reduce the magnitude of change to any lower than the assessed level of negligible to low. There is therefore potential for a direct, long-term residual effect of **negligible to minor** significance (not significant) on the limited, local peat deposits.

Impact on the Drainage and Groundwater Flow during Operation

12.11.7 The committed mitigation measures will reduce the magnitude of change to negligible to low. There is therefore likely to be a direct, long-term residual effect of **negligible** significance (not significant) on local surface water and groundwater.

12.12 Cumulative Assessment

12.12.1 A search has been undertaken to identify any other proposed wind farm or other major infrastructure projects currently operational, consented or in planning, with the potential to give rise to cumulative effects on geology, hydrology and hydrogeology receptors.

12.12.2 The consented Costa Head Wind Farm comprising four turbines is situated approximately 1.1 km north of the site, with the nearest turbine 2.3 km north of the site. This proposed wind farm is sited close to the north end of the Loch of Swannay, and its construction therefore has potential to impact on this receptor. A review of the EIA documentation for Costa Head indicates that no significant effects on surface water receptors, including Loch of Swannay were anticipated. With no significant effects anticipated from the Proposed Development, there is considered to be no potential for significant cumulative effects to arise, even if the construction periods for the two developments were to overlap.

12.13 Summary

12.13.1 An assessment of potential effects on geology, hydrology and hydrogeology receptors has been undertaken, taking account of impacts associated with the construction, operational and decommissioning phases of the Proposed Development.

12.13.2 The site geology comprises discontinuous till, with some shallow peat/peaty soils, over sandstone bedrock. No designated geological sites are located on or within close proximity of the site although the West Mainland Moors SSSI (designated for its breeding birds assemblage, which is likely to have at least some dependence on its bog habitat) is adjacent to the site to the south.

12.13.3 Surface watercourses in the vicinity includes the Loch of Swannay adjacent to the site, Loch of Hundland approximately 50 m west of the site, and field drains within the site boundary.

12.13.4 The site's sensitivity with respect to flooding has been assessed as low.

12.13.5 The sandstone underlying the site forms an aquifer in which flow is dominantly in fissures and other discontinuities. There is potential for localised groundwater within the thin superficial deposits and/or the upper weathered bedrock, however given the nature of the bedrock it is unlikely that there is any more substantial aquifer.

12.13.6 No private water supplies have been identified within 1 km of the Proposed Development and those within 5 km are within a different catchment and are not within influencing distance of the development.

12.13.7 Potential areas of GWDTE (predominately marshy grassland/wet modified bog) have been locally identified on site from an NVC survey, and with reference to Appendix 4 of SEPA Land Use Planning System Guidance Note 31. However, a review of the hydrological, geological and hydrogeological conditions has identified that these habitats are unlikely to actually be groundwater fed and are more likely to be sustained by surface water. It has been assessed that, due to the low likelihood of any significant aquifer being present, there would not be a significant effect on groundwater quality or quantity as a result of the Proposed Development.

12.13.8 Potential effects have been identified, resulting from potential pollution and sedimentation of watercourses during construction, soil compaction, impact on the integrity of watercourse banks, impacts on drainage and groundwater flows during construction and operation, and excavation/ removal of peat deposits (though limited) during construction.

12.13.9 The Proposed Development design iteration process has taken account of, and sought to minimise, effects on geology, hydrology and hydrogeology as far as possible while taking account of other technical and environmental constraints. The detailed design of site drainage and watercourse/ditch crossings will take account of relevant guidance and best practice and will be confirmed with SEPA prior to commencement of construction.

12.13.10 Embedded mitigation measures, in addition to mitigation by design, include: pre-construction intrusive site investigations and groundwater monitoring prior to and during construction; provision of appropriate drainage measures during construction and operation; and development and implementation of a CEMP.

12.13.11 Additional, specific mitigation measures including implementation of a Peat Management Plan, construction oversight by a geotechnical engineer to ensure peat slide risks are minimised, suitable management and treatment of site drainage including from the borrow pit, measures to appropriately manage dewatering where required, and suitable measures to prevent pollution from accidental spillages and contamination.

12.13.12 Taking account of the committed mitigation measures, no significant residual effects on geology, hydrology and hydrogeology receptors are predicted.

12.13.13 No relevant developments which could give rise to significant cumulative effects on geology, hydrology and hydrogeology receptors have been identified.

Table 12.5 – Summary of Effects

Description of Effect	Significance of Potential Effect		Mitigation Measure	Significance of Residual Effect	
	Significance	Beneficial/ Adverse		Significance	Beneficial/ Adverse
Construction					
Pollution/ sedimentation of watercourses (construction)	Moderate	Adverse	Appropriate drainage and watercourse crossing design. Implementation of CEMP to prevent silt-laden runoff entering watercourses. Design working platforms (if applicable) to drain away from watercourses. Maintenance of pollution control system, especially during wet weather, suspension of sensitive construction operations when extremely wet conditions are forecast.	Negligible (not significant)	Adverse
Chemical contaminated runoff to watercourses (construction)	Moderate	Adverse	Implementation of CEMP to ensure appropriate storage and management of oils and chemicals, spill response and contingency measures.	Negligible (not significant)	Adverse
Soil compaction (construction)	Minor-Moderate	Adverse	Implementation of CEMP to delineate working areas and ensure appropriate earthworks methods. Tracks to be constructed by stripping topsoil and subsoil to a substrate of firm till or rock. Stripped soils to be stored in temporary windrows, to be used in forming soft verges to roads.	Negligible (not significant)	Adverse

Description of Effect	Significance of Potential Effect		Mitigation Measure	Significance of Residual Effect	
	Significance	Beneficial/ Adverse		Significance	Beneficial/ Adverse
Impact on the integrity of banking (construction)	Minor	Adverse	Detailed design of watercourse crossings in line with relevant guidance and best practice, to be agreed with SEPA and regulated under the CAR licensing regime. Implementation of CEMP to ensure appropriate earthworks and construction methods.	Negligible- Minor (not significant)	Adverse
Impact on the groundwater quality and flow regime (construction)	Minor	Adverse	Pre-construction intrusive site investigations to aid in detailed foundation design and micro-siting. To include groundwater monitoring and permeability testing. Implementation of CEMP to minimise dewatering requirement through efficient excavation and concrete pouring.	Negligible-Minor (not significant)	Adverse
Erosion or drying out of peat during construction	Minor	Adverse	Pre-construction intrusive site investigations to fully characterise ground conditions and aid micro-siting. Avoidance of thick peat by iterative design process.	Negligible	Adverse
Operation					
Impact on the drainage and groundwater flow (operation)	Minor	Adverse	Pre-construction intrusive site investigations to aid in detailed foundation design and micro-siting. Appropriate drainage and watercourse crossing design.	Negligible-Minor (not significant)	Adverse

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