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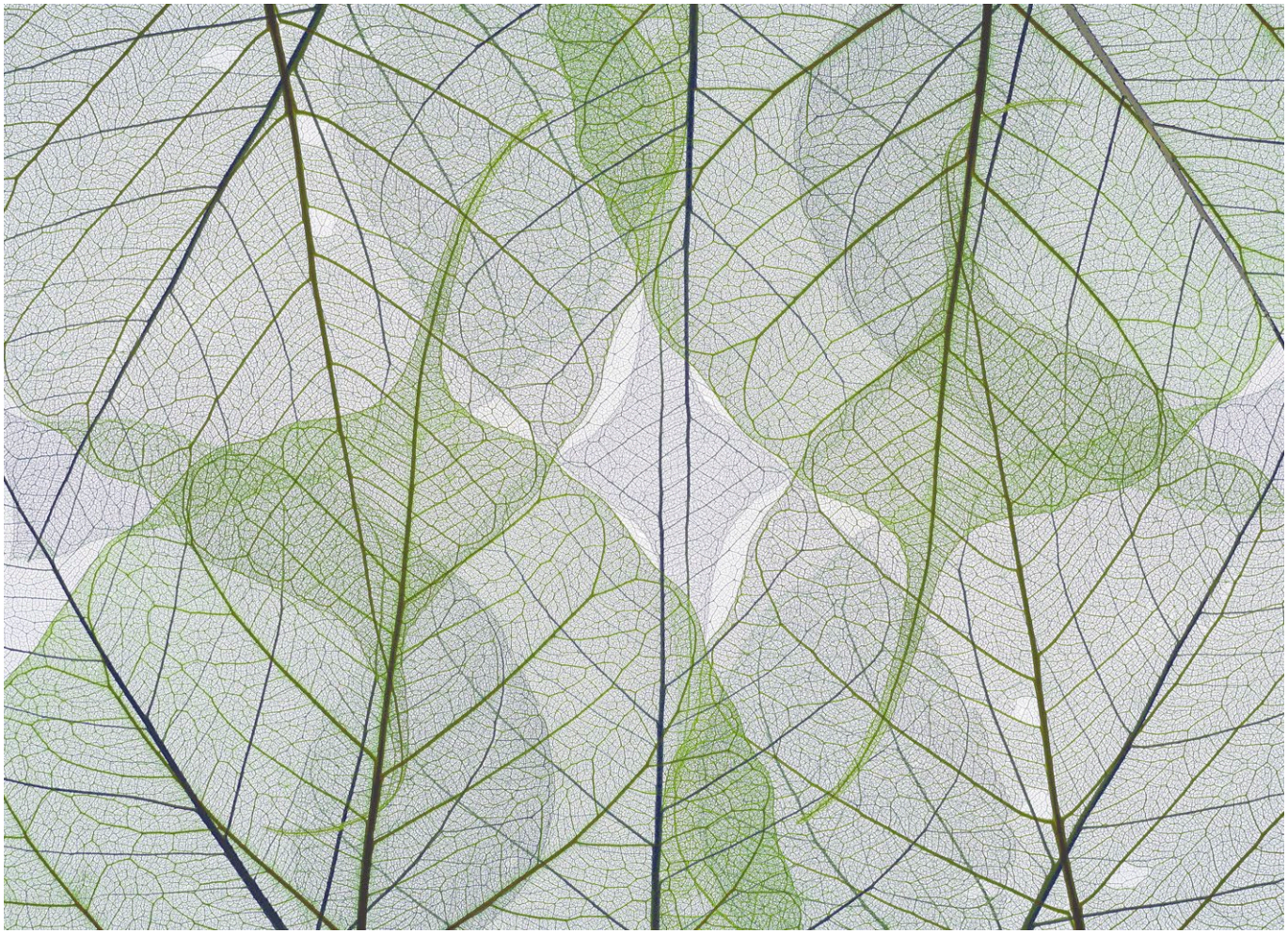
CRUACH CLENAMACRIE WIND FARM

APPENDIX 9.3 GROUNDWATER-DEPENDENT TERRESTRIAL ECOSYSTEMS ASSESSMENT



Voltalia

Cruach Clenamacrie Wind Farm: Groundwater-Dependent Terrestrial Ecosystems Assessment

Technical Appendix 9.3

2760951-P9.3 (02)

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WRc GENERAL NOTES

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1 INTRODUCTION

1.1 This report provides a Groundwater-Dependent Terrestrial Ecosystem (GWDTE) Assessment for Cruach Clenamacrie Wind Farm and associated development infrastructure (hereafter referred to as the 'Proposed Development').

1.2 This report forms a Technical Appendix to the Environmental Impact Assessment (EIA) Report for the Proposed Development and should be read in conjunction with this 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 Argyll and Bute Council (ABC) Ecology Officer.

1.3 Within this Technical Appendix the following definitions will be used: the 'Application Boundary' refers to the extent of the area relating to the application for which consent will be sought; The 'Site' refers to the area within the Application Boundary within which the Proposed Development lies; and the Study Area refers to the area for which the respective assessment or study is concerned.

1.4 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 within the Application Boundary 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

1.5 The Proposed Development is located 5km south-east of Connel and approximately 7km east of Oban within the Argyll and Bute Council area. The Site is bordered by Fearnoch Forest to the east, south and west. Access would be gained via the A85, to the north of Dailnamac. The A85 is the key transport route connecting the area with the central belt of Glasgow-Stirling-Edinburgh. The nearest settlement is Fearnoch, located approximately 800m north-west of the Site access track.

1.6 The land in the Site generally slopes northwards from higher ground in the west and south-east. The area is a characterised by craggy upland with rocky outcrops, areas of oak-birch woodland and several lochs in low-lying hollows. The terrain is hummocky with steep ground in places most noticeably the summit of Cruach Clenamacrie in the west.

Development Proposals

1.7 The Proposed Development infrastructure would include:

- New Access tracks, passing places, and turning heads;
- Site entrance from the A85;
- Access route through Fearnoch Forest;
- Turbine foundations;

- Hardstanding areas for cranes at each turbine location;
- Blade laydown areas;
- Temporary construction compound, including parking, and welfare facilities;
- Watercourse crossings;
- Drainage works;
- Power cables, linking the wind turbines, laid in trenches underground, including cable markers;
- An on-site electrical substation, parking, and a small storage compound;
-
- Borrow Pits; and

1.8 Aviation obstacle lighting fitted to turbines.Full details of the Proposed Development design are provided in **EIA Report Chapter 5**: **Project Description**.

Aims

1.9 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, including best practice measures, that should be implemented to minimise the risk of disturbance or damage to sensitive habitats during construction works and ongoing development operations.

Assessment Method

1.10 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.

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;
- Argyll and Bute Council's 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 situated within the UK Meteorological (Met) Office's Western Scotland climatic region. Much of Western Scotland is exposed to strong rain-bearing westerly winds, particularly in areas along the west coast.

2.1.2 The Western Scotland Climate District is generally milder and wetter than the east due to the stronger maritime influence (Met Office, 2016). Temperatures for the district are variable and depend factors such as topography and distance from the coast. Mean annual temperatures for the district range between 8 and 9.9°C.

2.1.3 Dunstaffnage Climate Monitoring Station is situated approximately 6.5km north-west of the Proposed Development. Rainfall patterns at the Proposed Development are likely to be similar to those observed at Dunstaffnage.

2.1.4 Average annual rainfall from 1991-2020 for the Dunstaffnage monitoring station was 1,727.89 millimetres (mm) compared to 1,818.14mm for the Western Scotland Climate District. The altitude at Dunstaffnage monitoring station is 3m above Ordnance Datum (AOD).

2.2 The Site is characterised by upland moor with irregular and undulating landforms. The highest point within the Site is the summit of Cruach Clenamacrie at 273m AOD. The wider area is characterised by similarly undulating areas of relatively high ground, notably Deadh Choimhead to the south at 383m AOD.

2.3 While most of the hill slopes within the Site are relatively gentle, steeper areas are present, notably along the south and south-east of the Application Boundary. Generally, the main Site area slopes northwards from higher ground in the west and south-east. The Site is located in the headwaters areas of the River Lonan, Allt Nathais and Lusragan Burn, meaning that there are a number of small watercourses distributed throughout the Proposed Development. Watercourses are shown on **Figure 9.6**.

Geology

2.4 Geological information is derived from the BGS GeoIndex (BGS, 2024a) online geological mapping at a 1:50,000 scale and the BGS Lexicon of Named Rock Units (BGS, 2024b). Geological mapping is shown on **Figures 9.2** and **9.3**.

Bedrock Geology

2.4.1 The Site is situated on bedrock of the Lorn Plateau Volcanic formation, mainly comprising extrusive basalts and andesites, of late Silurian to early Devonian age.

2.4.2 Some north-east to south-west trending microdiorite and appinitic diorite dykes are present within the Site, which form part of the North Britain Siluro-Devonian Calc-Alkaline Dyke Suite. Some lenses of tuff and agglomerate of the Lorn Plateau Volcanic Formation are found in the far west of the Site.

2.4.3 There is one minor displacement fault trending north-east to south-west, in the south-west of the Site.

Superficial Geology

2.5 There is very little mapped superficial geology within the Planning Application Boundary. BGS GeoIndex identifies some small areas of peat north of turbine T5 and the construction compound, as well as to the north-west of watercourse crossing WC6.

2.6 No areas of artificial ground are identified within the Application Boundary.

Soils and Peat

2.7 Soils and peat coverage is shown on **Figure 9.4**.

2.8 The Soil Survey of Scotland digital soils mapping indicates that the soil coverage within the Application Boundary is predominantly peaty gleys and peaty gleyed podzols of the Sourhope Association. Peaty gleys are described as poorly drained acidic soils which support wet heathland and rough grassland communities.

2.9 Areas of brown earth soil and a small area of humus-iron podzols with peaty gleys are present along the upper section of the access track.

2.10 Two phases of peat depth surveying have been undertaken by WRc across the Site and Site Access route. Details are provided in **Technical Appendix 9.2**.

2.11 NatureScot's Carbon and Peatland Map indicates that much of the Site is underlain by Class 2 peatland, considered to be nationally important carbon-rich soils, deep peat and priority peatland habitat. Smaller areas of Class 5 peatland, described as carbon-rich soils and deep peat, are present near the south and south-western parts of the Site and underly the majority of the Site access.

2.12 A section of Class 0 is present underlying the northern end of the Site access. Class 0 peatland is described as mineral soils where peatland habitats are not typically found.

Hydrogeology

2.13 The bedrock unit at the Site is classed as a low productivity aquifer of unnamed extrusive Silurian to Devonian rocks (BGS, 2024a). According to the BGS GeoIndex small amounts of groundwater are present in the near-surface weathered zone and flow is virtually all through fractures and discontinuities. Additionally, where springs are present, there can be a flow rate of up to 2 litres per second (BGS, 2024a).

2.14 Regional groundwater flow will tend to mimic natural topography. As the Site is located on high ground, drainage is directed to north, east, south and west from different parts of the Site, although the majority of the site drains north and north-west

2.15 The superficial deposits within the Site are limited and, where present, are predominantly peat. Peat bodies will hold some groundwater, but drainage is impeded and poor. Flow within peat is known to be extremely slow, although it can contribute some limited baseflow to local watercourses.

Hydrology

2.16 The Proposed Development is situated across three catchment areas: Lusragan Burn, River Lonan and Allt Nathais. The majority of the Site is located within the Allt Nathais catchment, while smaller sections of the Site are within the Lusragan Burn catchment in the north-west and the River Lonan catchment in the south-west. Catchment areas and key watercourses are shown on **Figure 9.6**.

Allt Nathais Catchment

2.17 The Allt Nathais catchment has a total area of 18.5km^2 and drains 64.63% of the land within the Application Boundary.

2.18 The Allt Nathais is the smallest of the three catchments but drains the largest area within the Application Boundary, including turbines T3, T4, T5 and T6, the construction compound area, substation and Site access. This catchment contains three of the eight watercourses located within the Application Boundary. These watercourses all combine to form the Eas nan Meirleach, a tributary to the Allt Nathais. The Allt Nathais flows directly into Loch Etive approximately 1.2km north of the Application Boundary.

2.19 An additional unnamed watercourse, which runs parallel to the south-eastern margin of the Application Boundary, forms a tributary to the Allt na Seabhaig. The Allt na Seabhaig is also a tributary to the Allt Nathais

River Lonan Catchment

2.20 The River Lonan Catchment has a total area of 20.7km^2 and drains 19.23% of the land within the Application Boundary.

2.21 The River Lonan catchment drains the south and south-west of the Site. Three of the watercourses near the western end of the site named Allt Fròg ach, Allt Oishnean and an unnamed tributary drain this area and flow south-west towards to the River Lonan.

2.22 The River Lonan then flows west into Loch Nell approximately 2.9km south-west of the Application Boundary.

Lusragan Burn Catchment

2.23 The Lusragan Burn Catchment has a total area of 21.8km^2 and drains 16.14% of the land within the Application Boundary.

2.24 The Lusragan Burn catchment drains the north-west of the Site. The remaining unnamed watercourse is a tributary, located just north of Cruach Clenamacrie, which flows northwards into the Allt an t-Sean-achaidh and onwards into the Black Lochs. The outflow from the Black Lochs via the Lusragan Burn eventually reaches the sea at Connel, just upstream of the Falls of Lora, approximately 4.5km north-west of the Application Boundary

Catchment Statistics

2.25 Catchment data have been derived from the Flood Estimation Handbook Web Service (CEH, 2024) and can be seen in **Table 9.3.1**.

2.26 The catchments wetness index (PROPWET) for all catchments is 0.79, indicating that soils in the Site are wet for 79% of the time. The area has a base flow index (BFI HOST 19) of between 0.31 and 0.39, indicating a low input of groundwater baseflow to surface watercourses. The standard percentage runoff (SPR HOST) is 50-53%, indicating that this percentage of rainfall onsite is converted into surface runoff from rainfall events; this represents a high runoff risk where soils have limited capacity to store rainfall and/or slow infiltration rate and will quickly saturate, leading to rapid runoff.

Table 9.3.1: Catchment Statistics

Catchment Name	Catchment Wetness Index (PROPWET)	Base Flow Index (BFI HOST19)	Standard Percentage Runoff (SPR HOST)	Area %
Lusragan Burn	0.79	0.31	52.13	16.14
River Lonan	0.79	0.39	53.82	19.23
Allt Nathais	0.79	0.39	50.14	64.63

Private Water Supplies

2.27 Data obtained from ABC regarding private water supplies (PWS) indicates that there are no PWS within the Application Boundary; however, 19 PWS were identified within 2km of the Application Boundary, one of which had potential linkage to Proposed Development. PWS are shown on **Figure 9.7**.

3 VEGETATION AND GROUNDWATER DEPENDENCY

3.1 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 concentration 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 10 - Ecology**, with mapping provided in **Figure 10.1.3**. 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 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 NVC survey mapping indicates that the site largely consists of mire and blanket mire, with smaller areas of rush-pasture, wet woodland and wet heath. There are a handful of bog pools and a small area of swamp. The potentially groundwater-dependent NVC communities identified within the site and their groundwater-dependency classifications can be found in **Table 9.3.1**.

Table 9.3.1: Potential Groundwater-Dependency Classification of Identified NVC Communities within the Proposed Development.

SEPA (2017a) Groundwater Dependency Classification	NVC Community	UKTAG (2009) Groundwater Dependency Classification
Highly groundwater dependent	M9 *Carex rostrata – Calliergon cuspidatum/ giganteum* **mire**	1 (High)
	M10 *Carex dioica – Pinguicula vulgaris* **mire**	1
	M11 *Carex demissa - Saxifraga aizoides* **mire**	1
	M29 *Hypericum elodes - Potamogeton polygonifolius* **soakway**	1
	W4 *Betula pubescens - Molinia caerulea* **woodland**	1
	M23 *Juncus effusus – Galium palustre* **rush-pasture**	2 (Moderate)
(not classified)	M4 *Carex rostrata – Sphagnum recurvum* **mire**	2
Moderately groundwater dependent	M15 *Scirpus cespitosus - Erica tetralix* **wet heath**	2
	M25 *Molinia caerulea - Potentilla erecta* **mire**	3 (Low)

4 DETAILED ASSESSMENT

4.1 The area assessed, which consists of land within the Application Boundary and a 250m 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 100m of access tracks, which typically have excavations less than 1m in depth, or within 250m of excavations deeper than 1m, such as turbine foundations and borrow pits (SEPA, 2017b). The combined infrastructure buffer is provided as a green dashed line in the figures provided, for reference purposes. An overview map of the Proposed Development showing the areas of potentially groundwater-dependent communities is provided in **Figure 9.3.5**.

Conceptual Site Model

4.3 Of the NVC communities identified in **Table 9.3.1**:

- SEPA (2017) identifies M9, M10, M11, M29 and W4 as '... likely to be ... highly groundwater dependent ... depending on the hydrogeological setting' and UKTAG (2009) identifies them as Class 1 (high) in Scottish settings.
- SEPA (2017) identifies M23 as '... likely to be ... highly groundwater dependent ... depending on the hydrogeological setting' and UKTAG (2009) identifies it as Class 2 (moderate) in Scottish settings.
- SEPA (2017) identifies M15 as '... likely to be ... moderately groundwater dependent ... depending on the hydrogeological setting' and UKTAG (2009) identifies it as Class 2 (moderate) in Scottish settings.
- SEPA (2017) does not classify M4, and UKTAG (2009) identifies it as Class 2 (moderate) in Scottish Settings.
- SEPA (2017) identifies M25 as '... likely to be ... moderately groundwater dependent ... depending on the hydrogeological setting' and UKTAG (2009) identifies it as Class 3 (low) in Scottish settings.

4.4 In this sense, communities M9, M10, M11, M29 and W4 are considered to be more sensitive than the other communities, and M25 is the least sensitive potentially groundwater dependent habitat on the site.

Habitats on Peat

4.5 A significant proportion of the habitats identified as potentially highly groundwater-dependent are on areas of confirmed peat over 0.5m in depth, notably NVC community M23 and parts of communities W4 and M25. Water flow through peat does occur but is very slow, except in areas with peat pipes or conduits to allow focused flow, and peat bodies are typically considered to be impermeable. Water held within peat is not usually considered to form part of the groundwater body.

4.6 Blanket bog and degraded blanket bog, such as is present within the Site, is generally considered to be ombrotrophic and receives all its nutrients from rainwater (JNCC, 2024). Localised flushing can occur adjacent to watercourses but is rarely extensive away from

the watercourse channel. It is recognised that peat present within the Site has a wide range of depths; however, it remains likely that the dominant water source in the Site, regardless of peat depth, is rainwater with shallow through-flow within the uppermost vegetated layer.

4.7 The Phase 1 and Phase 2 peat surveys noted that the base was predominantly hard, indicating little to no mineral soils between the peat and bedrock. This means that peat is likely to be present from the soil surface to bedrock, providing an impermeable barrier and effectively preventing any existing groundwater from reaching the ground surface.

4.8 Bedrock in the Site is classed as a low productivity aquifer; it is therefore unlikely that the small amount of potential groundwater present within the bedrock is accessible to surface habitats.

4.9 No springs or seepage features were identified within the study area or immediate surroundings.

Habitats not on Peat

4.10 Some of the identified habitats are within areas with no identified peat, particularly to the northern boundary and north-west regions of the Site. The majority of these habitats are potentially moderate to low groundwater-dependency (M25 mosaic habitats), with patches of potentially highly groundwater-dependent communities (W4) or moderately to highly groundwater dependent communities (M23) close to the north-east of the Site. The nature of the underlying substrate requires assessment to determine their sensitivity.

4.11 These areas are on soils identified as peaty gleys with dystrophic blanket peat and peaty gleyed podzols. Peaty soils can act as an impermeable layer to groundwater sources. The Phase 1 and Phase 2 peat surveys noted that the base was predominantly hard, indicating little mineral soil and impermeable peat between bedrock and soil surface. The site is also higher than most of the surrounding area, meaning that any groundwater within the bedrock would be at greater depth below ground and largely unavailable to surface habitats.

4.12 Combining these factors with the low-productivity aquifer with very low groundwater storage capacity, it is most likely that these habitats are not groundwater-dependent in this location.

Potential Impacts

4.13 Potential impacts to identified potential GWDTE include direct and indirect impacts.

4.14 Direct impacts would arise as a result of habitat loss through construction activity and the associated requirement to excavate vegetation and soil material within the identified sensitive habitat area.

4.15 Indirect impacts would arise as a result of changes in water supply to the sensitive habitat or of changes in the nutrient supply as a result of ‘flushing’. Most sensitive habitats are nutrient-poor and require continued supply of nutrient-poor water to retain their structure and vegetation community. Excavation works can provide a sudden influx of nutrient material arising from the soil disturbance, which can overwhelm such nutrient-poor communities causing temporary or permanent changes to the habitat as a result. Nutrient flushing is usually associated with changes to water supply pathways, and specifically

with introduction of drainage from areas of active excavation that discharge into or upslope of such sensitive habitat areas.

Conclusions Relating to Groundwater Dependency

4.16 It is concluded that those habitats within the study area that are found on peat are unlikely to be groundwater-dependent as there is no groundwater source available to them.

4.17 It is also concluded that the habitats within the study area cannot be truly described as groundwater-dependent because there is no reliable source of shallow groundwater on which they can depend. These habitats are instead likely to rely on a combination of rainfall and surface runoff, with some direct surface water in areas adjacent to watercourses. In many cases, habitats tend to follow the watercourses and waterbodies within the Site, indicating a reliance on surface water.

4.18 Nevertheless, habitats which have a potentially high groundwater-dependency are considered to be sensitive, and a level of protection is required to minimise and, if necessary, mitigate any impacts that may occur. The areas of habitats identified above are within the combined infrastructure buffer and are discussed individually in the following sections.

Potential GWDTE Area 1

4.19 Area 1 covers a section in the north-east of the Proposed Development where the access track meets the main Site **(Figure 9.3.1)**.

Habitats present

4.20 Area 1 includes two relatively large areas of W4 wet woodland habitats. One of these is located at the site entrance and extends down the Site's northern boundary. The other is an area of W4/U20 just to the south of this. The area of W4 along is situated along an unnamed tributary of Eas nam Meirleach.

4.21 There are several areas of M23 rush-pasture and M23-dominated mosaic habitats within this area. The access track and construction compound are both situated on a narrow area of M23, and the track passes through a small patch of M23 within the larger W4/U20 habitat.

4.22 The majority of the construction compound and substation hardstanding lies upon an area of M25/19 mire. Also within the 100m track buffer in Area 1 is a section of M15, located to the south-east of the track. As the track continues onwards towards the Site it passes through a section of M23/M25/M29 rush-pasture.

4.23 A borrow pit is located within Area 1. The borrow pit itself is situated outwith the habitat assessment area, in an area of clear-felled and replanted conifer forestry. The 250m buffer zone extends through both W4 habitats, as well as covering small areas of M23/M29 and M25.

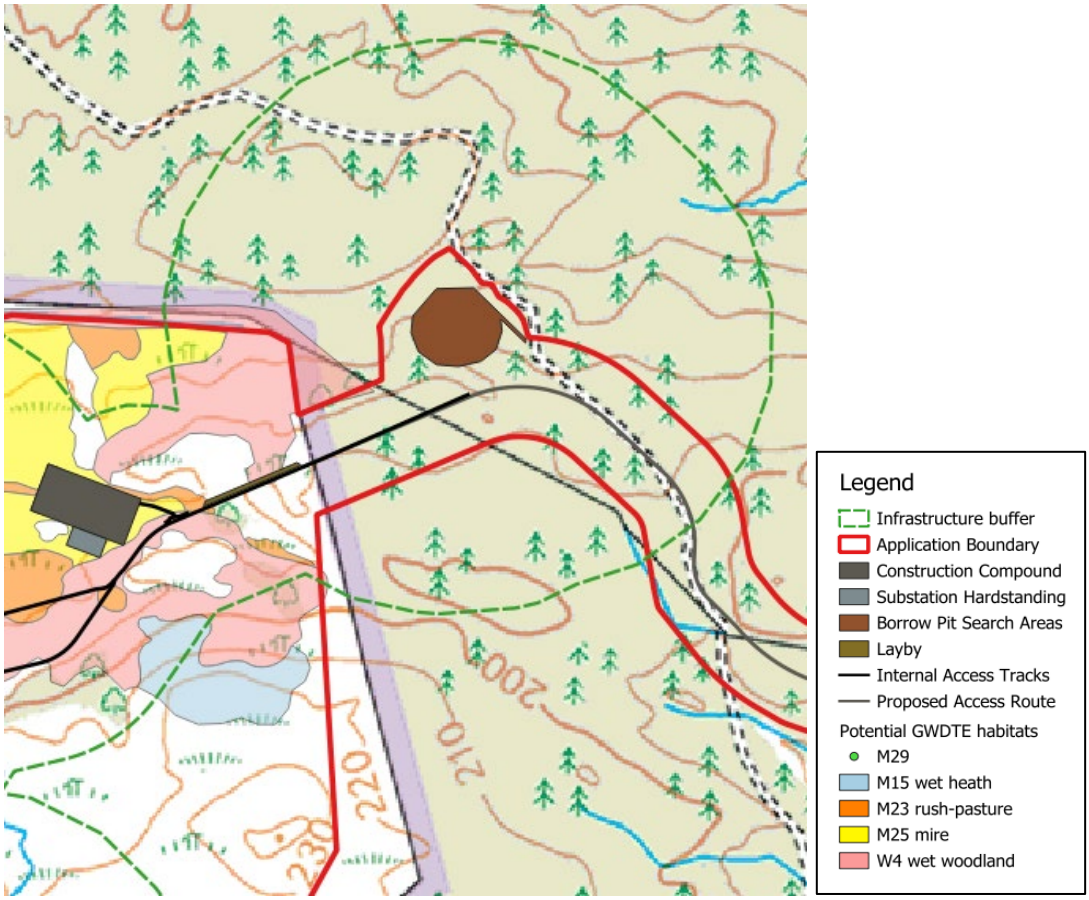

Figure 9.3.1: Potential GWDTE habitats in Area 1.

Setting and Infrastructure

4.24 Bedrock in this area from the Lorn Plateau Volcanic Formation. Superficial deposits are largely absent. Some pockets of relatively deep peat were recorded within Area 1.

4.25 The bedrock is a low productivity aquifer with flow virtually all through fractures and other discontinuities, small amounts of groundwater are present in near-surface weathered zones and secondary fractures.

4.26 Infrastructure in Area 1 includes the access track, construction compound and control building, BESS, substation and a borrow pit.

4.27 The south-west section of Area 1 is drained by two small unnamed tributaries of the Eas nam Meirleach.

Assessment and Mitigation

4.28 No indications of groundwater at surface were identified in Area 1.

4.29 The presence of blanket bog and areas of peat indicate that access to groundwater would be limited for most habitats in Area 1. Habitats on blanket peat rely on rainfall and shallow through-flow within the vegetated layer, as they are isolated from groundwater by the peat.

4.30 The areas of W4 woodland and M23 rush-pasture near the site entrance are in close association with a minor watercourse and most likely derive their main water supply from surface water.

4.31 The southern area of W4/U20 and M23 are also situated near a minor watercourse, and the other surrounding habitats are within a shallow valley. This indicates that these habitats rely on surface water run-off.

4.32 Direct impacts on the identified sensitive habitats primarily includes habitat loss from construction of tracks and the construction compound.

4.33 Where new track is required to cross areas of sensitive habitat, micrositing will be employed to minimise the area of habitat loss. Cross-drains would be employed to ensure continuity of flow within the habitat area. Any required modified or additional trackside and construction compound drainage would be minimised in terms of depth and length and would not discharge directly into or upslope of identified habitat areas, to minimise potential for water and nutrient flushing in these areas.

4.34 Deeper excavations required for the borrow pit would have perimeter drainage installed prior to the start of excavations. The preferred method would be to use earth bunds, rather than installation of cut-off drains, although in some circumstances cut-off drains are likely to be required. Any cut-off drains would be minimised in terms of length and depth, to minimise concentration of flows and unnecessary diversion of water. Water discharge from drainage systems would be spread across the ground in order to minimise changes to flow into downstream sensitive habitats and would not be discharged directly into sensitive habitat areas.

4.35 Water collecting in borrow pit excavations would be directed into settlement ponds to allow for removal of sediment. Treated water would not be discharged 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 sensitive habitat areas.

4.36 There may be options to improve or extend areas of habitats through vegetation management and/or drainage management within Area 1 as compensation for the unavoidable direct habitat loss. This would be discussed with the Ecological Clerk of Works (ECoW) as part of the construction works mitigation.

Potential GWDTE Area 2

4.37 Area 2 covers the eastern part of the Proposed Development (**Figure 9.3.2**).

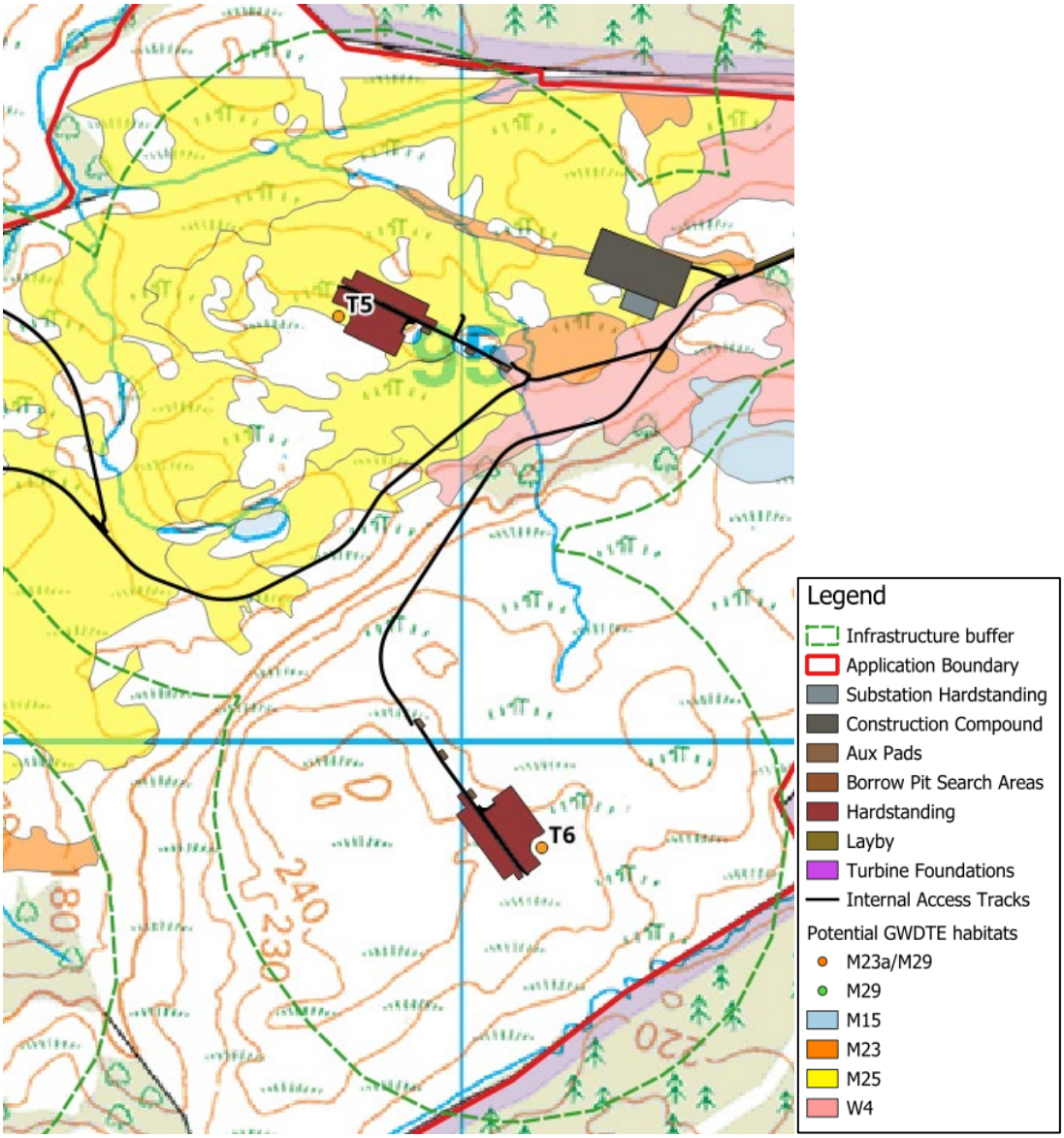

Figure 9.3.2: Potential GWDTE habitats in Area 2

Habitats present

4.38 Turbine T5 and associated infrastructure, and parts of the central spine access track, are situated upon an area of M25 mire.

4.39 The majority of sensitive habitat within the buffer zone for Turbine T5 is M25/M19 mire. A narrow band of M23 is found to the north-east of the turbine, in addition to areas of M15, M23 and W4 habitats in the central and eastern part of Area 2 around the access tracks to turbines T5 and T6.

Setting and infrastructure

4.40 Bedrock in this area is from the Lorn Plateau Volcanic Formation. Superficial deposits are largely absent. Some pockets of deep peat were recorded within Area 2.

4.41 The bedrock is a low productivity aquifer with flow virtually all through fractures and other discontinuities, small amounts of groundwater are present in near-surface weathered zones and secondary fractures.

4.42 Infrastructure in Area 2 includes Turbines T5 and T6, their hardstandings and sections of new track. The construction compound and substation area indicated in **Figure 9.3.1** are included in Area 1.

4.43 Area 2 is largely drained by two small unnamed tributaries to the Eas nam Meirleach, although the southernmost part of the area is drained by an unnamed tributary to the Allt na Seabhaig.

Mitigation Assessment

4.44 No indications of groundwater at surface were identified in Area 2.

4.45 The presence of peat indicates that access to groundwater would be limited for most habitats in Area 2. Habitats on blanket peat rely on rainfall and shallow through-flow within the vegetated layer, as they are isolated from groundwater by the peat.

4.46 The locations of habitats W4/U20, M23 and M25 are largely associated with surface watercourses, surface waterbodies or drainage channels. This is particularly evident for the M23 associated habitats, with their elongated and sinuous form.

4.47 The presence of mosaic habitats in Area 2, namely M25/19 and W4/U20, of which some elements are not groundwater-dependent, is further evidence of the low likelihood of habitats in this area being groundwater-dependent. It is likely that habitats with no connection to watercourses rely on rainfall, surface runoff and shallow through-flow rather than groundwater.

4.48 Direct impacts on the identified sensitive habitats primarily includes loss from construction of the access track and construction of the turbine and crane pad for Turbine T5.

4.49 Where new track is required to cross areas of sensitive habitat, micrositing will be employed to minimise the area of habitat loss. Cross-drains would be employed to ensure continuity of flow within the habitat area. Any required modified or additional trackside and turbine hardstanding drainage would be minimised in terms of depth and length and would not discharge directly into or upslope of identified habitat areas, to minimise potential for water and nutrient flushing in these areas.

4.50 Water collecting in the turbine and crane pad excavations would be directed into a settlement pond to allow for removal of sediment. Treated water would not be discharged 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 sensitive habitat areas.

4.51 Deeper excavations required for the turbine would have perimeter drainage installed prior to start of excavations. The preferred method would be to use earth bunds, rather than installation of cut-off drains, although in some circumstances cut-off drains are likely to be required. Any cut-off drains would be minimised in terms of length and depth, to minimise concentration of flows and unnecessary diversion of water. Water discharge from drainage systems would be spread across the ground in order to minimise changes to flow into downstream sensitive habitats and would not be discharged directly into sensitive habitat areas.

Potential GWDTE Area 3

4.52 Area 3 incorporates the central part of the Proposed Development (**Figure 9.3.3**).

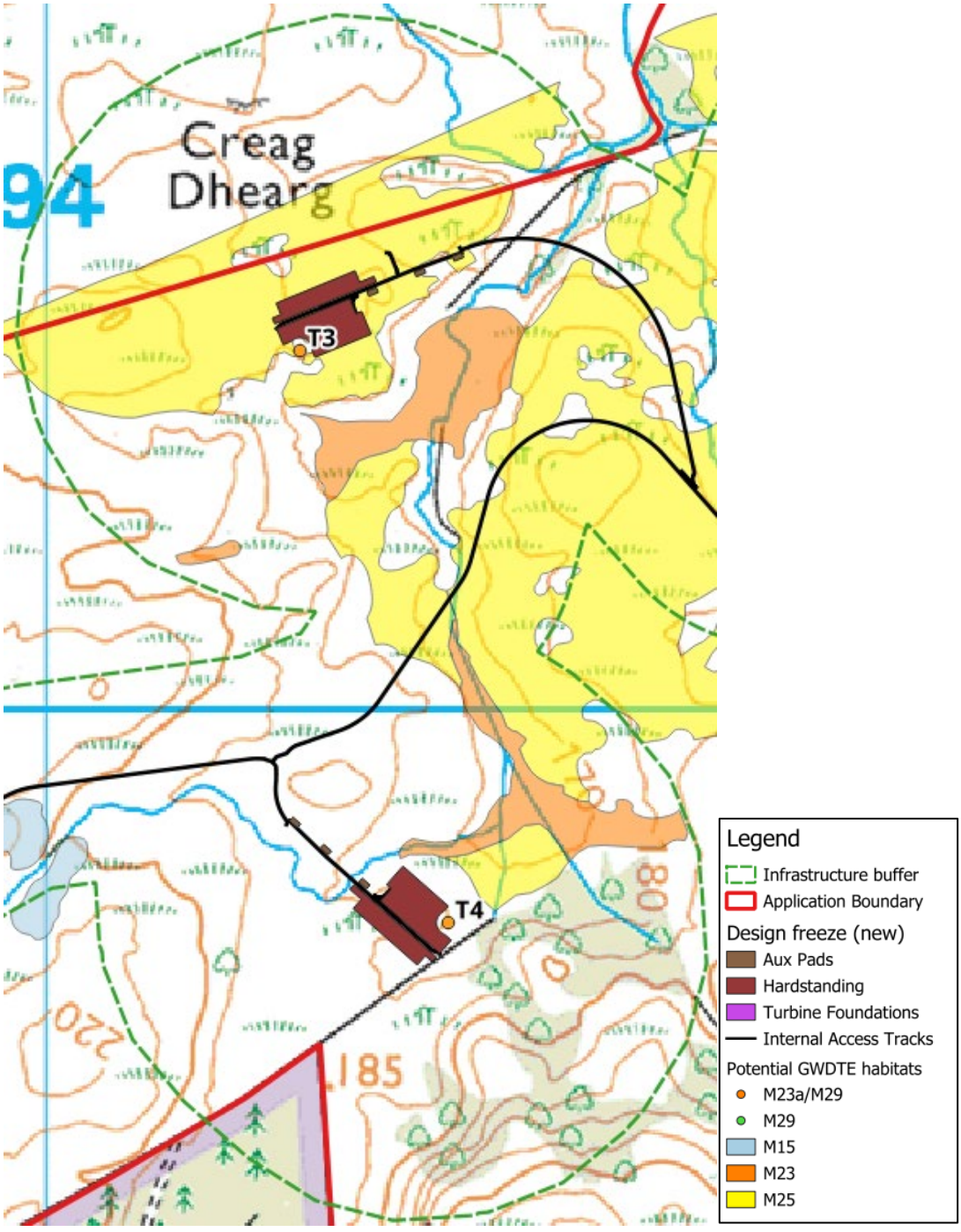

Figure 9.3.3: Potential GWDTE habitats in Area 3

Habitats Present

4.53 There two large M23-dominated mosaic habitats and two smaller areas of M23 rush-pasture are within this area of the Site. One section of M23/M25 is situated to the south and east of turbine T3, and a moderate sized area of M23/M29 is located within the buffer

zone for turbine T4, which extends northwards towards the access track. Both areas are located along a small unnamed watercourse which is a tributary of Eas nam Meirleach. To the south-west of Turbine T3 is a further small section of M23, in which is a section of M29 soakaway.

4.54 Turbine T3 and associated infrastructure is situated on a broad area of M25/M19 mire habitat. The access tracks to both turbines T3 and T4 also pass through a large area of M25/M19 mosaic habitat, in addition to passing through a smaller area of M25/M23 mire.

4.55 A section of M25 mire is situated north-east of Turbine T4.

Setting and infrastructure

4.56 Bedrock in this area is from the Lorn Plateau Volcanic Formation. Superficial deposits are largely absent. Some pockets of deep peat were recorded within Area 3.

4.57 The bedrock is a low productivity aquifer with flow virtually all through fractures and other discontinuities, small amounts of groundwater are present in near-surface weathered zones and secondary fractures.

4.58 Infrastructure in Area 2 includes turbines T4 and T3 and sections of access track.

4.59 Area 2 is drained by two tributaries of the Eas nam Meirleach, which is a tributary to the Allt Nathais.

Assessment and mitigation

4.60 No indications of groundwater at surface were identified in Area 3.

4.61 The presence of peat across much of this area indicates that access to groundwater would be limited for most habitats in Area 3. Habitats on blanket peat rely on rainfall and shallow through-flow within the vegetated layer, as they are isolated from groundwater by the peat.

4.62 The locations of habitats M23/M25 and M23/M29 are largely associated with surface watercourses or drainage channels, as indicated by their proximity to the minor watercourses. They are located within the watercourse valley and their elongated and sinuous form reflects the watercourse morphology.

4.63 The presence of mosaic habitats in Area 3, namely M25/19, of which some elements are not groundwater-dependent, is further evidence of the low likelihood of habitats in this area being groundwater-dependent. It is likely that habitats with no connection to watercourses rely on rainfall, surface runoff and shallow through-flow rather than groundwater.

4.64 Direct impacts on the identified sensitive habitats primarily includes loss from construction of the access track and construction of the turbines and crane pads for turbines T3 and T4.

4.65 Where new track is required to cross areas of sensitive habitat, micrositing will be employed to minimise the area of habitat loss. Cross-drains would be employed to ensure continuity of flow within the habitat area. Any required modified or additional trackside and turbine hardstanding drainage would be minimised in terms of depth and length and would not discharge directly into or upslope of identified habitat areas, to minimise potential for water and nutrient flushing in these areas.

4.66 Water collecting in excavations for the turbines would be directed into settlement ponds to allow for removal of sediment. Treated water would not be discharged 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 sensitive habitat areas.

4.67 Deeper excavations required for the turbines would have perimeter drainage installed prior to start of excavations. The preferred method would be to use earth bunds, rather than installation of cut-off drains, although in some circumstances cut-off drains are likely to be required. Any cut-off drains would be minimised in terms of length and depth, to minimise concentration of flows and unnecessary diversion of water. Water discharge from drainage systems would be spread across the ground in order to minimise changes to flow into downstream sensitive habitats and would not be discharged directly into sensitive habitat areas.

4.68 There may be options to improve or extend areas of habitats through vegetation management and/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.

Potential GWDTE Area 4

4.69 Area 4 covers the south-western part of the Proposed Development (**Figure 9.3.4**).

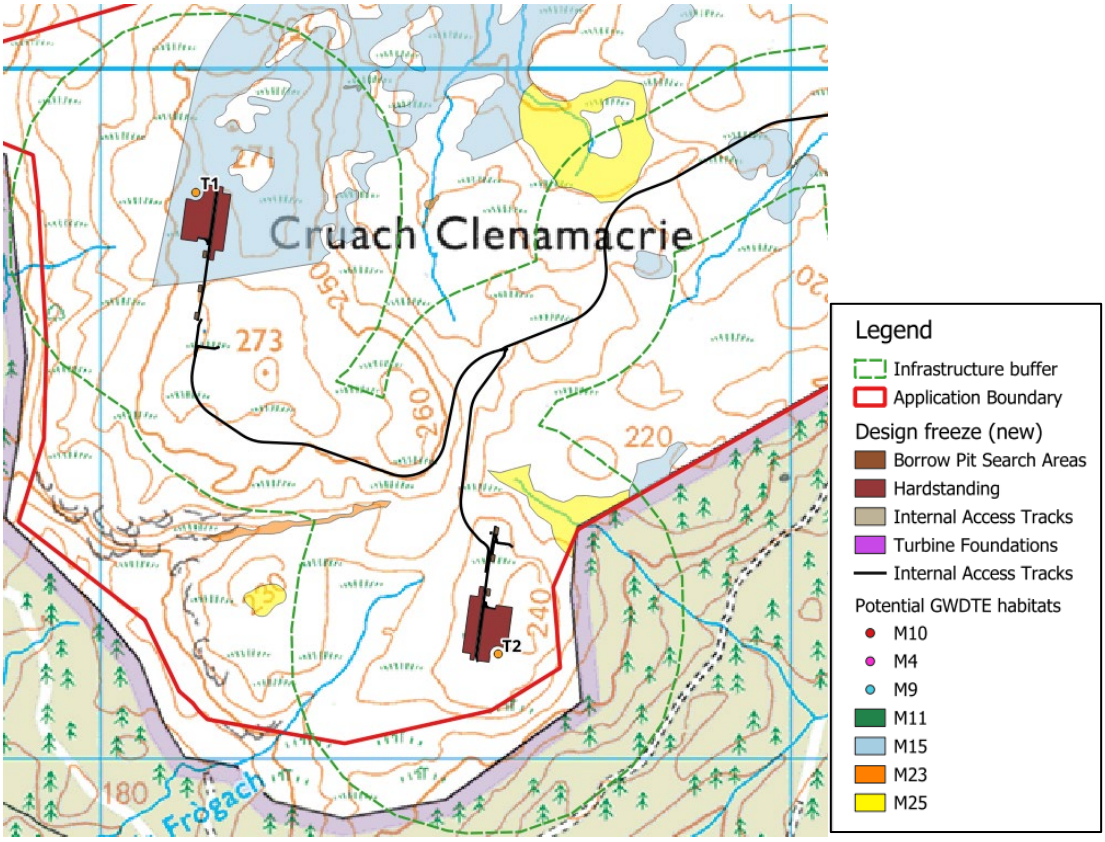

Figure 9.3.4: Potential GWDTE habitats in Area 4

Habitats present

4.70 Small areas of M15 wet heath are present to the south of the track, as well as M25 mire to the north.

4.71 An elongated area of M23 rush-pasture can be found south of the access to turbine T1. A section of M10 is located in the eastern part of the area.

4.72 Turbine T1 is located on a broad area of M15 wet heath. There is a small area of M11 located north-east of this turbine, and an area of M10 located to the south-east. To the east of turbine T1 there is an area of M9 mire.

4.73 To the north-east of Turbine T2 there is an area of M25 mire habitat.

Setting and Infrastructure

4.74 Bedrock in this area from the Lorn Plateau Volcanic formation. Superficial deposits are largely absent. Some pockets of deep peat were recorded within Area 4.

4.75 The bedrock is a low productivity aquifer with flow virtually all through fractures and other discontinuities, small amounts of groundwater are present in near-surface weathered zones and secondary fractures.

4.76 There are three watercourses which run through this area of the Site. The Allt Fròga ch and a tributary of Allt Oishnean drain the southern section. These both drain into the River Lonan. Allt an t-Sean-achaidh drains the northern section, which flows into the Black Lochs and subsequently into the Lusragan Burn.

4.77 Development in Area 4 includes turbines T1 and T2 and sections of access track.

Assessment and Mitigation

4.78 No indications of groundwater at surface were identified in Area 4.

4.79 The presence of peat across much of this area indicates that access to groundwater would be limited for most habitats in Area 4. Habitats on blanket peat rely on rainfall and shallow through-flow within the vegetated layer, as they are isolated from groundwater by the peat.

4.80 The locations of habitats M25 to the north-east of turbine T2 appears to be largely associated with surface watercourses or drainage channels, as indicated by their proximity to the minor watercourse. The shape of this area of habitat reflects the watercourse morphology. Furthermore, the area of M23 is located at the base of a steep valley, where surface water is likely to collect and drain, suggesting it is fed by rainwater and surface run-off rather than groundwater.

4.81 Direct impacts on the identified sensitive habitats primarily include loss from construction of the access track and construction of the turbines and crane pads for turbines T1 and T2.

4.82 Where new track is required to cross areas of sensitive habitat, micrositing will be employed to minimise the area of habitat loss. Cross-drains would be employed to ensure continuity of flow within the habitat area. Any required modified or additional trackside and turbine hardstanding drainage would be minimised in terms of depth and length and would not discharge directly into or upslope of identified habitat areas, to minimise potential for water and nutrient flushing in these areas.

4.83 Water collecting within the turbine excavations would be directed into settlement ponds to allow for removal of sediment. Treated water would not be discharged 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 sensitive habitat areas.

4.84 Deeper excavations required for the turbines would have perimeter drainage installed prior to start of excavations. The preferred method would be to use earth bunds, rather than installation of cut-off drains, although in some circumstances cut-off drains are likely to be required. Any cut-off drains would be minimised in terms of length and depth, to minimise concentration of flows and unnecessary diversion of water. Water discharge from drainage systems would be spread across the ground in order to minimise changes to flow into downstream sensitive habitats and would not be discharged directly into sensitive habitat areas.

4.85 There may be options to improve or extend areas of habitats through vegetation management and/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.

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 an 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.
- 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 Borrow Pit 1 to a depth of at least 1m below the deepest expected excavation. Groundwater level monitoring would be undertaken to determine whether groundwater is present within the borrow pit area 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 9.4 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. It is advised that 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:

- M4 mire;
- M9 mire;
- M10 mire;
- M11 mire;
- M23 rush-pasture;
- M29 soakway;
- W4 woodland;
- M15 wet heath; and
- M25 mire.

6.3 M9, M10, M11, M23, M29 and W4 have potentially high groundwater-dependency. M23 has potentially moderate to high groundwater-dependency. M15 and M4 have potentially moderate groundwater-dependency. M25 has potentially moderate to low 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, considering the local bedrock and superficial geology, peat distribution and site observations.

6.6 Superficial deposits within the Site consist mainly of peat. The bedrock is all classed as a low productivity aquifer with low potential for groundwater storage.

6.7 Blanket peat, such as is present across much of the Site, is considered to be ombrotrophic and receives all its nutrients from rainwater. Localised flushing can occur adjacent to watercourses but is rarely extensive away from the watercourse channel. It is recognised that peat present within the Site has a wide range of depths; however, it remains likely that the dominant water source in the Site, irrelevant of peat depth, is rainwater and surface runoff with shallow through-flow within the uppermost vegetated layer.

6.8 It is therefore determined that potentially groundwater-dependent communities within the Site Access are reliant on surface water and shallow groundwater in association with watercourses.

6.9 Impacts to sensitive habitats would arise from direct habitat loss as a result of construction activity; and indirect habitat loss or modifications arising from changes to water or nutrient supply to the habitats resulting from upslope construction works and installation of drainage structures such as ditches and earth bunds.

6.10 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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