



ESB Asset Development UK Limited

Millmoor Rig Wind Farm: Groundwater-Dependent Terrestrial Ecosystems Assessment

Technical Appendix 10.3

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Figure 10.3.1: Potentially groundwater-dependent terrestrial ecosystems

1 INTRODUCTION

- 1.1 This report provides a Groundwater-Dependent Terrestrial Ecosystem (GWDTE) Assessment for Millmoor Rig Wind Farm (hereafter the 'Proposed Development').
- 1.2 The report forms a Technical Appendix to the Environmental Impact Assessment (EIA) Report for the Proposed Development and should be read in conjunction with the EIA Report. It has been produced in response to concerns over development in areas with, or that have potential to affect, sensitive groundwater-dependent habitats raised by the Scottish Environment Protection Agency (SEPA) and the Scottish Borders Council's Ecology Officer (please refer to **Table 10.4** in **Chapter 10**, Volume 1).
- 1.3 GWDTE are protected under the Water Framework Directive and are potentially sensitive receptors to the impacts of development. This report identifies the potentially groundwater-dependent habitats present at the Proposed Development site ('the site') and identifies and assesses the potential impacts of the Proposed Development on these habitats. Design and mitigation methods to avoid or minimise these risks are set out, along with good construction practices that would be employed during all site works.

Site Location

- 1.4 The Proposed Development is located in the Scottish Borders, within a large area of commercial forestry in the Wauchope Forest. The location of the Proposed Development is shown in **Figure 1.1**, Volume 2. The site is close to the border between Scotland and England, being around 2.5 km at its closest point.
- 1.5 The land use within the Proposed Development site consists entirely of short rotation forestry (SRF) plantation. The plantation is currently active with some sections being felled, and other areas presenting recent crop plantation as well as mature stands. Only a few areas within the site are not covered by forestry:
- small areas kept clear around the abandoned settlement of Westshiels;
 - forestry rides;
 - areas adjacent to the streams and burns; and
 - a large quarry located in the western part of the site. The quarry area is recorded on Ordnance Survey (OS) mapping as disused but appears to be currently active.

Development Proposals

- 1.6 The Proposed Development infrastructure would include:
- up to 13 wind turbines, of approximately 6 MW each, five with a maximum tip height of 180 m, two with a maximum tip height of 200 m, four with a maximum tip height of 210 m and two with a maximum tip height of 230 m;
 - hardstanding areas at the base of each turbine, with a permanent area of approximately 2,156 m²;

- site entrance and access track from the A6088 using the route of an existing forestry track, and access track linking the turbine locations. Total length of access tracks is 14,909.9 m, of which 3,897.7 m is new access track with associated new watercourse crossings and 11,012.2 m is existing access track and watercourse crossings which will need to be upgraded;
- an operations control building with parking and welfare facilities;
- two potential substation compounds;
- an energy storage facility with a capacity of c. 14.8 MW;
- telecommunications equipment;
- up to two temporary construction compounds;
- three borrow pit search areas, to provide suitable rock for access tracks, turbine bases and hardstandings; and
- underground cabling linking the turbines with the substation.

1.7 Full details of the Proposed Development design are provided in **Chapter 2: Proposed Development** of the EIA Report.

Aims

1.8 This report aims to undertake a review of relevant baseline information, including all habitat and vegetation data and hydrogeological details, in order to provide an assessment of the risk to groundwater-dependent habitats. Recommendations will be made for mitigation measures and construction methods that should be implemented to minimise the risk of disturbance or damage to sensitive habitats during construction works and ongoing development operations.

Assessment Method

1.9 This assessment has involved the following stages:

- desk-study;
- vegetation mapping;
- hydrogeological assessment;
- detailed assessment of sensitive habitats; and
- identification of protection and mitigation measures.

Study Area

1.10 The study area for this Technical Appendix includes the land within the application boundary plus a buffer zone of 250 m around the boundary. Within this area, two sub-areas are described:

- the turbine area refers to everything within the application boundary except for the access route to the site; and
- the access area refers to the land within the access corridor from the A6088 to the turbine area.

2 DESK-STUDY

Information sources

- 2.1 The desk study involved a review of available relevant information sources on the ground conditions at the Proposed Development. Information sources included:
- OS topographical mapping at 1:50,000, 1:25,000 and VectorMap Local raster;
 - British Geological Survey (BGS) geological mapping, superficial and bedrock;
 - BGS online borehole records;
 - Centre for Ecology and Hydrology Flood Estimation Handbook Web Service;
 - Data provided by the applicant, including turbine foundation and track design specifications;
 - Scottish Borders Council private water supplies records;
 - Scotland's Soils digital soil mapping, 1:250,000 scale; and
 - Scottish Environment Protection Agency's *A functional wetland typology for Scotland*.

Climate and Topography

- 2.1.1 The Proposed Development is located in the Scottish Borders south of Chesters, within the south western part of the UK Meteorological (Met) Office's Eastern Scotland climate region. Much of Eastern Scotland is protected from the rain-bearing westerly winds associated with Atlantic depressions which pass close to, or across, the UK. However, the site is situated within an upland area which will afford less protection from rain-bearing westerly winds than some of the surrounding low-lying areas found further east.
- 2.2 The Eastern Scotland climate region comprises the valleys and estuaries of the eastward-flowing Rivers Tweed, Forth, Tay and Dee and extensive upland areas including the Grampian Mountains in the northern part of the region and the Southern Uplands in the southern part. The site is located to the east of the Tweedsmuir Hills (840 m above Ordnance Datum, AOD) in the Southern Uplands, which offers some protection from rain-producing westerly winds to the Proposed Development in the east.
- 2.3 The site lies on relatively high ground, with elevations above 200 m AOD. The topography of the site is characterised by higher ground in the south east and western sections, and lower ground in the north east in the Jed Water and Black Burn valleys. Five prominent hills surround the site: Green Law (368 m AOD) in the south, Wardmoor Hill (365 m AOD) in the west, Highlee Hill (307 m AOD) in the north and Charlie's Knowe (258 m AOD) and Tamshiel Rig (280 m AOD) in the east.
- 2.4 The highest point in the site is the eastern slope of Wardmoor Hill (located in the west) standing at (365 m AOD). The lowest elevations within the site are primarily located around the Jed Water, in the north east of the site, with elevations below 200 m in the north-eastern corner.

Geology

- 2.5 Geological information is derived from BGS GeoIndex online geological mapping on a 1:50,000 scale and the British Geological Survey Lexicon of Named Rock Units (BGS, 2022; UKRI, 2022).

Bedrock Geology

- 2.5.1 The BGS GeoIndex (2022) indicates that the northern and eastern region of the site is underlain by bedrock of the Hawick Group. The bedrock consists of thin to medium bedded calcareous greywacke and interbedded silty mudstones.
- 2.5.2 The southern region of the site, including the access area, is underlain by the bedrock of the Ballagan Formation, which comprises grey mudstone and siltstones, with nodules and beds of ferroan dolomite; evaporite deposits are also present within the formation.
- 2.5.3 The north westernmost part of the site is underlain by bedrock from the Riccarton Group, with small areas from the Stratheden and Inverclyde Groups and from the Hawick Group. The Riccarton Group strata consist of greywackes with interbedded mudstones and dark grey, finely laminated siltstone beds. The Stratheden and Inverclyde Groups include undifferentiated sandstone and fine-grained (argillaceous) rocks.
- 2.6 Some minor faulting is present in the area, with two faults located in the westernmost part of the site trending in a north-east to south west direction. One minor earthquake has been recorded at 358698 603196, 3.1 km south-west of the site, with a local magnitude (R_L) of 1.1, in 2016 (BGS, 2022).

Superficial Geology

- 2.7 Superficial deposits are dominated by Devensian till, comprising diamicton deposited during the last glacial period. Diamicton is a very variable glacial sediment consisting of unsorted material ranging in size from clay to boulders, usually with a matrix of clay to sand. The till covers the majority of the site, with the exception of high elevation areas of Wardmoor Hill in the west, Weasel Hill in the north and Green Law south; these areas have no superficial deposits present.
- 2.8 The channels of the Black Burn and Carter Burn in the east and the Jed Water in the central region of the site are indicated to contain alluvial deposits. The alluvium is a sorted or semi-sorted mixture of clay, silt, sand and gravel of fluvial origin deposited in the Holocene period.

Soils and Peat

- 2.9 National soil maps of Scotland (Soil Survey of Scotland, 1981; Soil Survey of Scotland, 1982) indicate that the northern and central regions of the site are covered by noncalcareous mineral gleys with some brown forest soils of the Ettrick and Carter soil associations, while the southern region is dominated by peaty gleys with dystrophic blanket peat. Some minor areas of brown forest soils and peaty gleyed podzols are present in the west of the site, around Wardmoor Hill and Black Hill. A small area to the west of the site is overlain by peaty podzols, some peaty gleys and peat of the Ettrick association (Soil Survey of Scotland, 1981).

- 2.10 Blanket peat is not mapped within the application boundary, although some areas of blanket peat are indicated south of the application boundary.
- 2.11 The peat depth surveys undertaken in the area confirm that peat cover within the site is patchy, with the majority of the site consisting of peaty soils with a depth of less than 0.5 m. Some localised areas of peat and rare pockets of deeper peat are present in the north central and southern parts of the site, mainly away from areas of proposed infrastructure.
- 2.12 Further details regarding peat characteristics are provided in **Technical Appendix 10.1**.

Hydrogeology

- 2.13 The southern region of the Ballagan Formation is part of the Inverclyde Group aquifer system, the aquifer is classified as a moderately productive, multi-layered aquifer with fracture flow. The very north westernmost region of the site contains the Stratheden Group, which is classed as a moderately productive aquifer, consisting of sandstone, partly pebbly with subordinate siltstone and mudstone; producing moderate amounts of groundwater.
- 2.14 The Hawick and Riccarton Groups are both classified as low productivity aquifers, both are highly indurated greywackes with limited groundwater in the near-surface weathered zone.
- 2.15 The superficial deposits covering the majority of the site have a range of potential permeabilities, and their productivity depends on their local composition and connectivity. Any pockets of sand and gravel-rich material within the diamicton till and alluvium are likely to have higher permeability, whereas areas of clay and silt will have low or negligible permeability.

Hydrology

- 2.16 The site lies across two main watercourse catchments: the Jed Water catchment and the Catlee Burn catchment. Most of the site lies within the Jed Water catchment, although, the north west part of the site is drained by the Catlee Burn catchment.

Jed Water catchment

- 2.17 The Jed Water catchment has a total area of 49.5 km² (CEH, 2022) and drains 95.5% of the site.
- 2.18 The Jed Water provides the main drainage for the site, the watercourse flows north east through the site. The Rough Sike and Westshiels Burn tributaries drain the central region of the turbine area into the Jed Water at Westshiels, while the Battling Sike tributary drains the northern and central regions of the turbine area into the Jed Water. Several smaller unnamed tributaries drain into to the Jed Water as it flows north east. The Black Burn and its tributary, the Fell Burn, drain the eastern region of the site around the hill named Millmoor Rig. The Black Burn and Jed Water merge in the very north-eastern region of the turbine area, flowing out of the turbine area northwards.
- 2.19 The Jed Water catchment is an upland region characterised by moorland, commercial forestry in the south and agricultural fields in the north. The site watercourses look to be

in their natural or near-natural conditions, with generally high levels of sinuosity, defined as having lots of river meanders.

Catlee Burn Catchment

- 2.20 The Catlee Burn catchment has a total area of 18.3 km² (CEH, 2022) and drains 4.5% of the site.
- 2.21 Within the turbine area, key watercourses in the Catlee Burn catchment are the Hass Sike and Harecairn Sike which drain the very south-western section. Both watercourses drain into the Hyndlee Burn. The very north-western part of the turbine area is drained by the Wolfhopelee Burn and its tributaries. The Wolfhopelee Burn drains directly into the Catlee Burn.
- 2.22 The Catlee Burn catchment is an upland region characterised by moorland, commercial forestry and agricultural fields in the north central region. The site watercourses are apparently in a natural or near-natural conditions, with generally high levels of sinuosity, defined as having lots of river meanders.
- 2.23 All watercourses in the catchments are shown on **Figure 10.4**, Volume 2.

Catchment Statistics

The catchment wetness index (PROPWET) for the Jed Water and Catlee Burn is 0.57, indicating soils in the site are wet for 57% of the time. The catchment has a base flow index (BFI HOST19) of between 0.32 and 0.45, indicating a moderate to low input of groundwater baseflow to surface watercourses. The standard percentage runoff (SPR HOST) is 37-50%, indicating that this percentage of rainfall on site is converted into surface runoff from rainfall events; this represents a high runoff risk where soils have a limited capacity to store rainfall and/or a slow infiltration rate and will quickly saturate, leading to rapid runoff.

- 2.24 Catchment statistics derived from the Flood Estimation Handbook Web Service (CEH, 2022) are provided in **Table 10.3.1**.

Table 10.3.1 Site Catchment Statistics

Catchment Name	Catchment Wetness Index (PROPWET)	Base Flow Index (BFI HOST19)	Standard Percentage Runoff (SPR HOST)	Area %
Jed Water	0.57	0.451	37.12 %	95.5
Catlee Burn	0.57	0.322	50.03 %	4.5

Private Water Supplies

- 2.25 Data obtained from the Scottish Borders Council's Environmental Health Department identifies one spring present within the site boundary at Dykeraw. In total, 15 private water supplies within 2 km of the application boundary are identified as having a groundwater source, either springs or boreholes.

3 VEGETATION AND GROUNDWATER DEPENDENCY

- 3.1 Groundwater-dependent terrestrial ecosystems (GWDTE) are defined by the UKTAG (2004) as:

“A terrestrial ecosystem of importance at Member State level that is directly dependent on the water level in or flow of water from a groundwater body (that is, in or from the saturated zone). Such an ecosystem may also be dependent on the concentrations of substances (and potential pollutants) within that groundwater body, but there must be a direct hydraulic connection with the groundwater body.”

- 3.2 In line with the guidance provided in UKTAG (2004), a dual ecological and hydrogeological approach to identifying GWDTE has been used. This involves a detailed study of vegetation communities in order to determine the potential level of groundwater dependency, combined with a detailed hydrogeological study in order to identify locations where groundwater reaches the surface and is therefore able to provide a source of water to terrestrial ecosystems.
- 3.3 Determining groundwater dependency is complex as most water-dependent terrestrial ecosystems rely on a combination of groundwater, surface water and rainwater, and many vegetation communities will use whatever source of water is available. In some topographical and hydrogeological conditions, a particular ecosystem can be groundwater-dependent whereas in others the same ecosystem is surface water-dependent. Seasonal patterns of water availability influence water use, providing an additional level of complexity; groundwater reliance is typically greater in the summer when rainfall and surface water are less available (Isherwood, 2013).

Vegetation Mapping

- 3.4 Vegetation on site has been surveyed using a combined Phase 1 habitat and National Vegetation Classification (NVC) survey method and is reported in full in **Chapter 8 Ecology**, with mapping provided in **Technical Appendix 8.1**, Volume 3. The key findings relating to groundwater dependency are summarised below.
- 3.5 NVC communities identified by SEPA as likely to be highly or moderately groundwater-dependent, depending on the hydrogeological setting, are listed in SEPA’s publications *“Planning advice on on-shore windfarm developments”* (SEPA, 2017a) and *“Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems”* (SEPA, 2017b).
- 3.6 The UKTAG Annex 1 table (UKTAG, 2009) differentiates communities by class, where Class 1 is potential high groundwater-dependency, Class 2 is potential moderate groundwater-dependency and Class 3 is potential low groundwater-dependency.
- 3.7 National Vegetation Classification (NVC) survey mapping indicates that the majority of the site consists of active SRF plantation; mature stands are present within the site as well as areas of recent clear-fell and new crop planting. Between areas of forestry – in clearings and along roadside verges – mosaic habitats predominate. The potentially

groundwater-dependent NVC communities identified within the site and their groundwater dependency classifications can be found in **Table 10.3.2**.

Table 10.3.2: Potential Groundwater-Dependency Classifications of Identified NVC Communities within the Proposed Development.

SEPA (2017b) Groundwater Dependency Classification	NVC Community	UKTAG (2009) Groundwater Dependency Classification
Highly groundwater dependent	M6 <i>Carex echinata</i> – <i>Sphagnum recurvum</i> mire	1 (High)
	M23 <i>Juncus effusus/acutiflorus</i> – <i>Galium palustre</i> rush-pasture	2 (Moderate)
	W4 <i>Betula pubescens</i> – <i>Molinia caerulea</i> woodland	1
	W7 Residual alluvial forests (<i>Alnus glutinoso-incanae</i>)	1
Moderately groundwater dependent	M15 <i>Scirpus cespitosus</i> – <i>Erica tetralix</i> wet heath	2
	M25 <i>Molinia caerulea</i> – <i>Potentilla erecta</i> mire	3 (Low)
	M27 <i>Filipendula ulmaria</i> – <i>Angelica sylvestris</i> mire	2
	MG9 <i>Holcus lanatus</i> – <i>Deschampsia cespitosa</i> grassland	2
	MG10 <i>Holcus lanatus</i> – <i>Juncus effusus</i> rush-pasture	2
	S7 <i>Carex acutiformis</i> swamp	2
	W2 <i>Salix cinerea</i> – <i>Betula pubescens</i> – <i>Phragmites australis</i> woodland	2

4 DETAILED ASSESSMENT

- 4.1 The area assessed, which consists of land within the application boundary and a 250 m buffer zone around this, has been reviewed to identify areas of NVC habitats that require assessment.
- 4.2 Detailed consideration is required for sensitive habitats that lie within 100 m of access tracks, which typically have excavations less than 1 m in depth, or within 250 m of excavations deeper than 1 m, such as turbine foundations and borrow pits (SEPA, 2017b). The combined infrastructure buffer is provided as a green dashed line in **Map 10.3.1, Map 10.3.2, Map 10.3.3, Map 10.3.4 and Map 10.3.5**, for reference purposes. An overview map of the Proposed Development showing the areas of potentially groundwater-dependent communities is provided in **Figure 10.3.1**.

Conceptual Site Model

- 4.3 Of the NVC communities identified in Table 10.3.2, SEPA (2017b) identifies M6, W4 and W7 as “... likely to be ... highly groundwater dependent ... depending on the hydrogeological setting” and UKTAG (2009) identifies them as Class 1 (high) in Scottish settings.
- 4.4 In this sense, M6, W4 and W7 would be considered to be potentially more sensitive than other communities identified that are classified as potentially moderately dependent.

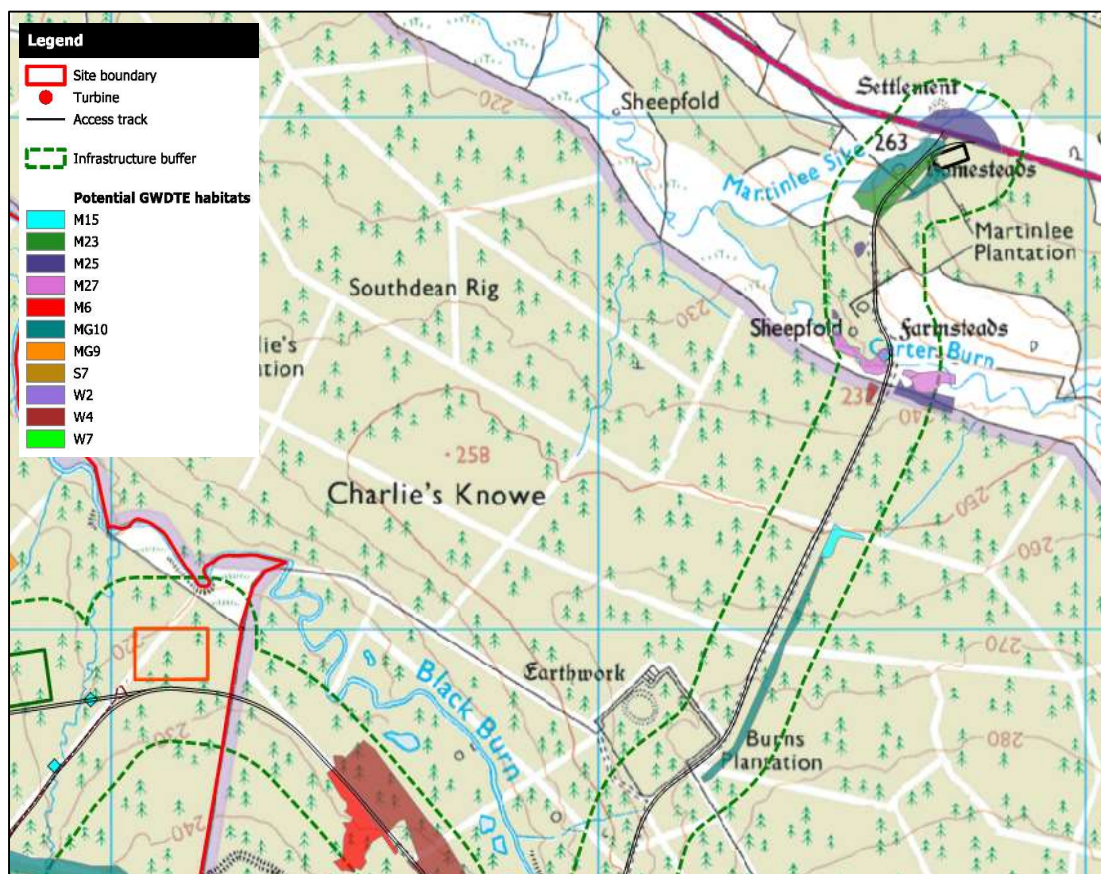
Access to Groundwater

- 4.5 Hydrogeological study of the site has identified the following key points in relation to groundwater availability at or near surface:
- bedrock present under most of the site is classed as moderate productivity, with fracture flow;
 - bedrock in the north western part of the site is classed as low productivity, with limited groundwater in the near-surface;
 - superficial deposits are likely to have variable productivity depending on local variations in composition;
 - a number of private water supplies are listed as having a spring source;
 - OS mapping does not indicate any springs within the site or within 2 km of the application boundary, although a small number are shown at greater distances; and
 - no evidence of springs or seepage lines were identified during the site visits.
- 4.6 As a result, it is likely that groundwater sources for vegetation communities are localised, infrequent and potentially seasonal.
- 4.7 Areas of peat can act to insulate surface features from groundwater. Although peat bodies do contain water, and support some water flow, this is typically very slow and peat is usually considered to be effectively impermeable. Peat coverage within the site is highly restricted, and this insulation effect would therefore be limited.

- 4.8 Diamicton till can form both an aquifer (source of water) and an aquitard (barrier to flow) as a result of its highly variable composition. Where visible within the site, the till deposits appeared mainly to be clay-rich, which would indicate that they act more to restrict groundwater movement. However, till composition is known to vary over very short distances and it is therefore impossible to rule out groundwater presence in some areas. Fractures and discontinuities within clay-rich till can also lead to spring development.
- 4.9 Habitats developed alongside watercourses may rely on water within the associated superficial deposits present in the watercourse channel. The water flow within the channel is usually the main supply source in these settings.
- 4.10 It remains possible that some groundwater-dependency may be present within the vegetation communities identified within the site.

Area 1

- 4.11 Area 1 covers the beginning of the access area into the site, from the A6088 to the watershed on Charlie's Knowe at Burns Plantation (**Map 10.3.1**).



Map 10.3.1: Area 1

Habitats Present

- 4.12 Four areas of M25 mire are present, one immediately north of the A6088, a second to the south of the Carter Burn, on the east side of the proposed access route, and two small areas west of the access route and north of the Carter Burn.

- 4.13 Three areas of MG10 rush-pasture are also present, with one either side of the access track immediately south of the A6088 and the third running parallel to the access track on the northern slope of Charlie's Knowe.
- 4.14 One area of M23 rush-pasture is present to either side of the access track, in continuity with the two areas of MG10 near the proposed site entrance.
- 4.15 Two areas of M27 are present adjacent to the Carter Burn, to either side of the access track.
- 4.16 One small area of W4 wet woodland is present within the northern margin of the woodland immediately south of the Carter Burn.
- 4.17 One area of M15 wet heath is located immediately north of the area of MG10 rush pasture on Charlie's Knowe.

Setting and Infrastructure

- 4.18 Bedrock in this area consists of sandstones, siltstones and limestones of the Ballagan Formation. Superficial deposits consist of diamicton till, and alluvium is present around the Carter Burn. The bedrock is a moderately productive, multi-layered aquifer with fracture flow.
- 4.19 Infrastructure development in Area 1 includes establishment of a mobilisation compound on the south eastern side of the access entrance and track widening. It is likely that the crossing of the Carter Burn would require some upgrading work.
- 4.20 The mobilisation compound footprint overlaps very slightly with one area of MG10 and the area of M23 near the proposed site entrance. Track widening work has potential to affect areas of MG10 and M23 near the proposed site entrance, as well as areas of M27, M25, W4 MG10 and M15 alongside the proposed access track.

Assessment and Mitigation

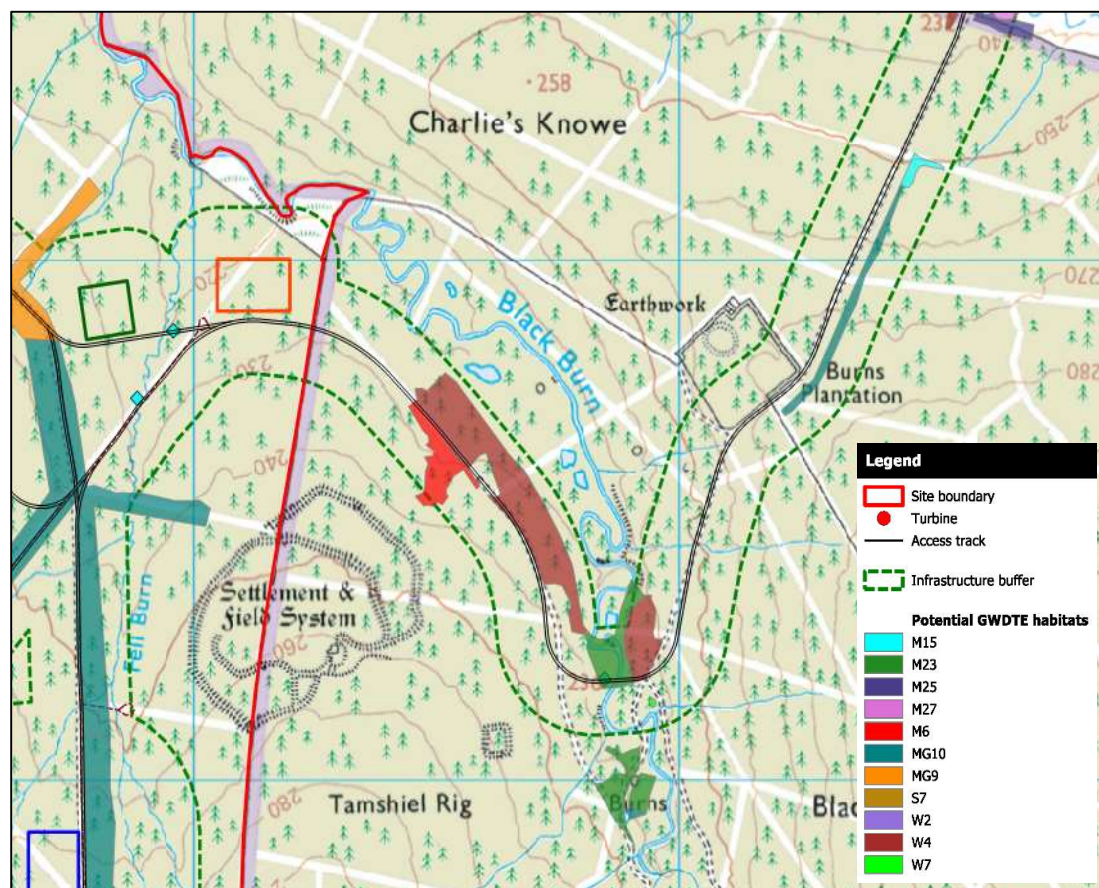
- 4.21 No indications of groundwater at surface were present in this area. It is anticipated that habitats adjacent to the Carter Burn are reliant on surface water and connected groundwater within the alluvial deposits around the main watercourse channel. Habitats adjacent to the Martinlee Sike, by the A6088, are likely to be reliant on surface water from the watercourse rather than on groundwater.
- 4.22 It is most likely that habitats with no connection to watercourses rely on rainfall and shallow through-flow rather than groundwater.
- 4.23 Micrositing of the mobilisation compound would potentially be able to prevent direct effects on the MG10 and M23 areas. This would be guided by the Environmental Clerk of Works (ECoW) during the compound establishment process.
- 4.24 Any required drainage from the mobilisation compound would be connected into the trackside drainage, to minimise potential for water and nutrient flushing into nearby sensitive habitats.
- 4.25 Track widening in the section between the A6088 and the Carter Burn would be targeted on the eastern side of the existing track in order to minimise incursion into identified habitats in this area. Habitats upslope of the existing track would have limited

susceptibility to changes in water supply as their principal source of water would be from upslope of the habitat area.

- 4.26 Any required additional trackside drainage would be minimised in terms of depth and length, and would not discharge directly into or upslope of identified sensitive habitat areas, to minimise potential for water and nutrient flushing into these areas.
- 4.27 Track widening on the northern slope of Charlie's Knowe would be targeted on the western side of the existing track, to maintain the separation between the identified sensitive habitats and the track. No direct or indirect impacts on these habitats are anticipated as they are located upslope of all proposed groundworks.

Area 2

- 4.28 Area 2 lies between Burns Plantation and the end of the Forestry and Land Scotland (FLS) property, immediately before the turbine area (marked in **Map 10.3.2** below by the application boundary defining the turbine area).



Map 10.3.2: Area 2

Habitats Present

- 4.29 Three areas of M23 rush-pasture habitat are present, one immediately north of the proposed access track and two areas to the south. All three areas lie close to the Black Burn. The southern areas lie outwith the 100 m infrastructure buffer zone and will not be considered further.

- 4.30 Two areas of W4 wet woodland are located within this area, one immediately east of the Black Burn and the area of M23 habitat, and a second, larger area to the west of the Black Burn running parallel to the proposed access track.
- 4.31 A very small area of W7 residual alluvial forest is present immediately south of the proposed access track and immediately east of the Black Burn.
- 4.32 An area of M6 mire has been identified on the western side of the proposed access track on the slopes of Tamshiel Rig.

Setting and Infrastructure

- 4.33 Bedrock in this area of the site consists of sandstones, siltstones and limestones of the Ballagan Formation. Superficial deposits consist of diamicton till, and alluvium is present around Black Burn. The bedrock is a moderately productive, multi-layered aquifer with fracture flow.
- 4.34 Infrastructure development in this area would involve widening of the existing access track, plus two sections of new track. A new crossing of the Black Burn would be required as part of the new access track sections.

Assessment and Mitigation

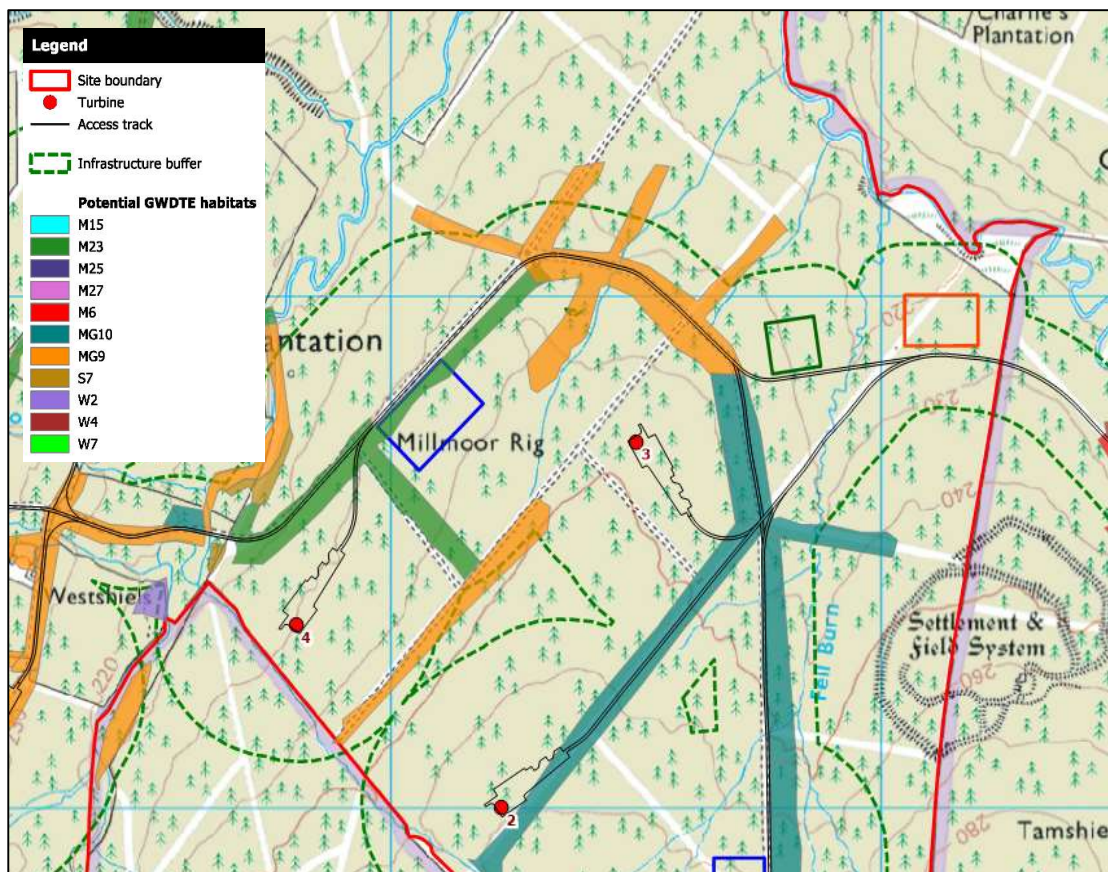
- 4.35 No indications of groundwater at surface were present in Area 2. It is anticipated that habitats adjacent to the Black Burn, particularly the M23 areas, are reliant on surface water and connected groundwater within the alluvial deposits around the main watercourse channel. It is possible that a spring or seepage line provides the water source for the area of M6 habitat in the western part of this area, although no direct evidence for this was observed.
- 4.36 The section of existing access track from Burns Plantation to near the Black Burn would have widening work targeted to the eastern side, away from the nearer areas of sensitive habitat within the Black Burn valley.
- 4.37 The new section of access track including the crossing of the Black Burn would be undertaken as sensitively as possible, to avoid incursion into the identified areas of M23 and W4 downslope of the track section. Care would also be taken not to impinge on the small area of W7 to the south of the track section.
- 4.38 The preferred Black Burn crossing option would be a single-span bridge with foundations located as far from the watercourse channel as practicable. All construction works in this area would be supervised by the ECoW to ensure that disruption to the M23 and W4 habitats is minimised.
- 4.39 The section of existing access track to the west of the Black Burn would have widening work targeted to its western side, to avoid incursion into the area of W4 habitat immediately downslope of the access track.
- 4.40 The section of new access track in the north western part of Area 2 threads a fine path between the area of M6 habitat to one side and W4 habitat to the other. To avoid unnecessary tree removal, it is likely that the track route would pass through the lower margin of the M6 habitat. As the majority of this habitat area is upslope of the proposed access track, impacts would be restricted to direct loss of habitat within the construction

corridor. Local micrositing is anticipated to be required in this area to minimise incursion into either habitat; this would be determined on the ground by the ECoW. The working corridor in this section would be kept to as narrow an area as practicable in order to restrict impacts to the sensitive habitat areas.

- 4.41 Any required modified or additional trackside drainage would be minimised in terms of depth and length, and would not discharge directly into or upslope of identified sensitive habitat areas, to minimise potential for water and nutrient flushing into these areas.
- 4.42 No construction work is anticipated upslope of the M6 habitat, and there should therefore be no effect on its water supply.

Area 3

- 4.43 Area 3 includes Substation option 1, the Construction Compound, turbines T03 and T04, and Borrow Pit 2. It begins at the boundary fence along the FLS boundary, extending west to the Jed Water and south to the track crossroads near turbine T3 (**Map 10.3.3**).



Map 10.3.3: Area 3

Habitats Present

- 4.44 Four areas of MG9 grassland are present within Area 3. Parts of this habitat lie alongside existing forestry tracks, with the remaining sections located within fire breaks or forest rides, or in open ground alongside the Jed Water channel.

- 4.45 Two areas of MG10 rush-pasture is present within this area, running alongside existing forestry tracks.
- 4.46 One area of M23 rush-pasture is present within this area. As with the MG9 grassland, the M23 rush-pasture lies either alongside existing forestry tracks or within fire breaks in the plantation.
- 4.47 Two areas of S7 swamp are located within the Jed Water valley.
- 4.48 One area of W2 wet woodland is located adjacent to the Jed Water.

Setting and Infrastructure

- 4.49 Bedrock in this area of the site consists of sandstones, siltstones and limestones of the Ballagan Formation. Superficial deposits consist of diamicton till, and alluvium is present around the Jed Water. The bedrock is a moderately productive, multi-layered aquifer with fracture flow.
- 4.50 Infrastructure development in this area would involve widening of sections of the existing forestry tracks, some short sections of new track, construction of turbines T3 and T4 plus associated hardstanding areas, construction of one potential substation and the construction compound, plus excavation of a borrow pit (BP2).
- 4.51 The existing crossing of the Jed Water is not anticipated to require any changes or upgrading.

Assessment and Mitigation

- 4.52 No indications of groundwater at surface were present in this area. It is anticipated that habitats adjacent to the Jed Water and other minor watercourses, particularly the MG9, S7 and W2 areas, are reliant on surface water and connected groundwater within the alluvial deposits around the main watercourse channel.
- 4.53 The larger areas of MG9, MG10 and M23 are all present within open areas left in the forestry plantation. It is likely that their location and extent is dictated more by the absence of forestry than by other factors.
- 4.54 Direct impacts on identified sensitive habitats are anticipated from track widening from the majority of the existing track present in this area. Where possible, track widening would be targeted to the northern side of the existing track, where the identified sensitive habitats are either not present or have a narrower footprint. This would help to maintain the wider areas of habitat as largely intact sections.
- 4.55 Minor additional direct impacts would be incurred by construction of the new track sections to turbines T03 and T04, where the new tracks leave the existing track network. In addition, the north western margin of Borrow Pit 2 includes a strip of M23 habitat.
- 4.56 Any required modified or additional trackside drainage and drainage for the Construction Compound and Substation option 1 would be minimised in terms of depth and length, and would not discharge directly into or upslope of identified sensitive habitat areas, to minimise potential for water and nutrient flushing into these areas.
- 4.57 The deeper excavations required for borrow pit BP2 and for turbines T03 and T04 would have perimeter drainage installed prior to excavations beginning. Preferred methods for perimeter drainage would be use of earth bunds rather than cut-off drains, although both

may be required in some circumstances. Cut-off drains would be minimised in terms of length and depth. Water discharge from drainage systems would be spread across the ground in order to minimise changes to flow into downstream sensitive habitats.

- 4.58 Excavations at BP2 would be kept to a practical minimum, to minimise effects on the identified habitat areas and also to minimise disruption to surface water and overland flows in this area.
- 4.59 Water collecting in excavations for the turbines and borrow pit would be removed into settlement ponds to allow for removal of suspended sediment. Treated water would not be discharged directly into or upslope of identified sensitive habitat areas, to minimise potential for water and nutrient flushing into these areas. If necessary, water would be directed into trackside drainage to avoid potential impacts on the sensitive habitat areas.
- 4.60 There may be options to improve or extend areas of M23 and MG9 habitats through scrub clearance or drainage management within Area 3 as compensation for the unavoidable direct habitat loss. This would be discussed with the ECoW as part of the construction works mitigation.

Area 4

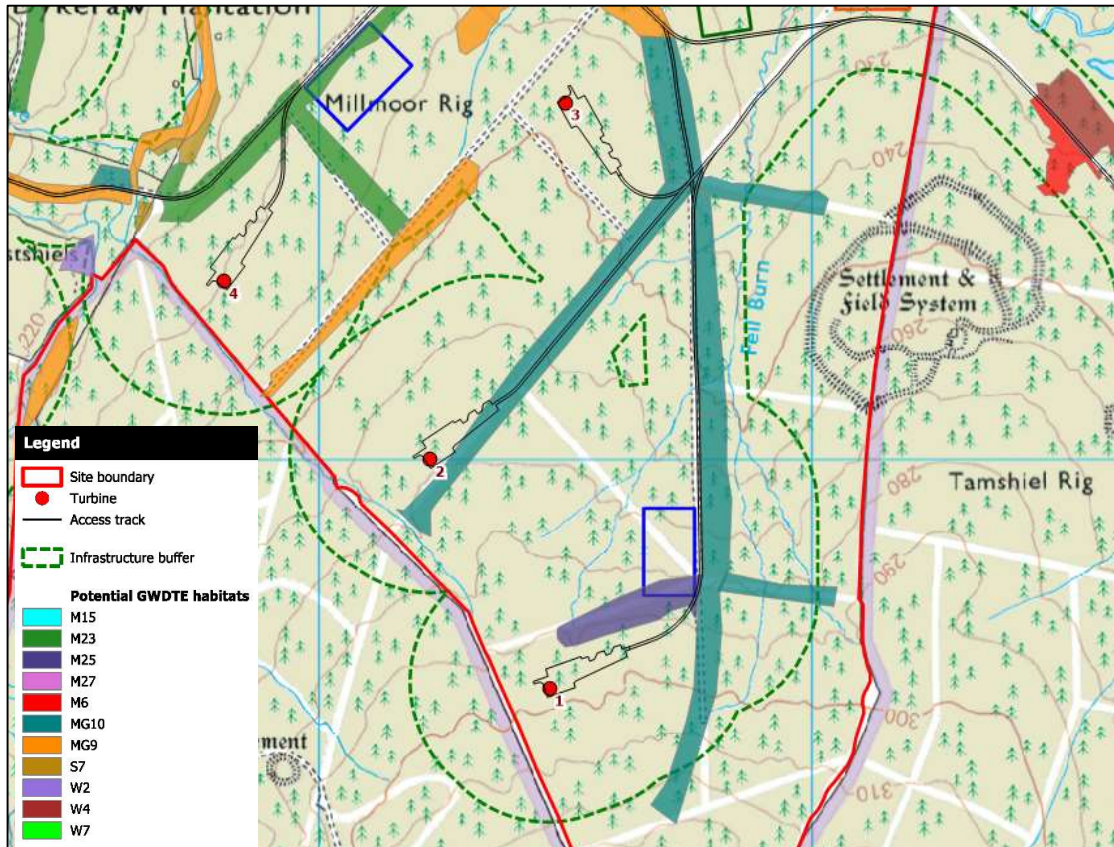
- 4.61 Area 4 includes turbines T01 and T02 and borrow pit BP3. It extends south from the track crossroads near turbine T03 (**Map 10.3.4**).

Habitats Present

- 4.62 Habitats in Area 4 include one extensive area of MG10 and a smaller area of M25. The MG10 habitat runs parallel to most of the existing tracks, with additional areas extending into open areas of fire breaks within the forestry. The area of M25 is associated with a fire break immediately north of the proposed turbine T01 hardstanding area.

Setting and Infrastructure

- 4.63 Bedrock in this area of the site consists of sandstones, siltstones and limestones of the Ballagan Formation. The bedrock is a moderately productive, multi-layered aquifer with fracture flow.
- 4.64 Area 4 is largely without superficial deposits. A small area of diamicton till coverage is present in the very northernmost part of the area.
- 4.65 Infrastructure development in this area would involve widening of sections of the existing forestry tracks, some short sections of new track, construction of turbines T01 and T02 plus associated hardstanding areas, and excavation of a borrow pit.



Map 10.3.4: Area 4

Assessment and Mitigation

- 4.66 No indications of groundwater at surface were present in this area. The areas of MG10 and M25 are present within open areas left in the forestry plantation. It is likely that their location and extent is dictated more by the absence of forestry than by other factors.
- 4.67 Direct impacts on identified sensitive habitats are anticipated from track widening from the existing track present in this area. Where possible, track widening would be targeted to the west side of the access to turbine T01 and to the south-east side of the access to turbine T02, where the identified sensitive habitats are either not present or have a narrower footprint. This would help to maintain the wider areas of habitat as largely intact sections.
- 4.68 Part of the hardstanding for turbine T02, and the southern margin of Borrow Pit 3, would also have direct impacts on identified habitat areas.
- 4.69 It may be possible to microsite excavations at Borrow Pit 3 to avoid direct impacts on the M25 habitat, depending on the total volume of material required from the excavation in this area.
- 4.70 Any required modified or additional trackside drainage would be minimised in terms of depth and length, and would not discharge directly into or upslope of identified sensitive habitat areas, to minimise potential for water and nutrient flushing into these areas.

- 4.71 The deeper excavations required for borrow pit BP3 and for turbines T01 and T02 would have perimeter drainage installed prior to excavations beginning. Preferred methods for perimeter drainage would be use of earth bunds rather than cut-off drains, although both may be required in some circumstances. Cut-off drains would be minimised in terms of length and depth. Water discharge from drainage systems would be spread across the ground in order to minimise changes to flow into downstream sensitive habitats.
- 4.72 Water collecting in excavations for the turbines and borrow pit would be removed into settlement ponds to allow for removal of suspended sediment. Treated water would not be discharged directly into or upslope of identified sensitive habitat areas, to minimise potential for water and nutrient flushing into these areas. If necessary, water would be directed into trackside drainage to avoid potential impacts on the sensitive habitat areas.
- 4.73 There may be options to improve or extend areas of M25 and MG10 habitats through scrub clearance or drainage management within Area 4 as compensation for the unavoidable direct habitat loss. This would be discussed with the ECoW as part of the construction works mitigation.

Area 5

- 4.74 Area 5 covers the western area of the site. Proposed infrastructure in this area includes turbines T05-T13, Substation Option 2 and borrow pit BP1 (**Map 10.3.5**).

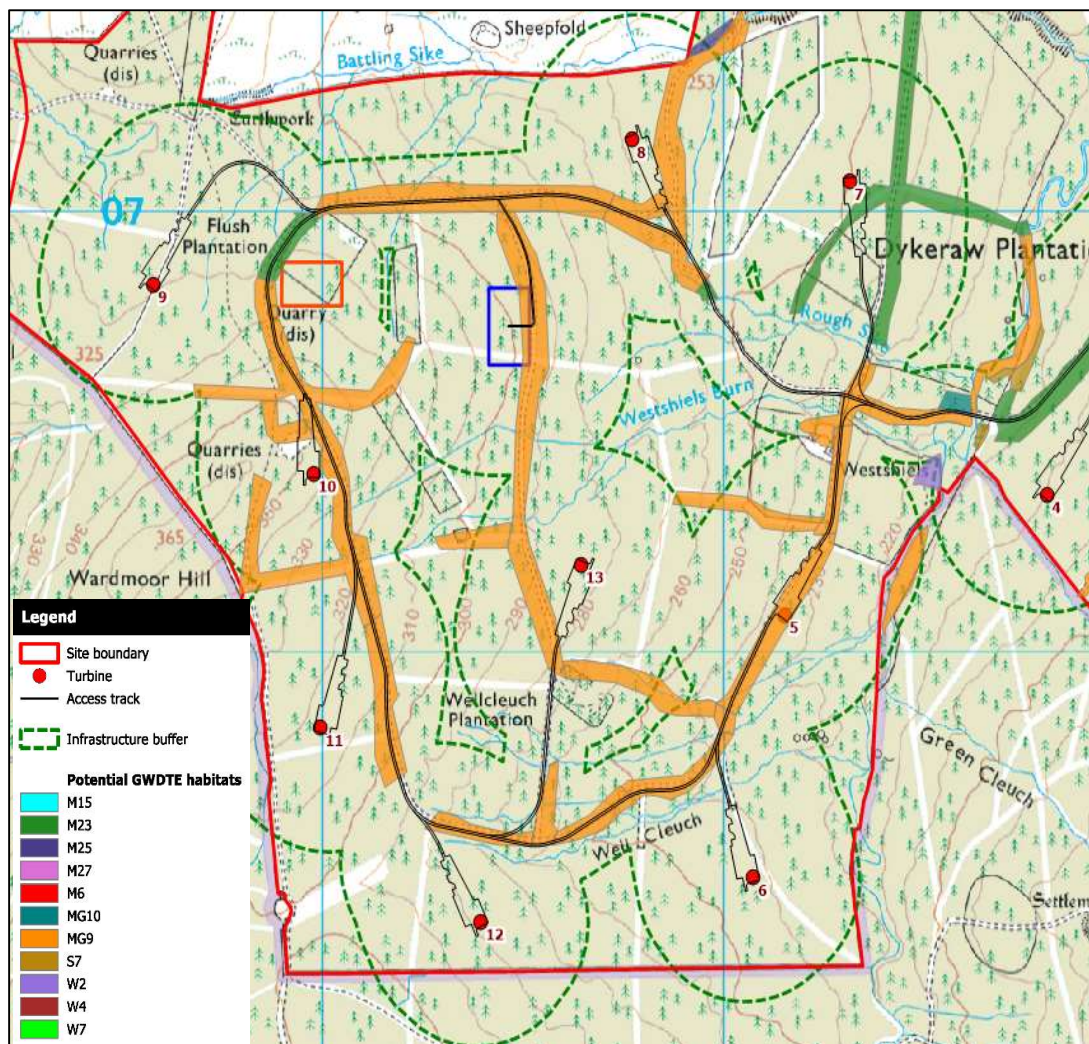
Habitats Present

- 4.75 Habitats in Area 5 include one extensive area of MG9 plus a smaller one alongside the Jed Water, three areas of M23 and one very small area of M25. The main MG9 habitat runs parallel to most of the existing tracks, with additional areas extending into open areas of fire breaks within the forestry.
- 4.76 The areas of M23 are both associated with existing tracks. The small area of M25 runs alongside a watercourse, Battling Sike, in the northern part of Area 5 to the north east of turbine T8.

Setting and Infrastructure

- 4.77 Bedrock in this area of the site is split into three main sections. The larger, south eastern part consists of sandstones, siltstones and limestones of the Ballagan Formation. The bedrock is a moderately productive, multi-layered aquifer with fracture flow. This includes turbines T05, T06, T07, T11, T12 and T13 plus associated hardstandings and access tracks.
- 4.78 The next slice to the north west, including turbines T8 and T10, Borrow Pit 1 and sections of access track, is underlain by bedrock from the Hawick Group, consisting of calcareous greywacke and silty mudstones. These strata are classed as low productivity with limited groundwater.
- 4.79 The north westernmost section, including turbine T09 and most of Substation option 2 plus some access tracks, is underlain by bedrock from the Riccarton Group, consisting of greywacke with interbedded mudstones and finely laminated siltstone beds. The Riccarton Group is also classed as low productivity with limited groundwater.

- 4.80 Much of Area 5 is underlain by diamicton till, extending from the area around turbine T09 in the north-west to turbines T08 and T07, and south to include turbines T05 and T06. Alluvium deposits are present alongside the Jed Water in the eastern part of the area. The remaining section including Substation option 2, Borrow Pit 1 and turbines T10-T13, has no mapped superficial deposits.
- 4.81 Infrastructure development in this area would involve widening of sections of the existing forestry tracks, some short sections of new track, construction of turbines T05 to T13 plus associated hardstanding areas, construction of Substation option 2 and excavation of a borrow pit (BP1).



Map 10.3.5: Area 5

Assessment and Mitigation

- 4.82 No indications of groundwater at surface were present in this area. The areas of MG9 and M23 are present within open areas left in the forestry plantation. It is likely that their location and extent is dictated more by the absence of forestry than by other factors.

- 4.83 The smaller area of MG9 near Westshiels, and east of turbine T05, and the small area of M25 habitat north east of turbine T08 are both associated with watercourses and are likely to rely on surface water. The area of MG9 is also likely to make use of connected groundwater within the alluvial deposits around the main Jed Water channel.
- 4.84 Direct impacts on identified sensitive habitats are anticipated from track widening of the existing track present in this area. Where possible, track widening would be targeted to the side of the track with least sensitive habitat, helping to maintain the wider areas as largely intact sections.
- 4.85 The majority of the hardstanding and foundation for turbine T05, plus parts of the hardstandings for turbines T07, T08 and T10 would have direct impacts on identified habitat areas. In addition, the eastern margin of borrow pit BP1 would have a direct impact on the habitat areas.
- 4.86 It may be possible to microsite excavations at borrow pit BP1 to minimise direct impacts on the MG9 habitat, depending on the total volume of material required from the excavation in this area. This would be assessed by the ECoW before excavation works begin.
- 4.87 Any required modified or additional trackside drainage would be minimised in terms of depth and length, and would not discharge directly into or upslope of identified sensitive habitat areas, to minimise potential for water and nutrient flushing into these areas.
- 4.88 The deeper excavations required for borrow pit BP1 and for all turbines in this area would have perimeter drainage installed prior to excavations beginning. Preferred methods for perimeter drainage would be use of earth bunds rather than cut-off drains, although both may be required in some circumstances. Cut-off drains would be minimised in terms of length and depth. Water discharge from drainage systems would be spread across the ground in order to minimise changes to flow into downstream sensitive habitats.
- 4.89 Water collecting in excavations for the turbines and borrow pit would be removed into settlement ponds to allow for removal of suspended sediment. Treated water would not be discharged directly into or upslope of identified sensitive habitat areas, to minimise potential for water and nutrient flushing into these areas. If necessary, water would be directed into trackside drainage to avoid potential impacts on the sensitive habitat areas.
- 4.90 There may be options to improve or extend areas of M23 and MG9 habitats through scrub clearance or drainage management within Area 5 as compensation for the unavoidable direct habitat loss. This would be discussed with the ECoW as part of the construction works mitigation.

5 PROTECTION AND MITIGATION

Design and Mitigation

- 5.1 Wetland habitats are known to be sensitive to changes in their water supply, whether this is from groundwater, surface water or rainwater. With this in mind, the following good practice construction methods would be used for all development on or adjacent to wetland or bog areas:
- Where track sections cross wetland or bog areas, cross-drainage would be provided within the track construction to ensure continuity of flow. This may take the form of a drainage layer within the track, suitably closely-spaced drainage pipes, or both as appropriate. These would be determined on a case-by-case basis to suit each individual area.
 - Removing protective layers of soil and superficial deposits makes groundwater vulnerable to pollution from leaks or spills from vehicles or equipment used during construction. Earthworks would be kept to a practical minimum within these areas, to reduce the area of wetland affected by the construction works.
 - Trackside drainage would be kept to a practical minimum and would only be installed where required to protect the track from erosion.
 - All works through and adjacent to wetland areas would be supervised by the ECoW.
 - Site-specific mitigation, including drainage segregation to avoid 'flushing' from excavation works, and micrositing to avoid specific higher sensitivity areas, would be identified and established where appropriate. For the Proposed Development, particular care would be required for works in the western half of the main access route to protect both the wetland habitat and the surface watercourses in this area.
 - Water would not be discharged directly into watercourses. Additional protection, in terms of sediment traps using silt fencing, straw bales or excavated sumps or settlement ponds, would be put in place between the water discharge location and watercourses. Sediment trap installation and monitoring would be overseen by the ECoW.

Monitoring

- 5.2 Targeted monitoring would be put in place to provide a check on the identified wetland areas and to ensure that mitigation and protection measures are in place and effective.
- 5.3 The monitoring programme would include establishment of groundwater monitoring boreholes within the three borrow pit areas to a depth of at least 1 m below the deepest expected excavation. Groundwater level monitoring would be undertaken to determine whether groundwater is present within the borrow pit areas and, if it is, at what level the seasonally highest groundwater table stands. Any groundwater within the borrow pit area would be managed in line with best practice, with discharge via a settlement pond to allow any entrained sediment to be removed prior to discharge. Any required discharge licence would be obtained prior to excavation commencing.

- 5.4 Surface water monitoring would be established within the existing watercourse network. Details are provided in **Technical Appendix 10.4 Drainage Impact & Watercourse Crossing Assessment**.
- 5.5 All areas of sensitive habitat would be visited and assessed prior to any construction work by the ECoW. Assessment would include collection of representative photographs of the areas which are most likely to be affected by the works. Regular assessment visits would be undertaken throughout the construction period and for a minimum of 12 months after reinstatement to ensure that habitat protection is effective and any restoration and recovery works become established.
- 5.6 All proposed monitoring would begin at least 6 months prior to construction work, would continue throughout the construction period and for at least 12 months following reinstatement.

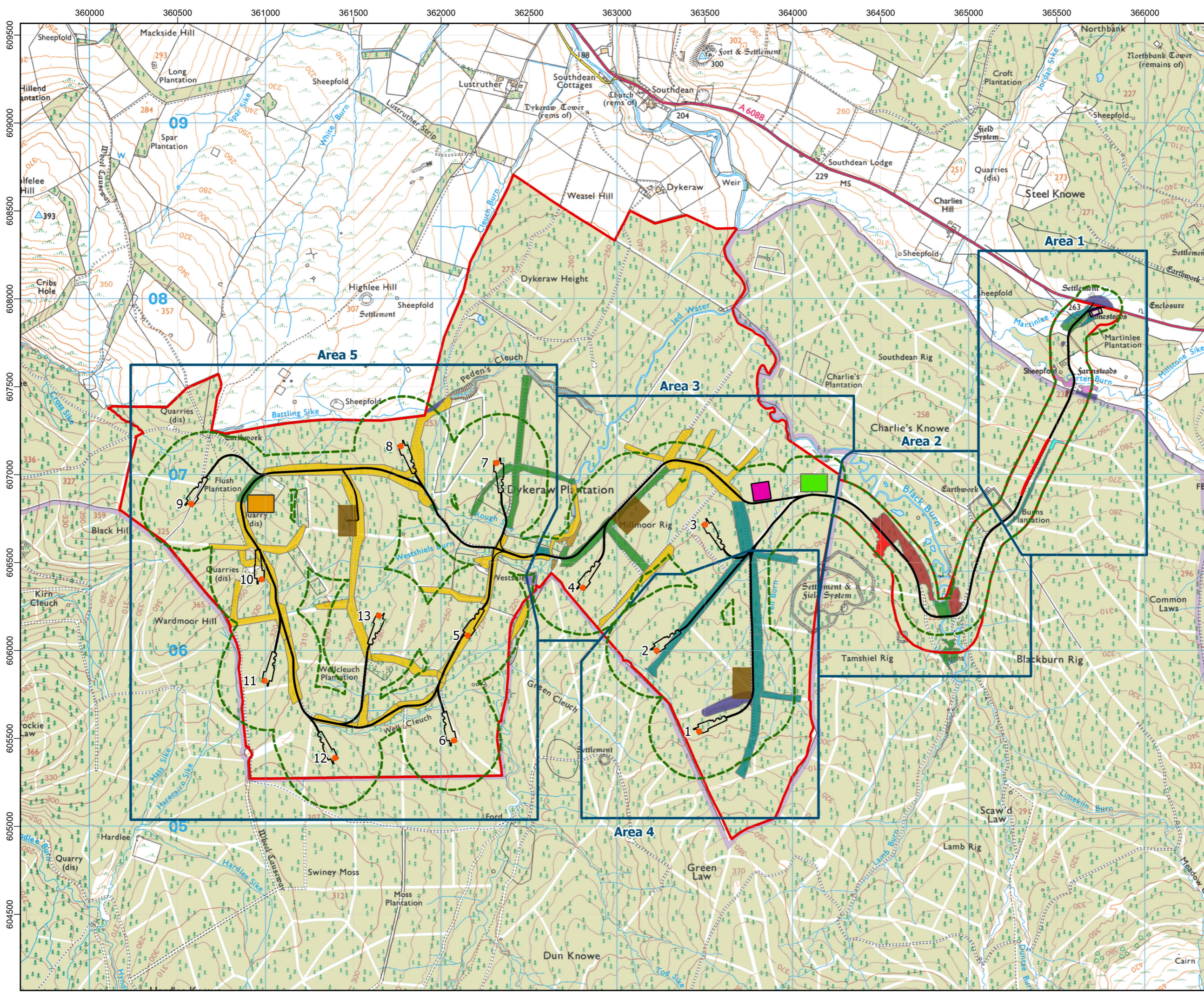
6 CONCLUSIONS

- 6.1 A detailed assessment of the interaction between the proposed works for the Proposed Development and any potentially groundwater-dependent terrestrial ecosystems has been undertaken.
- 6.2 The potentially groundwater-dependent NVC communities identified within the site are:
- M6 mire;
 - M15 wet heath;
 - M23 rush-pasture;
 - M25 mire;
 - M27 mire;
 - MG9 grassland;
 - MG10 rush-pasture;
 - S7 swamp;
 - W2 woodland;
 - W4 woodland; and
 - W7 residual alluvial forests.
- 6.3 M6 mire, W4 woodland and W7 alluvial have potentially high groundwater-dependency. M23 rush-pasture has potentially moderate to high groundwater-dependency. M15 wet heath, M27 mire, MG9 grassland, MG10 rush-pasture, S7 swamp and W2 woodland have potentially moderate groundwater-dependency. M25 mire has potentially low to moderate groundwater-dependency.
- 6.4 Owing to the distribution of habitats at the site, habitats have been assessed in smaller sub-areas within the site rather than across the site as a whole.
- 6.5 The potentially groundwater-dependent habitats have been assessed specifically within the context of the Proposed Development, taking into account the local bedrock and superficial geology, peat distribution and site observations. The superficial deposits, consisting largely of clay-rich diamicton till, are anticipated to act mainly to insulate the groundwater in the bedrock from the ground surface in areas where present, effectively preventing groundwater discharge at surface. Areas without significant superficial deposits are confined to higher ground, where springs and seepages are unlikely as a result of the topography and lack of recharge potential.
- 6.6 No evidence of springs or seepage zones was identified during site visits, although a number of local private water supplies are noted to rely on spring sources. Most of the habitats have been assessed as relying either on surface water and shallow groundwater in association with watercourses, or a location dictated more by gaps in the forestry. It remains possible that the area of Habitat M6 has a groundwater source; this habitat area is located upslope of proposed track construction and there would therefore be very limited potential impact on the habitat area.
- 6.7 Impacts to wetland habitats and watercourses would be kept to a practical minimum through use of best practice construction and mitigation measures. Specific mitigation measures, to avoid changes to the watercourse hydrochemistry through ‘flushing’ of

excavated material in surface runoff, have been set out and would be adhered to during all site works. Careful construction to ensure suitable continuity of flow across site tracks would help to minimise any potential impacts to the wetland habitats present within the site.

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Legend:

- Application Boundary
- Turbine
- Hardstands
- Mobilisation Compound
- Borrow Pit Search Areas
- Construction Compound
- Substation Compound
- Alternate Substation Option
- Temporary Turbine Layover Area
- Access Track
- Infrastructure buffer
- GWDTE Assessment Area

Potential GWDTE Habitats

- M15
- M23
- M25
- M27
- M6
- MG10
- MG9
- S7
- W2
- W4
- W7

Coordinate System: British National Grid
 Projection: Transverse Mercator
 Datum: OSGB 1936
 Units: Meter



Rev	Date	Description	Drn	Chk	App
01	16/11/2022	Revised Symbology	DL	CI	CI
00	10/11/2022	First Draft	DL	CI	CI

Millmoor Rig Wind Farm

TITLE: Figure 10.3.1
 Potentially Groundwater-Dependent
 Habitats

ID:P663320 GWDTE Assessment_Potential_GWDTE

Scale: 1:20,000 @ A3

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