



Pennant Walters

GLANLLYNFI GARTH WIND FARM

Draft Environmental Statement

Appendix 10C - Groundwater Dependent Terrestrial Ecosystems Assessment





Glanllynfi Garth Wind Farm Pennant Walters Ltd

ENVIRONMENTAL STATEMENT

Appendix 10C: GWDTE Assessment

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1 INTRODUCTION

1.1 SCOPE & PURPOSE

- 1.1.1. This technical appendix provides a summary and assessment of the Groundwater Dependent Terrestrial Ecosystems (GWDTE) in the context of the proposed Glanllynfi Garth Wind Farm (the 'Proposed Development') and supports **Chapter 10: Water Environment** of the Environmental Statement (ES).
- 1.1.2. GWDTEs are types of wetland specifically protected under the Water Framework Directive (WFD, 2000/60/EC)¹. GWDTEs are an important natural capital asset and provide ecosystem services including soil formation, biodiversity, purification of surface water and groundwater, natural water retention and runoff reduction.
- 1.1.3. Excavation of soil and bedrock during the construction and decommissioning phase of the Proposed Development has the potential to cause localised disruption and interruption to groundwater flow. Interruption of groundwater flow could potentially reduce the supply of water to GWDTE, thereby causing an alteration/change in the quality or quantity of and/or in the physical or biological characteristics of the GWDTE. Contamination of groundwater may also cause physical or chemical contamination of the GWDTE.
- 1.1.4. This assessment provides a description of the bedrock and superficial geology and takes into account the Phase 1 habitat surveys as well as further hydrological and hydrogeological surveys which were used to develop a Conceptual Site Model (CSM). The CSM was used to assess the potential groundwater dependence of identified habitats and proposes mitigation measures, where necessary.
- 1.1.5. This technical appendix has been prepared with reference to relevant legislation and policy as well as associated good practice presented in **Section 1.3**.
- 1.1.6. This technical appendix is supported by the following figures:
- **Figure 10.1: Hydrology, Geology and Hydrogeology Study Area;**
 - **Figure 10.2: Hydrology Overview;**
 - **Figure 11.2: Superficial Geology;**
 - **Figure 11.3: Bedrock Geology; and**
 - **Figure 10.6: Potential Groundwater Dependent Terrestrial Ecosystems.**

¹ Water Framework Directive (WFD, 2000/60/EC). Available at: <https://eur-lex.europa.eu/eli/dir/2000/60/oj/eng> (assessed July 2026)

1.2 PROJECT DESCRIPTION

1.2.1. As outlined in **Chapter 4: Development Description**, the Proposed Development comprises the following components:

- Up to 8 wind turbines each with a three-blade rotor;
- Two substations including transformer housing;
- Two temporary construction compounds;
- Two temporary site offices;
- Crane pads and cabling;
- Access track construction; and
- Overhead line connection (via wooden pole) to agreed Point of Connection (POC) with National Grid Electricity Distribution (NGED).

1.2.2. Traffic associated with the Proposed Development would access the Site via the A465 and A4061, using existing forestry tracks through the Pen y Cymoedd and Llynfi Afan Wind Farms. Some upgrades to the access tracks will be required to accommodate abnormal loads.

1.2.3. Geotechnical investigation (GI) work would be undertaken prior to construction to assess ground conditions and inform the detailed design and micro-siting of turbines, tracks, the construction compound, and substation. The work may include trial pits, boreholes, sampling, and laboratory testing, with the results used to support foundation and track design and identify any micro-siting requirements.

1.3 PLANNING POLICY, LEGISLATION, GUIDANCE AND GOOD PRACTICE

1.3.1. This assessment is carried out in accordance with the principles contained within the following legislation:

- The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017²;
- The Pollution Prevention and Control (England and Wales) Regulations 2000³; and
- The Town and Country Planning (Environmental Impact Assessment) (Wales) Regulations 2017⁴.

1.3.2. GWDTes are identified as potentially groundwater dependent in accordance with the Scottish Environment Protection Agency (SEPA) guidance (2024)⁵.

² The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017. Available at: <https://www.legislation.gov.uk/ukxi/2017/407/contents> (assessed July 2026)

³ The Pollution Prevention and Control (England and Wales) Regulations 2000. Available at: The Pollution Prevention and Control (England and Wales) Regulations 2000 (assessed July 2026)

⁴ The Town and Country Planning (Environmental Impact Assessment) (Wales) Regulations 2017. Available at: <https://www.legislation.gov.uk/wsi/2017/567/contents> (assessed July 2026)

⁵ Scottish Environment Protection Agency (SEPA) 2024: Guidance on Assessing the Impacts of Developments on Groundwater Dependent Terrestrial Ecosystems. Available online at: <https://www.sepa.org.uk/media/a1yh0blq/guidance-on-assessing-the-impacts-of-developments-on-groundwater-dependent-terrestrial-ecosystems.docx>

- 1.3.3. With regard to the assessment of GWDTE, Natural Resources Wales (NRW) has not formally adopted SEPA's 2024 guidance. Nevertheless, as there is currently no specific Welsh guidance for the assessment of GWDTE, SEPA's 2024 guidance has been applied as the basis for the assessment of this Proposed Development.
- 1.3.4. Good practice guidance documents as well as other technical documents that have been considered in the completion of this assessment include:
- NatureScot (2024) Good practice during wind farm construction⁶;
 - UK TAG (2004) Risk assessment of groundwater dependent terrestrial ecosystems⁷;
 - Scotland & Northern Ireland Forum for Environmental Research (SNIFFER) (2007) Wetland Hydrogeomorphic Classification for Scotland – Final Report⁸;
 - SNIFFER (2009) WFD95: A Functional Wetland Typology for Scotland - Field Survey Manual. Version 1⁹;
 - Botanaeco GWDTE Decision Tool, Version 4¹⁰; and
 - Centre of Expertise for Waters (CREW) (2022) Effectiveness of construction mitigation measures to avoid or minimise impact to groundwater dependent wetlands and to peat hydrology¹¹.
- 1.3.5. All other applicable legislation, policy and guidance with respect to GWDTE associated with the Proposed Development is described in **Chapter 10: Water Environment**.

1.4 METHODOLOGY

- 1.4.1. The GWDTE assessment presented in this appendix is based exclusively on information gathered during the Phase 1 Habitat Survey undertaken on 18 and 19 February and 11 and 12 March 2025. As portions of the survey were completed outside the optimal botanical survey period, comprehensive data on species composition and abundance were not available across all habitats.
- 1.4.2. In the absence of detailed NVC survey data, the assessment is necessarily high level and should be regarded as indicative only. Consequently, habitat descriptions could not be refined to a level that would enable the confident assignment of NVC communities. Given that the assessment is focused on the identification of potential GWDTEs, potential corresponding NVC communities have been

⁶ NatureScot. 2024. Good practice during wind farm construction. Available at <https://www.nature.scot/doc/good-practice-during-wind-farm-construction> (accessed July 2026)

⁷ UK Technical Advisory Group on the Water Framework Directive (UK TAG) (2004) Risk assessment of groundwater dependent terrestrial ecosystems. Available at: https://www.wfduk.org/sites/default/files/Media/Characterisation%20of%20the%20water%20environment/Risk%20assessment%20of%20terrestrial%20ecosystems%20groundwater_Draft_210104.pdf

⁸ Scotland & Northern Ireland Forum for Environmental Research. 2007 Wetland Hydrogeomorphic Classification for Scotland. Available at: https://www.researchgate.net/publication/342452431_Wetland_Hydrogeomorphic_Classification_for_Scotland_-_Final_Report_Project_WFD66

⁹ SNIFFER. 2009. A Functional Wetland Typology for Scotland - Field Survey Manual. Version 1. Available at https://notcoul.org/wp-content/uploads/2024/09/SnifferWFD95_FunctionalWetlandTypologyGWDTE_NVC.pdf

¹⁰ Botaneco. 2018. GWDTE Decision Tool. Available at https://drive.google.com/file/d/1_q0Tjh9TfzLFUdDoczt7SP-dZLMv8w1L/view

¹¹ Daniel Gilmour, Ehsan Jorat, Andrew Minto, Irene Tierney (2022). Effectiveness of construction mitigation measures to avoid or minimise impact to groundwater dependent wetlands and to peat hydrology. CD2019_03. Available at https://www.crew.ac.uk/sites/www.crew.ac.uk/files/publication/D527-CD2019_03-5.pdf

identified only for those habitats recorded during the Phase 1 survey that may represent GWDTEs. Any NVC communities referred to within this assessment should therefore be considered indicative of the vegetation communities most likely to be present and used as a guide only. Updated NVC classifications will be provided following completion of the targeted NVC survey as part of the final ES.

- 1.4.3. The identification and assessment of GWDTE has been completed with reference to SEPA guidance (2024)⁵. The identification of GWDTE habitats has used Phase 1 Habitat survey information, which is presented in **Figure 10.6: Potential Groundwater Dependent Terrestrial Ecosystems**.
- 1.4.4. In accordance with SEPA (2024) guidance⁵ the 'GWDTE Study Area' comprises a 250 m buffer of the Proposed Development where excavations are likely to be greater than 1 m depth, reduced to a 100 m buffer from excavations less than 1 m depth. To be precautionary, all excavations associated with tracks, turbines and other infrastructure are considered to be >1 m and therefore a 250 m buffer has been used.
- 1.4.5. Habitats with potential groundwater dependency were initially identified using the classifications set out in SEPA guidance (2024)⁵. The assigned dependency status was then evaluated using habitat survey information and a CSM, incorporating findings from site walkovers and an assessment of the Development Site's topographical, hydrological, and hydrogeological setting.
- 1.4.6. Potential GWDTEs were assessed for groundwater dependency using habitat information and the CSM. No habitats were identified as being partially or wholly dependent on groundwater and therefore no GWDTEs were taken forward for detailed assessment. Consequently, significant adverse effects associated with a reduction in groundwater availability are not anticipated.

2 BASELINE CONDITIONS & OCCURRENCE OF GWDTE

2.1 HYDROLOGY, HYDROGEOLOGY, GEOLOGY, & SOILS

- 2.1.1. In order to assess the level of dependency of the GWDTE on groundwater at the GWDTE Study Area, baseline environmental information was collected and is presented in **Chapter 10: Water Environment**. This information was used to develop a site-specific CSM presented in **Section 3**.

2.2 NVC HABITAT CLASSIFICATION

- 2.2.1. Regions of the GWDTE Study Area have been surveyed using the potential corresponding NVC communities (see **Figure 10.6 Potential Groundwater Dependent Terrestrial Ecosystems**). The map was reviewed for GWDTE in accordance with SEPA guidance (2024)⁵ and was used to determine the NVC communities that indicate the potential presence of GWDTE¹².
- 2.2.2. Potential GWDTE communities identified at the GWDTE Study Area are presented below in **Table 2-1**.

Table 2-1 – Potential Groundwater Dependent NVC Communities

NVC Community (GWDTE)	Number of GWDTE Habitats within the GWDTE Study Area	Total Area of Habitats within the GWDTE Study Area (Ha)
M23/MG10 mosaic - <i>Juncus effusus/acutiflorus</i> - <i>Galium palustre</i> Rush-pasture / <i>Holcus lanatus</i> - <i>Juncus effusus</i> Rush-pasture	1	3.4
H4/H9/H12/M15 mosaic - <i>Scirpus cespitosus</i> - <i>Erica tetralix</i> Wet heath	1	0.02

¹² In accordance with SEPA's latest guidance (2024), M25 marshy grassland is not classified as a potential GWDTE and has therefore not been included within this assessment.

- 2.2.3. Habitat parcels were allocated IDs, and these have been used for reference when conducting the assessment. Habitat parcel IDs as well as their location within the GWDTE Study Area and potential dependency are illustrated in **Figure 10.6 Potential Groundwater Dependent Terrestrial Ecosystems**. A summary of the NVC habitats situated within the GWDTE Study Area with the potential to be groundwater dependent are discussed below. A description of typical groundwater dependency identified within published literature is also provided^{13,14,15}.

M23 JUNCUS EFFUSUS/ACUTIFLORUS - GALIUM PALUSTRE RUSH-PASTURE

- 2.2.4. This rush-pasture is a community of gently sloping ground in and around the margins of soligenous flushes, as a zone around topogenous mires and wet heaths, and in poorly drained, comparatively unimproved or reverted pasture. It can be found on a variety of moderately acid to neutral soils that are kept moist to wet for most of the year. As a result, this community can be, at least partially, potentially dependent on groundwater; however, it is also commonly associated with surface water flows and surface water collection.

MG10 HOLCUS LANATUS - JUNCUS EFFUSUS RUSH-PASTURE

- 2.2.5. Mesotrophic grassland/rush-pasture is a form of rush-pasture characteristic of areas with strongly impeded drainage over a wide range of usually acid to neutral mineral soils on level to gently sloping ground. Vegetation type of damp acid to neutral soils on level to gently sloping ground in enclosed pastures, also in neglected situations such as ditches, pond sides and roadside verges. This community is widespread in lowland Great Britain; it also occurs at low altitudes in most upland areas.

M15 SCIRPUS CESPITOSUS - ERICA TETRALIX WET HEATH

- 2.2.6. This wet heath community is characteristic of moist and generally acid and oligotrophic peats and peaty mineral soils in the wetter western and northern parts of Britain. It is also associated with thinner or better-drained areas of ombrogenous peaty podzolic soil types. It is generally associated with low groundwater dependency. Consequently, small stands are present in the central heathland area where soils are more freely draining. The stands are well marked with much acute-leaved bog moss *Sphagnum capillifolium* among a short sward of heather, cross-leaved heath and deer grass *Trichophorum cespitosum*.
- 2.2.7. However, in accordance with SEPA guidance (2024)¹, the following NVC communities are not considered to be potential GWDTEs and were therefore excluded from further groundwater dependency assessment:

- **H4** – *Calluna vulgaris*–*Ulex gallii* heath (dry heath);
- **H9** – *Calluna vulgaris*–*Deschampsia flexuosa* heath (dry heath); and
- **H12** – *Calluna vulgaris*–*Vaccinium myrtillus* heath (dry heath).

¹³ Elkington, T., Dayton, N., Jackson, D.L., & Strachan, I.M. (2001) National Vegetation Classification: Field guide to mires and heaths. ISBN 1 86107 526 X

¹⁴ Rodwell, J. S. (ed.) (1992) British Plant Communities. Volume 3. Grasslands and Montane Communities. Cambridge University Press, Cambridge

¹⁵ Cooper, E.A. (1997) Summary Descriptions of National Vegetation Classification grassland and montane communities. ISBN 1 86107 433 3

2.3 OTHER POTENTIAL GWDTE (INCLUDING DESIGNATED SITES)

- 2.3.1. A review of DataMapWales¹⁶ indicates there are several potential priority habitats identified by NRW within the 1 km GWDTE Study Area and may be groundwater dependent. These include;
- Several narrow parcels of upland flushes, fens and swamps (NRW potential priority habitat) located on steep mid slopes of the northern array;
 - Numerous swards of purple moor grass and rush pasture (NRW potential priority habitat), located predominantly on mid slopes and lower slope sections around the Northern Array. Other swards and isolated flush parcels are located north and south of the Southern Array within riparian zones; and
 - Cwm Du Woodlands Site of Special Scientific Importance (SSSI) is located 1.2 km south of the Northern Array and 0.4 km west of the Southern Array. The SSSI designation falls under biological criteria but is noted for local groundwater flushes supporting a rich ground flora.
- 2.3.2. Apart from a series of purple moor grass parcels located north of T6 in the Southern Array, all other potential GWDTEs identified within DataMapWales are located outside the GWDTE Study Area and therefore significant adverse effects are not anticipated. As such, these will not be considered further as part of this GWDTE assessment.
- 2.3.3. The areas of purple moor grass identified by DataMapWales are located within the Phase 1 Habitat Survey extent described in **Section 2.2**. The area identified by DataMapWales coincides with an area of mapped marshy grassland (B5) according to the Phase 1 Habitat Survey and was described as a molinia dominant and interpreted as likely to be M25. As noted in **Section 2.2**, M25 is no longer identified by SEPA guidance (2024)⁵ as a potential GWDTE habitat and is therefore not considered further in this assessment.

¹⁶ Data and maps from the Welsh public sector. Available at: <https://datamap.gov.wales/maps/new#/> (accessed July 2026)

3 CONCEPTUAL SITE MODEL

3.1 GEOLOGY & SOILS

- 3.1.1. The geology section, presented in **Chapter 11: Ground Conditions**, indicates the Proposed Development is underlain by Upper Carboniferous strata of the Pennant Sandstone Formation (Warwickshire Group), deposited during the Westphalian Stage approximately 315-307 million years ago. The bedrock comprises predominantly thickly bedded massive sandstone with subordinate mudstone, siltstone and local coal horizons associated with the South Wales Coalfield. The resistant nature of the Pennant Sandstone has resulted in the formation of the elevated upland plateau and steep valley sides that characterise the local landscape.
- 3.1.2. The Proposed Development is within the South Wales Coalfield Syncline and is a major Variscan-age east-west trending fold structure formed during late Carboniferous to early Permian tectonic compression. Bedrock strata are typically gently to moderately folded and are locally affected by faulting associated with the South Wales Coalfield structural regime. These faults are predominantly east-west to northeast southwest and locally off-set the coal-bearing strata.
- 3.1.3. Superficial deposits are mapped as largely absent within the Proposed Development, with discrete areas of alluvial sands and gravels within basins and riparian corridors along with glacial till (diamicton) draping lower and middle sections of the valley sides. Discrete areas of peat are mapped within Duraven Forest to the east.
- 3.1.4. Soils within the Proposed Development are dominated by shallow mineral soils, with an average topsoil depth of 0.18 m and maximum profile depth of 1.04 m. Soil profiles comprise predominantly medium-textured silty clay mineral soils and localised peaty soils. No peat soils (≥ 0.3 m peat) were recorded. Organic-rich soils were restricted to four isolated peaty soil locations associated with depressions, flushes and wetter ground, with a maximum peat depth of 0.28 m. Mineral soils typically comprise silty clay topsoils over clayey silt, silty clay or clay subsoils, often underlain by coarse sand, siltstone gravel or weathered bedrock. Weathered bedrock generally occurs within 0.3 to 0.4 m of the ground surface. The Southern Array is largely improved grassland, where soils are generally free-draining but locally wetter within depressions and flushes. Further information on soils is presented in **Appendix 11B: Phase 1 Soil and Peat Survey Report**.

3.2 HYDROGEOLOGY

- 3.2.1. The Carboniferous bedrock units underlying the Proposed Development are classified as a Secondary A Aquifer, with groundwater storage and flow occurring primarily within fractures, joints and faults, with limited intergranular permeability. Groundwater productivity is generally low to moderate, with localised enhancement where sandstone units are fractured. The hydrogeological regime is controlled by the interbedded sandstone and mudstone sequence, whereby the sandstone horizons act as the principal groundwater-bearing units and the mudstones act as lower permeability barriers. Groundwater movement is expected to occur predominantly along fractures and bedding planes, with faulting locally enhancing hydraulic connectivity. Where groundwater-bearing units and structural networks outcrop on valley sides where soils are thinner these can lead to the formation of springs and issues forming the headwaters of minor watercourses or flush features.
- 3.2.2. No superficial aquifers are recorded, and superficial deposits are generally absent or discontinuous. Consequently, rainfall is expected to drain largely via shallow near-surface drainage pathways as

well as surface runoff and in watercourses. In flatter zones at higher elevations, areas of peaty soils, wet heath, flushes and poorly drained ground are likely to be sustained primarily by rainfall, shallow perched groundwater and topographic flow accumulation rather than significant groundwater discharge from the bedrock.

3.3 CONCEPTUAL SITE MODEL

- 3.3.1. The hydrogeological regime at Proposed Development is interpreted to comprise a shallow groundwater system within thin soils, localised peaty soil deposits, weathered bedrock and superficial materials, together with a deeper groundwater system associated with fractures, joints and faults within the Pennant Sandstone Formation and underlying Coal Measures. Groundwater storage within the bedrock is generally limited and controlled by secondary permeability, with more permeable sandstone units acting as the principal groundwater-bearing horizons and intervening mudstones restricting groundwater movement.
- 3.3.2. The principal flow pathways at the Proposed Development are considered to be surface runoff and shallow subsurface throughflow within shallow soils and weathered bedrock. The upland setting, generally thin soils and widespread areas of exposed or near-surface compact sandstone bedrock limit groundwater infiltration and storage and promote rapid runoff generation. Rainfall is therefore expected to move predominantly downslope via overland flow and shallow through flow before discharging to the network of headwater streams and flush zones. As a result of this, waterlogging on gentle slopes and depression at higher elevations will encourage soligenous conditions leading to the formation of mesotrophic / nutrient poor habitats which may present as extensive swards or narrow flush zones depending on the topography.
- 3.3.3. Although groundwater flow is expected to occur locally within fractured sandstone units and fault zones, there is little evidence that discharge from the deeper bedrock groundwater system exerts a significant control on the hydrology of the Proposed Development, apart from where permeable units and structural features outcrop on valley sides on low to mid-slopes. In these areas, base-rich flush zones may present as spring heads or more extensive soligenous areas fed by diffusely emerging groundwater. The degree of connectivity within the groundwater between discharge at mid-slope flushes and spring heads and infiltration in the upland plateau will depend on the presence and nature of vertical / sub-vertical fractures between sequences of sandstone and mudstone.
- 3.3.4. In summary, the dominant hydrological processes are rainfall runoff and shallow topographically constrained throughflow. In this regard, surface water catchments are considered a reasonable proxy for understanding groundwater flow pathways and groundwater-dependent habitats across the Proposed Development.

4 ASSESSMENT OF LIKELY DEPENDENCE

4.1 PRELIMINARY CONSIDERATIONS

- 4.1.1. The hydrogeological regime is dominated by shallow soils, superficial deposits and weathered bedrock, with limited groundwater storage. Rainfall-driven surface runoff and shallow throughflow are the principal flow pathways, feeding streams and flushes located primarily on peripheral slopes. Deeper groundwater exerts only a local influence where fractured sandstone outcrops on peripheral slope sections, supporting spring-fed habitats. Hydrologically connectively between the upland plateau and limited areas of groundwater emergence on slopes will be limited.
- 4.1.2. The potential GWDTE habitats within the GWDTE Study Area comprised rush pastures and wet heaths. No GWDTE habitats which are characteristic of diffuse or point emergence of groundwater were identified, such as M10a, M11, M37 / M38.

4.2 POTENTIAL EFFECTS

- 4.2.1. The construction and decommissioning of the Proposed Development could result in changes to groundwater quantity through direct physical changes such as compaction and consequential increase in density and infiltration capacity, as well as indirect changes such as dewatering or diversion of flow. Construction activities could also affect groundwater quality through accidental pollution from sediment or release of chemicals as well as changes in pH associated with the use of cement in concrete foundations. These effects occurring in isolation or combination could adversely impact the functionality of GWDTE.
- 4.2.2. Deep excavations, such as those required for the turbine foundations, could disrupt shallow groundwater systems. Groundwater controls, such as physical cut-offs or dewatering, would be utilised to prevent these excavations filling with water. This may result in the lowering of groundwater levels in the immediate vicinity of the excavations and alterations to flow paths during dewatering activities. However, it would be expected that natural conditions of groundwater level and flow would recur close to these locations and any groundwater which is present is likely to flow around discrete obstructions such as turbine foundations and therefore flows would be maintained. Deep excavations associated with the construction phase of the Proposed Development (turbine foundations) are of limited spatial extent in comparison to the entire GWDTE Study Area and rarely coincide with areas identified as potentially groundwater dependent.
- 4.2.3. Linear infrastructure such as access tracks and associated peripheral drainage could also interrupt shallow groundwater flow. This may also occur to a lesser extent with permanent drainage where the water table is very high, such as flush or peatland habitats. In both instances, the disruption of shallow throughflow could result in localised dewatering upgradient of the linear infrastructure, as well as reduction in throughflow reaching areas downgradient. Other linear infrastructure such as cable trenches can also impact groundwater if backfilled with more permeable material than surrounding soil, and can create preferential pathways for groundwater flow, resulting in local lowering of groundwater level.

4.3 SCREENING & ASSESSMENT OF LIKELY DEPENDENCE IDENTIFICATION

- 4.3.1. A total of two potentially groundwater (see **Table 2.1**) dependent habitat parcels were identified within the GWDTE Study Area.
- 4.3.2. The SNIFFER (2007)⁸ guidance states that the dependence of wetlands on groundwater bodies is a result of the hydrological connectivity. The degree of dependency will vary depending upon whether the wetland is underlain by a low productivity or high productivity aquifer and whether there is a hydrological linkage mechanism between groundwater and the surface wetland. Therefore, the determination of likely groundwater dependence is a function of the communities setting spatially within the landscape and the corresponding hydrological and hydrogeological setting described by the CSM:
- 4.3.3. Where GWDTE vegetation is evidently dependent on groundwater discharge, there is high likelihood of groundwater dependency. Identifying features include water appearing in the absence of surface water features at a point source spring head (M31, M32 & M33), more diffuse sources such as a flush (M6, M32 & M33) or floristic indicators of base enrichment (M10, M11, M37 & M38);
- 4.3.4. Where GWDTE vegetation is associated with surface water features, there is a very low likelihood of groundwater dependency. Identifying features include association with seeps, sills or runnels; upslope / upstream presence of ombrotrophic bog / mire (wet heath or blanket bog); situated away from likely groundwater rises (flat areas, topographic highs) or where they are situated in a watercourse, floodplain, or other ponding locations;
- 4.3.5. Where GWDTE vegetation is associated within ombrotrophic systems (rain-fed), there is a very low likelihood of groundwater dependency. Identifying features include:
- the presence of M6 in close association with M15;
 - upslope / upstream presence of ombrotrophic bog / mire (wet heath or blanket bog);
 - situated away from likely groundwater rises (flat areas, topographic highs); and
 - the presence of peat.
- 4.3.6. Where these habitats occur within artificial drainage ditches, groundwater dependence is likely to be low or even not dependent.
- 4.3.7. Where GWDTE vegetation is associated with surface water / ombrotrophic systems but there is evidence of some groundwater interaction, there is a low likelihood of groundwater dependency. Identifying features would be acid rich habitats that have low base enrichment as a result of dilution (M23, MG10) occurring in tandem with features indicating groundwater emergence.
- 4.3.8. The screening and assessment of likely dependence using the habitats information and CSM has indicated that habitats within the GWDTE Study Area are not groundwater dependent. All also identified to be supported by a combination of rainfall, surface runoff and nearby watercourses. Further details are provided below **Table 4-1**.
- 4.3.9. Embedded design and good practice mitigation measures that should be implemented to minimise impacts on habitats with a partial dependence on groundwater which are discussed in **Table 4-1** are presented in **Section 6**.

Table 4-1 – Potential GWDTE Habitats Identified within the GWDTE Study Area

GWDTE (NVC Community)	GWDTE ID	Potential GW Dep.	Likely Dependence based on habitat information, CSM and site walkover	Actual GW Dependency	Suggested Mitigation Arrangements
H4/H9/H12/M15 – heath and wet heath mosaic	1	Yes	The H4/H9/H12/M15 habitat parcel comprises a small area of heathland mosaic located 125 m from the nearest excavation (turbine). The mosaic is broadly cross-gradient from the turbine T3 so hydrological connectivity is limited, but nevertheless potentially within the indicative catchment for the GWDTE. Review of OS 1:25,000 mapping indicates that the parcel is situated on the upland plateau on level ground and is not associated with an obvious flush, spring or other feature indicative of groundwater discharge. The parcel is dominated by H4, H9 and H12 heath communities, which are not classified as potential GWDTEs, with a minor component of M15 wet heath. Given the small extent of the habitat and its topographic setting, the occurrence of M15 is considered most likely to reflect localised surface water retention and soil moisture rather than a significant groundwater influence. On the basis of habitat characteristics and the CSM, the parcel is considered unlikely to be substantially groundwater-dependent and has therefore been screened out from further GWDTE assessment.	Low / Not Dependent	No specific GWDTE mitigation is considered necessary. Standard good practice measures will be implemented through the Construction Environmental Management Plan (CEMP) during construction, including pollution prevention controls and maintenance of existing surface water drainage pathways to avoid indirect impacts on habitat hydrology.

GWDTE (NVC Community)	GWDTE ID	Potential GW Dep.	Likely Dependence based on habitat information, CSM and site walkover	Actual GW Dependency	Suggested Mitigation Arrangements
MG10/M23b – mesotrophic grassland and rush pasture mosaic	2	Yes	Several large swards of MG10/M23b mosaic are located in a hilltop setting bounded in the west by a wall structure. The parcel is located 20 m from the nearest excavation at its closest point, and since it is upgradient is unlikely to be hydrologically connected with the Proposed Development. A review of OS 1:25,000 mapping indicates that the habitats are situated on very gently sloping ground with uniform topography. The OS 1:25,000 identifies a spring downslope of the parcel; however, there is no evidence that groundwater emerges within the habitat itself. The spring is interpreted to represent a drainage point for the micro-catchment within which the parcel is located. Although MG10 and M23b are identified by SEPA as potential GWDTE communities, the habitat's topographic hilltop setting suggests that it is likely to be sustained predominantly by rainfall and slowed surface runoff. Based on the CSM, the parcel is considered unlikely to be substantially groundwater-dependent and has therefore been screened out from further GWDTE assessment.	Low / Not Dependent	No specific GWDTE mitigation is required. Standard embedded mitigation measures will be implemented through the CEMP during construction, including pollution prevention controls, maintenance of existing surface water drainage pathways, and avoidance of changes to local runoff patterns that could adversely affect habitat hydrology.

SUMMARY

- 4.3.10. In summary, two habitat parcels within the GWDTE Study Area were identified as potential GWDTE on the basis of their indicative NVC communities.
- 4.3.11. A review of their habitat characteristics, topographic setting and the CSM indicates that neither is substantially groundwater dependent. The H4/H9/H12/M15 heath and wet heath mosaic is located on level upland ground and is considered to be sustained by localised surface water inputs and nearby runoff. The MG10/M23b rush pasture mosaic occupies a similar hilltop setting and is also considered to be supported predominantly by rainfall and slowed surface runoff.
- 4.3.12. Neither parcel shows evidence of groundwater emergence, nor has likely hydrological connectivity with proposed excavations. On this basis, the habitats have been screened out from further GWDTE assessment, and no specific GWDTE mitigation is required beyond standard embedded and good practice mitigation.
- 4.3.13. It is anticipated that supplementary NVC surveys will be undertaken in due course and shall be incorporated into an updated version of this GWDTE assessment prior to the final ES submission. It's possible that this survey may identify additional potential GWDTE communities in addition to those assessed in **Table 4-1**. However, on the basis of the conceptual understanding of the Proposed Development presented in **Section 3**, it is unlikely that any new potential GWDTE communities within the GWDTE Study Area are likely to be classified as substantially dependent on groundwater. This is because, according to the CSM, the setting for groundwater emergence (and therefore the potential for substantial groundwater dependence of the habitat) will be constrained to moderately sloping ground on valley sidewalls and peripheral slopes where soils are thin and where fractures / permeable strata will outcrop. In general, the Proposed Development infrastructure has avoided these areas and is located within the upland plateau in a hilltop setting. These areas are dominated by a hydrological regime governed by rainfall and surface runoff, with limited infiltration to groundwater and water logging as a result of topography. As such, it is judged that further survey information is unlikely to substantially alter the assessment outcomes or conclusions in relation to the presence of potential GWDTE communities that are actually dependent on groundwater and consequential likely adverse effects.

5 EMBEDDED & GOOD PRACTICE MITIGATION

5.1 INTRODUCTION

- 5.1.1. The design process has aimed to balance engineering and infrastructure layout requirements with the need to minimise impacts on environmental receptors, including areas of sensitive habitat such as GWTDE.
- 5.1.2. A site-specific assessment considering the habitats, topography, hydrology and hydrogeology has indicated the identified habitats are not entirely dependent on groundwater. Nevertheless, embedded and good practice mitigation should be deployed to minimise deleterious impacts arising from the modification of surface and near-surface hydrology.
- 5.1.3. A summary of proposed embedded design mitigation as well as good practice controls are provided below.

5.2 EMBEDDED DESIGN MEASURES

AVOIDANCE

- 5.2.1. No actual GWDTEs were identified. The Proposed Development has nevertheless sought to minimise potential effects on habitats with possible groundwater influence, including avoiding impacts on potential groundwater contribution areas where practicable.

DESIGN MEASURES

- 5.2.2. The permanent (and temporary) drainage system will be designed to mimic greenfield runoff patterns and maintain hydrological connectivity for infrastructure situated upgradient, downgradient, or bisecting potential GWDTEs. This will include the use of perimeter drains around turbines and regular cross drains for linear infrastructure which would be installed to avoid a reduction in water quantity and maintain surface flows. The use of watertight materials around turbine edges will also be considered if required. Measures such as French drains (using a gravel layer as water conduit, rather than pipework, running downhill to a soakaway zone designed to enable water to percolate back into soil), would be installed at hardstanding locations where applicable. Within areas adjacent to potential GWDTE, the use of peripheral drains (both temporary and permanent) would be minimised as far as possible, particularly in areas of organic soils (or areas plausibly connected too) to minimise dewatering effects. In 'cut' areas this may also include the placement of vegetation / turves over exposed soil edges to act as a 'seal' to reduce upslope dewatering. Where the gradient is sufficiently low, the use of regular dams within the base of the drain could also create ponded water to reduce adjacent drawdown effects.
- 5.2.3. Cable trench design should avoid the creation of preferential pathways, and within / near potential GWDTEs areas or zones of topographical convergence would include low permeability caps (clay or similar) to reduce infiltration down into the trench and encourage onward downslope movement of surface water and shallow groundwater.
- 5.2.4. For foundations, the selection of the appropriate cement type depending on the wetland's pH would be adopted to minimise impacts on wetland water chemistry. Aggregate used for other infrastructure such as hardstands, tracks or cable trench backfill would similarly be chosen to not affect the pH of wetlands.

5.3 GOOD PRACTICE CONSTRUCTION METHODS

PRE-CONSTRUCTION CONTROLS

- 5.3.1. Prior to construction, the temporary and permanent drainage plans prepared with the Construction and Environmental Management Plan (CEMP) will be reviewed with reference to this GWDTE Assessment. The proposed arrangement of the drainage, including cross drains and other measures to be embedded in the design, shall consider the findings of this GWDTE Assessment, including the habitats identified in **Table 4-1**.
- 5.3.2. Sensitive areas should be demarcated by the Environmental Clerk of the Works (ECoW) ahead of construction to avoid accidental disturbance.

CONSTRUCTION PHASE CONTROLS

- 5.3.3. Construction phase controls have been detailed in the **Outline CEMP** (see **Appendix 4A**), that will inform a final CEMP prepared prior to construction. The CEMP will include surface water and groundwater management arrangements associated with minimising impacts on water quality and quantity in wetland areas.
- 5.3.4. Any necessary dewatering activity would be limited to the minimum necessary duration and would be discharged to adjacent ground and away from watercourses. The timing of construction works would avoid periods of high runoff where dewatering requirements would increase.
- 5.3.5. The placement and distribution of sustainable drainage measures associated with wetlands should accord with the embedded design principles that will be presented in the final CEMP and include the use of regular cross drainage in areas upslope of GWDTE or in other areas of flow convergence.
- 5.3.6. Pollution prevention controls associated with erosion control, sedimentation as well as accidental spillages will minimise the occurrence of incidents that could lead to deleterious effects on wetlands.
- 5.3.7. Soil compaction in areas of wetlands should be minimised as far as possible to avoid decreases in infiltration. Contractors will be required to work within the narrowest practical construction corridor when working in or near wetlands and vehicle movements should be minimised.

6 CONCLUSION

- 6.1.1. Based upon the assessment methodologies provided in the **Chapter 10** of the ES: **Water Environment**, which assumes the successful design and implementation of mitigation measures, the magnitude of impact from i) pollution incidents, ii) erosion and sedimentation, iii) modification of surface drainage patterns, iv) disturbance and compaction of soils, and v) modification of groundwater flows and levels on GWDTE (**Low importance**) is considered to be **Negligible**, and of **Low** probability to occur, resulting in a **Negligible Adverse Effect** (not significant).
- 6.1.2. No additional mitigation requirements have been identified and therefore there are no residual effects.
- 6.1.3. Whilst this GWDTE assessment will be updated following the provision of additional NVC information prior to final ES submission, it is judged that based on the hydrogeological setting of the site and prevailing ecohydrology conditions, the assessment conclusion that impacts on GWDTE will be not significant, is unlikely to change.



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