

Appendix 10-6: Groundwater Dependent Terrestrial Ecosystem (GWDTE) Assessment

Calderdale Energy Park

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Appendix 10-6: Groundwater Dependent Terrestrial Ecosystems (GWDTE) Assessment

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1 Introduction

This technical appendix presents the findings of the potential groundwater dependent terrestrial ecosystems (GWDTEs) assessment for Calderdale Energy Park (Proposed Development) and is an appendix to **Chapter 10: Hydrogeology, Hydrology, Geology and Peat** of the Preliminary Environmental Impact Report (PEIR).

As set out in Chapter 1: Introduction of the PEIR, the Proposed Development at this point in time includes a number of components and associated areas, as follows:

- Turbine Area, where the wind turbines and associated infrastructure will be located;
- Eastern Access Route and Western Access Route (collectively referred to as the 'Access Routes'), providing access to the Turbine Area; and
- Bradford West Cable Corridor, where the export cable will run from the Turbine Area to the Bradford West Substation to connect the wind turbines to the grid.

Altogether, these areas are termed the 'PEIR Boundary'. The extent of the PEIR Boundary is shown in **Figure 3-1** of the PEIR.

The Turbine Area comprises an undulating landscape within the Walshaw Moor Estate, located to the north of Heben Bridge. Land use consists of undulating upland moorland and farmland. Upland areas reach heights of 463m Above Ordnance Datum (AOD) at Heather Hill summit in the northwest of the Turbine Area and 452m AOD at Withins Heights in the north. With the exception of a small portion of the far west of the Turbine Area, the drains to the River Calder at Hebden Bridge. A small area in the far west of the Turbine Area drains west to Thursden Brook and on to the River Brun through Burnley. This portion of the Turbine Area is located within the Ribble Management Catchment of the North West River Basin District and is within the Calder Operational Catchment.

GWDTEs are protected under the Water Framework Directive (WFD), as implemented in England through the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017. Assessments are regulated by the Environment Agency (EA).

This assessment identifies areas of potential GWDTEs in proximity to the proposed infrastructure locations, considering the hydrological and hydrogeological setting, topography, geology and existing infrastructure. The findings inform the evaluation of effects on GWDTEs presented in **Chapter 10: Hydrogeology, Hydrology, Geology and Peat** of the PEIR.

Detailed guidance has been developed for the assessment of wind farm infrastructure on GWDTE in Scotland by SEPA (LUPS GU31, 2017) and updated for NPF4 'Guidance on Assessing the Impacts of Developments on Groundwater Dependent Terrestrial Ecosystems' (SEPA, August 2024) which refers to the UKTAG (2008) list of NVC Communities and Associated Groundwater Dependency Scores, Annex 1 (updated October 2009). Although for Scotland primarily, this guidance is relevant for this assessment in the absence of specific guidance in England.

2 Methodology

A detailed National Vegetation Survey (NVC) survey for the Turbine Area has been completed by Logika (April 2025) and is presented within **Chapter 8: Biodiversity** of the PEIR.

A total of 139 polygons were identified across the NVC Survey Area, which is defined in **Chapter 8: Biodiversity** of the PEIR.

The methodology for the identification of potential GWDTEs is as follows:

- Review of all NVC categories to determine which are potentially groundwater dependent (GWD) in accordance with the SEPA ‘Guidance on Assessing the Impacts of Developments on Groundwater Dependent Terrestrial Ecosystems’ (August 2024), identifying eight potentially GWDTE polygons associated with potentially GWD features across the NVC Survey Area.
- The relevant buffer zones for GWDTE were then created for the proposed infrastructure locations at a distance of:
 - 10m radius of all activities;
 - 100m around subsurface activities where excavation would be less than 1m depth, and
 - 250m from subsurface activities turbines where excavation could exceed 1m depth, e.g. turbines and borrow pits.

All eight of the potentially GWD NVC polygons were within these relevant buffer zones as listed below.

- The SEPA guidance presents the NVC categories to be considered as potentially GWD and refers to the UKTAG (2008) ‘List of NVC Communities and Associated Groundwater Dependency Scores, Annex 1’ (updated October 2009), which relates to whether they are considered potentially low, moderate or high groundwater dependence). The identified potentially GWDTE polygons within the buffers were then categorised into potentially moderately GWDTEs and potentially highly GWDTEs based on the UKTAG scores. This resulted in the following potential GWDTEs within the buffers presented in **Figure 10-13**.
 - Five potentially highly GWDTEs polygons; and
 - Three potentially moderately GWDTE polygons;
- The eight remaining polygons with potential for groundwater dependency within the buffer zones proposed infrastructure locations are presented in **Table 2** of this appendix.

This report provides an assessment of groundwater dependency of the remaining polygons that are potentially GWD based on the geological, hydrogeological and topographical setting.

3 Hydrogeological Assessment

A qualitative hydrogeological assessment has been undertaken on features that have been identified as being potentially GWD within the buffers and where other factors do not rule out the habitat as either being linked to the Proposed Development or being GWD.

This assessment is based primarily on the hydrogeological information presented within **Figure 10-12**, which presents the hydrogeological potential of the bedrock and shows the type and extent of any superficial deposits (including actual peat depth data from the Peat Depth Survey Report (**Appendix 10-2**) as well as the topographical setting and site inspection. The particular hydrogeological setting at each location is discussed in relation to the habitat in Section 5 of this GWDTE Assessment.

The degree of groundwater dependence of a waterbody varies from wetland to wetland and is dependent on hydrogeological connectivity. The Sniffer guidance document (2007) 'Wetland Hydrogeomorphic Classification for Scotland' produced a hydrogeomorphic classification for potential wetland areas within the Scottish landscape. The document states that *'The dependence of wetlands on groundwater bodies is also 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.'*

There are three qualitative levels of groundwater dependency, depending on whether the wetland is underlain by a low or high productivity aquifer:

- *'high likelihood of groundwater dependency: intergranular high productivity drift aquifer and dominantly intergranular high productivity aquifer;*
- *moderate likelihood of dependency: intergranular moderate productivity drift aquifer and fractured very low productivity aquifer; and*
- *low likelihood of dependency: intergranular low productivity drift aquifer and fractured very low productivity aquifer'.*

The British Geographical Survey (BGS) indicates that the bedrock beneath the Turbine Area comprises interbedded layers of Upper Kinderscout Grit – Sandstone and Millstone Grit Group – Mudstone, siltstone and sandstone in the west of the Turbine Area; and interbedded layers of Woodhouse Flags – Sandstone and Marsden Formation – Mudstone and Siltstone in the centre and east of the Turbine Area across higher elevations.

BGS mapped superficial deposits across the Turbine Area comprise predominantly peat (**Figure 10-7**). There is a small area of alluvium in the south of the Turbine Area. However, this is not near any of the potentially GWD National Vegetation Communities mapped during habitat surveys. Peat surveys undertaken by Fluid show a similar distribution to the BGS mapped superficial peat deposits (**Figure 10-11**). The BGS superficial geology layer has been omitted as peat deposits are the only relevant deposits to this GWDTE assessment and therefore the peat depth survey data obtained by Fluid provides a higher degree of accuracy.

The BGS Aquifer designation dataset for England and Wales provided on the MAGIC website (<https://magic.defra.gov.uk/MagicMap.html>) classifies the bedrock as a Secondary A aquifer and the superficial deposits as unproductive. Secondary A aquifers support water supplies at a

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local scale and may contribute baseflow to rivers; they were formerly classified as minor aquifers.

The Millstone Grit formation of the Central Pennines is classed by the BGS as a locally important, moderately productive aquifer. Groundwater flow occurs mainly through fractures, with sandstone horizons acting as discrete aquifers and intervening siltstone and mudstone layers forming aquicludes or aquitards. Intergranular permeability is low, borehole yields are variable but typically <10 L/s, and significant groundwater flow generally occurs within the upper ~60m, though deeper structurally controlled flow may occur.

Millstone Grit aquifers are known to host springs, historically mapped on slopes draining to Alcomden Water and Walshaw Dean Water.

The hydrogeological setting described above suggests that any potential GWDTEs underlain by sandstone bedrock should be considered as having a moderate likelihood of groundwater dependency. Where potential GWDTEs are underlain by BGS mapped mudstone and siltstone then some degree of groundwater dependency is possible, particularly where located close to a mapped boundary between higher permeability sandstone layers and lower permeability mudstone and siltstone. These habitats are assessed through a combination of aerial imagery, topography, habitat geomorphology and the presence or absence of surface water features that imply surface water inputs to these habitats.

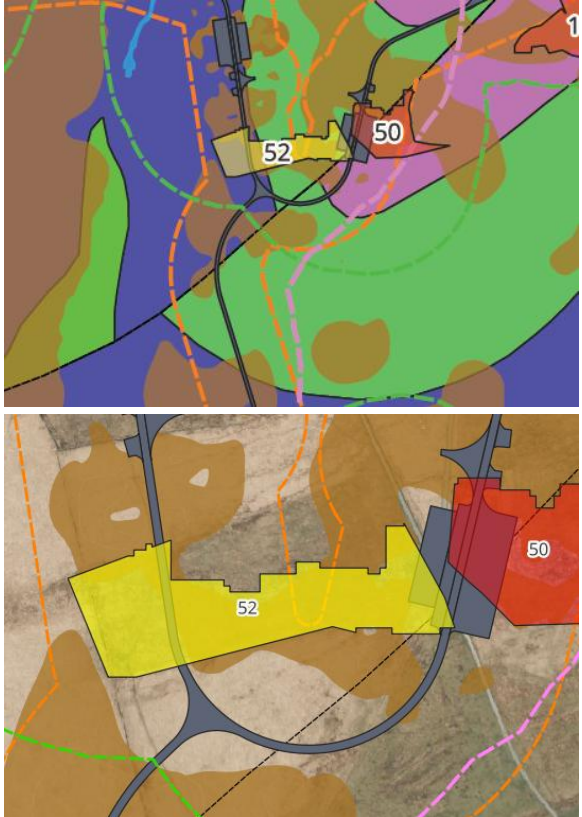
Where mapped peat deposits are present, these likely act as an aquitard layer between the underlying bedrock and the surface NVC habitats. Areas underlain by Fluid mapped peat deposits are therefore not considered to be GWD, unless a visible absence of peat and spring/flush features are visible on aerial photography, that may not be reflected in the peat data due to the resolution of the survey and the small areas that these features generally comprise.

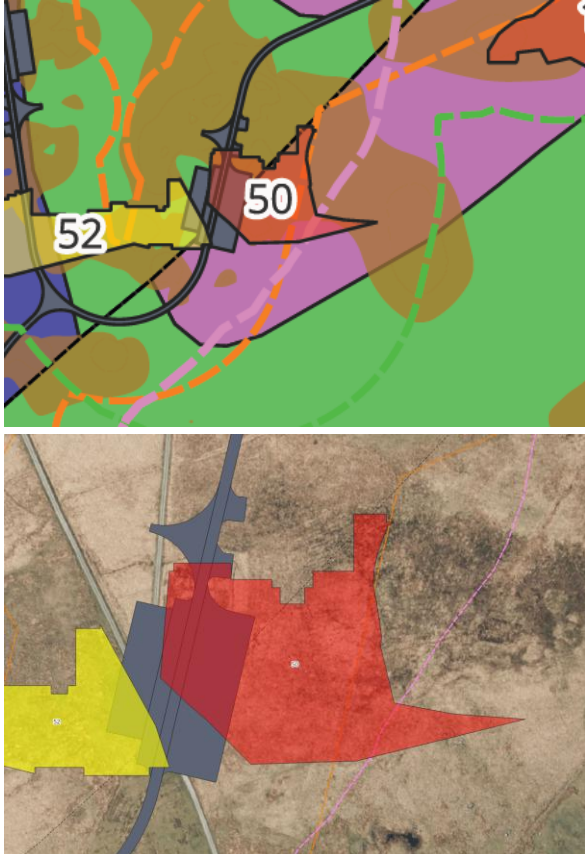
4 GWDTE Assessment


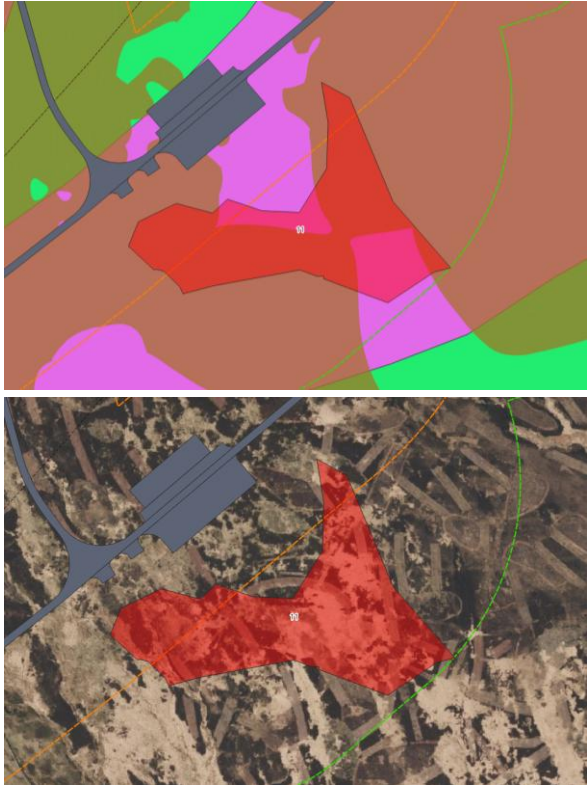
The following section considers the hydrological/hydrogeological setting and the likelihood of effects considering topography, geology and existing infrastructure.

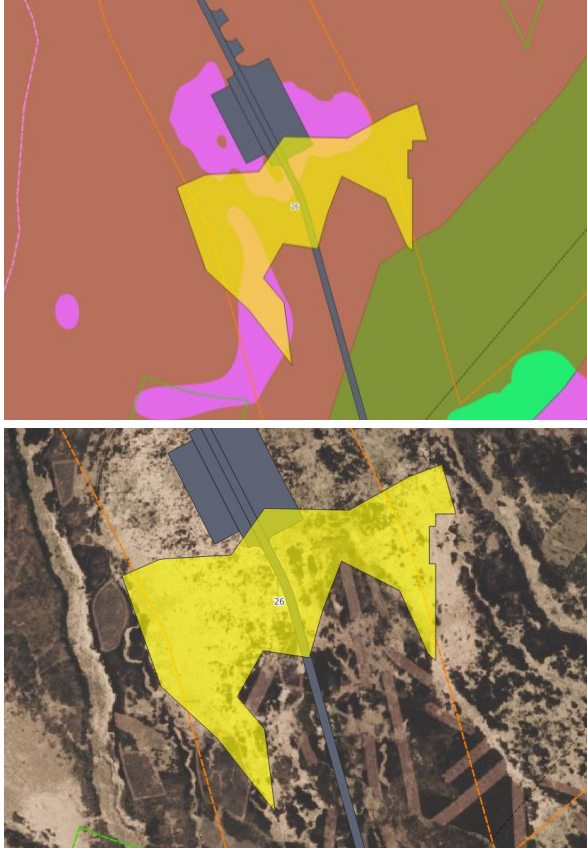
Table 1 provides an assessment of each of the habitats within the buffer zones of the proposed infrastructure footprints that are potentially highly GWD and are not scoped out of the assessment following the methodology described in **Section 2**. It is identified whether they are actually GWD and if so, if they are actually connected to the Proposed Development.


Table 1 Assessment of Potential GWDTEs with the Proposed Infrastructure Buffer Zones


NVC or Target Note Area	GWDTE Assessment
<p>Area 52</p> 	<p>NVC Category: M23 – <i>Juncus effusus/acutiflorus</i> - <i>Galium palustre</i> rush-pasture</p> <p>Classification: Potentially moderately GWD</p> <p>Assessment: This habitat covered a large continuous area overlain by discontinuous peat deposits with mudstone, siltstone and sandstone deposits. No mechanism of groundwater discharge was visible on the aerial photography, and the underlying bedrock is relatively impermeable. This habitat is therefore not considered to be groundwater dependent.</p>

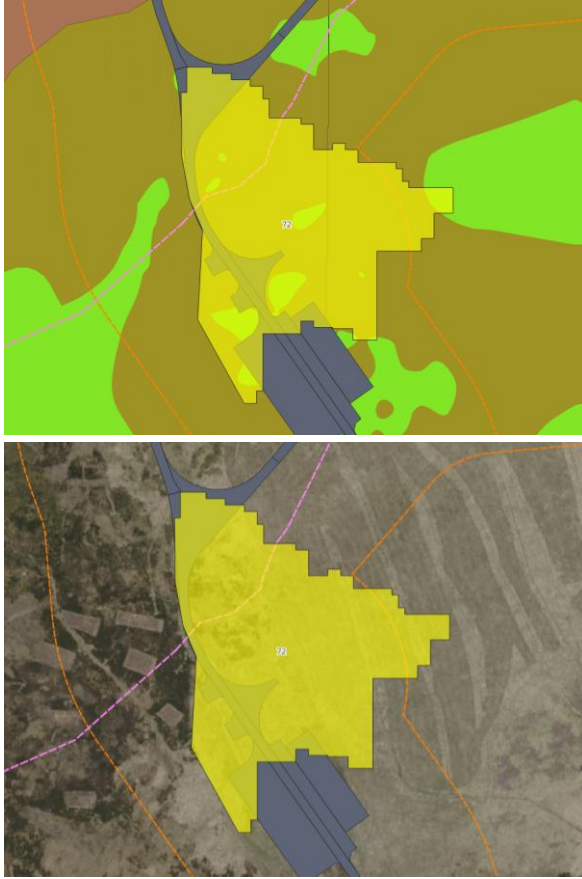
NVC or Target Note Area	GWDTE Assessment
<p>Area 50</p> 	<p>NVC Category: <i>W4 - Betula pubescens - Molinia caerulea woodland</i></p> <p>Classification: Potentially highly GWD</p> <p>Assessment:</p> <p>This polygon is underlain by predominantly sandstone bedrock, with mudstone, siltstone and sandstone bedrock at the northeast section of the habitat. The majority of the habitat is situated on peat deposits, however the centre and southeast of the polygon are devoid of superficial deposits.</p> <p>Sandstone bedrock is classed as a moderately permeable aquifer, however given that the habitat forms a fairly large continuous area and is situated near to the catchment divide with no mechanism of groundwater discharge visible on the aerial photography it is unlikely to be truly groundwater dependent. It is likely predominantly rainfall fed.</p>

NVC or Target Note Area	GWDTE Assessment
<p>Area 110</p> 	<p>NVC Category: <i>W4 - Betula pubescens - Molinia caerulea woodland</i></p> <p>Classification: Potentially highly GWD</p> <p>Assessment: Area 110 is comprised of two polygons, underlain almost entirely by sandstone bedrock. Fluid peat surveys show the polygons to be almost completely underlain by peat deposits except for a few small patches.</p> <p>Although the underlying bedrock is moderately permeable, there are no areas of potential groundwater discharge visible on the aerial photography and the habitat forms a large continuous area mostly covered in impermeable peat deposits.</p> <p>It is therefore considered to be predominantly rainfall fed, and not truly groundwater dependent.</p>
<p>Area 11</p> 	<p>NVC Category: <i>W4 - Betula pubescens - Molinia caerulea woodland</i></p> <p>Classification: Potentially highly GWD</p> <p>Assessment: This polygon similarly covers a large continuous area underlain by sandstone bedrock with almost complete coverage of impermeable peat deposits with no springs, flushes or other mechanisms of groundwater discharge visible on the aerial photography. It is also considered to be rainfall fed.</p>

NVC or Target Note Area	GWDTE Assessment
<p>Area 26</p>  <p>The top image is a map showing various colored polygons (red, purple, yellow, green, blue) overlaid on a landscape. A yellow polygon, labeled '26', is the central focus. The bottom image is an aerial photograph of the same area, with a yellow polygon labeled '26' overlaid on the terrain, which appears to be a mix of open land and some structures.</p>	<p>NVC Category: <i>M15 - Scirpus cespitosus - Erica tetralix wet heath</i></p> <p>Classification: Potentially moderately GWD</p> <p>Assessment:</p> <p>This polygon similar covers a large continuous area underlain by sandstone bedrock. The majority of the polygon is covered by impermeable peat deposits with no springs, flushes or other mechanisms of groundwater discharge visible on the aerial photography. It is also considered to be rainfall fed.</p>

NVC or Target Note Area	GWDTE Assessment
<p>Area 115</p> 	<p>NVC Category: M6 – <i>Carex echinata</i> – <i>Sphagnum recurvum/auriculatum</i> mire</p> <p>Classification: Potentially highly GWD</p> <p>Assessment: This habitat is entirely covered by impermeable deep peat up to a depth of 3m. It is therefore likely to be predominantly rainfall fed.</p>

NVC or Target Note Area	GWDTE Assessment
<p>Area 124</p> 	<p>NVC Category: M6 – <i>Carex echinata</i> – <i>Sphagnum recurvum/auriculatum</i> mire</p> <p>Classification: Potentially highly GWD</p> <p>Assessment: This habitat is underlain by relatively impermeable mudstone and siltsone bedrock and is almost entirely covered with a layer of impermeable shallow peats, with no mechanism of groundwater discharge visible on aerial photography. It is therefore considered to be rainfall fed.</p>

NVC or Target Note Area	GWDTE Assessment
<p>Area 72</p> 	<p>NVC Category: M6 – <i>Carex echinata</i> – <i>Sphagnum recurvum/auriculatum</i> mire</p> <p>Classification: Potentially moderately GWD</p> <p>Assessment:</p> <p>This habitat is underlain by sandstone bedrock, mostly covered by impermeable peat deposits. The habitat covers a fairly large continuous area with no potential springs or flushes visible on aerial photography. It is therefore considered to be rainfall fed.</p>

Note: orange dashed line = 100 m buffer, green dashed line = 250 m buffer; yellow polygon = moderate potential GWD polygon; red fill = high potential GWD polygon, pink dashed line + catchment boundaries.

5 Conclusion

The analysis above has considered the hydrological/hydrogeological setting and the likelihood of effects considering topography, and bedrock and superficial geology.

Despite the presence of moderately permeable sandstone aquifer underlying a proportion of the Turbine Area, none of the potentially GWDTE identified were found to be truly GWD. They tended to form large, continuous areas with no visible means of groundwater discharge such as flushes or visible springs. Often, they were also covered by impermeable superficial peat deposits. As such, all eight potentially GWDTE were interpreted as being rainfall fed.

The results of the above assessment and observations from the hydrology walkover survey therefore indicate that none of the mapped potentially GWDTEs are truly groundwater dependent. There will therefore be no impact from the Proposed Development on the GWDTEs identified in this report. However, further detailed assessment for the other components of the Proposed Development (e.g. Access Routes and Bradford West Cable Corridor) will be undertaken for the ES and significant effects cannot be ruled out at this stage.

The following good practice methods are recommended to maintain hydraulic continuity within and between wetland habitats that may receive inputs from surface water and run-off:

- Where infrastructure excavations are required, any water captured should be discharged in close proximity and downgradient of the infrastructure and in a diffuse manner to maintain continuity of flow;
- Drains running parallel to tracks should be routed to regular and frequent cross drains to avoid the tracks acting as interceptors to both surface and groundwater flow; and
- If more diffuse zones are crossed a series of small culverts to promote hydrological continuity are recommended.