EnergieKontor UK

GLENVERNOCH WIND FARM

Technical Appendix 12.1 Schedule of Watercourse Crossings

JUNE 2024

PUBLIC

EnergieKontor UK

GLENVERNOCH WIND FARM

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TYPE OF DOCUMENT (VERSION) PUBLIC

PROJECT NO. 70119752

DATE: JUNE 2024

EnergieKontor UK

GLENVERNOCH WIND FARM

Technical Appendix 12.1 Schedule of Watercourse Crossings

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CONTENTS

1 INTRODUCTION

1.1.1. This document provides a Schedule of Watercourse Crossings at the Proposed Glenvernoch Wind Farm (the Proposed Development) as part of Chapter 12 of the Environmental Impact Assessment Report (EIAR). The purpose of this document is to provide the relevant information associated with the watercourse crossings required as part of the Proposed Development and to assist in the identification of regulatory licensing requirements.

1.1.2. All the watercourse crossings are designed to maintain hydrology as well as, where necessary, allowing the free passage of mammals and aquatic species.

1.1.3. All new crossings will be able to convey 1 in 200 year flow volumes plus an appropriate uplift for climate change. Hydraulic modelling to demonstrate compliance would be undertaken prior to construction as part of the detailed drainage design.

1.2 REGULATORY LEGILSLATION

1.2.1. The Water Framework Directive (2000/60/EC) (WFD) represents a significant piece of environmental legislation which has implications for the Proposed Development. The WFD has been transposed into Scottish legislation as the Water Environment and Water Services (Scotland) Act 2003 (or WEWS) and has given Scottish Ministers powers to introduce regulatory controls over activities in order to protect and improve Scotland's water environment. The water environment includes wetlands, rivers, lochs, transitional waters (estuaries), coastal waters and groundwater. These regulatory controls, known as The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR) came into force on the 31st of March 2011.

1.2.2. With respect to watercourse crossings required for the Proposed Development, CAR requires that all 'engineering works in inland waters and wetlands' are subject to authorisation and allow for proportionate risk-based regulation. The authorisation process operates at three levels:

- General Binding Rules (GBR);
- Registration; and
- Licence (Simple or Complex).

1.2.3. GBR are a set of mandatory rules which cover low risk activities. Activities complying with the rules do not require an application to be made to the Scottish Environment Protection Agency (SEPA), however it is mandatory for activities that fall under GBR to comply with the standard rules.

1.2.4. The three authorisation process levels cover activities with increasing levels of potential impact upon the hydrological environment. SEPA will be required to provide authorisation for watercourse crossings shown on the 1:50,000 scale Ordnance Survey (OS) maps (Landranger series). All watercourses, minor or major, are regulated under CAR if works include culverting for land gain, realignment or diversion of watercourses and, in these instances, authorisations are always required. Where appropriate, likely authorisations required for the surveyed crossings are described in this report.

1.2.5. Following an update to CAR in 2018 and in 2021 all large construction projects, which exceed a certain aerial extent, also require a Construction Runoff Permit (CRP), formerly known as a Construction Site License, which must be obtained from SEPA prior to the initiation of construction. Whilst the design of watercourse crossings is in part related to the site's drainage and associated impacts (which is an integral element of the CRP), this document is associated with identifying the licensing requirement for engineering works within the water environment only.

1.3 LIMITATIONS OF ASSESSMENT

1.3.1. This report should be considered ‘live’ and as such changes may be needed should new information come to light. WSP has endeavoured to identify the watercourse crossings required as part of the construction associated with the Proposed Development. However, it is possible additional watercourse crossings, which do not feature on either the OS mapping or were not encountered during the site visit, will be identified within the site. Should the construction process identify additional crossings, then these should be surveyed, and due consideration given to the legislation above to ensure compliance.

1.3.2. The information presented in this document is only intended to act as a guide. The actual design, construction and/or improvements to the crossings during construction will be the responsibility of the appointed Principal Contractor.

2 METHODOLOGY

2.1 DESK STUDY

2.1.1. The desk study consisted of an examination of the infrastructure layout and the identification of watercourses which will require crossings, including those marked on the 1:50,000 scale OS maps. Watercourse buffers are shown in related figures and were applied to those shown on a 1:50,000 scale OS map and were allocated a 50m buffer.

2.1.2. As outlined in Chapter 12 of the EIAR and Technical Appendix 12.1: Schedule of Watercourse Crossing, many of the minor watercourses encountered at the Proposed Development, including those shown only on the 1:50,000 scale OS map.

2.1.3. Details of the hydrological regime and associated flood risk affecting the Proposed Development is presented in Chapter 12 of the EIAR.

2.2 SITE VISIT

2.2.1. Following the desk study, a survey of the identified crossings was undertaken to obtain information specific to each watercourse. Photographs and detailed field notes were taken, reporting the dimensions of the watercourse channel and flood channel (where apparent), the type of substrate and the crossing type.

2.2.2. Watercourse surveys were undertaken in March 2024. The weather conditions during the survey were dry and sunny.

2.2.3. A plan indicating the site boundary and survey points is illustrated in Figure 12.1 of the EIAR – Hydrology Overview.

2.3 WATER CROSSING SELECTION CRITERIA

2.3.1. The design process adopted for each watercourse crossing is complex, taking account of a range of design criteria and constraints to develop the most appropriate crossing for each watercourse. The primary technical standards driving the design of culverts are DMRB HA107/04 Design of Outfall and Culvert Details (2004)[1] and the CIRIA Culvert design and operation guide (C689) (2010)[2]. However, in addition to these technical standards, there are other site-specific drivers that influence the culvert design which include among others: flood risk; maintenance requirements; ecological considerations; and geomorphological considerations. Reference should be made to the UK

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[1] The Highway Agency et al., (2004) *Design Manual for Roads and Bridges, Volume 4, Section 2, Part 7 HA 107/04*

[2] Construction Industry Research and Information Association (CIRIA) (2010) *Culvert design and operation guide.*

Forestry Standard Guidelines[3] which focuses on engineering features, SEPA guidance documents[4] [5] for the construction considerations and Scottish Government guidance for best practice[6] and ecology[7].

2.3.2. The design process for each watercourse crossing is iterative, such that the final design meets the fundamental design standard; which is that the Proposed Development remains free from flooding during the design flood event whilst maintaining adequate freeboard (typically 600 mm) and flood risk is not compromised elsewhere.

2.3.3. Boughty Burn, Clachaneasy Burn, Castle Stewart Burn and their tributaries are not classified under SEPA's River Basin Management Plan (RBMP). However, they drain into the River Cree (u/s Minnoch Conf) and River Cree (u/s Newton Stewart) which have Moderate and Good status respectively under SEPA's RBMP. For future objectives, water crossings that maintain natural flow, gradient and aid fish passage have been recommended.

2.3.4. The River Cree is recognised as having potential to support fish populations (including salmonids). Fish populations could also be present in minor watercourses, and tributaries of the noted tributaries.

[3] Forestry Commission (2017) *The UK Forestry Standard, The governments' approach to sustainable forestry, 4th edition.*

[4] Scottish Environment Protection Agency (SEPA) (2010) *Engineering in the water environment, Good Practice Guide – Construction of River Crossings, 2nd edition.*

[5] SEPA (2015) *WAT-PS-06-02: Culverting of Watercourses - Position Statement and Supporting Guidance, 2nd edition.*

[6] Scottish Government (2019) *Good Practice During Wind Farm Construction, 4th edition.*

[7] Scottish Government (2012) *River Crossings and Migratory Fish: Design Guidance*.

3 WATER CROSSING ASSESSMENT SUMMARY

3.1.1. Ten watercourse crossings were identified for the access tracks constructed as part of the Proposed Development and a summary of the proposed CAR authorisations is summarised in Table 3.1.

Table 3.1 – Car Authorisations

CAR Authorisations	Number of Crossings
Simple License	0
Registration	10
General Binding Rules (GBR)	0
Total	**10**

3.1.2. Table 3.2 provides a summary of the surveyed natural watercourses, including proposed crossing type and proposed CAR authorisation.

Table 3.2 – Surveyed natural watercourses

ID	Easting	Northing	Type	Car Authorisation
WCX1	236643	571994	New	Registration
WCX2	235834	571555	New	Registration
WCX3	235726	571565	New	Registration
WCX4	235598	572098	New	Registration
WCX5	235530	572534	New	Registration
WCX6	234832	573936	New	Registration
WCX7	234565	573931	New	Registration
WCX8	234170	573797	New	Registration
WCX9	233680	573555	New	Registration
WCX10	234548	572573	New	Registration

Note: CAR Authorisations classified as a "registration" are identified as a watercourse or water body on an Ordnance Survey Landranger 1:50,000 scale series.

3.1.3. The location of the watercourse crossings in relation to the proposed infrastructure is provided in Figure 12.1 Hydrological Overview. More detailed information on the watercourse crossings is provided in Section 3.2 and takes into account the preceding information, as well as photographs and hydromorphological information associated with each crossing.

3.1.4. In addition to the watercourse presented in this schedule, additional crossings may be required on unmapped, minor artificial ditches. Some of these ditches may be blocked as part of habitat enhancement proposals and in other culverts or other cross drainage structures would be utilised. Good practice mitigation regarding pollution prevention is outlined in Chapter 12. Further details on the identification of artificial ditches and their corresponding management as part of flood elevation and enhancement through Natural Flood Management is presented in Technical Appendix 9.4: Biodiversity Restoration and Enhancement Plan (BREP).

3.1.5. In addition to the CAR authorisations summarised in Table 3.1, the Proposed Development will also require a Construction Runoff Permit (CRP) to meet SEPA's permitting principles and must be obtained prior to construction.

4 RATIONALE & DESIGN

4.1.1. The design of the Proposed Development has been optimised as far as possible to reduce the total area of land-take and minimise the number of watercourse crossings whilst accommodating other environmental or engineering related constraints. At each watercourse crossing location, consideration has been given to the nature and size of the crossing, fluvial scour and environmental requirements.

4.1.2. In designing the watercourse crossings, industry good practice will be applied, ensuring that various conditions will be considered during the works, and which are summarised below:

- All watercourses, over which the access tracks cross, will be routed through circular or box culverts, bottomless arch culverts or under bridges appropriately sized and designed not to impede the flow of water;
- Safe passage for wildlife, such as fish, water voles, otters etc. will also be considered in the design through increased capacity of culvert or separate mammal crossing (pipe);
- When constructing culverts, the appointed Principal Contractor takes care to ensure that the construction does not pose a permanent obstruction to migrating species of fish, or riparian mammals;
- If instream works are planned in a watercourse supporting trout/salmon then such works should avoid taking place between October – May to protect spawning redds. Also, a fish rescue by electrofishing should take place prior to instream works in fish supporting watercourses. Final arrangements would be clarified with the Galloway Fisheries Trust;
- Culvert design will be engineered to ensure that the invert can be sunk into the bed of the watercourse allowing riverine substrate to stabilise on the floor of the culvert, in this regard a preference for box culverts is advocated;
- Designed to convey a minimum of 1 in 200 year plus climate change return period flood events[8] and individually sized and designed to suit the specific requirements and constraints of its location. For larger crossings such as single span structures, a minimum freeboard of 0.6m above the 1 in 200 flow must also be incorporated; and
- All watercourse crossings to include splash boards and run-off diversion measures to prevent any direct siltation of watercourses.

4.1.3. Erosion protection will be implemented at the outfall of all culverts. Where required, the type of erosion protection would depend on a number of factors including:

- Flow;
- Velocity;
- Channel bed material;

[8] As per SEPA Land Use Planning Guidance CC1 (LUPS-CC1), it is predicted that there will be increases in rainfall intensity due to climate change which will increase the severity and frequency of flooding on small watercourses. This will subsequently increase the peak runoff flows in these small catchments. The climate change uplift required for the Solway River Basin region for total change to the year 2100 is a 53% increase in peak river flows and a 38% increase in peak rainfall intensity.

- Vegetation;
- The effects/consequences of erosion; and
- Types of erosion protection including:
  - Geotextile bank reinforcement;
  - Vegetation;
  - Dumped stone;
  - Laid stone (Rip-rap or equivalent); and
  - Concrete block systems.

4.1.4. The appointed Principal Contractor will adhere to the following principles for culvert design and construction:

- Where appropriate, the natural low flow depths are maintained through culvert base;
- The culvert base should be buried below the natural bed level to allow for a naturalised culvert bed to be maintained during scour associated with high flow events;
- The culvert should be at least the same width as the natural active channel width, with consideration to low flows and channel migration;
- Culvert alignment should match alignment of the watercourse i.e. in a parallel direction to flow;
- The slope of the culvert base should be similar to that of the bed of the watercourse;
- The culvert must not present a barrier by creating a step or hydraulic drop at the culvert inlet or outlet;
- The culvert must be designed not to exacerbate or create flooding;
- A natural stone headwall should be provided upstream and downstream to protect the road embankment where necessary;
- Culverts should not be constructed under high flow conditions; and
- A mammal tunnel should be provided where considered appropriate by the Environmental Clerk of Works (ECoW), so that no restriction is related to established animal movement routes.

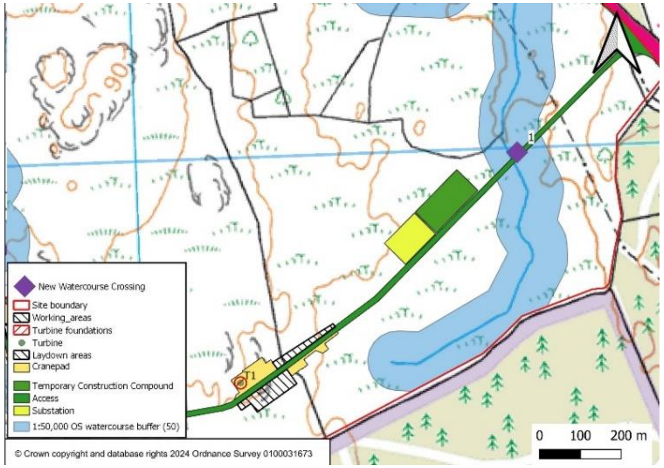
4.1.5. Following the completion of detailed site investigation and micro-siting, **a revised version of this assessment should be produced** to estimate peak flows in the watercourses for which flows need to be accommodated to ensure that any potential risk to flooding is minimised. Due to the small size of the catchments, and it being unlikely that local flow data will exist, in line with SEPA guidance, a number of techniques should be presented in the estimation of peak flows. These estimated peak flows will help inform the detailed design considerations required for each of the identified crossing locations. An indication of the required sizing for crossing dimensions would also be provided.

5 DETAILED CROSSING ASSESSMENT

5.1.1. Information on the new watercourse crossings outlined in Table 5.1 are provided below.

WXC 1 (E236643 & N571994)

Crossing Location



Crossing Description

Existing Crossing: No

Channel Type: Undefined

Gradient: Gentle

Valley form: Shallow vee

Bank condition: Poorly defined, rushes and wet ground

Bed material: Vegetated

Riparian corridor: Moorland

Flow condition: Stagnant

Water width (m): 2.5

Water depth (m): 0.1

Bankfull width (m): 2.5

Bankfull height (m): 0.1

Note: Shown on 1:50,000 scale OS Map.

CAR Auth Level: Registration

Proposed Crossing Type: To accommodate flow and aid fish passage oversized culverts which contain natural bed material or similar is recommended. Several smaller culverts may be required to maintain flows outside of main channel.

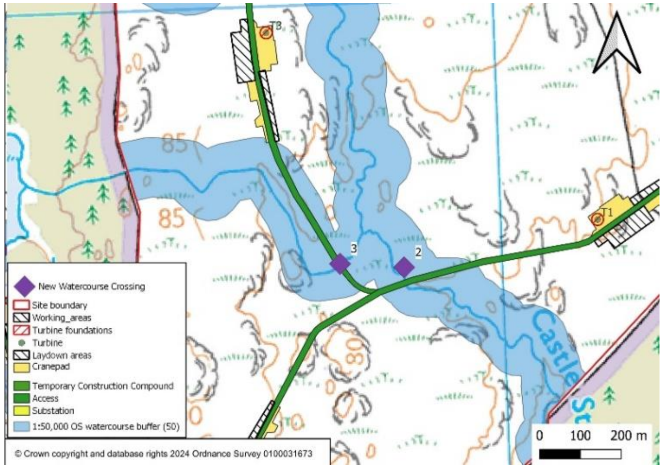
Crossing Photographs

Upstream

Across

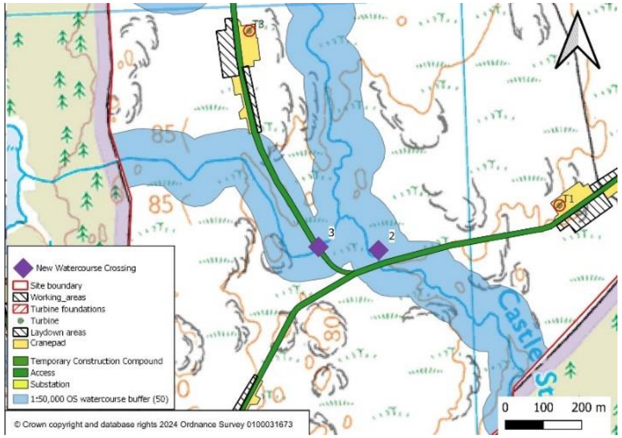
Downstream

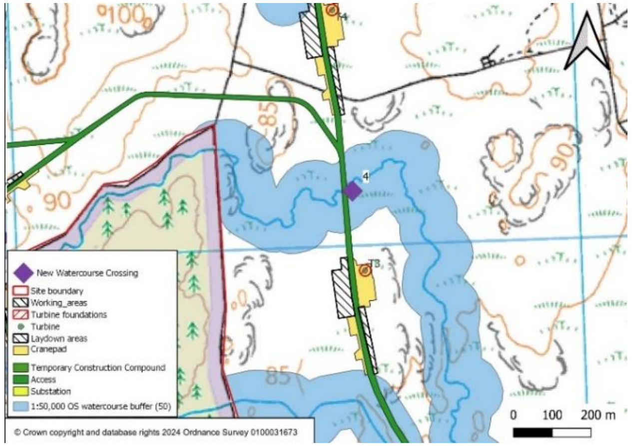
WXC 2 (235834 & 571555)

Crossing Location	Crossing Description	
	Existing Crossing: No Channel Type: Step-pool Gradient: Gentle Valley form: Steep vee Bank condition: Vegetated with some erosion Bed material: Rocks, gravel & sand Riparian corridor: Moorland Flow condition: Fast	Water width (m): 2 Water depth (m): 0.5 Bankfull width (m): 4 Bankfull height (m): 0.7 Note: Shown on 1:50,000 scale OS Map. **CAR Auth Level: Registration** Proposed Crossing Type: To accommodate flow and aid fish passage oversized culverts which contain natural bed material or similar is recommended.

Crossing Photographs

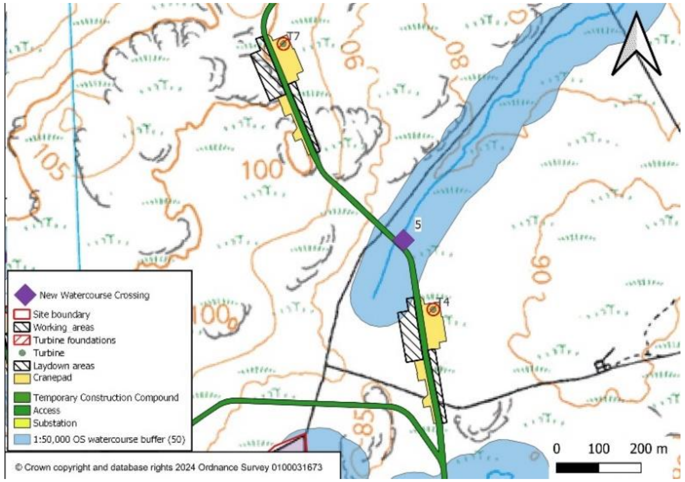
Upstream	Across	Downstream
		

WXC 3 (235726 & 571565)		
Crossing Location	**Crossing Description**	
	Existing Crossing: No Channel Type: Incised Gradient: Gentle Valley form: Shallow vee Bank condition: Vegetated with boulders Bed material: Gravel Riparian corridor: Moorland Flow condition: Fast	Water width (m): 0.35 Water depth (m): 0.25 Bankfull width (m): 0.50 Bankfull height (m): 0.50 Note: Shown on 1:50,000 scale OS Map. **CAR Auth Level: Registration** Proposed Crossing Type: To accommodate flow and aid fish passage oversized culverts which contain natural bed material or similar is recommended.
Crossing Photographs		
Upstream	**Across**	**Downstream**
		

WXC 4 (235598 & 571565)		
Crossing Location	**Crossing Description**	
	Existing Crossing: No Channel Type: Incised Gradient: Gentle Valley form: Undefined Bank condition: Vegetated with some erosion Bed material: Silt & bedrock Riparian corridor: Moorland Flow condition: Slow / Stagnant	Water width (m): 1 Water depth (m): 0.2 Bankfull width (m): 1.3 Bankfull height (m): 0.5 Note: Shown on 1:50,000 scale OS Map. **CAR Auth Level: Registration** Proposed Crossing Type: To accommodate flow and aid fish passage oversized culverts which contain natural bed material or similar is recommended.
Crossing Photographs		
Upstream	**Across**	**Downstream**
		

WXC 5 (235530 & 572534)

Crossing Location



Crossing Description

Existing Crossing: No

Channel Type: Undefined

Gradient: Gentle

Valley form: Undefined vee

Bank condition: Poorly defined

Bed material: Vegetated

Riparian corridor: Moorland

Flow condition: Stagnant

Water width (m): N/A

Water depth (m): N/A

Bankfull width (m): N/A

Bankfull height (m): N/A

Note: Shown on 1:50,000 scale OS Map.

CAR Auth Level: Registration

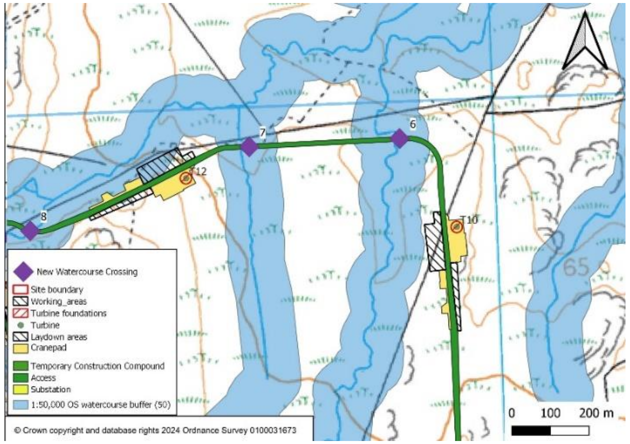
Proposed Crossing Type: To accommodate flow and aid fish passage oversized culverts which contain natural bed material or similar is recommended.

Crossing Photographs

Upstream	Across	Downstream
no photo		*no photo*

WXC 6 (234832 & 573936)

Crossing Location



Crossing Description

Existing Crossing: No

Channel Type: Incised

Gradient: Gentle

Valley form: Undefined

Bank condition: Vegetation, gravel and rock

Bed material: Gravel

Riparian corridor: Moorland

Flow condition: Fast

Water width (m): 1.5

Water depth (m): 0.3

Bankfull width (m): 1.5

Bankfull height (m): 0.3

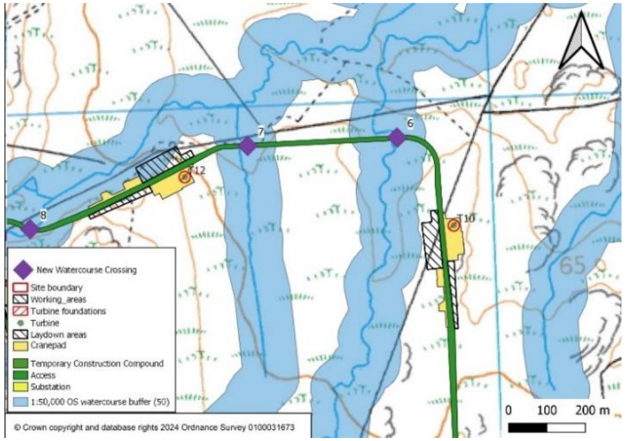
Note: Shown on 1:50,000 scale OS Map.

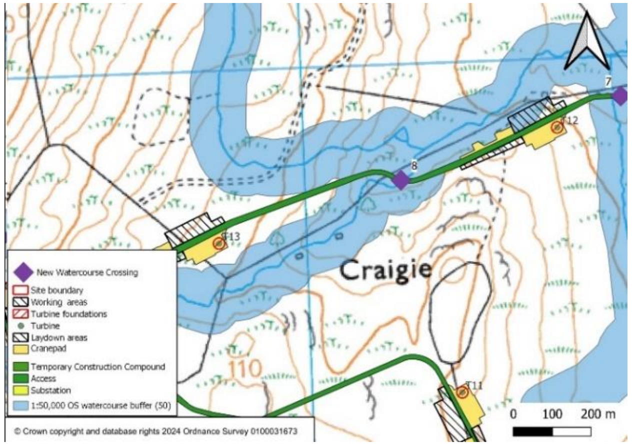
CAR Auth Level: Registration

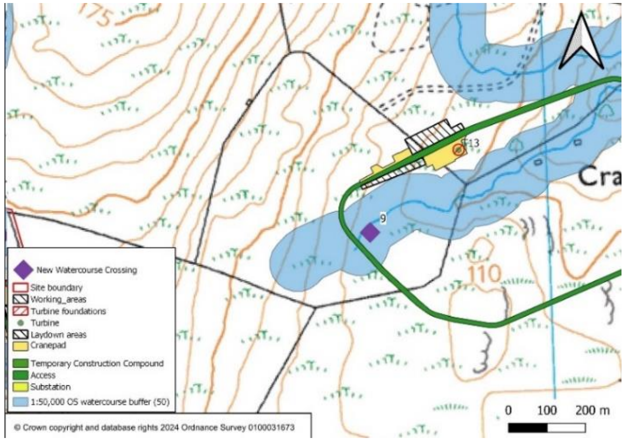
Proposed Crossing Type: To accommodate flow and aid fish passage oversized culverts which contain natural bed material or similar is recommended.

Crossing Photographs

Upstream	Across	Downstream
	*no photo*	

WXC 7 (234565 & 573931)		
Crossing Location	**Crossing Description**	
	Existing Crossing: No Channel Type: Incised Gradient: Gentle Valley form: Shallow vee Bank condition: Vegetated with boulders Bed material: Gravel, vegetation and peat Riparian corridor: Moorland Flow condition: Fast	Water width (m): 0.5 Water depth (m): 0.3 Bankfull width (m): 0.6 Bankfull height (m): 0.7 Note: Shown on 1:50,000 scale OS Map. **CAR Auth Level: Registration** Proposed Crossing Type: To accommodate flow and aid fish passage oversized culverts which contain natural bed material or similar is recommended.
Crossing Photographs		
Upstream	**Across**	**Downstream**
		

WXC 8 (234170 & 573797)		
Crossing Location	**Crossing Description**	
	Existing Crossing: No Channel Type: Plane bed and riffles Gradient: Gentle Valley form: Shallow vee Bank condition: Vegetated, trees with some erosion Bed material: Gravel, cobbles Riparian corridor: Moorland Flow condition: Moderate	Water width (m): 2 Water depth (m): 0.1 Bankfull width (m): 2.5 Bankfull height (m): 0.3 Note: Shown on 1:50,000 scale OS Map. **CAR Auth Level: Registration** Proposed Crossing Type: To accommodate flow and aid fish passage oversized culverts which contain natural bed material or similar is recommended.
Crossing Photographs		
Upstream	**Across**	**Downstream**
		

WXC 9 (233680 & 573555)		
Crossing Location	**Crossing Description**	
	Existing Crossing: No Channel Type: Incised Gradient: Gentle Valley form: Shallow vee / poor definition Bank condition: Vegetated, boggy Bed material: Gravel Riparian corridor: Moorland Flow condition: Slow	Water width (m): 0.2 Water depth (m): 0.2 Bankfull width (m): 0.3 Bankfull height (m): 0.3 Note: Shown on 1:50,000 scale OS Map. **CAR Auth Level: Registration** Proposed Crossing Type: To accommodate flow and aid fish passage oversized culverts which contain natural bed material or similar is recommended.
Crossing Photographs		
Upstream	**Across**	**Downstream**
		

<table>
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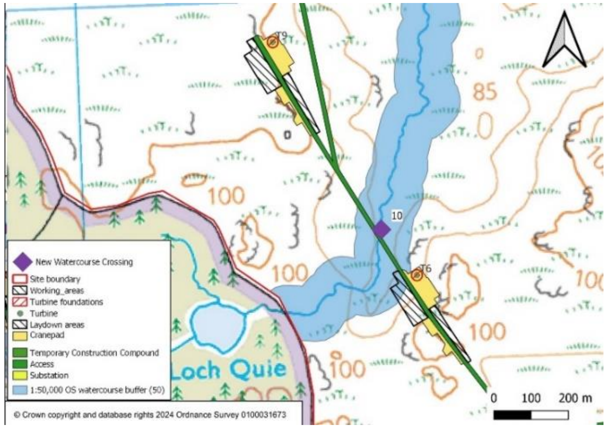
<td>
</td>
<td>Existing Crossing: No
Channel Type: Incised
Gradient: Gentle
Valley form: Shallow vee / poor definition
Bank condition: Vegetated, boggy
Bed material: silty gravel with some in stream grass and moss
Riparian corridor: Moorland
Flow condition: Slow</td>
<td>Water width (m): 1.3
Water depth (m): 0.3
Bankfull width (m): 1.5
Bankfull height (m): 1.0

Note: Shown on 1:50,000 scale OS Map.
CAR Auth Level: Registration
Proposed Crossing Type: To accommodate flow and aid fish passage oversized culverts which contain natural bed material or similar is recommended.</td>
</tr>
<tr><th colspan="3">Crossing Photographs</th></tr>
<tr><th>Upstream</th><th>Across</th><th>Downstream</th></tr>
<tr><td></td><td></td><td></td></tr>
</table>

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CONTENTS

EXECUTIVE SUMMARY

Peat Avoidance

The assessment presented in Section 2 of this Soil and Peat Management Plan (SPMP) identifies that peat and peatlands are present within the Proposed Development, albeit discontinuously.

The peat survey recorded ~72% of depths at less than 0.4m, such material is considered as an organic peaty soil. Approximately 16% of survey locations recorded peat within the range of >0.4 - ≤1.0m and ~12% locations recorded peat depths over 1m.

The avoidance of peat has been integral to the design evolution and whilst it has not been possible to entirely avoid peat areas, using survey data has enabled disturbance to be reduced, whilst taking account of various other constraints and engineering requirements for the Proposed Development.

Further measures to minimise peat disturbance through latter stages of design and construction management practices have been proposed.

Minimising Disturbance

Direct and indirect impacts on peat and peatland arising from the construction of the Proposed Development shall be minimised through a combination of design measures as well as the implementation of good practice. All contractors will be made aware of the sensitivity of peat and wetland habitats, and will be required to work within the narrowest practical construction corridor when working in or near areas of peat.

Where peat and peatland excavation is unavoidable, excavation methods would be in accordance with good practice, including seeking to schedule excavation to enable reinstatement to a planned receptor location as quickly as possible. Good practice associated with temporary storage (if direct transfer cannot be achieved), handling and transport also apply.

The exploration of further opportunities for minimising disturbance through embedded design and micrositing would be undertaken following the completion of detailed design post-consent, and would be provided in a later revision of this SPMP.

The SPMP demonstrates that peat has been afforded appropriate consideration during the construction phase of the Proposed Development, should consent be granted.

Restoration

A site-specific peat balance assessment has concluded that excavated peat and peat soil can be re-used as part of the reinstatement of the Proposed Development.

All acrotelmic peat will be re-used in the final surface reinstatement, with catotelmic peat (amorphous and fibrous) prioritised for re-use first in the sequential backfill of excavations to maintain a connection with the water table.

Where there is insufficient capacity for peat re-use at discrete infrastructure locations, peat may be transported short distances to other areas which may have additional re-use capacity (where peat conditions are present). There is the potential to re-use peat infilling natural basins and hollows, which has proven on other peatland developments to be a very effective alternative to re-use in verge reinstatement.

The re-use of peat shall accord with good practice presented in this SPMP to maximise the potential for the re-used soils to become part of a functioning peatland system.

Offset and Enhance

Details on habitat restoration, including proposals for peatland restoration are provided in Volume 3 Technical Appendix: 9.4: Biodiversity and Restoration Enhancement Plan (BREP)of the Environmental Impact Assessment Report (EIAR).

In order to provide a beneficial effect, targeted peatland restoration can be undertaken to improve peatland quality. This would not involve transfer and re-use of peat excavated from the development. Instead, such works would aim to improve the functionality of adjacent peatland through local mechanical intervention. Local restoration techniques could include drain blocking, fugitive juvenile tree removal, gully blocking, hag or eroding edge reprofiling and bare peat pan restoration.

1 INTRODUCTION

1.1 BACKGROUND

1.1.1. The Proposed Development comprises the construction and operation of Glenvernoch Wind Farm (the Proposed Development), as described within Chapter 3 of the EIAR.

1.1.2. The Proposed Development comprises the following:

- 13 turbines and associated foundations;
- Hardstanding areas for erecting cranes at each turbine location;
- On-site tracks connecting each turbine;
- Underground cables linking the turbines to the substation;
- A temporary construction compound; and
- Site substation.

1.1.3. A detailed description of the Proposed Development is set out within Chapter 3 of the EIAR.

1.1.4. The purpose of this Stage 1 Soil and Peat Management Plan (SPMP) is to consider the potential peat management at the site of the Proposed Development such that suitable controls and appropriate methodologies can be employed during the construction and commissioning of the Proposed Development to safeguard peatland and peat as far as possible. This report presents the findings obtained by peat depth surveys undertaken by WSP in 2024.

1.2 PLANNING POLICY, LEGISLATION, GUIDANCE AND GOOD PRACTICE

1.2.1. Scotland's National Planning Framework (NPF4) states that under Policy 5 – Soils [a] "*development proposals should only be supported if they are designed and constructed in accordance with the mitigation hierarchy by first avoiding and then minimising the amount of disturbance to soils on undeveloped land and in a manner that protects soils from damage including from compaction and erosion, and that minimises soils sealing*."

1.2.2. Policy 5[c] also states that "*Development proposals on peatland, carbon rich soils and priority peatland habitat will only be supported for… (ii,) The generation of energy from renewable sources that optimises the contribution of the area to greenhouse gas emissions reductions targets*".

1.2.3. Policy 5[d] states that "*where development on peatland, carbon-rich soils or priority peatland habitat is proposed, a detailed site specific assessment will be required". Policy 5[d] goes on to state that the site specific assessment "should inform careful project design and ensure, in accordance with relevant guidance and the mitigation hierarchy, that adverse impacts are first avoided and then minimised through best practice. A peat management plan will be required to demonstrate that this approach has been followed, alongside other appropriate plans required for restoring and/ or enhancing the site into a functioning peatland system capable of achieving carbon sequestration*".

1.2.4. This Stage 1 SPMP has accommodated the requirements of NPF4 Policy 5 in demonstrating how the mitigation hierarchy has been followed and provides a site-specific assessment suitable for demonstrating the safeguarding of peat.

1.2.5. Legislation relevant to the management of peat includes the following:

- The UK Climate Change Act 2008 (c27);
- Environmental Protection Act 1990 (as amended);

- Landfill (Scotland) Regulations 2003 (as amended);
- The Waste Management Licensing (Scotland) Regulations 2011;
- Scotland's National Planning Framework 4, 2023; and
- Wildlife Management and Muirburn (Scotland) Bill, 2024.

1.2.6. There are a number of guidance documents appropriate to the activities planned on site which have been used to guide this assessment, as follows:

- Guidance on Developments on Peatland (SNH, SEPA 2017);
- Guidance on the assessment of peat volumes, reuse of excavated peat and the minimisation of waste (SR, SEPA, January 2012);
- SEPA Regulatory Position Statement – Developments on Peat (SEPA, February 2010);
- Advising on peatland, carbon rich soils and priority peatland habitat in development management. Published April, 2023, revised November 2023 (NatureScot, 2023);
- Good practice during wind farm construction (SR, SNH, SEPA, FCS, HES; September 2015);
- Floating roads on peat (SNH, FCS; August 2010);
- Constructed tracks in the Scottish Uplands (SNH, September 2015); and
- Restoration techniques using peat soil from construction works (SEPA 2011).

MITIGATION HIERACHY

1.2.7. The Scottish Environment Protection Agency (SEPA) and NatureScot (NS) has provided a hierarchy of management approaches through which the effectiveness of the approach to peat management is optimised at development sites, as summarised below:

- **Avoid**
  - Development should first seek to avoid areas of peatland, carbon-rich soils and priority peatland habitat.
- **Minimise**
  - Prevention – prevent or minimise peat excavation/disturbance through considered design that avoids or minimises wind farm infrastructure within areas of peat. Where avoidance is not possible, minimise excavation of peat using engineering solutions such as floating roads.
  - Re-Use/Reinstatement – re-use extracted peat close to its original location in the reinstatement or restoration of temporary infrastructure, road verges and borrow pits. Peat may also be used where appropriate to improve or restore peatland habitats.
  - Recycle/Recover/Treat – while the priority should always be to prevent and re-use peat on site there may be situations in which there may still be a surplus of excavated peat. Where demonstrated that it is suitable for use, peat may be blended, dewatered or treated to improve its properties to support re-use on site.
  - Temporary storage – store the peat temporarily during construction prior to re-use in on site reinstatement or restoration activities.
- **Restore**
  - Repairing damaged habitats.
  - Any habitats that are damaged by the proposal (whether direct or indirect impacts) should be restored as far as is possible.

- **Offset**
  - Compensating for residual impact that remains, with preference to on-site over off-site measures.
  - Effective restoration and management of equivalent degraded habitat should compensate for any losses.
- **Enhance**
  - Enhance biodiversity, including by restoring degraded habitats and building, and strengthening nature networks.
  - This is a requirement to provide biodiversity enhancements, these measures are in addition to the restoration and offsetting requirements.

1.3 OBJECTIVES OF THIS SPMP

1.3.1. This Stage 1 SPMP summarises the investigation that has been undertaken to characterise the Study Area and includes secondary sources of published information as well as primary data collected through fieldwork.

1.3.2. The objective of this report is to ensure that there has been a systematic consideration of peat management and a quantitative assessment throughout the development process.

1.4 METHODOLOGY

1.4.1. The SPMP outlines the overall approach of minimising disruption to peatland, and it aims to ensure that all further opportunities to minimise peat disturbance and extraction would be taken during detailed design and construction of the Proposed Development. The Stage 1 SPMP is based on pre-construction information and will be superseded post-consent by further Stage 2 and Stage 3 assessments utilising detailed design.

1.4.2. The report provides methodologies required to assess all potential surplus materials and presents preliminary estimates of the expected volume of excavated materials and required re-use volumes for reinstatement and restoration purposes. In particular, this report considers the excavation and re-use of peat as part of the construction process.

1.4.3. The report also demonstrates how the Proposed Development layout has been modified following an iterative approach to avoid potentially difficult or sensitive areas. Such areas include:

- Areas of deep peat, requiring potentially large volumes of excavation;
- Areas of very wet peat (such as flushes, pool and hummock complexes and gullied peatland);
- Areas of moderate to steep slopes (where site construction might increase the chance of peat instability); and
- Areas of sensitive habitat.

1.5 SITE DESCRIPTION

1.5.1. The Study Area considered by this SPMP is defined in Chapter 12 of the EIAR.

1.5.2. The land-use is a mixture of moorland /pastoral land used for rough grazing. Artificial drainage is present to a degree across all of these areas.

1.6 DEFINITION OF PEAT

PEAT DEPTH

1.6.1. Peat is defined in the Wildlife Management and Muirburn (Scotland) Bill (2024) as a soil which has an organic content of more than 60%. Peatland is defined as land where the soil layer of peat has a thickness of greater than 40 cm.

1.6.2. Peat consists of the partially decomposed remains of plant material and organic matter preserved over a period of time in a waterlogged environment resulting in anaerobic conditions and has been considered for applicable material with depths greater than 0.4 m, based on the aforementioned Wildlife Management and Muirburn (Scotland) Bill (2024).

1.6.3. Peat can be classed as two principal types; the acrotelm and the catotelm. The acrotelm is found in the upper layer of peat where conditions are relatively dry, with seasonal variation, comprising living vegetation and partially decomposed plant material. Hydraulic conductivity in this layer tends to be higher in relation to distance from the underlying (but seasonally rising) water table.

1.6.4. The thickness of the acrotelm layer varies depending on topography such as steepness of slope, peat hags and hummocks. In particular, the acrotelm layer can be affected during periods of drought or as a consequence of drainage. Fibrous in texture, the acrotelm layer has some tensile strength and is generally considered to be stable for storage and re-use. The acrotelm has very similar properties to peaty soils (organic soils with depths of less than 0.4 m).

1.6.5. The catotelm layer is found under the acrotelm layer and comprises decayed plant material and organisms and is denser and with a very low hydraulic conductivity. The catotelm layer is located below the water table, resulting in permanent anaerobic conditions. The catotelm layer is fibrous in its upper horizon but usually becomes increasingly amorphous with depth. Amorphous peat has very low tensile strength, with poor structural characteristics and higher sensitivity to handling, making it less suitable for storage and re-use.

PRIORITY PEATLAND

1.6.6. According to NS (2023), priority peatland corresponds with particular habitat communities that show evidence of being undisturbed and actively forming peat, as defined below:

- M1 Sphagnum denticulatum, M2 Sphagnum fallax/S. cuspidatum and M3 Eriophorum angustifolium
  - Bog pools occupy waterlogged depressions, shallow pools and erosion channels on bogs;
- M17 Trichophorum-Eriophorum and M18 Erica-Sphagnum
  - Communities of wetter peat and have species such as Molinia caerulea, Trichophorum cespitosum, Myrica gale and Erica tetralix; and
- M19 Calluna-Eriophorum.

1.6.7. Certain vegetation communities occurring in blanket bog above 600 m (known as montane bogs) are also identified as priority peatland habitat, these are particularly sensitive and can be difficult to restore.

1.6.8. Peat and peatlands can be degraded over time due to natural erosion and anthropogenic factors such as dewatering from land drainage and erosion from livestock. Climate change, in particular weather extremes, warmer temperatures and intensive rain, can further exacerbate these natural and anthropogenic causes. Particular vegetation and habitat communities can indicate degradation, being unlikely to be reflective of priority peatland. These include:

- M20 Eriophorum vaginatum
  - A degraded form of M19 where the heather and most of the Sphagna have been eliminated by heavy grazing, repeated burning and/or atmospheric pollution;
- M15 Trichophorum-Erica, M16 Erica-Sphagnum and M25 Molinia-Potentilla
  - Classed as blanket bog when they are on deep peat, as they are almost always a replacement for the original bog vegetation, following unfavourable management such as regular burning and/or heavy grazing.

1.6.9. In accordance with the mitigation hierarchy presented in Section 1.2 of this SPMP, priority peatland communities should be avoided by development or impacts minimised through design and mitigation. Areas of degraded peatland present opportunities for restoration of enhancement.

2 OCCURRENCE OF PEAT

2.1 FIELD SURVEYS

2.1.1. Peat depth surveys were undertaken to inform this SPMP as well as Technical Appendix 12.3 Peat Landslide Hazard Risk Assessment (PLHRA).

2.1.2. Surveys were undertaken in April 2023, and then April and May 2024.

2.1.3. Peat survey campaigns have generally been conducted with reference to the Scottish Government guidance for peat surveys;

- A site-wide Phase 1 (100 m x 100 m grid) peat depth survey was completed by a Third Party in April 2023 (with data shared with WSP, following project engagement);
- After design chill, Phase 2 (detailed) peat surveys were undertaken at all infrastructure locations in April 2024 and comprised of the following;
  - 10 x 10 m grid at all turbines, crane pads and auxillary laydown areas, substation and temporary construction compound;
  - Along access tracks points were sampled at 50 m intervals with x2, 10 m perpendicular offset points.
- Following the review of the design against the Phase 2 peat survey results, the layout was modified to avoid and reduce disturbance to areas of peat and particularly deeper peat, as far as possible. Additional Phase 2 surveys were then undertaken in May 2024. The modification of the design are presented in Section 4.1 of this SPMP.

2.1.4. Peat depth survey methods followed good practice. Depths were measured using utility probes advanced by hand through the soil until refusal. Notations on morphology, peat condition and a judgement of the likely substrate were also recorded.

2.1.5. Six peat cores were taken using a Russian auger allowing field tests and observations of the peat column and substrate (where possible). The following information was recorded during peat core sampling;

- Depth of acrotelm;
- Degree of humification using Von Post classification;
- Water content; and
- Substrate underlying the peat (where possible).

2.1.6. The distribution of survey points is shown in Volume 1 Figure 12.7: Peat Depth & Condition.

2.2 PEAT CONDITIONS

PEAT DEPTH & DISTRIBUTION

2.2.1. A total of 4,408 probing measurements were undertaken, with the results summarised in Table 2-1 Peat Probing Summary below.

2.2.2. The peat was found to vary across the site in terms of thickness and coverage. Where depth of less than 0.4 m was recorded, this has been considered to be an organic peaty soil rather than peat. 71.7% peat probing locations identified organic peaty soils or soft mineral soils that were <0.4 m deep, 16.2% of survey locations encountered peat within the >0.4 - ≤1.0m and 12.1% locations recorded peat over 1m deep.

2.2.3. Areas of deeper peat (>1m) were generally localised to flat expanses in the west of the Site. The most notable occurrences of deep peat were coincident with the area of mapped Class 1 peat north of Loch Quie in the central west of the Site.

Table 2-1 – Peat Depth Survey Summary

Peat Thickness (m)	Survey Points (count)	Average peat depth (m)	Percentage (of total points)
<0.4 m (peaty soil)	3,160	0.16	71.7%
0.4 to 1.0	714	0.71	16.2%
1.0 to 1.5	197	1.22	4.5%
1.5 to 2.0	142	1.77	3.2%
2.0 to 3.0	133	2.39	3.0%
>3.0	62	4.02	1.4%
Total	4,408	0.46	100%

PEAT HABITATS & PRIORITY PEATLAND

2.2.4. Various plant communities, which are associated with blanket bog and mire, are present at the Site. In more elevated locations the cover of peat-forming sphagnum mosses remains relatively high. These habitats were most closely aligned to the NVC community M25: *Molinia caerulea – Potentilla erecta* mire, *Erica tetralix* sub-community M25a.

2.2.5. The encountered blanket bog is ombrogenous (rainwater fed) and not considered to be dependent on groundwater. Within the blanket bog habitats there are also areas of soligenous mire communities, associated with surface water flow occurring with flush zones or areas intensely drained. There are also more discrete linear acid flush habitats within and on the periphery of these areas of modified and unmodified blanket bog.

2.2.6. Priority peatland habitats were observed on flat areas to the north, east and south-east of Loch Quie, and to the east of Craigie. These habitats are most closely aligned to the NVC community M17*: Trichophorum cespitosum – Eriphorum vaginatum* blanket mire*, Cladonia sub-community* M17b which occurs on slightly drier peats. The NVC community M19 *Calluna Eriophorum vaginatum* blanket mire was observed to the east of a watercourse draining Loch Quie.

Photograph 2-1: Moorland habitat with shrubs and occasional self-seeded trees or juvenile trees (NGR 235699, 571471)

Photograph 2-2: Grassland/rough pasture found on higher ground at the Site and moorland vegetation in flat areas in the background (NGR 234269, 573454)

PEAT CHARACTERISTICS & CONDITION

2.2.7. Peat condition information in accordance with the Peatland Condition Assessment categories was collected on targeted peat surveys undertaken in 2024. Where peat was identified, it was most commonly characterised as Modified or Drained (~750 locations). Modifying pressures were generally associated with erosion from livestock, less frequently from artificial drainage.

2.2.8. None of the peat surveyed was identified as actively eroding.

2.2.9. The peat survey also obtained six peat cores to support **Technical Appendix 12.3 PLHRA**, which were logged according to the von Post scale of humification. The upper layers of peat, to about 0.5 m depth below ground level, were typically H3 to H4, light brown to brown, consisting of fibrous, slightly decomposed material. Decomposition increased with depth, becoming less fibrous and increasingly amorphous. None of the cores encountered H10 completely amorphous peat.

2.2.10. Whilst no specific attempt has been made to differentiate between acrotelmic and catotelmic peat across the Site, alteration of the surface of the peat arising from current and historic land use such as land drainage, forestry encroachment and livestock has resulted in the peat being poorly defined.

2.2.11. Further information on peat condition is presented in **Technical Appendix 12.3 PLHRA**.

SUBSTRATE

2.2.12. The assessment of the underlying substrate was limited with an interpretation only made from the peat probing and coring. The most common substrates, based on surveyor record at refusal depth, was bedrock (56%) or coarse gravel (13%), with some sand (5%) as well as silts and clays (5%) also identified, typically in riparian areas.

2.2.13. None of the six peat cores retrieved substrate. Two were interpreted to be underlain by gravel or sandy gravel and four by bedrock.

3 CONSTRUCTION ACTIVITIES & POTENTIAL EFFECTS

3.1.1. The key elements for construction of the Proposed Development comprise the excavation of turbines and crane pads as well as formation of access to and around the site. These will require the stripping of peat and topsoil down to a suitable load bearing substrate and formation level and applies to following elements of the Proposed Development:

- Wind turbine foundation and permanent crane pad excavations[1] (2,250 m^2);
- Laydown and additional areas at crane pads[2] for the duration of construction (5,650 m^2);
- Cut access tracks (~5 m running width with an additional 1 m either side of drainage);
- Substation (3,600 m^2);
- Cable trenches; and
- Temporary construction compound (5,000 m^2).

3.1.2. Other construction activities that have the potential to disturb peat include:

- Trafficking of plant and machinery over areas underlain by peat and peaty soils;
- Drawdown of the water table for adjacent peatland during excavation dewatering;
- Laydown of materials (including excavated peat and mineral soils) on peat or peatland vegetation; and
- Reinstatement of peat and peaty soils and/or other revegetation activities to reinstate or tie pre-construction peatland habitats into the Development.

3.1.3. These activities have the potential to cause a range of effects during construction and operation including the loss of integrity and vegetation, drying, erosion, oxidation, interruption of peatland hydrology as well as loss of function:

- Loss of structural integrity and peat strength, due to stripping or damaging the surface vegetation turf, excavation, handling and transporting peat (particularly wet, sub-surface peat);
- Erosion and gullying, caused by exposure and desiccation of bare peat surfaces primarily caused by water erosion, due to surface runoff after rainfall;
- Contamination, caused by leaks, spillages or inappropriate laydown of materials; and
- Peat slide, caused by laying wet peat on top of wet peat, laying other heavy materials (including excavated mineral soil or other construction materials) on top of wet peat or by inappropriate stockpiling, such as attempting to create stockpiles of peat that are too high, without bunding, engineering or geotechnical support.

[1] A general arrangement drawing of the Typical Crane Hardstanding layout is presented in Volume 3, Figure 3.7. Refer to Section 5.2 of this SPMP for more details on turbine foundations and permanent crane pads.

[2] A general arrangement drawing of the Typical Crane Hardstanding layout is presented in Volume 3, Figure 3.7. Refer to Section 5.2 of this SPMP for more details on temporary crane pad areas and laydown areas.

4 AVOIDING & MINIMISING PEAT DISTURBANCE DURING CONSTRUCTION

4.1 AVOIDANCE

4.1.1. The infrastructure layout has been iteratively designed to avoid or minimise impact on blanket bog habitats and peat, particularly peat deeper than 1 m. An example demonstrating how a phased approach to design avoided peat, peatland and priority peatland habitat (NVC M17b) is presented in Figure 4-1.

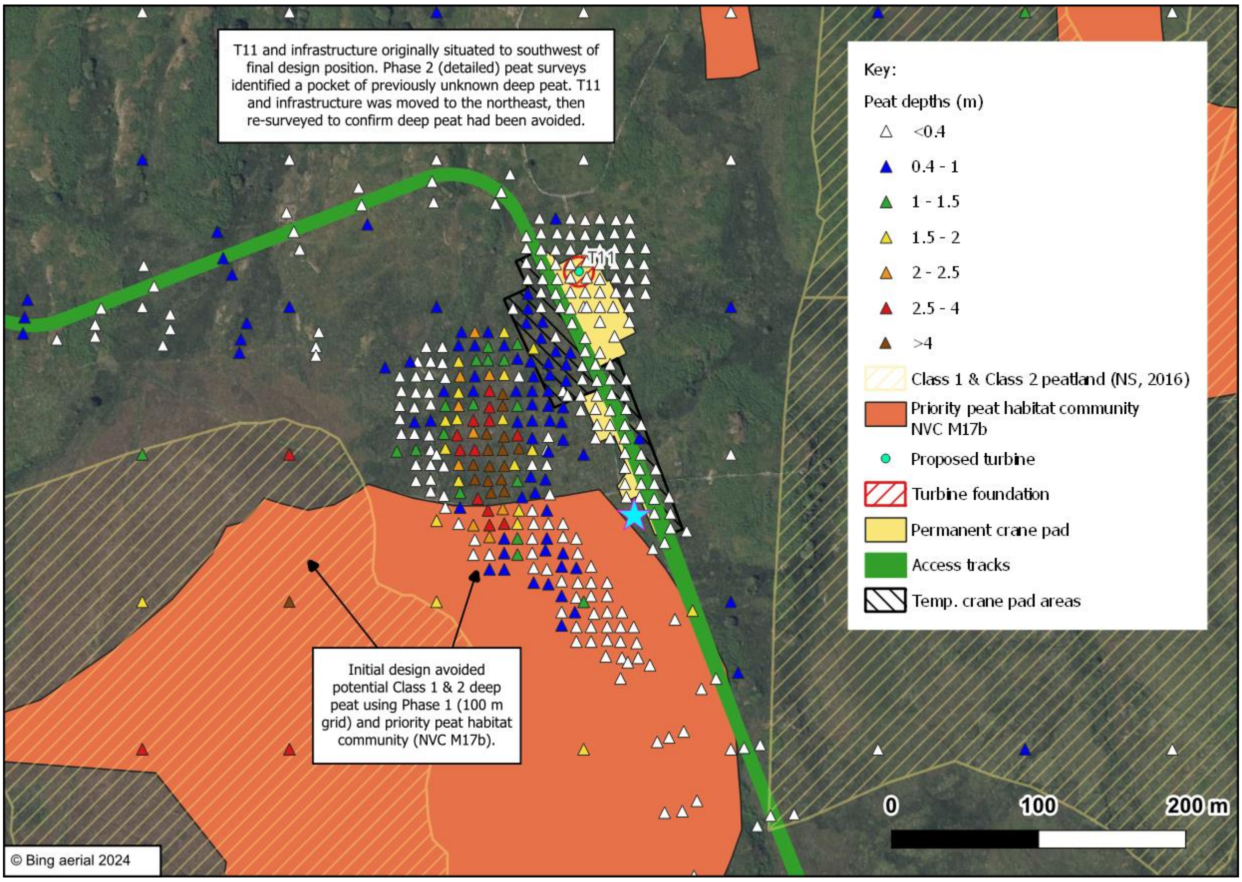

Figure 4-1 – An example of how the phased approach to surveys has allowed the design to evolve and avoid the disturbance of peat and peatland as far as possible. This includes the avoidance of a large expanse of blanket bog habitat and deep peat north of Loch Quie.

4.1.2. Further examples are presented in Volume 1 Figure 12.7: Peat Depth & Condition, which also demonstrates that the majority of the Proposed Development is situated on peaty soil, where depth was recorded as <0.4 m.

4.1.3. Following consent, micrositing of the Proposed Development into areas of shallow peat may be undertaken following further investigation and detailed design, subject to approval from the Environmental Clerk of Works (ECoW). It is expected that the use of micrositing to further avoid peat during detailed design would be secured by way of appropriate planning condition.

4.2 MINIMISE PEAT DISTURBANCE

4.2.1. Where it has not been possible to avoid peat and peatlands, embedded design and good practice mitigation shall be implemented to minimise disturbance.

4.2.2. All contractors will be made aware of the sensitivity of peat and peatland habitats and will be required to work within the narrowest practical construction corridor when working in or near areas of peat. An access plan following the consented access track routes will be developed and physically demarcated. The plan and demarcated route will provide a controlled route and a permissible corridor within which service vehicles and plant can operate prior to peat and topsoil stripping. The purpose of this is to protect in situ peat in areas that will not be affected by the Development layout and prevent unnecessary damage.

4.2.3. Further measures to minimise unnecessary peat disturbance could include the use of construction traffic exclusion zones, signage and demarcation through sensitive areas such as blanket bog habitat north of Loch Quie (Photograph 4-1).

Photograph 4-1: Example of using signage to demarcate peat sensitive areas to avoid inadvertent access.

4.2.4. Measures to minimise peat disturbance outlined in this SPMP will be adopted into the Stage 2 SPMP, as well as the CEMP, that shall be implemented by the Principal Contractor. The ECoW shall monitor compliance of the construction activities with the CEMP and Stage 2 SPMP.

EXCAVATION

4.2.5. All infrastructure would be marked out on the access plan and demarcated on the ground to minimise unnecessary disturbance.

4.2.6. Excavation would be undertaken by suitably experienced personnel in appropriately sized plant, such as 360 degree low-pressure tracked excavators.

4.2.7. The timing of excavation should be planned as to allow reinstatement to be undertaken as quickly as possible in order to minimise the peat and vegetation drying out, which would adversely affect successful re-use.

4.2.8. Excavation activities should be undertaken in accordance with other good practice mitigation including drainage management and pollution prevention. It is essential to minimise the effects of erosion on excavated peat and peatlands through good practice.

4.2.9. Peat should be excavated as turves, including the acrotelm (surface vegetation) and a layer of adjoining catotelm (more humified peat) typically up to 0.5 m thick in total, or as blocks of catotelm; the acrotelm should not be separated from its underlying peat:

- The turves should be as large as possible to minimise desiccation during storage;
- Contamination of excavated peat with substrate materials should be avoided; and
- Consider timing of excavation activities to avoid very wet weather and multiple mechanical handling requirements to minimise the likelihood of excavated peat losing structural integrity.

4.2.10. If possible, extract intact full depth acrotelm layers from the top surface of the peat deposit. This technique will maintain connectivity between the surface vegetation and the partially decomposed upper layers of the catotelm.

4.2.11. Any dewatering of excavations in peat and peatland should only be undertaken when absolutely necessary. Measures to minimise the effects of dewatering from upgradient areas around excavations should be implemented where possible, including the use of stripped vegetation to seal low angled cut peat faces.

STORAGE

4.2.12. Consideration for the storage of peat has been undertaken with respect to the Scottish Renewables Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and Minimisation of Waste[3].

4.2.13. The priority should be to transfer peat straight to a suitable area for reinstatement. However, where peat cannot be transferred immediately, short term storage will be required and the following good practice applies:

- Where accessible, the storage of peat should be located in areas that have been previously subject to necessary disturbance and should be at least 25 m from a watercourse;
- Local gullies, diffuse drainage lines (or very wet ground) and locally steep slopes should be avoided for peat storage;
- The Principal Contractor, ECoW and appointed Geotechnical Adviser will determine the requirements for any preparatory works including ground smoothing, benching, or bunds. Drainage and pollution prevention controls would be implemented as necessary;

[3] Guidance on the assessment of peat volumes, reuse of excavated peat and the minimisation of waste (SR, SEPA, January 2012).

- Peat and peat turves would be transported intact, with vegetation upright (Photograph 4-1), in a single layer on top of geotextile membrane. Stored peat would also be covered with turves in a manner to maximise coverage (Photograph 4-2);
- Stored upper turves (incorporating vegetation) should be organised and identified according to NVC community (assisted by the ECoW) for reinstatement adjacent to like communities in the intact surrounding peat blanket;
- Wet peat can be stored to a thickness <1.0 m, drier and more stable peat can be stored to a thickness of <2.0 m;
- Drying of stored peat should be avoided by irrigation (although this is unlikely to be significant for peat materials stored for less than 2 months);
- Regular inspection of the temporary storage areas should be undertaken by the ECoW. Issues or concerns should be appropriately actioned by the Principal Contractor; and
- When peat storage is no longer required, the removal of peat would be subject to the same controls outlined for Peat Excavation.

4.2.14. A number of temporary peat storage areas have been identified in Figure 12.7. These locations are indicative, and will be finalised following the completion of detailed design.

Photograph 4-1: Good practice temporary storage of turves: stored upright, with minimal overlapping.

Photograph 4-2: Use of turves in a “checker-board” pattern on top of catotelmic peat to maximise coverage and minimise drying out.

TRANSPORT

4.2.15. Movement of turves should be kept to a minimum once excavated, and therefore it is preferable to transport peat planned for translocation and reinstatement to its destination at the time of excavation.

4.2.16. If Heavy Goods Vehicles (HGVs) / dump trucks that are used for transporting non-peat material are also to be used for peat materials, measures should be taken to minimise cross-contamination of peat soils with other materials.

4.3 RESTORATION & RE-USE

SUITABILITY FOR RE-USE

4.3.1. The characteristics of the excavated peat (e.g. fibrosity and water content) determines its suitability for re-use with the wettest, most amorphous peat generally being the least suitable. The von Post classification undertaken for peat at the site indicated that humification values were typically ~H3-H6. In areas of deeper peat von Post values of up to H9 were recorded.

4.3.2. For the purpose of this SPMP it has been assumed that the top 0.4m will be acrotelmic peat consisting of fibrous peat and the surface vegetation. The following assumptions have been made with regard of the characteristics of the peat and the intended suitable reuses at the Proposed Development;

- **Acrotelmic peat / peat soils** – when stripped with the vegetation, intact turves of acrotelmic peat or peaty soils will be suitable for surface reinstatement, dressing back and tying in infrastructure to the surrounding vegetation and habitats.
- **Fibrous catotelmic peat** – most suitable for reinstatement beneath the replaced acrotelm. It may also be used as a surface layer with careful site selection and management to control erosion and encourage vegetation recovery (e.g. seeding, translocation of vegetation and fencing to deter deer grazing).
- **Amorphous peat** – peat of this type will only be suitable for reinstatement of excavations beneath a surface vegetation layer. The peat may also be used in the restoration of the borrow pit beneath an acrotelmic layer to create conditions which will support development of a mire habitat. However, the volume of amorphous peat that will require removal is anticipated to be small, given that infrastructure has avoided the need to excavated deep peat where possible.

4.3.3. Based on site specific observations and the general avoidance of deep peat through the careful placement of infrastructure, it is unlikely that amorphous / catotelmic peat will be generally encountered and therefore reinstatement volumes are likely to be minimal.

4.3.4. Where excavated peat contains large volumes of residual forest materials such as brash or stumps this can affect the suitability of the peat for reinstatement. No forestry clearance is anticipated at the Proposed Development.

RE-USE IN INFRASTRUCTURE REINSTATEMENT

4.3.5. In line with NPF4 and associated good practice guidance, the primary design aim is to avoid peat and therefore peat excavation. Whilst the design has avoided deep peat, due to engineering, logistical, or to avoid other environmental constraints, the complete avoidance of peat by Proposed Development infrastructure isn't possible. Therefore, the Development must minimise the effects of disturbance through design and mitigation, namely reinstatement of peat that allows it to remain part of the peatland system and not for it to degrade and lose function as a means of carbon sequestration.

4.3.6. All excavated material (including peat and non-peat soils) from the construction of the Proposed Development would be re-used on site to provide the best environmental outcome. The principles of peat re-use and reinstatement of excavated peat as part of development reinstatement are as follows:

- Peat should not be re-used where no peat is present before (and includes types of peat, i.e. avoiding re-using catotelmic peat if it was not there before);
- The placement of amorphous catotelmic peat in locations that encourages amorphous catotelmic peats functionality within the peatland system (i.e. connected to the water table); and
- The placement of acrotelmic peat and turves over the top of amorphous catotelmic peat.

4.3.7. In following these principles, the following must be considered:

- The placement of amorphous catotelmic peat must be in a location that will encourage the retention of water and thus decrease the risk of the peat drying, oxidising and degrading;
- The placement of amorphous catotelmic peat must not form topographic highs, at an elevation above the likely surrounding water table;
- The source of the amorphous catotelmic peat should be from excavations / temporary storage as local as possible in order to minimise transport distances; and
- The placement of amorphous catotelmic peat must not result in any geotechnical instability.

4.3.8. Table 4.1 presents how peat would be successfully re-used / reinstated at the Proposed Development and provides assumptions for the Peat Balance Assessment in Section 5.

Table 4-1 – Proposals for peat re-use and retainment through infrastructure reinstatement.

Infrastructure	Proposed strategy for re-use at the Proposed Development
Turbines, crane pads and auxiliary crane pads (permanent)	Turbine foundations will be situated immediately adjacent to the permanent crane pad with both infrastructure components being broadly within the same excavation area. In accordance with good practice guidance, the crane pads would not be reinstated but retained to allow for future turbine maintenance. The batter slope surrounding the turbine and crane pad shall be reinstated with soil, peat soil and peat on sides not adjoining the access track (width 3.5 m). Where present, catotelmic peat would be used in lower slope sections where it is more likely to be connected to the water table. The slope angle would be suitably low (1: 4 to 1:6) to reduce runoff rate and encourage infiltration.
Blade laydown areas and working areas (temporary)	Blade laydown areas or other temporary areas adjacent to the crane pad are temporary and would be completely reinstated after construction. Temporary areas would be reinstated by removing the previously placed engineering fill and then placing peat from temporary peat stores to a thickness similar to the pre-existing depth (as determined by pre-construction peat depth data) that also ties into the local topography without creating topographic highs. Peat would not be placed where it was not originally present. The low infiltration capacity of the underlying subsoil and bedrock and careful placement of peat on flattened areas adjacent to the permeant crane pads should ensure the successful reinstatement of peat in these areas. Where the creation of an edge is unavoidable, these should be sealed with turves to retain moisture within the reinstated peat.

Infrastructure	Proposed strategy for re-use at the Proposed Development
New cut and fill type access tracks	The verges of new cut access tracks will be reinstated to ensure visible tie-in with surrounding vegetation and habitat but also to ensure stability and functionality of the re-used peat. The reinstatement calculations are based on verges 3.5 m wide along either side of the track and 1.1 m height, tied in with existing vegetation.
New floating type tracks	Verges can be reinstated to ensure suitable visual tie-in with the surrounding vegetation and habitats. As floating track can only be used where the ground is near level, including cross-slope, verges will be smaller and may only have capacity for vegetation stripped locally from track creation.
Substation	The substation verges shall be reinstated with peat on sides not adjoining the access track. Acrotelmic peat or turves may be used to dress cut slopes (if present) to minimise dewatering effects in upgradient areas.
Cable trenches	All peat excavated for cable trenches would be reinstated in the excavation after cable installation has been completed. Any catotelmic peat would be reinstated from the point of origin after the cables have been placed and would be placed below the water table.
Temporary construction compound	The temporary construction compound would be reinstated with peat following completion of construction. Due to the longevity of this temporary infrastructure element, it is likely that peat excavated from the footprint (if required) would be re-used elsewhere to enable more rapid reinstatement.

ADDITIONAL RE-USE IN DEPRESSIONS & HOLLOWS

4.3.9. Excavated peat can also be re-used within the vicinity of the Proposed Development in filling depressions or basins where excavated peat can be retained on account of favourable hydrological / hydrogeological conditions. Re-using peat in this manner will minimise potential soil losses through drying, erosion and degradation and maximise the chances that excavated peat could function as a peatland system. This potential re-use option could provide an additional method to retain and beneficially re-use excavated peat and is based on observations made over the course of innumerable upland developments in peat and peatland. Experience has proven that with appropriate planning, effective implementation and monitoring, peat retainment in this manner can be a very effective method for excavated peat reinstatement and restoration.

4.3.10. During the re-use of excavated peat in hollows or depressions, the following best practice applies:

- Carefully evaluate potential re-use sites, for their suitability, and agree that these sites are appropriate with the landowners and relevant consultees. This should include checking the ecological status of receiving sites by a suitably qualified ecologist;
- Undertake necessary vegetation clearance and rework mineral soil to provide optimum conditions prior to peat re-use;
- Reinstatement profiles should reflect the existing topography and not create topographic highs. Peat re-use should be minimised, not to exceed 1.5 m in height;
- Minimise transport distances and ensure that suitable machinery (low pressure excavators) and access methods (bog matting) are adopted;

- Careful handling of surface turves to be used after peat placement. Undertake re-use and revegetation work as soon as possible or order to minimise the effects of erosion;
- Where required, consider exclusion of livestock from areas of peat re-use, to minimise impacts on revegetation; and
- As far as reasonably practicable, re-use should be carried out concurrently with construction rather than at its conclusion.

RE-SEEDING

4.3.11. Natural regeneration of vegetation is the preferred option for reinstatement and re-use.

4.3.12. During the construction works, in areas where the spreading of seed rich materials or natural regrowth are considered impractical, ineffective, or where re-establishment of vegetation is observed to be failing, consideration will be given to re-seeding methods.

4.3.13. Where additional re-seeding is deemed necessary, a suitable seed mix will be agreed with the local planning authority.

OFFSET & ENHANCEMENT

4.3.14. In order to provide a beneficial effect, it is recommended that targeted peatland restoration be undertaken within the vicinity of the Proposed Development. This would not involve the re-use of peat excavated from the development as importing peat is not necessary for the peatland habitat enhancement. Instead, such works would aim to improve the functionality of adjacent peatland through mechanical intervention. Restoration techniques could include drain blocking, fugitive juvenile tree removal, and gully blocking. Examples from across the Proposed Development are illustrated below in Image 4-2 and Photographs 4-3 to 4-4.

4.3.15. The current statutory guidance associated with compensatory / enhancement peatland restoration advocates a ratio of 10:1 (i.e. restoration be undertaken across an area 10 times what was disturbed or lost). Targeted restoration could be undertaken to provide enhancement in accordance with NPF4, Policy 5.

4.3.16. Any peatland restoration works should be undertaken in accordance with the principles outlined in Section 4.3. Peat restoration activities should be planned and undertaken by a suitably experienced contractor. Further advice on specific restoration prescriptions can be found at: https://www.nature.scot/doc/peatland-action-technical-compendium.

MONITORING AND INSPECTION

4.3.17. The success of construction and the subsequent re-use of peat across the site will be monitored by the ECoW to ensure that effects on the peatland environment are appropriately understood and disturbance reduced via any remedial works that can be undertaken. The details of monitoring would be discussed and agreed with SEPA, NatureScot and the Local Planning Authority prior to commencement. Appropriate monitoring is important to:

- Provide reassurance that established mitigation and reinstatement measures are effective and that the site is not having a substantial adverse impact upon the local and/or wider environment;
- Indicate whether further investigation is required, where pollution is identified or unsuccessful reinstatement, with the need for additional mitigation measures; and
- Understand the long-term effects of the site on the natural environment.

4.3.18. Due to the nature of the construction activities and the possibility that such works can increase the volume of dissolved and particulate matter from entering the natural drainage network a robust hydrological monitoring strategy will be implemented.

4.3.19. A reinstatement monitoring strategy can also be implemented, where surveys can be carried out to monitor the success of peat re-use and subsequent reinstatement. Complimentary to the hydrological monitoring highlighted above and best practise geotechnical monitoring, the success of vegetation reinstatement can provide an insight into the effects of the wind farm on the local environment. Full details of the environmental monitoring strategies will be finalised following consultation with SEPA, NatureScot and the Local Planning Authority.

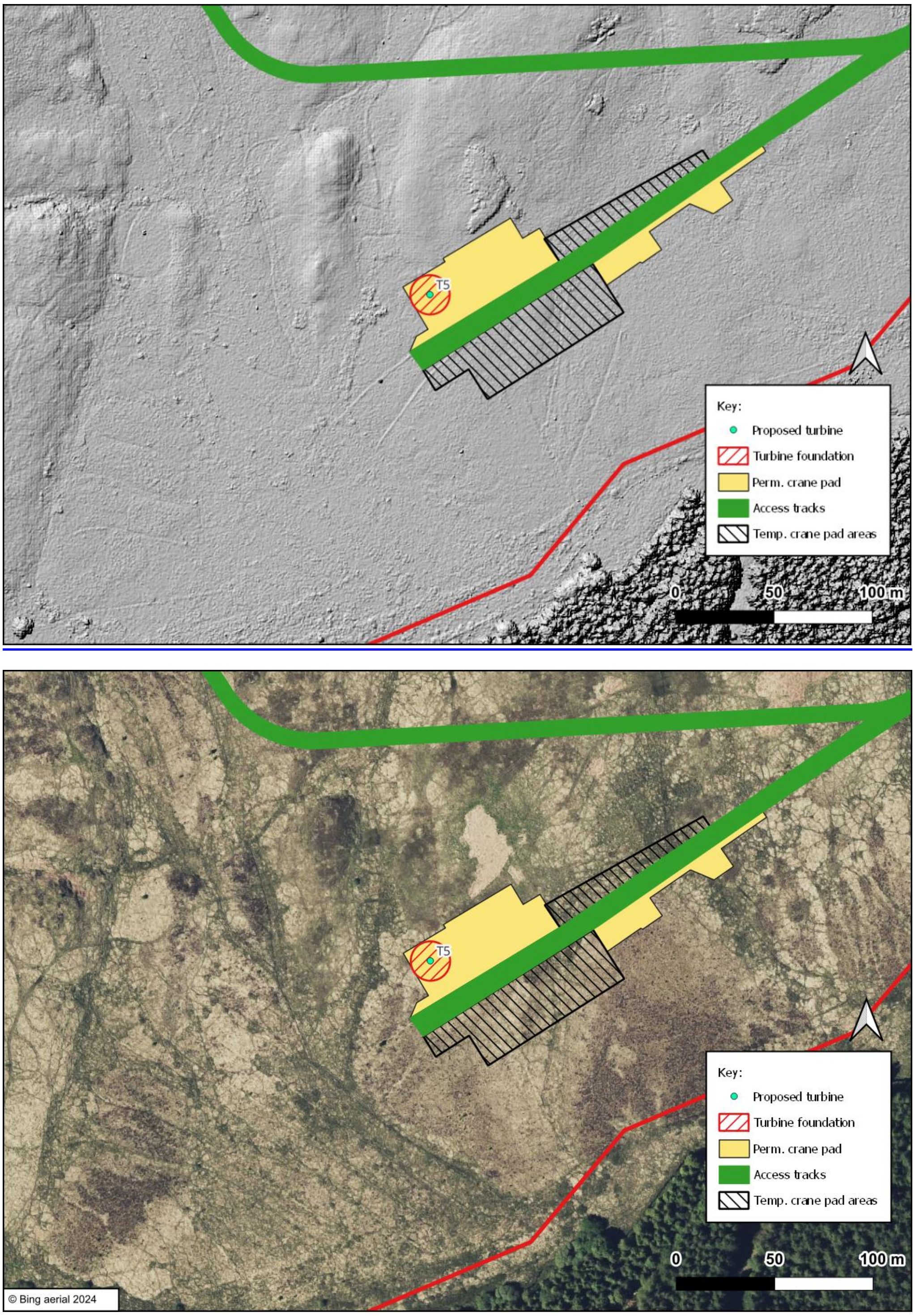

Figure 4-2 LiDAR (top) and satellite imagery (bottom) showing a potential restoration area, where drainage blocking could be applied. Numerous drainage ditches oriented north-west to south-east are visible to the south-west of T5, where deep peat was also confirmed.
LiDAR © Crown copyright Scottish Government, SEPA and Fugro (2020)**. Microsoft Bing Aerial Photography reprinted with permission from Microsoft Corporation.**

Photograph 4-3 Example of a potential area for restoration using ditch blocking and fugitive tree removal (NGR 234875, 572015).

Photograph 4-4 Example of a typical moorland grip / artificial drainage ditch within the Site (NGR 234568, 572343)

5 PEAT BALANCE ASSESSMENT

5.1 INTRODUCTION

5.1.1. To estimate the volume of soil and peat that could be re-used as part of construction and demonstrate that no excavated soil and peat shall be generated as waste, an indicative estimate has been calculated based on best practice and past project experience. This estimate has incorporated the predicted volumes of both acrotelmic and catotelmic peat to be excavated and opportunities for peat re-use.

5.1.2. To provide a precautious assessment, the entire soil column is assumed to be peat. The upper 0.4 m is assumed to be acrotelmic peat and beyond 0.4 m considered to be fibrous catotelmic peat. All catotelmic peat >1.0 m is assumed to be amorphous.

5.1.3. Estimated peat re-use assumptions are aligned with good practice outlined in Section 4.3. Soil and peat re-use shall be appropriate to the setting i.e. where catotelmic peat was not widely present before, re-use estimates are not provided.

5.1.4. It should be noted that this assessment has not accounted for excavation volumes of glacial sub-soils or weak bedrock material which may be deemed unsuitable for incorporation into foundations and hardstand elements.

5.1.5. No bulking factor has been applied for peat volumes**.**

5.2 DESIGN ASSUMPTIONS

5.2.1. The activities which would generate volumes of peat are described in the following sections. The construction methodology is subject to the mitigation measures to minimise peat disturbance presented in Section 4.2.

WIND TURBINE FOUNDATIONS & CRANE PADS

5.2.2. To provide a precautious approach to excavation requirements, each crane hardstanding and turbine are assumed to be stripped of soil and peat in a single excavation that includes an additional buffer to accommodate for the total working area (2,550 m^2), including adjacent batter zone. The area of hardstanding for the assist crane is included in this total and will also be retained for the lifetime of the Proposed Development.

5.2.3. The laydown area, trestles area for blades and storage area for components will be stripped of soil but will only be necessary during construction (5,650 m^2). This infrastructure is temporary and would be reinstated prior to operation.

ACCESS TRACKS

Excavated Stoned Access Tracks

5.2.4. Excavate and replace ('cut') construction of access tracks is proposed for the majority of the proposed on-site access. This is owing to the generally shallow nature of the peat and peaty soils present within the site.

5.2.5. The cut construction method requires the removal of soil deposits down to a suitable sub-grade layer within the superficial or bedrock geology. Excavated material is then reinstated carefully along cut access track landscaped verges on either side of the cut access track or utilised in appropriate landscaping across the Proposed Development infrastructure.

5.2.6. Cut access track construction sequences shall be designed in accordance with local ground conditions and following a detailed site investigation. For the purpose of this SPMP, a 5 m running width with additional 1 m to either side to accommodate for drainage is assumed.

Floating Access Tracks

5.2.7. Where ground conditions allow, access track situated on peat >1.0 thickness should be constructed using floating construction methods to minimise peat disturbance.

5.2.8. The extent to which floating access tracks could be used at the Proposed Development is limited by the general absence of peat and deep peat along the track alignment. Following the completion of detailed design, it may be possible to reduce peat excavation volumes by using short sections of floating track in isolated pockets or basins. Further details would be provided in the Stage 2 SPMP.

SUBSTATION

5.2.9. The substation will require the formation of a platform (3,600 m^2) which will require the excavation of superficial soils down to a suitable load bearing stratum.

CONSTRUCTION COMPOUNDS

5.2.10. The construction compounds will be a temporary feature and will require the formation of a platform (5000 m^2) will require the excavation of superficial soils down to a suitable load bearing stratum.

CABLE TRENCHES

5.2.11. Cable trenches are not included within the peat balance assessment as it is assumed all material excavated would be re-used as backfill.

5.3 PEAT BALANCE ASSESSMENT

5.3.1. The following sequence of tables provides a summary of the indicative soil and peat excavation volumes calculated for infrastructure elements, with the final table, Table 5-5 providing a summary of the peat excavation and re-use balance for the Proposed Development.

Table 5-1 – Peat excavation and re-use balance for turbines and permanent crane pads (~2,550 m²)

Turbine ID	Average Soil / Peat Depth (m)	Peat Excavation Volumes			Total Peat & Soil Excavation	Peat Re-Use Volume			Total Peat Re-Use	Balance*
		Topsoil & Acrotelmic Peat	Fibrous Catotelmic Peat	Amorphous Catotelmic Peat		Topsoil & Acrotelmic Peat	Fibrous Catotelmic Peat	Amorphous Catotelmic Peat		
T1	0.33	865	0	0	865	298	0	0	298	567
T2	0.23	590	0	0	590	298	0	0	298	292
T3	0.39	1,008	0	0	1,008	298	0	0	298	710
T4	0.22	572	0	0	572	298	0	0	298	273
T5	0.60	1,020	524	0	1,544	164	48	0	212	1331
T6	0.30	786	0	0	786	298	0	0	298	487
T7	0.18	459	0	0	459	298	0	0	298	160
T8	0.16	430	0	0	430	298	0	0	298	132
T9	0.25	654	0	0	654	298	0	0	298	355
T10	0.13	354	0	0	354	298	0	0	298	56
T11	0.20	517	0	0	517	298	0	0	298	219
T12	0.22	562	0	0	562	298	0	0	298	264
T13	0.14	357	0	0	357	298	0	0	298	59

**A negative balance volume indicates there is more than sufficient capacity for re-use during reinstatement. A positive value indicates a surplus of material could be generated and it will need to be re-used locally as part of other infrastructure reinstatement.*

Table 5-2 – Peat excavation and re-use balance for temporary laydown areas at cranepads (~5,650 m^2)

Turbine ID	Average Soil / Peat Depth (m)	Peat Excavation Volumes			Total Peat & Soil Excavation	Peat Re-Use Volume			Total Peat Re-Use	Balance*
		Topsoil & Acrotelmic Peat	Fibrous Catotelmic Peat	Amorphous Catotelmic Peat		Topsoil & Acrotelmic Peat	Fibrous Catotelmic Peat	Amorphous Catotelmic Peat		
T1	0.235	1,327	0	0	2,655	1,327	0	0	2,655	0
T2	0.341	1,927	0	0	3,855	1,927	0	0	3,855	0
T3	0.675	2,260	1,551	0	3,811	2,260	1,551	0	3,811	0
T4	0.335	1,892	0	0	3,784	1,892	0	0	3,784	0
T5	1.087	2,260	3,390	492	6,142	2,260	3,390	492	6,142	0
T6	0.260	1,466	0	0	2,932	1,466	0	0	2,932	0
T7	0.210	1,188	0	0	2,376	1,188	0	0	2,376	0
T8	0.280	1,579	0	0	3,159	1,579	0	0	3,159	0
T9	0.244	1,380	0	0	2,760	1,380	0	0	2,760	0
T10	0.178	1,005	0	0	2,010	1,005	0	0	2,010	0
T11	0.339	1,913	0	0	3,826	1,913	0	0	3,826	0
T12	0.142	801	0	0	1,602	801	0	0	1,602	0
T13	0.491	2,260	511	0	2,771	2,260	511	0	2,771	0

**A negative balance volume indicates there is more than sufficient capacity for re-use during reinstatement. A positive value indicates a surplus of material could be generated and it will need to be re-used locally as part of other infrastructure reinstatement.*

Table 5-3 – Peat excavation and re-use balance for access tracks (~7 m excavation diameter)

Section Description	Approx. Length	Average Soil / Peat Depth (m)	Peat Excavation Volumes			Total Peat & Soil Excavation	Peat Re-Use Volume			Total Peat Re-Use	Balance*
			Topsoil & Acrotelmic Peat	Fibrous Catotelmic Peat	Amorphous Catotelmic Peat		Topsoil & Acrotelmic Peat	Fibrous Catotelmic Peat	Amorphous Catotelmic Peat		
T6 to T11	780	0.33	1,807	0	0	1,807	1,950	484	289	2,722	-915
T10 to T8	420	0.19	549	0	0	549	1,470	0	0	1,470	-921
T11 to T13	750	0.28	1,494	0	0	1,494	1,875	465	278	2,618	-1,124
T12 to T13	420	0.14	406	0	0	406	1,470	0	0	1,470	-1,064
T10 to T12	520	0.30	1,079	0	0	1,079	1,820	0	0	1,820	-741
T1 to T2 & T3	930	0.57	2,604	1,084	0	3,688	2,325	577	344	3,246	443
Entrance to T1	610	0.28	1,205	0	0	1,205	1,525	378	226	2,129	-924
T3, T5 & T6	1,630	0.59	4,564	2,152	0	6,716	4,075	1,011	603	5,689	1,028
T4 to T7	280	0.45	784	98	0	882	700	174	104	977	-95
T7 to T8	260	0.23	421	0	0	421	650	161	96	907	-487
T6 to T11	780	0.33	1,807	0	0	1,807	1,950	484	289	2,722	-915

**A negative balance volume indicates there is more than sufficient capacity for re-use during reinstatement. A positive value indicates a surplus of material could be generated and it will need to be re-used locally as part of other infrastructure reinstatement.*

Table 5-4 – Peat excavation and re-use balance for ancillary infrastructure (temporary construction compound & substation)

Infrastructure	Average Soil / Peat Depth (m)	Peat Excavation Volumes			Total Peat & Soil Excavation	Peat Re-Use Volume			Total Peat Re-Use	Balance*
		Topsoil & Acrotelmic Peat	Fibrous Catotelmic Peat	Amorphous Catotelmic Peat		Topsoil & Acrotelmic Peat	Fibrous Catotelmic Peat	Amorphous Catotelmic Peat		
Temp. Construction Compound	0.45	2,000	247	0	2,247	2,000	247	0	2,247	0
Substation	0.25	901	0	0	901	327	0	0	327	547

**A negative balance volume indicates there is more than sufficient capacity for re-use during reinstatement. A positive value indicates a surplus of material could be generated and it will need to be re-used locally as part of other infrastructure reinstatement.*

Table 5-5 – Summary of excavation & re-use for the Proposed Development

Infrastructure	Peat Excavation Volumes			Total Peat & Soil Excavation	Peat Re-Use Volume			Total Peat Re-Use	Balance*
	Topsoil & Acrotelmic Peat	Fibrous Catotelmic Peat	Amorphous Catotelmic Peat		Topsoil & Acrotelmic Peat	Fibrous Catotelmic Peat	Amorphous Catotelmic Peat		
Turbines and crane pads (permanent)	8,175	524	0	**8,699**	3,419	48	0	**3,467**	**5,232**
Temporary working and laydown areas at crane pads	21,260	5,453	492	**27,205**	21,260	5,453	492	**27,205**	**0**
Access Tracks	14,913	3,335	0	**18,248**	18,336	3,249	1,939	**23,524**	**-5,275**
Ancillary Infrastructure	2,901	247	0	**3,148**	2,327	247	0	**2,574**	**574**
Totals	47,250	9,558	492	**57,300**	45,343	8,996	2,431	**56,770**	**530**

**A negative balance volume indicates there is more than sufficient capacity for re-use during reinstatement. A positive value indicates a surplus of material could be generated and it will need to be re-used locally as part of other infrastructure reinstatement.*

5.3.2. Comparing the total capacity for peat re-use with total volume of excavated peat presented in Table 5-5, it is indicated that the Development will have a slight surplus of material that would be generated when compared with opportunities for peat re-use in reinstatement. Notwithstanding, the re-use balance demonstrates there is more than sufficient capacity to accommodate all anticipated volumes of fibrous and amorphous catotelmic peat.

5.3.3. As the surplus volume represents <1% of the total anticipated excavation volume for the Proposed Development, the implications of such a nominal surplus is likely to be negligible, and be within the margin of error and uncertainty associated with determining peat balance without detailed design.

5.3.4. Furthermore, the re-use balance does not include any volumetric estimate for the re-use of peat in depressions and hollows, which offers further contingency for any surplus that may arise.

5.3.5. On the basis of the peat balance calculations provided, measures for the recycling, other recovery and disposal of waste peat (and consequential peat waste management plan) are therefore not required.

5.3.6. No additional material would be imported to make up for any shortfall.

5.4 RECOMMENDATIONS

5.4.1. Recommendations to further reduce peat excavation volumes based on the peat balance assessment that should be investigated as part of the detailed design and Stage 2 SPMP post-consent are summarised in Table 5-6 below.

Table 5-6 – Summary of recommendations for Stage 2 SPMP

Recommendation	Potential benefit	Justification for why this could not be incorporated into the Stage 1 SPMP
Use of floating track design for the access track between T1, T2 and T3 as well as the sections between T3, T5 and T6	Reduction in peat excavation volumes. Minimises hydrological separation for adjacent peat bodies.	The micro-topography within the Proposed Development is complex and the feasibility of floating track design in these sections will require detailed design. Assuming that it would be feasible at Stage 1 without this information could underestimate peat excavation volumes and is therefore not aligned with the precautionary principle.
Micrositing of T5 further to the north to avoid peat at temporary infrastructure	Slight reduction in peat excavation volumes and disturbance.	T5 was relocated to the north following the initial Phase 2 (detailed survey), and was then re-surveyed which confirmed permanent infrastructure had largely avoided peat. Relocation further to the north is not possible due to other environmental and engineering constraints.
Identify candidate receiving sites for peat placement in depressions & hollows	Proven method for effective peat reinstatement and reduces necessity for reinstatement in verges	Current site topographical information is too coarse and detailed design and site topography information is required, along with the final layout arrangements to identify candidate areas. The Stage 2 SPMP should contain an appraisal of candidate areas, an outline method statement for implementation, as well as success monitoring.

6 DISCLAIMER

The information presented in this SPMP is based on the results of peat surveys carried out by WSP prior to EIAR submission.

It is highlighted that whilst attempts have been made to collect peat depth and condition information, further investigations can be carried out as part of detailed site investigation (post-consent). This process can provide further information across all infrastructure locations, which should be used to further refine the peat excavation and reuse volumes provided in this report.

The SPMP should be considered a live document throughout the planning process and any future pre-construction phases of works. As such, additional information can be incorporated following the results of detailed site investigations carried out prior to construction, as well as from any discussions with SEPA or other engaged stakeholders throughout the development process.

The peat extraction and re-use volumes are intended as a preliminary indication. The total peat volumes are based on a series of assumptions for the infrastructure layout and peat depth data averaged across discrete areas of the Proposed Development. Such parameters can still vary over a small scale and therefore local topographic changes in the bedrock profile may impact the total accuracy of the volume calculation.

The accuracy of these predictions may be improved though further detailed site investigation (post consent). It is therefore important that the SPMP remains a live document throughout pre-construction and construction phases and is encapsulated within a wider CEMP. The SPMP and volumetric assessments can be updated as more accurate information becomes available.

The purpose of this report is to ensure that there has been a systematic consideration of peat management and a quantitative assessment throughout the development process.

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EnergieKontor UK

GLENVERNOCH WIND FARM

Technical Appendix 12.3: Stage 1 Peat Landslide Hazard and Risk Assessment

JUNE 2024

PUBLIC

EnergieKontor UK

GLENVERNOCH WIND FARM

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TYPE OF DOCUMENT (VERSION) PUBLIC

PROJECT NO. 70119752

DATE: JUNE 2024

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CONTENTS

1 INTRODUCTION

1.1 BACKGROUND

1.1.1. The Proposed Development comprises the construction and operation of Glenvernoch Wind Farm (the 'Proposed Development'), as described within Chapter 3 of the EIA Report. The Proposed Development is in Dumfries and Galloway, Scotland, comprising the following:

- 13 turbines and associated foundations;
- Hardstanding areas for erecting cranes at each turbine location;
- On-site tracks connecting each turbine;
- Underground cables linking the turbines to the substation;
- A temporary construction compound; and
- Substation.

1.1.2. A detailed description of the Proposed Development is set out within Chapter 3 of the EIA Report.

1.1.3. The Scottish Government's Peat Landslide Hazard and Risk Assessment Guidance[1] provides information on methods for identifying, mitigating and managing peat landslide hazards and their associated risks. This Guidance has been used for this assessment. Section 36 applications under the Electricity Act 1989, should also be assessed for peat landslide risk where infrastructure is proposed in peatland areas, as applies to this project.

1.1.4. This document presents WSP's method for a Peat Landslide Hazard Risk Assessment (PLHRA), also referred to as peat stability assessment, the analyses undertaken and the findings, which are based on peat depth surveys undertaken by a third party in 2023 and by WSP in 2024.

1.2 STUDY AREA

1.2.1. The Study Area for this assessment covers the majority of the area within the site boundary, including extending 200 m beyond the boundary. However, the northernmost extent within the Site boundary is not included in this peat landslide hazard risk assessment, with this area over 1.5 km from all Proposed Infrastructure and very unlikely to be effected by the Proposed Development.

1.2.2. The land-use is a mixture of moorland /pastoral land used for rough grazing. Artificial drainage is present to a degree across the Site.

1.3 OBJECTIVES OF THIS PLHRA

1.3.1. The broad aims of this assessment were to:

- provide a good level of understanding of site baseline (pre-development) peat stability conditions;

[1] Scottish Government (2017). Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments (Second Edition). [online] Available at: http://www.gov.scot/Publications/2017/04/8868 [Accessed in April 2024].

- aid the development design in order to reduce development activities that could cause an increased likelihood of peat instability, by careful consideration of infrastructure location and also construction techniques employed;
- identify the receptors that would be subject to adverse consequences, should a peatslide occur; and
- report peat stability risk assessment outcomes of the design following the principles of the Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments.

1.4 METHODS

1.4.1. The methods adopted by WSP for the PLHRA of the Proposed Development have involved the following stages:

- desk study review of peat stability literature and available site data;
- aerial and LiDAR imagery review;
- site reconnaissance including peat depth survey to characterise the prevailing ground conditions and identify existing or potential peat instability;
- Ground Investigation (GI) at specific locations of concern to provide additional data;
- initial stability analysis to identify likelihood, using a purposefully cautious factor of safety (FoS) method;
- identification of receptors;
- initial risk assessment undertaken to identify locations of concern ('Moderate' or 'High' initial risk level);
- revised risk assessment based on additional site information and visits to locations of concern, presented as datasheets detailing local characteristics and appropriate mitigation for specific locations of concern; and
- summarising key findings, including appropriate recommendations for further investigations at later stages of the development, subject to planning consent.

1.4.2. The PLHRA applied a phased approach, with findings at each phase feeding into the iterative design process and associated EIA. This included gathering further site information as the design progressed and revising stability calculations using the best information available.

1.4.3. Further detail on each of these stages is provided in the following sections, with Geographical Information System (GIS) software employed to manage, analyse, and visualise spatial datasets.

1.4.4. Figures have been provided that demonstrate the data available and analysis undertaken within this assessment, as **Figures 12.6** to **12.5.**

2 DESK STUDY

2.1 LITERATURE REVIEW OF PEAT STABILITY

2.1.1. Peat is a soft to very soft, highly compressible, and highly porous organic material which can consist of up to 90% water by volume. Scottish Government guidance[2] defines peat as a soil with a surface organic layer greater than 0.50 metres (m) depth, which has an organic matter content of more than 60%. The Wildlife Management and Muirburn (Scotland) Bill (2024) defines peat as soil which has an organic content of more than 60% and peatland as land where the soil layer of peat has a thickness of greater than 40 cm. For the purpose of this assessment, the Scottish Government guidelines for PLHRA[1&2] are followed. Unmodified peat typically has two layers:

- Acrotelm (surface layer) - often around 0.30 m thick (but can vary widely in depth depending on local conditions), highly permeable and receptive to rainfall. It generally has a high proportion of fibrous material and often forms a crust under dry conditions; and
- Catotelm (base layer) – in deeper peat deposits, this layer lies beneath the acrotelm and forms a stable colloidal substance which is generally impermeable. As a result, the catotelm usually remains saturated with little groundwater flow. A sub-division in catotelmic peat may occur, but is not always present, with fibrous catotelmic peat above amorphous catotelmic peat. Amorphous catotelmic peat is characterised as highly decomposed plant matter, with low structural integrity and may act as a liquid in terms of physical or geotechnical qualities, with associated challenges in terms of excavation, handling and storage.

2.1.2. The peat on the Site, where present, is predominantly characterised as blanket peat and peaty podzols (with associated habitat known blanket bog communities, wet heathland and rough grassland communities). Blanket peat tends to be formed in areas with high rainfall and low temperatures. In the Scottish context, blanket peat can be over 5.00 m in depth, especially in hollows or valleys, but is generally much shallower. Peaty podzols are characteristic of any topographic position where aerobic conditions prevail, and water can percolate freely through the upper part of the profile. Podzols are formed in acid, coarse textured, well drained materials. Blanket peat is the most common form of peat in Scotland, podzols are widespread throughout Scotland.

2.1.3. Peat is thixotropic, meaning that its viscosity decreases under applied stress. This property may be considered less important where the peat has been modified through artificial drainage and is drier but can be an important factor when the peat body is saturated and is an important issue to consider in relation to potential peat stability failures.

2.1.4. Peat movements can be small-scale or large-scale. Small-scale movements include slope terracing, slumps, collapse of peat banks and collapses above peat pipe features. These small-scale events are relatively widespread in peatland environments and have limited consequences to receptors, although they do provide useful indicators of peatland morphology and processes which may influence large-scale peat instability.

[2] Scottish Government (2017). Guidance on Developments on Peatland - Peatland Survey (2017 Edition). [online] Available at: https://www.gov.scot/publications/peatland-survey-guidance/ [Accessed in January 2024].

2.1.5. A series of large scale (mass movement) peat events in autumn 2003, including at Derrybrien in the Republic of Ireland, and Dooncanton in Channerwick (South Shetland Mainland), Scotland, led to an increased recognition of the mass movement hazard, particularly in relation to development design and construction of windfarm projects on peatland. This led to Scottish Government guidance for energy developments being published in 2006 and updated in 2017[1] to assess development risk of peat landslide. More recently, in November 2020 a mass movement of peat was recorded and widely reported at Meenbog Wind Farm, in County Donegal, Republic of Ireland.

2.1.6. Peat mass movement events have been classified by geomorphologists Dykes & Warburton[3], within a Scottish context the primary processes of concern are peat landslides and peaty debris slides, with limited evidence of historic bog bursts and other phenomena. These features are defined below:

- Peat landslide – failure of a blanket bog slope, involving intact peat material shearing and sliding along at, or immediately above, the interface with underlying mineral soil, bedrock or boulder clay substrate[3]. The peat above the shear plane generally initially moves as an intact mass, then breaks into smaller pieces and may then act as a liquid flow and follow drainage routes until material has been deposited[4]; and
- Peaty debris slides - shallow translational failure of a slope, often on very steep gradients, with the failure zone occurring wholly in mineral soil substrate below a shallow organic soil surface layer which may be less than 0.50 m depth. Surface peat is sheared and displaced due to failure of underlying material, rather than inherent peat instability[3].

2.1.7. In comparison with other peat mass movement phenomena described by Dykes & Warburton[3], peat landslides and peaty debris slides typically involve lower volumes of material, estimated as 500 - 50,000 m^3, with estimated velocities of 0.1 - 5.0 m/s for peat landslides and 0.1 - 10.0 m/s for peaty debris slides.

2.1.8. Peatland characteristics that may initially suggest a higher likelihood of peat mass movement, i.e. pre-disposition, include:

- increasing depth of peat;
- increasing slope angle;
- the presence of amorphous peat (well humified/decomposed); with less structural integrity and cohesion to remain on slope;
- convex slopes; instability may occur at or immediately downhill of the ‘break of slope’, often at the interface of deeper peat on a lower slope angle plateau or ridge; and
- waterlogged peat conditions; providing extra weight upon slope and lubricating transition zone/ basal surface between peat and underlying materials, such as clay, mineral soil or bedrock.

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[3] Dykes, A.P. & Warburton, J. (2007). Mass movements in peat: A formal classification scheme. Geomorphology, Volume 86, 2007.

[4] Boylan, N., Jennings, P. & Long, M (2008). Peat slope failure in Ireland. Quarterly Journal of Engineering Geology and Hydrogeology, Volume 41, 2008.

2.1.9. Specific conditions that are generally recognised as triggers for mass movement of peat include:

- Removal of slope support; reduces slope stability by natural or anthropogenic removal of support material below peat body. This could also be caused by decreased strength of slope materials on a temporal basis.
- Additional loading of slope; reduction in slope stability due to increasing of mass of slope above the peat body. This could be a result of development design or ancillary activities such as stockpiling of materials or heavy plant movement.
- Alteration to drainage patterns; increasing the mass of the peat body and lubricating the transition zone, potentially also increasing pore-water pressure at base of peat body. Can be a particular concern when intense rainfall follows a prolonged dry period, as fissures in peat body may enable rapid ingress to the transition zone. Prolonged wet periods in autumn and winter months in Ireland are considered as having a greater probability for peatslide events[4] and seasonal accumulation of snow may also be a factor, in terms of both weight and snowmelt input.
- Vibration; construction activities such as piling, stockpiling of materials or traffic, including heavy plant, movement. Potentially also caused by earth movement at susceptible geological locations.

2.1.10. Examples of mass peat instability can occur involving peat of less than 1.00 m depth and on relatively low gradient slopes (<5°), where appropriate combinations of conditions occur. Where depths are relatively shallow and gradients relatively shallow, events may be expected to be more limited in terms of area, volume of material and run-out distance. Peatslide events often commence on a susceptible slope and then follow drainage pathways downslope, with sediment release into such receptors.

2.1.11. There are a number of geotechnical variables in relation to peat properties. Those applicable to the FoS stability methodology applied by WSP are detailed below. The FoS calculation and method is discussed further in Section 1.4 of this report. These variables include both site data and values based on academic literature. Where using literature values, conservative values are typically applied as a precautionary approach, which can then be potentially refined where there is justification to do so from further site information:

- Depth of peat – measured onsite, to full depth with an accuracy of +/- 0.05 m;
- Slope angle – measured using site Digital Terrain Model (DTM) data at 5 m resolution, for both peat probes and using mean values for grid cells. The slope angles have been assessed as follow:
  - Low slope: 0° – <5°;
  - Gentle slope: 5° – <10°;
  - Moderate slope: 10° - <15°;
  - Steep slope: >15°;
- Shear strength of peat – Literature values suggest an expected pressure (expressed as force per area) range between 4 - 20 Kilonewton / square metre (kN/m^2)[4], with higher values for less humified/decomposed peat.

- Cohesive strength of peat – back-calculated using site-specific data using a 99th percentile value from the site depth data, this parameter largely dictates the shear strength of the peat in the FoS calculation. As above, literature values of shear strength suggest a range between 4 – 20 kN/m[4].
- Undrained bulk density of peat – values for in situ peat range from 900 – 1300 kg/m^3 quoted in various papers and reports, with a typical value of 1,000 kg/m^3 (1.0 Mg/m^3) referenced in literature[4 & 5].
- Bulk density of water – Standard scientific value of 1,000 kg/m^3.
- Water table depth as ratio of peat depth – a value of 1 represents water level being constantly at surface, this is conservative as the water level will vary temporally and geographically across the Site, often dropping below ground level.
- Angle of internal friction – a number of variables are present in peat (particularly fibre content and water content), a lower angle is more susceptible to movement on a slope. At 'quaking bog' locations, where the peat takes the form of a slurry beneath a surface mat of vegetation, the angle of internal friction will be very low (less than 5°) as the peat will effectively act as a fluid, however peat values of up to 58° are quoted in literature[4].

2.1.12. The Von Post classification system is a field-based method for characterising the level of peat humification/decomposition across 10 classes, with H1 categorised as completely undecomposed peat and H10 categorised as completely decomposed peat. Amorphous catotelmic peat is generally considered to be classified as H6 - H10, i.e. strongly decomposed or greater on this scale[2].

2.1.13. There are a number of recognised indicators that may occur in advance of mass peat instability, with the factors below particularly applicable to low velocity peat slides:

- development of tension fracture cracking across the slope or in semi-circular patterns, particularly if these reach to base of peat;
- boggy ground or new springs appearing at the base of slopes;
- sudden reactivation of spring lines;
- peat creep or compression features, such as bulging of ground;
- displacement and leaning of trees, fence posts, dykes etc.; and
- breaking of underground services.

2.2 INFORMATION SOURCES

2.2.1. A desk study was undertaken, reviewing available information on the ground conditions within the Site; sources included:

- Ordnance Survey (OS) digital raster maps at 1:50,000 and 1:25,000 scale;
- OS Historical mapping, 1:25,000 scale;
- OS Terrain 5 DTM (5 m resolution);

[5] Dykes AP, Kirk KJ (2006). Slope instability and mass movements in peat deposits. Peatlands: Evolution and Records of Environmental and Climate Changes. Elsevier, Amsterdam, 377-406

- British Geological Survey maps of bedrock, superficial and linear geology at 1:50,000 scale, available through Geology Digimap;
- British Geological Survey GeoSure Natural Ground Stability dataset 1:50,000;
- British Geological Survey Hydrogeological Map of Scotland, 1:625,000 scale;
- James Hutton Institute Soil Maps of Scotland, digital dataset (1:250 000 scale);
- Bing Aerial Imagery available via QGIS plugin;
- The Scottish Public Sector LiDAR (Phase 3) Digital Surface Model data captured between 2015 and 2019 (0.5 m resolution) available from: https://remotesensingdata.gov.scot
- Nature Scot Designated nature and conservation sites available at: https://map.environment.gov.scot/sewebmap/

2.3 BASELINE CONDITIONS

2.3.1. The Site is covered by moorland used for rough grazing. Artificial drainage is present throughout the Site.

2.3.2. Baseline conditions at the Site are discussed in detail within Chapter 12: Hydrology, Hydrogeology, Geology and Soils of the EIA Report.

2.3.3. **Appendix 12.2 Soil and Peat Management Plan** of the EIA Report includes details of peat depths at various infrastructure locations and an analysis of the potential locations where the more sensitive amorphous catotelmic peat may be anticipated.

2.4 TOPOGRAPHY

2.4.1. The topography of the Site is gently undulating, with the lowest points being located adjacent to the A714 close to the River Cree at approximately 50m above Ordnance Datum (AOD). There are several small hills within the central areas of the Site rising to 90m AOD and 100m AOD, with the highest peak to the north-west of the Site at Glenvernoch Fell (180m AOD).

2.4.2. The Site is hummocky with numerous bedrock outcrops interspersed with flat basins. Bedrock outcrops are convex (whale-back) shaped and generally glacially smoothed. These were most prevalent in the south of the site and were interspersed by small basins containing peat, organic soil, sand and gravel. In the north and west of the Site the landscape became a patchwork of well drained sand and gravel deposits covered with semi-improved grassland interspersed between more boggy areas. The hummocky terrain exhibits a range of slope angles.

2.4.3. Further geomorphology information is provided within **Chapter 12: Hydrology, Hydrogeology, Geology and Soils** of the EIA.

2.5 GEOLOGY & HYDROLOGY

2.5.1. The majority of the Site is located within the catchment of the River Cree and a very small extent on the eastern border is within the River Bladnoch catchment. Among the River Cree tributaries flowing through the Site are the Boughty Burn, Clachaneasy Burn and Castle Stewart Burn.

2.5.2. Further baseline information for geology and hydrology is provided in **Chapter 12: Hydrology, Hydrogeology, Geology and Soils** of the EIA.

2.5.3. Hydrology features, bedrock geology, and superficial deposits (superficial geology) are presented on **Figure 12.1 Hydrology Overview, Figure 12.2 Bedrock Geology**, and **Figure 12.3 Superficial Geology** and of the EIA, respectively.

2.6 NATIONAL PLANNING FRAMEWORK 4

2.6.1. The publication of National Planning Framework 4 (Scottish Government, 2023[6]) provides a national spatial strategy, with Policy 5 seeking to protect valued soils, including peat. This establishes the expectation to firstly avoid and then minimise disturbance to soils on undeveloped land (Policy 5a-i), in a manner that protects soil from damage, including compaction and erosion, whilst minimising soil sealing.

2.6.2. In relation to the Proposed Development, developments on peatland, carbon-rich soils and priority peatland habitat shall only be supported if deemed essential infrastructure with no alternative sites (Policy 5c-i). Specific to the scope of work for this report, it will support addressing the requirements of Policy 5d-i and 5d-ii. Namely, providing a detailed site specific assessment to identify depth, habitat condition, quality and stability of carbon rich soils, to assess the likely effects of the development.

2.7 CARBON RICH SOILS, DEEP PEAT AND PRIORITY PEATLAND HABITATS

2.7.1. The NatureScot Carbon and Peatland Map[7], a dataset covering Scotland, presents the importance of these environmental interests. It was derived using a matrix of soil carbon categories (derived from Soil Survey of Scotland maps) and peatland habitat types (derived from Land Cover of Scotland 1988 map).

2.7.2. Carbon-rich soils, deep peat and priority peatland habitat importance categories (also referred to as Classes) 1 and 2 are considered as the most sensitive and valuable peatlands, with low levels of disturbance. Desktop study indicates that 26% of Site is within Class 1 and 2 peatland of national importance (NatureScot, 2016). Field surveys confirmed the presence of peat at the Site. The remainder of the Site is covered by Classes 5, 4, 3 and 0. These classes are not classified as priority peatland habitat.

2.7.3. The outcomes of the more detailed peat survey, discussed below, provide site-specific peat depth information which supersedes the higher-level characterisation from the NatureScot Carbon and Peatland Map[7]. This more detailed peat information was used to inform the design of the Proposed Development and the subsequent assessment (see **Figure 12.7 Peat Depth & Condition**). Further information on peat management is provided in **Appendix 12.2 Soil and Peat Management Plan** of the EIA Report.

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6 Scottish Government (2023). National Planning Framework 4. [online] Available at: https://www.gov.scot/publications/national-planning-framework-4/carbon [Accessed in January 2024].

7 NatureScot (2016). *Carbon and Peatland Map*. [online] Available at: https://www.nature.scot/professional-advice/planning-and-development/planning-and-development-advice/soils/carbon-and-peatland-2016-map [Accessed in January 2024].

2.8 GEOSURE NATURAL GROUND STABILITY

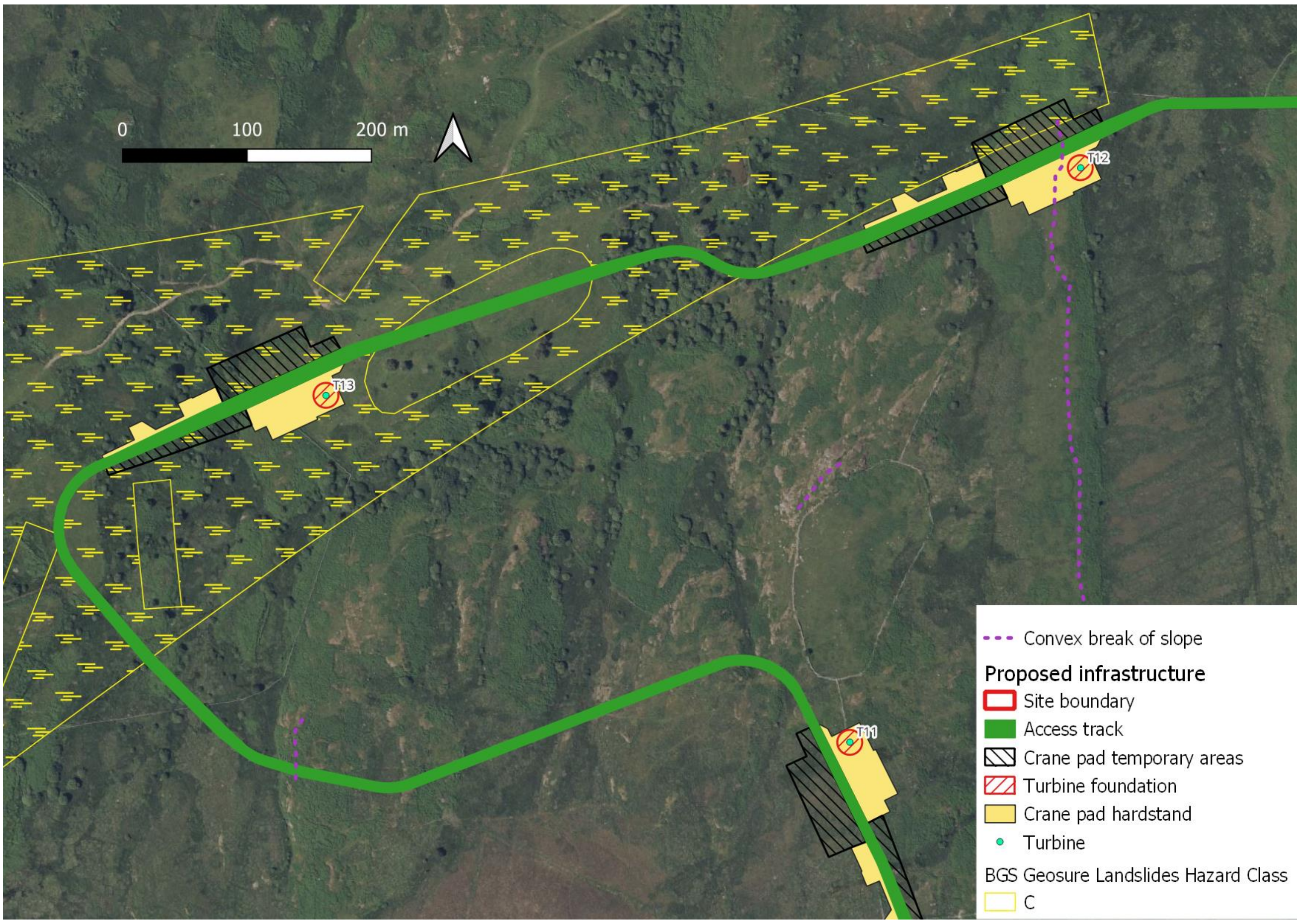
2.8.1. GeoSure Natural Ground Stability data from the British Geological Survey was used to identify areas within the Site susceptible to landslides and mass movement. The dataset uses five classes to categorise landslide hazard, with Classes D or C being of concern. The definitions for these classes are as follows:

- GeoSure Landslide Hazard Class D; slope instability problems are probably present or have occurred in the past. Land use should consider specifically the stability of the Site; and
- GeoSure Landslide Hazard Class C; slope instability problems may be present or anticipated. Site investigation should consider specifically the slope stability of the Site.

2.8.2. Class C zones were identified in the northern part of the Site and a small zone along the southern Site boundary. T12, T13 and part of the access track are within a Class C zone, but the rest of the Proposed Infrastructure is outwith Class C zones. There are no Class D zones within the Site. **Image 2.1** displays an example of GeoSure data overlain on Aerial Imagery.

2.8.3. The GeoSure Class C zones and other geomorphology data is presented on **Figure 12.6 Geomorphology** and on datasheets provided in **Annex A**.

Image 2.1 Area of the Site with BGS GeoSure Landslide hazard Class C



Microsoft Bing Aerial Image reprinted with permission from Microsoft Corporation. GeoSure data shown, with the permission of the British Geological Survey.

2.9 LANDSLIDE SUSCEPTIBILITY AND PEAT MORPHOLOGY

2.9.1. In addition to GeoSure Ground Stability Data, aerial and LiDAR imagery was reviewed for evidence of landslides and peat morphology features such as peat landslides, peaty debris slides, gully head failures and collapsing peat banks, with particular attention to features within 100 m of Proposed Infrastructure. No evidence of peat instability was identified.

2.10 HISTORICAL INFORMATION

2.10.1. OS historical mapping was reviewed and identifies moorland or rough pasture land use as at present.

3 SITE RECONNAISSANCE & FIELD SURVEYS

3.1.1. Walkover and peat surveys were carried out in April 2023, and then April and May 2024. These site visits focussed on gaining a good overall understanding of the Site, collecting representative peat depth data and peat coring.

3.1.2. During site visits, surveyors did not observe any evidence of previous peat instability within the Site.

3.1.3. The weather during the site visits was generally good. There were no occasions where frozen conditions prevented peat depth measurements being taken.

3.2 SITE RECONNAISSANCE

3.2.1. **Photographs 3.1** to **3.6** provide images and descriptive text of the landscape and vegetation at the Site. It should be noted that these photos provide context and do not necessarily indicate the location of infrastructure, which has been located to avoid the steepest and deeper peat areas, where possible.

Photograph 3.1: Looking north from T3, at NGR 235616, 571956 (85 m AOD). Bedrock outcrop oriented north to south, abutting flat basin containing peat / organic soil. Peat depth nearby was 0.26 m. Slope gradients over the outcrop is gentle. No evidence of peat instability was noted. Moorland vegetation dominated by grasses and heather.

Photograph 3.2: Looking south from NGR 236159, 571635 near T1 (70 m AOD). This is a generally low slope area with the gradient increasing from 5° to 9° eastwards. Peat depth at this location is 0.09 m. No evidence of peat instability was noted. Moorland vegetation dominated by grasses and heather.

Photograph 3.3: Looking south from T11, NGR 234264, 573418. Peat in this area is less than 0.5 m. Slope gradients approximately 6°. No evidence of peat instability was noted. Moorland vegetation dominated by grasses on well drained substrate in the foreground.

Photograph 3.4: Looking north, photograph taken at NGR 235654, 571942, east of T3 (84 m AOD). Flat basin surrounded by hummocky terrain. Slope gradients rise where bedrock outcrops to approximately 5°. Peat in the basin ranged from 0.54 to 1.53 m. No evidence of peat instability was noted. Moorland vegetation dominated by grasses and heather.

Photograph 3.5: Looking west towards T10. Photograph taken at NGR 234909, 573775 (70m AOD). Peat depths in the area were less than 0.15 m. Area of low slope gradient. No evidence of peat instability was noted. Improved grass vegetation.

Photograph 3.6: Looking west towards T12, photograph taken at NGR 234590, 573929 (70m AOD). Peat depths in the area were less than 0.15 m. Area of low slope gradient. No evidence of peat instability was noted. Improved grass vegetation.

3.3 FIELD SURVEYS

3.3.1. Peat depth surveys were undertaken to inform this PLHRA as well as Technical Appendix 12.2 SPMP.

3.3.2. Peat survey campaigns have generally been conducted with reference to the Scottish Government guidance for peat surveys;

- A site-wide Phase 1 (100 m x 100 m grid) peat depth survey was completed by a Third Party in April 2023;
- After design chill, Phase 2 (detailed) peat surveys were undertaken at all infrastructure locations in April 2024 and comprised of the following;
  - 10 x 10 m grid at all turbines, crane pads and auxiliary laydown areas, substation and temporary construction compound;
  - Along access tracks points were sampled at 50 m intervals with x2, 10 m perpendicular offset points.

- Following the review of the design against the Phase 2 peat survey results, the layout was modified to avoid areas of deep peat as far as possible and additional Phase 2 surveys were undertaken. This was completed in May 2024. The evolution of the design and changes made to avoid peat and deep peat are presented in **Technical Appendix 12.2 SPMP**.

3.3.3. Peat depth survey methods followed good practice. Depths were recorded using utility probes advanced by hand through the soil until refusal. Notations on morphology, condition and a judgement of the likely substrate were also recorded.

3.3.4. The distribution of survey points is shown in Volume 1 **Figure 12.7: Peat Depth & Condition**.

3.4 PEAT CORES

3.4.1. Six peat cores were taken using a Russian auger in May 2024. The following information was recorded during peat core sampling (where possible) with details provided in **Table 3.1**:

- Depth of acrotelm;
- Degree of humification using Von Post classification;
- Water content; and
- Substrate underlying the peat (where possible).

3.4.2. Peat cores were collected during the additional Phase 2 survey in locations of initial peat stability concern coinciding with the proposed turbines. Where the design was modified to avoid areas of deep peat, cores were planned to be collected from both, the original and new turbine location. In three cases, cores were not recovered in the new turbine locations (T4_A, T11_A, and T5_A; **Figure 12.7 Peat Depth & Condition)** due to shallow peat demonstrating that peat was successfully avoided by the layout modification.

3.4.3. Amorphous catotelmic peat has been confirmed by five cores collected. Two of the core locations exhibited a Von Post value of H8 humification degrees, very strongly decomposed peat.

3.4.4. A threshold depth between fibrous catotelmic and amorphous catotelmic peat is suggested to be 1.0 m.

3.4.5. The geotechnical input (peat probing and coring surveys) provided to date does not replace geotechnical site investigations that would take place prior to construction commencing to inform the detailed site design, with the above information intended to provide design advice and the basis for assessment for the purposes of the application submission.

3.4.6. Peat core locations are presented on **Figure 12.7 Peat Depth & Condition**, and photographs are provided in **Annex C**. Data from these sources were applied to the datasheet locations provided in **Annex A**.

Table 3.1: Peat core and additional ground investigation data

Peat Core ID	National Grid Reference (NGR)	Core Depth (m)	Core Description and Results	Core Location Information
T1_A	NGR 236163, 571624	0.8	Von Post H8 – Brown very strongly decomposed from 0.5 m depth.	No visual evidence of instability, low gradient. Moorland Peat core shown on **Photographs in Annex C**.
T3_A	NGR 235616, 571956	0.8	Von Post H5 – Brown moderately decomposed from 0.5 m depth. Water table likely at approximately 0.55 m below the ground.	No visible evidence of instability, low gradient. Moorland. Peat core shown on **Photographs in Annex C**.
T3_B	NGR 235621, 571993	2.1	Von Post H6 – Brown strongly decomposed. Water table likely at approximately 1.5 m below the ground.	No visible evidence of instability in vicinity to the core. In a depression. Moorland. Peat core shown on **Photographs in Annex C**.
T4_B	NGR 235601, 572463	4.2	Von Post H6 – Brown strongly decomposed. Substrate – not recovered, likely bedrock. Water table likely at approximately 0.6 m below the ground.	No visible evidence of instability. Flat area at the bottom of a slope. Grassland. Peat core shown on **Photographs in Annex C**. This core location is noted on PSA Area B in **Annex A**.
T5_B	NGR 234875, 572015	2.2	Von Post H7-8 – Brown strongly to very strongly decomposed. Substrate – not recovered, likely bedrock. Water table likely at approximately 1.1 m below the ground.	No visible evidence of instability. Flat basin, Moorland vegetation with juvenile trees. Peat core shown on **Photographs in Annex C**.

Peat Core ID	National Grid Reference (NGR)	Core Depth (m)	Core Description and Results	Core Location Information
T11_B	NGR 234241, 573381	0.8	Von Post H6 – Dark brown strongly decomposed. Substrate – not recovered. Water table likely at approximately 0.55 m below the ground.	No visible evidence of instability. Moorland vegetation, wet underfoot. Peat core shown on **Photographs in Annex C**.

4 PEAT DEPTH & DISTRIBUTION

PEAT DEPTH SURVEY RESULTS

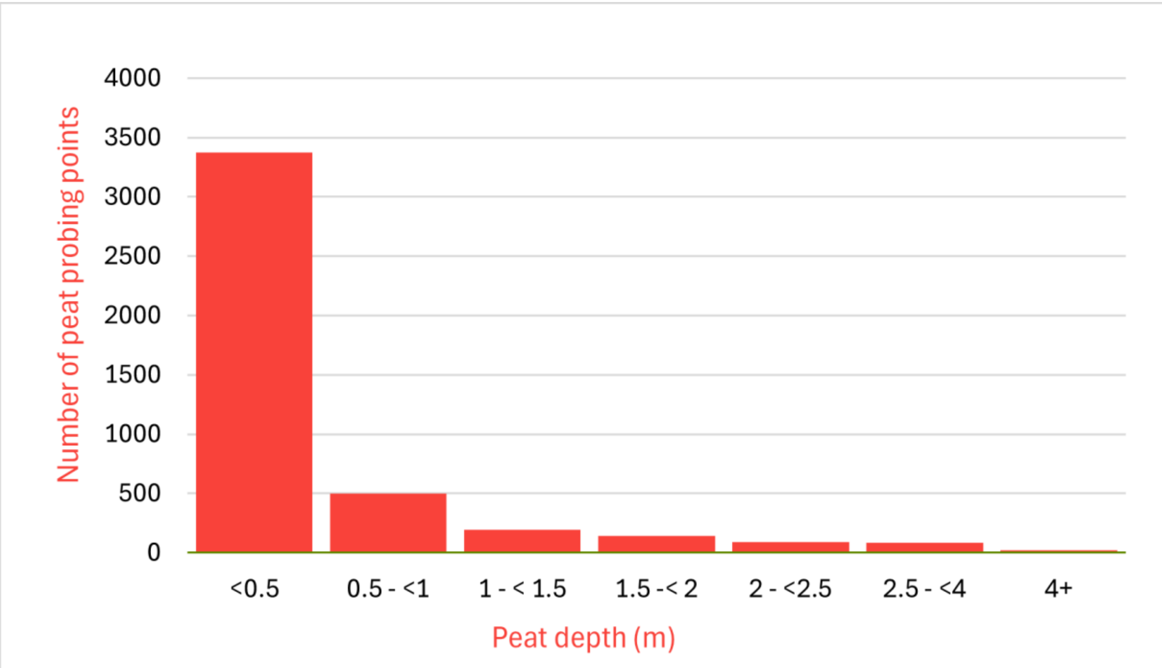
4.1.1. The peat was found to vary across the site in terms of depth and character.

4.1.2. A total of 4,408 peat depth measurements were made, with the results summarised in **Table 4-1** Results of peat depth survey below. 76.5% of the points probed had a peat depth of less than 0.50 m (non-peat), with 87.0% of the results less than 1.00 m and 92.4% less than 1.50 m, the average peat depth was 0.46 m. The peat depth results are presented in **Figure 12.7 Peat Depth & Condition.**

Table 4-1 – Results of the peat depth survey

	Number of locations surveyed	**Percentage of locations surveyed**	
0.0 to <0.5	3,373	76.5%	0.18
≥0.5 to <1.0	501	11.3%	0.69
≥1.0 to <1.5	197	4.5%	1.22
≥1.5 to <2.0	142	3.2%	1.72
≥2.0 to <2.5	88	2.0%	2.22
≥2.5 to <4.0	86	2.0%	3.0
≥4.0	21	0.5%	5.36
Total / Aggregate	**4,408**	**100.0%**	**0.46**

Image 4.1: Number of peat probing points by peat depth category



4.1.3. Deeper peat (≥2.0 m) represented only 4.5% of the total depths recorded. These areas of deep peat were generally localised to flat expanses in the west of the Site. The most notable occurrences of deep peat were coincident with the area of mapped Class 1 peat north of Loch Quie in the central western part of the Site.

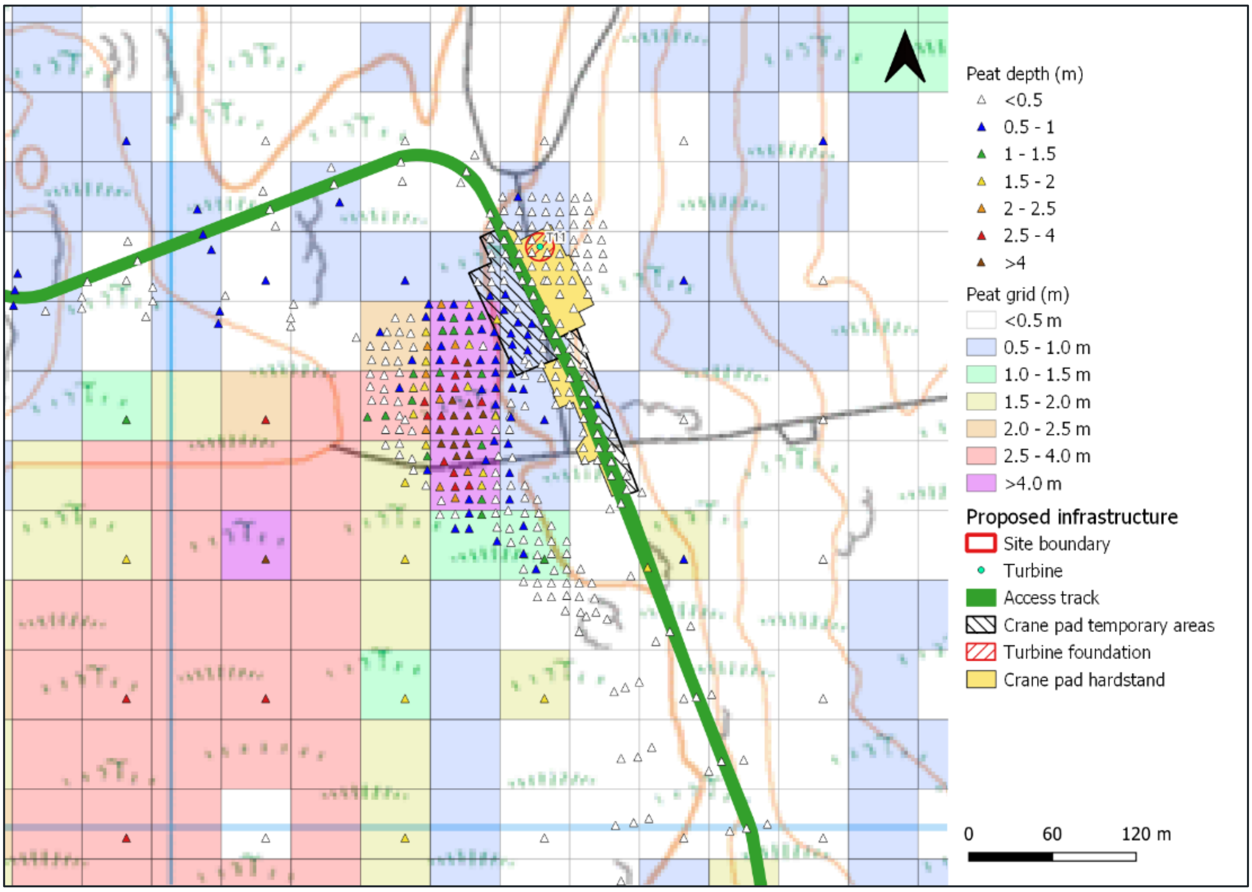
INDICATIVE PEAT DEPTH MAPPING

4.1.4. To assess peat landslide risk across the Site and to inform the refinement of the infrastructure layout, recorded peat depth data were extrapolated to a 50 x 50 m grid covering the entire Site. The use of a regular grid for terrain analyses of this type is a standard geospatial technique and is widely applied in a range of situations. It allows for a systematic extrapolation of relevant properties across the terrain, including in locations with no measurements. In this analysis, peat depths are extrapolated and mean, maximum and minimum slope angles for each cell derived from a DTM.

4.1.5. The choice of 50 x 50 m grid is determined by the resolution of DTM as using a very fine grid with a resolution identical to or finer than the DTM would return spurious results with a false indication of accuracy. For the Proposed Development, a 50 x 50 m grid was used in line with WSP's established peat stability analysis method as this resolution is fine enough to provide an appropriate level of detail for analysis but also sufficiently large to gain meaningful results from the 5 m DTM and derived slope model.

4.1.6. Each cell within the peat depth grid is assigned a peat depth value either based on a maximum measured peat depth within the given cell or extrapolated. Peat depth extrapolation is done manually using professional judgement, taking into account nearby peat depth measurements and slope angles, and an indicative value assigned to each cell. An enlarged portion of the peat depth grid is shown in **Image 4.2.** In some cases, aerial imagery is also consulted, for instance if it shows bare ground, this is taken as an indication of no peat present. The peat grid is then categorised following the peat depth ranges detailed in **Table 4.1**. The full indicative peat depth map across the Site is included as **Figure 12.7 Peat Depth & Condition.**

Image 4.2. An example of peat grid mapping



4.1.7. Peat depth categories were chosen in the context of energy projects development; for example, the threshold between considering cut-and-fill and floating access track construction is typically around 1.00 m - 1.50 m peat depth. Equally, the practicalities of installing turbines in peat over 2.50 m deep makes this a less attractive option. The minimum threshold for peat of 0.50 m is based on the Scottish Government guidelines[1&2]. Although the Wildlife Management and Muirburn (Scotland) Bill (2024) defines peat as a soil which has an organic content of more than 60% and peatland as land where the soil layer of peat has a thickness of greater than 40 cm, the Scottish Government guidelines for PLHRA[1&2] are followed here, as previously mentioned in Section 2.

4.1.8. From observation, it is clear that both slope and elevation have an influence on the development of peat, although the exact mechanism is not definitive and there is no mathematical growth/ decay model for the development and depth of peat. However, slope and elevation factors may be used intuitively when extrapolating from peat sampling data in the creation of an indicative peat depth map. It is often evident that deeper peat is generally found in flatter areas such as valleys, plateaux and hollows. Flat areas on hill summits tend to have relatively little peat; this is possibly due to a combination of exposure and slow growth rate as well as better drainage. Steep slopes also generally have less peat, owing for the most part to the reduced potential for peat to form due to more efficient runoff process.

4.1.9. As can be seen from **Image 4.2** and **Figure 12.7 Peat Depth & Condition**, where a cluster of peat probing points is all within the same peat depth category this has been taken as a good indication of the general peat depth in the surrounding area and the indicative peat depth map has been coloured accordingly. However, where clusters of peat probing points have returned depths in a range of depth categories a cautious approach has been taken, with the indicative peat depth map being classified in line with the deepest category of peat found in the area. This leads to a conservative indicative peat depth map.

4.1.10. The peat depth category breakdown for the peat depth grid, for all cells within the grid and cells with measured peat depths, is given in **Table 4.3**.

Table 4.3: Peat depth category breakdown

Peat Depth Range (m)		**<0.50**	**0.50 - <1.00**	**1.00 - <1.50**	**1.50 - <2.00**	**2.00 - <2.50**	**2.50 - <4.00**	**≥4.00**	**Total**
Probing Data	**No. of points**	**3,373**	**501**	**197**	**142**	**88**	**86**	**21**	**4,408**
	% of points	76.5%	11.3%	4.5%	3.2%	2.0%	2.0%	0.5%	100.0%
Indicative Peat Depth Grid	**No. of cells**	**2,528**	**1,949**	**181**	**92**	**43**	**67**	**7**	**4,867**
	% of cells	51.9%	40.1%	3.7%	1.9%	0.9%	1.4%	0.1%	100.0%
Indicative Peat Depth Grid (with measured peat depths)	**No. of cells**	**817**	**209**	**94**	**51**	**35**	**37**	**7**	**1,250**
	% of cells	65.3%	16.7%	7.5%	4.1%	2.8%	3.0%	0.6%	100.0%

5 FACTOR OF SAFETY ANALYSIS

5.1.1. To establish the stability of peatland areas, WSP applies the 'Factor of Safety' methodology. This procedure involves the application of site data (peat depth and slope angle) alongside values for a number of further variables, with the more sensitive of these being the values allocated for cohesive strength and in situ (undrained) bulk density of peat. The values applied are based on literature review and are generally considered conservative, in accordance with a purposefully precautionary approach.

5.1.2. This PLHRA initially determined areas at greatest risk of slope failure, based on FoS slope stability calculations, which were then considered in greater detail, including site visits to gather further information.

5.1.3. Using the collated data an initial analysis of slope stability can be carried out using the infinite slope model. The stability of a slope can be assessed by calculating the FoS, *F* which is the ratio of the sum of resisting forces (shear strength) and the sum of the destabilising forces (shear stress):

$$F = \frac{c' + (\gamma - m\gamma_w) z \, Cos^2 \beta \, Tan\phi}{\gamma \, z \, Sin\beta \, Cos\beta}$$

5.1.4. Where *c'* is the effective cohesion, γ is the unit weight of saturated peat, γ_w is the bulk density of water, *m* is the height of the water table as a fraction of the peat depth, *z* is the peat depth in the direction of normal stress, β is the angle of the slope to the horizontal and φ' is the effective angle of internal friction.

5.1.5. The FoS, *F*, represents the ratio of the forces resisting a slide to the forces causing the material to slide. If *F* > 1 then the slope is stable and normally if *F* >1.4 then there is a degree of comfort that the slope would not fail. The boundary value of 1.4 is in accordance with the current recommendations of Eurocode 7[8].

5.1.6. To get an indication of the stability of the peat at the proposed pole locations, the FoS can be calculated for each peat probing location. In addition, to gain a better view of peat stability in the areas surrounding the infrastructure, FoS calculations can be carried out for the grid cells of the indicative peat depth map in the vicinity of the infrastructure. To do this, we must know or be able to reasonably infer the parameters for the FoS equation for each probing location and grid cell.

5.1.7. The slope angle, *β*, can be derived from the DTM for the Site. For the peat probing locations, a single slope angle value is generated for each point, whilst for the grid maximum, minimum and mean slope values are calculated for each grid cell. The mean slope angle was used in the grid FoS calculations, although the other statistics provide useful supporting information on the variability of slope within the cells.

5.1.8. The measured peat depth data for each probing location is used in calculating the point FoS values. Measured peat depths are presented as a histogram in **Image 4.1**, with reference to **Tables 4.1** and **4.3**; 76.5% of results are less than 0.50 m and 87% are less than 1.00 m. For the grid-based FoS

[8] BSI (2004 & 2007). Geotechnical design. Eurocode 7: BS EN 1997-1: 2004 & BS EN 1997-2: 2007, British Standards Institute.

assessment, the peat depth grid is used with indicative values assigned to cells with no measurements (as described in **Section 4**).

5.1.9. The bulk density of water, γ_w, is known to be 1.00 Mg/m^3.

5.1.10. The bulk density of peat is known to vary with the level of decomposition. In situ undrained bulk density of peat reported in literature ranged from 0.50 to 1.40 Mg/m^3. Laboratory analyses undertaken on samples collected by or on behalf of WSP from other projects have returned bulk density values generally ranging between 0.80 and 1.40 Mg/m^3. Based on this experience and also after reviewing externally published values Lindsay[9], Dykes & Warburton[3] and Scottish Government guidance[2] an average wet bulk density value of 1.00 Mg/m^3 has been applied for the FoS calculations.

5.1.11. If it is assumed that the Site is covered with active blanket bog, it follows that the peat must be completely saturated, with a water table at or close to the surface. On site observations indicate that this assumption is only valid on limited areas of this site, as ground conditions were noted to be relatively dry underfoot by survey teams with few evident wetter areas. Consequently, a water table ratio, m, of 1.0 has been chosen, which is considered conservative given most of the Site exhibits drier conditions, but may occur locally during or following heavy rainfall 'trigger' events.

5.1.12. The angle of internal friction in peat also varies, decreasing with increasing decomposition and moisture content. For the FoS calculations, a φ' value of 5° has been selected as per WSP's conservative approach.

5.1.13. Finally, a value for the effective cohesion, *c'*, must be derived. Literature values for *c'* in peat vary widely, generally ranging from 4 – 20 kN/m^2. To provide an indication of the cohesive strength of the peat at this Site, a back-calculation using the FoS equation and measured peat depth data for the Site has been completed. The techniques involved are discussed below.

9 Lindsay, R.A (2010). *Peatbogs and Carbon, a critical synthesis to inform policy development in oceanic peat bog conservation and restoration in the context of climate change.. Available at* https://repository.uel.ac.uk/item/862y6 [Accessed in April 2024].

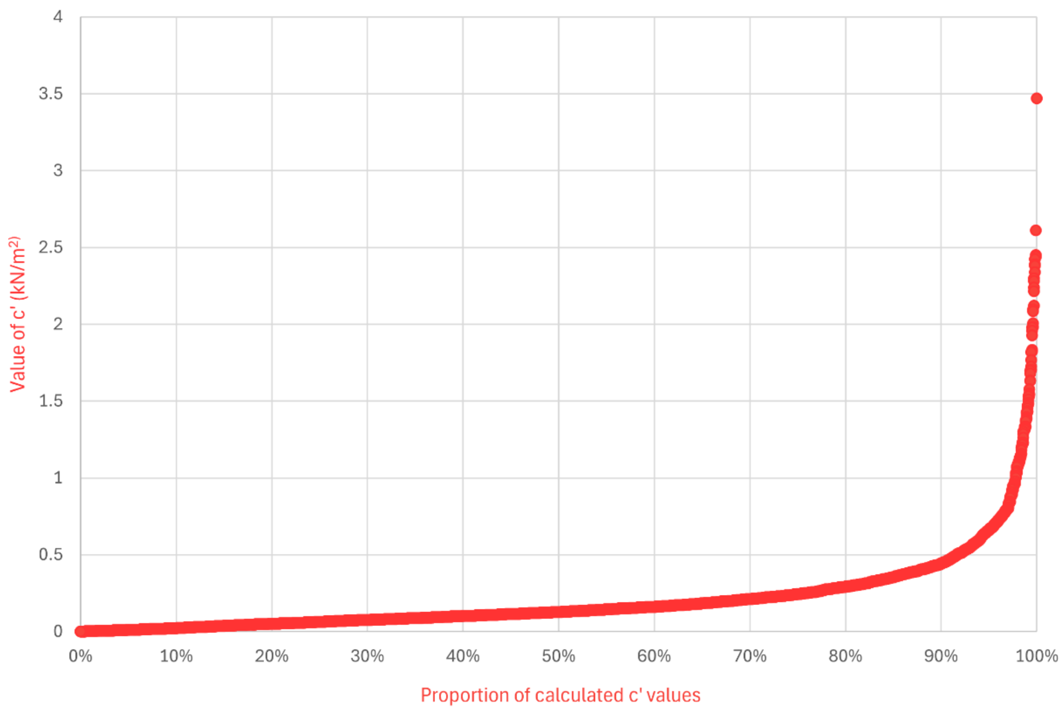
5.2 ESTIMATION OF COHESIVE STRENGTH

5.2.1. A range of field and laboratory tests can be carried out to determine the effective cohesion of a material. However, owing to its fibrous and thixotropic nature and the variation in strength with decomposition, peat is a particularly difficult material to analyse both in the field and in the laboratory. An alternative approach to assessing the strength of the peat is to rearrange the FoS equation to calculate a value of *c'* at actual peat probing locations. Essentially, this approach assumes that if the hillside is stable then the material must have at least a certain minimum strength.

5.2.2. Each peat probing location visited is known to have been stable at the time of the visit and therefore must have a FoS of at least 1. If we assume conservatively that *F*=1 and use values for the other parameters as discussed above, the FoS equation can be rearranged to allow derivation of a value for *c'* at each probing location. Slope angles for the probing points are generated from the DTM. It is important to note that the value of *c'* calculated for each location represents the minimum cohesive strength necessary for the peat to be stable at that location. In fact, the shear strength may be, and in most cases probably is, considerably higher.

5.2.3. In the Study Area, 4408 locations have been probed during the different phases of fieldwork, *c'* values for each of these have been calculated and the distribution of these values is shown in **Image 5.1**. For example, reading from the graph, 80% of the probing locations require a theoretical *c'* value of 0.29 kN/m^2 or less to be stable and retain peat on the slope.

Image 5.1: Estimate of minimum cohesive strength, *c'*



5.2.4. From this work it is possible to state, with reasonable confidence, that across the Site as a whole the shear strength of the peat is unlikely to be less than 1.43 kN/m^2 as this is the value of the 99th percentile point on the graph.

5.2.5. Similarly, *c'* values for the grid cells were calculated giving the 99th percentile value of 1.52 kN/m², slightly higher than for the point data due to inclusion of indicative depths for a number of cells.

5.2.6. The basis for applying these calculation details depends upon:

- The deliberate choice of conservative values for assumed parameters such as bulk density and water table level, coupled with the assumption of an FoS of 1 when back-calculating c' values.
- Recognition of what the calculations are stating, which is that these are the minimum strengths that would be required, not the actual in situ strengths. Therefore, where slopes are gentle and the peat shallow, very little shear strength is required to ensure stability of the slope. This accounts for the vast majority of the lower values.
- Assuming a reasonable degree of homogeneity for peat properties, particularly strength, across the Site. This seems reasonable, except for very shallow peat where the acrotelm, which is more fibrous, represents a significant proportion of the total depth. Such areas are, in any case, unlikely to be areas of concern.
- Given the above considerations, it is the higher strength values that are relevant. If this were not the case, then one would expect large areas of the Site to be denuded of peat as it would not have the strength to adhere to the hillsides.

5.2.7. For the purposes of the FoS Assessment *c'* values of 1.52 kN/m² and 1.43 kN/m² have been used for the grid-based and point calculations, respectively. These values are low in comparison with other locations assessed across Scotland, reflecting local characteristics of shallow peat and relatively gentle slopes. Compared with literary values of 4 – 20 kN/m², the actual effective cohesion of the peat at the Site may be substantially higher. However, application of these site-derived values ensures a reasonably conservative initial assessment using data from the Site, in tandem with an understanding of literary values.

5.3 FOS STABILITY RESULTS

5.3.1. Having assigned measured or inferred values to each parameter in the FoS equation, the FoS value was calculated for each probing location and for each cell of the indicative peat depth grid. The results of the FoS assessment for the probing points and site grid are summarised in **Table 5.1.** The FoS assessment maps generated with these values are shown across the Site as series **Figure 12.9 Factor of Safety**.

Table 5.1: Summary of FoS assessment

Factor of Safety	<1.0	1.0 - <1.4	1.4 - <3.0	≥3.0	No Peat (less than 0.5 m depth)	Total
Probing Data (points)	45	49	260	681	3,373	4,408
% of Probing Points	1.0%	1.1%	5.9%	15.5%	76.5%	100%
Grid Cells	49	122	584	1,314	2,528	4,867
% of Grid Cells	1.0%	2.5%	17.5%	27.0%	52.0%	100%
Grid Cells (with measured peat depths)	23	33	142	235	817	1,250
% of Grid Cells (with measured peat depths)	1.8%	2.6%	11.4%	18.8%	65.4%	100%

5.3.2. Selecting the 99th percentile value of the back-calculated *c'* strengths implies that 1.0 % of the sample locations are subject to slope failure, plus any similar cells across the Site as a whole. As can be seen in **Table 5.1**, only 1% of all cells (49) and 1% of probing locations have a FoS value of less than 1; in theory these should either have failed or currently be failing. In reality, this is unlikely to be the case and these results are a consequence of the conservative approach adopted. Also, only 2.5% of cells and 1.1% of points have a FoS between 1.0 and 1.4, where stability can be considered marginal. Taken together, only 3.5% of the cells have FoS values of less than 1.4, 4.4% of cells with measured peat depths. As noted previously, indicative depths are conservatively assigned to cells and often overestimate the actual peat depths.

5.3.3. Note that where peat depth is less than 0.50 m, these cells were not considered as peat and are removed from further stability investigation.

5.3.4. To summarise, 97.9% of the peat probing locations have a FoS of 1.4 or greater (including locations with peat less than 0.50 m depth), where stability can be assumed with a degree of comfort. 96.5% of grid cells with measured peat depths have FoS values greater than 1.4 (including cells with peat less than 0.50 m depth), again these are locations where stability can be assumed with a degree of comfort.

5.3.5. The results demonstrate that the majority of the infrastructure would be built in areas where there is a degree of comfort in inferring stability.

6 INITIAL RISK ASSESSMENT

6.1.1. Based on the data collated from the desk study, reconnaissance survey, peat probing and FoS stability analysis the peat stability risk across the site can be classified. The Guidelines[1] define risk as a function of likelihood and consequence and this has been applied by WSP as:

Risk = Likelihood x Adverse Consequence

6.1.2. The risk level is derived by applying a matrix of likelihood and consequence outcomes to derive a risk value ranging from 'Negligible' to 'High Risk'. Additionally, where peat is not present (such as organic soils with depth less than 0.50 m) these areas were identified as 'N/A – Not Peat'.

6.1.3. Central to WSP's analysis is a grid model of the Study Area, using 50 m x 50 m individual cell dimensions. It is therefore essential to have processes that assign likelihood and consequence ratings to the cells and build a map of spatial variability across the Study Area. The rationale for evaluating likelihood and consequence is given in the following sections.

6.2 LIKELIHOOD

6.2.1. Although overall the topography is gently undulating, bedrock outcrops exhibit a range of slope gradients. Peat surveys show that deeper peat is generally found in flat basins in between bedrock outcrops. Cells with Likely and Probable Initial Likelihood values generally recorded low to gentle mean slope gradients but exhibited a relatively wide range of slope gradients, some recorded mean cell slopes of up to 10.5 ^{o}.

6.2.2. In WSP's method, the primary and non-subjective measure of likelihood of slope stability is the FoS calculation. Slopes with FoS values greater than 1.4 are generally regarded as 'safe', with lower FoS value slopes of greater stability concern.

6.2.3. Within FoS analysis, the parameter which may be considered to have the greatest uncertainty is the shear strength of the peat. The derivation of this parameter has been discussed above. The back-calculation approach is more conservative (i.e. gives a safer assumption) than that commonly derived from in situ shear vane tests, which have known limitations when applied to peat. For the initial risk assessment, the likelihood is based solely on FoS, enabling an objective, reasonably cautious initial 'screening' approach to likelihood. The initial likelihood criteria and classification of cells is provided on **Tables 6.1** and **6.2**, respectively.

Table 6.1: Criteria relating to Initial Likelihood values

Likelihood	Factor of Safety
Almost certain	Not applied at initial likelihood stage, better determined in conjunction with additional data available from a specific peat stability survey of such areas
Probable	FoS <1.0
Likely	FoS is between 1.0 and <1.4
Unlikely	FoS is between 1.4 and <3.0
Negligible	FoS 3.0+
N/A – No Peat	Soil at depth shallower than 0.50 m or confirmed as non-peat material

Table 6.2 Summary of Initial Likelihood grid classification

Likelihood							
	Almost Certain	**Probable**	**Likely**	**Unlikely**	**Negligible**	**No Peat**	**Total**
No. of Grid Cells	Not Applied	49	122	854	1,314	2,528	4,867
% of Grid Cells	Not Applied	1.0%	2.5%	17.5%	27.0%	52.0%	100%
No. of Grid Cells (with measured peat depths)	Not Applied	23	33	142	235	817	1,250
% of Grid Cells (with measured peat depths)	Not Applied	1.8%	2.6%	11.4%	18.8%	65.4%	100%

6.2.4. The initial likelihood classification of grid cells across the Site is presented as **Figure 12.10 Initial Likelihood**.

6.3 ADVERSE CONSEQUENCE

6.3.1. The Guidelines[1] identify that 'Consequence' relates to impact upon receptors, this would include property, existing infrastructure and assets, environmental features and/or the Proposed Development infrastructure. These terms need to be taken in their broader context if an itemised list of receptors is to be considered which would include:

- existing public and private infrastructure (roads, bridges, buildings, business facilities, etc.);
- terrestrial ecology;

- aquatic ecology and water quality;
- archaeology; and
- proposed internal infrastructure (access tracks, turbines, cabling, etc.).

6.3.2. In order to include nearby receptors (shown on **Figure 12.11 Receptors**), the Site grid extends at least 200 m beyond the Proposed Development. This enables consideration of sensitive features outwith the Proposed Development.

6.3.3. These features have varying dimensions of costs and magnitude caused by an occurrence of mass peat instability, but in addition there may be irretrievable personal, societal or habitat losses:

- Costs: the only quantification provided within the Guidelines is in terms of project costs, which are easier to apply to infrastructure assets than to ecology. If ecology is of relatively minor importance for a particular site, economic impacts or delays in the construction programme may be the main drivers.
- Magnitude: naturally occurring peatslides have been observed to range in size from small-scale, localised slides involving tens of square metres to large-scale slides involving thousands of square metres and with run-out distances of km. Consequently, magnitude may be expressed in terms of area, peat volume and run-out distance and receptor. Provided sufficient peat probing has been undertaken and an indicative peat depth map produced, areas and peat volumes can be derived using professional judgement given local ground conditions. The associated run-out distance is of less significance than the receptor damaged and again should be considered taking account of local conditions to arrive at a realistic outcome.

6.3.4. **Table 6.3** assembles the above considerations to outline the degrees of consequence. Using the table, the three columns are considered, and professional judgement applied, to identify the appropriate 'Consequence' rating. The consequence values were identified and applied using mapping software to escalate the value based on local receptors, with the default (starting) position being that each grid cell was considered of 'Low' consequence, taking a reasonably precautionary approach.

6.3.5. The consequence classification of cells is provided in **Table 6.3**. The consequence classification of grid cells is presented as **Figure 12.12 Consequence**.

Table 6.3: Criteria for Consequence values

Consequence	Habitat	Internal Infrastructure	Public / Private Infrastructure
Extremely High	Large loss/damage to valued terrestrial and/or aquatic habitat, i.e. within designated sites. Large loss/damage to archaeological designated sites.	N/A	Damage to property: domestic/public building or business (*within 100 m*). Impact on railways or A class road or bridges, including lower category roads which provide key transport corridors in remote locations (*within 100 m*). Impact on public utilities, water, gas, electricity, telecoms, etc. (*within 100 m*).
High	Medium loss/damage to valued terrestrial and/or aquatic habitat, i.e. designated sites (*within 100 m*). Medium loss/damage to archaeological designated sites (*within 100 m*).	Damage to substation and/or control building *(within 100 m).*	Damage to minor/unclassified public roads or bridges *(within 100 m)*. Impact on private utilities, local electrical connection, water and wastewater *(within 100 m).*
Moderate	Small loss/damage to valued terrestrial and/or aquatic habitat. Large loss/damage to common terrestrial and/or hydrology features shown on 1:10,000 OS mapping (*within 50 m*). Peat grid cells identified with peat depth 1.50 m+.	Damage to planned turbines (*within 100 m*). Damage to section of new access track, construction compound and borrow pits *(within 50 m)* which would require repair to enable functionality. Damage to car parking (*within 50 m*). Interruption to construction or operation of development.	Damage to section of existing unclassified access track, or bridge *(within 100 m).*
Low *Default Position*	Medium loss/damage to common terrestrial and/ or hydrology features shown on 1:10,000 OS mapping.	Minor damage to section of access track which does not necessitate immediate repair for access.	Minor damage to assets.
Very Low *Not Applied*	Small temporary loss/damage to common terrestrial and/or aquatic habitat.	No damage to assets.	No damage to assets.

Table 6.4: Summary of Consequence grid classification

	Consequence				
	Extremely High	**High**	**Moderate**	**Low**	**Total**
No. of Grid Cells	634	98	2037	2098	4867
% of Grid Cells	13.0%	2.0%	41.9%	43.1%	100%
No. of Grid Cells (with measured peat depth)	52	34	720	444	1250
% of Grid Cells (with measured peat depth)	4.2%	2.7%	57.6%	35.5%	100%

6.3.6. Grid cells with 'Extremely High' consequence values were identified along the eastern Site boundary, many being outwith the Site boundary, and in the north. These grid cells coincide with public roads and buildings. Additional cluster of grid cells with 'Extremely High' consequence is found at the Site boundary in the west, identified due to the presence of scheduled monuments. None of these cells are in the vicinity of the Proposed Infrastructure. A cluster of cells with 'High' consequence is identified in the north coinciding with a private water supply and cells around the proposed substation were assigned 'High' consequence too. The remainder of the Site is of 'Moderate' or 'Low' consequence, the former primarily due to the presence of watercourses and the Proposed Infrastructure.

6.4 INITIAL RISK ASSESSMENT OUTCOMES

6.4.1. The results of the initial likelihood (solely based on FoS) and consequence grid cell categorisations reflect the characteristics of the Site, with the methods and key features of both elements covered in preceding sections.

6.4.2. The Guidelines[1] risk scoring is determined via a matrix table, combining likelihood and consequence. This has been provided as **Table 6.5** and replicates Table 5.3 in the guidance[1]. An initial risk value has been derived for each grid cell through combining the Likelihood and Consequence ratings using the matrix in **Table 6.5**. A summary of the grid cell counts for each risk category is provided in **Table 6.6**.

Table 6.5: Risk matrix based on Likelihood and Consequence values

		Adverse Consequence				
		Extremely High	High	Moderate	Low	Very Low
Peat Landslide Likelihood (over Development Lifetime)	Almost Certain	High	High	Moderate	Moderate	Low
	Probable	High	Moderate	Moderate	Low	Negligible
	Likely	Moderate	Moderate	Low	Low	Negligible
	Unlikely	Low	Low	Low	Negligible	Negligible
	Negligible	Low	Negligible	Negligible	Negligible	Negligible

Table 6.6: Summary of Initial Risk assessment outcomes and actions

Initial Risk	Number of Grid Cells	% of Grid Cells	Number of Gridat depth)	% of Grid Cells (with measured peat depth)	Suggested 'Guideline' Actions (Table 5.4[1])
High	8	0.2%	0	0%	*"Avoid project development at these locations".*
Moderate	43	0.9%	23	1.8%	*"Project should not proceed unless risk can be avoided or mitigated at these locations, without significant environmental impact, in order to reduce risk ranking to low or negligible".*
Low	733	15.1%	158	12.6%	*"Project may proceed pending further investigation to refine assessment and mitigate hazard through relocation or re-design at these locations*".
Negligible	1,555	31.9%	252	20.2%	*"Project should proceed with monitoring and mitigation of peat landslide hazards at these locations as appropriate*".
N/A No Risk (No Peat)	2,528	51.9%	817	65.4%	Non-peat material, no peatslide risk.
Total Cells:	**4,867**	**100.0 %**	**1,250**	**100.0 %**	

6.4.3. As can be seen on **Table 6.6**, the majority of the Site has been assessed as having 'No Risk', 'Negligible' or 'Low' risk of peatslide hazard at the initial risk assessment stage (98.9% of all cells and 98.2% of cells with measured peat depth).

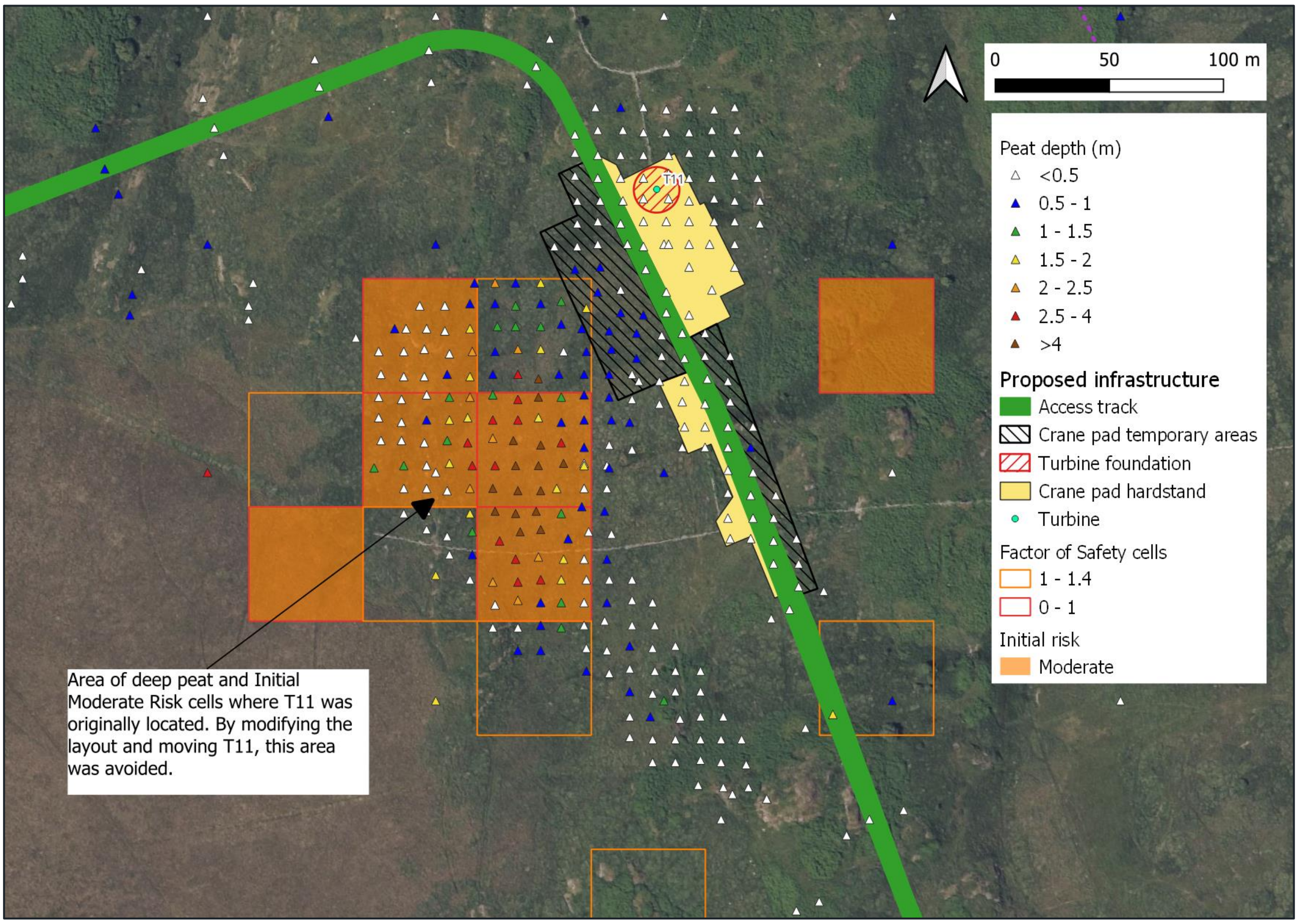
6.4.4. **Figure 12.13 Initial Risk** shows the planned infrastructure layout overlaid on the Initial Risk mapping, from which 'High' or 'Moderate' risk of peat instability are identified as red or orange cells, respectively.

6.4.5. High initial risk value cells are located outwith the Site boundary near the River Cree. Given the distance from the Proposed Infrastructure, these are not considered of concern. Moderate initial risk cells are typically located where deeper peat depths were recorded, coincident with gentle to moderate slope gradients (shown on **Figure 12.11 Receptors**).

6.4.6. When considering the grid cells with measured peat depths, none recorded a 'High' initial risk and 1.8% of cells recorded a 'Moderate' initial risk.

6.4.7. Modification of the layout to avoid areas of deep peat following the Phase 2 survey also served to avoid cells of Initial Moderate risk as demonstrated in **Image 6.1.**

Image 6.1 Area of the Site where the layout modification avoided cells of Initial Moderate risk.



Microsoft Bing Aerial Image reprinted with permission from Microsoft Corporation.

6.4.8. After review of Initial Risk locations to exclude those outwith close proximity to planned infrastructure, regarded as highly unlikely to be adversely affected by the Proposed Development, the remaining cells cluster into two peat stability assessment areas, PSA Areas A & B, and further location-specific information has been focused on these in the Revised Risk Assessment and datasheets provided in **Annex B**.

6.4.9. There are several cells with Initial Moderate risk, which were considered in the Revised Risk Assessment, but detailed assessment sheets are not provided for these. Most of these are near, but not directly overlapping with the Proposed Infrastructure (see **Image 6.1**), one cell coincides with T1 and T13, and one with the access track to T2. They exhibit very similar conditions to PSA A & B and the same mitigation measures apply.

6.4.10. Both, PSA A & B were initially identified as being at potentially ‘Moderate’ risk of peat landslide (orange cells), with likelihood defined by factor of safety values <1 combined with ‘Moderate’ consequence values.

6.4.11. Further location-specific information has been focused on these locations in the Revised Risk Assessment and datasheets provided in **Annex B**, to ensure that these outcomes were considered reasonable as part of a sensitivity analysis of the theoretical data.

7 DETAILED ASSESSMENT AND REVISED RISK ASSESSMENT

7.1.1. For each of the PSA Areas, a Detailed Assessment has been undertaken and reported on individual datasheets. This includes description of the peat depths, FoS values, local characteristics including geomorphology and geotechnical information, remote sensing/aerial imagery and available photographs. These datasheets also identify site-specific mitigation, considering the additional information gathered at each of the PSA Areas. The individual datasheets are provided in **Annex A**, with an overview of the locations presented in **Figure 12.14 Detailed Assessment Areas**.

7.1.2. Maps in the detailed assessment datasheets display grid cells with Moderate Initial Risk values (each cell measuring 50 m x 50 m) and cells with FoS values less than 1.4. **Annex B** provides additional imagery.

7.1.3. Likelihood values assigned to each cell are based solely on FoS values, as discussed for the initial risk assessment, however, regional and local context information may provide additional data that justifies changing the likelihood category at the revised risk assessment stage for locations of concern. These contextual factors are consolidated into **Table 7.1**, which provides rationale to assigning revised likelihood values to refine the assessment process:

7.1.4. In a regional context, some areas have a higher propensity for peatslide events than others and this may be evident from historical records, if reliable. Regional climatic factors influence the development of peat, its coverage and depth; at a site-level peat depths are determined from peat probing fieldwork rather than generalisations. Although the regional context does not provide any spatial differentiation within the Study Area, it may influence the level of caution applied.

7.1.5. In a local context, the variability of local factors material to the development of peatslides may be considered. The primary local factors not already incorporated into the FoS calculations include convex slopes, breaks of slope, drainage patterns, landuse, grazing intensity and incidental events such as fire, which may alter the likelihood of peatslides. These factors may operate across the whole Study Area, in which case they offer no spatial differentiation, but if localised to specific parts of the Site they may be helpful in spatial characterisation. Identification of instability identified from aerial imagery and confirmed by ‘ground truthing’ as non-peatslide events, such as peaty debris slides, may be relevant as these forms of instability are not caused by peat instability (rather, are due to the slope failure of material underlying the peat layer, or where peat is not present). The Peat Landslide and Hazard Risk Assessment Guidance[1] included suggestions of probability values, these have been included in italics as a contextual reference.

Table 7.1: Criteria relating to Revised Likelihood values

Likelihood/ Hazard	**Regional Context**	**Local Context**
Almost Certain	The wider region (if it consists of similar condition units to the Study Area) has several historic peatslides. Study Area has several historic peatslides.	FoS <1.0 Ancillary considerations: ✓ Locally, indications of incipient mass peat instability such as tension cracks, bulges, misaligned fences or trees etc; ✓ Peat depths on slopes consistently over 1.50 m; ✓ Topography: convex breaks in slope; extensive unconfined slopes; ✓ Drainage: converging flow paths; large contributing area; peat pipes; ✓ GeoSure Landslide Hazard Class D; *Probability of mass peat instability event occurrence during lifetime of scheme considered greater than 1 in 3.*
Probable	Study Area has evidence of historic peatslide	FoS <1.0 Ancillary considerations: ✓ Locally, indications of incipient mass peat instability; ✓ Peat depths on slopes consistently over 1.00 m; ✓ Topography: convex breaks in slope; extensive unconfined slopes; ✓ Drainage: converging flow paths; large contributing area; peat pipes; ✓ GeoSure Landslide Hazard Class D; *Probability of mass peat instability event occurrence during lifetime of scheme considered between 1 in 3 – 1 in 10.*

Likelihood/ Hazard	Regional Context	Local Context
Likely	Study Area has evidence of historic peatslide	FoS is between 1.0 and 1.4 Ancillary considerations: ✓ Locally, no adjacent indications of incipient mass peat instability but some within 100 m; ✓ Peat depths on slopes consistently over 1.00 m; ✓ Topography: generally rounded/undulating landforms; ✓ Drainage: suspicious absence of surface channels indications of peat pipes; ✓ GeoSure Landslide Hazard Class C; *Probability of mass peat instability event occurrence during lifetime of scheme considered between 1 in 10 – 1 in 100.*
Unlikely	Study Area has no evidence of past peatslides.	FoS is between 1.4 and 3.0 Ancillary considerations: ✓ Locally, no indications of incipient mass peat instability ✓ Isolated peat depths over 1.00 m on slopes; ✓ Topography: generally rounded/undulating landforms; ✓ Drainage: natural well-defined channels; artificial improvements to drainage; ✓ Not GeoSure Landslide Hazard Class D or C; *Probability of mass peat instability event occurrence during lifetime of scheme considered between 1 in 100 – 1 in 10,000,000.*

Likelihood/ Hazard	Regional Context	Local Context
Negligible	The wider region (if it consists of similar condition units to the Study Area) has no historic peatslides. Study Area has no evidence of historic peatslides.	FoS > 3.0 Ancillary considerations: ✓ Locally, no indications of incipient mass peat instability; ✓ Peat depths less than 1.00 m on slopes; ✓ Topography: concave or no break in slope; small confined slopes or pockets; ✓ Drainage: diverging flow paths; small contributing area; natural well-defined channels; artificial improvements to drainage; ✓ Not GeoSure Landslide Hazard Class D or C; *Probability of mass peat instability event occurrence during lifetime of scheme considered less than 1 in 10,000,000.*
N/A – No Peat		Soil at depth shallower than 0.50 m or confirmed as non-peat material.

7.1.6. To aid the revised risk assessment process, focussed on detailed assessment areas, geomorphology data was collated, including grid cells with peat depths greater than 1.50 m, BGS GeoSure Landslide Hazard classes C and D, slope angles greater than 8º and convex and concave breaks in slope. These features are displayed with planned infrastructure on **Figure 12.6 Geomorphology**.

7.1.7. A series of images for each area are also presented in **Annex B** for the PSA Areas. These display aerial and LiDAR imagery, OS background mapping and slope derived from the DTM data.

7.1.8. In addition to good practice and design measures, there are also a number of area-specific mitigation measures that are proposed to be deployed to reduce likelihood at particular locations, with further details in **Section 1.8**.

7.1.9. The revised risk information on the nine individual datasheets (**Annex A**) reflects refinement, following consideration of specific characteristics for each area, using applicable ground investigation information and the identification and application of any appropriate mitigation measures during design, construction and operation.

7.1.10. Potential runout distances and volumes of material for each datasheet have been estimated, factoring-in local conditions, with these estimates recorded within the Detailed Assessment datasheets, alongside identified receptors within and outwith the Site Boundary.

7.2 REVISED RISK ASSESSMENT OUTCOMES

7.2.1. Following Detailed Assessment of the PSA Areas, using contextual criteria provided in **Table 7.1** and assuming application of appropriate good practice and area-specific mitigation measures, likelihood for all cells within the PSA areas was reduced to Unlikely. Location-specific rationale and details are provided for each PSA Area in the Datasheets. This revised outcome anticipates proposed tracks constructed using techniques to avoid or minimise excavation where applicable, slope monitoring and consideration of micro-siting to avoid breaks of slope.

7.2.2. Following the risk matrix displayed in **Table 6.5**, the revised risk is reduced to 'Low' for all PSA areas. The updated risk outcomes are shown in **Table 7.2** and **Figure 12.15 Revised Risk**.

Table 7.2: Revised Risk outcomes

Revised Risk	**Number of Grid Cells**	**% of Grid Cells**	**Number of Grid Cells (with measured peat depth)**	**% of Grid Cells (with measured peat depth)**	**Suggested 'Guideline' Actions**
High	8	0.2 %	0	0.0 %	*"Avoid project development at these locations".*
Moderate	16	0.3 %	1	0.1 %	*"Project should not proceed unless risk can be avoided or mitigated at these locations, without significant environmental impact, in order to reduce risk ranking to low or negligible".*
Low	760	15.6	180	14.4%	*"Project may proceed pending further investigation to refine assessment and mitigate hazard through relocation or re-design at these locations".*
Negligible	1555	32.0%	252	20.2%	*"Project should proceed with monitoring and mitigation of peat landslide hazards at these locations as appropriate".*
N/A No Risk (No Peat)	2528	51.9%	817	65.4%	Non-peat material, no peatslide risk.
Total Cells:	**4867**	**100.0 %**	**1250**	**100.0 %**	

8 ASSESSMENT ASSUMPTIONS AND LIMITATIONS

8.1.1. Following previous peat stability report feedback from the Scottish Government Peat Stability Independent Assessor (Ironside Farrar) from similar sites, this section identifies key assumptions which have been applied during the preparation of this deliverable. These assumptions are considered appropriate and proportionate for a development seeking planning consent, with expectation that further data shall be available as the design progresses into construction.

STUDY AREA

8.1.2. A study area extending 200 m beyond the Site boundary was applied (excluding northern extent where no infrastructure is planned), with peat mass movement events likely to be limited to within this zone, based on local ground conditions and slope angles and taking account of the Proposed Development activities. It is considered unlikely that any peat landslide that occurred outwith this zone would be caused by or cause adverse influence to the Proposed Development.

8.1.3. This is taking into consideration the fact that peatslides in Scotland tend to originate and complete run-out over distances of up to 250 m, with small-scale events a more common occurrence than such larger events.

8.1.4. Longer run-out zones may occur in areas with less constraints, increasingly likely where mass peat movement events meet and then follow watercourse flow paths, as occurred in some well-documented examples such as Meenbog and Derrybrien in the Republic of Ireland. These Irish events may be more likely to represent bog burst phenomena, with higher water content within the peat body involved. Intermittent areas of shallow peaty soils, bedrock exposures, variable gradients, change of slope direction and forestry are local factors that may act individually or collectively to reduce run-out distances in the context of this project.

PEAT SURVEY CONSTRAINTS AND PEAT DEPTH GRID INTERPOLATION

8.1.5. Due to the existing electrical assets present, there were constraints to the extent of peat depth survey. In addition, the final placement of the proposed assets occurred subsequently to the latest peat survey. This has reduced the number of peat probe records at Proposed Development locations, with indicative values used where measured depths were not available. To establish indicative peat depths for grid cells without recorded peat depths, WSP applied professional judgement, with determination using the context of local slope angles and regional peat depth records. This manual process adopted the precautionary principle, purposefully registering deeper peat estimates as indicative depths for unsurveyed grid cells where less certainty was available. As this process did not apply automated interpolation procedures, there was much less reliance on peat survey point data than could be the case with software-led determination. WSP have confidence that sufficient data was available (and could be reasonably inferred) to enable a robust assessment at this stage.

8.1.6. This initial (conservative) allocation of indicative peat depths across the grid cells by experienced staff was a critical step for the subsequent analysis that determines factor of safety results, which determined the initial likelihood value, input alongside consequence value to evaluate the initial risk of grid cells, irrespective of collected peat survey data.

8.1.7. The initial risk assessment was refined by undertaking a detailed assessment of all locations with 'Moderate' initial risk levels. To ensure representative locations were included and not dependent solely on peat depth records, GeoSure datasets and aerial imagery were reviewed, alongside the factor of safety outcomes. Site surveys included peat probing and coring by experienced personnel.

8.1.8. WSP's staged approach, with professional judgement applied throughout, results in a high degree of confidence that relevant locations have been identified appropriately risk assessed by experienced assessment staff. This included noting recommendations for future tasks, including further peat surveys, as the design develops and more GI information may become available.

FACTOR OF SAFETY

8.1.9. The key variables and most sensitive factors in the FoS analysis are peat depth and slope angle, which are directly applied using a large dataset of site information focussed on planned pole positions, applying a back-calculated c' specific to site data and conservative lower-bound literature values for other calculation inputs. Thus, the assessment of peat stability at this stage follows an inherently conservative approach. The site visit observations act as a form of sensitivity analysis, as the method bases initial probability directly upon FoS outcomes for the initial risk stage and typically leads to the identification of locations which can be justifiably reduced to a lower probability and potentially lower revised risk, following the collation of ancillary local information.

8.1.10. Reduction in slope stability due to increasing of mass of slope above the peat body is considered as a trigger for mass movement of peat, although peat loading is not a parameter included as part of the Factor of Safety method, specific mitigation measures seek to avoid or reduce this situation occurring at locations of concern. The application of temporary track is part of the design strategy to minimise loading of slopes and removal of slope support. Furthermore, the temporary tracks are of limited duration and will be removed once local construction is completed. This assessment focussed upon in situ (undrained) peat, at the detailed design stage it may be deemed appropriate to also conduct analysis for drained peat for representative locations including the PSA Areas.

RECEPTORS

8.1.11. OS infrastructure digital layers were primarily used to determine receptors and consequence values alongside some data source listed in section 2.2 of this report. The assessment relies on the completeness and accuracy of these datasets.

PEAT MANAGEMENT

8.1.12. Excavated peat would be re-used in as short a timescale as feasible and follow principles provided in **Appendix 12.2 Soil and Peat Management Plan**. Post-consent, the detailed design would include details of plans for temporary storage of peat and associated methodologies for excavation/transfer/storage/reuse and include specific storage locations. The Geotechnical Risk Register would include peat storage as a specific risk, with applicable controls that would be kept up-to-date with current good practice and lessons learned from Site works.

MAPPING

8.1.13. Convex breaks of slope were only mapped in areas of ‘Moderate’ initial risk in the vicinity of the Proposed Infrastructure based on OS Terrain 5 DTM, and where the break extended horizontally for at least 10 m. However, the complex hummocky terrain exhibits a variety of slope gradients and orientations across the Site, and should additional break of slope mapping be considered appropriate at the detailed design stage, this could be undertaken.

8.1.14. Artificial drainage is present at the Site but these features have not been mapped. These channels are not all shown on OS mapping. Should additional channel mapping be considered appropriate at the detailed design stage, this could be undertaken.

9 MITIGATION AND GOOD PRACTICE MEASURES

9.1.1. The purpose of the PLHRA is to identify areas of the Site which are potentially at most risk of peat instability and thereafter assess potential construction impacts. Where avoidance through design is not possible, mitigation measures require to be implemented to avoid or reduce the risk of peat instability. In addition to specific mitigation measures which may be deployed at particular locations, itemised in the specific detailed assessment datasheets, there are a number of generic construction good practice measures that would be applied, where applicable, as additional data becomes available at the pre-construction stage. A number of these potential actions are set out in **Table 9.1**, including area-specific mitigation measures identified for the Proposed Development PSAs; A and B.

9.1.2. Good practice guidance documents, such as Floating Roads on Peat[10], Managing Geotechnical Risk[11] (Clayton, 2001) and Peat Landslide Hazard and Risk Assessments: Best Practice[1] would be consulted to inform the design and construction processes. All site investigation work would be undertaken in compliance with relevant British Standards (BS), including BS 5930:1999[12] and BS 6031:2009[13].

9.1.3. Onsite construction staff are often the best placed to provide advance notification of potential problems, provided sufficiently trained and with an appropriate reporting mechanism. There are a number of recognised indicators for slope failures and these may indicate a potential peatslide or the commencement of a peatslide event, as outlined in **Section 1.2** of this report. The suspected identification of any of these indicators should be assessed by specialist peat stability or geotechnical personnel.

9.1.4. Additional items to those identified in **Table 9.1** may be introduced as further site data becomes available at pre-construction and construction stages.

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[10] FCE & SNH N (2010). Floating Roads on Peat. Scottish Natural Heritage and Forestry Civil Engineering. [online]. Available at: http://www.roadex.org/wp-content/uploads/2014/01/FCE-SNH-Floating-Roads-on-Peat-report.pdf [Accessed in April 2024].

[11] Clayton, C. R. I. (2001). Managing Geotechnical Risk: Improving Productivity in UK Building & Construction. Thomas Telford, London.

[12] BSI (1999). Code of practice for site investigations. BS 5930:1999, British Standards Institute.

[13] BSI (2009). Code of practice for earthworks. BS 6031: 2009, British Standards Institute.

Table 9.1: Good practice and mitigation measures

Potential Actions	Good Practice	PSA Area-Specific Mitigation Measures, as applicable
1. Geotechnical specialist onsite during the construction phase to undertake advance inspection, carry out regular slope monitoring and provide ongoing advice at locations of concern.	✓	PSA A & B
2. Maintain and update geotechnical risk register or similar management system.	✓	PSA A & B
3. Construction staff should be made aware of peatslide indicators and emergency procedures (see below).	✓	
4. Emergency procedures should include steps to be taken on detection of any evidence of potential peat instability.	✓	
5. Microsite the infrastructure in order to avoid the area of concern (subject to non-violation of other constraints).	✓	PSA B
6. Ensure that good groundwater and surface water control, such as moor gripping or drainage ditches, is in place in advance of construction activities.	✓	
7. Installation of stand-pipes / piezometers to monitor ground water levels and pore pressures.	✓	
8. Ensure artificial drainage does not concentrate flows onto slopes, gully heads or into excavations.	✓	
9. Ensure that sediment control measures are incorporated into all artificial drainage measures and including specific scour protection mitigation where steep slopes or high activity erosion processes are identified. Concrete aprons, rip rap, gabion/reno mattress or geotextile mats may be applicable options, depending on watercourse characteristics and sensitivities.	✓	

Potential Actions	Good Practice	PSA Area-Specific Mitigation Measures, as applicable
10. Earthmoving activities should be restricted during and immediately after heavy and/or prolonged rainfall events, including use of weather forecasting and re-programming of construction activities as applicable. Particular care should be taken when heavy rainfall events are predicted following a prolonged dry spell.	✓	
11. The construction plan should minimise the extent and duration of open excavations and bare ground.	✓	
12. Avoid placing excavated material or other forms of loading on or immediately above breaks of slope or any other potentially unstable slopes.	✓	PSA A & B
13. Avoid removing slope support, particularly where slope stability has been highlighted as of concern. Consider temporary or floating access track at appropriate locations to avoid removing slope support.	✓	PSA A & B
14. Establish / re-establish vegetation as soon as possible to improve slope stability and provide sediment transport control.	✓	
15. Consider limiting loads crossing newly created peat embankments to enable pore water pressure in both embankment and underlying peat to reduce to pre-construction levels and original shear strength.	✓	
16. Modify slope geometry to provide a 'weighted toe'.	✓	
17. Use of retaining structures, such as gabion terracing to support specific slopes.	✓	
18. In locations where limited opportunity for avoidance or other mitigation to reduce likelihood, the application of debris nets, catch fences, catch ditches and/or deflection systems to protect receptors and reduce adverse consequences. Such installations should be subject to routine inspection and maintenance.	✓	

Potential Actions	Good Practice	PSA Area-Specific Mitigation Measures, as applicable
19. Forestry clearance activities should be undertaken following good practice, including careful positioning of log piles to avoid overloading of slope, sediment control and consideration of retaining tree roots *in situ* for soil stabilisation in appropriate locations.	✓	
20. Borrow pit blasting activities to take account of any peat stability locations of concern in the proximity, including seeking alternative methods that avoid blasting. If sensitive peat stability receptors are identified, there are a number of methods to manage, mitigate and monitor, such as careful placement, charge size, vibration monitoring and pre- and post-blasting slope monitoring.	N/A	

10 SUMMARY AND RECOMMENDATIONS

10.1.1. Peat depth probing in conjunction with slope angle mapping is a cost-effective method to establish peat depth and peat stability profiles across large areas. Combining this with aerial imagery data interpretation and GeoSure datasets enables potential evidence of mass movement events to be efficiently identified. Experienced staff used professional judgement to interpolate and determine indicative peat depths, where measured results were not available.

10.1.2. The Proposed Development is underlain by peat of varying depths and shallower peaty soil, ranging from 0 to 5.36 m, with an average depth of 0.46 m across the Study Area. Slope angles and orientation vary greatly reflecting the hummocky terrain of the Site. Convex breaks of slope were also identified in several places near the Proposed Infrastructure. Where deeper peat coincides with steeper slopes, the likelihood of peatslide increases. Higher likelihood for instability was identified primarily in areas with deeper peat deposits (> 0.99 m, measured or inferred) found on gentle to moderate slopes.

10.1.3. Initial risk was determined following a conservative approach based on FoS analysis and the presence of receptors. The potentially least stable areas in any specific locations were initially applied 'Moderate' or 'High' risk, with this risk level relative to the remainder of the Site. In order to review the initial risk, two areas with initial 'Moderate' risk locations close to Proposed Infrastructure were selected for the detailed assessment and revised risk process.

10.1.4. Modification of the layout following peat surveys to avoid areas of deeper peat has also led to general avoidance of areas of 'Moderate' initial risk.

10.1.5. **Annex A** provides datasheets for the two locations identified for 'Detailed Assessment', initially identified as of 'Moderate' risk. Further information was collated in the datasheets to discuss initial and revised risk assessment outcomes for these locations.

10.1.6. Following the Detailed Assessment process, 'Low' risk was confirmed for all locations. This takes account of local ground conditions, surveyor observations and mitigation measures, including construction of access tracks without excavation where appropriate to avoid/minimise disturbance of deeper peat, ensuring slope support is retained and slope monitoring where appropriate, and consideration of micrositing to avoid breaks of slope. On the basis of applying mitigation recommendations, no areas likely to be impacted by the Proposed Infrastructure are considered to be above 'Low' revised risk (with the vast majority of the Site considered 'Negligible', 'Low' risk or non-peat) in terms of peat stability assessment. Revised risk outcomes for the Site are shown on **Figure 12.15 Revised Risk**.

10.1.7. The Guidelines[1] quote the following requirements, of which 'Low' and 'Negligible' risk applies to this Site:

- High risk - 'Avoid project development at these locations';
- Moderate risk - 'Project should not proceed unless risk can be avoided or mitigated at these locations, without significant environmental impact, in order to reduce risk ranking to low or negligible';
- Low risk - 'Project may proceed pending further investigation to refine assessment and mitigate hazard through relocation or re-design at these locations'; and

- Negligible risk - 'Project may proceed with monitoring and mitigation of peat landslide hazards at these locations as appropriate'.

10.1.8. Further geotechnical investigation is proposed as part of the site investigations, which would take place post-submission and prior to construction. This is standard practice and would inform the final, detailed design of the Development, along with detailed mitigation to be implemented during construction, undertaken by an appropriately qualified geotechnical engineer. Any additional areas of concern identified by surveys pre-construction, should be added to the areas for further investigation.

10.1.9. Whilst good practice and specific mitigation measures have been identified in this document in order to minimise risk, the suggested techniques are not exhaustive and it is expected that a design consultancy and contractor would use these and other techniques, as appropriate, to effectively manage the peat stability risk.

10.1.10. Management of peat stability risk would remain a consideration throughout the subsequent detailed design processes, including additional site investigation, pre-construction activities and during construction, subject to the development receiving consent. A key issue is that the design remains 'live' and subject to ongoing optimisation, with the iterative design process continuing into construction phase. The contractor shall consider to microsite to reduce peat instability risk, whilst taking account of other local environmental and engineering constraints.

10.1.11. The need for risk management has been emphasised throughout this report. Risk management would include the regular review of the Geotechnical Risk Register, supported by appropriate actions within the contractor's Construction Method Statement (CMS) and Construction Environmental Management Plan (CEMP), in due course.

10.1.12. It is considered that the Proposed Development is in accordance with National Planning Framework 4, specifically Policy 5c-i, given there is a requirement to upgrade the connection between existing electrical assets, with this report providing supporting information in relation to Policy 5d-i and Policy 5d-ii.

11 TECHNICAL AUTHOR EXPERIENCE

11.1.1. The technical reviewer of this report was Stuart Bone BSc (Hons.) MSc PIEMA CWEM CEnv.

11.1.2. Stuart Bone is a Chartered Environmentalist (CEnv) and Chartered Water and Environmental Manager (CWEM) holding chartered status since 2005 and is also a Practitioner Member of the Institute of Environmental Management & Assessment (PIEMA). Stuart has a BSc (Hons.) in Environmental Geography from the University of Aberdeen and a MSc in Marine Resource Development and Protection from Heriot-Watt University. Stuart has over 20 years environmental experience, since 2006 focused on delivering PLHRA and other soil and water EIA deliverables in the renewable energy sector and highways. He has been involved in the planning of fieldwork and the delivery of PLHRA reports since 2006, following the initial Scottish Government guidance being published, becoming a technical lead on these deliverables in 2012. Stuart has a strong understanding of peat morphology, geomorphological processes, environmental data collection, FoS stability analysis and risk assessment both from project experience and from his academic background. Stuart has a thorough familiarity of the latest guidance and promotes early data collation and stability interpretation to inform the iterative design process in accordance with good risk management and proportionate assessment principles. Stuart has been supported by a range of staff undertaking various field and desk tasks, providing guidance and technical reviews at every stage of this PLHRA process, leading the GIS-based assessment, detailed assessment refinements and acting as report reviewer.

11.1.3. Monika Mendelova undertook a number of the peat surveys, undertook the peat depth data and FoS stability analysis, risk assessment and drafted this report, under supervision and guidance of Stuart Bone. Monika has over 5 years of research experience in geomorphology, holds a PhD from the University of Edinburgh, MSc in Polar and Alpine Change from the University of Sheffield and a MA (Hons.) in Geography from the University of Aberdeen. Monika has a strong understanding of geomorphological processes, landscape and climate change, and extensive experience with field data collection, sedimentological analysis, geomorphological mapping, and remote sensing.

Legend for Detailed Assessment Datasheets

Peat depth (m)
- <0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 2.5
- 2.5 - 4
- >4

Peat grid (m)
- <0.5 m
- 0.5 - 1.0 m
- 1.0 - 1.5 m
- 1.5 - 2.0 m
- 2.0 - 2.5 m
- 2.5 - 4.0 m
- >4.0 m
- Peat core
- Peat cells > 1m
- Convex break of slope
- PSA area

BGS Geosure Landslides Hazard Class
- C

Slope (degrees)
- <= 5
- 5 - 10
- 10 - 15
- 15 - 20
- > 20

Factor of Safety cells
- 1 - 1.4
- 0 - 1

Factor of Safety points
- 0 - 1
- 1 - 1.4
- 1 - 3
- 3 - inf

Initial risk
- High
- Moderate

Proposed infrastructure
- Site boundary
- Access track
- Construction compound
- Crane pad temporary areas
- Substation
- Turbine foundation
- Crane pad hardstand
- Turbine

PSA Area A: Initial Likelihood - Probable; Consequence – Moderate; **Risk - Moderate**
Revised Likelihood - Unlikely; Consequence - Moderate; **Revised Risk - Low**

Good Practice and Design

Section 1.8 details standard good practice measures.

The Proposed Infrastructure of T6 and T9 partially coincide with two cells of Moderate Initial Risk and the proposed access track crosses all three Moderate Initial Risk cells within PSA A.

Specific Mitigation, Potential Scale and Receptor

Section 1.8 lists standard mitigation measures.

In areas of deep peat, temporary access tracks shall adopt construction techniques to reduce or avoid excavation, e.g. using matting to protect underlying peatland whilst enabling vehicle access. Slope monitoring would be applied, as applicable. This area should be recorded in the Geotechnical Risk Register.

Should peatslide occur: approximated width 20m, length 20m, at an average depth of 1.5 m; volume of peat 600m^3; Receptors – The Proposed Infrastructure.

Photograph 1: Looking east, NGR 234413, 572951 (93 m AOD)

Revised Risk

No peat instability evidence was observed during Site visit or identified on aerial imagery. The majority of the Proposed Infrastructure is in areas of shallow or no peat (< 0.5 m) and deeper peat is found in areas with low slope angle. Taking account of the peatland morphology, existing drainage, individual peat probe FoS, design and mitigation (limiting excavation to construct tracks):

Peat-related instability is reduced to Unlikely and the Revised Risk reduced to Low.

Area Details

This area is primarily identified due to areas of localised gentle to moderate (10º - 15º) slopes and areas of deep peat. The consequence is moderate due to the presence of the Proposed Infrastructure and a watercourse. No Class C or D landslide hazard area were identified from the BGS GeoSure data within PSA A. No evidence of peat instability was identified from satellite imagery, nor any noted during site visits. The area is covered by moorland and rough pasture. Breaks of slope have been identified from DTM data east of T6 (**Annex B)**.

PSA Area A images with OS background and DTM data are also provided in **Annex B**.

Peat depth measurements within the PSA A range from 0 to 4.5 m and an average depth of 0.34 m.

1.6% of the probing locations recorded FoS value of less than 1.4, with the lowest FoS value of 0.93 based on 6º slope and 1.53 m peat depth.

The Moderate Initial Risk cell to the south-east of T6 has a FoS value of 0.62, based on a 3.3 m peat depth and a mean slope of 4.3º. If applying a shear strength value of 4 kN/m2, as literature lower-bound value, to this grid cell, the revised FoS outcome would be 1.64.

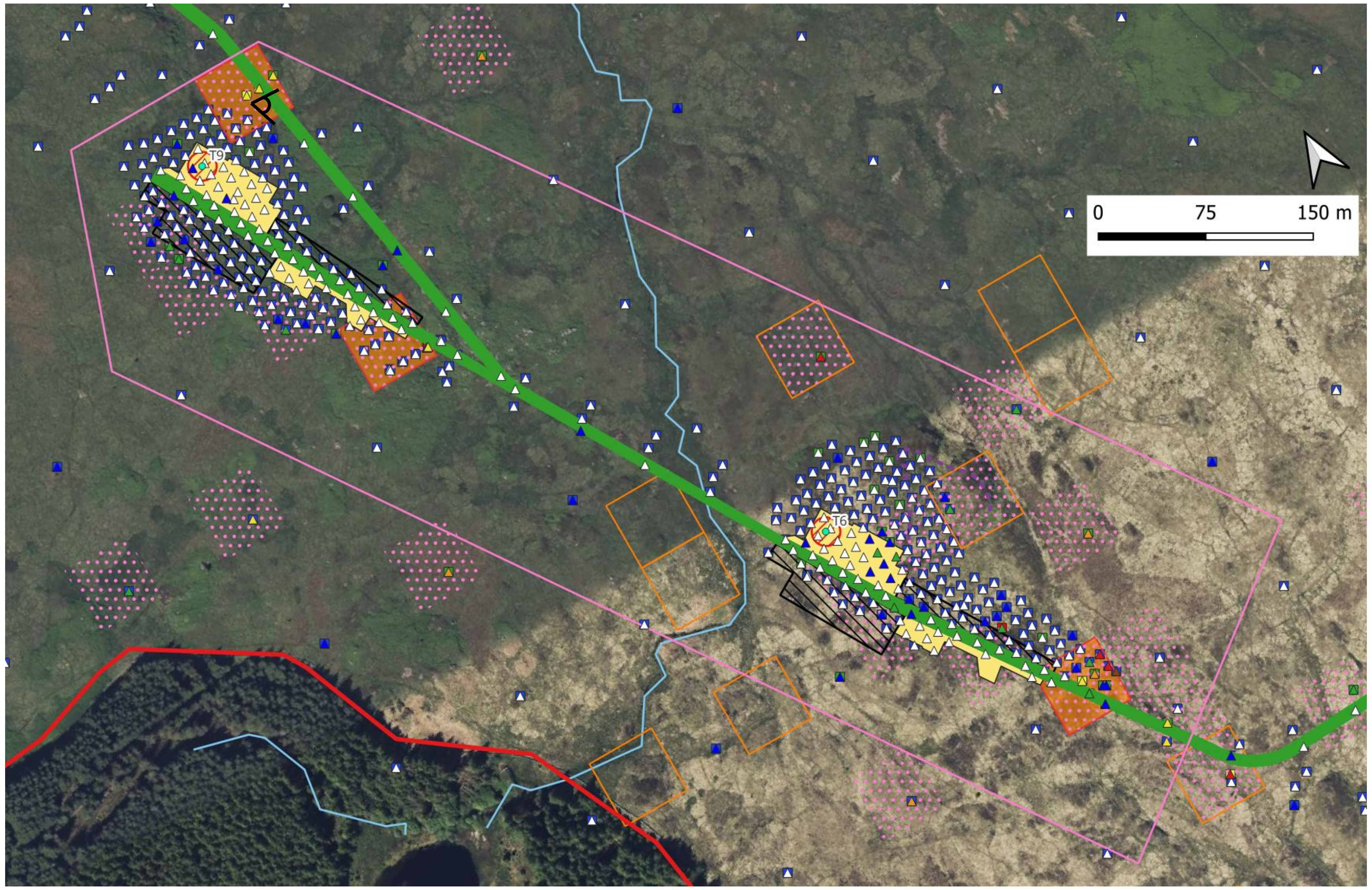


Image 1: Aerial Image of PSA Area A (grid cells are 50m x 50m)
Microsoft Bing screen shot reprinted with permission from Microsoft Corporation. Contains Ordnance Survey data © Crown copyright and database right 2024.

PSA Area B: Initial Likelihood - Probable; Consequence – Moderate**; Risk - Moderate**
Revised Likelihood - Unlikely; Consequence - Moderate**; Revised Risk - Low**

Good Practice and Design

Section 1.8 details standard good practice measures.

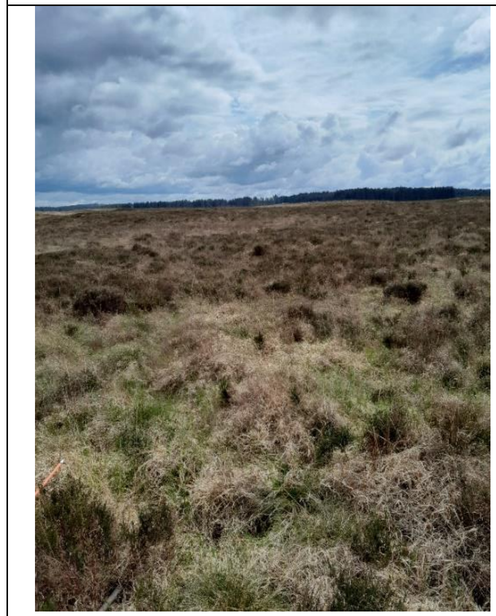
T4 borders three cells of Moderate Initial Risk and the proposed access track crosses two and Moderate Initial Risk cells. T7 and the nearby access track are in the vicinity of a Moderate Initial Risk.

Specific Mitigation, Potential Scale and Receptor

Section 1.8 lists standard mitigation measures.

In areas of deep peat, temporary access tracks shall adopt construction techniques to reduce or avoid excavation, e.g. using matting to protect underlying peatland whilst enabling vehicle access. Consider micrositing to avoid breaks of slope coinciding with T7 and in the vicinity of T4 (**Annex B**) and ensure slope support is retained. Slope monitoring would be applied, as applicable.

Should peatslide occur; approximated width 20m, length 20m, at an average depth of 3.0 m; volume of peat 1200m^3; Receptors – Proposed Infrastructure.



Photograph 2: Looking south from core T4_B location, NGR 235601, 572463 (80 m AOD).

Photograph 3: Looking south-east from core T4_B location, NGR 235601, 572463 at 80 m AOD.

Also see Core T4_B photographs in **Annex C.**

Revised Risk

Even though the location of T7 coincides with a Class C Landslide hazard area, the survey confirmed no peat within it (< 0.5 m). The majority of T7 and T4 infrastructure is located outwith deep peat areas. Most deep peat areas within PSA B are found on low slope gradients (< 5º). No peat instability evidence was observed from Site visit or identified on aerial image. Taking account of the peatland morphology, existing drainage, individual peat probe FoS, design and mitigation (avoiding break of slope):

Peat-related instability is reduced to Unlikely and the Revised Risk reduced to Low.

Area Details

This area is primarily identified due to moderate (10º - 15º) to steep (>15º) slopes and areas of deep peat. The consequence is moderate due to the presence of the Proposed Infrastructure and a watercourse. Class C landslide hazard area is identified from the BGS GeoSure data, coincident with T7. No evidence of peat instability was identified from satellite imagery, nor any noted during site visits. The area is covered by moorland and rough pasture. Convex break of slope runs underneath T7 in the north-south direction and to the north of T4 (see **Image 6** in **Annex B**).

PSA Area B images with OS background and DTM data are also provided in **Annex B**.

Peat depth measurements within the PSA B range from 0 to 6.1 m and an average depth of 0.53 m with deepest measurements to the north-east of T4.

The FoS values for peat probing locations ranged from 0.68 to 433. 2.5% of these recorded FoS values of less than 1.4. The location with the lowest FoS value is based on 8º slope and 1.53 m peat depth.

The Moderate Initial Risk cell to the north of T4 has a FoS value of 0.28, based on a 4.3 m peat depth and a mean slope of 7.5º. If applying a shear strength value of 4 kN/m^2, as literature lower-bound value, to this grid cell, the revised FoS outcomes would be 0.74.

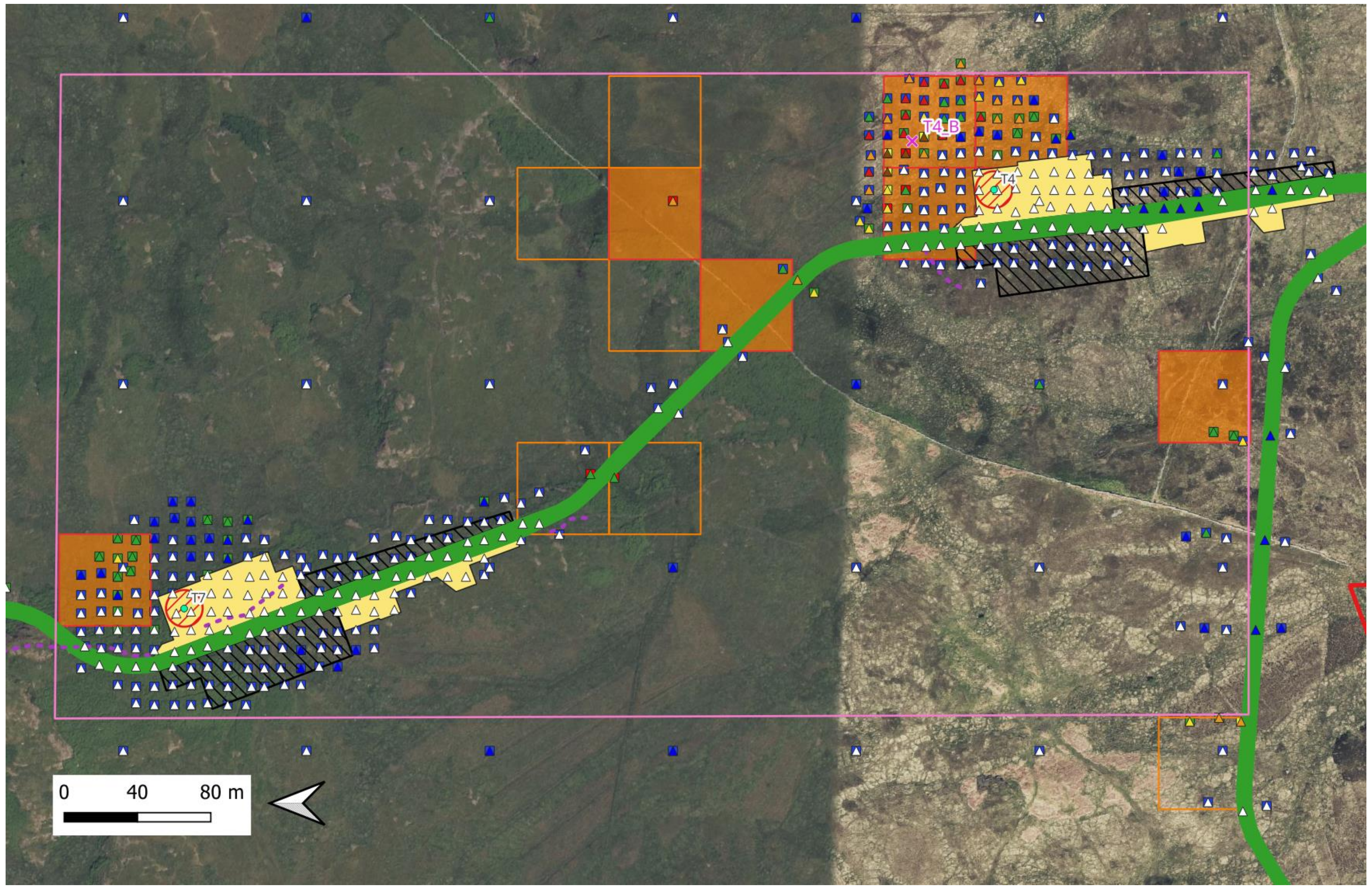
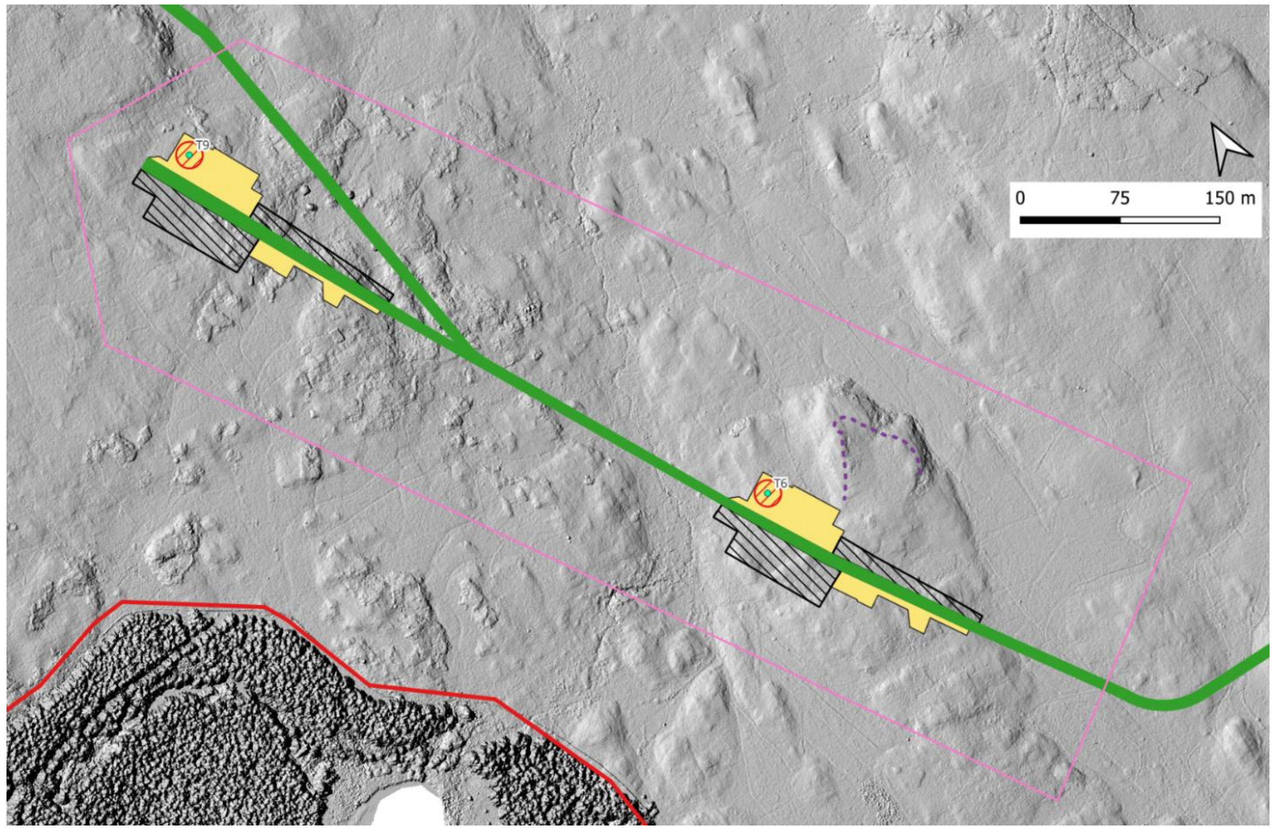
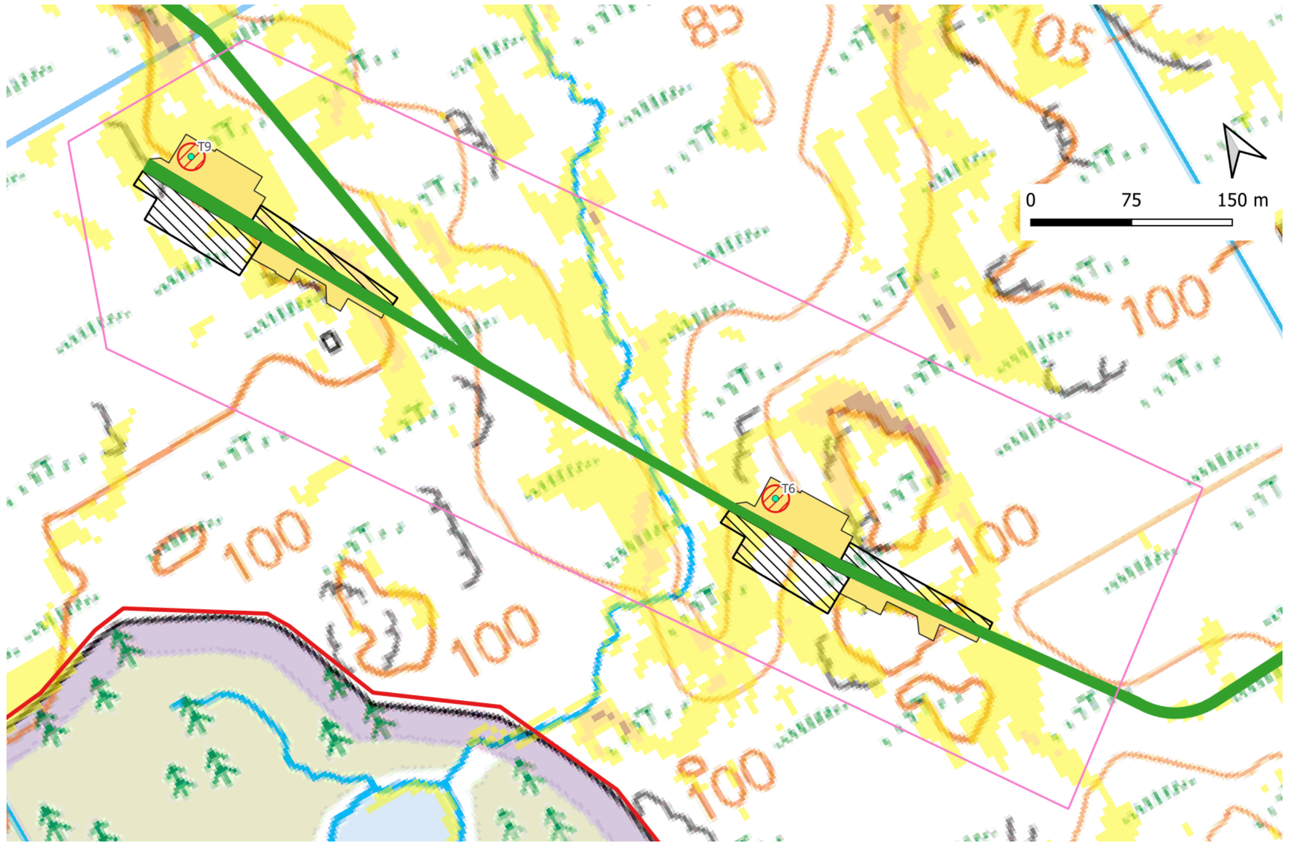


Image 2: Aerial Image of PSA Area B (grid cells are 50m x 50m)
Microsoft Bing screen shot reprinted with permission from Microsoft Corporation. Contains Ordnance Survey data © Crown copyright and database right 2024. GeoSure data shown, with the permission of the British Geological Survey

ANNEX C ADDITIONAL IMAGES OF PSA AREAS





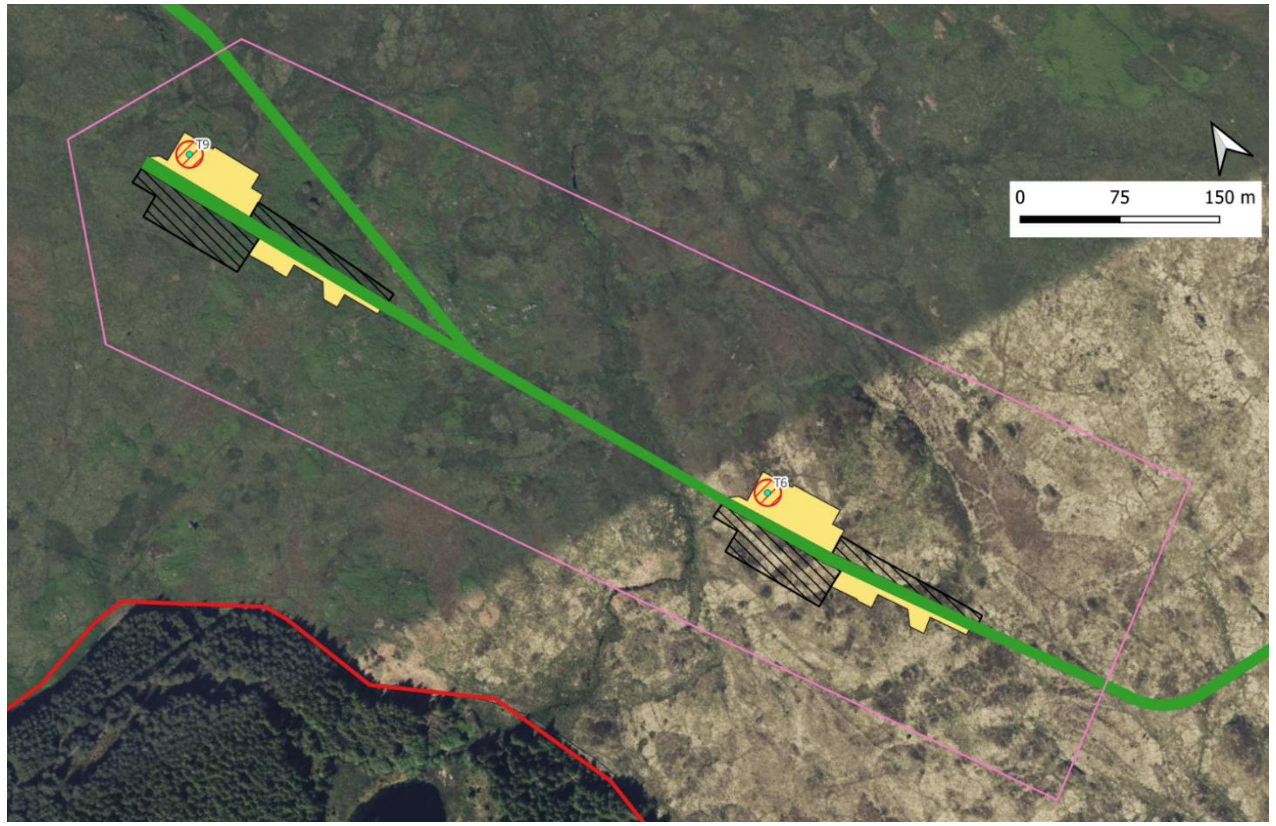
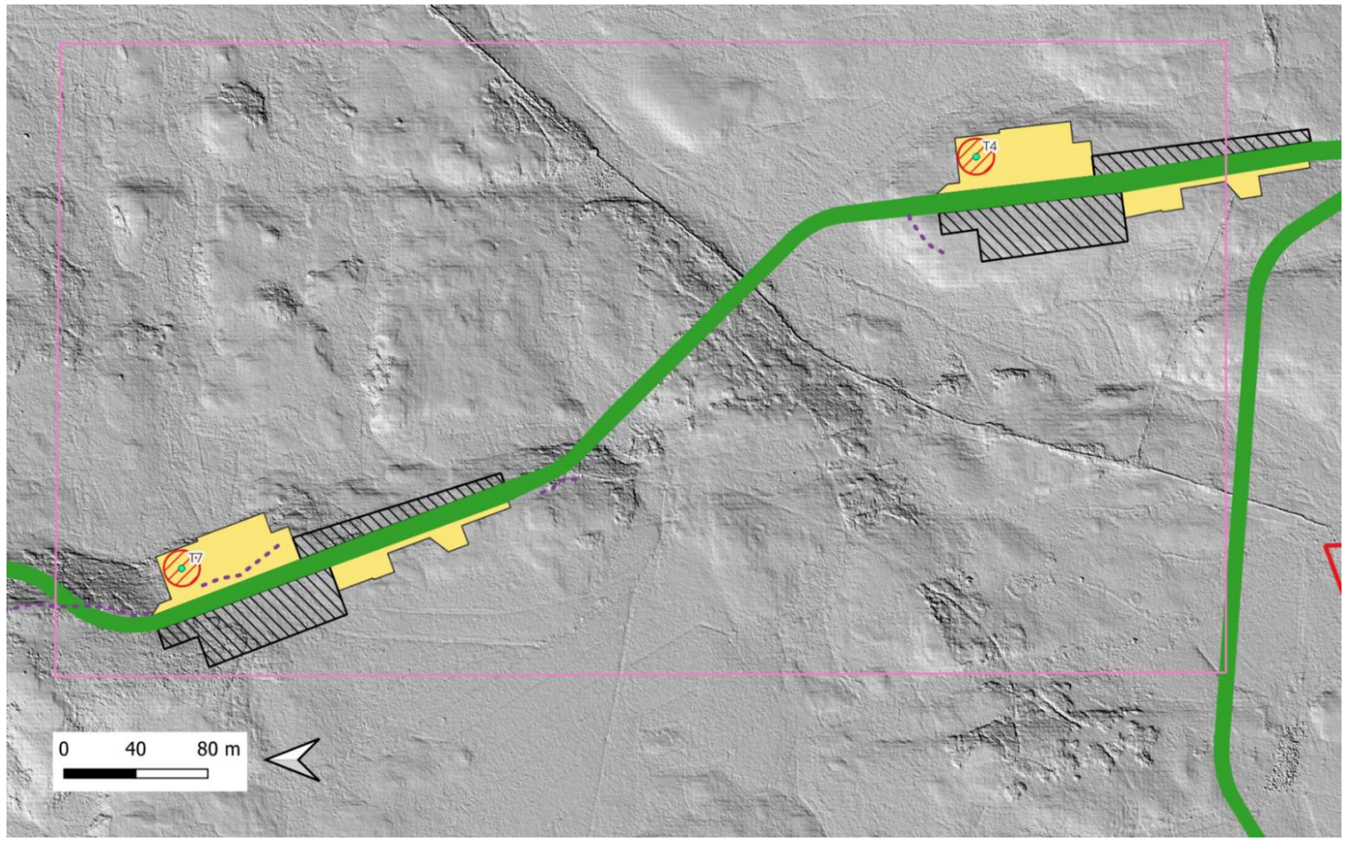


Image 3 (top left): LiDAR Image of PSA Area A

Image 4 (top right): OS overview with DTM slope data of PSA Area A

Image 5 (bottom left): Aerial overview of PSA Area A



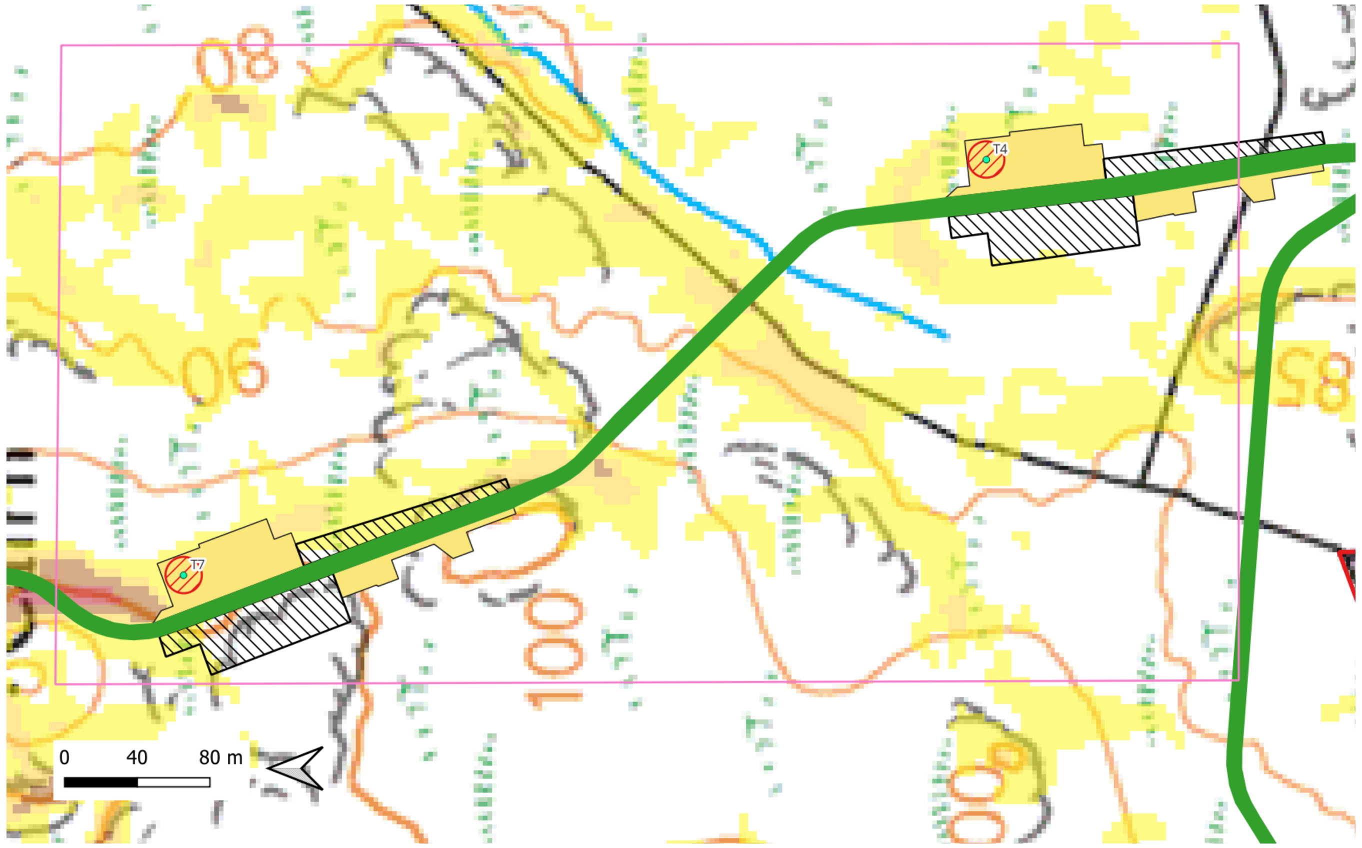


Image 6 (top left): LiDAR Image of PSA Area A
© Crown copyright Scottish Government, SEPA and Fugro (2020).

Image 7 (top right): OS overview with DTM slope data of PSA Area A
Contains Ordnance Survey data © Crown copyright and database right 2023.

Image 8 (bottom left): Aerial overview of PSA Area A
Microsoft Bing screen shot reprinted with permission from Microsoft Corporation.

ANNEX D. PEAT CORE PHOTOGRAPHS

Core ID	T1_A	Location	236163, 571624
Peat Depth (m)	0.8	Substrate	Unobserved, rock substrate
Notes	Water table ~0.5 m below ground level.		
Sample	Depth collected (m bgl)	Description / Observations	
1	0 – 0.5	Brown and fibrous moderately decomposed peat (H3 to H7)	
			
2	0.5 – 0.8	Brown psudofibrous peat that was highly decomposed (H8) and wet.	
			

Core ID	T3_A	Location	235616, 571956
Peat Depth (m)	0.8	Substrate	Unobserved, bedrock substrate.
Notes	Flat ground with grass and heather vegetation, in amongst rock outcrops. Water table ~0.55 m below ground level.		
Sample	Depth collected (m bgl)	Description / Observations	
1	0.0 – 0.5	Distinctly fibrous, dry, no peat expressed (H3 to H4).	
			
2	0.5 – 0.8	Brown moderately decomposed fibrous peat, turbid brown water with moderate expression (H5)	
			

Core ID	T4_B	Location	235601, 572463
Peat Depth (m)	4.2	Substrate	Unobserved, bedrock substrate
Notes			
Sample	Depth collected (m bgl)	Description / Observations	
1	0.0-0.6	Brown, distinctly fibrous, insignificant degree of decomposition (H2 to H3), some woody material identified.	
			
2	0.6-1.1	Brown, moderately decomposed peat with indistinct fibrous material (H5), some woody material identified.	
			
3	1.2 – 1.7	Brown, moderately decomposed peat with indistinct fibrous material (H5).	
			
4	1.7 – 2.2	Brown, moderately decomposed to highly decomposed peat with indistinct plant features (H5 to H7).	
			
5	2.2 – 2.7	Brown to dark brown, moderately decomposed to strongly decomposed peat with unrecognisable plant features (H5 and H6 and H9)	
			
6	2.7 – 3.2	Light to dark brown peat with a varied degree of decomposition, distinct but unrecognisable fibrous materials (H3 and H5 and H6)	
			

7	3.2 – 3.7	Light brown, moderately decomposed to highly decomposed pseudofibrous peat (H5 to H6) becoming amorphous.
		
8	3.7 – 4.2	Brown, wet, highly decomposed peat with indistinct fibrous materials (H6)
		

Core ID	T5_B	Location	234875, 572015
Peat Depth (m)	2.2	Substrate	Unobserved, bedrock substrate
Notes	Juvenile trees and heather grass vegetation on a mostly flat basin landscape. Water table ~1.1 m below ground level.		
Sample	Depth collected (m bgl)	Description / Observations	
1	0.0-0.6	Brown, insignificant degree of decomposition, easily distinguishable plant material (H1 to H3).	
			
2	0.6-1.1	Brown, moderately decomposed peat (H5) with recognisable but indistinct plant structures.	
			
3	1.1 – 1.6	Brown, highly decomposed peat with indistinct fibrous plant material (H6 and H7) with large wood chip identified.	
			
4	1.7 – 2.2	Brown, highly decomposed peat with very indistinct plant material (H7 and H8)	
			

Core ID	**T11_B**	**Location**	234241, 573381
Peat Depth (m)	0.8	**Substrate**	Sandy gravel, none collected
Notes	Grassy, mossy, heather. Wet and boggy underfoot. Water table ~0.55 m below ground level.		
Sample	**Depth collected (m bgl)**	**Description / Observations**	
1	0.0-0.5	Dark brown, very slightly decomposed peat with distinctly recognisable plant material (H3).	
			
2	0.5-0.8	Dark brown, moderately decomposed peat with recognisable but indistinct plant material (H4 to H6).	
			

Core ID	T3_B	**Location**	235621, 571993
Peat Depth (m)	2.1	**Substrate**	Firm gravel substrate, not recovered
Notes	Area was in a depression. Water table ~1.5 m below ground level.		
Sample	**Depth collected (m bgl)**	**Description / Observations**	
1	0-0.5	Light brown fibrous peat, little to no turbid water, no expression (H2 to H3)	
			
2	0.6-1.1	Light brown, distinctly to indistinctly fibrous, moderately decomposed peat (H4 to H6).	
			
3	1.1-1.6	Brown moderately decomposed pseudofibrous peat (H6) with some expression and saturation.	

		
4	1.6-2.1	Brown moderately decomposed pseudofibrous peat (H6) with some expression and saturation.
		

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GLENVERNOCH WIND FARM

Technical Appendix 12.4 Private Water Supply Risk Assessment

AUGUST 2024

PUBLIC

EnergieKontor UK

GLENVERNOCH WIND FARM

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TYPE OF DOCUMENT (VERSION) PUBLIC

PROJECT NO. 70119752

DATE: AUGUST 2024

EnergieKontor UK

GLENVERNOCH WIND FARM

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TABLES

FIGURES

APPENDICES

1 INTRODUCTION

1.1 GENERAL

A Private Water Supply Risk Assessment (PWSRA) has been carried out for water supplies that may be affected during the construction and operation of Glenvernoch Wind Farm ("the Proposed Development").

The Proposed Development is in Dumfries and Galloway near Newton Stewart. The Proposed Development will consist of the construction, 35 year operation and subsequent decommissioning of up to 13 wind turbines including associated development.

The Proposed Development is situated within the Dumfries and Galloway (D&GC) council area. This document should be read in conjunction with Chapter 12 of the Environmental Impact Assessment Report (EIAR); Hydrology, Hydrogeology, Geology and Soil.

1.2 SCOPE

This PWSRA forms a Technical Appendix to Chapter 12: Hydrology, Hydrogeology, Geology and Soil of the EIAR. The purpose of this assessment is to ascertain the potential risk to the identified private water supplies (PWS) within 3 km of the Proposed Development which could be affected as a result of its construction and/or operation. The assessment will adopt a phased approach evaluating risk through the formulation of a Source-Pathway-Receptor conceptual model. Where appropriate, the assessment will provide recommendations for potential mitigation measures.

The PWSRA also identifies any groundwater abstractions and where necessary provides a detailed qualitative / quantitative risk assessment in accordance with Option 4 of the Scottish Environment Protection Agency (SEPA) Land Use Planning Guidance Note 31: Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems.

1.3 POLICY & GUIDANCE

Legislation and guidance related to good practice during the construction of onshore wind farms that has been considered in the preparation of this document is provided within Chapter 12 of the EIAR.

2 METHODOLOGY

2.1 GENERAL

The PWSRA has been undertaken based on the following methodology:

- Completion of a desktop assessment and conceptual site model (CSM) to put the hydrological and hydrogeological setting of the Proposed Development into context (available in Chapter 12 of the EIAR);
- Consultation with D&GC and PWS users to confirm the location and nature of each supply. An additional review of Ordnance Survey (OS) and aerial imagery aided in the identification of any potentially unregistered PWS;
- Based on the information provided, screening out of supplies that are considered unlikely to be affected by the Proposed Development. For PWS with a plausible hydrological / hydrogeological connection to the development, further consideration or a site visit to verify the location and nature of their supply;
- Preparing a risk assessment to determine the potential effects of the Proposed Development; and
- Identification of any additional measures, that should be included as part of the environmental documentation and risk assessments, to avoid and mitigate against any potential adverse effects resulting from the Proposed Development.

2.2 CONCEPTUAL SITE MODEL

A desktop assessment has been used to compile a CSM and was supported using the following secondary data sources:

- Geological and hydrogeological information obtained from The British Geological Survey;
- Monthly precipitation and climate data from The Met Office;
- Information from the Scotland's Environment website;
- Scottish Environment Protection Agency (SEPA) River Basin Management Plans; and
- Other information published online concerning details of PWS within the vicinity of the Proposed Development.

Details of the existing site conditions can be found in the Baseline section of Chapter 12 of the EIAR.

The CSM has also been supported by site specific walkover surveys by a suitably qualified professional. These include walkovers of specific PWS as well as the wider catchment areas.

2.3 SCREENING

Consultation with D&GC was undertaken regarding the records held on PWS within a 3 km buffer of the site. Following data returns, an initial screening was carried out to determine which properties required direct consultation. The screening exercise excluded properties where hydrological or hydrogeological connectivity is implausible. These were determined through considering the following;

- Surface water catchment boundaries and channel networks, specifically including surface water abstractions that are downgradient and within 500 m of the Proposed Development;
- Aquifer properties including groundwater flow pathways, specifically including any groundwater abstractions within 250 m of the Proposed Development;

- Dominant land use; and
- Topography.

PWS with no plausible pathway between their source abstractions and the Proposed Development infrastructure were screened out of further assessment.

2.4 CONSULTATION

PWS users were contacted to obtain more information regarding their supply. This process involved sending residents a letter, a questionnaire and map:

- The letter explained the nature of the works and the purpose of the assessment;
- The brief questionnaire asked residents to provide details on their supply;
- A map showing the location of the property was also included with residents asked to indicate the location of their supply;
- The questionnaire also included a request for permission for WSP to undertake an inspection should further information be needed.
- Information obtained from consultation / site walkover survey was used to develop the CSM and Risk Assessment.

A copy of the letter and questionnaire is provided in the Appendix to this PWSRA.

2.5 RISK ASSESSMENT

GENERAL

A methodology for risk assessment of PWS is contained within the Private Water Supplies Technical Manual. Due to the nature of works being carried out at the Proposed Development, it is deemed impractical to use the methodologies set out in this guidance. When assessing supply compliance with the PWS regulations listed in 1.3, local authorities are required to consider factors, such as: proximity of the supply to cattle and wildlife, historical and current land use, and historical maintenance carried out on the supply. While such factors are useful for understanding the baseline qualities of a supply, they are inappropriate for determining the risk to the PWS during the construction and operation of the Proposed Development, which is based on the Source-Pathway-Receptor model.

The methodologies set out are based on WSP's professional experience, however, the guidance has been utilised where possible, when trying to establish the varying factors which influence the baseline conditions of the supplies.

The risk assessment considered the type of hazard associated with the project, release and exposure potential and severity of impact.

The Source-Pathway-Receptor concept model was used as the underlying model to assess the risk posed by the development activities. In this model:

- Source refers to the source of the potential hazard (not to be confused with PWS source);
- Receptor refers to anything or anyone that could be adversely affected by the hazard (including the source of water supplying the abstraction and associated infrastructure); and
- Pathway refers to the mechanisms by which the hazard is transmitted to the receptor.

Where hydrological/hydrogeological connectivity exists between a potential contamination source and the receptor by means of a pathway, then a 'pollutant linkage' and associated risk exists. Where there is no pollutant linkage, there will be no associated risk. For any PWS it must first be established if there is a risk to mitigate and then, if necessary, mitigation measures to reduce the risk introduced. Such risks are often sufficiently reduced through embedded design and good practice mitigation. In the event a risk remains even after these, then additional mitigation may be required in order to sufficiently reduce the residual risk.

The risk assessment considers the type of hazard associated with the Proposed Development, the probability and magnitude of an impact occurring based on the results of the investigation, and the severity of such an impact based on a combination of the probability and magnitude values. In addition to contamination, there is also the possibility that supply continuity could be jeopardised through water quantity reduction.

For the purpose of this assessment a generic approach has been adopted and considers the catchment to the water supply as the source of water for the supply, the PWS as the receptor and the natural water environment as the pathway that connects both of these.

In the presence of an identified risk or uncertainty meaning the presence of a potentially unacceptable risk, protection or mitigation should be provided that must ensure the PWS:

- Is adequately preserved in terms of both water flow and water quality; and/or
- Is replaced by an alternative process whereby potable water is made available on a temporary or permanent basis, as appropriate.

Whilst of low national or regional importance, a PWS can be of extremely high local importance to the PWS user. In accordance with definitions presented in Table 12.4; Receptor Sensitivity, PWS are considered of High Sensitivity.

RISK CRITERIA

The potential impact to PWS has been assessed in relation to the probability of an impact occurring on the receiving environment and the receiving environments sensitivity to change.

The probability has been classified as high likelihood, likely, low likelihood or unlikely based on criteria outlined in Table 2-1. The likelihood of any impacts on the quality and quantity of water serving the PWS is influenced by the type of supply and its source abstraction location within the catchment in relation to construction activities.

Table 2-1 – Probability of Impact

Probability	Definition	Examples
High	There is pollutant linkage and an event would appear very likely in the short-term and almost inevitable over the long-term, or there is evidence at the receptor of harm or pollution.	Proposed infrastructure overlies point of abstraction or is immediately upgradient (<100 m); Proposed infrastructure footprint occupies >25% of indicative upgradient abstraction catchment area; Proposed infrastructure will bisect delivery pipework.
Medium	There is pollutant linkage and all the elements are present and in the right place which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short-term and likely over the long-term.	Proposed infrastructure is upgradient and within the vicinity of point of abstraction (>100 m to 250 m); Proposed infrastructure footprint occupies 5-25% of indicative upgradient abstraction catchment.
Low	There is pollutant linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a long period such an event would take place and is less likely in the shorter term.	Proposed infrastructure is within the same catchment area and upgradient but >250 m from point of abstraction; Proposed infrastructure footprint occupies <5% of indicative upgradient abstraction catchment.
Unlikely	There is pollutant linkage but circumstances are such that it is improbable that an event would occur even in the very long-term.	Proposed infrastructure is within the same catchment area and upgradient but >500 m from point of abstraction.

As outlined above the potential impacts on the PWS have been assessed taking account of the type of supply possible connection to the source through the presence/absence of pollutant linkages. The magnitude of potential change to that supply is defined below in Table 2-2.

Table 2-2 – Magnitude of Effect

Magnitude	Example
Major	Major change to the hydrological/hydrogeological conditions resulting in temporary or permanent change.
Moderate	Complete disruption to operation of supply, impacting on quality and quantity available, new resource to be identified.
Minor	Detectable change to the hydrological/hydrogeological conditions resulting in non-fundamental temporary or permanent change. Potential new supply is required for a temporary period of time.
Negligible	No detectable change to the hydrological / hydrogeological conditions.

The likelihood and magnitude of the potential impacts are combined to define the significance of the impact, as shown in Table 2-3. This table provides a guide to assist in the decision making but should not be considered a substitute for professional judgement and interpretation. In some circumstances, the magnitude of effects may be unclear and professional judgement remains the most effective manner for identifying the potential significance.

The significance of the risk considers the successful implementation of the good practice environmental management practices that will be adopted throughout the works. Should the supply still be considered at risk, further details on specific mitigation and/or monitoring recommendations are provided along with the residual risk.

Table 2-3 – Risk Matrix (Combined Risk)

Probability of Impact	Magnitude of Effect			
	Major	Moderate	Minor	Negligible
High	Very High	High	Medium	Medium/ Low
Medium	High	Medium	Medium/ Low	Low
Low	Medium	Medium/ Low	Low	Negligible
Unlikely	Medium/ Low	Low	Negligible	Negligible

The risk categories are further defined in Table 2-4.

Table 2-4 – Combined Risk Definitions

Risk	Definition
Very High	There is a high probability that significant harm could arise to a designated receptor from an identified hazard at the site without appropriate mitigation.
High	Significant harm is likely to arise to a designated receptor from an identified hazard at the site without appropriate mitigation.
Medium	It is possible that without appropriate mitigation, harm could arise to a designated receptor, but it is relatively unlikely that any such harm would be severe and if any harm were to occur, it is likely that such harm would be relatively mild.
Low	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised, it is not likely to be severe.
Negligible	Harm is unlikely to be realised or perceived.

Very high or high risks are likely to constitute Major or Major/Moderate effects, as defined in Table 12.6 of Chapter 12 of the EIAR.

3 CONCEPTUAL SITE MODEL

For a pollutant linkage to exist, sources, pathways and receptors must align in a manner that facilitates the transmission of a pollutant (or harm) to a receptor. The main impacts that can be imparted upon a PWS receptor is a degradation in water quality or a reduction in quantity.

Information concerning the environmental setting of the Proposed Development and the surrounding area is presented in Chapter 12 of the EIAR. Based on the assessment, the following CSM is presented that will be used to support the assessment of potential risks to PWS.

The desktop assessment indicates the presence of two main groundwater systems; a shallow system that is largely dependent on surface water runoff (1) and a deeper system heralding from the underlying bedrock (2) (see insert Figure 3-1). The former may comprise of catch pits and collection systems that obtain surface runoff and shallow throughflow over large areas which are topographically constrained. Supplies obtaining water from the underlying bedrock geology will be constrained by the nature and extent of tectonic features or fractures. Under such circumstances, the upper weathered margins of the bedrock or fractures will be a preferential flow pathways typically extending 0.1 to 1.0 km. The majority of rainfall will discharge as runoff, with infiltration to the bedrock aquifer limited where glacial till or peat are present. Owing to the local bedrock being a low productivity aquifer and with the exception of tectonic features, surface water catchments will provide a reasonable proxy for modelling groundwater. In the cases of the PWS considered, it is possible that recharge to abstraction points may be via a combination of surface / shallow and bedrock systems.

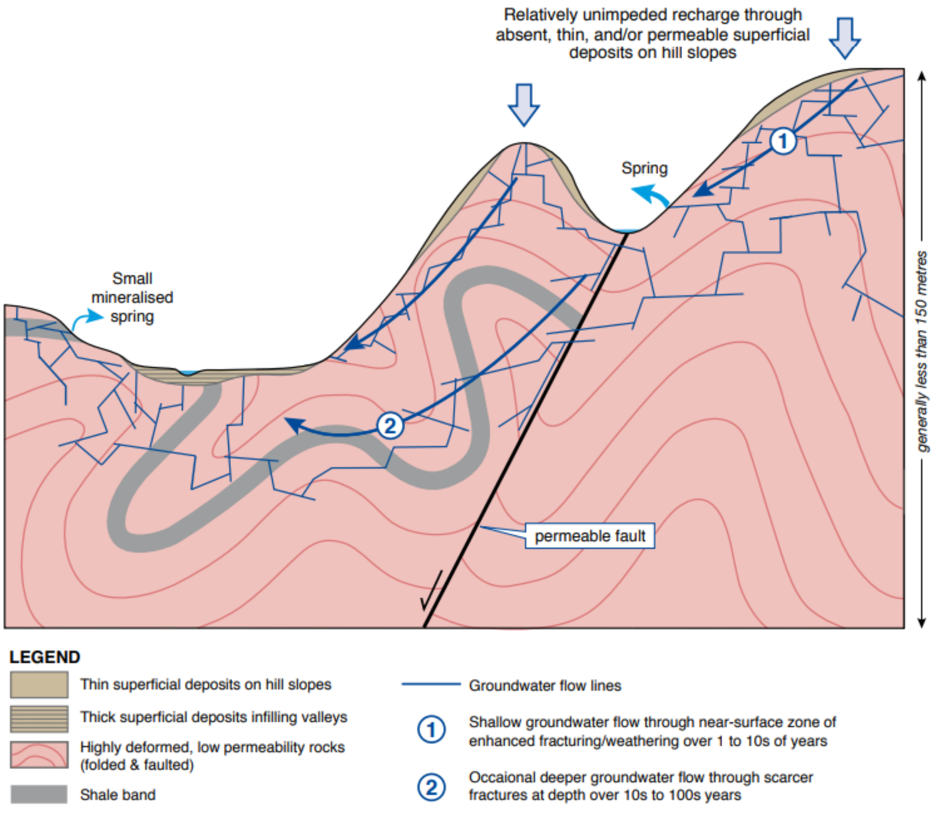


Figure 3-1 – Cross sectional illustration of the CSM for the Proposed Development and underlying groundwater.

4 SCREENING

4.1 GENERAL

A request was submitted in 2023 to DGC Environmental Health for a copy of the Register of Private Water Supplies. The Register identified twenty three (no.) PWS sources.

A review of aerial imagery and OS maps indicated that four further rural properties may use a potentially unregistered PWS.

Table 4.1 presents information collected from the returned questionnaires, public consultation events, DGC, and the conceptual model.

The findings from Table 4.1 can be summarised as follows;

- One PWS source (Knockville) is derived from a combination of surface water and groundwater and potentially at risk from the development. The PWS source is not within the 250 m of an excavation >1 m depth. Further assessment is required;
- One PWS source (Clachaneasy) is suspected to be surface water or groundwater and is potentially at risk from the development. The PWS source is not within the 250 m of an excavation >1 m depth. Further assessment is required; and
- Twenty five PWS source are unlikely to be plausibly impacted by the development, or are connected to Scottish Water mains supply, and require no further assessment.

4.2 SITE INSPECTION

Hydrological walkover surveys were undertaken in April and May 2024.

Table 4-1 – Identified PWS within 3 km of the Proposed Development

Property ID	Property Name	Abstraction Type	Abstraction Grid Reference (Property if unknown*)	Distance to Proposed Development infrastructure	Potential complete Source-Pathway-Receptor link?	Details	Further Assessment Required?
1	Beoch	Spring	232181, 571646	2.5 km (T6 crane pad)	No – PWS source and pipework not considered to be at risk	Abstraction is a spring situated near to the property. Abstraction is situated in a separate catchment to the development and there is no plausible S-P-R.	No
2	Brigend,	Spring	234728, 576203	2.3 km (T12 crane pad)	No – PWS source and pipework not considered to be at risk	Abstraction is a spring situated upgradient of property. Abstraction is situated in a separate catchment to the development and there is no plausible S-P-R.	No
3	Brigton	Unknown	236035, 574499	1.3km (T10 crane pad)	No – PWS source and pipework not considered to be at risk	Abstraction is unknown and is assumed to be within vicinity of property. Property is situated on the far side of the River Cree and Cashnabrock Water. Therefore is situated in a separate catchment to the development and there is no plausible S-P-R.	No
4	Cordorcan,	Unknown	236982, 572610	0.48 km (A174 bell mouth)	No – PWS source and pipework not considered to be at risk	Abstraction is unknown and is assumed to be within vicinity of property. Property is situated on the far side of the River Cree. Therefore is situated in a separate catchment to the development and there is no plausible S-P-R.	No
5	Creebank Cottage	Unknown	234778, 577056	3.2 km (T12 crane pad)	No – PWS source and pipework not considered to be at risk	Abstraction is unknown and is assumed to be within vicinity of property. Property is situated on the far side of the River Cree. Therefore is situated in a separate catchment to the development and there is no plausible S-P-R.	No
6	Creebank Farmhouse,	Unknown	234559, 575351	3.1 km (T12 crane pad)	No – PWS source and pipework not considered to be at risk	Abstraction is unknown and is assumed to be within vicinity of property. Property is situated on the far side of the River Cree. Therefore is situated in a separate catchment to the development and there is no plausible S-P-R.	No

7	Dalnaw	Unknown	232219, 576942	3.6 km (T13 crane pad)	No – PWS source and pipework not considered to be at risk	Abstraction is unknown and is assumed to be within vicinity of property. Property is situated on the far side of the River Cree. Therefore is situated in a separate catchment to the development and there is no plausible S-P-R.	No
8	Fyntalloch,	Well	231292, 571444	3.5 km (T6 crane pad)	No – PWS source and pipework not considered to be at risk	Abstraction is a well situated within the vicinity of the property. Abstraction is situated in a separate catchment to the development and there is no plausible S-P-R.	No
9	Garchew Farm	Well and spring	233947, 575655	1.9 km (T13 crane pad)	No – PWS source and pipework not considered to be at risk	Abstraction is a well and spring situated ~300 m south of the property. Both abstractions are situated in a separate catchment to the development and there is no plausible S-P-R.	No
10	Glassoch	Unknown	233669, 569555	2.5 km (T2 crane pad)	No – PWS source and pipework not considered to be at risk	Abstraction is unknown and is assumed to be within vicinity of property. Abstraction is situated in a separate catchment to the development and there is no plausible S-P-R.	No
11	Glenhapple	Unknown	237473, 571302	1 km (substation)	No – PWS source and pipework not considered to be at risk	Abstraction is unknown and is assumed to be within vicinity of property. The likely location of the abstraction is unlikely to be hydrologically connected to the development on account of the topography, and consequential surface overland and shallow groundwater flow pathways. There is no plausible S-P-R.	No
12	Glenvernoch Farm	Two wells	234335, 575350 & 234564, 575326	Both are 1.4 km (T12 crane pad)	No – PWS source and pipework not considered to be at risk	Abstraction comprises of two wells, one which is adjacent to the property and the other which is ~300 m to the west upslope. Both abstractions are situated in a separate catchment to the development and there is no plausible S-P-R.	No
13	High Minniwick	Well	237263, 577451	4.3 km (T10 crane pad)	No – PWS source and pipework not considered to be at risk	The well is situated within the vicinity of property. Abstraction is situated on the far side of the River Cree. Therefore is situated in a separate catchment to the development and there is no plausible S-P-R.	No

14	Holm of Bargrennan,	Unknown	237600, 576900	4.1 km (T10 crane pad)	No – PWS source and pipework not considered to be at risk	Abstraction is unknown and is assumed to be within vicinity of property. Abstraction is situated on the far side of the River Cree. Therefore is situated in a separate catchment to the development and there is no plausible S-P-R.	No
15	Knowe Schoolhouse	Unknown	231088, 572454	2.8 km (access track east of T13)	No – PWS source and pipework not considered to be at risk	Abstraction is unknown and is assumed to be within vicinity of property. Abstraction is situated in a separate catchment to the development and there is no plausible S-P-R.	No
16	Larg Bargrennan	Unknown	236091, 574086	1.2 km (T10 crane pad)	No – PWS source and pipework not considered to be at risk	Abstraction is unknown and is assumed to be within vicinity of property. Abstraction is situated on the far side of the River Cree. Therefore is situated in a separate catchment to the development and there is no plausible S-P-R.	No
17	Forest Lodge	Borehole	234796, 576733	2.9 km (T12 crane pad)	No – PWS source and pipework not considered to be at risk	Borehole (~12 m deep) situated just north of property in gardens. Abstraction is situated on the far side of the River Cree. Therefore is situated in a separate catchment to the development and there is no plausible S-P-R.	No
18	Longwood	Unknown	235017, 576634	2.8 km (T12 crane pad)	No – PWS source and pipework not considered to be at risk	Abstraction is unknown and is assumed to be within vicinity of property. Abstraction is situated on the far side of the River Cree. Therefore is situated in a separate catchment to the development and there is no plausible S-P-R.	No
19	Marrbury Smokehouse	Unknown	234174, 578492	4.6 km (T12 crane pad)	No – PWS source and pipework not considered to be at risk	Regulated (Type A) PWS. Abstraction is unknown but assumed to be within the vicinity of the property. Abstraction is situated in a separate catchment to the development and there is no plausible S-P-R.	No
20	North Lodge	Unknown	237946, 570502	2 km (substation)	No – PWS source and pipework not considered to be at risk	Abstraction is unknown and is assumed to be within vicinity of property. Abstraction is situated in a separate catchment to the development and there is no plausible S-P-R.	No

21	Old Schoolhouse	Unknown	234989, 576690	2.9 km (T12 crane pad)	No – PWS source and pipework not considered to be at risk	Abstraction is unknown and is assumed to be within vicinity of property. Abstraction is situated on the far side of the River Cree. Therefore is situated in a separate catchment to the development and there is no plausible S-P-R.	No
22	Snap Inn	Unknown	231830, 571435	3.4 km (T6 crane pad)	No – PWS source and pipework not considered to be at risk	Abstraction is unknown and is assumed to be within vicinity of property. Abstraction is situated in a separate catchment to the development and there is no plausible S-P-R.	No
23	Fyntalloch,	Well	231292, 571444	3.4 km (T6 crane pad)	No – PWS source and pipework not considered to be at risk	Well is situated adjacent to property. Abstraction is situated in a separate catchment to the development and there is no plausible S-P-R.	No
24	Glenruther	Unknown	232351, 573196	1.3 km (access track west of T13)	No – PWS source and pipework not considered to be at risk	Abstraction is unknown and is assumed to be within vicinity of property. Abstraction is situated in a separate catchment to the development and there is no plausible S-P-R.	No
25	Glenruther Lodge	Well	232116, 572419	2.3 km (T9 crane pad)	No – PWS source and pipework not considered to be at risk	Well is situated ~200 m southwest of property. Abstraction is situated in a separate catchment to the development and there is no plausible S-P-R.	No
26	Knockville Farm	Well	236121, 572409	0.54 km (T4)	Yes – PWS source / pipework potentially at risk	Abstraction is a shallow groundwater well is situated ~200 m west of the property. Abstraction is within the development boundary and broadly in the same catchment area and therefore requires further assessment.	Yes
27	Clachaneasy	Unknown	-	1.4 km (access track between T12 and T10	Yes – PWS source / pipework potentially at risk	Abstraction is unknown and is assumed to be within the vicinity (~250 m) of the property. Property is broadly in the same catchment at the Proposed Development infrastructure and requires further assessment.t	Yes

5 RISK ASSESSMENT

5.1 GENERAL

The nature of the potential risk to the PWS abstraction is either a reduction in water volume (quantitative) or adverse change in the quality of the water (qualitative).

Risk management techniques involve managing one or more of the components in the Source-Pathway-Receptor chain. Where practical, actual or potential pollutant linkages should be broken to eliminate the risk of a hazard impacting the receptor and where a residual risk remains, management controls and contingency arrangements should be implemented to minimise risks to an acceptable level.

The risk assessment process involves identifying the probability of an impact and the likely magnitude of change at the receptor and assumes that embedded and good practice mitigation have been successfully implemented. This is based on a more detailed consideration of a PWS with reference to the CSM presented in Section 3. In the event the risk remains elevated, then additional mitigation will be used to further reduce the residual risk.

5.2 HAZARDS

The main hazards which can manifest at a PWS are related to degradation in quality or quantity. The specific activities and operations associated with the Proposed Development which have the potential to impact water quality and quantity have been adapted from CIRIA guidance documents and are presented below.

- Activities potentially affecting water quality;
  - Accidental discharges of fuels / oils / chemicals as a result of spillages;
  - Accidental discharge of effluent as a result of spillages;
  - Introduction and release of concrete materials;
  - Discharge of sediment from surface water networks; and
  - Accidental damage to the supply delivery infrastructure.
- Activities potentially affecting water quantity;
  - Modification of overland flow pathways (i.e. installation of new drainage and addition of impermeable surfaces); and
  - Modification of groundwater flow pathways (i.e. removal of superficial sediments, additional of impermeable surfaces, excavation of borrow pits and associated dewatering).

Point source pollution may arise from accidental releases of fuels / chemicals / effluent from a discrete location. Such sources may introduce contaminants of potential concern into surface waters or groundwater depending on the circumstance of the incident. This could include the accidental release of fuels or oils during construction, or the leaching of transformer oils or chemicals from permanent infrastructure such as the Substation. Other point source pollution may include the pouring of concrete foundations, or specific discharges from damaged or inadequate drainage networks.

Diffuse source pollution may arise from non-point source specific activities such as the discharge of water from drainage networks. In such circumstances isolated and discrete discharges may not pose a source of contamination, however cumulatively these can combine to amplify the risk under more confining conditions such as within a watercourse.

A full list of the effects considered to have the potential to effect hydrological receptors arising from the construction and operation of the Proposed Development are presented in Chapter 12 of the EIAR.

5.3 STANDARD GOOD PRACTICE MITIGATION

As presented within the EIAR, good practice mitigation measures will be implemented as outlined in the site-specific Pollution Prevention Plans and Drainage Management Plans as part of the Construction Environmental Management Plan (CEMP) for the Proposed Development. The site-specific CEMP will facilitate the implementation of industry good practice measures in such a manner as to prevent or minimise effects on the surface and groundwater environment.

An outline CEMP summarising good practice mitigation measures relevant to the safeguarding of private water supplies is presented in Chapter 12.

Prior to construction the Principal Contractor may undertake additional investigation to confirm abstraction locations for PWS. Where required, this PWS should be updated to accommodate new information.

5.4 ADDITIONAL MEASURES

In the event that significant adverse effects on private water supplies are predicted, additional mitigation would be proposed to reduce the risk.

Such measures may include exclusion zones around abstractions, the preclusion of refuelling or overnight storage of fuels within the indicative PWS supply catchment area, or the provision of a suitable permanent alternative water supply prior to construction.

As illustrated within Section 5.6, this assessment has not identified any significant adverse effects, and therefore no additional measures are necessary.

5.5 PWS MONITORING & METHOD STATEMENT

Prior to construction a PWS Monitoring Plan and Method Statement (PWSMP) will be prepared detailing all mitigation measures to be delivered to secure the quality, quantity and continuity of water supplies which may be affected by the Proposed Development. The PWSMP will also contain contact information for the Construction Site Manager (or similar) that will be provided to the PWS User prior to construction. PWS Users will be informed of any planned works that may affect their supply.

MONITORING ARRANGEMENTS

A water level and quality monitoring programme will be undertaken prior to any construction and during construction. The method statement shall include water quality sampling methods and shall specify abstraction points. Post-construction monitoring would also be completed to ensure there is no long-term impact on water quality or quantity that could be associated with the Proposed Development.

The PWS water monitoring programme will be aligned with the CEMP including wider surface water or groundwater monitoring programme related to the Proposed Development, i.e. sampling, frequency, and analysis suite (with exception to taste) are matched at the surface water monitoring locations. The document would also outline any site-specific additional mitigation outlined in this assessment relevant to each PWS.

The monitoring arrangements would be discussed with DGC and SEPA post-consent. An example monitoring strategy is included in the Appendix.

CONTINGENCY ARRANGEMENTS

The PWSMP will also include a pollution response plan and contingency measures that would detail responsibilities and lines of communication between Principal Contractor, PWS users and other stakeholders. Contact details (land and mobile numbers / email addresses) for PWS users would be maintained by the Principal Contractor at all times.

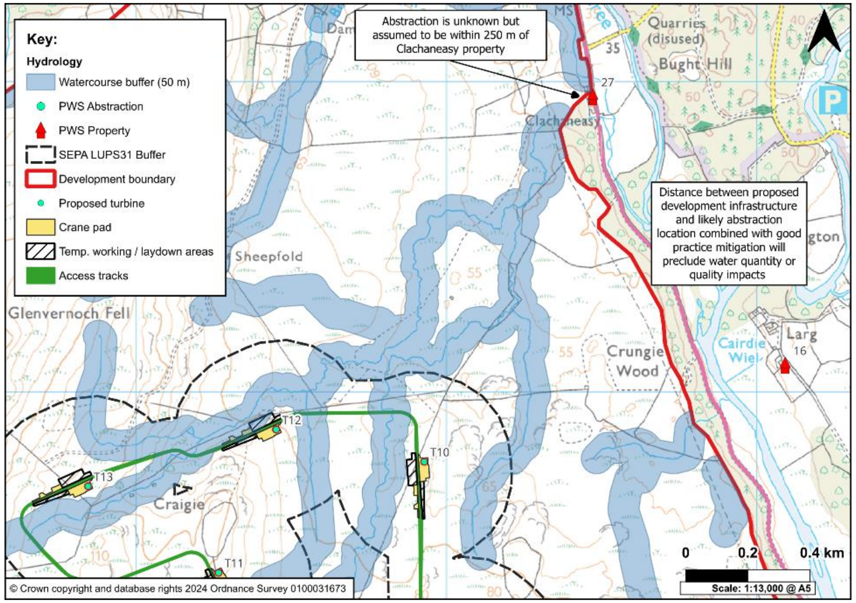
Contingency measures will include provisions to provide alternative water supplies on a temporary and permanent basis in the event of an unforeseen impact on the existing PWS arising from the construction and operation of the Proposed Development as follows:

- Provision of bottled potable water in the event of a short or transient derogation of a water supply (bottled water would be retained on site ready for quick dispatch to any effected property); and
- Provision of an alternative water source (e.g. spring, borehole, alternative surface water abstraction location) in the very unlikely event of a permanent derogation of a water supply.

In the event of an alternative water source being implemented D&GC would be advised as soon as is practical.

5.6 RISK ASSESSMENT SUMMARY

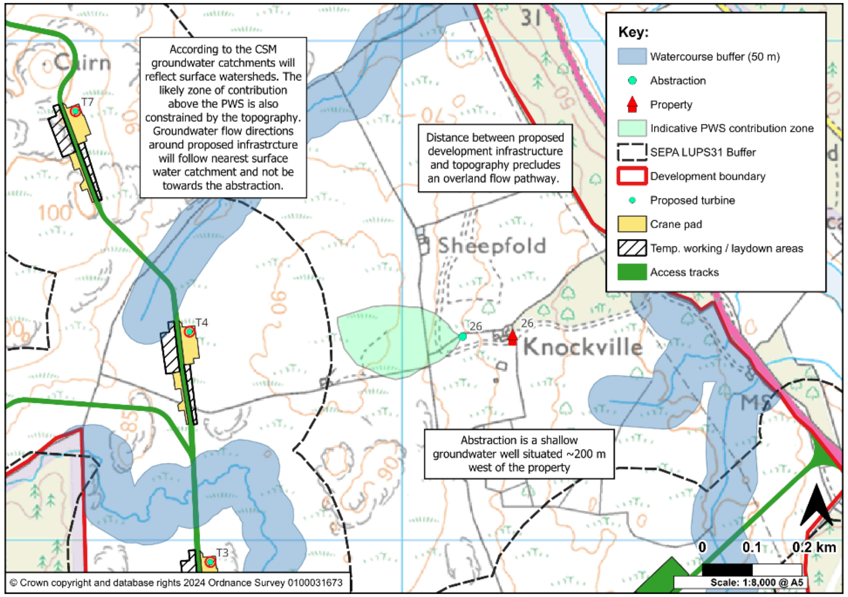
Clachaneasy (ID 27)

Proximity of abstraction to Proposed Development	Assessment notes
	Clachaneasy is located east of the Proposed Development adjacent to the A714. It was not on the D&GC Register of PWS, but given its rural location, may be served by a PWS. A questionnaire was issued but the opportunity to respond was declined. The location and type of abstraction is unknown but is assumed to be within the vicinity of the property (~within 250 m). The property is broadly in the same catchment as the Proposed Development infrastructure and is approximately 1.4 km to the north-east. In the event the property was served by a groundwater abstraction, the intervening distance would preclude a plausible connection and means of impact according to the CSM. If it were a surface water abstraction, watercourses will be safeguarded through good practice mitigation associated with minimising erosion and sedimentation as well as pollution prevention as detailed in Chapter 12 of the EIAR. Similarly, water quantity impacts would be minimised through embedded and good practice mitigation measures associated with surface water flow modification. Considering this, and the implementation of mitigation specific to the protection of PWS (outlined below) the probability of impact is considered unlikely, magnitude of change negligible, with a combined risk of negligible.

Mitigation	Additional Measures
Good practice mitigation delivered through the CEMP, including investigation by the Principal Contractor prior to construction; A programme of water quality and quantity monitoring will be developed to monitor this supply; and Monitoring and management measures (including contingency) which would be outlined in PWSMP prior to construction.	None.

Hazard	Receptor	Probability of Impact	Magnitude of Change	Combined Risk	Additional Measures?	Details	Residual Risk
Activities affecting water quality	All source of water serving PWS	Unlikely	Negligible	Negligible	None	-	-
	Pipework delivering water from PWS to Property	Unlikely	Negligible	Negligible	None	-	-
Activities affecting water quantity	All source of water serving PWS	Unlikely	Negligible	Negligible	None	-	-
	Pipework delivering water from PWS to Property	Unlikely	Negligible	Negligible	None	-	-

Knockville Farm (ID 26)

Proximity of abstraction to Proposed Development	Assessment notes
	Knockville Farm is located within the Proposed Development boundary, west of the A714. It was not on the D&GC Register of PWS, but following direct consultation with the resident, was confirmed as using a PWS. The abstraction is 540 m east of the T4 and is also outside of the SEPA LUPS 31 250 m buffer distance. The abstraction is a shallow groundwater well situated ~200 m west of the property in boggy ground. The surface water catchment area (shown as the indicative zone of contribution determined using DTM) has been determined to extend ~350 m to the west, terminating at an area of high ground just upslope. Therefore, its unlikely that a pathway would exist between the Proposed Development and the abstraction. According to the CSM, groundwater flow pathways for the underlying aquifer extend 0.1 to 1 km. Whilst its plausible that a pathway via the groundwater could exist given the distance to T4 from the abstraction, the CSM also states that groundwater flows will follow the topography and surface water catchments. The groundwater flow direction around T4 (and associated infrastructure) would be towards the Castle Stewart Burn, and not towards the abstraction. The groundwater catchment for the abstraction is also likely to be reflective of the surface water catchment extent; which is unlikely to be connected with the Proposed Development. Therefore, the probability of an impact via groundwater is also considered unlikely.

Mitigation	Additional Measures
Good practice mitigation delivered through the CEMP, including investigation by the Principal Contractor prior to construction; A programme of water quality and quantity monitoring will be developed to monitor this supply; and Monitoring and management measures (including contingency) which would be outlined in PWSMP prior to construction.	None.

Hazard	Receptor	Probability of Impact	Magnitude of Change	Combined Risk	Additional Measures?	Details	Residual Risk
Activities affecting water quality	All source of water serving PWS	Unlikely	Negligible	Negligible	None	-	-
	Pipework delivering water from PWS to Property	Unlikely	Negligible	Negligible	None	-	-
Activities affecting water quantity	All source of water serving PWS	Unlikely	Negligible	Negligible	None	-	-
	Pipework delivering water from PWS to Property	Unlikely	Negligible	Negligible	None	-	-

6 CONCLUSION

A PWSRA has been carried out for PWS that may be affected during the construction and operation of the Proposed Development. The formation of this report has included a desk review of baseline information as well as data returns provided by D&GC on identified PWS within a 3km buffer of the site, consultation with selected residents, OS mapping data and targeted site visits.

The risk assessment was undertaken using the Source-Pathway-Receptor model to establish the likelihood of a potential pollutant linkage existing between the Proposed Development and the supply of the identified PWS. Factors taken into consideration in the risk assessment include the proximity of the Proposed Development to the PWS source, layout of PWS infrastructure and pipework, the type of works being undertaken, the likely presence of pathways between the development and the source, the local topographic conditions, and the underlying geology.

The PWS has been evaluated based on the information provided to determine the risks based on the prescribed matrix scenarios. To minimise the risk of the Proposed Development construction activities potentially impacting any PWS supply, mitigation measures have been outlined which will be implemented by the Principal Contractor.

Standard good practice mitigation will be incorporated within a CEMP, which will be prepared prior to construction. In addition to this mitigation, a PWSMP will be prepared prior to construction and will detail all relevant mitigation, management measures, monitoring requirements and contingency plans relevant to PWS considered within this assessment and those listed in Chapter 12 of the EIAR. This includes safeguarding measures required for Knockville and Clachaneasy.

In the event that further information on PWS is obtained, this risk assessment should be updated to ensure that PWS are appropriately safeguarded.

6.1 LIMITATIONS OF ASSESSMENT

This report has been prepared by WSP with all reasonable skill, care and diligence for the Client, for the specific purpose of assessing the risk to PWS posed from the construction and operation of the Proposed Development. This report details the findings of the risk assessment considering information provided by D&GC, the relevant landowners and PWS users and is therefore, as accurate as this information will allow. This document should be considered live and as such, changes will be made should new information come to light.

WSP accepts no responsibility whatsoever to third parties to whom this report, or any part thereof, is made known, unless formally agreed by EnergieKontor beforehand. Any such party relies upon the report at their own risk. WSP disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the services.

Owing to the inherent complexity of the subsurface, it is rarely possible to determine the mechanics of any hydrological system with absolute certainty. In this regard, investigations as part of this assessment will strive to determine the circumstance of each supply based on the evidence available to support this assessment. Where uncertainty exists associated with understanding the details of a PWS or in accurately conceptualising the subsurface, this will be stated and risks and assessment considered conservatively in accordance with the precautionary principle. Whilst the assessment assesses relative risk, no detailed quantitative risk assessment has been completed.

Appendix A

COPY OF PWS QUESTIONAIRE

PRIVATE WATER SUPPLY QUESTIONNAIRE

Your details

Name: ....

Property name and address: ....

....

Telephone number and email address: ....

....

If you are a tenant, please also provide your landlord's contact details:

Name: ....

Address: ....

Telephone number and/or email address: ....

Supply source type *(Please tick or specify if other)*

Borehole (please indicate approx. depth below) ☐ Well ☐ Spring ☐ River ☐

Lake ☐ Pond ☐ Stream ☐ Surface water ☐ Mains (Scottish Water) ☐

Other: ....

Supply source location

Source of supply known and marked on enclosed map? Yes ☐ No ☐

Approximate grid coordinates of source of supply: ....

Is water fed into a storage tank or reservoir prior to distribution? Yes ☐ No ☐

If yes, please provide grid coordinates for location of storage tank: ....

Supply uses *(Please tell us what the water is used for at your property – please tick as appropriate and tell us any other uses not listed)*

Domestic use ☐ Holiday let ☐ B&B/Hotel ☐ Catering ☐

Dairy farm ☐ Brewery ☐ Residential care home ☐ Tenanted property ☐

Livestock drinking water ☐

Other: ....

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Supply usage

Number people supplied (approximately): ....

Number of animals supplied (approximately): ....

Type of animals (if applicable): ....

Approximate volume of water abstracted (m^3/day): ....

Supply water treatment and condition *(Please tick or specify if other)*

Type of water treatment:

Chlorination ☐ UV with pre-filter ☐ UV without pre-filter ☐ Filtration ☐

Other: ....

Is the water supply checked periodically (for condition and maintenance): Yes ☐ No ☐

Has the supply been risk assessed formally by owner/council/others to date? Yes ☐ No ☐

If so, approximately when was this conducted: ....

Any comment on the condition/quality/yield of your water supply: ....

....

....

Supply users

Please provide the addresses of any other properties on the same supply as you, including name and telephone number if known (continue on the enclosed Additional Information Sheet if required):

....

....

....

....

If you have any questions or queries, please contact Sam Wainwright on sam.wainwright@wsp.com .

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www.wsp.com

Appendix B

EXAMPLE MONITORING STRATEGY

Introduction

PWS Monitoring is recommended at properties that maintain a PWS source and where there is a source-pathway-receptor linkage to the Proposed Development.

Preconstruction monitoring can be used to establish baseline water levels and quality and assessment or trigger values to which routine monitoring data collected during construction can be compared against. These can be used to benchmark the effectiveness of pollution mitigation.

The final monitoring arrangements including the analytical suite, locations, frequency and escalation procedure will be outlined in the PWSMS and will be in agreement with SEPA and D&GC and is expected to be secured by way of planning condition.

Methodology

PWS Monitoring would be undertaken by an appropriately qualified and experienced contractor.

Monitoring methods will include visual and extractive, with the former comprising of pictures and notes on water conditions, weather, pollution, etc. The latter involves the collection of a water sample from the abstraction with analysis at a suitably accredited laboratory. All samples will be dispatched to the laboratory, under chilled conditions accompanied with the relevant chain of custody documentation. All samples will be dispatched to the laboratory within 24 hours of being collected.

An example analytical suite along with trigger values (assessment criteria) against which water quality results should be benchmarked is provided below.

Table B.1 - Example Monitoring Analytical Suite

Parameter	Units	Limit of Detection**	Method	Assessment Criteria*
pH	-	-	Probe	6.5-9.5
Colour	Pt/Co	1	Colorimetric	20
Electrical Conductivity	uS/cm	10	Potentiometric	2500
Alkalinity (as CaCO3)	mgCaCO3/L	3	Discrete Analyser	-
Calcium (dissolved)	mg/L	0.012	ICP-OES	-
Magnesium (dissolved)	mg/L	0.005	ICP-OES	-
Potassium (dissolved)	mg/L	0.025	ICP-OES	-
Sodium (dissolved)	mg/L	0.01	ICP-OES	200
Sulphate as SO4	mg/L	0.045	ICP-OES	250
Chloride	mg/L	0.15	Discrete Analyser	250
Orthophosphate (as PO4)	µg/L	62	Discrete Analyser	-

Nitrate (as N04)	mg/L	0.05	Colorimetric	50
Aluminium (dissolved)	µg/L	1	ICP-MS	200
Selenium (dissolved)	µg/L	0.6	ICP-MS	10
Iron (dissolved)	µg/L	0.004	ICP-OES	200
Manganese (dissolved)	µg/L	0.05	ICP-MS	50
Zinc (dissolved)	µg/L	0.5	ICP-MS	5000
Copper (dissolved)	µg/L	0.5	ICP-MS	10
Suspended Solids	mg/L	2	Gravimetric	-
Turbidity	NTU	1	Spectrophotometry	4
Dissolved Organic Carbon (DOC)	mg/L	0.1	TOC Analyser	-
TPH CWG inc BTEX & MTBE	µg/L	1 - 10	GC/MS	10
Total coliforms	MPN/100ml	0	-	0
E.coli	MPN/100ml	0	-	0
Enterococci	cfu/100mls	0	-	0
**PCV values taken from Statutory Instrument No. 209 - The Private Water Supplies (Scotland) Regulations 2006. Available at https://www.legislation.gov.uk/ssi/2006/209/pdfs/ssi_20060209_en.pdf (accessed May 2024).* *Total Petroleum Hydrocarbon Criteria Working Group (TPH CWG) PCV value taken from Statutory Instrument No. 2790 – The Private Water Supplies Regulations 1991 (revoked). Available at http://www.legislation.gov.uk/uksi/1991/2790/made (accessed May 2024).*				
***Actual LOD may vary and can be confirmed with the nominated laboratory if required by the LPA*				

Frequency and Duration

During the baseline (pre-construction) at least 6 monitoring visits should be undertaken across a minimum of 6 months and ideally capture a variety of flow and weather conditions. During the construction phase, monitoring should be monthly, but additional ad-hoc monitoring may also be required in the event of a spurious result or pollution incident. A period of post-construction monitoring should be undertaken with the frequency and duration subject to consultation with SEPA and D&GC.

Reporting

Reports summarising the results of water monitoring should be provided following the completion of each phase. Additional reporting requirements during the construction phase may be subject to consultation with SEPA and D&GC.

Trigger Levels and Escalation Procedures

Trigger levels refer to actions which must be taken in the event of an environmental incident that may affect a PWS. Trigger level actions could be required following the reporting of an incident by the Principal Contractor. In the event of a potential incident the Principal Contractor and the Environmental Clerk of Works (ECoW) would undertake a preliminary assessment to decide whether an incident requires an immediate stop to works. This should be undertaken as soon as possible following an incident being reported. In the event of a stop to works, a proportionate investigation should be undertaken to determine the cause for the impact and complete actions to minimise / mitigate any effects. Communication of any incident potentially affecting a PWS should be undertaken by the Project Manager or delegated representative as soon as possible. Depending on the scale of the incident, D&GC and SEPA may also need to be notified.

It is not proposed that the results of monitoring would trigger suspension of the construction works unless the results of the above assessment indicated a high risk to water quality if work is continued. Where exceedances have been recorded, a re-test of the samples may be requested, or confirmatory samples collected for confirmation of water quality degradation. This protocol should be included to avoid unnecessary cessation of site works on the basis of single results. Should works be suspended as a result of the monitoring values, the source of the problem would be investigated with emergency monitoring being undertaken and will continue whilst mitigation measures are being implemented. The duration of emergency monitoring will be determined based on the severity of the incident and following consultation with the Principal Contractor and the ECoW, and works would resume following consultation and approval with D&GC and SEPA.

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