EUCHANHEAD RENEWABLE ENERGY DEVELOPMENT

Technical Appendix 10.3: Groundwater Dependent Terrestrial Ecosystems (GWDTE) Assessment

Prepared for: ScottishPower Renewables

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Version 3
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DOCUMENT REFERENCES

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1.0 Introduction

This Technical Appendix presents an assessment of potential areas of Groundwater Dependent Terrestrial Ecosystems (GWDTE) at the proposed Euchanhead Renewable Energy Development site ('the Site').

A number of surveys, including a programme of peat depth probing, hydrological walkover surveys and a National Vegetation Classification (NVC) survey, have been undertaken at the Site. This data, slope data and other constraints (e.g. ecology, noise, landscape, cultural heritage etc.) have been used to develop the proposed Development.

This assessment is supported by **Figure 10.3.1.**

2.0 Geology, Hydrology and Hydrogeology

2.1 Geology

An extract of the published British Geological Survey (BGS) superficial geological map is shown as EIAR Figure 10.3.

Peat is mapped extensively across the Site, including much of the proposed access track. The peat is underlain by Glacial Till. Peat is absent beneath the northern section of the proposed access track and at the highest elevations. Adjacent to the larger watercourses, Alluvium and small areas of Hummocky Glacial Deposits are recorded. Peat and superficial deposits are also shown as absent in the headwaters of the steeper water channels.

An extract of the published BGS solid geological map is shown on EIAR **Figure 10.5** and shows that the site is underlain by several Ordovician sedimentary units, the majority of which comprises of the Kirkcolm Formation (wacke) which underlies the north of the Site and Portpatrick Formation (wacke) to the south. The Marchburn Formation (wacke and chert) and the Blackcraig Formation (wacke) underlie part of the proposed access route whilst the Moffat Shale Group (mudstone, chert and smectite claystone), is located in several outcrops across the southern section of the Site. A number of small igneous intrusions are also present across the Site.

A number of detailed peat probing campaigns have been undertaken. The results are reported in **Technical Appendix 10.2: Peat Management Plan** which confirms there are more than 3,500 peat probe locations and that:

- more than half of probes (63 %) proved no peat or peaty soils;
- approximately 8 % of peat probes recorded peat in excess of 1.5 m thick; and
- of the probes that proved peat, approximately 92 % were <1.5 m thick.

2.2 Hydrology and Hydrogeology

The majority of the Site lies within the River Nith surface water catchment which flows generally southwards, east of the Site. Tributaries of the River Nith which rise within the Site include (from north to south) the Kello Water, Euchan Water, Scar Water and Shinnel Water. The western extent of the Site is drained by the Water of Ken which is a tributary of the larger River Dee surface water catchment. See EIAR **Figure 10.1**.

The average annual rainfall is relatively high and is reported by the Flood Estimation Handbook for the River Nith catchment locally as 1,480 mm/a.

BGS hydrogeological mapping confirms that all the bedrock deposits beneath the Site are classified as a low productivity aquifers. The highly indurated nature of the greywacke rocks means that there is limited groundwater flow within the bedrock, although limited groundwater flow near surface weathered zones and secondary fractures is possible.

The superficial deposits are not classified by the BGS; however, the Glacial Till deposits typically exhibit limited groundwater potential due to the dominance of clay within the Till and discrete pockets of poorly sorted sand and gravel. Groundwater will be present in the Alluvium adjacent to the larger watercourse channels and this is likely to be in hydraulic continuity with the water in the watercourses. This groundwater is likely to be perched above the low permeability glacial deposits and not be in hydraulic continuity with deeper groundwater in the bedrock.

Peat deposits typically comprise two layers: a thin (up to 50 cm) acrotelm layer, which allows relatively free water movement; and the lower catotelm layer comprising the thicker bulk of peat. Water movement in the catotelm layer is very slow and normally the water table in peat never drops below the acrotelm layer.

2.2.1 Conceptual Hydrological Site Model

Following review of the Site setting, the following conceptual Site model has been developed:

- the Site is located in an area that receives frequent rainfall and has a relatively high annual rainfall total;
- where there are no drift deposits present (e.g. on the hill tops), there is potential for some shallow groundwater to form in the upper weathered surface of the bedrock. This is however, generally on elevated, sloping ground where rainfall would preferentially form surface runoff and therefore groundwater quantities will be small;
- any groundwater in the upper weathered surface of the sedimentary bedrocks will readily flow within the weathered upper surface of the bedrock and follow topography to the valleys between the hills;
- the presence of Glacial Till deposits below the peat and Alluvial deposits is likely to result in groundwater in the peat and alluvium being locally perched above the regional groundwater table in the bedrock deposits;
- the potential for rainwater recharge to groundwater within the bedrock will be limited by the presence of peat and clays associated with the Glacial Till deposits. Incident rainfall is likely to preferentially pond on the ground surface and where surface gradients allow form surface runoff or shallow interflow within the acrotelm rather than infiltrate and form significant groundwater recharge; and
- surface water runoff will pond and saturate soils on land with shallow relief.

3.0 NVC Mapping and Occurrence of Potential GWDTE

3.1 NVC Mapping

A comprehensive NVC mapping exercise has been completed. The methodologies adopted and findings are detailed in EIAR **Technical Appendix 8.2**: **Vegetation Survey Report**.

The potential for NVC communities to be GWDTE has been assessed using SEPA guidance[1] (Error! Reference source not found.**).** The NVC communities CG10, M6, M10, M31, M32 and M23 recorded at the Site have high potential to be dependent on groundwater and five communities recorded at Site, whereas M15, M25, MG9,

[1] SEPA. 2017. Land use planning system SEPA guidance note 31. Guidance on assessing the impacts of development proposals on groundwater abstractions and ground water dependent terrestrial ecosystems. Version 3, 11/09/2017.

MG10 and U6 communities have moderate potential. Their locations are shown on **Figure 03** (**EIAR TA 8.2: Vegetation Survey Report, Appendix 01**). For mosaic habitats, a precautionary approach has been adopted whereby GWDTE potential has been based on the NVC community with the highest GWDTE potential within the mosaic.

3.2 Occurrence of Potential GWDTE

The areas of potential moderate or high groundwater dependent habitat are shown on **Figure 10.3.1.**

The particular characteristics of these communities are subject to further site-specific scrutiny in terms of topography and hydro-ecological context below.

3.2.1 Habitats with Potential Moderate Groundwater Dependency

Review of **Figure 10.3.1** shows that areas of potential moderate groundwater dependent habitat (M15, M25, MG9, MG10 and U6) are located either along the watercourse corridors or on areas of steeper topography towards the hill tops in areas within the southern section of the Site, in forest rides and along the proposed access route. Specially, the following distribution was noted:

M15 *Scirpus cespitosus (Trichophorum germanicum)-Erica tetralix* Wet Heath Community

M15 wet heath was restricted to patches along the proposed access route, a small area north east of Meikledodd Hill, both as a distinct habitat patch and in mosaic with acid grassland (U4 and U5); and a larger area northeast of Altry Hill. The community was typically dominated by *T. germanicum*, with *Nardus stricta* and *Vaccinium myrtillus* common in the sward. *Erica tetralix* was absent from areas around the main site indicating that the M15 is modified in this area, likely by drainage, as it prefers wetter ground.

Along the proposed access route, *Erica tetralix* was present in most examples of the typical community M15b and all areas of M15c, the *Cladonia spp* sub-community. Much of the wet heath was in very grassy M15d, the *Vaccinium myrtillus* sub-community: a grassy sward with much *Trichophorum*, this generally lacked *Erica tetralix* so would not qualify as Annex l priority habitat.

M25 *Molinia caerulea-Potentilla erecta* Mire Community

This community has been able to develop where heavy grazing and/or extensive drainage has modified the habitats by reducing the water table level on what was once likely to have been M17 or M19 mire. *Molinia caerulea* is the most abundant species with the general flora associated with this community being species-poor. Other species commonly found include *Juncus acutiflorus, Angelica sylvatica*, *Cirsium palustre, Polytrichum commune, Sphagnum fallax, Sphagnum capillifolium, Sphagnum fimbriatum* and *Deschampsia cespitosa*.

M25 was common on open hill sides, and along watercourses and rides within the commercial forestry, where it is typically interspersed with areas of M23. In these areas M25 has typically been classed as marshy grassland.

The most extensive tract of this community type has been assigned to an area of relatively deep peat (generally greater than 1 m) in the bottom of the Polskeoch Burn valley. There are a number of drainage ditches in this area indicating that the water table in this area has been artificially lowered and that it may once have been a more species-rich mire type such as M17. The presence of *Angelica sylvestris* in this area indicates that it is slightly nutrient-enriched, likely from inputs from surrounding forestry. In this location M25 is classed as wet modified bog.

MG9 *Holcus lanatus – Deschampsia cespitosa* Grassland

This community was present close to agricultural land both at Shinnelhead and Polskeoch. Both locations have small crofter's cottages/farmsteads that, over many years, have likely contributed to the nutrient enrichment of adjacent areas likely through grazing of livestock and potentially also the application of fertilisers. *Deschampsia cespitosa* was dominant in this community. It was found in association with communities MG10 and M23.

MG10 *Holcus lanatus-Juncus effusus* Rush Pasture Community

This community was present close to agricultural land both at Shinnelhead and Polskeoch. Both locations have small crofter's cottages/farmsteads that, over many years, have likely contributed to the nutrient enrichment of adjacent areas likely through grazing of livestock and potentially also the application of fertilisers. The MG10 areas adjacent to the crofts were more mesotrophic in nature than the wider area, with species such as *Juncus effusus, Holcus lanatus, Poa trivialis* and *Ranunculus repens.* MG10 was present in damp areas often intergrading with slightly wetter M23 and slightly drier MG9.

U6 Juncus *squarrosus-Festuca ovina* Grassland Community

This community was identified in the open hillside areas particularly on slopes along the proposed access route, the ridge between North of Lamgarroch Hill and Colt Hill, and to the east of Lorg Hill and Meikledodd Hill. The community which is the best fit here is the U6c *Vaccinium myrtillus* sub-community, this is due to the abundance of mosses such as *Rhytidiadelphus loreus, Polytrichum commune, Hylocomium splendens* and *Pleurozium schreberi* that were present. Sprigs of *Vaccinium myrtillus* poked out of the top of these. Old flowers of *Deschampsia flexuosa and Agrostis vinealis,* and leaves of *Anthoxanthum odoratum* gave this community a significant grassy component

Discussion

It has been shown that the areas of potential moderate GWDTE are typically associated with modified ground, as a result of forestry, drainage or farming activity. The distribution of the moderate GWDTE is not typical of that sustained by emerging groundwater, such as a groundwater spring, but rather is influenced by land use.

It is, therefore, considered that the potential moderate GWDTE are sustained by the high average annual rainfall, surface water runoff and localised surface water ponding rather than by groundwater. Buffers specified in SEPA guidance to this habitat therefore need not apply, but safeguards will be required during construction to maintain existing surface water flow paths to these habitats.

3.2.2 Habitats with Potential High Groundwater Dependency

Areas of potential high groundwater dependent habitat (CG10, M6, M10, M31, M32 and M23) are also typically located along watercourse corridors, and specially the following characteristics have been recorded:

CG10 *Festuca ovina/ Agrostis capillaris/ Thymus polytrichus* grassland

CG10a was found in mosaic with acid grassland (U4a) in one area along the proposed access route where it contributed 10 % of the ground cover. CG10 is typically a species-rich community, at Euchanhead it was dominated by *Festuca ovina, Agrostis capillaris, Thymus polytrichus*, *Arrhenatherum elatius, Pilosella officinarum* and *Hylocomium splendens.* U5c was also found in this area.

M6 *Carex echinata-Sphagnum fallax/denticulatum* mire

M6 was predominantly found in small patches along the proposed access route and on the slopes around Altry Hill, both as distinct patches and in mosaic with other communities, particularly M23, M25 and U4. It was dominated by *Sphagnum* species and *Juncus effusus*, with occasional *Potentilla erecta*, *Galium saxatile* and *Polytrichum commune*. Sphagnum mires are common in neglected and abandoned pastures on the upland margins. At Euchanhead, they occur in locations typical of this community including wet hollows, seepage lines, flushes, shallow gullies, along the margins of streams and as patches within other communities.

M10 *Carex dioica – Pinguicula vulgaris* mire

M10 was present in distinct patches and in mosaic with other habitats in the area surrounding proposed Borrow Pit BP07 along the proposed access route. There is one particularly large, quite expansive fan of M10 base-rich flush, originating at National Grid Reference (NGR) NS 65225 06904 at the head of the Bottom Burn. M10 habitats at Euchanhead are typically dominated by *Tricophorum cespitosum, Eriophorum angustifolium, Carex dioica and*

Pinguicula vulgaris. The area around proposed Borrow Pit BP07 is generally relatively rich in springs and flushes compared to the rest of the survey area and includes the headwaters/ source of the Bottom Burn.

M31 *Anthelia julacea–Sphagnum denticulatum* spring

M31 was present in a very small area along the proposed access route, mapped as a Target Note 25 (TA8.2). This area was dominated by *Sphagnum denticulatum, Anthelia julacea* and *Narthecium ossifragum* and was adjacent to an area of H18. The H18 appeared to be the natural community at that location, on a steep, east/northeast facing rocky slope, at altitude of 600-660m, which suggests that there is some snow accumulation here in winter. The M31 spring is below this area, and typical as M31 springs are often found at high altitudes and sustained by meltwater from snow beds.

M32 *Philonotis fontana – Saxifraga stellaris spring*

M32 springs were found along the proposed access route near the location of proposed Borrow Pit BP07 as four discrete areas and in mosaic with other habitats. At three of the four locations where M32 formed discrete areas, water was observed emerging from the hillside either within the polygon or close by downstream. The floral character of these M32 springs changed with distance from their sources, for example from mainly *Chiastophyllum oppositifolium*, with some *Sphagnum denticulatum,* broadening into typical bryophyte-rich M32 community, e.g. with *Saxifraga stellaris*, *Stellaria alsine, Philonotis fontana, Dicranella palustris* and *Scorpidium cossini*.

M23 *Juncus effusus/Juncus acutiflorus-Galium palustre* Rush Pasture Community

This community was typically associated with watercourses and flushes and/or the transitional margin between the plantation woodland and the heath/mire/ grasslands of the open hillsides. M23 was also present in some of the wider rides of the plantation woodland which still support some of their original species.

This community was found on the steeper, wetter slopes, often adjacent to watercourses. Dominated by both *Juncus effusus* and/or *J. acutiflorus*, some areas were relatively species-rich, with *Ranunculus repens, Succisa pratensis, Viola palustris, Cardamine pratensis* and *Angelica sylvestris* being recorded. Other areas were relatively species-poor, with large amounts of *Holcus lanatus* and *Holcus mollis* growing between the *Juncus acutiflorus* stems.

Both M23 sub-communities are represented within the survey area. The M23a *Juncus acutiflorus* sub-community, which is the richer form, has a range of species including *Succisa pratensis* and *Angelica sylvestris;* and M23b the *Juncus effusus* sub-community, where fewer forbs were present.

3.3 Discussion

With the exception of a number of groundwater springs recorded near proposed Borrow Pit BP07, the distribution of potential high GWDTE is not characteristic of habitat that is sustained by groundwater.

The areas of potential high GWDTE are typically not associated with linear spring lines or areas of groundwater emergence but rather are sustained by saturated soils which result from waterlogging due to surface water runoff and ponding, within a part of Scotland which receives relatively frequent and high rainfall. It is concluded, therefore, in this instance buffers specified in SEPA guidance to this habitat need not apply. With the exception of watercourse crossings (the number of which has been minimised) the proposed 50 m standoff either side of watercourses will ensure direct impacts on these habitats is minimised or avoided.

Best practice construction methods will be required as part of the site design to ensure (a) existing surface water flow paths are maintained to these habitats (e.g. where the surface water catchments to the habitats are crossed by proposed infrastructure), and (b) aggregate used to establish tracks and hardstanding's etc. is derived on site or has similar geochemical characteristics to the geology present at the site.

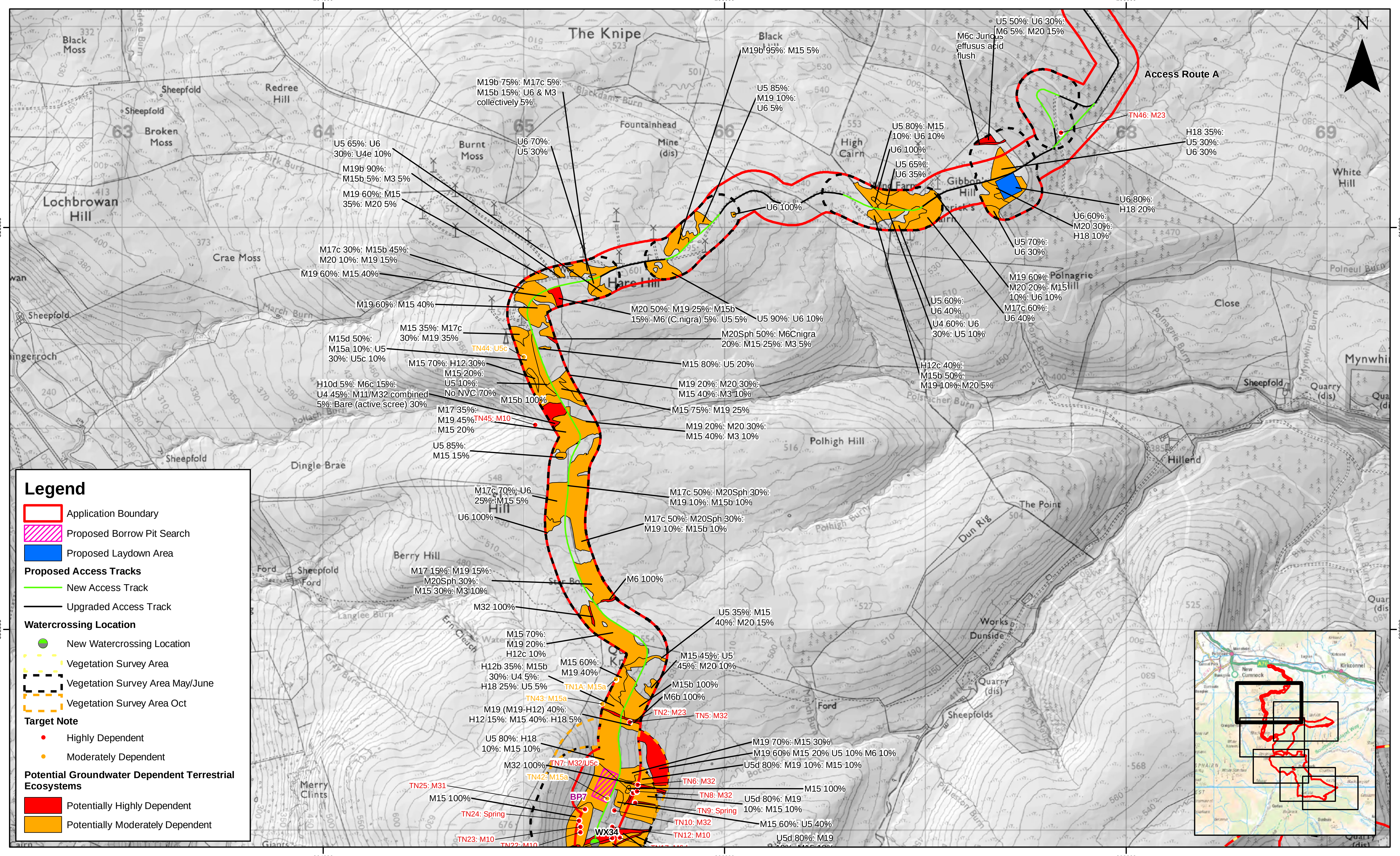
A number of groundwater springs have been recorded near to and within 250 m of proposed Borrow Pit BP07. Springs are located east and at a lower elevation than the borrow pit, and others are recorded south and at a slightly higher elevation than the borrow pit. Review of published mapping and peat probe data confirms that soils are shallow and superficial deposits are absent at and near to Borrow Pit BP07. Groundwater flow locally is likely to follow topography and be shallow within the upper weathered surface of the bedrock; groundwater emerges (in springs) where the steep eastern slopes of Blackcraig Hill slacken.

It is not considered that the springs to the south and at a higher elevation than Borrow Pit BP07 are at risk from development of the borrow pit as they are 'upstream' of the borrow pit and the catchment area to the springs will not be affected by any element of the proposed development.

Similarly, the M10 habitat near to borrow pit BP07, is not considered at risk from the borrow pit. The habitat is located south of the borrow pit and is a different groundwater catchment to the borrow pit. The proposed access track does cross the M10 habitat and it is proposed that the track is locally floated so that the track does not impede the existing flow paths in the associated with the M10 habitat.

Without appropriate design however, there is potential that construction of the borrow pit could intercept groundwater and reduce the flow of the water emerging east of Borrow Pit BP07. To mitigate this, and as part of the detailed site design, measures will be required to ensure shallow groundwater flow paths to the springs are maintained. For example, a shallow cut-off drain could be installed on the western boundary of the borrow pit to route shallow groundwater around the borrow pit to the habitat located east of the borrow pit and proposed access track. A diffuse discharge from the drain would need to be maintained to ensure that all the habitat to the east of the borrow pit is sustained. The drainage measures would need to be routinely inspected by the Site ECoW.

FIGURES



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Rev	Date	By	Comment

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Euchanhead Renewable Energy Development EIAR

GWDTE

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Potential Groundwater Dependent Terrestrial Ecosystems

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Figure	10.3.1.1

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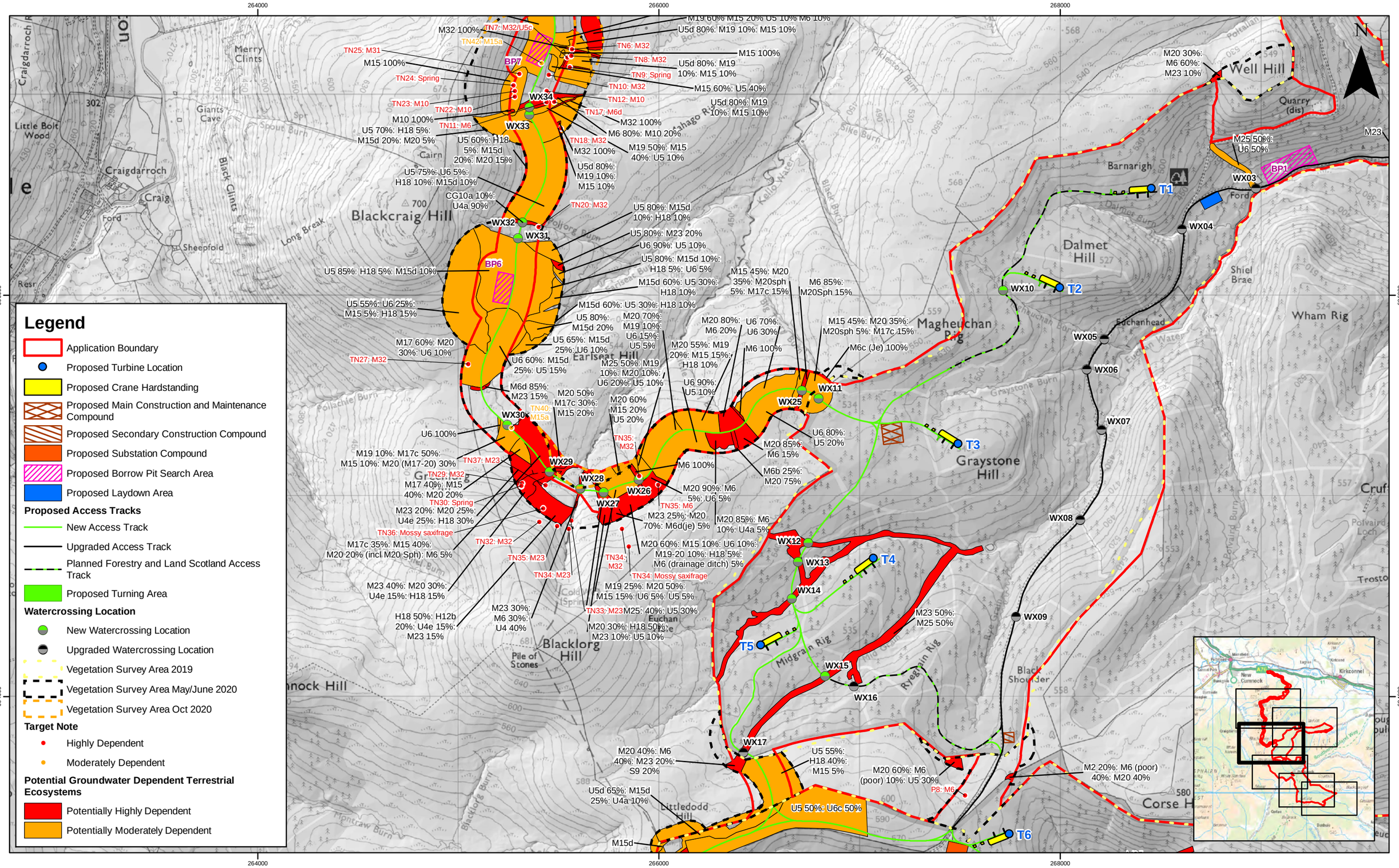

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Rev	**Date**	**By**	**Comment**				**Figure** 10.3.1.2

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268000 270000 272000

608000 606000

M15 30%
M15 20% U5 10% M6 10%
19 10%: M15 10%
M15 100%

M20 30%:
M6 60%:
M23 10%

M25 50%:
U6 50%

Legend

- Application Boundary
- Proposed Turbine Location
- Proposed Crane Hardstanding
- Proposed Main Construction and Maintenance Compound
- Proposed Security Compound
- Proposed Borrow Pit Search Area
- Proposed Laydown Area

Proposed Access Tracks

- New Access Track
- Upgraded Access Track
- Planned Forestry and Land Scotland Access Track
- Proposed Turning Area

Watercrossing Location

- New Watercrossing Location
- Upgraded Watercrossing Location
- Vegetation Survey Area 2019
- Vegetation Survey Area May/June 2020

Potential Groundwater Dependent Terrestrial Ecosystems

- Potentially Highly Dependent
- Potentially Moderately Dependent

Access Route B

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Potential Groundwater Dependent Terrestrial Ecosystems

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Figure	10.3.1.3

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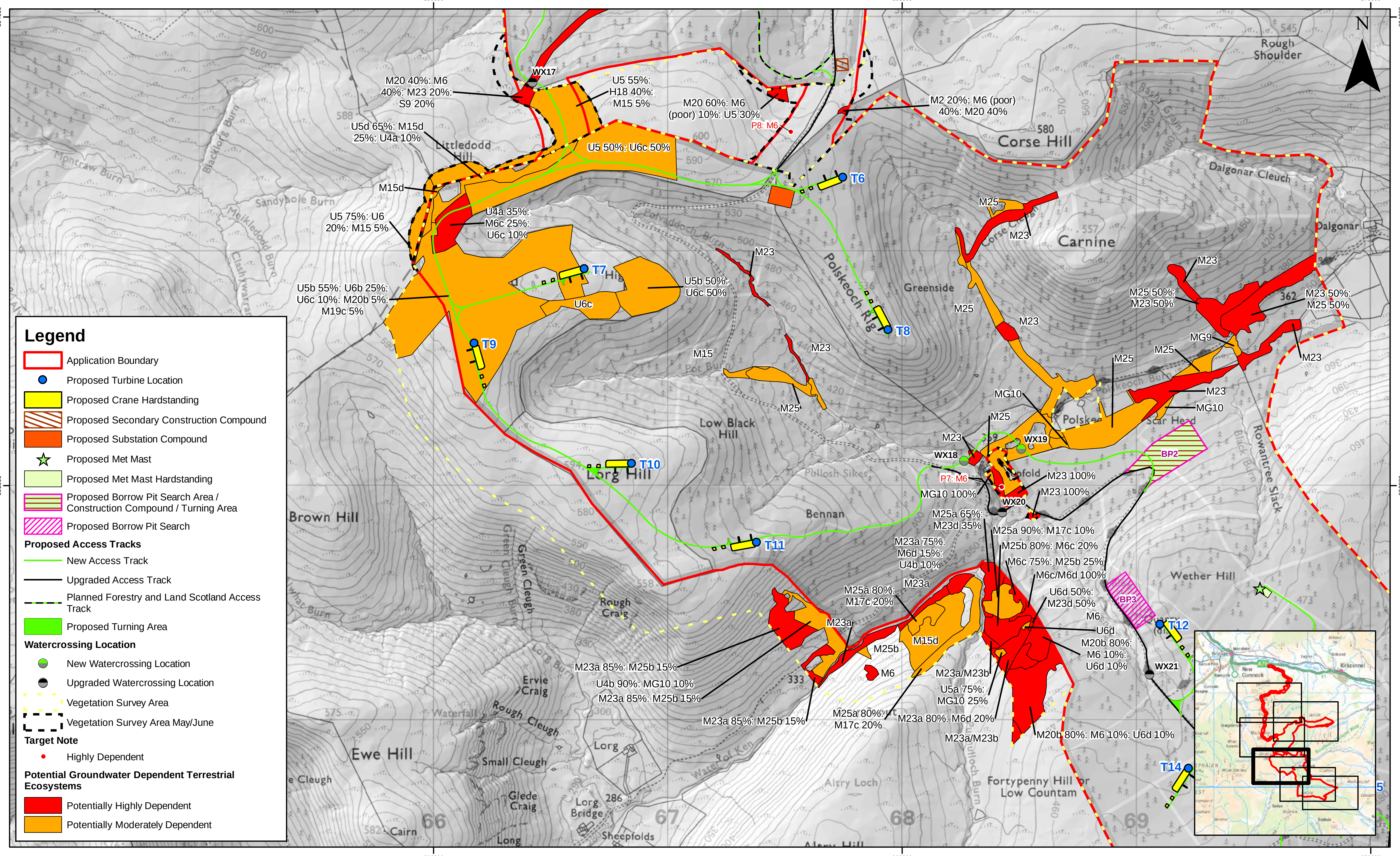

266000
268000
270000
604000
602000
Legend
Application Boundary
Proposed Turbine Location
Proposed Crane Hardstanding
Proposed Secondary Construction Compound
Proposed Substation Compound
Proposed Met Mast
Proposed Met Mast Hardstanding
Proposed Borrow Pit Search Area / Construction Compound / Turning Area
Proposed Borrow Pit Search
Proposed Access Tracks
New Access Track
Upgraded Access Track
Planned Forestry and Land Scotland Access Track
Proposed Turning Area
Watercrossing Location
New Watercrossing Location
Upgraded Watercrossing Location
Vegetation Survey Area
Vegetation Survey Area May/June
Target Note
Highly Dependent
Potential Groundwater Dependent Terrestrial Ecosystems
Potentially Highly Dependent
Potentially Moderately Dependent
N
T6
T7
T8
T9
T10
T11
T12
T14
WX17
WX18
WX19
WX20
WX21
BP2
BP3
M20 40%: M6 40%: M23 20%: S9 20%
U5 55%: H18 40%: M15 5%
M20 60%: M6 (poor) 10%: U5 30%
P8: M6
M2 20%: M6 (poor) 40%: M20 40%
U5d 65%: M15d 25%: U4a 10%
U5 50%: U6c 50%
M15d
U4a 35%: M6c 25%: U6c 10%
U5 75%: U6 20%: M15 5%
U5b 55%: U6b 25%: U6c 10%: M20b 5%: M19c 5%
U6c
U5b 50%: U6c 50%
M23
M25
M15
MG9
MG10
M25 50%: M23 50%
M23 50%: M25 50%
P7: M6
M23 100%
MG10 100%
M25a 65%: M23d 35%
M23a 75%: M6d 15%: U4b 10%
M25a 90%: M17c 10%
M25b 80%: M6c 20%
M6c 75%: M25b 25%
M6c/M6d 100%
U6d 50%: M23d 50%
M6
U6d
M20b 80%: M6 10%: U6d 10%
M23a
M25a 80%: M17c 20%
M15d
M25b
M23a 85%: M25b 15%
U4b 90%: MG10 10%
M23a/M23b
U5a 75%: MG10 25%
M23a 80%: M6d 20%
Rough Shoulder
Corse Hill
Carnine
Dalgonar Cleuch
Dalgonar
Greenside
Polskeoch Rig
Littledodd Hill
Low Black Hill
Lorg Hill
Brown Hill
Bennan
Pullosh Sikes
Polskeoch
Scar Head
Wether Hill
Rowantree Slack
Rough Craig
Ervie Craig
Ewe Hill
Small Cleugh
Glede Craig
Lorg Bridge
Sheepfolds
Lorg
Altry Loch
Fortypenny Hill or Low Countam
Green Cleugh
Polvaddoch Burn
Sandyhole Burn
Montraw Burn
Blacklorg Burn
Clashywatra
Water of Ken
Waterfall
Cairn
Rough Cleugh
580
557
362
473
333
286
5

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Potential Groundwater Dependent Terrestrial Ecosystems

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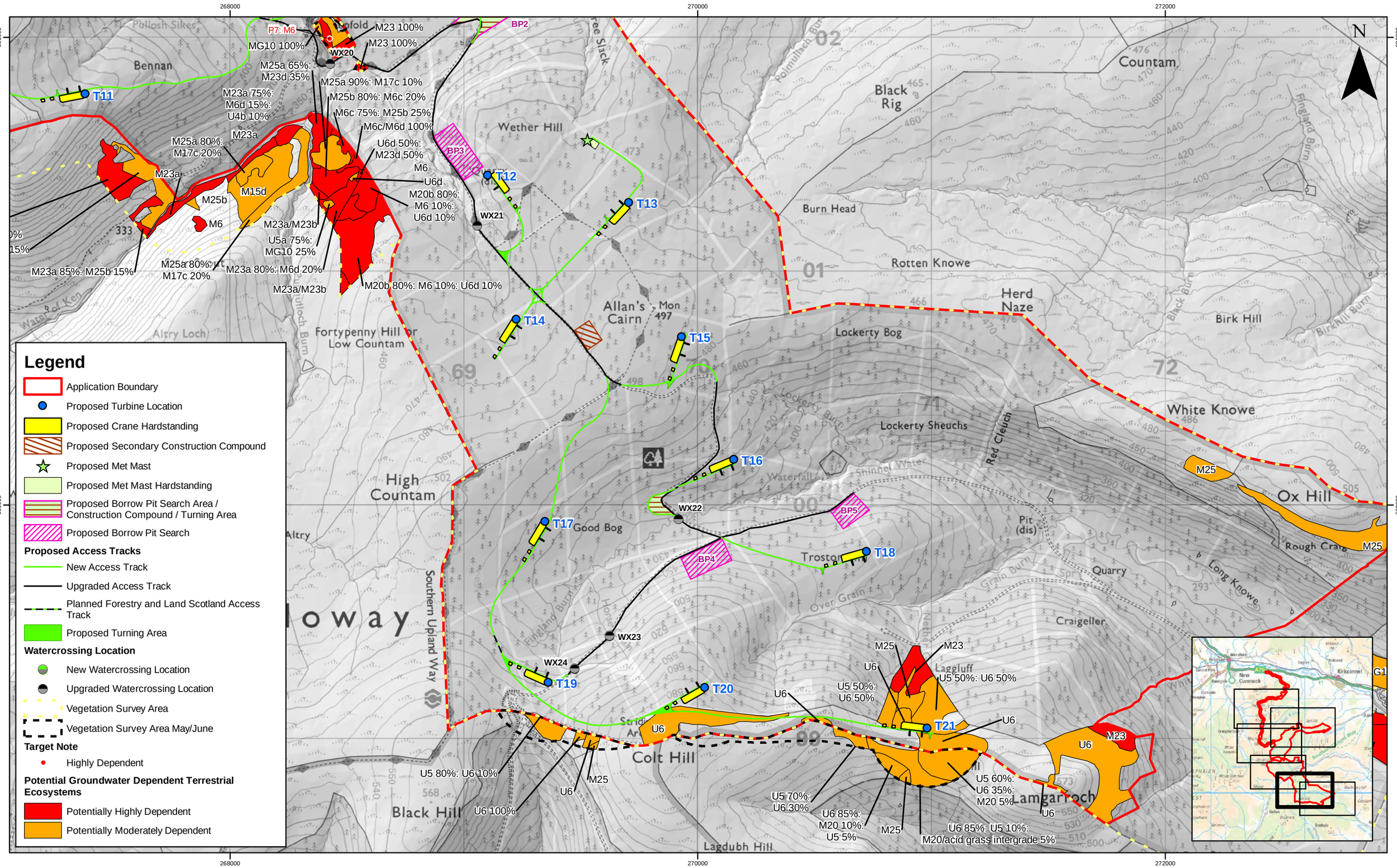

Legend

- Application Boundary
- Proposed Turbine Location
- Proposed Crane Hardstanding
- Proposed Secondary Construction Compound
- Proposed Met Mast
- Proposed Met Mast Hardstanding
- Proposed Borrow Pit Search Area / Construction Compound / Turning Area
- Proposed Borrow Pit Search

Proposed Access Tracks

- New Access Track
- Upgraded Access Track
- Planned Forestry and Land Scotland Access Track
- Proposed Turning Area

Watercrossing Location

- New Watercrossing Location
- Upgraded Watercrossing Location
- Vegetation Survey Area
- Vegetation Survey Area May/June

Target Note

- Highly Dependent

Potential Groundwater Dependent Terrestrial Ecosystems

- Potentially Highly Dependent
- Potentially Moderately Dependent

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Rev	A
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Figure	10.3.1.5

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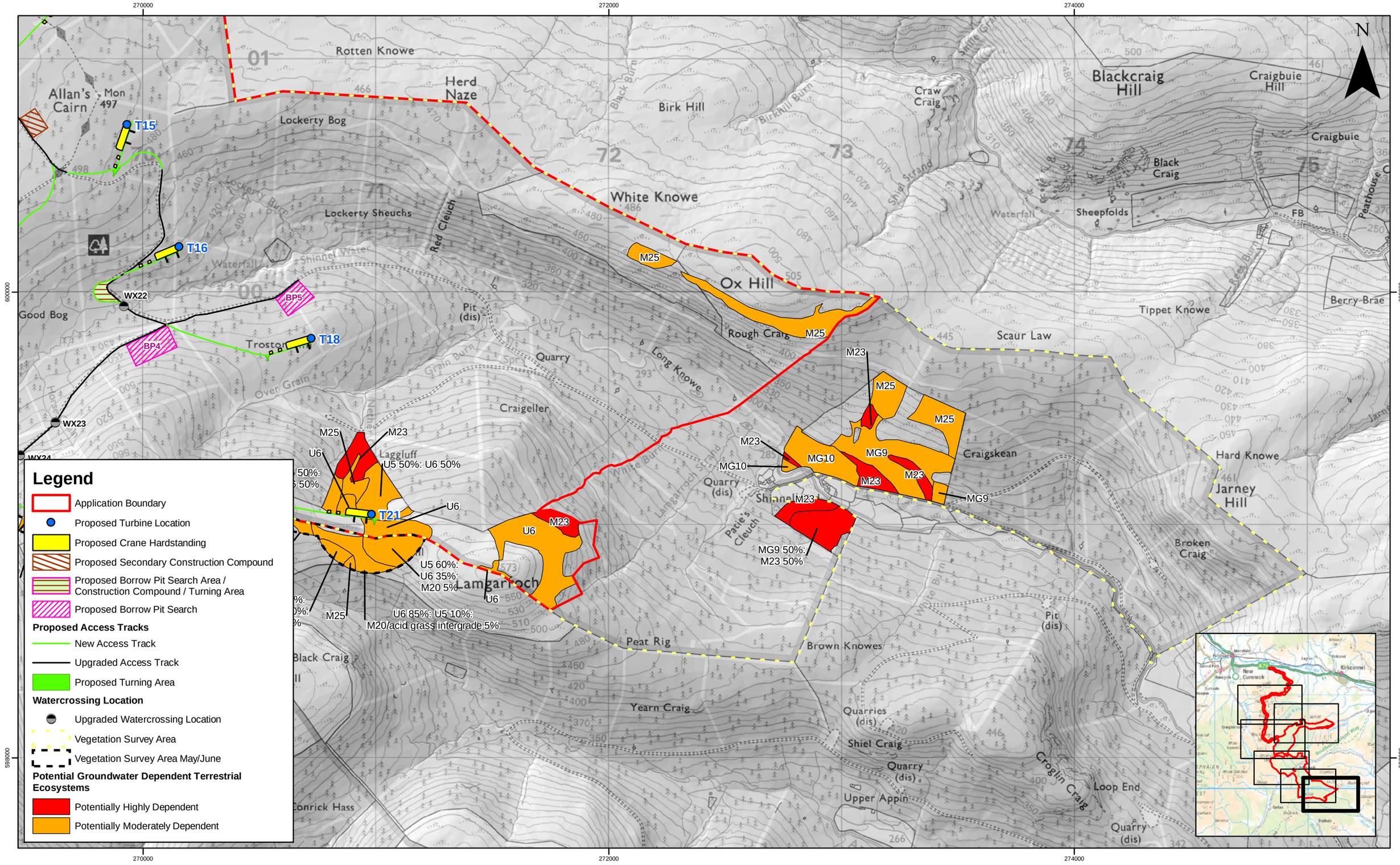

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- Proposed Borrow Pit Search Area / Construction Compound / Turning Area
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Proposed Access Tracks

- New Access Track
- Upgraded Access Track
- Proposed Turning Area

Watercrossing Location

- Upgraded Watercrossing Location
- Vegetation Survey Area
- Vegetation Survey Area May/June

Potential Groundwater Dependent Terrestrial Ecosystems

- Potentially Highly Dependent
- Potentially Moderately Dependent

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Rev	Date	By	Comment
A	22/10/20	AA	Initial Issue

1:15,000 Scale @ A3

0 125 250 375 500 Metres

Euchanhead Renewable Energy Development EIAR

GWDTE

Potential Groundwater Dependent Terrestrial Ecosystems

Drg No	00481.00052.0288.0
Rev	A
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Figure	10.3.1.6

Datum: OSGB36 Projection: TM

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