Technical Appendix 9: Hydrology, Hydrogeology and Geology

TA 9.1: Groundwater Dependent Terrestrial Ecosystems

TA 9.2: Watercourse Crossing Assessment

Technical Appendix 9.1: Groundwater Dependent Terrestrial Ecosystems

Technical Appendix 9.1: Groundwater Dependent Terrestrial Ecosystems

1.1 Introduction

1.1.1 This Technical Appendix provides a summary of Groundwater Terrestrial Ecosystems (GWDTEs) within the context of the Proposed Artfield Wind Farm (the 'Proposed Development'). It forms a Technical Appendix (TA), as part of the submission of an EIA for the Proposed Development. This TA provides a description of geological and hydrogeological conditions underlying the Site. Characterisation of the Proposed Development area takes into account National Vegetation Classification (NVC) surveying carried out by Avian Ecology in May 2020, and hydrological surveying carried out by Ramboll in September 2020. Hydrogeological assessment of the identified potential GWDTEs is provided with associated mapping.

1.1.2 This TA is supported by the following:

- Figure 9.1.1: BGS 1:625,000 Bedrock Geology
- Figure 9.1.2: BGS 1:625,000 Superficial Geology
- Figure 9.1.3: BGS 1:625,000 Hydrogeology
- Figure 9.1.4: NVC GWDTE Classification
- Figure 9.1.5: Ramboll GWDTE Assessment

1.2 Baseline

Bedrock Geology

1.2.1 A review of online British Geological Survey (BGS)[1] mapping indicates that the majority of the Site is underlain by Wacke of the Portpatrick Formation and Glenwhargen Formation. A fault is present within the northernmost area of the Site and the underlying geology is Wacke of the Kirkcolm Formation (Figure 9.1.1).

Superficial Geology

1.2.2 The superficial geology of the Site predominantly comprises peat with the south east of the Site comprising Diamicton Till (Figure 9.1.2). Some areas are mapped as having no superficial deposits present which could imply that rockhead is relatively shallow in these areas.

1.2.3 The Kirkcown Flow SAC and Site of Special Scientific Interest (SSSI) is located approximately 1.4 km north of the Site. This area is designated for containing blanket bog and depressions on peat substrates.

Hydrogeology

1.2.4 According to the BGS Hydrogeological and Groundwater Vulnerability Maps of Scotland (1:625,000), the underlying geology is recognised as a low productivity aquifer (Figure 9.1.3). Such aquifers are characterised as having limited groundwater potential, with small amounts of groundwater limited to near surface weathered zones and secondary fractures. Low productivity aquifers do not widely contain groundwater in exploitable quantities; however, some bedrock formations can locally yield water supplies in sufficient quantities for private/ domestic use. The overlying superficial deposits are considered to be generally of low permeability; however, groundwater may be present in sand and gravel lenses, hence locally important aquifers or perched groundwater bodies may be present, although are unlikely to be continuous over a wide area.

1.3 Groundwater Dependent Terrestrial Ecosystems

Introduction

1.3.1 Excavation of soil and bedrock during the construction phase of the Proposed Development may cause localised disruption and interruption to groundwater flow. Interruption of groundwater flow would potentially reduce the supply of groundwater water to GWDTEs thereby causing an alteration/ change in the quality or quantity of and/ or the physical or biological characteristics of the GWDTE. Contamination of groundwater may also cause physical or chemical contamination to the GWDTE.

1.3.2 Following identification of potential GWDTEs from NVC mapping data, the hydrological and hydrogeological desktop study information has been used to help qualitatively determine the potential sensitivity of each potential GWDTE.

1.3.3 Further details with regard to each GWDTE identified are provided below. The sensitivity of each of the GWDTE receptors has been classed based upon classifications provided within SEPA's guidance document LUPS4[2].

National Vegetation Classification

1.3.4 A number of potential Moderately Highly GWDTE habitat areas were identified during NVC surveys conducted by Avian Ecology in May 2020. Further details with regard to each GWDTE identified are provided below and illustrated in Figure 9.1.4.

1.3.5 The majority of potentially groundwater dependent vegetation communities identified are present on low-lying areas of the Site in connection to the Tarf Water, or grazed areas of land in the south of the Site. Further very small areas toward the north of the Site are associated with the presence of forest tracks and associated drains.

1.3.6 Following identification of habitats with potential to be GWDTEs from NVC mapping data, the hydrological and hydrogeological desktop study information has been used to help qualitatively determine the sensitivity of each potential GWDTE.

1.3.7 Where a mosaic of NVC classifications was observed, only the community occupying the largest proportion of the mosaic has been considered as representative of the potential for the mosaic to be a GWDTE. Ecological surveying has been carried out on-site, up to 250 m from the infrastructure for the Proposed Development.

1.3.8 The sensitivity of each GWDTE receptor has been classified in accordance with Scottish Environment Protection Agency (SEPA) guidance LUPS – GN31[3]. The SEPA classification is modified from the UKTAG (2008)[4] list of NVC communities, which provides the full list for all communities. The relevant UKTAG classification is also provided.

[1] British Geological Survey. Geology of Britain Viewer. http://mapapps.bgs.ac.uk/geologyofbritain/home.html?&_ga=2.86032856.1169274852.1604068096-1921194967.1578408888 [Accessed 30 October 2020].

[2] Scottish Environment Protection Agency, Land Use Planning System SEPA Guidance Note 4, Planning guidance on on-shore windfarm developments, Version 7, May 2014

[3] Scottish Environment Protection Agency, 2017. Land Use Planning System SEPA Guidance Note 31, Guidance on Assessing the Impacts of Development Proposals on

Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems

[4] Guidance within GN31 is adapted from 'UK Technical Advisory Group list of NVC communities and associated groundwater dependency scores (2008)

1.3.9 Table 9.1.1 sets out the predominant NVC communities encountered across the Site and confirms those with the potential to be a GWDTE which have been assessed further (Figure 9.1.4). Table 9.1.2 assesses the likely degree of dependency on the underlying groundwater body, according to site-specific ecological and hydrological conditions. For each area assessed within Table 9.1.2, justification of the assessment of potential groundwater dependency is provided.

1.3.10 Ramboll has assessed site-specific conditions in relation to potential GWDTEs taking into account hydrogeological assessment of groundwater dependency as presented in Table 9.1.2 and Figure 9.1.5. This assessment includes consideration of:

- The direct hydrological connection of a potential GWDTE to surface water sources;
- Underlying geological conditions including the productivity of bedrock and superficial geology, the presence of peat soils and permeability of upgradient geology;
- Topography and the presence of rills or runnels indicative of surface runoff;
- The presence of indicative 'flush' patterns of vegetation communities;
- Land use; and
- The relative proportion of NVC communities and the potential dominance of non-GWDTE communities within surveyed areas.

Table 9.1.1: NVC Communities Present and their Potential Groundwater Dependency, according to SEPA NVC Classification

GWDTE ID on Figure 9.1.4	NVC Communities Present	Dominant Community	Potential GWDTE Classification (SEPA GN 31)	Shape Area (m²)
1	M23b	*Juncus effusus/ acutiflorus – Galium palustre* rush pasture	High	2,063
2	M23b(M6)	*Juncus effusus/ acutiflorus – Galium palustre* rush pasture	High	44,931
3	M23b	*Juncus effusus/ acutiflorus – Galium palustre* rush pasture	High	4,308
4	M23b	*Juncus effusus/ acutiflorus – Galium palustre* rush pasture	High	9,213
5	M23b	*Juncus effusus/ acutiflorus – Galium palustre* rush pasture	High	1,449
6	M23b	*Juncus effusus/ acutiflorus – Galium palustre* rush pasture	High	16,173
7	M23b	*Juncus effusus/ acutiflorus – Galium palustre* rush pasture	High	25,784
8	M15	Northern Atlantic wet heaths with *Erica tetralix*	Moderate	6,586
9	M23b/ M25a	*Juncus effusus/ acutiflorus – Galium palustre* rush pasture	High	10,685
10	M25a/ M23b	*Molinia caerulea - Potentilla erecta* mire	Moderate	30,955
11	MG10/ M25a	*Holcus lanatus - Juncus effusus* rush-pasture	Moderate	8,164
12	MG10/ M25a	*Holcus lanatus - Juncus effusus* rush-pasture	Moderate	37,010
13	M25/ M6	*Molinia caerulea - Potentilla erecta* mire	Moderate	17,647
14	M25(U4)	*Molinia caerulea - Potentilla erecta* mire	Moderate	14,256
15	U4/ M25/ M23 (S4)	*Festuca ovina - Agrostris capillaris - Galium saxatile* grassland	Moderate	7,049
16	M25(M6)	*Molinia caerulea - Potentilla erecta* mire	Moderate	9,975
17	M15/ U4	*Scirpus cespitosus - Erica tetralix* wet heath	Moderate	4,553
18	M23b	M23 *Juncus effusus/ acutiflorus – Galium palustre* rush pasture	High	850
19	M15	*Trichophorum germanicum - Erica tetralix* wet heath	Moderate	9,427
20	M15	*Trichophorum germanicum - Erica tetralix* wet heath	Moderate	5,568
21	M15	*Trichophorum germanicum - Erica tetralix* wet heath	Moderate	1,929
22	M25[70]/ M6[30] (M23)(U4)(S4)	*Molinia caerulea - Potentilla erecta* mire	Moderate	48,639
23	MG9	*Holcus lanatus - Deschampsia cespitosa* grasslands	Moderate	12,541
24	M25a	*Molinia caerulea - Potentilla erecta* mire	Moderate	16,414
25	M23b	M23 *Juncus effusus/acutiflorus – Galium palustre* rush pasture	High	12,162
26	M15	*Scirpus cespitosus - Erica tetralix* wet heath	Moderate	0
27	M15	*Trichophorum germanicum-Erica tetralix* wet heath	Moderate	11,458

Table: 9.1.2: Groundwater Dependency, according to Site-specific Ecological Conditions

GWDTE ID on Figure 9.1.1	GWDTE Classification (SEPA GN 31)	Ramboll Groundwater Dependency Assessment	Justification	Shape Area (m²)
1	High	Not groundwater dependent	Direct connection to surface water feature	2,063
2	High	* Not groundwater dependent	Located in a depression on poorly drained grazed land, accumulation of surface water and in connection to surface drainage features	44,931
3	High	Not groundwater dependent	Surface water accumulation on a low-lying area and connection to a watercourse	4,308
4	High	Not groundwater dependent	Surface water accumulation on a low-lying area and connection to a watercourse	9,213
5	High	*Moderate	Potential flush, topography suggests surface water accumulation due to runoff	1,449
6	High	Not groundwater dependent	Surface water accumulation on a low lying area with connection to the Tarf Water and a surface water drain	16,173
7	High	Not groundwater dependent	Surface water accumulation on a low lying area with connection to the Tarf Water and a surface water drain	25,784
8	Moderate	Not groundwater dependent	Direct connection to Tarf Water (floodplain)	6,586
9	High	Not groundwater dependent	Surface water accumulation on a low lying area with connection to the Tarf Water and a surface water drain	10,685
10	Moderate	Not groundwater dependent	Surface water accumulation on a low lying area with connection to a surface water drain	30,955
11	Moderate	Not groundwater dependent	Direct connection to Tarf Water (floodplain)	8,164
12	Moderate	Not groundwater dependent	Surface water accumulation on a low lying area with connection to a surface water drain	37,010
13	Moderate	Not groundwater dependent	Direct connection to Tarf Water (floodplain)	17,647
14	Moderate	Not groundwater dependent	Connection to surface water drain, surface water accumulation	14,256
15	Moderate	Not groundwater dependent	Direct connection to Tarf Water (floodplain)	7,049
16	Moderate	Not groundwater dependent	Direct connection to Tarf Water (floodplain)	9,975
17	Moderate	Not groundwater dependent	Surface water accumulation from forest tracks and associated runnels/ drains, level area at junction of tracks	4,553
18	High	*Moderate	Surface water accumulation in depression on uneven, grazed area	850
19	Moderate	Not groundwater dependent	Surface water path on forest track with connection to associated drain	9,427
20	Moderate	Not groundwater dependent	Connection to unnamed watercourse (tributary to Tarf Water)	5,568
21	Moderate	Not groundwater dependent	Surface water path on forest track with connection to associated drain	1,929
22	Moderate	Not groundwater dependent	Direct connection to Tarf Water (floodplain)	48,639
23	Moderate	Not groundwater dependent	Direct connection to Tarf Water (floodplain)	12,541
24	Moderate	Not groundwater dependent	Surface water accumulation on a low-lying area, connection to an unnamed watercourse/ drain	16,414
25	High	Not groundwater dependent	Surface water accumulation on a low-lying area, connection to an unnamed watercourse/ drain	12,162
26	Moderate	Not groundwater dependent	Uneven topography and visible patterns of surface water accumulation in runnels draining in an easterly direction, defined by use for grazing	0
27	Moderate	Not groundwater dependent	Surface water path on forest track with connection to associated drain	11,458

* Hydrological assessment of these areas is suggestive of the predominant significance of surface water contribution to the maintenance of vegetation communities in these areas (based on the accumulation of surface water due to depressions in local topography and the presence of upslope sources of surface runoff). However, without further intrusive ground investigation the potential for a degree of groundwater contribution is not ruled out. Both areas would not be impacted by the Proposed Development.

1.4 Groundwater Dependency

1.4.1 UKTAG guidance (2004)[4] recognises that most "*water dependent terrestrial ecosystems lie along a continuum between always only groundwater dependent and always only surface water dependent […]. The source of water supply for some wetlands does not appear to be critical, therefore the task of identifying dependence upon groundwater is sometimes complex*".

1.4.2 SNIFFER (2007) guidance[5] states that the dependence of wetlands on groundwater bodies is a result of hydrological connectivity. The degree of dependency will vary depending on whether the wetland is underlain by a low productivity or high productivity aquifer and whether there is a hydrological linkage mechanism between groundwater and the surface wetland. Likelihood of dependency is based upon the following:

- High Likelihood: characterised by intergranular, high productivity drift aquifer and dominantly intergranular, highly productive aquifer;
- Moderate Likelihood: characterised by intergranular, moderate productivity drift aquifer and fractured, very low productivity aquifer; and
- Low Likelihood: characterised by intergranular, very low productivity drift aquifer and fractured, very low productivity aquifer.

1.4.3 The underlying bedrock aquifer is assessed by the BGS to be of Low productivity highly indurated greywackes, with limited groundwater in the near surface weathered zone and secondary fractures.

5 SNIFFER (2007) WFD66 – Wetland Hydrogeomorphic Classification for Scotland. Edinburgh: SNIFFER.

Where drift deposits are present within the site, these would be of low productivity. Therefore, it is assumed that there is low likelihood of groundwater dependency for all the GWDTEs within the Site (Table 9.1.3), based on assessment of underlying hydrogeology.

1.4.4 The UKTAG (2004) guidance provides criteria for identification and inclusion of GWDTEs in the risk assessment process, based on complementary ecological and hydrogeological assessments. These criteria have been used to produce the following matrix (Table 9.1.3), which provides an identification of sensitive and potentially sensitive GWDTEs that require a qualitative assessment to ascertain the significance of the risks the Proposed Development poses to them.

Table 9.1.3: Matrix for Identification of Sensitive GWDTEs from Ecological and Hydrogeological Assessments

		Hydrogeological Assessment Groundwater Dependency Level		
		High Likelihood	**Moderate Likelihood**	**Low Likelihood**
Ecological Assessment of NVC Communities	Highly groundwater dependent	Sensitive GWDTE	Potentially sensitive GWDTE	Potentially sensitive GWDTE
	Moderately groundwater dependent	Potentially sensitive GWDTE	Potentially sensitive GWDTE	Not sensitive
	Not groundwater dependent	Potentially sensitive GWDTE	Not sensitive	Not sensitive

1.4.5 Since the likelihood of groundwater dependency is considered to be Low for all of the potential GWDTEs across the Site, in line with underlying hydrogeological conditions (as specified in SNIFFER (2007) guidance[5]), and all potential GWDTE areas are identified in the site-specific assessment of NVC communities as being not groundwater dependent or of Moderate groundwater dependency, potential GWDTE areas identified are considered not sensitive (Table 9.1.1) and have therefore been excluded from further assessment.

1.5 Mitigation and Further Assessment

1.5.1 As the potential GWDTE areas assessed are not considered likely to be groundwater dependent, specific mitigation with respect to groundwater supplies are not considered to be applicable.

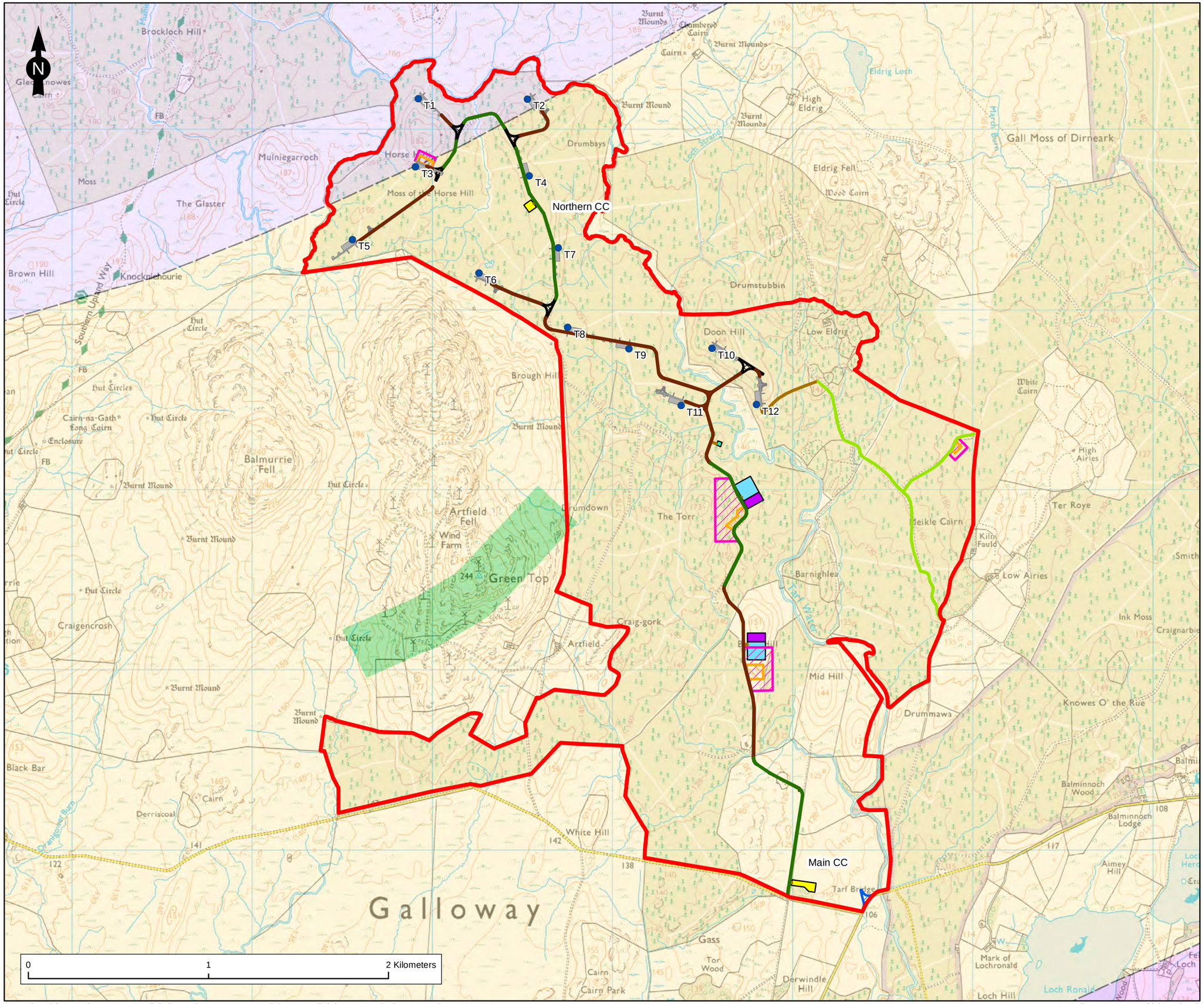
1.5.2 None of the proposed substation, borrow pit or energy storage areas intersect with habitats identified as potentially groundwater dependent. One turbine pad location (Turbine 8) crosses an area assessed to be potentially moderately groundwater dependent through NVC surveying (an area of M15 - *Trichophorum germanicum* - *Erica tetralix* wet heath), this area is defined by the presence of a forest track and is not assessed to be groundwater dependent based on hydrological assessment.

1.5.3 Tracks cross areas assessed to be potentially moderately groundwater dependent through NVC surveying at three locations. These comprise an area of M15 (*Scirpus cespitosus* - *Erica tetralix* wet heath) in the south of the Site; an area of M25, M6, M23, U4 and S4 communities (predominantly M25 Molinia caerulea - Potentilla erecta mire) which is on an area of flood plain in connection to the Tarf Water at the proposed crossing to Turbines 10/12; and, an area of MG10/ M25a (predominantly MG10 *Holcus lanatus-Juncus effusus* rush-pasture) on low lying areas in connection a drain at the north west foot of Black Hill. None of these areas are assessed to be groundwater dependent taking in to account site-specific hydrological conditions.

1.5.4 It is considered that the maintenance of quality and quantity in surface water distribution across these areas will be important. Suitable drainage and surface water measures would be used to maintain hydrological connectivity in peatland and wetland habitats and prevent deleterious impacts on surface water distribution, which would be addressed in a CEMP for the Site to be developed by the contractor.

Mitigation measures would include those presented in the draft CEMP to be provided with the EIAR and cover the following:

- Avoidance of direct impacts by construction activity in such areas;
- Implementation of Sustainable Drainage System (SuDS) measures to maintain quality of water supply;
- Maintenance of flow paths/ redistribution of water where diverted;
- Implementation of pollution control measures; and
- Demarcation of the most sensitive habitat areas identified in ecological surveying, and monitoring of works in close proximity by the ECoW.



Legend

Site Boundary

BGS 625k BEDROCK

Formation

KIRKCOLM FORMATION

PORTPATRICK FORMATION AND GLENWHARGEN FORMATION (UNDIFFERENTIATED)

SHINNEL FORMATION AND GLENLEE FORMATION (UNDIFFERENTIATED)

Figure Title
Figure 9.1.1: Bedrock Geology

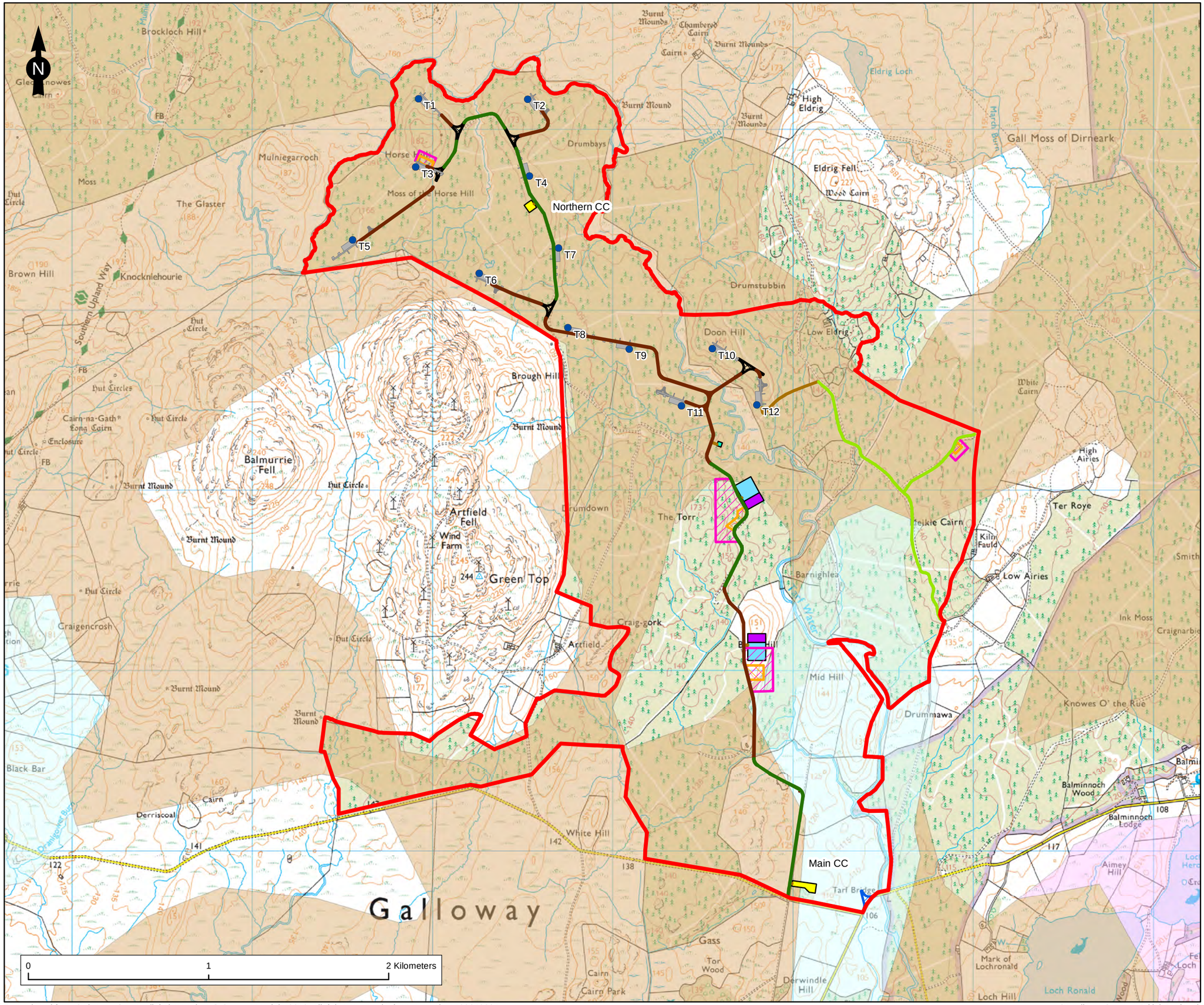
Project Name
Artfield Forest Wind Farm

Project Number	Figure No.
1620008937	9.1.1
Date	**Prepared By**
November 2020	JT
Scale	**Issue**
1:20,000 @A3	1

Client
Artfield Forest Wind Farm Ltd

RAMBOLL

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



Legend

- Site Boundary
- GSG-SAND AND GRAVEL
- PEAT-PEAT
- TILL-DIAMICTON

Figure Title
Figure 9.1.2: Superficial Geology

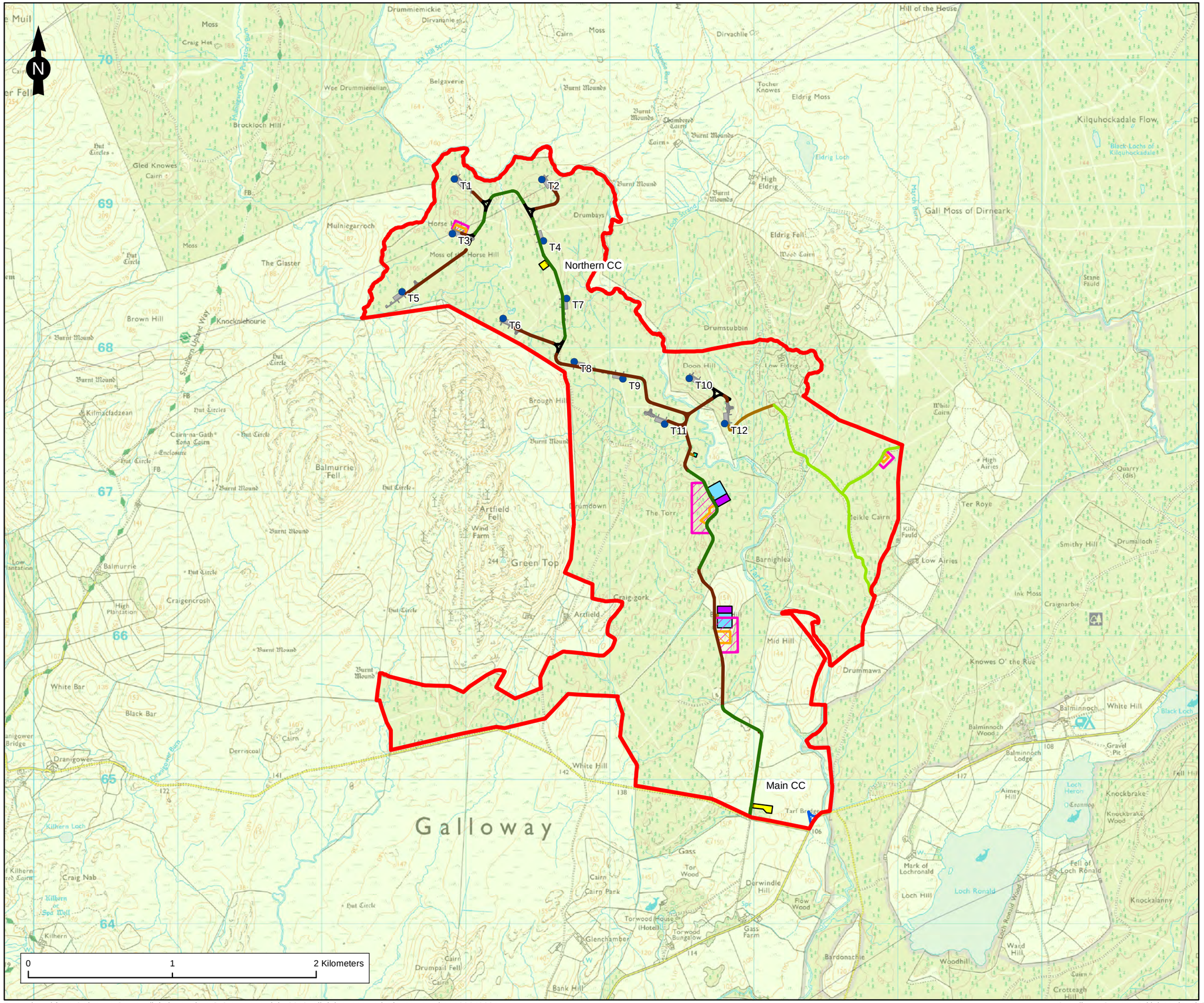
Project Name
Artfield Forest Wind Farm

Project Number	Figure No.
1620008937	9.1.2
Date	**Prepared By**
November 2020	JT
Scale	**Issue**
1:20,000 @A3	1

Client
Artfield Forest Wind Farm Ltd

RAMBOLL

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



Legend

Site Boundary

Hydrogeology BGS 1:625K

Aquifer Classification

Aquifers with significant intergranular flow

- Highly productive aquifer
- Moderately productive aquifer
- Low productivity aquifer

Aquifers in which flow is virtually all through fractures and other discontinuities

- Highly productive aquifer
- Moderately productive aquifer
- Low productivity aquifer
- Rocks with essentially no groundwater

Figure Title
Figure 9.1.3: Hydrogeology

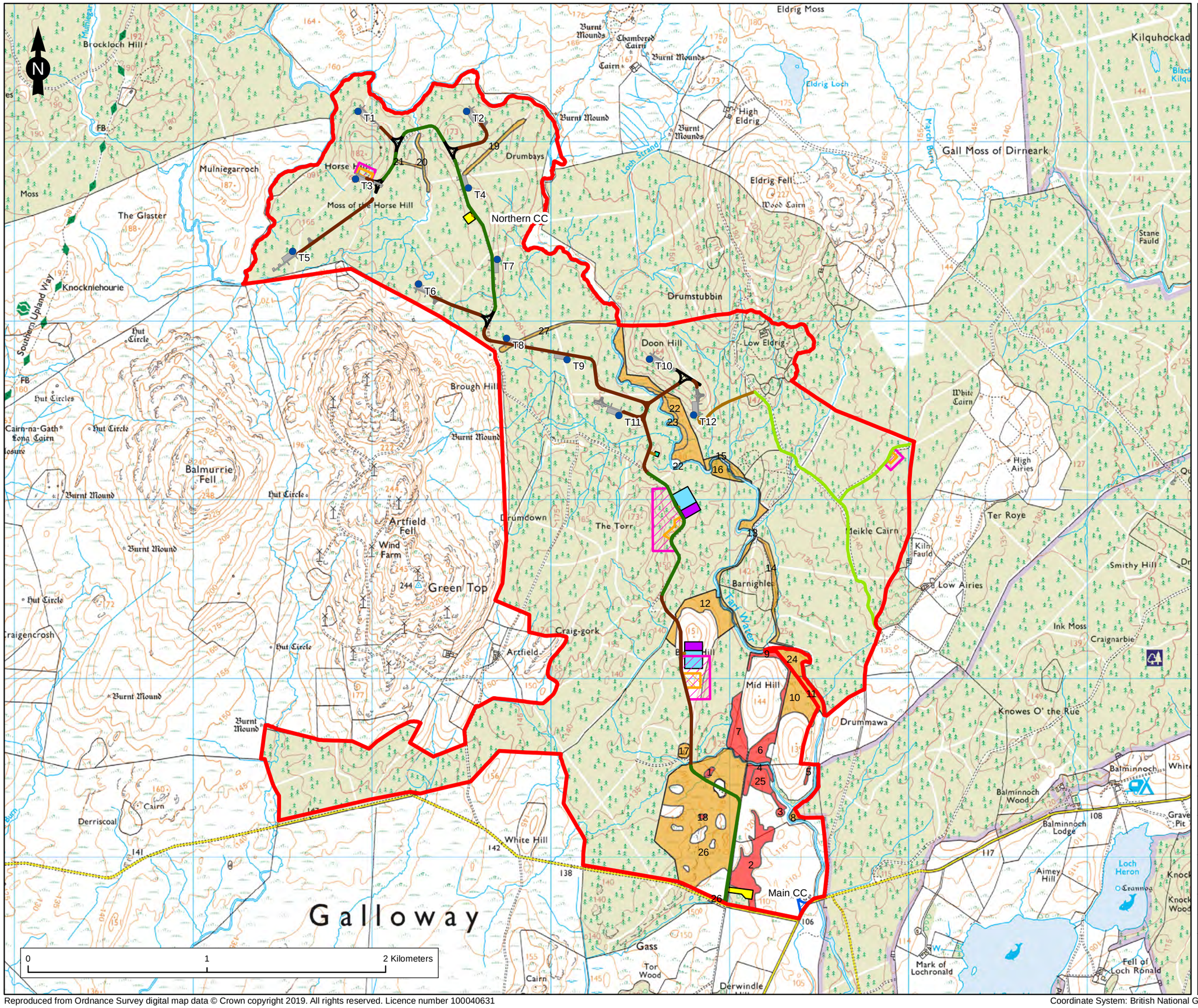
Project Name
Artfield Forest Wind Farm

Project Number	Figure No.
1620008937	9.1.3
Date	**Prepared By**
November 2020	JT
Scale	**Issue**
1:25,000 @A3	1

Client
Artfield Forest Wind Farm Ltd

RAMBOLL

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



Legend

NVC GWDTE Classification

GWDTE

- High
- Moderate
- Not GWDTE

Figure Title
Figure 9.1.4: GWDTE NVC Classification

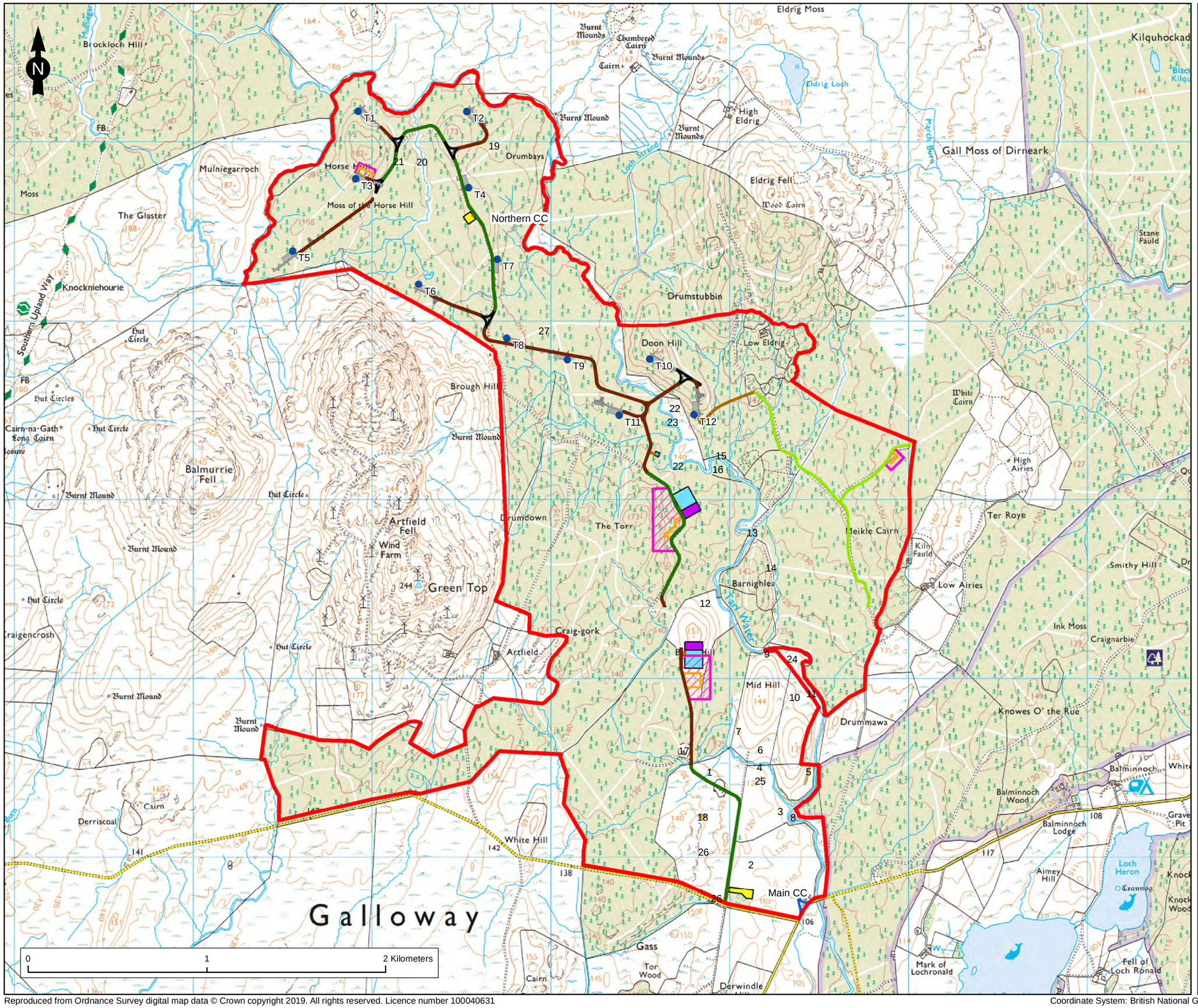
Project Name
Artfield Forest Wind Farm

Project Number	Figure No.
1620008937	9.1.4
Date	**Prepared By**
November 2020	JT
Scale	**Issue**
1:20,000 @A3	1

Client
Artfield Forest Wind Farm Ltd

RAMBOLL

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



Legend

- Site Boundary

Ramboll GWDTE Assessment

- Moderate

Figure Title	Figure 9.1.5: Ramboll GWDTE Assessment
Project Name	Artfield Forest Wind Farm
Project Number	1620008937
Figure No.	9.1.5
Date	November 2020
Prepared By	JT
Scale	1:20,000 @A3
Issue	1
Client	**Artfield Forest Wind Farm Ltd**

RAMBOLL

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

Technical Appendix 9.2: Watercourse Crossing Assessment

Technical Appendix 9.2: Watercourse Crossing Assessment

1.1 Introduction

Background

1.1.1 As part of the Environmental Impact Assessment (EIA) process, it was identified that a number of watercourses which discharge into the River Bladnoch Special Area of Conservation (SAC) would be crossed by the access tracks of the Proposed Development. This document provides a conceptual assessment of watercourse crossings including the strategy for their development but does not comment on detailed engineering design. The Principal Contractor (the 'Contractor') will have overall responsibility for designing water crossings, for the production of a final Watercourse Crossing Plan and for compliance with Controlled Activity Regulations[1] (CAR) regulations and the Scottish Environment Protection Agency's (SEPA) good practice guidance.

1.1.2 Field surveys of likely crossings, based on the proposed alignment of the Proposed Development, have been used to determine various watercourse characteristics (bed width, channel depth, bed substrate, bankside vegetation) in order to identify the likely level of CAR authorisation required. This Technical Appendix also sets out the general principles of design which the Contractor will follow in order to minimise changes to the hydrological regime and reduce any potential impacts on river morphology and aquatic ecology.

Legislation

1.1.3 Principal legislation regarding the water environment is provided by the EU Water Framework Directive (WFD) which aims to protect and enhance the quality of surface freshwater (including lakes, rivers and streams), groundwater, Groundwater Dependent Terrestrial Ecosystems (GWDTEs), estuaries and coastal waters.

1.1.4 The key objectives of the WFD relevant to this assessment are:

- To prevent deterioration and enhance aquatic ecosystems; and
- To establish a framework for protection of surface freshwater and groundwater.

1.1.5 The WFD resulted in the Water Environment and Water Services (Scotland) Act 2003 (WEWS Act[2]), which gives Scottish Ministers powers to introduce regulatory controls over water activities in order to protect, improve and promote sustainable use of Scotland's water environment.

1.1.6 SEPA is the public body responsible for environmental protection in Scotland under both the Environment Act 1995 and the WEWS Act. Many SEPA policies relating to water are now delivered by the regulatory methods produced to implement the CAR Regulations. The CAR Regulations make it an offence to undertake the following activities with regard to watercourse crossings without an authorisation under the CAR Regulations:

- Discharges to all wetlands, surface waters and groundwaters (replacing the Control of Pollution Act 1974);
- Impoundments (dams and weirs) of rivers, lochs, wetlands and transitional waters; and
- Undertaking of engineering works in inland waters and wetlands.

1.1.7 Any proposed access track water crossings would therefore require authorisation under the CAR Regulations. This assessment takes into account SEPA guidance on the implementation of CAR.

1.1.8 The SEPA Position Statement on Culverting of Watercourses[3] (WAT-PS-06-02) and Supporting Guidance on Sediment Management[4] (WAT-SG-78) have also been taken into account within this assessment along with the supporting guidance provided in the River Crossings Good Practice Guide[5].

Identification of Watercourse Crossing Locations

1.1.9 Field surveys of potential watercourse crossings were carried out along the route of the proposed access tracks. The surveys were completed by Briony McIntosh and Scott Jamieson of Ramboll on the 10tand 11 September 2020. A total of nine potential watercourse crossings were identified and are presented in Annex 1.

1.1.10 Photographs of the identified locations are presented in Annex 2. The average channel width and depth, as well as the bed substrate material are presented below.

Table 9.2.1: Watercourse Crossing Identification

Reference	Description	Width (m)	Depth (m)	Bed Substrate
WC2	Small burn	0.4	0.5	Peat, silt
WC3	Small burn	0.4	0.15	Gravel, pebble
WC4†	Small burn	0.3	0.1	Silt, peat
WC5†	Tarf Water	8.0	unknown	unknown
WC6†	Small burn	0.5	0.1	Cobble
WC7	Small burn	0.2	0.15	Cobble

† Surveying was carried out at the early stages of design and surveyed points are not therefore at the exact proposed crossing point. Crossings are over watercourses with very little hydrological variation along their course. Assessment is therefore applicable to the proposed development.

Table 9.2.2: Existing Watercourse Crossing Identification

Reference	Description	Crossing Width (m)	Crossing Height (m)	Type of Crossing
WC1	Watercourse (existing crossing)	3.2	1.5	Circular Culvert
WC8	Watercourse (existing crossing)	4.0	1.2	Circular Culvert
WC9	Watercourse (existing crossing)	4.0	2.0	Circular Culvert

Types of Crossing

1.1.11 The watercourse characteristics, both physical and ecological, will be matched to the most appropriate crossing type during detailed design. The potential crossing types are described below:

[1] The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended): A Practical Guide. Version 8.4 October 2019.

[2] Water Environment and Water Services (Scotland) Act 2003. https://www.legislation.gov.uk/asp/2003/3/contents [Last accessed: November 2020].

[3] SEPA Position Statement to support the implementation of the Water Environment (Controlled Activities) (Scotland) Regulations 2001: WAT-PS-06-02: Culverting of Watercourses – Position Statement and Supporting Guidance. June 2015. Version 2.0. https://www.sepa.org.uk/media/150919/wat_ps_06_02.pdf [Last accessed November 2020].

[4] SEPA Supporting Guidance (WAT-SG-78). Sediment Management Authorisation (replacing WAT-PS_06-03). Version 1. December 2012. https://www.sepa.org.uk/media/151062/wat-sg-78.pdf [Last accessed November 2020].

[5] Engineering in the water environment: good practice guide: River crossings. Second edition, November 2010 https://www.sepa.org.uk/media/151036/wat-sg-25.pdf [Last accessed November 2020].

- Single span structures - recommended where there is a need to minimise disturbance to the bank and bed of the watercourse. Where it is possible to set back abutments from the watercourse, it should be possible to maintain bank habitats under the crossing. Taking into account the maximum width of crossings to be undertaken on the proposed development, it is not anticipated that in-stream supports will be necessary at any crossings.
- Bottomless Box/ Arches - can be used where there are watercourses narrower than those appropriate for bridge construction but which have a requirement to provide mammal and/ or fish passage and ensure sufficient hydraulic capacity during peak flow periods. Arches minimise disruption to the streambed. Box culverts may incorporate mammal ledges and can be buried below stream bed level to enable bed material replacement.
- Circular Culverts - where potential impact is negligible due to the size, location or typology of the watercourse, circular culverts can be embedded into the channel to allow the natural bed to re-establish. Where necessary, provision can also be made for mammals adjacent to the culvert. Where a circular culvert is utilised, it is assumed that neither natural bed material nor water velocity nor depth are critical other than in respect of very localised hydraulics. In these cases, circular culverts are a more economic solution.
- Porous granular rock fill blanket and perforated pipes - where there is no clearly defined channel flow, flow can be maintained by a drainage blanket wrapped in geotextile placed below the road construction. Where such a crossing structure is utilised, flow is predominantly sub-surface interflow and a porous fill below the track provides flow continuity without concentrating the discharges into a narrow channel.

CAR Authorisations

1.1.12 As set out previously, the CAR advise on which activities are regulated by SEPA. In particular, Section 6 of the Water Environment Regulation Practical Guide sets out that CAR requires authorisation for the carrying out of building or engineering works or works other than impounding works in:

- inland surface waters (other than groundwater) or wetlands; or
- in the vicinity of inland water or wetlands and having, or likely to have, a significant adverse impact on the water environment.

1.1.13 In order to allow for proportionate regulation based on the risk an activity poses to the water environment, there are three types of CAR authorisation as described in the following paragraphs.

Levels of Authorisation

GENERAL BINDING RULES

1.1.14 General Binding Rules (GBRs) cover specific low risk activities. Activities complying with the rules do not require an application to be made to SEPA because compliance with a GBR is considered to be compliance with an authorisation. Since the Applicant or its Contractor is not required to apply to SEPA, there are no associated charges.

1.1.15 SEPA uses its statutory role in the land use planning system to highlight GBRs that may apply to a given proposal. The individual GBRs are described in more detail in the appropriate regime-specific sections of the CAR: Practical Guide. They are numbered according to Schedule 3 of the CAR Regulations.

REGISTRATIONS

1.1.16 These allow for the registration of small-scale activities that individually pose low environmental risk but, cumulatively, can result in greater environmental risk. The Applicant or its Contractor must apply to SEPA to register these activities. A registration will include details of the scale of the activity and its location, and there will be a number of conditions of registration that must be complied with. There is an application fee for registrations, though subsistence (annual) charges do not apply.

LICENCES

1.1.17 These allow for site-specific conditions to be set to protect the water environment from activities that pose a higher risk. Licences can cover linked activities on a number of sites over a wide area, as well as single or multiple activities on a single site. Application fees apply to all licences, and subsistence (annual) charges may apply. SEPA has simple licences and complex licences for activities for which different charges apply.

1.1.18 A key feature of CAR licences, unlike GBRs and registrations, is that they require the applicant to nominate a 'responsible person' (i.e. an individual/ partnership/ company) to be held accountable for securing compliance with the terms of the licence.

Requirements for Bridges and Other Crossings

1.1.19 The detailed design of bridges and other crossings will include the application to SEPA for the necessary consents under CAR.

Likely Levels of CAR Authorisation

1.1.20 One crossing will span the Tarf Water, the largest watercourse identified during surveying of the Site (WC5, Annex 1). SEPA guidance typically requires that single span structures be designed where feasible, especially for larger watercourse crossing widths where a bridge design would typically be considered more appropriate. The track is indicated to be 6 m wide and it is anticipated a bridge structure here would affect less than 20 m of total bank. Subject to detailed design, this bridge crossing is considered likely to fall under CAR Registration.

1.1.21 At the remaining potential watercourse crossing locations, it has been assumed for the purposes of this Technical Appendix that the proposed watercourse crossings could constitute culverts with construction on the bed or banks of the watercourses only. Where feasible, bottomless arced culverts may be installed. However, it is noted that closed culverts are likely to be appropriate at most locations due the small size of watercourses, artificial morphology or intermittent flow. This suggests that these smaller crossings would require Registration or a Simple Licence, subject to detailed design.

1.1.22 In order to adopt a conservative approach, it is assumed that the watercourses at these locations would require a Simple Licence. However, this will need to be confirmed by the Contractor through further consultation with the Applicant and SEPA at detailed design stage. These crossings may only require Registration, dependant on detailed design, where closed culverts are proposed on single track roads and where the watercourses are less than or equal to 2 m wide.

Watercourse Crossings

1.1.23 The detailed design of each watercourse crossing would seek to ensure hydraulic conveyance is maintained to prevent any restriction of flows, as well as allowing the free passage of mammals and aquatic ecology. Therefore, it is proposed that each watercourse crossing would have sufficient capacity to pass the climate change-adjusted 1:200-year flood including an allowance for partial blockage. Anticipated watercourse crossing types are specified in Table 9.2.3 below.

1.1.24 Detailed flow calculations would be undertaken by the Contractor in order to inform detailed design and to inform applications for CAR authorisation. Any new crossings identified by the Contractor, additional to those above, would give consideration to any local variations in channel dimensions and to bankside conditions. Where feasible within micrositing allowances, the narrowest locations will be selected, and the stability of the channel banks will also be considered.

1.1.25 Construction shall be carried out in accordance with best SEPA practice[6] and SEPA Guidance for Pollution Prevention[7]. Splash boards and run-off diversion measures, including silt fencing adjacent and parallel to watercourses beneath bridges and at culvert crossings, will be used at all crossings during construction to prevent direct siltation of watercourses.

Table 9.2.3: Anticipated Watercourse Crossing Type

Reference	Description	Likely Crossing Method	Justification
WC1	Watercourse	Upgrade of existing crossing – circular culvert	Limited potential hydraulic or ecological impact
WC2	Small burn	Circular culvert	Limited potential hydraulic or ecological impact
WC3	Small burn	Circular culvert	Limited potential hydraulic or ecological impact
WC4	Small burn	Circular culvert	Limited potential hydraulic or ecological impact
WC5	Tarf Water	Single-span (bridge)	Minimise disturbance to bed and banks, ensure 1:200 + climate change flow capacity
WC6	Small burn	Circular culvert	Limited potential hydraulic or ecological impact
WC7	Small burn	Circular culvert	Limited potential hydraulic or ecological impact
WC8	Watercourse	Upgrade of existing crossing – circular culvert	Limited potential hydraulic or ecological impact
WC9	Watercourse	Upgrade of existing crossing – circular culvert	Limited potential hydraulic or ecological impact

Track Drainage

1.1.26 To ensure that all drainage measures employed during the construction phase of the Proposed Development are maintained appropriately and remain effective, the performance of the drainage measures will be monitored. The drainage management works will, therefore, be supervised by the Environmental Clerk of Works (ECoW).

1.1.27 As the Proposed Development exceeds 4 ha, does and contains >5 km track/ road, it is anticipated that a construction site license will be required under CAR. The appointed contractor would prepare application materials in consultation with SEPA.

1.1.28 Greenfield 'clean' run-off and track run-off should be kept separate where possible and be discharged separately to suitably-vegetated areas at least 50 m from watercourses to allow the settlement of solids. Where settlement over vegetation is not ecologically sound (e.g. involving intact blanket bog, requiring only rain-fed nutrients), or where this is not practical due to the type or scarcity of vegetation cover and/ or available area, silt traps or settlement lagoons will be utilised and monitored to ensure stored surface water is kept to a minimum.

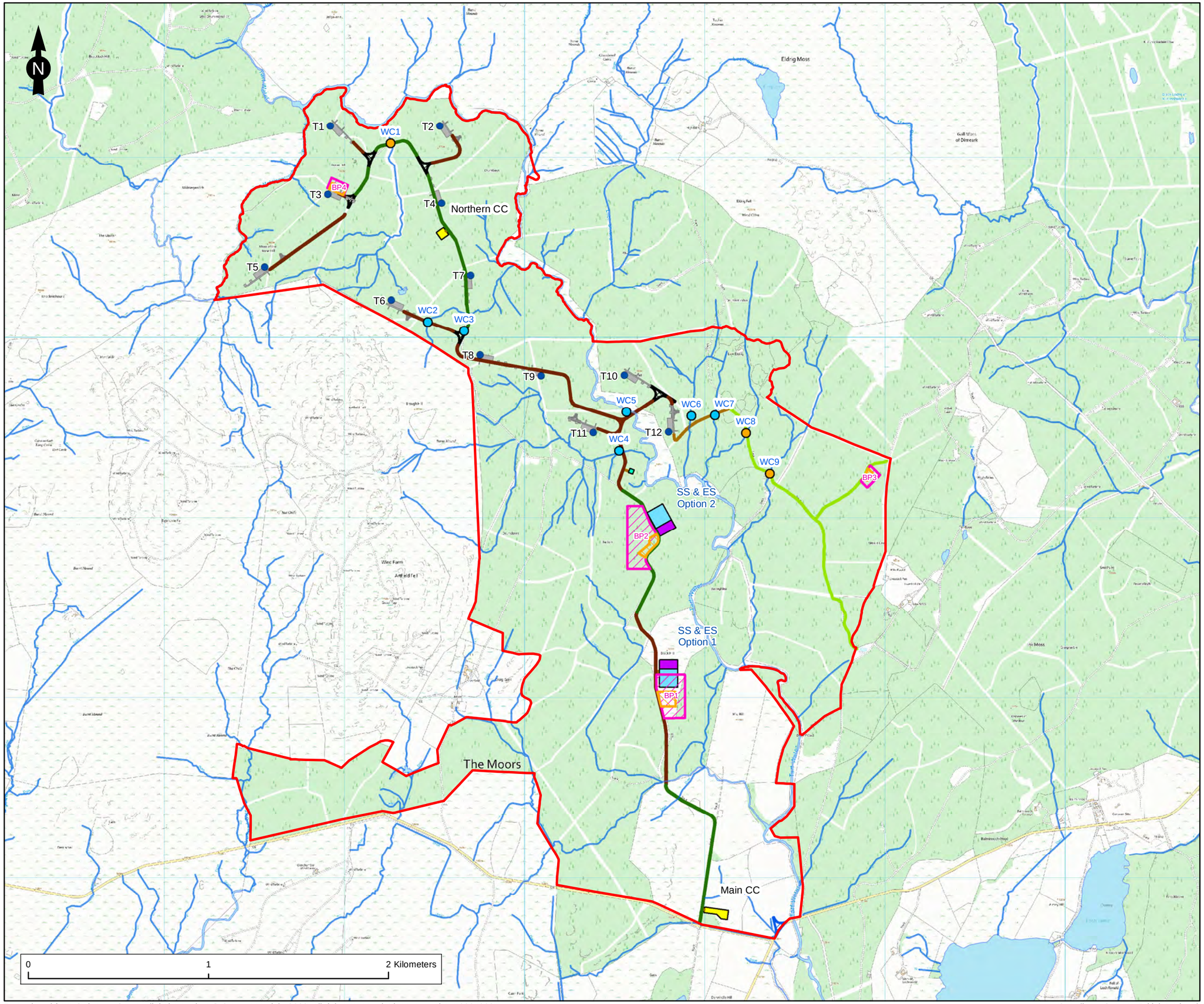
1.1.29 Cross drains will be installed at regular intervals along trackside drainage. Cross drains will be installed as pipe culverts under the track surface. The frequency of cross drains should increase in areas where higher flows are anticipated such as in areas of high surface flow (e.g. flushes or low-lying areas); where bank seepages are noted; and where historical or active drains are intercepted. Requirements for a temporary silt trap at each end of a cross drain will be assessed prior to the works being undertaken.

1.1.30 Pipe culverts used for cross drainage will be long enough so that road fill does not extend beyond the end of a culvert. Pipes will be laid at grades at least 2% (1:50) but no greater than 10% (1:10) and angled 30 degrees to 45 degrees cross-track to improve inlet efficiency. Check dams will be installed immediately above a cross drain inlet and silt traps are required at the inlet points to prevent blockage of the pipe due to silt build up.

[6] SEPA, 2010. Engineering in the Water Environment: Good Practice Guide, River Crossings.

[7] SEPA 2018. Works and Maintenance in or Near water: GPP5

Annex 1 - Figures



Legend

- Site Boundary
- Proposed Turbine
- Proposed Turbine Hardstanding
- Existing Forestry Track No Upgrade
- Existing Forestry Track Upgrade
- New Track (Infrastructure only 4m)
- New Track (6m)
- Proposed Turning Head (Loaded)
- Proposed Turning Head (Unloaded)
- Proposed Temporary Construction Compound (CC)
- Proposed Substation Option (SS)
- Proposed Energy Storage Option (ES)
- Proposed Met Mast and associated hardstanding
- Proposed Borrow Pit Search Area (BP)
- Potential Borrow Pit Excavation Area
- Watercourse Crossing
- Existing Watercourse Crossing
- Watercourse
- Waterbody

Figure Title
Figure 9.2.1: Watercourse Crossing Survey

Project Name
Artfield Forest Wind Farm

Project Number	Figure No.
1620008937	9.2.1
Date	**Prepared By**
February 2021	BM
Scale	**Issue**
1:20,000 @A3	1

Client
Artfield Forest Wind Farm Ltd

RAMBOLL

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

Technical Appendix 9.2: Annex 2 – Photodoc

Location: WC 1

Photo 1: Downstream

Photo 2: Upstream

Location: WC 2

Photo 1: Downstream

Photo 2: Upstream

Location: WC 3

Photo 1: Downstream

Photo 2: Upstream

Location: WC 4

Photo 1: Downstream

Photo 2: Upstream

Location: WC 5

Photo 1: Downstream

Photo 2: Upstream

Location: WC 6

Photo 1: Downstream

Photo 2: Upstream

Location: WC 7

Photo 1: Downstream

Photo 2: Upstream

Location: WC 8

Photo 1: Downstream

Photo 2: Upstream

Location: WC 9

Photo 1: Downstream

Photo 2: Upstream