Technical Appendix 8.3

Groundwater Dependent Terrestrial Ecosystems Risk Assessment

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TA 8.3 Groundwater Dependent Terrestrial Ecosystems Risk Assessment

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1 Groundwater Dependent Terrestrial Ecosystems Risk Assessment

1.1 Introduction

1.1.1 This Technical Appendix provides an assessment of potential areas of Groundwater Dependent Terrestrial Ecosystem (GWDTE) identified at the Proposed Development and considers actual groundwater dependency of these habitats, and if relevant, any impact the Proposed Development may have.

1.1.2 This hydrological assessment of identified GWDTEs, follows on from the conclusions of the National Vegetation Classification (NVC) survey report presented within **Chapter 7** of the EIA Report. The hydrological assessment was undertaken by reviewing desk-based information including topography, watercourses, geology etc. combined with notes and photographs taken during hydrological walkovers of the site.

1.1.3 The Proposed Development site comprises a total area of c.965 hectares (ha), split into two main development areas connected by the B743. The proposed wind turbines are located in the northern development area (Dungavel Forest), and the proposed solar development and short/long duration battery energy storage systems (BESS) is located in the southern development area (Netherwood). These two areas of the Proposed Development site will hereafter be referred to as 'the northern development area' and 'the southern development area'.

1.2 Baseline

1.2.1 A detailed NVC survey was completed, as outlined in **Chapter 7**. From the NVC survey data, communities have been identified that have the potential to be groundwater dependent in accordance with Scottish Environment Protection Agency (SEPA) Guidance on Assessing the Impacts of Developments on Groundwater Dependent Terrestrial Ecosystems (August, 2024).

1.2.2 In accordance with the SEPA guidance note, the following infrastructure buffer zones will be implemented to assess areas for potential GWDTE:

- 10 m radius of all activities;
- 100 m radius of all subsurface activities less than 1 m in depth; and
- 250 m of all subsurface activities deeper than 1 m.

1.2.3 In accordance with guidance, only potential GWDTE communities within infrastructure buffers of 10 m, 100 m and 250 m buffers have been scoped into assessment, as shown in **Annex 2 (TA8.3 Figure 1)**.

1.2.4 Based on the SEPA guidance note, the following potential GWDTE communities were identified:

- M4;
- M6;
- M23a, M23b;
- MG9a;
- MG10, MG10a;
- W4b; and
- W7a.

1.2.5 Previous assessment of the NVC survey data based on previous SEPA-LUPS-GU31 guidance identified the presence of NVC community M25 as being 'Moderately' groundwater dependent. As this was the guidance at the time of surveys these areas of M25 were identified as potential GWDTEs. These were reviewed by hydrologists on a site-specific basis and were not found to be groundwater dependent, in line with updated SEPA guidance.

1.2.6 A review of the baseline features that may affect the groundwater dependency was undertaken in **Chapter 8**.

1.2.7 The northern development area primarily comprises commercial forestry across several hills, including Dungavel Hill (458 m, Above Ordnance Datum (AOD)) in the west of the site, Auchengilloch (462 m AOD) in the east, and Regal Hill (428 m AOD) to the south. The southern development area is located on the south facing lower slopes of Middlefield Law, north of the Greenock Water, comprising primarily agricultural fields.

1.2.8 The northern development area is primarily underlain by superficial deposits of peat, with Devensian till, alluvium and glaciofluvial deposits mapped along on-site watercourses, as shown in **EIA Report Figure 8.3**. The southern development area is primarily underlain by Devensian till deposits with areas of alluvium and glaciofluvial deposits largely associated with on-site watercourses.

1.2.9 The northern development area is predominantly underlain by Silurian Plewland Sandstone Formation and Middlefield Conglomerate Formation of the Dungavel Group, as shown in **EIA Report Figure 8.6**. A rare, isolated intrusion of the South of Scotland Granitic Suite of the Caledonian Supersuite, is present in the west of the northern development area. The Logan Formation, consisting of sandstone, siltstone and mudstone, of the Waterhead Group underlies the north-east of the northern development area. The Swanshaw Sandstone Formation of the Lanark Group underlies the north-west of the northern development area. The northern development area is heavily faulted with 11 inferred faults mapped.

1.2.10 The west of the southern development area is underlain by Devonian Kinnesswood Formation, consisting of sandstone, and the Carboniferous Ballagan Formation, consisting of argillaceous rock, dolostone and sandstone, both of the Inverclyde group. The centre and east of the site is underlain predominantly by Silurian Ponesk Burn Formation, and in the north by the Patrick Burn Formation, Castle Formation, Blaeberry Formation and Dunside Formation, all of the Hagshaw Group, consisting of greywackes, sandstones, siltstones and mudstones. The southern development area is also faulted, with eight inferred faults mapped.

1.2.11 A review of the baseline features including topography, underlying geology, and surface water features, was undertaken to determine the groundwater dependency for each group of habitats. This is shown in **Table 1** in **Annex 1**. Following this, identified mosaics of potential GWDTEs were scoped into further assessment.

1.2.12 During the site walkover observations were noted on the following:

- ground conditions including surface wetness;
- peat depth;
- habitat type;
- topography;
- breaks in slope or slumps present; and
- identification of any springs or flushes.

1.2.13 In addition to these, features identified in SEPA guidance as being indicative of groundwater dependency were also noted if present:

- habitats associated with springs;

- where soils are persistently waterlogged on otherwise well drained steep to moderate slopes, in the absence of surface water sources;
- upper edge of GWDTE is aligned with concave breaks in slope;
- diffuse groundwater emergence is often focused along linear geological features (fractures, faults etc);
- persistent flow even during dry weather;
- limited variation in temperature; and
- may be base enriched.

1.2.14 These observations combined with the desk-based assessment are shown in Table 2 and Table 3 in **Annex 1**, with the revised groundwater dependency.

1.3 Mitigation

Embedded Mitigation

1.3.1 Throughout the iterative design process, avoidance of GWDTEs was considered where possible taking into account other technical constraints, including landscape and visual, ecology, peat depth and peatland condition. No Proposed Development infrastructure is sited on areas assessed as being groundwater dependent.

Committed Mitigation

1.3.2 Best practice mitigation and guidance for protection of surface and groundwater receptors will be followed throughout the construction phase, as outlined in **Chapter 8**. These measures will include and are not limited to:

- Sediment pollution mitigation measures will be emplaced across the Proposed Development, this may include: drainage; silt fencing; settlement lagoons; and check dams.
- To avoid unnecessary compaction and disturbance to soils, working areas and corridors would be established and demarcated, with construction operatives appropriately inducted and trained to avoid work outside the designated work areas.
- Sufficient and continued dewatering at the turbine foundation excavation until the concrete is cured, to prevent leaching.
- Dewatering at the turbine will be minimised through careful management and reducing the time the excavation is open, including concrete pouring.
- Fuel and chemicals will be stored in impermeable bunded containers at least 110% of the volume stored. All fuelling on-site will occur in a designated location, at least 50 m from watercourses.
- Trackside drainage ditches will be designed to ensure separation of clean water drainage from potentially contaminated drainage.
- Check dams will be employed to slow down the flow of water and decrease erosion within drainage ditches.
- Sumps and settlement lagoons will be used to treat and slow down the flow of water during periods of high rainfall. This will be employed at drainage outlets prior to reaching watercourses.

1.3.3 A Watercourse Crossing Schedule (WCS) has been prepared and included as **Technical Appendix 8.1**. This provides recommended crossing types for required watercourse crossings. Detailed drainage

design will be undertaken prior to construction to account for cross-drainage and culverts required to maintain hydrological connectivity upslope and downslope of the Proposed Development tracks and hardstanding.

1.3.4 An Construction Environmental Management Plan (CEMP) will be in place to control potentially polluting activities to prevent adverse impacts to surrounding receptors. An outline CEMP is provided as **Technical Appendix 3.1** of the EIA Report. Relevant mitigation measures to be implemented during construction to control water quality and quantity impacts will be outlined within the CEMP.

1.4 Potential Effects

1.4.1 GWDTE habitats identify areas where groundwater emerges and is in close proximity to the surface. The indicator GWDTEs and underlying designated groundwater may be impacted by changes in water quality and quantity. If construction activities of the Proposed Development are undertaken in close proximity to GWDTEs, this can have adverse impacts on underlying groundwater.

1.4.2 The Proposed Development can affect water quality through removal of protective layers of soil and subsoil increasing the vulnerability of underlying groundwater to pollution. The groundwater quality can also be affected from leaks or spills from vehicles, plant or equipment used or from leaching of concrete foundations.

1.4.3 The Proposed Development turbine foundations, borrow pits and linear infrastructure such as roads, tracks and trenches can disrupt or divert groundwater flow. Dewatering of below groundworks may also change the quantity of groundwater available in the surrounding area.

1.5 Residual Effects

1.5.1 As outlined within **Annex 1 Table 1**, **Table 2** and **Table 3**, all potential GWDTEs identified have been assessed as not being groundwater dependent.

1.5.2 As defined in detail within **Annex 1**, the following reasons have been determined to result in potentially groundwater dependent NVC polygons being assessed as being not groundwater dependent:

- Polygons located along watercourses, minor streams, artificial and existing trackside drainage, indicating their dependence on surface water flow rather than groundwater.
- Polygons underlain by low permeability till or peat, which limit vertical and lateral hydrological connectivity to underlying groundwater.
- Polygons located downslope of ombrotrophic habitats of wet modified bog or blanket bog, which are fed by surface water run-off.
- Polygons where no point or diffuse groundwater emergence identified.

1.5.3 Embedded and committed mitigation measures, as outlined above, will be implemented to ensure protection of groundwater from potential impacts. Following implementation of these measures, no significant adverse effects on indicator GWDTEs, groundwater quality or quantity are anticipated.

1.6 References

BGS (2024) Online GeoIndex Map Viewer. Available at: https://mapapps2.bgs.ac.uk/geoindex/home.html. Accessed on: 5 February 2025.

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SEPA. (2023). Online Water Environment Hub and Classification Hub. Available at: https://www.sepa.org.uk/data-visualisation/water-environment-hub/. Accessed on: 5 February 2025.

SEPA (2024) Guidance on Assessing the Impacts of Developments on Groundwater Dependent Terrestrial Ecosystems. Available at: Guidance and advice notes | Scottish Environment Protection Agency (SEPA). Accessed on 12 February 2025.

Annex 1

Table 1 – NVC Community Review of Potential Groundwater Dependency

NVC Community	Habitat	Location	Description of Baseline Features	Potential Groundwater Dependency
M4	Mire	One polygon in northern development area.	Underlain by low productivity bedrock aquifer dominated by fracture flow, with no inferred faults present. Located on gently sloping area underlain by deep peat, upslope of small watercourse. Onsite found to be wet underfoot with runoff observed from peatland on surrounding slopes.	This polygon is **scoped out** of further assessment, as onsite observations confirm this to be underlain by deep peat deposits and supplied by rainfall and surface water runoff from upslope ombrotrophic habitats.
M6	Mire	One polygon in northern development area.	Underlain by low productivity bedrock aquifer dominated by fracture flow, with no inferred faults present. Located on steep slopes with no mapped underlying superficial deposits. In area of plantation forestry, located along small artificially modified watercourse. Polygon found to be dry underfoot.	This polygon is **scoped out** of further assessment, as onsite observations confirm no persistent flow of groundwater, not associated with break in slope or underlying geological faults. Found at break in plantation forestry in area of surface water flow.
M23a, M23b	Marsh/marshy grassland, and wet modified bog	There are 17 polygons located primarily in southern development area.	Underlain by low and moderately productive bedrock aquifer dominated by fracture flow. Located on moderate to gentle slopes Underlain by peat, till and glaciofluvial deposits. Located in areas of plantation forestry and grassland used for grazing. Often located along surface watercourses, or downslope of areas of deep peat and ombrotrophic habitat.	These polygons are **scoped out** of further assessment, as onsite observations confirm this to largely be fed by surface water run-off along watercourses or from run-off from upslope ombrotrophic peatland habitats.
MG9a	Neutral grassland	Three polygons in southern development area.	Underlain by low and moderately productive bedrock aquifer dominated by fracture flow. Located on moderate to gentle slopes Underlain by till and alluvium, or no superficial deposits mapped. Located along or upslope of surface watercourses.	These polygons are considered to largely be fed by surface water along watercourses. Further mosaic specific assessment undertaken.
MG10, MG10a	Marsh/marshy grassland	Four polygons in northern development	Underlain by low productive bedrock aquifer dominated by fracture flow. Located on moderate to gentle slopes. Underlain by till and glaciofluvial deposits, or peat located upslope.	These polygons are considered to largely be associated with areas of high surface water flow and underlain by lower

NVC Community	Habitat	Location	Description of Baseline Features	Potential Groundwater Dependency
		area and southern development area.	Located along or upslope of surface watercourses. One polygon located in area of flood risk along the Greenock Water.	permeability deposits which limit vertical connectivity to groundwater. Further mosaic specific assessment undertaken.
W4b	Woodland	Two polygons in southern development area.	Largely underlain by low productivity bedrock aquifer dominated by fracture flow. Underlain by till and alluvium, located downslope of peat deposits. Present along minor watercourses or within floodplain of larger watercourses.	These polygons are **scoped out** of further assessment, as found on slopes along watercourses, which will be primarily fed by surface water flow.
W7a	Woodland	One polygon in southern development area.	Underlain by low productive bedrock aquifer dominated by fracture flow. Underlain by till deposits, located on steep slopes above area of flood risk along the Greenock Water. Located downslope of waterlogged area of peat deposits with surface water runoff.	This polygon is **scoped out** of further assessment, as underlain by low productivity bedrock and low permeability superficial deposits.

Table 2 – Mosaic Specific Review of Potential Groundwater Dependency in Northern Development Area

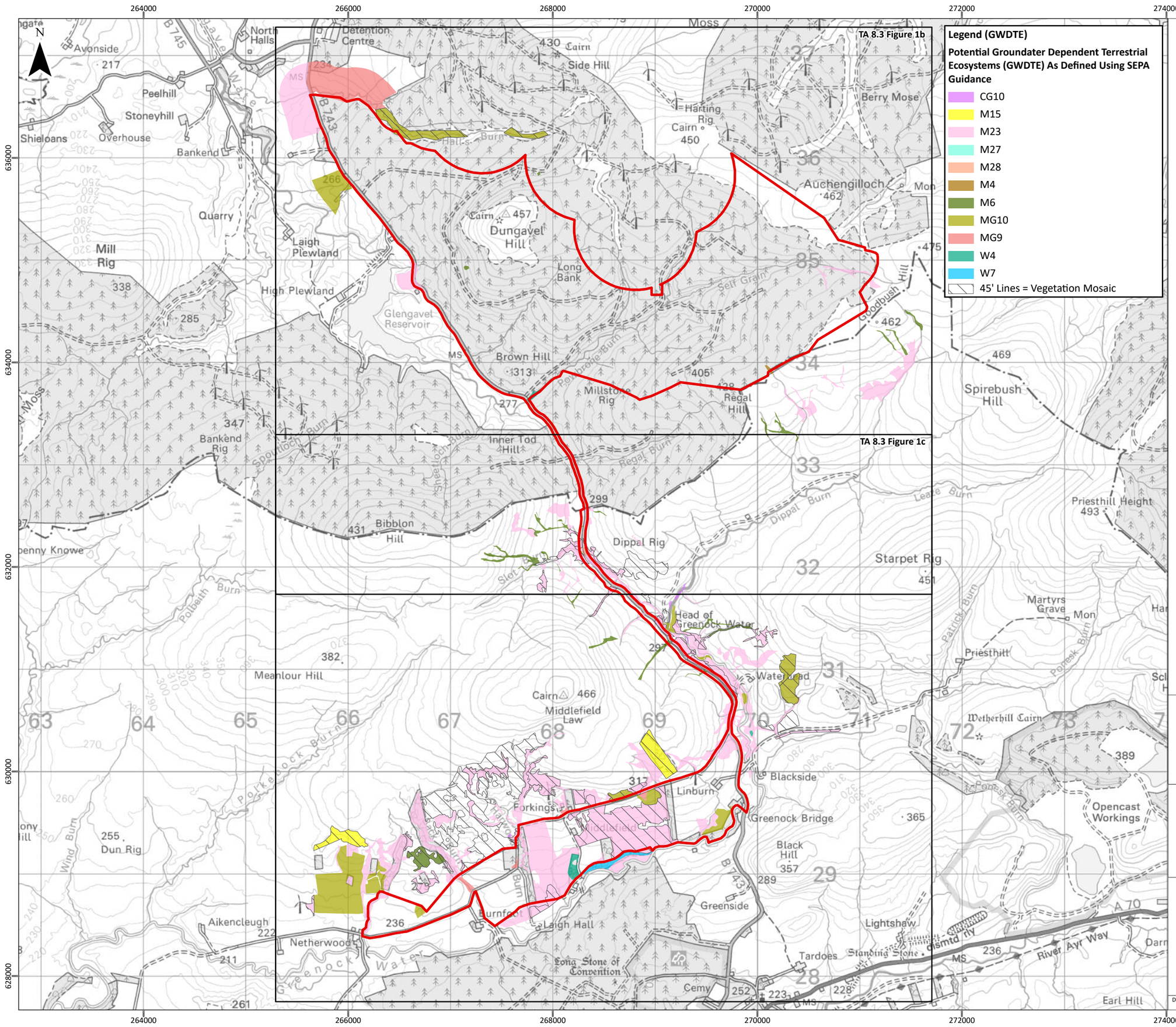
NVC Communities	Habitat	Location	Description of Baseline Features	Groundwater Dependency
MG10	Rush pasture	Within 250 m of T1	Underlain by low productivity bedrock aquifer with no underlying faults. Located downslope of peat deposits, along watercourse channel.	**Not groundwater dependent**, supplied by surface water runoff from upslope peat and flow along surface watercourse.
MG10a	Rush pasture	Within 100 m of access track	Underlain by low productivity bedrock aquifer with no underlying faults. Located downslope of peat deposits, underlain by till and glaciofluvial deposits. Located in area of high surface water run off with surface watercourse within polygon.	**Not groundwater dependent**, supplied by surface water runoff from upslope peat and flow along surface watercourse.

Table 3 – Mosaic Specific Review of Potential Groundwater Dependency in Southern Development Area

NVC Communities	Habitat	Location	Description of Baseline Features	Groundwater Dependency
MG9a	Neutral grassland	Within 10 m of solar PV modules, 100 m of access tracks.	Located on gentle slopes along Back Burn watercourse. Underlain by moderately productive bedrock, which is dominated by fracture flow, with no underlying faults. Superficial deposits of till and alluvium present.	**Not groundwater dependent**, while there may be some input from near-surface groundwater in higher permeability superficial deposits, is supplied by surface water run-off and flow along watercourse.
MG9a	Neutral grassland	Within 100 m of access tracks.	Underlain by moderately productive bedrock downslope of fault, no mapped superficial deposits are present. Located on moderate slopes upslope of watercourse. Located along edge of plantation forestry, and upslope of existing access road. No features associated with groundwater dependence identified.	**Not groundwater dependent**, while there may be some input from near-surface groundwater, surrounding hydrology has been artificially modified by forestry and access road.
MG9a	Neutral grassland	Within 250 m of Long Duration Energy Storage.	Underlain by low productivity bedrock, with no mapped superficial deposits. Located on slopes above Lamon Burn and downslope of existing road. No diffuse groundwater emergence noted. Area of wet modified bog and peat deposits on slopes to north.	**Not groundwater dependent**, supplied by surface water overland flow towards watercourse.
MG10a	Marsh/marshy grassland	Underlying and within 10 m of solar PV modules in the west of the southern development area.	Underlain by moderately productive bedrock aquifer which is multi layered with fracture flow. Underlain by inferred fault, however, distribution does not follow linear feature. Mapped superficial deposits of peat, glaciofluvial and till present. Located on gentle slopes, downslope of wet modified bog habitat with peat and deep peat deposits.	**Not groundwater dependent**, underlying deposits of peat and till will limit vertical connectivity, and is likely supplied by surface water run-off from upslope habitats.
MG10a	Marsh/marshy grassland	Within 10 m of solar PV modules, 100 m of access tracks and 250 m of Long Duration Energy Storage.	Underlain by low productivity productive bedrock aquifer. Underlain by inferred fault, however, distribution does not follow linear feature. Located on moderate slopes with thin superficial deposits. Located immediately upslope of Lamon Burn and downslope of existing road. No diffuse groundwater emergence noted. Area of wet modified bog and peat deposits on slopes to north.	**Not groundwater dependent**, supplied by surface water runoff from upslope peat and flow along watercourse.

NVC Communities	Habitat	Location	Description of Baseline Features	Groundwater Dependency
MG10a	Marsh/marshy grassland	Within 100 m of access tracks and Short Duration Energy Storage.	Underlain by low productivity bedrock aquifer with no underlying faults. Underlain by till and glaciofluvial deposits. Located on gentle slopes, upslope of coniferous forestry and Greenock Water. Partly located in area considered to be at risk of fluvial flooding. Noted to be dry underfoot onsite.	**Not groundwater dependent**, with limited connectivity to low productivity underlying groundwater by till deposits. In area of high surface water run-off between small tributary and Greenock Water.

Annex 2 – Figures



HAGSHAW ENERGY CLUSTER WESTERN EXPANSION

3R Energy

SLR

Hagshaw Energy Cluster - Western Expansion
Phase 1
EIA Report

TA 8.3 Figure 1a
Potential Groundwater Dependent Terrestrial Ecosystems

Date:	Drawn by:	Checked by:	Version:
31/03/2025	DB	JC	V1

266000 268000 270000

636000 634000 632000

N

Legend (GWDTE)

Potential Groundater Dependent Terrestrial Ecosystems (GWDTE) As Defined Using SEPA Guidance

- CG10
- M23
- M28
- M4
- M6
- MG10
- MG9
- W4
- 45' Lines = Vegetation Mosaic

Legend

- Site Boundary
- Turbine Location (200m to tip)
- Turbine Location (230m to tip)
- Temporary Hardstand
- Permanent Hardstand
- Turning Heads
- Underground Electricity Export Cable(s)
- Proposed Development Substation
- SPEN Substation
- SPEN Temporary Compound & BESS
- Temporary Construction Compound
- Borrow Pit and Bund
- Borrow Pit Surface Water Drain
- Proposed Access Point

Access Tracks

- Existing - Upgraded
- Floating
- Cut
- Existing Forest Road
- Forestry Spur Road

Watercourse Crossing

- New
- Existing - Upgraded
- Existing
- Wind Infrastructure 100 m Buffer
- Wind Infrastructure 250 m Buffer

Note: NVC Classification
NVC Community presence is symbolised by a solid fill colour.
Vegetation mosaic is symbolised by a hashed line.

0 0.25 0.5 0.75 1 Km

Scale 1:20,000 @ A3

HAGSHAW ENERGY CLUSTER WESTERN EXPANSION

3R Energy

SLR

Hagshaw Energy Cluster - Western Expansion
Phase 1
EIA Report

TA 8.3 Figure 1b
Potential Groundwater Dependent Terrestrial Ecosystems

Date:	Drawn by:	Checked by:	Version:
31/03/2025	DB	JC	V1

266000 268000 270000

632000 630000 628000

N

Legend (GWDTE)

Potential Groundwater Dependent Terrestrial Ecosystems (GWDTE) As Defined Using SEPA Guidance

- CG10
- M15
- M23
- M27
- M28
- M6
- MG10
- MG9
- W4
- W7
- 45' Lines = Vegetation Mosaic

Legend

- Site Boundary
- Underground Electricity Export Cable(s)
- Solar PV Module
- Solar Inverter
- Long Duration Energy Storage
- Short Duration Energy Storage
- Proposed Development Substation
- SPEN Substation
- SPEN Temporary Compound
- Temporary Construction Compound
- Borrow Pit and Bund
- Security Fence
- Proposed Access Point

Access Tracks

- Existing - Upgraded
- Cut

Watercourse Crossing

- New
- Existing - Upgraded
- Existing
- Solar Infrastructure 10 m Buffer
- Solar Infrastructure 100 m Buffer
- Solar Infrastructure 250 m Buffer
- Wind Infrastructure 100 m Buffer

Note: NVC Classification
NVC Community presence is symbolised by a solid fill colour.
Vegetation mosaic is symbolised by a hashed line.

0 0.25 0.5 0.75 1 Km

Scale 1:20,000 @ A3

HAGSHAW ENERGY CLUSTER WESTERN EXPANSION

3R Energy

SLR

Hagshaw Energy Cluster - Western Expansion
Phase 1
EIA Report

TA 8.3 Figure 1c
Potential Groundwater Dependent Terrestrial Ecosystems

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31/03/2025	DB	JC	V1