Quantans Hill Wind Farm
Volume 3 - Part 2
Technical Appendices

VATTENFALL

natural power

CONTENTS

Appendix 1	**See Part 1**
Appendix 5	**See Part 1**
Appendix 6	**See Part 1**
Appendix 7	**See Part 1**
Appendix 8	**8.1 Watercourse Crossing Assessment**
	8.2 Peat Stability Risk Assessment
	8.3 Peat Management Plan
	8.4 Private Water Supply Risk Assessment
	8.5 Flood Risk Appraisal
	8.6 Pollution Prevention and Incident Plan
	8.7 Borrow Pit Assessment
Appendix 9	**9.1 Settings**
	9.2 Plates
	9.3 Gazetteer Report
Appendix 10	**10.1 Noise Prediction Methodology**
Appendix 11	**11.1 Abnormal Indivisible Load Route Survey**
	11.2 Traffic Management Plan
	11.3 Offsite Accommodation Works Impact Assessment
Appendix 12	**12.1 Woodland Removal Area**
	12.2 Planting Year and Species
Appendix 13	**13.1 Carbon Balance**
	13.2 Proximity-Activated Lighting System Report
	13.3 Civil Aviation Authority Approval Letter

PREFACE

An Environmental Impact Assessment Report (EIAR) has been prepared in support of an application submitted by Natural Power Consultants Limited (Natural Power) on behalf of the Applicant (Vattenfall Wind Power Ltd). The application seeks consent under Section 36 of the Electricity Act 1989 and the EIAR has been prepared in accordance with the Electricity Works (Environmental Impact Assessment) (Scotland) Amendment Regulations 2017. The application also seeks a direction under Section 57(2) of the Town and Country Planning (Scotland) Act 1997 as amended that planning permission for the development be deemed to be granted. This EIAR contains the information carried out for the Environmental Impact Assessment to develop a wind farm comprising of up to fourteen wind turbines and associated infrastructure (the Proposed Development). The Proposed Development is located in Dumfries & Galloway local authority area.

The Electricity Works (Miscellaneous Temporary Modifications) (Coronavirus) (Scotland) Regulations 2020 ("the Temporary Regs") came into effect on 24 April 2020. These Regulations are temporary and were due to expire on 30 September 2020. However, these safeguards will now continue to be in place for the duration of the extension period, with the expiry date of the Scottish Acts by this Bill, to 30 September 2022.

Copies of the EIAR may also be obtained from Vattenfall Wind Power Ltd at a charge of £1,400 per hard copy. Copies of Non-Technical Summary and USB format of entire application are available free of charge upon request.

- **This is Volume 3 of the EIAR** which presents the Technical Appendices associated with the EIAR Chapters.
- Volume 1 of the EIAR presents the 15 Chapters of the EIAR.
- Volume 2a of the EIAR presents the technical Figures associated with the EIAR Chapters except for Chapter 5 (Landscape & Visual Impact Assessment).
- Volume 2b of the EIAR presents the technical Figures associated with EIAR Chapter 5.
- Volume 2c of the EIAR presents the Visualisations produced for EIAR Chapter 5 and 9 (Landscape & Visual Impact Assessment and Cultural Heritage).
- Volume 4 of the EIAR presents the Non-Technical Summary.

In addition to the EIAR, the application is also supplemented by accompanying documents including:

- Planning, Design & Access Statement,
- Pre-Application Consultation (PAC) Report.

IEMA
Transforming the world to sustainability
- EIA -

This is to certify that

Natural Power Consultants Limited

is a member of the

EIA Quality Mark

for the registration period covering

18th April 2022 – 17th April 2023*

*Subject to meeting the requirements of registration

natural power

IEMA Transforming the world to sustainability

Document history

Author	Sam Wainwright	23/08/2021
Checked	Emma Bryder	08/09/2021
Approved	Katherine Arthur	18/10/2021

Client Details	
Contact	Matt Bacon
Client Name	Vattenfall Wind Power Ltd.

Issue	Date	Revision Details
A	03/12/2021	First draft
B	16/12/2021	Released
C	22/06/2022	Update and Released

Appendix 8.1

Watercourse Crossing Assessment

Contents

	Glossary	1
	List of Abbreviations	1
A8.1	Introduction	2
	Regulatory Legislation	2
	Disclaimer	2
A8.2	Methodology	2
	Desk Study	2
	Site Visit	2
	Water Crossing Selection Criteria	2
A8.3	Watercourse Crossing Assessment Summary	3
A8.4	Rationale and Design	3
A8.5	Detailed Crossing Assessment	4

Glossary

Refer to Chapter 8: Hydrology, Geology and Hydrogeology in Volume 2 of the EIAR for the Glossary.

List of Abbreviations

Refer to Chapter 8: Hydrology, Geology and Hydrogeology in Volume 2 of the EIAR for the List of Abbreviations.

A8.1 Introduction

A8.1.1. This document details the requirements for a Watercourse Crossings Assessment at the Proposed Development as part of Chapter 8 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.

A8.1.2. All the watercourse crossings are designed to maintain hydrology as well as, where necessary, allowing the free passage of mammals and aquatic species.

A8.1.3. All new crossings will be able to convey 1 in 200 year flow volumes (plus an allowance for climate change) without constriction. Hydraulic modelling to demonstrate compliance would be undertaken prior to construction as part of the detailed drainage design.

Regulatory Legislation

A8.1.4. 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.

A8.1.5. 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).

A8.1.6. 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.

A8.1.7. 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 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.

A8.1.8. 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.

Disclaimer

A8.1.9. This report should be considered 'live' and as such changes may be needed should new information come to light. Natural Power 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 Ordnance Survey (OS) mapping or were not encountered during the site visit, will be identified within the Proposed Development Area. Should the construction process identify additional crossings, then these should be surveyed, and due consideration given to the legislation above to ensure compliance.

A8.1.10. 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.

A8.2 Methodology

Desk Study

A8.2.1. The desk study consisted of an examination of the track layout and the identification of watercourses which will require crossings, including those marked on the 1:10,000 and 1:50,000 scale OS maps. Watercourse buffers are shown in related figures and were applied using GIS on the following basis:

- All watercourses (1:10,000 and 1:50,000 scales) mapped within the Benloch Burn (drinking water protected area only) were allocated a 100 m buffer;
- Watercourses mapped on a 1:50,000 scale OS map were allocated a 50 m buffer; and
- All other minor watercourses (including mapped artificial ditches) were allocated a 10 m buffer.

A8.2.2. Details of the hydrological regime and associated flood risk affecting the Proposed Development is presented in Chapter 8 of the EIAR as well as Technical Appendix 8.5 Flood Risk Appraisal.

Site Visit

A8.2.3. 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.

A8.2.4. Watercourse surveys were undertaken in February, August and October 2021. The weather conditions during the survey were extremely wet in February, drier in August and wet again in October.

A8.2.5. A plan indicating the site boundary and survey points is illustrated in Figure 8.1 of the EIAR – Hydrology Overview.

Water Crossing Selection Criteria

A8.2.6. 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) and the CIRIA Culvert design and operation guide (C689) (2010). 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; among others.

A8.2.7. 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.

A8.3 Watercourse Crossing Assessment Summary

A8.3.1. Thirty one 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 8.1.1.

Table 8.1.1: Summary of Watercourse Crossings

CAR Authorisation	Number of Crossings
General Binding Rules (GBR)	21
Registration	8
Simple License	2
Total	**31**

Source: Natural Power

A8.3.2. Table 8.1.2 provides a summary of the surveyed natural watercourses, including proposed crossing type and proposed CAR authorisation.

Table 8.1.2: Summary of Watercourse Crossing Types

ID	Easting	Northing	Type	Preliminary* Drain / Culvert Diameter (mm)	CAR Authorisation
WCX1	257156	593357	New	900	GBR
WCX2	257259	593557	New	900	GBR
WCX3	257648	593831	New	900	GBR
WCX4	257776	593890	New	600	GBR
WCX5	257849	593875	New	1500	Registration
WCX6	258043	593836	New	600	GBR
WCX7	258254	593879	New	750	GBR
WCX8	258961	594275	New	450	GBR
WCX9	259059	594187	New	300	GBR
WCX10	259195	594070	New	900	GBR
WCX11	259190	593956	New	600	GBR
WCX12	257327	594751	New	Single Span Structure	Reg / Simple L.
WCX13	257360	594860	New	450	Registration
WCX14	257454	594920	New	1050	Registration
WCX15	257470	594909	New	750	Registration
WCX16	259245	595153	New	600	GBR
WCX17	259364	595001	New	1050	Registration
WCX18	259816	594757	New	900	GBR
WCX19	259838	594417	New	1050	GBR
WCX20	259687	594237	New	900	GBR
WCX21	260437	594343	New	1200	GBR
WCX22	260961	594585	New	900	Registration
WCX23	261026	594586	New	Single Span Structure	Reg / Simple L.
WCX24	261135	594261	New	1500	Registration
WCX25	260943	593245	New	1200	Registration
WCX26	260842	593359	New	600	GBR
WCX27	260466	592944	New	900	GBR
WCX28	259631	594829	New	1050	GBR
WCX29	260620	594355	New	600	GBR
WCX30	260804	594433	New	900	GBR
WCX31	261044	593333	New	600	GBR

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

**Dimensions taken from catchment assessment diagram illustrated at the end of this document. Final culvert dimensions / type subject to further hydraulic analysis at detailed design stage, and once site surveys at inverts, and final track micrositing has been confirmed.*

***The requirement for a registration or simple license would be determined based on the final design and extent of the abutments in the banks.*

Source: Natural Power

A8.3.3. The location of the watercourse crossings in relation to the proposed infrastructure is provided in Figure 8.1 Hydrology Overview. More detailed information on the watercourse crossings is provided in Section 8.5 and takes into account the preceding information, as well as photographs and hydromorphological information associated with each crossing.

A8.3.4. For WCX12 and WCX23, crossings in these locations are noted to bisect the modelled 1 in 200 flood inundation envelopes as identified in Section 8.6 of Technical Appendix 8.5. Following the completion of detailed site investigation and micro-sitting, an appropriate hydraulic assessment would be undertaken to demonstrate that the installation of spanning structures at these locations would not result in any increased flood risk downstream.

A8.3.5. In addition to the CAR authorisations summarised in Table 8.1.1, the Proposed Development will also require a CRP to meet SEPA's permitting principles and must be obtained prior to Construction.

A8.4 Rationale and Design

A8.4.1. The design of the consented track layout 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. Additional consideration has been given to the findings of the Fisheries Habitat Survey undertaken by the Galloways Fisheries Trust which makes recommendations for single span structures across the Marbrack Burn and Benloch Burn[1].

A8.4.2. 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 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 contractor takes care to ensure that the construction does not pose a permanent obstruction to migrating species of fish, or riparian mammals;
- 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;
- Designed to convey a minimum of 1 in 200 year plus climate change return period flood events, 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 0.6 m 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.

A8.4.3. 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;
- 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.

A8.4.4. 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.

A8.4.5. Following the completion of micro-siting and detailed site investigation, **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.

A8.5 Detailed Crossing Assessment

A8.5.1. Tables 8.1.3 to Table 8.1.31 provide information on the new watercourse crossings outlined in Table 8.1.2.

[1] Galloway Fisheries Trust. August 2021. Fisheries habitat survey for Quantans Wind Farm. Report No. – SBAD030821.

Table 8.1.3: Crossing for WCX1

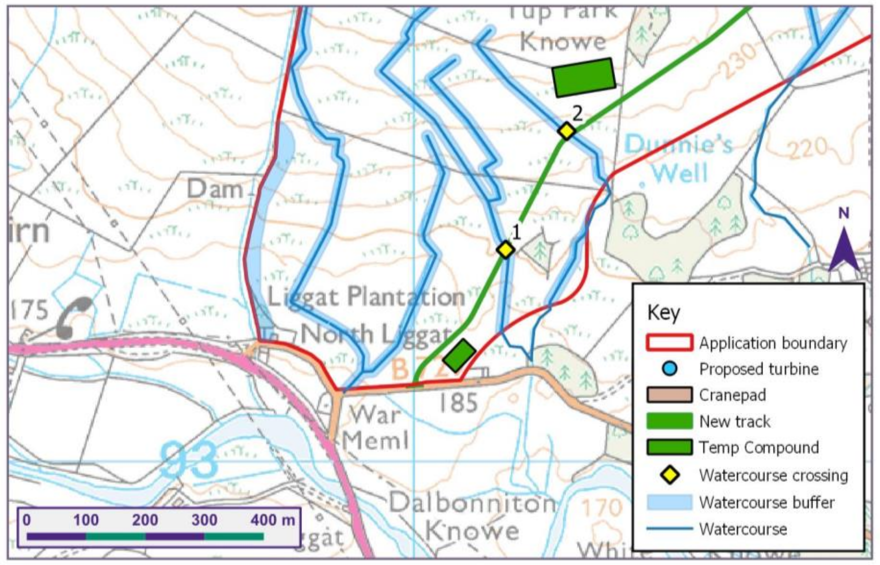
WCX1 (257156,593357)		
Crossing Location	**Crossing Description**	
 © Crown Copyright 2021. All rights reserved. Ordnance Survey Licence 0100031673.	**Existing Crossing:** No **Channel Type:** Poorly defined, Incised **Gradient:** Moderate **Valley form:** Shallow vee **Bank condition:** Stable **Bed material:** Rounded pebbles, Coarse gravel, Vegetation **Riparian corridor:** Moorland, Agricultural Grazing **Flow condition:** Moderate	**Water width (m):** 0.35 **Water depth (m):** 0.12 **Bankfull width (m):** 0.6 **Bankfull height (m):** 0.34 **Flooded Bankfull width (m):** 3.0 **Flooded Bankfull height (m):** 0.8 **Notes:** None. **CAR Auth Level:** GBR **Proposed Crossing Type:** Circular Culvert
Crossing Photographs		
Upstream	**Across**	**Downstream**
		

Table 8.1.4: WCX2

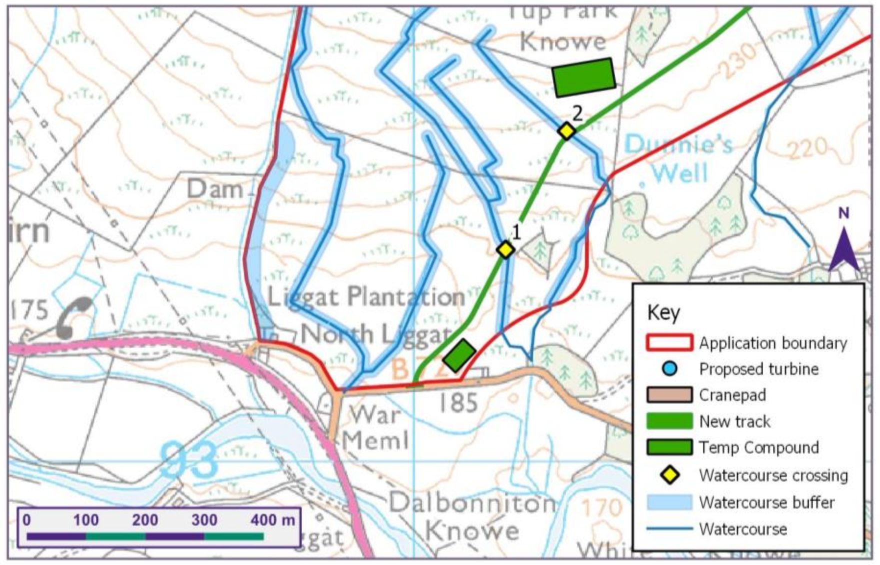
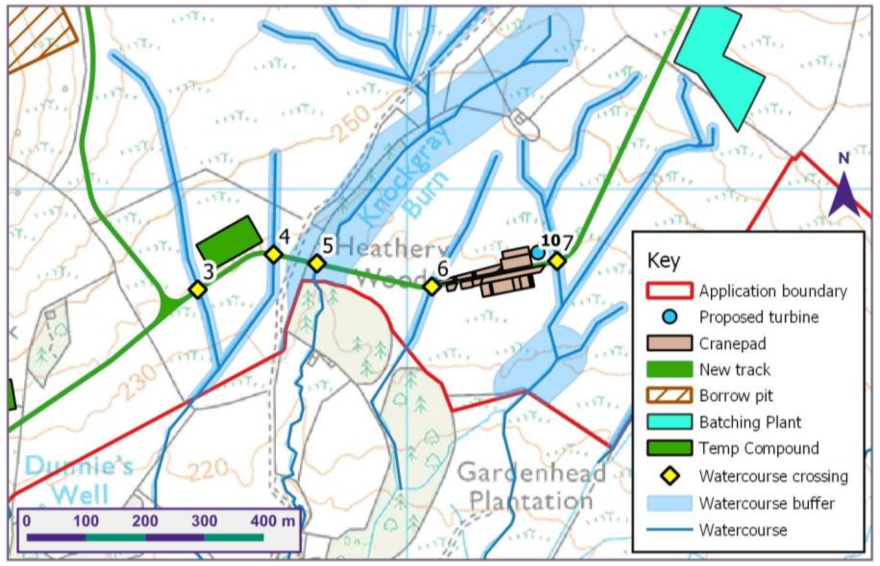
WCX2 (257259,593557)		
Crossing Location	**Crossing Description**	
	**Existing Crossing:** No **Channel Type:** Poorly defined, Incised **Gradient:** Gentle **Valley form:** Shallow vee **Bank condition:** Stable **Bed material:** Vegetation, Peat **Riparian corridor:** Moorland, Agricultural Grazing **Flow condition:** Moderate	**Water width (m):** 0.3 **Water depth (m):** 0.2 **Bankfull width (m):** 0.6 **Bankfull height (m):** 0.7 **Banktop height (m):** 1.15 **Flooded Bankfull width (m):** 1-1.5 **Flooded Bankfull height (m):** 1.2 **Notes:** Probable drainage ditch. **CAR Auth Level:** GBR **Proposed Crossing Type:** Circular Culvert
© Crown Copyright 2021. All rights reserved. Ordnance Survey Licence 0100031673.		
Crossing Photographs		
Upstream	**Across**	**Downstream**
		

Table 8.1.5: WCX3

WCX3 (257648,593831)

Crossing Location	Crossing Description	
	**Existing Crossing:** No	**Water width (m):** 0.4
	Channel Type: Incised, Artificially modified watercourse,	**Water depth (m):** 0.12
	Gradient: Gentle	**Bankfull width (m):** 0.8
	Valley form: Shallow vee	**Bankfull height (m):** b
	Bank condition: Stable	**Flooded Bankfull width (m):** 1.7
	Bed material: Coarse gravel, Cobbles, Vegetation	**Flooded Bankfull height (m):** 0.9
	Riparian corridor: Moorland, Agricultural Grazing	
	Flow condition: Moderate	**Notes:** Probable drainage ditch.
		CAR Auth Level: GBR
		Proposed Crossing Type: Circular Culvert

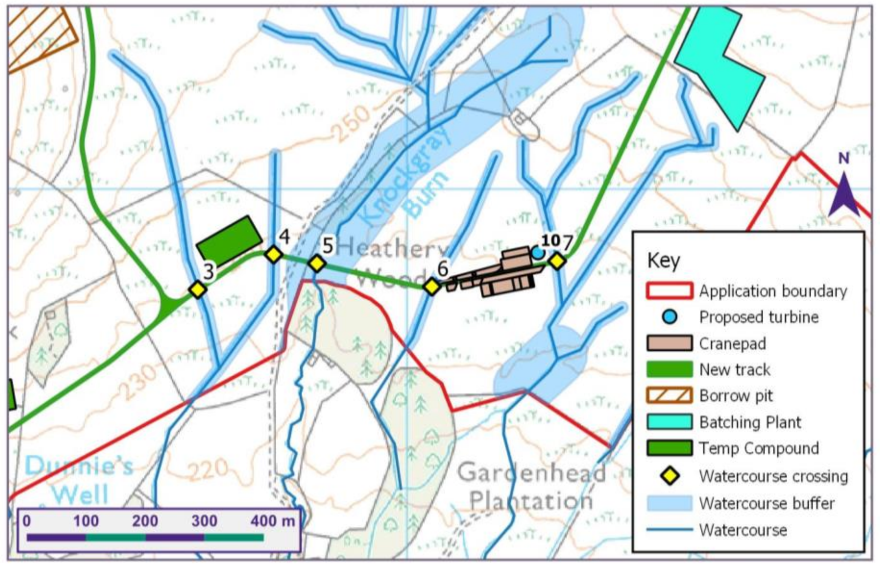
Crossing Photographs

Upstream	Across	Downstream
		

Table 8.1.6: WCX4

WCX4 (257776,593890)

Crossing Location



Crossing Description

Existing Crossing: No
Channel Type: Incised
Gradient: Gentle
Valley form: No obvious valley sides
Bank condition: Stable
Bed material: Vegetation, Cobbles, Coarse gravel
Riparian corridor: Moorland, Agricultural Grazing
Flow condition: Moderate

Water width (m): 0.30
Water depth (m): 0.17
Bankfull width (m): 1.1
Bankfull height (m): 0.74
Flooded Bankfull width (m): 1.6 - 2.1
Flooded Bankfull height (m): 0.94

Notes: Probable drainage ditch.

CAR Auth Level: GBR
Proposed Crossing Type: Circular Culvert

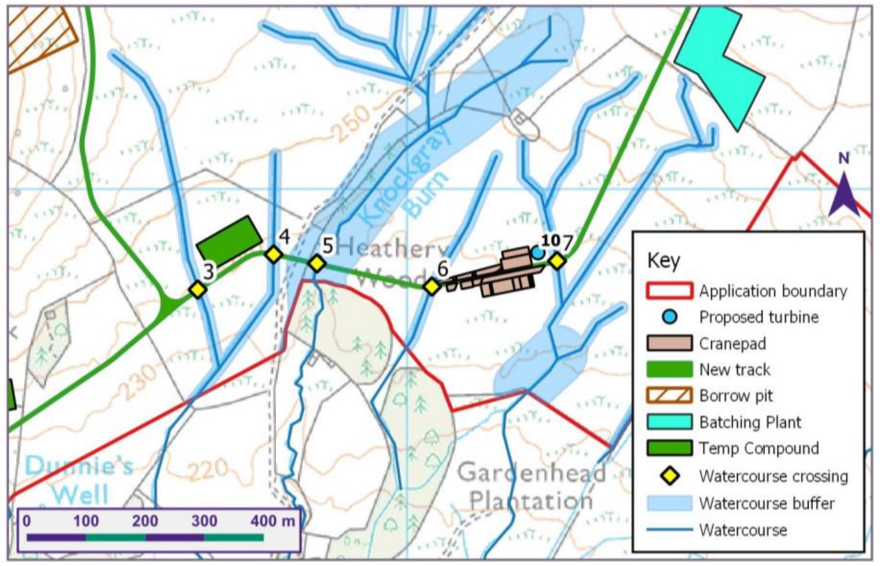
Crossing Photographs

Upstream	Across	Downstream
		

Table 8.1.7: WCX5

WCX5 (257849,593875)

Crossing Location



Crossing Description

Existing Crossing: Yes - Ford

Channel Type: Incised

Gradient: Gentle

Valley form: Shallow vee

Bank condition: Stable

Bed material: Fine sand/silt, Rounded pebbles, Coarse gravel, Boulders, Vegetation

Riparian corridor: Moorland, Agricultural Grazing, Commercial Forestry, Natural Woodland

Flow condition: Moderate

Water width (m): 1.0

Water depth (m): 0.3

Bankfull width (m): 1.0

Bankfull height (m): 0.7

Flooded Bankfull width (m): 2-2.5

Flooded Bankfull height (m): 1-1.5

Notes: Point used as an occasional ford for agricultural traffic but does not appear engineered at all.

CAR Auth Level: Registration

Proposed Crossing Type: Circular Culvert*

Culvert would be sized to enable the formation and retention of natural bed material.

Crossing Photographs

Upstream

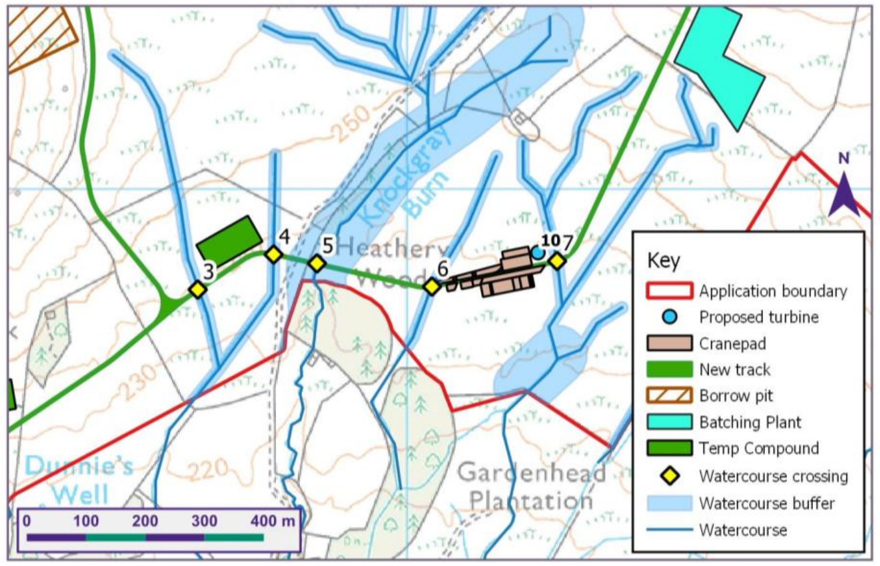
Across

Downstream

Table 8.1.8: WCX6

WCX6 (258043,593836)

Crossing Location



Crossing Description

Existing Crossing: No

Channel Type: Incised, Artificially modified watercourse, Artificial drainage channel

Gradient: Gentle

Valley form: Shallow vee

Bank condition: Stable

Bed material: Vegetation, Peat

Riparian corridor: Moorland, Natural Woodland

Flow condition: Moderate

Water width (m): 0.34

Water depth (m): 0.15

Bankfull width (m): 1.1

Bankfull height (m): 0.8

Flooded Bankfull width (m): 1.6

Flooded Bankfull height (m): 1.0

Notes: Probable drainage ditch.

CAR Auth Level: GBR

Proposed Crossing Type: Circular Culvert

Crossing Photographs

Upstream

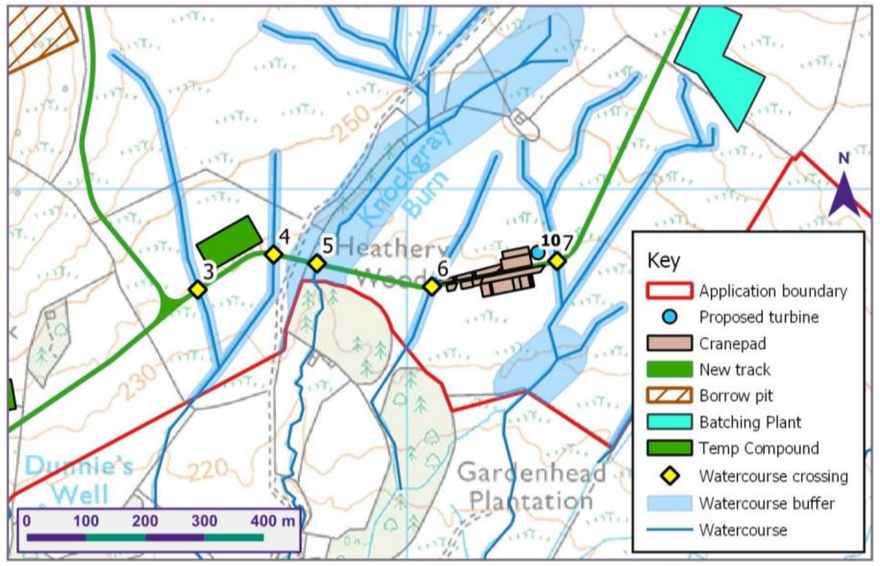
Across

Downstream

Table 8.1.9: WCX7

WCX7 (258254,593879)

Crossing Location



Crossing Description

Existing Crossing: No

Channel Type: Incised, Artificially modified watercourse, Artificial drainage channel

Gradient: Gentle

Valley form: Shallow vee

Bank condition: Stable

Bed material: Coarse gravel, Rounded pebbles, Vegetation, Peat

Riparian corridor: Moorland, Agricultural Grazing

Flow condition: Moderate

Water width (m): 0.35

Water depth (m): 0.35

Bankfull width (m): 0.6

Bankfull height (m): 0.5

Flooded Bankfull width (m): 1

Flooded Bankfull height (m): 0.6

Notes: Probable drainage ditch.

CAR Auth Level: GBR

Proposed Crossing Type: Circular Culvert

Crossing Photographs

Upstream

Across

Downstream

Table 8.1.10: WCX8

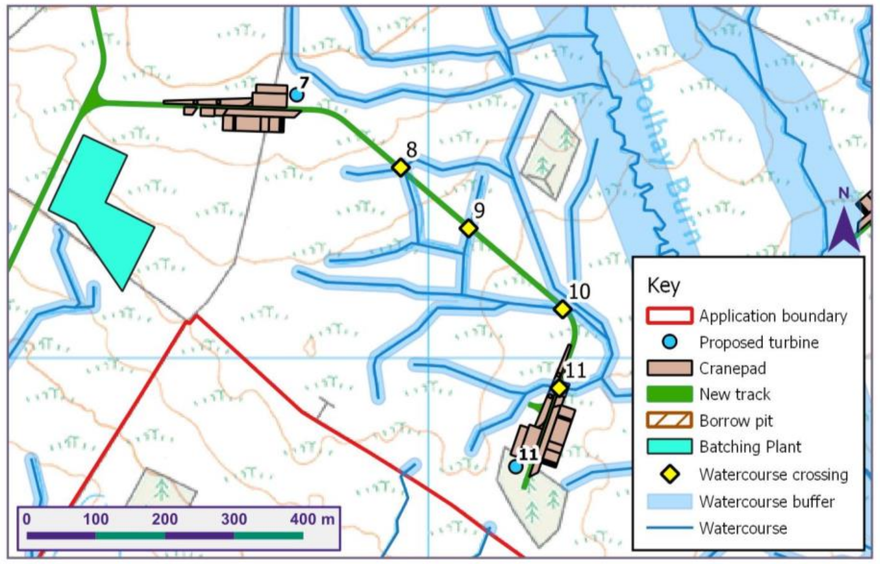
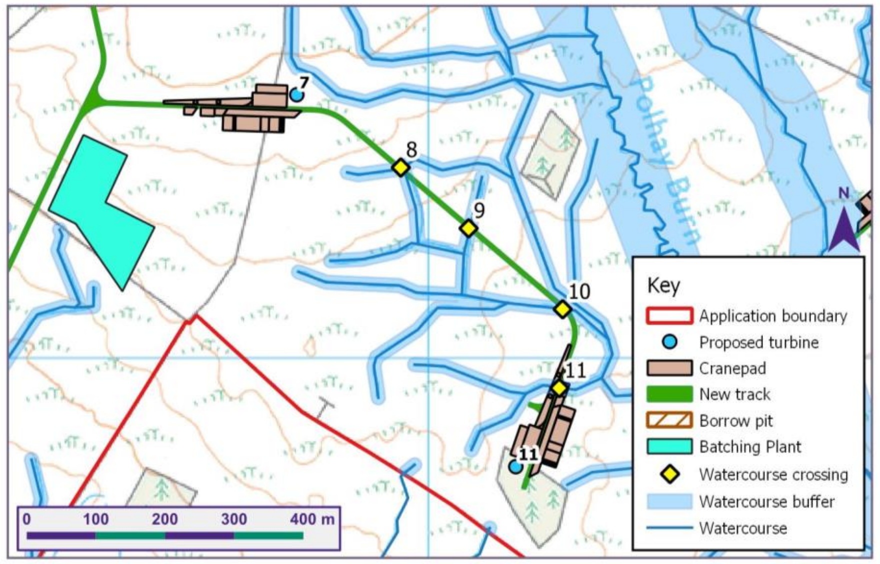
WCX8 (258961,594275)		
Crossing Location	**Crossing Description**	
 	**Existing Crossing:** No **Channel Type:** None evident, Poorly defined, Surface run-off/wetlands only, Artificially modified watercourse **Gradient:** Gentle **Valley form:** No obvious valley sides **Bank condition:** Stable **Bed material:** Vegetation, Peat **Riparian corridor:** Moorland, Agricultural Grazing **Flow condition:** Stagnant	**Water width (m):** 0.6 **Water depth (m):** 0.7 **Bankfull width (m):** 1.0 **Bankfull height (m):** 0.1 **Flooded Bankfull width (m):** 1.7 **Flooded Bankfull height:** 0.2 **Notes:** Poorly defined watercourse, may at some point have been a drainage ditch, but almost dry now. **CAR Auth Level:** GBR **Proposed Crossing Type:** Circular Culvert
Crossing Photographs		
Upstream	**Across**	**Downstream**
		

Table 8.1.11: WCX9

WCX9 (259059,594187)

Crossing Location



Crossing Description

Existing Crossing: No

Channel Type: None evident, Surface run-off/wetlands only, Artificially modified watercourse, Artificial drainage channel

Gradient: Gentle

Valley form: No obvious valley sides

Bank condition: Stable

Bed material: Vegetation, Peat

Riparian corridor: Moorland, Agricultural Grazing

Flow condition: Stagnant

Water width (m): 1.1

Water depth (m): 0.16

Bankfull width (m): 1.6

Bankfull height (m): 0.2

Flooded Bankfull width (m): 2-3

Flooded Bankfull height (m): 0.3

Notes: This is an old drainage ditch, one of many in this location (most of the others are dry).

CAR Auth Level: GBR

Proposed Crossing Type: Circular Culvert

Crossing Photographs

Upstream

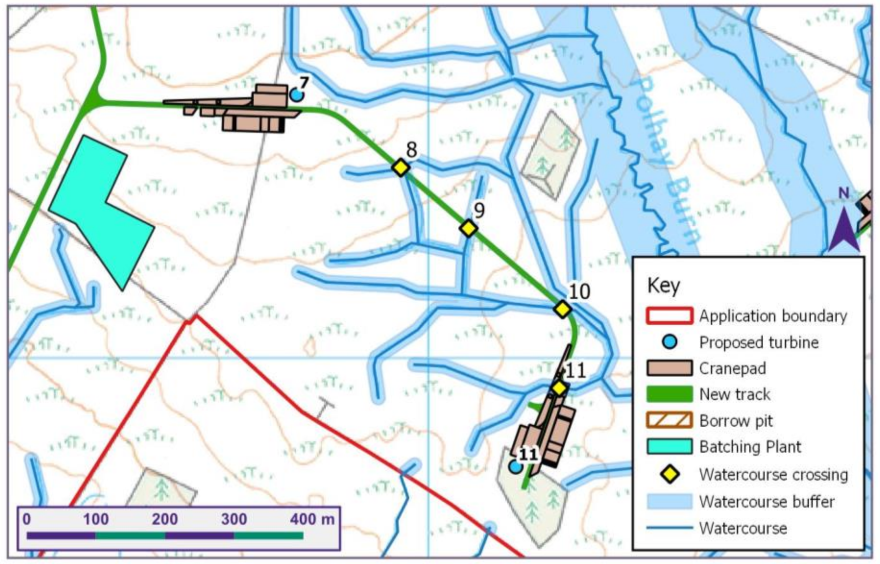
Across

Downstream

Table 8.1.12: WCX10

WCX10 (259195,594070)

Crossing Location



Crossing Description

Existing Crossing: No

Channel Type: None evident, Surface run-off/wetlands only watercourse

Gradient: Gentle

Valley form: No obvious valley sides

Bank condition: Stable

Bed material: Vegetation, Peat

Riparian corridor: Moorland, Agricultural Grazing

Flow condition: Moderate

Water width (m): 0.5

Water depth (m): 0.14

Bankfull width (m): 0.5-1

Bankfull height (m): 0.25

Flooded Bankfull width (m): 5-10

Flooded Bankfull height: 0.3-0.5

Notes: Probable drainage ditch.

CAR Auth Level: GBR

Proposed Crossing Type: Circular Culvert

Crossing Photographs

Upstream

Across

Downstream

Table 8.1.13: WCX11

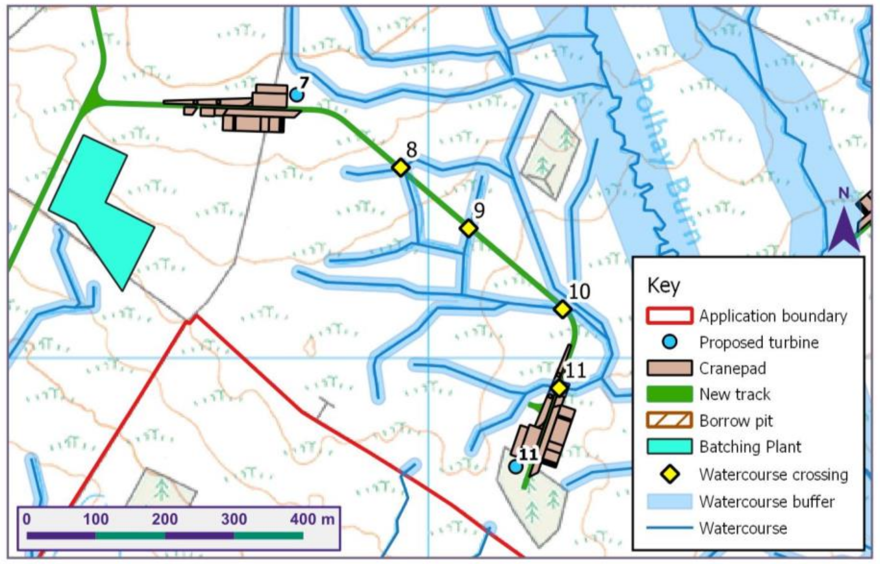
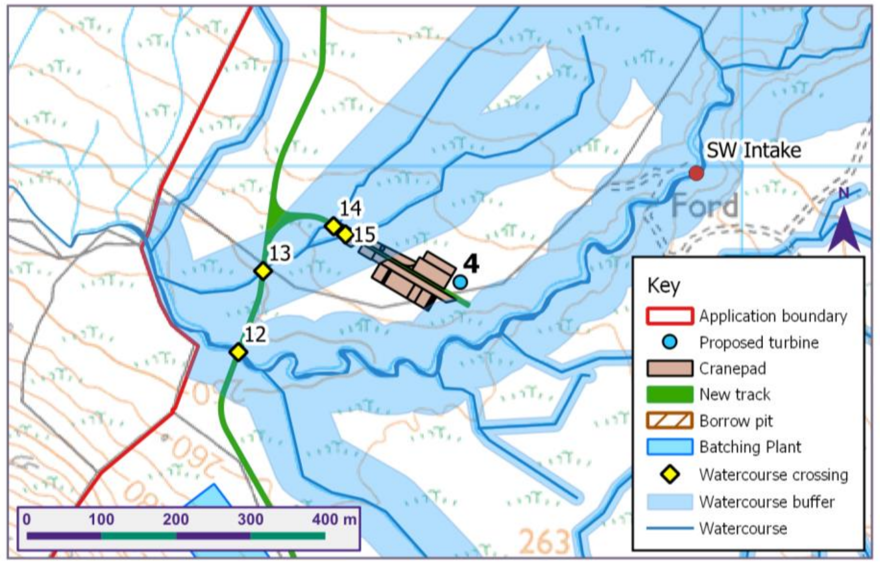
WCX11 (259190,593956)		
Crossing Location	**Crossing Description**	
 	**Existing Crossing:** No **Channel Type:** None evident, Surface run-off/wetlands only, Poorly defined **Gradient:** Gentle **Valley form:** No obvious valley sides **Bank condition:** Stable **Bed material:** Vegetation, Peat **Riparian corridor:** Moorland, Agricultural Grazing **Flow condition:** Very slow	**Water width (m):** 1 **Water depth (m):** 0.1 **Bankfull width (m):** 1.5 **Bankfull height (m):** 0.2 **Flooded Bankfull width (m):** 2.5 **Flooded Bankfull height (m):** 0.3-0.5 **Notes:** Survey suggested this is a probable drainage ditch. **CAR Auth Level:** GBR **Proposed Crossing Type:** Circular Culvert
Crossing Photographs		
Upstream	**Across**	**Downstream**
		

Table 8.1.14: WCX12

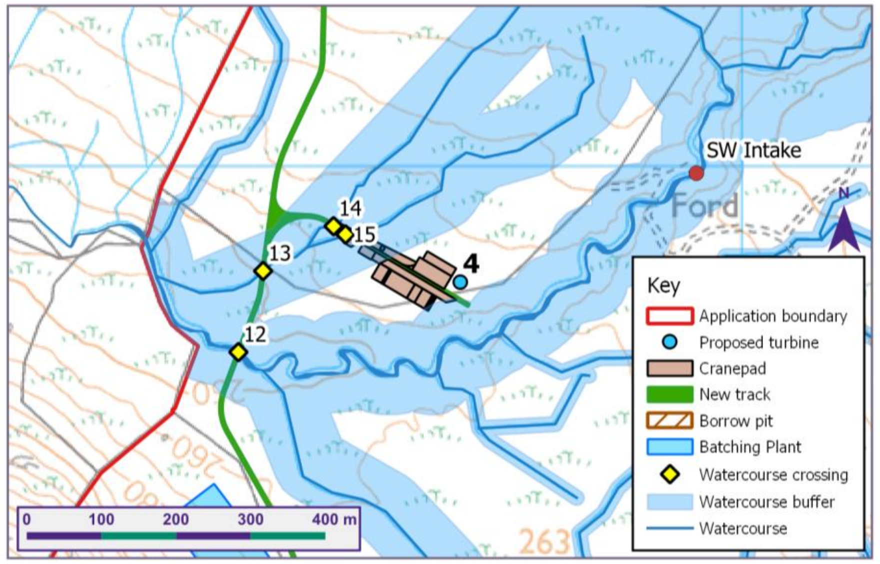
WCX12 (257327,594751)		
Crossing Location	**Crossing Description**	
 	**Existing Crossing:** No **Channel Type:** Incised, Meandering **Gradient:** Moderate **Valley form:** Asymmetrical **Bank condition:** Stable **Bed material:** Boulders, Coarse gravel, Rounded pebbles **Riparian corridor:** Moorland **Flow condition:** Slow **AREA**: 4.16 km2 **QMED:** 6.28 m3 s-1 **Q200+CC:**25.83 m3 s-1	**Water width (m):** 1.4 **Water depth (m):** 0.1 **Bankfull width (m):** 2 **Bankfull height (m):** 0.5 **Banktop height (m):** 0.7 **Flooded Bankfull width (m):** 2 **Flooded Bankfull height:** 0.7 **Notes:** None. **CAR Auth Level:** Registration / Simple License **Proposed Crossing Type:** Single Span Structure

Crossing Photographs		
Upstream	**Across**	**Downstream**
		

Table 8.1.15: WCX13

WCX13 (257360,594860)

Crossing Location



Crossing Description

Existing Crossing: No
Channel Type: Incised, Poorly defined
Gradient: Moderate
Valley form: No obvious valley sides
Bank condition: Stable
Bed material: Boulders, Coarse gravel, Rounded pebbles
Riparian corridor: Moorland
Flow condition: Dry

Water width (m): 0
Water depth (m): 0
Bankfull width (m): 0.7
Bankfull height (m): 0.2
Banktop height (m): 0.3
Flooded Bankfull width (m): 1
Flooded Bankfull height (m): 0.5

Notes: Surveyed in August, when flow levels were much lower than surveys earlier in 2021.

CAR Auth Level: Registration
Proposed Crossing Type: Circular Culvert

Crossing Photographs

Upstream

Across

Downstream

Table 8.1.16: WCX14

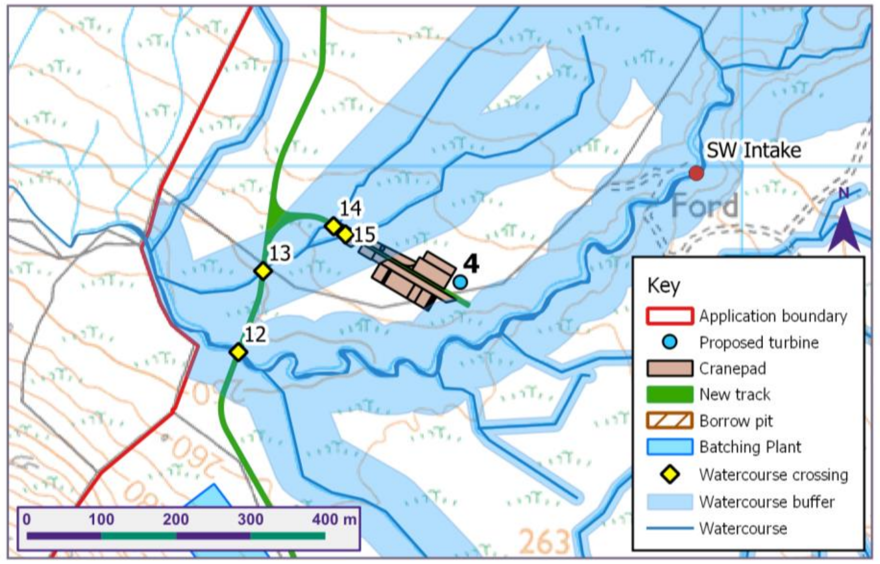
WCX14 (257454,594920)		
Crossing Location	**Crossing Description**	
 	**Existing Crossing:** No **Channel Type:** Incised, Meandering **Gradient:** Moderate **Valley form:** No obvious valley sides **Bank condition:** Stable, Undercut (no evidence of recent collapse) **Bed material:** Rounded pebbles, Coarse gravel, Boulders **Riparian corridor:** Moorland **Flow condition:** Fast	**Water width (m):** 0.6 **Water depth (m):** 0.05 **Bankfull width (m):** 0.8 **Bankfull height (m):** 0.8 **Flooded Bankfull width (m):** 1 **Flooded Bankfull height:** 1 **Notes:** None. **CAR Auth Level:** Registration **Proposed Crossing Type:** Circular Culvert
Crossing Photographs		
Upstream	**Across**	**Downstream**
		

Table 8.1.17: WCX15

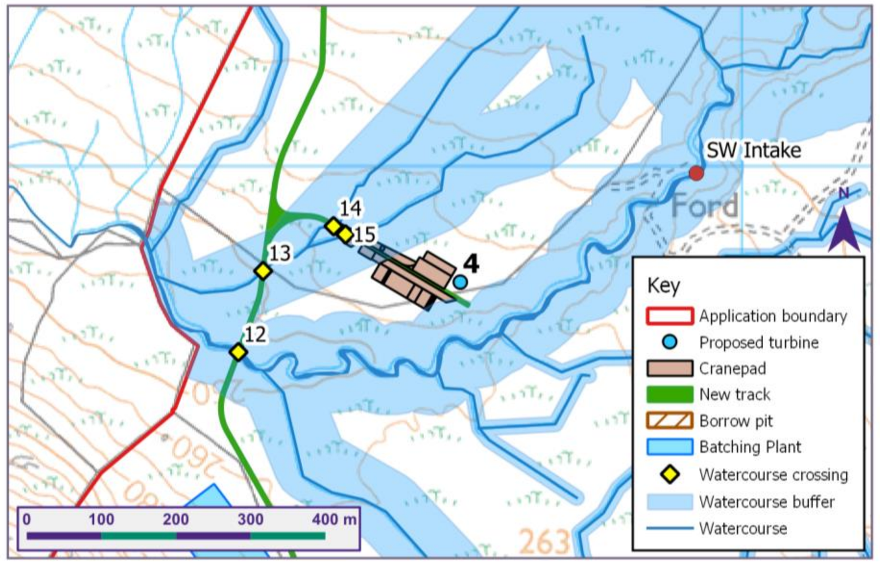
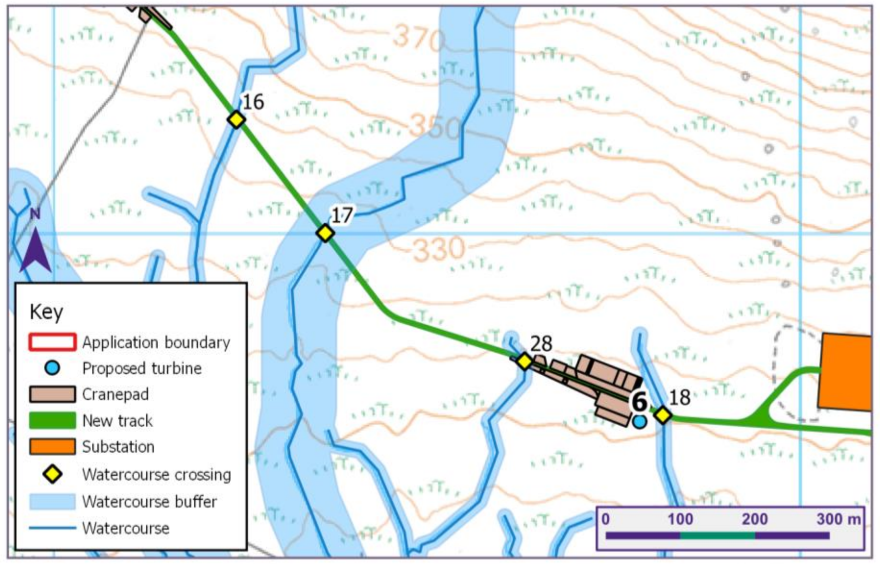
WCX15 (257470,594909)		
Crossing Location	**Crossing Description**	
 	**Existing Crossing:** No **Channel Type:** Incised, Surface run-off/wetlands only **Gradient:** Gentle **Valley form:** No obvious valley sides **Bank condition:** Stable **Bed material:** Vegetation, Soil, Peat **Riparian corridor:** Vegetated **Flow condition:** Slow	**Water width (m):** 0.3 **Water depth (m):** 0.3 **Bankfull width (m):** 0.5 **Bankfull height (m):** 0.45 **Flooded Bankfull width (m):** 0.65 **Flooded Bankfull height (m):** 0.6 **Notes:** None. **CAR Auth Level:** Registration **Proposed Crossing Type:** Circular Culvert
Crossing Photographs		
Upstream	**Across**	**Downstream**
		

Table 8.1.18: WCX16

WCX16 (259245,595153)

Crossing Location



Crossing Description

Existing Crossing: No

Channel Type: Incised, Poorly defined

Gradient: Gentle

Valley form: Shallow vee

Bank condition: Stable

Bed material: Coarse gravel, Boulders, Vegetation

Riparian corridor: Moorland, Agricultural Grazing

Flow condition: Moderate

Water width (m): 0.2

Water depth (m): 0.25

Bankfull width (m): 0.3

Bankfull height (m): 0.35

Flooded Bankfull width (m): 0.5-1

Flooded Bankfull height: 0.45

Notes: None.

CAR Auth Level: GBR

Proposed Crossing Type: Circular Culvert

Crossing Photographs

Upstream

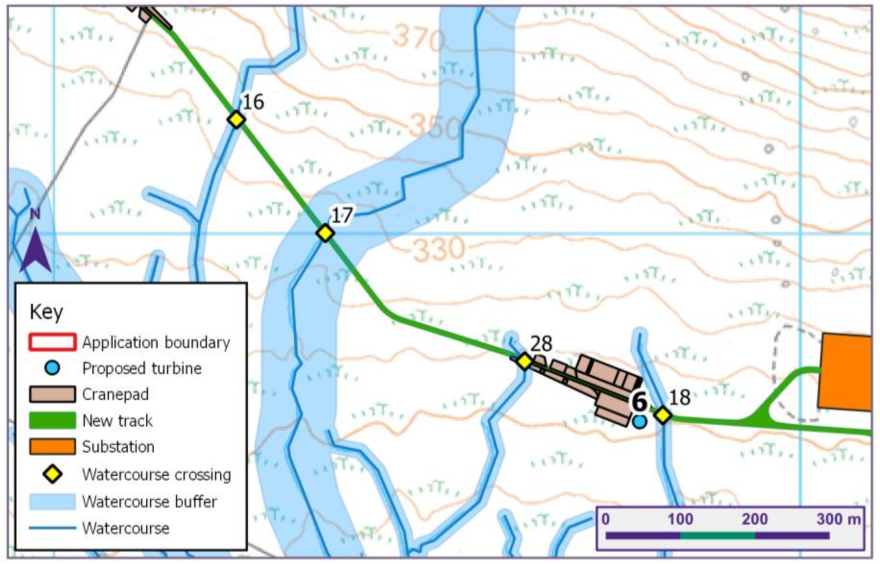
Across

Downstream

Table 8.1.19: WCX17

WCX17 (259364,595001)

Crossing Location



Crossing Description

Existing Crossing: No

Channel Type: None evident, Poorly defined, Incised

Gradient: Gentle

Valley form: Shallow vee

Bank condition: Stable

Bed material: Fine sand/silt, Rounded pebbles, Coarse gravel, Vegetation

Riparian corridor: Moorland, Agricultural Grazing

Flow condition: Moderate

Water width (m): 0.3

Water depth (m): 0.2

Bankfull width (m): 0.6

Bankfull height (m): 0.3

Flooded Bankfull width (m): 2-3

Flooded Bankfull height (m): 0.6

Notes: None.

CAR Auth Level: Registration

Proposed Crossing Type: Circular Culvert

Crossing Photographs

Upstream

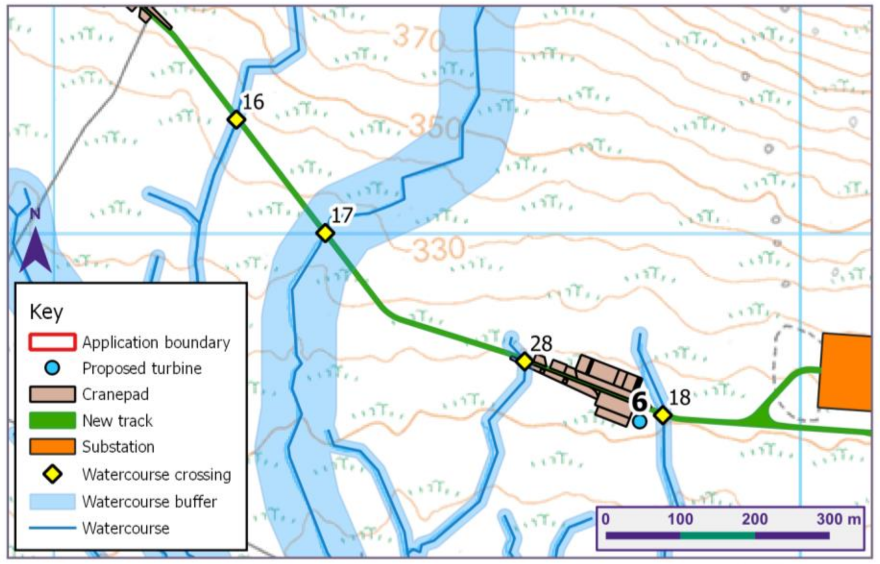
Across

Downstream

Table 8.1.20: WCX18

WCX18 (259816,594757)	
Crossing Location	**Crossing Description**

Crossing Location



Crossing Description

Existing Crossing: No
Channel Type: Incised, Poorly defined
Gradient: Gentle
Valley form: Shallow vee
Bank condition: Stable, Unstable (potential recent collapse)
Bed material: Rounded pebbles, Coarse gravel, Boulders
Riparian corridor: Moorland
Flow condition: Moderate

Water width (m): 0.35
Water depth (m): 0.19
Bankfull width (m): 1.1
Bankfull height (m): 0.55
Flooded Bankfull width (m): 3-4
Flooded Bankfull height: 0.65

Notes: None.

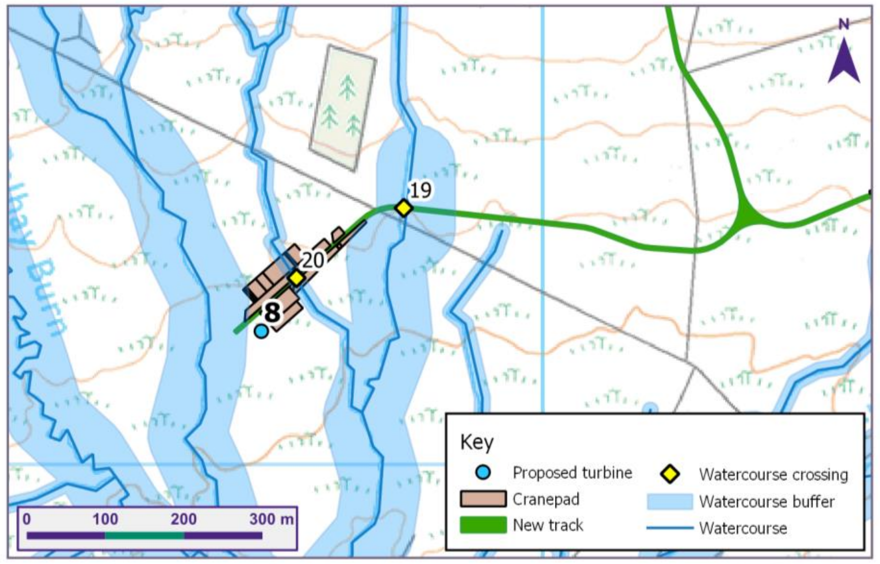
CAR Auth Level: GBR
Proposed Crossing Type: Circular Culvert

Crossing Photographs

Upstream	Across	Downstream
		

Table 8.1.21: WCX19

WCX19 (259838,594417)		
Crossing Location	**Crossing Description**	



Existing Crossing: No
Channel Type: Incised, Poorly defined
Gradient: Gentle
Valley form: Shallow vee
Bank condition: Stable
Bed material: Rounded pebbles, Coarse gravel, Boulders
Riparian corridor: Moorland, Heavily Vegetated
Flow condition: Moderate

Water width (m): 1.1
Water depth (m): 0.1
Bankfull width (m): 1.2
Bankfull height (m): 1.5
Flooded Bankfull width (m): 5.5
Flooded Bankfull height (m): 1.7

Notes: None.

CAR Auth Level: GBR
Proposed Crossing Type: Circular Culvert

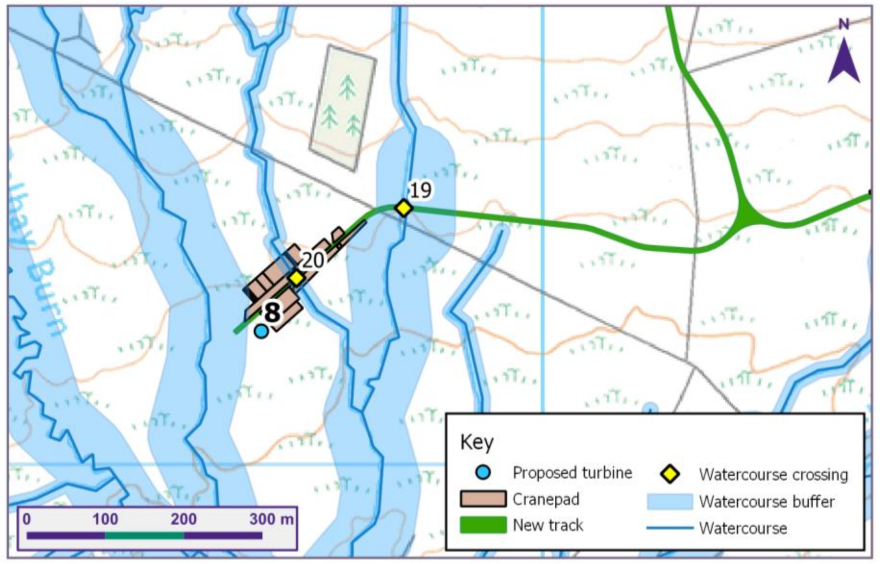
Crossing Photographs

Upstream	Across	Downstream
		

Table 8.1.22: WCX20

WCX20 (259687,594237)

Crossing Location



Crossing Description

Existing Crossing: No
Channel Type: Incised
Gradient: Gentle
Valley form: Shallow vee
Bank condition: Stable
Bed material: Rounded pebbles, Coarse gravel, Boulders
Riparian corridor: Moorland, Agricultural Grazing
Flow condition: Moderate

Water width (m): 0.5
Water depth (m): 0.1
Bankfull width (m): 0.5
Bankfull height (m): 0.7
Flooded Bankfull width (m): 1.5-2
Flooded Bankfull height (m): 0.9

Notes: Probable drainage ditch.

CAR Auth Level: GBR
Proposed Crossing Type: Circular Culvert

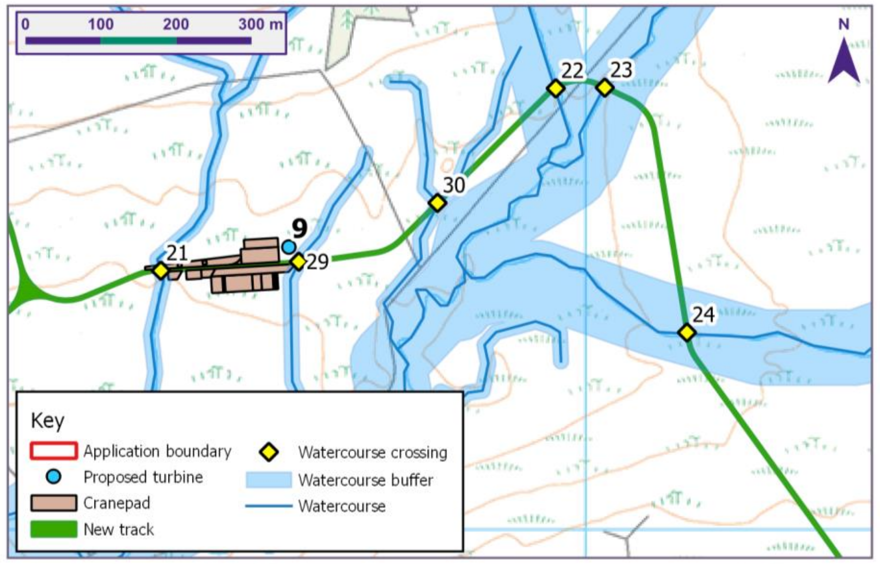
Crossing Photographs

Upstream

Across

Downstream

Table 8.1.23: WCX21

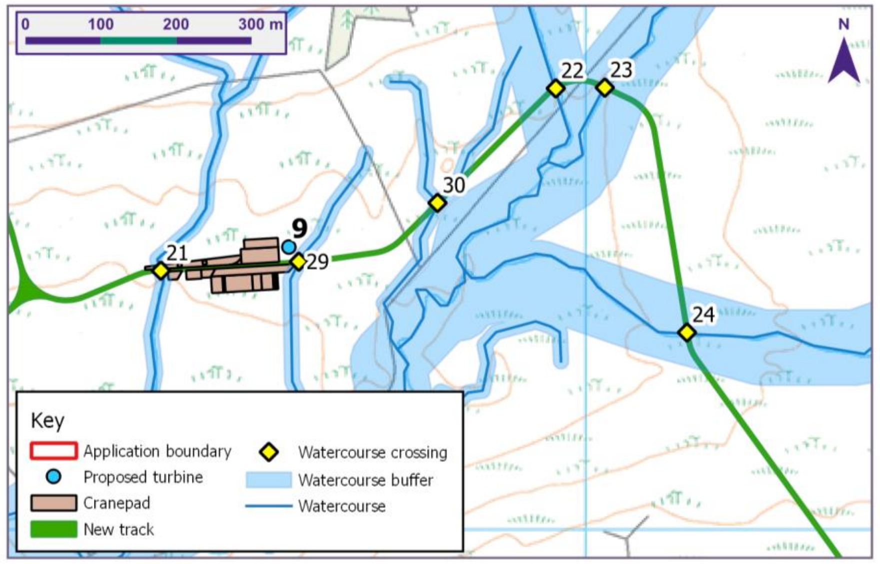
WCX21 (260437,594343)		
Crossing Location	**Crossing Description**	
 © Crown Copyright 2022. All rights reserved. Ordnance Survey Licence 0100031673.	**Existing Crossing:** No **Channel Type:** Poorly defined, Incised, Artificially modified watercourse, Artificial drainage channel **Gradient:** Gentle **Valley form:** No obvious valley sides, Shallow vee **Bank condition:** Stable **Bed material:** Vegetation, Peat **Riparian corridor:** Moorland, Agricultural Grazing **Flow condition:** Moderate	**Water width (m):** 0.2 **Water depth (m):** 0.3 **Bankfull width (m):** 0.3 **Bankfull height (m):** 0.7 **Flooded Bankfull width (m):** 1-2 **Flooded Bankfull height (m):** 0.9 **Notes:** Probable drainage ditch. **CAR Auth Level:** GBR **Proposed Crossing Type:** Circular Culvert

Crossing Photographs		
Upstream	**Across**	**Downstream**
		

Table 8.1.24: WCX22

WCX22 (260961,594585)

Crossing Location



Crossing Description

Existing Crossing: No
Channel Type: Incised, Meandering
Gradient: Moderate
Valley form: Shallow vee
Bank condition: Unstable (potential recent collapse)
Bed material: Fine sand/silt, Coarse gravel, Boulders
Riparian corridor: Moorland, Agricultural Grazing
Flow condition: Moderate

Water width (m): 0.9
Water depth (m): 0.11 to 0.2
Bankfull width (m): 0.66 (bank is undercut)
Bankfull height (m): 0.5
Banktop height (m): 0.6
Flooded Bankfull width (m): 2.9
Flooded Bankfull height (m): 1.2

Notes: None.

CAR Auth Level: Registration
Proposed Crossing Type: Circular Culvert

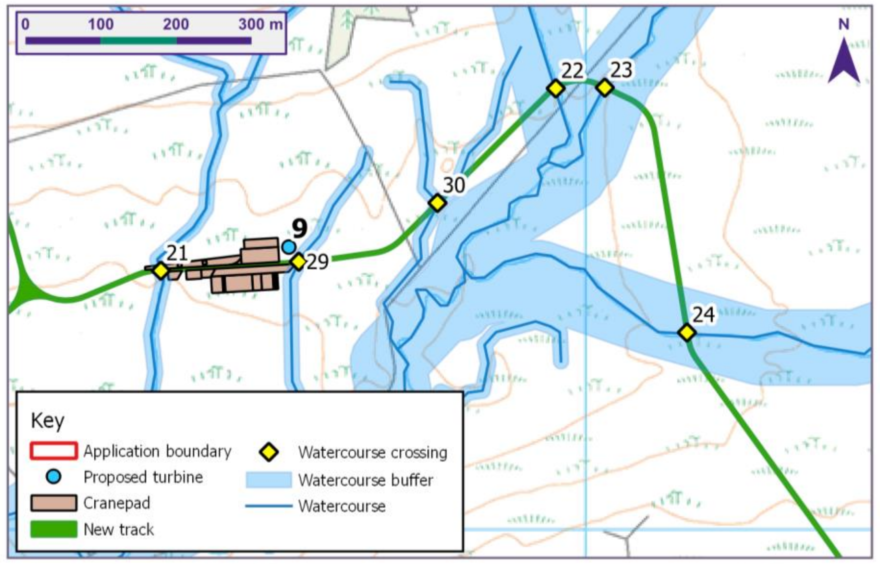
Crossing Photographs

Upstream	Across	Downstream
		

Table 8.1.25: WCX23

WCX23 (261026,594586)

Crossing Location



Crossing Description

Existing Crossing: No
Channel Type: Broad, Meandering
Gradient: Moderate
Valley form: Deep vee
Bank condition: Undercut (no evidence of recent collapse)
Bed material: Rounded pebbles, Boulders, Fine sand/silt, Coarse gravel, Bedrock
Riparian corridor: Moorland, Agricultural Grazing
Flow condition: Moderate

AREA: 5.81
QMED: 8.86
Q200+CC: 35.32

Water width (m): 3.5
Water depth (m): 0.4
Bankfull width (m): 4
Bankfull height (m): 1
Banktop height (m): n/a
Flooded Bankfull width (m): 5
Flooded Bankfull height (m): 2

Notes: None.

CAR Auth Level: Registration / Simple License
Proposed Crossing Type: Single Span

Crossing Photographs

Upstream

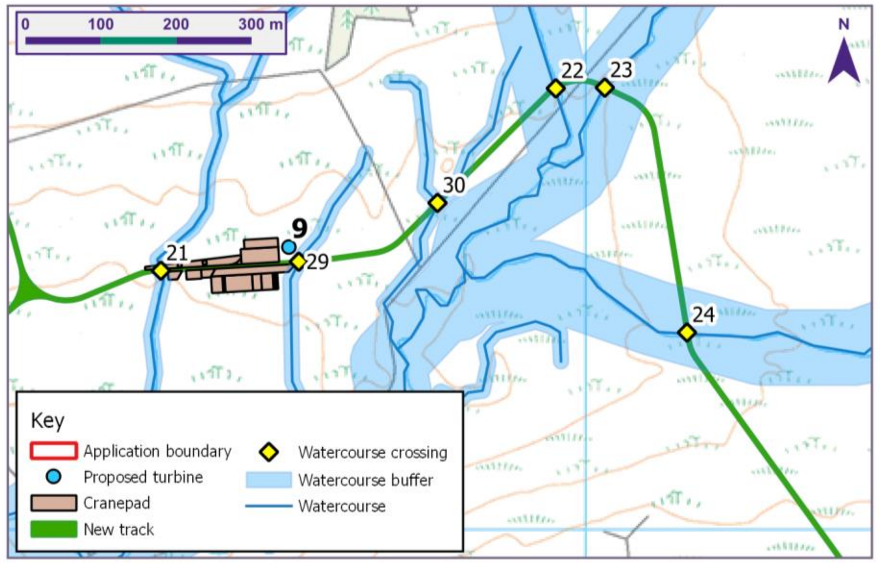
Across

Downstream

Table 8.1.26: WCX24

WCX24 (261135,594261)

Crossing Location



Crossing Description

Existing Crossing: No
Channel Type: Incised, Meandering
Gradient: Moderate
Valley form: Concave/bowl
Bank condition: Stable
Bed material: Boulders, Fine sand/silt, Rounded pebbles, Vegetation
Riparian corridor: Moorland, Agricultural Grazing
Flow condition: Slow

Water width (m): 1.6
Water depth (m): 0.45
Bankfull width (m): 1.8
Bankfull height (m): 0.7
Banktop height (m): n\a
Flooded Bankfull width (m): 3.4
Flooded Bankfull height (m): 1

Notes: Measured at widest part. immediately upstream and downstream watercourse is narrowed, approx. 0.4m.

CAR Auth Level: Registration
Proposed Crossing Type: Circular Culvert

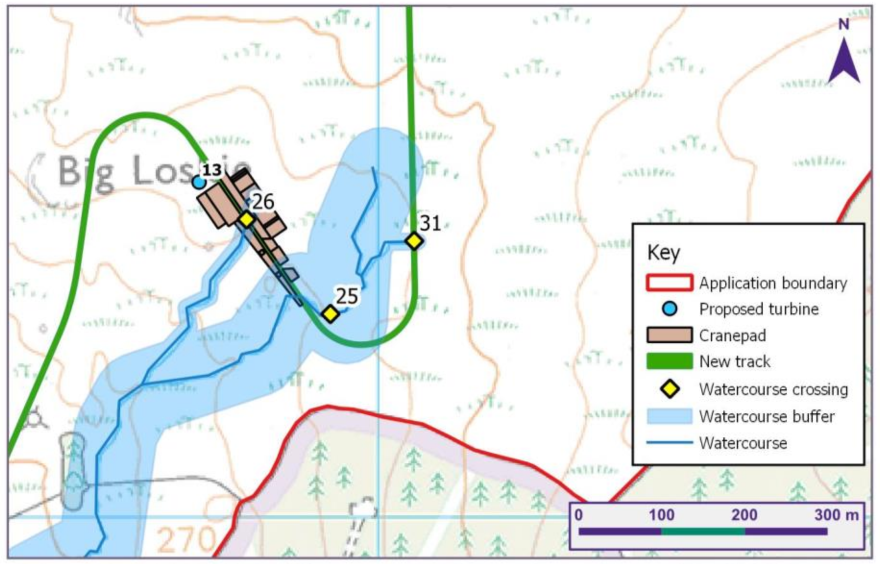
Crossing Photographs

Upstream	Across	Downstream
		

Table 8.1.27: WCX25

WCX25 (260943,593245)

Crossing Location



Crossing Description

Existing Crossing: No

Channel Type: Incised, Meandering

Gradient: Moderate

Valley form: U-shape valley, Concave/bowl

Bank condition: Unstable (potential recent collapse)

Bed material: Rounded pebbles, Coarse gravel, Boulders, Vegetation, Soil

Riparian corridor: Moorland, Agricultural Grazing

Flow condition: Fast

Water width (m): 0.8

Water depth (m): 0.1 to 0.19

Bankfull width (m): 0.6 (narrower than water width because bank is undercut)

Bankfull height (m): 0.4

Banktop height (m): n\a

Flooded Bankfull width (m): 1.2

Flooded Bankfull height (m): 0.55

Notes: None.

CAR Auth Level: Registration

Proposed Crossing Type: Circular Culvert

Crossing Photographs

Upstream

Across

Downstream

Table 8.1.28: WCX26

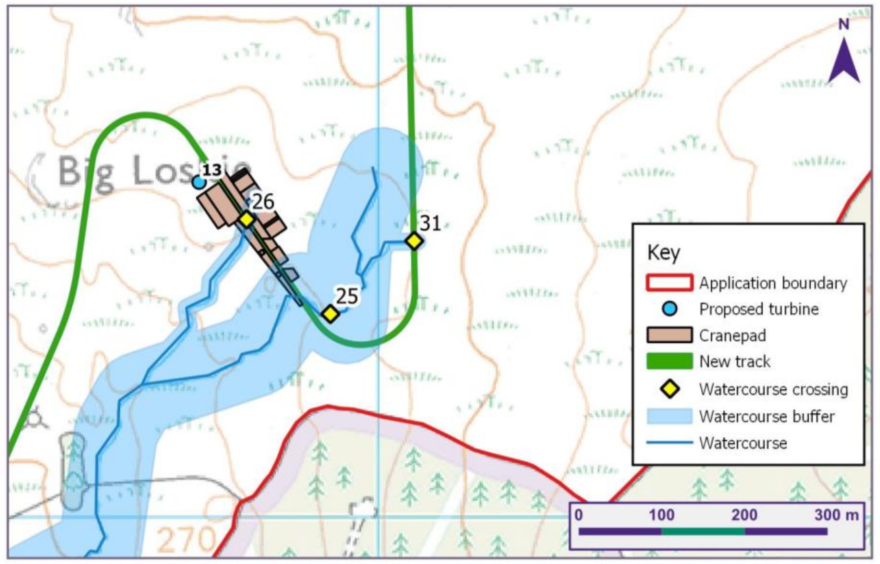
WCX26 (260842,593359)		
Crossing Location	**Crossing Description**	
 	**Existing Crossing:** No **Channel Type:** Incised **Gradient:** Gentle **Valley form:** No obvious valley sides **Bank condition:** Unstable (potential recent collapse) **Bed material:** Boulders, Vegetation, Soil, Peat **Riparian corridor:** Moorland, Agricultural Grazing **Flow condition:** Moderate	**Water width (m):** 0.5 **Water depth (m):** 0.25 **Bankfull width (m):** 0.65 **Bankfull height (m):** 1.4 **Banktop height (m):** 1.5 **Flooded Bankfull width (m):** 1.0 **Flooded Bankfull height:** 1.7 **Notes:** Some local bank collapse noted with consequential widening. Generally narrow. **CAR Auth Level:** GBR **Proposed Crossing Type:** Circular Culvert
Crossing Photographs		
Upstream	**Across**	**Downstream**
		

Table 8.1.29: WCX27

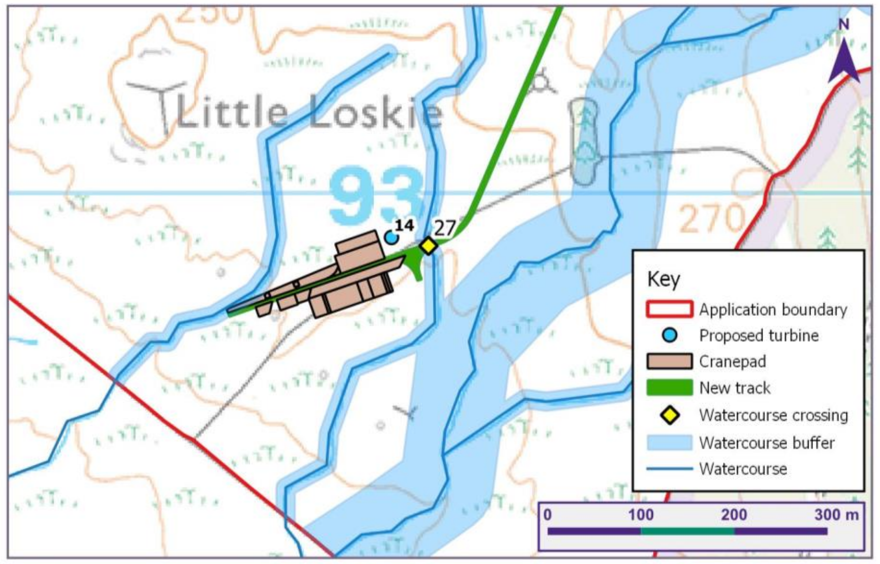
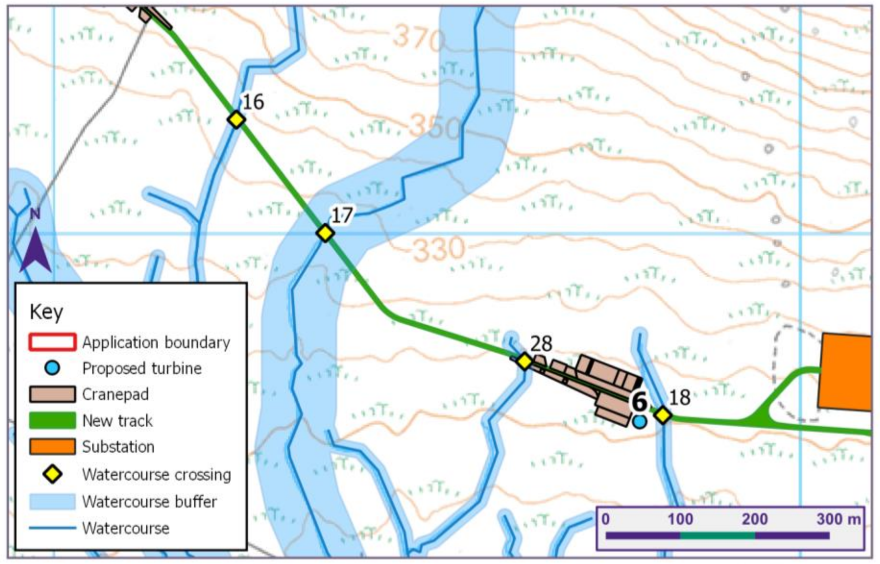
WCX27 (260466,592944)		
Crossing Location	**Crossing Description**	
 	**Existing Crossing:** No **Channel Type:** Surface run-off/wetlands only **Gradient:** Gentle **Valley form:** U-shape valley **Bank condition:** Stable **Bed material:** Vegetation, Soil, Peat **Riparian corridor:** Moorland, Agricultural Grazing **Flow condition:** Very slow	**Water width (m):** ~3m of boggy ground **Water depth (m):** n/a **Bankfull width (m):** n/a **Bankfull height (m):** n/a **Banktop height (m):** n\a **Flooded Bankfull width (m):**n/a **Flooded Bankfull height (m):** n/a **Notes:** Very poorly defined watercourse. Very slow flow. Difficult to define likely bankfull/flooded widths and heights, these numbers are an estimate and highly uncertain. The channel is boggy ground with only slight flow. **CAR Auth Level:** GBR **Proposed Crossing Type:** Circular Culvert
Crossing Photographs		
Upstream	**Across**	**Downstream**
		

Table 8.1.30: WCX28

WCX28 (259631,594829)

Crossing Location



Crossing Description

Existing Crossing: No
Channel Type: Incised
Gradient: Moderate
Valley form: Shallow vee
Bank condition: Stable
Bed material: Fine sand/silt, Rounded pebbles, Coarse gravel, Boulders
Riparian corridor: Moorland
Flow condition: Moderate

Water width (m): 0.25-0.85
Water depth (m): 0.18
Bankfull width (m): 0.85
Bankfull height (m): 0.6
Banktop height (m): n\a
Flooded Bankfull width (m): 2-3
Flooded Bankfull height (m): 1

Notes: Probable drainage ditch.

CAR Auth Level: GBR
Proposed Crossing Type: Circular Culvert

Crossing Photographs

Upstream

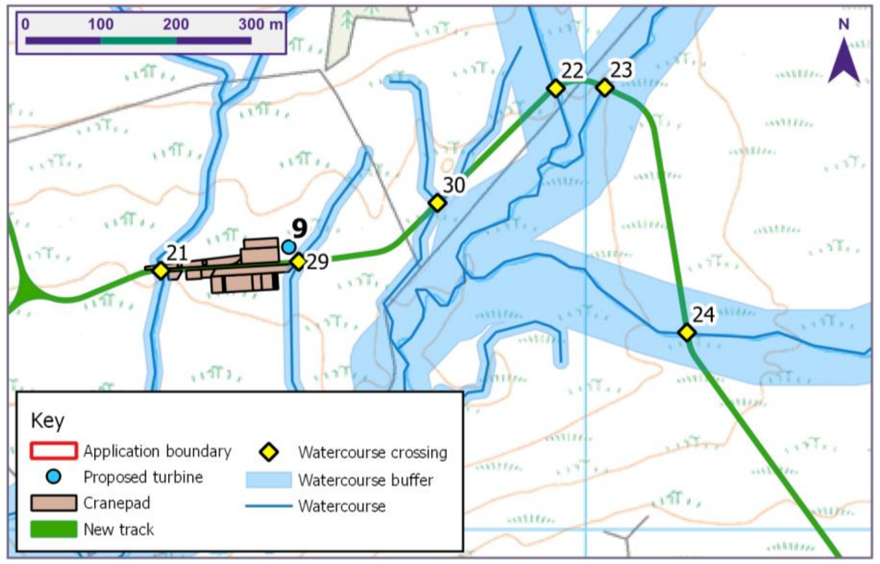
Across

Downstream

Table 8.1.31: WCX29

WCX29 (260620,594355)

Crossing Location



Crossing Description

Existing Crossing: No
Channel Type: Incised
Gradient: Moderate
Valley form: Concave/bowl
Bank condition: Stable
Bed material: Vegetation, Peat, Soil
Riparian corridor: Agricultural Grazing, Moorland
Flow condition: Very slow

Water width (m): 0.42
Water depth (m): 0.42
Bankfull width (m): 0.9
Bankfull height (m): 0.5
Banktop height (m): 0.7
Flooded Bankfull width (m): 1.16
Flooded Bankfull height (m): 0.6

Notes: Probable drainage ditch.

CAR Auth Level: GBR
Proposed Crossing Type: Circular Culvert

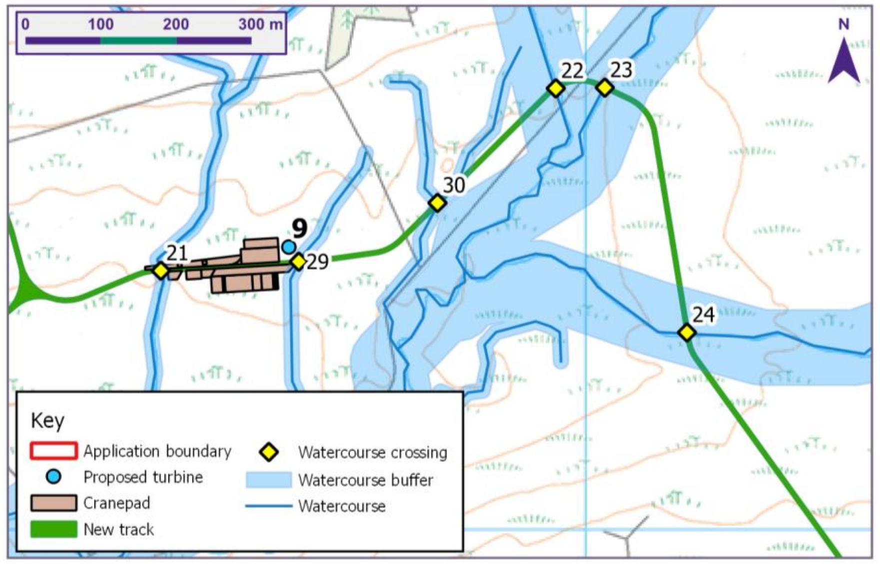
Crossing Photographs

Upstream	Across	Downstream
		

Table 8.1.32: WCX30

WCX30 (260804,594433)

Crossing Location



Crossing Description

Existing Crossing: No

Channel Type: Surface run-off/wetlands only

Gradient: Gentle

Valley form: Concave/bowl

Bank condition: Stable

Bed material: Vegetation, Soil, Peat

Riparian corridor: Agricultural Grazing, Moorland

Flow condition: Very slow

Water width (m): 0.5

Water depth (m): 0.1

Bankfull width (m): 2

Bankfull height (m): 0.2

Banktop height (m): n\a

Flooded Bankfull width (m): n/a

Flooded Bankfull height: n/a

Notes: Very poorly defined watercourse. boggy ground immediately east of crossing location. Probable drainage ditch.

CAR Auth Level: GBR

Proposed Crossing Type: Circular Culvert

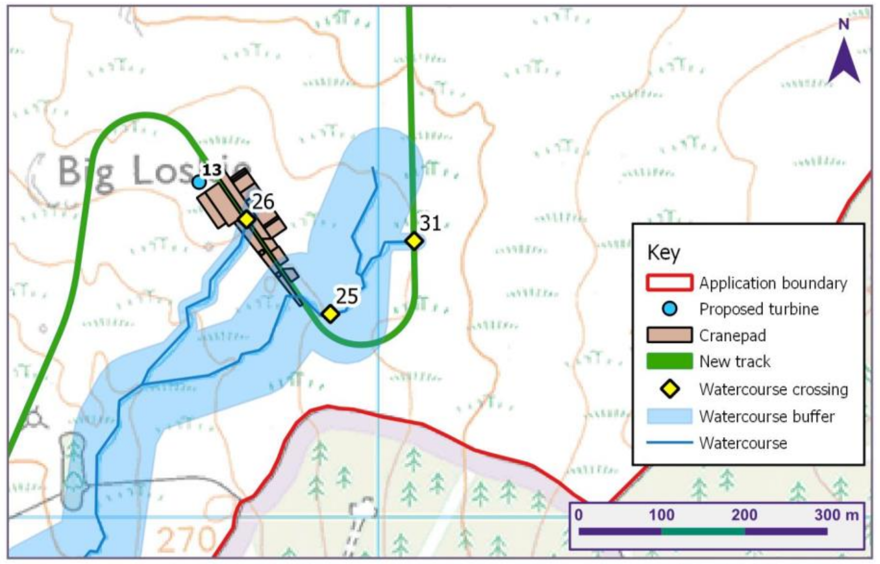
Crossing Photographs

Upstream	Across	Downstream
		

Table 8.1.33: WCX31

WCX31 (261044,593333)

Crossing Location



Crossing Description

Existing Crossing: No
Channel Type: Surface run-off/wetlands only, None evident
Gradient: Gentle
Valley form: Concave/bowl
Bank condition: Stable
Bed material: Vegetation, Soil, Peat
Riparian corridor: Moorland, Agricultural Grazing
Flow condition: Very slow

Water width (m): 0.25 to 0.45
Water depth (m): 0.12 to 0.19
Bankfull width (m): 0.62
Bankfull height (m): 0.3
Banktop height (m): n\a
Flooded Bankfull width (m): 2.0
Flooded Bankfull height (m): ~0.32

Notes: Measurements provided above relate to the first location where a flowing channel is encountered (at grid ref provided) downgradient from the original crossing location. no watercourse at original crossing location - only boggy ground with mosses.

CAR Auth Level: GBR
Proposed Crossing Type: Circular Culvert

Crossing Photographs

Upstream

Across

Downstream

Appendix 8.2

Peat Slide Risk Assessment

Quantans Hill Wind Farm

Peat Slide Risk Assessment

December 2021

1252721

Vattenfall Wind Power Ltd

Document history

Author	Chris McCulla, Geotechnical Engineer	10/05/2021
Checked	Mae Aldridge, Geosurvey Project Manager	11/05/2021
Approved	Gavin Germaine, Principal Geotechnical Engineer	16/09/2021

Client Details	
Contact	Matthew Bacon
Client Name	Vattenfall Wind Power Ltd
Address	St Andrews House, Haugh Ln, Hexham, NE46 3RB

Issue	Date	Revision Details
A	11/05/2021	First Issue - CM
B	16/09/2021	Second issue with additional probing data across new layout iteration. Change to WTG Numbering - CM
C	09/12/2021	Third Issue following client and legal review - GG
D	16/12/2021	Released
E	07/07/2022	Update to location of Substation, Compound & Borrow Pit

Local Office:

The Green House
Forrest Estate Dalry
Castle Douglas
DG7 3XS
SCOTLAND
UK
Tel: +44 (0) 1644 430 008

Reg No: SC177881

Registered Office:

The Natural Power Consultants Limited
The Green House
Forrest Estate, Dalry
Castle Douglas, Kirkcudbrightshire
DG7 3XS

VAT No: GB 243 6926 48

Contents

1. Introduction 1
2. Survey Methodology 7
3. Geology & Environment 8
4. Peat Slide Risk Assessment 12
5. Conclusions...50
6. Recommendations 51
7. References...54
8. Glossary...56

1. Introduction

1.1.1 **Report Author:** & lead surveyor on-site – Chris McCulla is a geotechnical engineer and geologist by training (BA Environmental Science & Geology) and Fellow of the Geological Society of London with over five years of relevant geotechnical experience. On behalf of Natural Power, Chris has been involved in field work and reporting of multiple peat slide risk assessments for renewable energy projects across the UK.

1.1.2 **Report Approver**: - Gavin Germaine is a principal geotechnical engineer at Natural Power and engineering geologist by training (MSc Engineering Geology) with greater than 12 years of relevant geotechnical experience. Gavin is a Chartered Geologist (CGeol) and a Fellow of the Geological Society of London. Over the last decade has completed multiple peat slide risk assessments for wind energy projects across the UK and Ireland. Gavin has further provided expert technical advice as part of public inquiry and joined international teams examining new geotechnical investigation techniques for in-situ testing and sampling of peat. Gavin attended initial site reconnaissance visits at the proposed development and has been involved in the projects' development history since 2013.

1.2.1 This Peat Slide Risk Assessment (PSRA) details for the Proposed Development is a semi-quantitative peat stability risk assessment. The primary objectives of this report are:

- Desk study pertinent to the subject of peat stability assessment at the Proposed Development;
- Report on walkover, survey and geomorphological mapping exercise to inform the assessment;
- Identify any areas of existing instability or which may pose a risk to the Proposed Development;
- Qualitative and quantitative peat slide risk assessment;
- Provide robust and targeted recommendations for any future construction process and mitigate any potential contributory factors to elevated risk of instability.

1.2.2 This report and survey work has been undertaken in general accordance with the Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Development, second edition, published by the Scottish Government in April 2017.

1.2.3 The following mapping has been produced in support of the Peat Slide Risk Assessment;

- Peat Depth Interpolation Map (Ref: 13736UKC_PSRA_001)
- Slope Angle Map (Ref: 13736UKC_PSRA_002)
- Peat Slide Risk Map (Ref: 13736UKC_PSRA_003)
- Factor of Safety against Peat Slide Map (Ref: 13736UKC_PSRA_004)
- Geomorphology Map (Ref: 13736UKC_PSRA_005)
- Aerial Photo Map (Ref: 13736UKC_PSRA_006)

1.2.4 The Peat Stability Risk Assessment utilises data and visual reconnaissance assessment collected during two main phases of site survey. This data and information are combined with desk study and review of all salient published materials. The following data sources have been integrated into this assessment: (Table 1.1)

Table 1.1: PSRA Data Sources

Data Source	Location	Date
British Geological Survey – Onshore Geological Map Data: (Linear Features, Mass movement deposits, Artificial ground, superficial deposits, bedrock geology, faulting,1:50,000 scale)	http://mapapps2.bgs.ac.uk/geoindex/home.html	2021

Data Source	Location	Date
British Geological Survey – Engineering Geology Viewer: 1:1M Superficial Engineering Geology; 1:1M Bedrock Engineering Geology	http://mapapps.bgs.ac.uk/engineeringgeology/home.html	2021
British Geological Survey – Hydrogeological Map of Scotland: 1:625,000 Scale	http://www.largeimages.bgs.ac.uk/iip/hydromaps.html?id=scotland.jp2	1988
National soil map of Scotland – main soil types originally mapped at 1:250,000 scale	http://soils.environment.gov.scot/maps/	1947-1981
National Library of Scotland, Historical mapping	https://maps.nls.uk/	Various
Historical Aerial Photograph Data ESRI Satellite World Imagery Google Earth Professional	https://server.arcgisonline.com/ArcGIS/rest/services/World_Imagery/MapServer/tile/{z}/{y}/{x}	2021
Online news archival search	Various web-based search engines	2021
Liaison with adjacent wind farm site operators (Windy Standard & Anecdotal evidence from current land users)	-	2021
SEPA rainfall data	www.sepa.org.uk/rainfall/	2021

1.2.5 The work programme:

- Stage 1: Review existing peat probe data set covering previous scheme design iteration dating back to 2013;
- Stage 2: (100m grid, development wide) infill peat probing survey to ascertain the depth and distribution of peat deposits (Q1 2021);
- Stage 3 detailed peat survey across infrastructure locations where peat is present determined from site reconnaissance findings and where soil probing depths of >0.5m was detected in Stage 1/2 (Q2 2021);
- In-situ strength testing, peat coring and sampling at targeted deeper peat locations (April 2021);
- Site walkover, reconnaissance survey: These surveys conducted by the reporting principal geotechnical engineer and geotechnical engineer, alongside a hydrologist covering all key aspects and locations across the Proposed Development (April 2021);
- Additional peat probing at T01 and T03 after design freeze iterations, and addition of refined borrow pit search areas.

1.3.1 The Proposed Development will consist of the erection, operation, and subsequent decommissioning of up to 14 wind turbines. The Proposed Development includes associated turbine foundations and transformers, hardstanding areas for erecting cranes at each turbine location, a series of on-site tracks connecting each turbine, underground cables linking the turbines to the grid connection, an on-site substation and battery energy storage facility, multiple construction compound, three borrow pit search areas, and a new access into the Site.

1.3.2 Please refer to Chapter 3 of the EIAR for the detailed project description.

1.3.3 Onsite borrow pits would be utilised for the supply of construction aggregate to the construction of access and hardstand areas. Detailed design and working methods for the rock extraction is beyond the scope of this assessment however each borrow pit search area has been subject to the peat slide risk assessment.

1.4.1 The proposed Quantans Hill Wind Farm is located within Dumfries and Galloway, approximately 2.8 km northeast of the village of Carsphairn and is 36 km north-west of Castle Douglas. The site is located in upland moorland mainly used for sheep farming with some isolated coniferous plantations.

1.4.2 The site entrance is 1 km east of the village of Carsphairn, located at NGR [257127E, 593136N]. The site is accessed via the A713 and minor road (B729).

1.5.1 The site is an upland site rising to significant elevation. A broad topographic high is reached in the central zone of 336m AOD although the majority of the central zone of the development remains at approximately 330m AOD. The access track rises from 180m AOD at the B729 to 350m AOD at T03. (Figure 1.1).

1.5.2 **Eastern Zone:** contours around the slopes of Furmiston Craig descending to a lower lying area to the Northeast of the development. Within the eastern zone the upper reaches of Furmiston Craig are steeper with exposed rock outcrops. This is used primarily for grazing land for cattle and sheep. To the northeast there is an area of significant blanket bog. Gradients are low across this area allowing saturated conditions to prevail. Vegetation cover is interspersed with scrub grasses and reeds in wetter areas. This is again used for livestock grazing but is subject to a consented planning application for commercial forestry expected to be planted in 2022. The basin drains via one main channel into the Marbrack Burn which provides the main relief of the site.

1.5.3 **Central Zone:** exhibits higher relief being drained by a number of incised natural watercourses. The vegetation is typical of an upland landscape with sparse scrub grasses and some areas of improved grassland. The areas surrounding water courses generally are more saturated but provide efficient drainage to the area. The elevation range is from 250m-350m AOD. Gradients are generally higher in the north of the zone on the lower reaches of Knockwhirn. The zone is well drained with generally dryer ground conditions encountered. A c.60Ha area in the centre of the Central Zone has recently been planted with commercial forestry.

1.5.4 **Western Zone:** The western zone rises from an elevation of 180m AOD at the site entrance to 350m AOD. The track contours the lower slopes of Craig of Knockgray before climbing the south-western slope of Quantans Hill. The track splits contouring to both the south and north of the summit. Again, the steeper slopes are well drained with areas of lower relief generally being more saturated resulting in the formation of isolated peat basins.

1.5.5 **Surrounding Area:** The wider area surrounding the development varies. To the North the land rises towards the summit of Cairnsmore of Carsphairn. To the south lies the river valley of the Water of Deugh. Gradients shallow to the south and as the detailed network of drainage channels merge to form the Marbrack burn a main tributary of the Water of Deugh. A large commercial coniferous plantation lies to the east of the development site. To the west the area comprises similar upland moorland as is seen on the development site.

Source: Ordnance Survey Crown Copyright © 2022

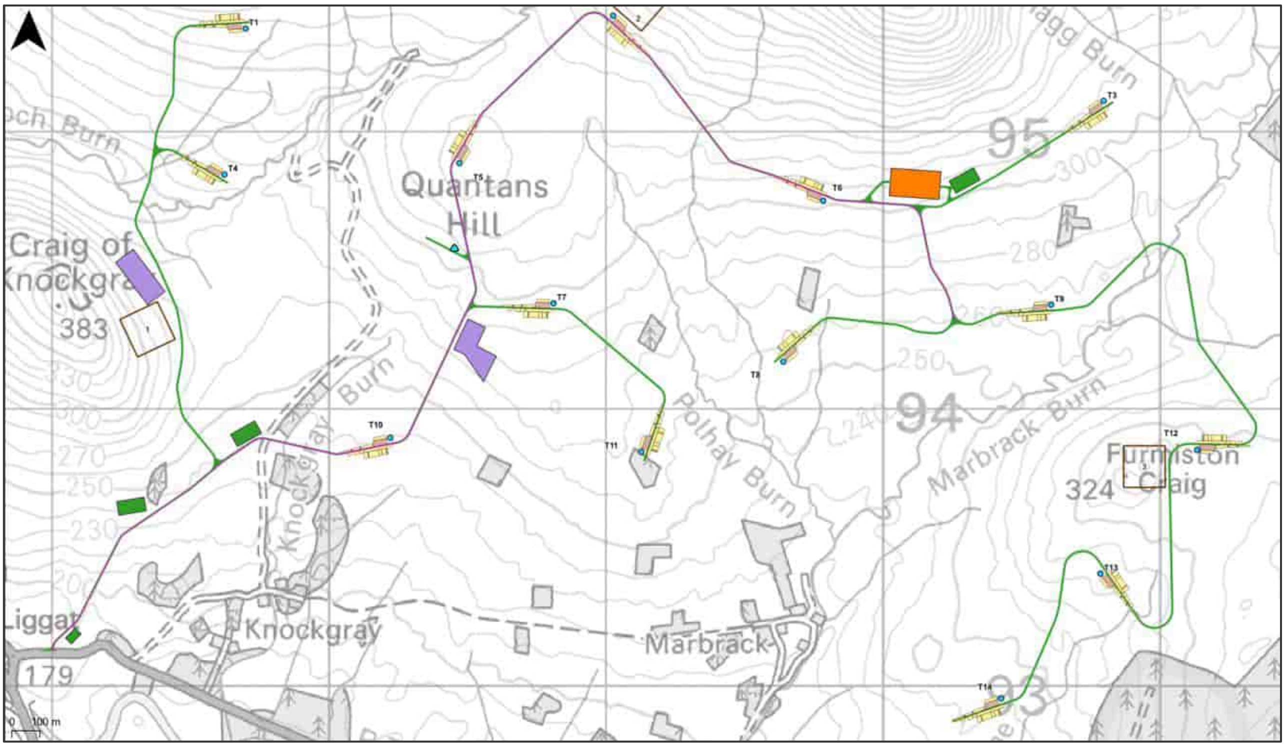


Figure 1.1: Site Area & Topography

1.6.1 The following photographs provide context for the terrain and environmental setting of the Proposed Development.

Source: Natural Power

Figure 1.2: View north towards the Knockwhirn and the elevated terrain beyond the development

Source: Natural Power

Figure 1.3: View East towards development boundary with commercial forestry plantations

Source: Natural Power

Figure 1.4: Typical example of incised watercourse showing limited peat and underlying glacial sub-soils

Source: Natural Power

Figure 1.5: View southeast onto lower elevations of development.

2. Survey Methodology

2.1.1 In preparation of this report, an initial desk-based assessment has been undertaken to allow subsequent surveys to be targeted. Table 1.1 highlights the key sources of information for this report. Online searches for local peat or major landslides returned several instances within the region. None however had similar ground conditions or were in close proximity to the site. Readily accessible aerial imagery records dating to 2004 do not show any major changes occurring through to the present day. Natural Power's project directory and online sources were searched for reports of peat slide incidents on adjacent wind farm developments. These searches did not provide any pertinent information.

2.2.1 Reconnaissance and geomorphological mapping were carried out during March 2021. This exercise provided opportunity for geotechnical engineers to visualise the terrain, access geological and soil exposures, examine slope systems, vegetation cover and record any hydrological features impacting peat stability.

2.2.2 The culmination of this survey and desk-based review of aerial photographs was the production of a geomorphology map, 13736UKC_PSRA_005, Appendix A. This map was used in the qualitative stability risk assessment and maps the major features across the development pertinent to the risk model.

2.3.1 The probing coverage has allowed for:

- Stage 1 probe survey implementing a 100 m grid of probes across the Proposed Development infrastructure areas.
- Stage 2 prove survey with detailed coverage of proposed wind farm infrastructure locations.
  - 50m intervals along tracks with probing at 10-20m offset to capture data across the construction corridor;
  - 10m grid spaced probes across turbine centres extending 100m in each cardinal direction;
  - 10-20m grid spacing across temporary infrastructure locations.

2.3.2 Peat probing data was available to Natural Power through previous engagement with the development. Thus probe data dating back to 2013 has been reviewed and incorporated into the dataset where relevant.

2.3.3 Peat depths were recorded using probes inserted into the peat and measuring the depth to refusal. This provides a wide-ranging dataset, but the data carries the following limitations:

- Peat probes may record depth to obstructions (e.g., tree roots, rock clasts) and not the true depth of the peat;
- Peat probes may over-estimate peat depth where the underlying soil strata is very soft;
- Peat probes can underestimate peat depth in very dry peat deposits due to early refusal of the probe;
- Peat probes do not differentiate between peat and mineral sub-soils.

2.3.4 Detailed peat probing survey was focussed at locations of peat (where visual evidence and probes record depths of >0.5 m). In-situ hand shear vane tests were conducted to provide an estimate of undrained shear strength within the peat at relevant turbine locations. Supplementary to this, peat cores have been taken at select locations to provide confirmation of probe depth correlation, material classification and morphology.

2.3.5 Peat depth mapping is shown on drawing: 13736UKC_PSRA_001, Appendix A. To prepare the interpolated peat depth mapping; a spatial interpolation method termed 'Ordinary Kriging' was applied.

2.3.6 This is a statistical interpolation function examines point data (and weights the surrounding measured values) to derive a prediction for unmeasured locations. Ordinary Kriging is considered generally acceptable for geological / soil science applications. Limitations of the Kriging method are widely accepted to be:

- Confidence in the output related to number and density of points within the input dataset.
- Search window needs to be set to limit influence of distant data points.

2.3.7 The interpolation parameters and peat depth data set are deemed suitable for informing the peat slide risk assessment.

2.4.1 Terrain Slope Angle Map (13736UKC_PSRA_002) is comprised from digital elevation model data, carrying a grid resolution of 5m. The risk assessment considers slope angle in two aspects. Firstly, the slope angle is used to screen the site for instability within the slope analysis numerical calculation. This is adjoined to qualitative assessment of the slope angle category in terms of a contributory factor to failure. This combined approach ensures a robust assessment of the risk and increases the sensitivity of the assessment to characterise risk more accurately across the expansive area.

3. Geology & Environment

3.1.1 **Peat:** Forms isolated accumulations in discrete areas of the development. Across the majority of the development peat is absent or represented by thin peaty soils. Soil conditions have been heavily modified by artificial drainage and overgrazing. Areas of peat accumulation are thus now only focussed within topographic depressions and occasionally in close proximity to water courses. The peat encountered across the development is typically dark brown, plastic, pseudo-fibrous with limited amorphous material due to the low depths encountered. Von Post classes are H2 – H7.

3.1.2 **Glacial Till:** Beneath the peat and spatially variable in extent, a variety of glacial deposits are understood to be present. These materials are remnants from the last glacial retreat. All are erosional, transported sediments of glacial diamicton; sands, gravels and fine soil mixtures. The lithics within these deposits are understood to be sourced from the surrounding country bedrock formations. Glacial deposits can be deposited under a wide variety of conditions including lodgement (ice contact), glacio-fluvial (sub / en – glacial), ablation (melt-out) and in-situ weathering processes.

Source: British Geological Survey, NERC © 2022

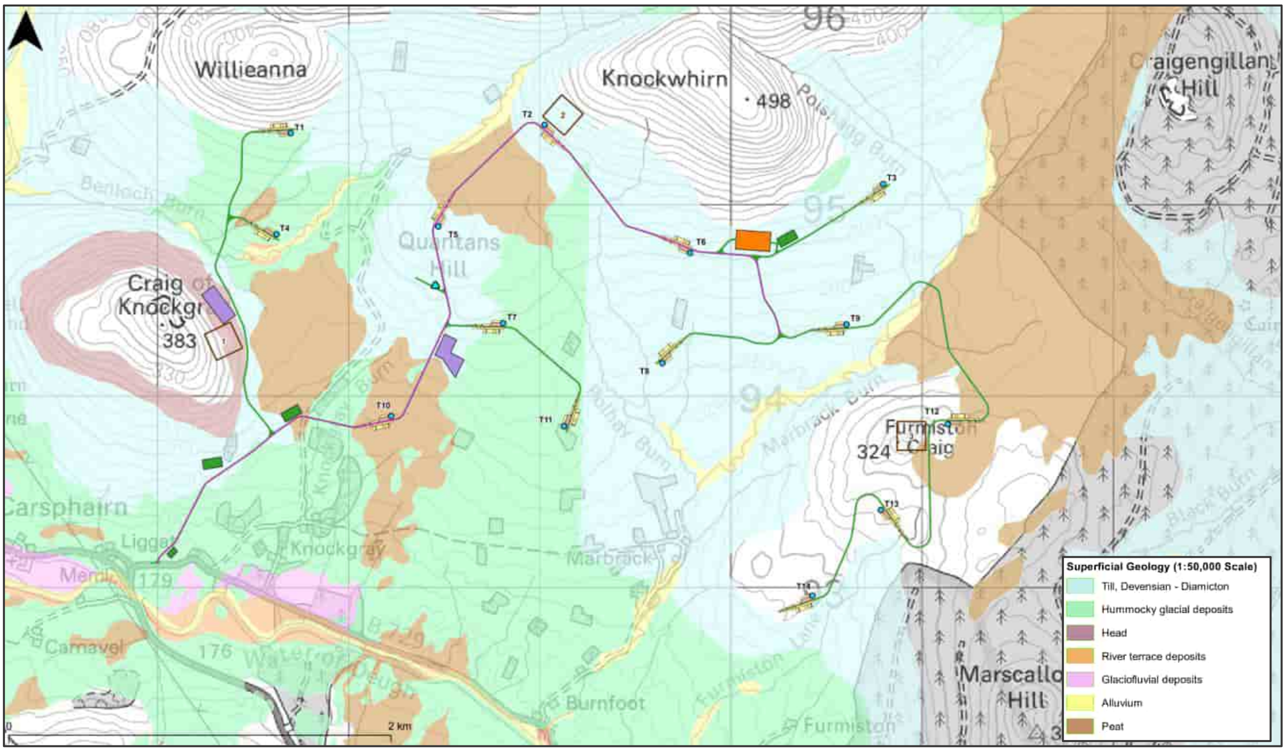


Figure 3.1: 1:50,000 Superficial Geological Map

3.1.3 **Peri-glacial:** head deposits may also be obscured by the blanket peat. These polymict deposits comprise clay, sand and gravel in proportions which depend on the upslope provenance of material. These deposits are poorly sorted and poorly stratified and formed during the post glacial period predominantly by solifluction (down slope freeze / thaw transport and deposition) and / or hill wash and soil creep. Sand and gravel may exist locally with lenses of silt, clay or peat and organic material. Some of these processes were possibly visible north of the development and off site on higher elevations.

3.1.4 **Alluvium:** may be present across parts of the site in proximity and restricted to watercourses. These deposits generally comprise differing proportions of clay, silt, sand and gravel, all transported and deposited under relatively recent fluvial environmental conditions.

3.2.1 The 1:50,000 scale British Geological Survey map data indicates the development to be underlain by the bedrock from the Ashgill and Caradoc Formations of the lower Ordovician (449-458MA). The sedimentary bedrock is part of the Portpatrick formation with some outcrops of the Kirkholm and Glenwhargen formation. Minor igneous intrusions are present comprising granite and microdiorite although these lithologies are not thought to be coincident with proposed infrastructure. Regional and contact metamorphism of the sedimentary lithologies can be expected across the northwester zone of the site which may have imparted schistosity, mineralisation and induration.

Source: British Geological Survey, NERC © 2021

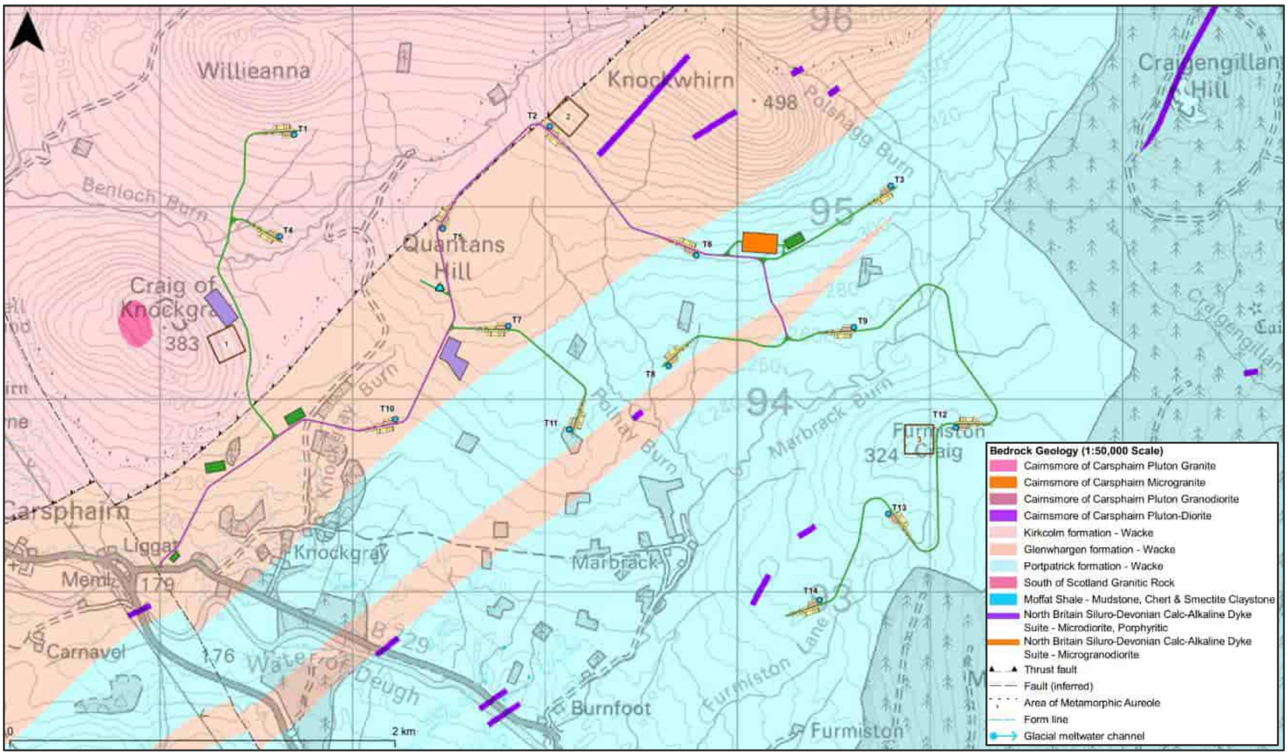


Figure 3.2: 1:50,000 Solid Geological Map

3.3.1 Groundwater information has been recorded using a number of the published data sources and from observations made during the field surveys. The groundwater vulnerability map of Scotland indicates the site is underlain by weakly permeable strata of low primary permeability. These do not widely contain ground water in exploitable quantities.

3.3.2 The site is only partially covered by peat or peat soils, which also forms an aquifer. Groundwater within such peat aquifers is generally perched on the less permeable basement they overlie. The peat aquifers, together with the weathered bedrock zone, provide base flow to the local surrounding watercourses.

3.3.3 In lower lying areas of lesser relief, the water table generally occurs at or just below the surface. This is demonstrated by the presence of areas of saturated ground across the site.

3.3.4 The location of Ground Water Dependent Terrestrial Ecosystems was reviewed as part of the peat slide risk assessment. Layout iteration was undertaken in order to avoid any potential areas. Further information is provided within the Hydrology/Geology chapter of the Environmental Statement.

3.4.1 Hydrologically the Proposed Development lies within the catchment of the Water of Deugh. The Western area of the development drains into Benloch Burn a tributary of the Water of Deugh discharging at NGR NX 56177 95114. Additional drainage is provided by the many tributaries of Knockgray Burn which also discharges into the Water of Deugh at NGR NX 57651 92786 The watercourses draining the central part of the site are headwater and tributary channels discharging directly into the Marbrack Burn. The Marbrack Burn is a large channel meandering through the Eastern zone and much of the central zone before discharging into the Water of Deugh at NGR NX 59016 92187.

3.4.2 The position of the main tributary watercourses are therefore key targets for receptor and pathway risk assessment during this peat slide risk assessment.

3.4.3 The watercourses on site are typical upland watercourses, situated in areas of saturated ground with vegetated riparian zones. The channels are deeply incised and generally choked with vegetation providing relief across the upper reaches of the site. These channels become more open and exhibit beds of sand and gravel as they discharge into the larger watercourses such as Marbrack, Knockgray and Benloch Burn.

3.4.4 Flood information provided by SEPA indicates the Marbrack Burn watercourse within the main areas of proposed infrastructure is at risk from flooding (less than 0.5% (1 in 200) chance of flooding each year). Additionally, the Benloch Burn is also at risk from flooding (less than 0.5% (1 in 200) chance of flooding each year) however, this is out with the site infrastructure. There is the potential for overland flow to occur due to the dominance of slowly permeable peat and/or peaty soils underlying the site.

3.4.5 A detailed flood risk assessment is out-with the scope of this report.

3.5.1 Historical mapping for the Site has been reviewed from the National Library of Scotland archive. Indications are that the Site area has largely been unchanged and dedicated to upland farming and estate agricultural practices since the mid 1800s.

3.5.2 There has been limited development of commercial forestry from the 1970's onwards, although none is majorly coincident with the proposed wind farm infrastructure. Very recent commercial plantation in Marbrack has taken place with more expected in Furmiston in 2022.

3.5.3 The site walkover has identified an extensive network of artificial cut drainage ditches which are not evident on the historical mapping and thought to be contemporaneous with upland drainage practices of the early 20th Century. No evidence of instability is recorded on the historical mapping. Artificial drainage areas are represented on the geomorphological map (13736UKC_PSRA_005, Appendix A).

3.5.4 Limited historical aerial imagery records were available for the site area; however, available records typically corroborate with the findings of the historical mapping review.

3.6.1 A variety of environmental and cultural assets have been identified as part of the scheme design process and incorporated into the peat slide risk assessment considerations. This has included the following assets:

- Hydrology watercourses
- Private water supplies
- Groundwater Dependent Terrestrial Ecosystems
- Cultural Heritage sites including archaeological features, burial grounds, WW2 aircraft crash site and monuments.

4. Peat Slide Risk Assessment

4.1.1 The peat probe dataset comprises 6,202 individual data points which have been compiled over several years of survey and wind farm design iterations. The peat depth interpolation map is provided at 13736UKC_PSRA_001, Appendix A. Table 4.1 below provides a summary of the depth ranges recorded.

Table 4.1: Peat Depth Range Summary

Peat Depth Range	No. of Results	%
= 0.0m	839	14
>0.0 ≤ 0.5 m	3352	54
>0.5 ≤ 1.0 m	1039	16
>1.0 ≤ 2.0 m	664	11
>2.0 ≤ 3.0 m	211	3
>3.0 m	97	2
Total	**6,202**	**100%**

Source: Natural Power

4.1.2 The highest proportion (54%) of recorded peat depths were shallow (≤0.5 m) indicating that peat slide risk will if present be isolated to discrete regions of deeper peat. 14% was recorded as 0.0m, but it should be noted depths between 0.0 and 0.5, are generally not considered as peat deposits of the type which may give rise to peat slide condition.

4.2.1 A 25mm hand shear vane was used to record the undrained shear strength of the in-situ peat deposits. Vane testing was undertaken in isolated areas where peat conditions were of sufficient depth.

4.2.2 The method of determining un-drained shear strength was carried out by inserting a steel vane vertically into the peat deposit. At increasing depth increments within the peat, a torque head is turned at the surface which rotates the shear vane within the peat deposit. The maximum shearing resistance is recorded on the torque head which is calibrated to the peak un-drained shear strength of the peat. Once the peak un-drained shear strength was determined the shearing resistance of the free turning shear vane was recorded and is representative of the re-moulded un-drained shear strength.

4.2.3 It is highlighted that the shear vane has a small surface area compared to the scale of the soil structure within the peat. This scale factor is highlighted as the main limitation of this in-situ test method. The scale effect can lead to an underestimation of peat strength. The hand shear vane therefore only provides a preliminary and conservative estimate of peak and re-moulded un-drained shear strength.

4.2.4 Where a significant increase in the un-drained shear strength was recorded at the basal contact of the peat, it is inferred from peat cores derived from the same location that the highest un-drained shear strength values represent the sub-soil interface. This material typically comprises sandy, gravelly clay soil.

4.2.5 The un-drained shear strength (Cu) ranges from 14kPa to 52kPa with a mean value of **30kPa**. The mean re-moulded shear strength is recorded at 20kPa. Lowest shear strengths were recorded immediately to the east of turbine T11.

4.2.6 A soil description including degree of humification has been recorded at locations where deep peat was core sampled. (T09, T02, Access to T4, Access to T12, T11, T13, T14 & T10. The peat has been characterised according to the Von Post Classification (Von Post & Granland, 1926). Table 4.2 below presents the classifications.

Table 4.2: Peat Core Sampling

Core ID	Peat Depth	Von Post Class	Description
(1)Deep peat east of T09	0.00-0.20	H6/B2	Soft, black, amorphous, plastic PEAT
	0.20-1.00	H5/B4	Very soft, black, pseudofibrous, plastic PEAT
	1.00-1.90	H6/B3	Very soft, dark brown, pseudofibrous, plastic PEAT
(2)Deep peat east of T02	0.00 – 1.60	H5/B2	Soft, dark brown pseudofibrous to plastic PEAT
	1.60-1.70	-	Sandy CLAY
(3)Access to T04	0.00-0.40	H4/B3	Firm, dark brown, fibrous, plastic PEAT
	0.40-2.00	H6/B2	Soft, dark brown, pseudofibrous, plastic PEAT (1.00-2.00 wood fragments, refused, no subsoil retrieved)
(4)Access to T12	0.00-0.20	H6/B3	Soft, dark brown, pseudofibrous, plastic PEAT
	0.20-0.50	H7/B4	Very soft, dark brown, amorphous, plastic PEAT
	0.50-0.60	-	Clayey, SAND
(5)Deep peat south of T11	0.00-1.00	H6/B2	Soft, dark brown, pseudofibrous, plastic PEAT
	1.00-1.40	H7/B3	Very soft, dark brown, pseudofibrous, plastic PEAT
	1.40-2.00	H7/B4	Very soft, dark brown, amorphous, plastic PEAT
	2.00-2.90	H7/B3	Very soft, black, amorphous plastic PEAT with 10% wood fragments
(6)Deep peat east of T13	0.00-1.40	H7/B2	Soft, dark brown, pseudofibrous/amorphous, plastic PEAT (refusal on cobbles)
(7)Deep peat east of T14	0.00-1.00	H4/B3	Soft, dark brown, pseudofibrous, plastic PEAT
	1.00-1.70	H5/B3	Very soft, dark brown, pseudofibrous, plastic PEAT
(8)T10	0.00-0.10	H2/B2	Soft, brown, fibrous, spongy PEAT
	0.10-0.20	H4/B3	Soft, dark brown, pseudofibrous, plastic PEAT
	0.20-0.30	-	Firm, dark grey, peaty CLAY

Source: Natural Power

4.2.7 Core sample locations are depicted on map 13736UKC_PSRA_001, Appendix A. The peat encountered across the Site is typically very soft to soft pseudofibrous. In the deeper deposits, characteristically humification increases with depth at the catotelmic layer. Photographs below (Fig 4.1-4.15) provide a visual record of the peat core samples.

Figure 4.1: Peat Core (1) 1of2

Figure 4.2: Peat Core (1) 2of2

Figure 4.3: Peat Core (2) 1of2

Figure 4.4: Peat Core (2) (2of2)

Figure 4.5: Peat Core (3) (1of2)

Figure 4.6: Peat Core (3) (2of2)

Figure 4.7: Peat Core (4) (1of1)

Figure 4.8: Peat Core (5) (1of3)

Figure 4.9: Peat Core (5) (2of3)

Figure 4.10: Peat Core (5) (3of3)

Figure 4.11: Peat Core (6) (1of2)

Figure 4.12: Peat Core (6) (2of2)

Figure 4.13: Peat Core (7) (1of2)

Figure 4.14: Peat Core (7) (2of2)

Figure 4.15: Peat Core (8) (1of1)

4.3.1 The key principals of the peat slide risk assessment are presented below. Discussions of the factors which contribute to peat failure have been presented in Table 4.3.

Table 4.3: Contributory Factors to Peat Instability

Factor	Discussion
Groundwater Infiltration	There are two processes which may facilitate groundwater infiltration: • Periods of drying, resulting in cracking of the peat surface; and • Slope creep resulting in additional tension cracks. Drying out of the upper peat, particularly in areas of thinner peat, is likely to result in the development of near-surface cracks which could facilitate ingress of water into the peat.
Surface Loading	Any mechanisms which increase the surface load on a peat deposit can increase the likelihood of failure. This can include surface water ponding and surcharge loading, for example; construction works, stockpiling and forestry operations.
Vegetation Loss	Loss of vegetation can have a negative impact, making the peat susceptible to weathering, increasing rates of infiltration and a loss of strength.
Soil Weathering/Erosion	Weathering can weaken in-situ peat materials and destabilise a slope system. This may be in the form of weathering of peat or underlying mineral soils which could reduce shear strength at the peat/ mineral soil interface. Vertical cracking and slope creep may slowly break down peat structure over long periods of time. This can develop into peat 'hagging', which is a strong indication that natural weathering processes are ongoing. Peat hags expose the peat to increased weathering rates and may provide preferential surface water flow pathways. There was no marked peat hagging across the Site.
Precipitation	The likely failure mechanism following a period of heavy rainfall is linked to the infiltration of surface water. There is a resulting build-up of pore water pressures within the soils and therefore reduced effective shear strength. This may be focussed within the peat deposit or at the interface between the peat and underlying mineral soil. Secondary effects may include swelling of the peat deposit and increased loading due to surface water ponding. Snow and subsequent melt can have a similar effect.
Slope Morphology	There are three main effects arising from slope morphology: Firstly, the concentration of tensile stress at the apex of a convex slope predisposes the slope for failure initiation at that point. In a convex slope the material lower down supports the material above which is held in compression. A concave slope has the opposite characteristics as material at the base maintains the apex in tension. Secondly, at the point of maximum slope convexity, because of favourable down-slope drainage conditions, a body of relatively well-drained and relatively strong peat material develops. This body of peat acts as a barrier providing containment for growth of peat upslope. This relatively well drained body of peat can subsequently fail due to a build-up of lateral pressure on the upslope face. In this scenario the slope is not supported from below so eventually the lateral pressures exceed the forces resisting sliding. The apex or point of

Factor	Discussion
	convexity is also a likely initiation point for slope failure due to the slope tension being concentrated at this point. Thirdly a failure mechanism, analogous to a piping failure underneath a dam, is postulated where springs are present in locations immediately down-slope of the relatively well drained peat body. Under these circumstances high pore pressure gradients within the peat can lead to hydraulic failure and undermining of the relatively well drained peat body resulting in a breach and loss of lateral support to peat upslope. Evolving slope morphology can be significant; for example, in the case of slope undercutting by water erosion. Any mechanism by which mass is removed from a slope toe or deposited on a slope crest will contribute to instability.
Peat Depth & Slope Angle	Peat slides correspond in appearance and mechanism to translational landslides and tend to occur in shallow peat (up to 2.0m) on slopes between (5° – 15°). A great majority of recorded peat landslides in Scotland, England & Wales are of the peat slide type. MacCulloch, (2005) highlights that a slope angle of 20° appears to be the limiting gradient for the formation of deep peat. Therefore, the risk assessment has assigned slope angles >20° to be an unlikely contributory factor to failure. Slope angle indicators and corresponding probability factors have been similarly adapted from MacCulloch, (2005). Boylan et al, (2008) indicates that most peat failures occur on slope angles between 4° and 8°. It is postulated that this may correspond to the slope angles that allow a significant amount of peat to develop that over time becomes potentially unstable. Thus, for this assessment <3degrees has been assigned a low risk.
Hydrology	Natural watercourses and artificial drainage measures have often been identified as a contributory factor of peat failure. Preferential drainage paths may allow the migration of water to a failure plane therefore triggering failure when groundwater pressures become elevated. Within a peat mass, sub surface peat pipes can enable flow into a failure plane and facilitate internal erosion of slopes. It is also noted that in some instances, agricultural works can lead to the disturbance of existing drainage networks and cause failures. Forestry preparations and harvesting may also impact upon surface hydrology is implemented poorly. Multiple drainage ditch networks are present across the Site as a result of historical and ongoing upland agricultural drainage practices.
Existing / Relict Failures	The presence of relict failures and any indication of previous instability are often important, indicating that site conditions exist that are conducive to peat failure. Relict peat slides may be dormant over long periods and be re-activated by any number of the contributory factors discussed in this table.
Anthropogenic Effects	Human impact on peat environments can include a range of affects associated with wind farm construction. Activities such as drainage, access tracks across peat, peat cutting, and slope loading are all examples. Rapid ground acceleration is one such example where shear stress may be increased by trafficking or mechanical vibrations.

Source: Natural Power

4.4.1 Peat failure in this assessment refers to the mass movement of a body of peat that would have a significant adverse impact on the surrounding environment or infrastructure. This definition excludes localised movement of peat, for example movement that may occur below an access track, creep movement or erosion events and failures in underlying mineral soils.

4.4.2 The potential for peat failure across the development is examined with respect to the activities envisaged during construction and operation of the wind farm. There are several classification systems for the mass movement of peat that were drawn together by PLHRAG, (2017).

4.4.3 Hutchinson (1988) defines the two dominant failure mechanisms, namely peat flows and peat slides.

- Peat Flows & Bog Bursts: are debris flows involving large quantities of water and peat debris. These flow down slope using pre-existing channels and are usually associated with raised bog conditions.
- Peat Slides: comprise intact masses of peat moving bodily down slope over comparatively short distances. A slide which intersects an existing surface water channel may evolve into a debris flow and therefore travel further down-slope. Slides are historically more common within blanket bog settings.

4.4.4 Due to the discrete areas of peat recorded across the development widespread instability comprising peat flows and bog bursts are considered unlikely at this stage. Smaller scale peat slides and debris flows are therefore the focus of the study and characterised by the definition above.

4.5.1 The main geotechnical parameters that influence peat stability are:

- Shear strength of peat;
- Peat depth;
- Pore water pressure (PWP);
- Loading conditions.

4.5.2 The stability of any slope is defined by the relationship between resisting and destabilising forces. In the case of a simplified infinite slope model with a translational failure mode, sliding is resisted by the shear strength of the basal failure plane and the element of self-weight acting normal to the failure plane. The stability assessments within this report considers an undrained 'total stress' scenario when the internal angle of friction (φ') = zero.

4.5.3 An undrained peat deposit may be destabilised by; mass acting down the slope, angle of the basal failure plane and any additional loading events. The ratio between these forces is the Factor of Safety (FoS). When the FoS is equal to unity (1) the slope is in a state of 'limiting equilibrium' and is sensitive to small changes in the contributory factors leading to peat failure.

4.5.4 The infinite slope model as defined in Skempton et al. (1957) has been adapted to determine the FoS of a peat slope. A modified approach has been used; assuming a minimum FoS (Typically 1.3 after, BS6031: 2009).

4.5.5 The infinite slope analysis is based on a translational slide. This analysis adopts total stress (undrained) conditions in the peat. This state applies to short-term conditions that occur during construction and for a time following construction until construction induced pore water pressures (PWP) dissipate. (PWP requires time to dissipate as the hydraulic conductivity can be low in peat deposits). The following assumptions were used in the analysis of peat deposits across the Site:

- The groundwater is resting at ground level;
- Minimum acceptable factor of safety required is 1.3;
- Failure plane assumed at the basal contact of the peat layer;
- Slope angle on base of sliding assumed to be parallel to ground surface and that the depth of the failure plane is small with respect to the length of the slope;
- Thus, the slope is considered as being of infinite length with any end effect ignored;

- The peat is homogeneous.

4.5.6 The analysis method for a planar translational peat slide along an infinite slope was for calculated using the following equation in total stress terms highlighted by MacCulloch, (2005) and originally reported by Barnes, (2000):

$$F = Cu / (\gamma * z * \sin\beta * \cos\beta)$$

Where:

- F = Factor of Safety (FoS)
- Cu = Undrained shear strength of the peat (kPa)
- γ = Bulk unit weight of saturated peat (kN/m^3)
- z = Peat depth in the direction of normal stress
- β = Slope angle to the horizontal and hence assumed angle of sliding plane (degrees)

4.5.7 Undrained shear strength values (Cu) are used throughout this assessment. Effective strength values are not applicable for the case of rapid loading of the peat during short term construction phase of works hence the formula cited above, has been adopted. Drawing 13736UKC_PSRA_004, Appendix A maps out the calculated FoS for the Proposed Development when applying a conservative 14kPa as the undrained shear strength for peat soils. This mapping includes the predicted FoS where a 20 kPa surcharge is applied to the surface. The factor of safety map shows no part of the proposed development footprint to fall below a factor of safety of 1.4.

4.6.1 Natural Power has undertaken this assessment following the principles of the Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments (Scottish Executive 2017). Updated as a second edition in April 2017, this guide provides best practice methods which should be applied to identify, mitigate and manage peat slide hazard and associated risks in respect of consent application for electricity generation projects in the UK.

4.6.2 This guidance clearly acknowledges risk assessment as an iterative process and as such this assessment should be updated throughout the development and as more information becomes available particularly as pre-construction phases are reached.

4.6.3 A semi quantitative risk assessment has been used to determine the risk of peat failure. The methodology is defined in PLHRAG, (2017) and has been augmented with methods set out by Clayton (2001) & MacCulloch, (2005) Risk factors are summarised on Table 4.4.

4.6.4 The assessment uses the numerical stability analysis and presents results for factor of safety (FoS) across the Proposed Development. The calculated FoS, is complimented with an assessment of the slope angle, peat depth and key geomorphological features. A peat slide risk map has been produced using GIS computation of these factors. (13736UKC_PSRA_003, Appendix A). The risk map is used screening wide areas of the study area, additional engineering judgement has been applied according to discrete conditions within Table 4.7/8 of this report.

Table 4.4: Risk Factors

Contributory Factor	Comment	Criteria	Probability	Scale
Peat Depth* (A)	Peat slides tend to occur in shallow peat (up to 2.0m) on the great majority of recorded peat landslides in Scotland, England & Wales are of the peat slide type.	0 – 0.5 m	Negligible	1
		>3.0 m	Unlikely	2
		0.5 – 1.0 m	Likely	3

Contributory Factor	Comment	Criteria	Probability	Scale
		2.0 – 3.0 m	Probable	4
		1.0 – 2.0 m	Almost certain	5
Slope Angle* (B)	It has been acknowledged that peat slide tends to occur in shallow peat (up to 2.0m) on slopes between 5o and 15o. Slopes above 20o tend to be devoid of peat or only host a thin veneer deposit.	0 – 3º	Negligible	1
		>20º	Unlikely	2
		4 – 9º	Likely	3
		16 – 20º	Probable	4
		10 – 15º	Almost certain	5
FoS* (C)	Values are from Infinite slope model using Cu characteristic value of 14kPa derived from hand shear vane in-situ testing. Slope angle and peat depth also input to this factor.	≥ 1.3	Negligible	1
		1.29-1.20	Unlikely	2
		1.10-1.19	Likely	3
		1.00-1.09	Probable	4
		<1.0	Almost certain	5
Cracking (D)	Visual assessment undertaken in the field during detailed probing survey and covers the same extents of this survey. Field workers examined for evidence of any major crack networks which may allow surface water to penetrate the peat mass. Reticulate cracking was not investigated as this normally requires intrusive ground investigation to remove the surface fibrous layer. This may be a more important consideration for forested areas or previously forested areas of a development site.	None	Negligible	1
		Few	Unlikely	2
		Frequent	Likely	3
		Many	Probable	4
		Continuous	Almost certain	5
Groundwater (E)	Challenging to evaluate without very detailed mapping and/or intrusive data. Look for entry / exit points. Evidence of surface hollows, collapse features at surface reflecting evidence of sub-surface peat pipe network, audible indicators including the sound of sub-surface running ground water surrounding proposed infrastructure locations	None	Negligible	1
		Few	Unlikely	2
		Frequent	Likely	3
		Many	Probable	4
		Continuous	Almost certain	5
Surface *Hydrology (F)	Ranging from wet flushes to running burns to hags. Must be evaluated in conjunction with the season and weather preceding the site visit. Artificial drains (grips) have also been identified across the Site. Their presence is generally linked to historical peat cutting sites which are factored into the risk assessment.	None	Negligible	1
		Few	Unlikely	2
		Frequent	Likely	3
		Many	Probable	4
		Continuous	Almost certain	5
Previous Instability (G)	Visual survey, scale and age are important as small to medium relict failures may be easy to detect but very large ones may require remote imaging. Recent failures should be obvious due to the scar left.	None	Negligible	1
		Few	Unlikely	2
		Frequent	Likely	3
		Many	Probable	4
		Continuous	Almost certain	5
Land Management (H)	Anthropogenic influences: forestry operations and removal of vegetation can be associated with de-stabilising peat deposits. This can occur as a result to surface disturbance and remoulding of peat through excavation, vehicle movements and loading. Changes in land use activities may also be associated with changes in drainage conditions. Criteria based on evidence of disturbance of peat deposit, i.e. broken surface, scarring or disrupted hydrology. A land management scale of '2-3' has been chosen where significant artificial drainage has potential to create increase peat slide susceptibility.	None	Negligible	1
		Few	Unlikely	2
		Frequent	Likely	3
		Many	Probable	4
		Continuous	Almost certain	5

Note: Denotes where risk factor applied to GIS model only*

4.6.5 Environmental Impact Zones based on proximity buffer zones applied to the main watercourses within the Proposed Development have bene identified. Watercourses are a primary sensitive receptor to a peat failure event. Table 4.5 denotes the potential impact scales to the environment. Location of existing or planned infrastructure downslope from Proposed Development is also assessed in Table 4.7/8 for each infrastructure element.

4.6.6 The distance to main watercourses has been used as the primary means of impact assessment within the risk assessment. Where watercourses are ephemeral/transient or minor artificial features they were not included as direct receptors. The impact distances are based on experience and guidance values provided within MacCulloch, F. (2006).

4.6.7 The approach advocated by MacCulloch is to divide the survey area into Environmental Impact Zones driven by site specific criteria and survey information. It is noted that defining a definitive distance for impact is extremely challenging due to the complex nature of terrain, peat depth, flow mechanics will all influence the flow path characteristics. At present there exists no defined method to accurately define the flow distances. Therefore Table 4.5 within report provides a framework estimate for the purposes of repeatable and representative semi quantitative risk mapping. Natural Power considers this approach alongside the multitude of site-specific factors which are considered during the risk assessment a valid approach for this development.

4.6.8 Distances to the main watercourses have been assessed within GIS and input to the risk mapping. The proximity classes are based on Table 4.5 within the report.

Table 4.5: Environmental Impact Zonation

Criteria	Potential Impact	Scale
Proposed access road/turbine within 50m of watercourse	High	4
Proposed access road/turbine within 50-100m of watercourse	Medium	3
Proposed access road/turbine within 100-150m of watercourse	Low	2
Proposed access road/turbine greater than 150m from watercourse	Negligible	1

Source: Natural Power

4.6.9 For each main infrastructure element, the Risk Ranking is assessed from the combined probability of occurrence for the main contributory factors which are greater than (1), multiplied by the highest impact scale. Table 4.6 identifies the risk ranking based on concepts of PLHRAG, (2017).

4.6.10 Access track sections have screened through the GIS based stability risk model and the elevated risk sections reviewed with further risk analysis and control measures. It is important to highlight that the full scope of the proposed infrastructure layout has been subject to field survey and review of stability risk factors.

Table 4.6: Risk Rankinng and Actions

Risk Ranking Score	Actions
17 - >25	**High**: Avoid project development at these locations.
11 - 16	**Medium**: 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.
5 - 10	**Low**: Project may proceed pending further investigation to refine risk assessment and mitigate hazard through relocation or re-design at these locations.
1 - 4	**Negligible**: Project should proceed with monitoring and mitigation of peat landslide hazards at these locations as appropriate.

Source: Natural Power

4.7.1 A preliminary numerical slope analysis has been undertaken. Numerical slope stability was assessed across the development location using slope angle measurements (DTM derived), peat depth, and the minimum undrained shear strength measured using an in-situ hand shear vane. In addition, a 20 kPa surcharge has been modelled thus the sensitivity of slopes to failure is assessed under construction conditions. GIS modelling was used to produce a factor of safety (FoS) map for the proposed development (13736UKC_PSRA_004, Appendix A).

4.7.2 The numerical stability analysis indicates no potential for translational peat slide at proposed turbine and infrastructure locations under current equilibrium and modelled surcharge loading conditions. The natural slope condition has been calculated to be stable and was observed to be so around the wind turbine locations during the field survey.

4.7.3 In the absence of more detailed sub-surface data, the surface slope angle has been used as a reference to the likely slope surface angle at the base of the peat in the analysis. Further advanced in-situ test methods should be considered as part of a detailed site investigation phase usually carried out post-consent. The potential of disturbing sensitive peat deposits during pre-construction survey access should also be considered during future phases of intrusive investigation work.

4.7.4 The FoS accounts for a 20 kPa surcharge representing scenarios at infrastructure such as temporary storage stockpiles. The Peat Management Plan (PMP) details mitigation measures for peat stockpiling. Slope stability assessments would be carried out during design phase for site tracks, hardstands and other relevant structures ensuring the proposed design results are safe, stable and environmentally compliant. It is Natural Power's view that, if during design phase structures are proposed (i.e. floating tracks), additional numerical stability assessment should be carried out by the appointed designer.

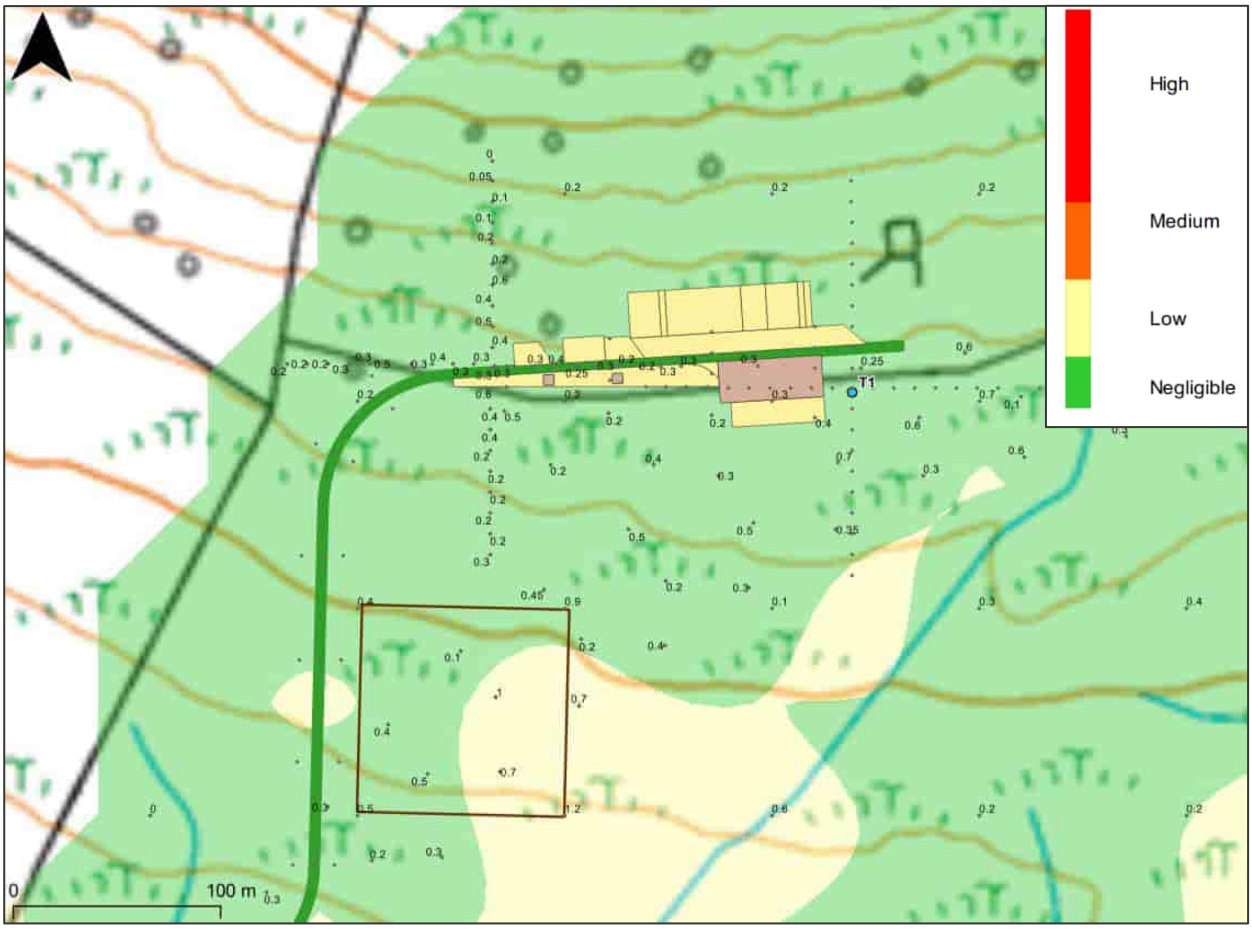
4.8.1 Risk rankings for the proposed turbine positions are presented in Table 4.7/8. Across each turbine the qualitative risk scoring has been provided along with key inset map information.

4.8.2 The peat slide risk map, 13736UKC_PSRA_003, Appendix A; provides a representation of the risk zonation across the Site and includes all infrastructure elements. The map is based on a Site wide GIS analysis and should not be viewed in isolation without the narrative of this report. The Risk Mapping does not show residual risk following implementation of control measures.

4.8.3 The indicative residual risk rating is provided assuming implementation of appropriate mitigation measures. Further detail of the risk assessment is highlighted within the preliminary geotechnical risk register presented in Table 4.14.

Table 4.7: Infrastructure Risk Assessment

Location ID	Infrastructure Asset Impact Scale	Environment Impact Scale	Contributory Factors (Probability)		Risk Ranking Residual Risk
T01	1	1	Peat Depth 0-0.5m	1	=5x1=5 **Low**
			Slope Angle **4-10º**	3	
			Factor of Safety (FoS)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	**Negligible**
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	

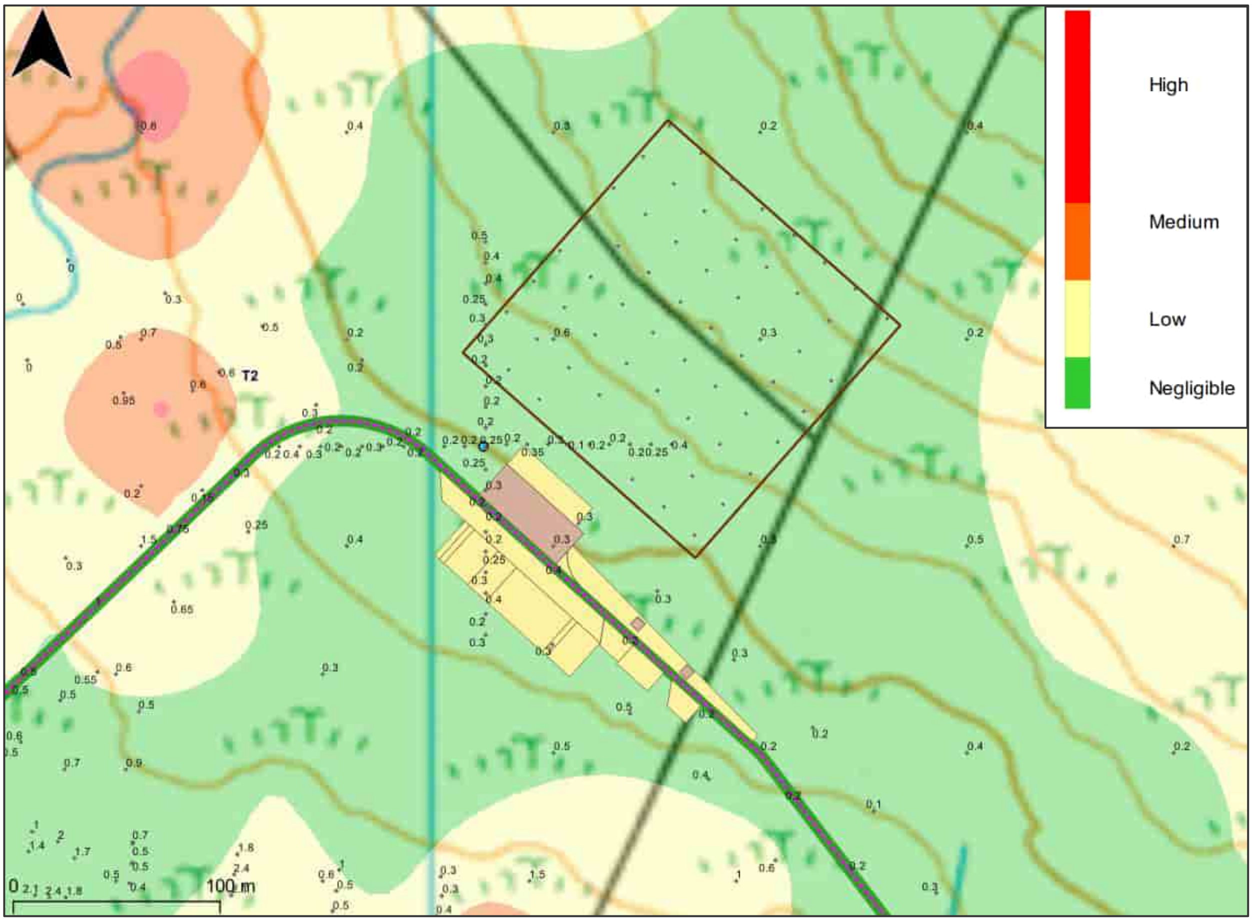


T01 Location — GIS Risk Mapping Extract - (Unmitigated Risk Zonation)

Location Specific Mitigation:

Peat is thin or absent at this location due to the position at the higher elevation on the slope system. Following further intrusive site investigation post-consent, the risk ranking should be re-evaluated. The risk of peat slide should be negligible due to the thin peat soils. The location is within an area which has been subject to intense artificial drainage providing a slight elevation to the risk level. The nature of the thin peat soil however, means that this factor has a diminished impact on the risk of peat slide at this location.

Location ID	Other Asset Impact Scale	Environment Impact	Contributary Factors (Probability/Exposure		Risk Ranking <u>Residual Risk</u>
T02	**1**	**1**	Peat Depth 0-0.5m	1	=3x1=3 **Negligible**
			Slope Angle **4-10º**	3	
			Factor of Safety (FoS)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	**<u>Negligible</u>**
			Hydrology	1	
			Previous Instability	1	
			Land Management	1	

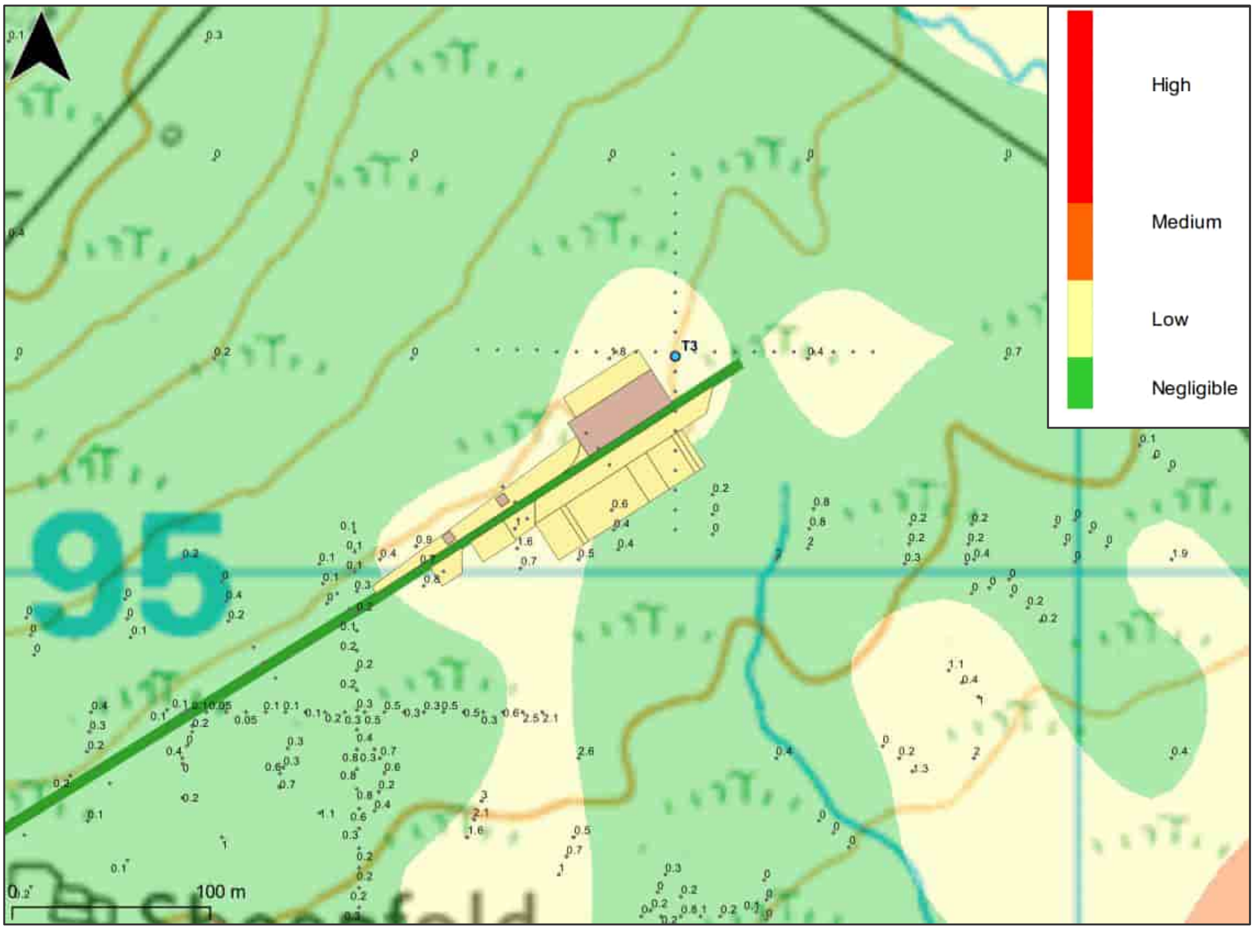


T02 Location — GIS Risk Mapping Extract (Unmitigated Risk Zonation)

Location Specific Mitigation:

Peat is predominantly absent at this location due to the higher elevation position on the slope system. Following further intrusive site investigation post-consent, the risk ranking should be re-evaluated. The risk of peat slide should remain negligible due to the thin peat soils present. The location is not majorly affected by artificial drainage.

Location ID	Other Asset Impact Scale	Environment Impact	Contributary Factors (Probability/Exposure		Risk Ranking Residual Risk
T03	1	1	**Peat Depth 1.0-2.0m**	5	=(5+3+2)x1=10 **Low**
			Slope Angle 3-5º	3	
			Factor of Safety (FoS)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	**Negligible**
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	



T03 Location — GIS Risk Mapping Extract (Unmitigated Risk Zonation)

Location Specific Mitigation:

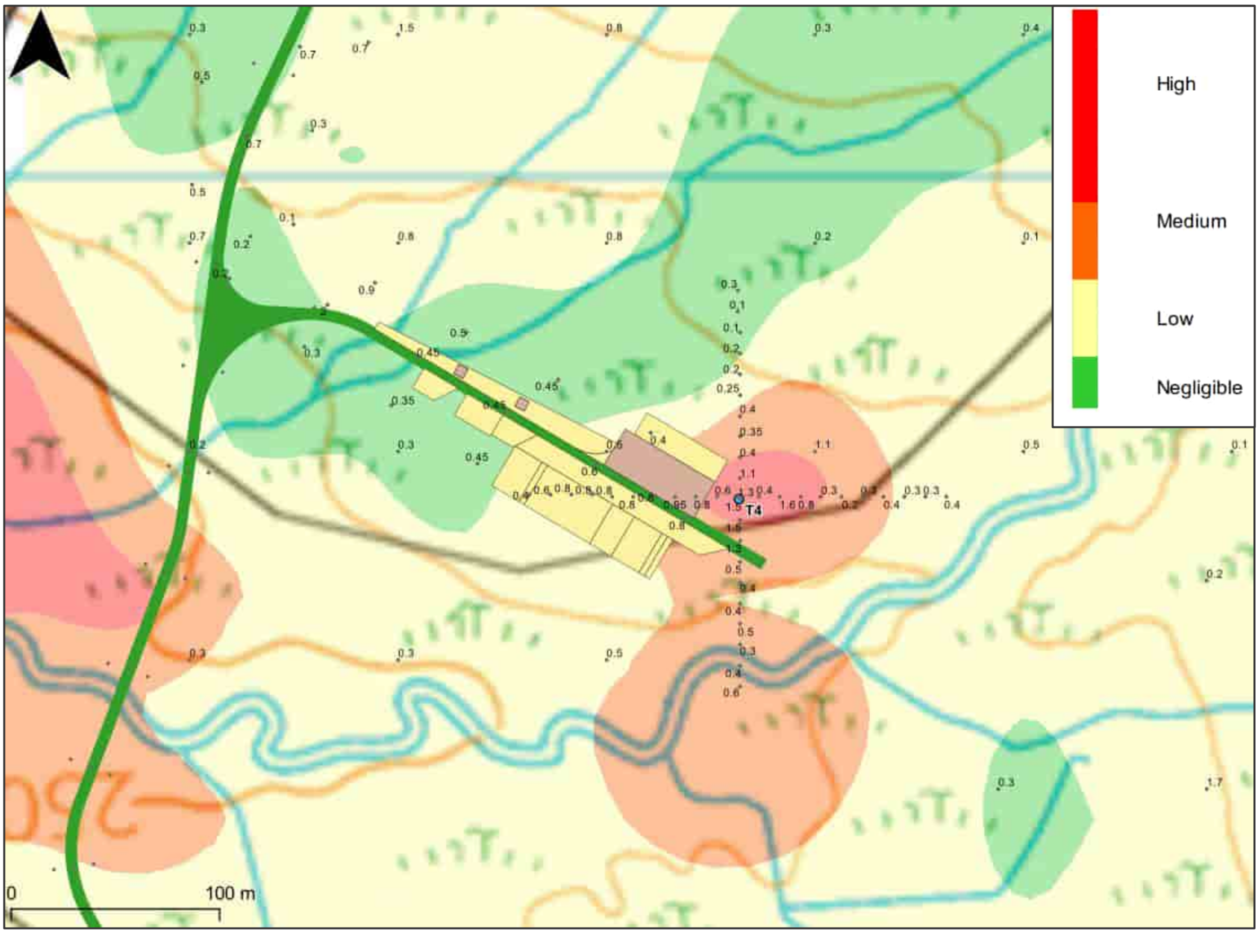
Low volume construction techniques should be employed for suitable infrastructure at T03 to leave deposits in place and reduce risks.

Following further intrusive site investigation post-consent, the risk ranking should be re-evaluated.

No temporary storage or stockpiling of material in the vicinity of turbine T03 where peat depth is >0.5m;

Slope system south of T03 is not uniform and is punctuated with shallow sloping plateau areas which would control/ limit scale of a potential peat slide event.

Location ID	Other Asset Impact Scale	Environment Impact	Contributory Factors (Probability/Exposure		Risk Ranking <u>Residual Risk</u>
T04	3 (Nearby watercourse linked to PWS)	3	Peat Depth **0.50-1.0m**	3	=6x3=18 **High**
			Slope Angle **4-10º**	3	
			Factor of Safety (FoS)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	**<u>Low</u>**
			Hydrology	1	
			Previous Instability	1	
			Land Management	1	



T04 Location — GIS Risk Mapping Extract (Unmitigated Risk Zonation)

Location Specific Mitigation:

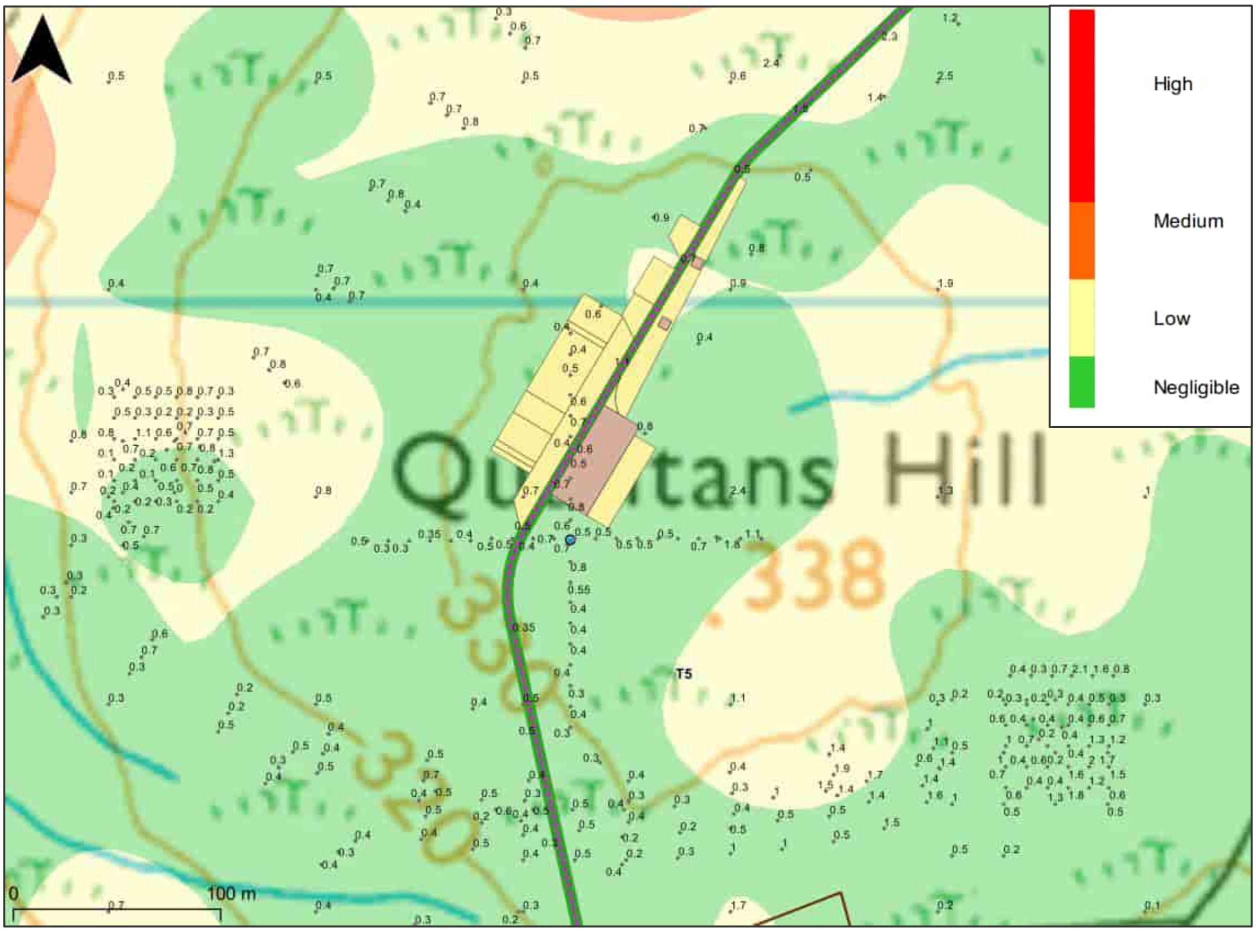
Microsite turbine approximately ~40m north onto shallow or absent peat deposits away from discrete area of deeper peat.

Without micro-siting: design slope stabilisation measures to protect the Benloch Burn. This may comprise soil stabilisation or retention to prevent destabilisation and mobilisation of peat material into the watercourse.

Throughout construction stability and water quality monitoring should be ongoing to protect the public water supply source of the Benloch Burn. It is acknowledged that the supply intake is situated approximately 300m upstream. However disruption of the flow in the watercourse resulting from a peat slide in a worst case damming the flow could result in upstream impact.

Following further intrusive site investigation post-consent, the risk ranking should be re-evaluated. With the control measures; the risk of peat slide would be controlled to low levels. The location is not majorly affected by artificial drainage.

Location ID	Infrastructure Asset Impact Scale	Environment Impact Scale	Contributary Factors (Probability)		Risk Ranking <u>Residual Risk</u>
T05	1	1	Peat Depth **0.5-1.0m**	3	=3x1=3 **Negligible**
			Slope Angle 0-4°	1	
			Factor of Safety (FoS)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	**<u>Negligible</u>**
			Hydrology	1	
			Previous Instability	1	
			Land Management	1	



T05 Location — GIS Risk Mapping Extract (Unmitigated Risk Zonation)

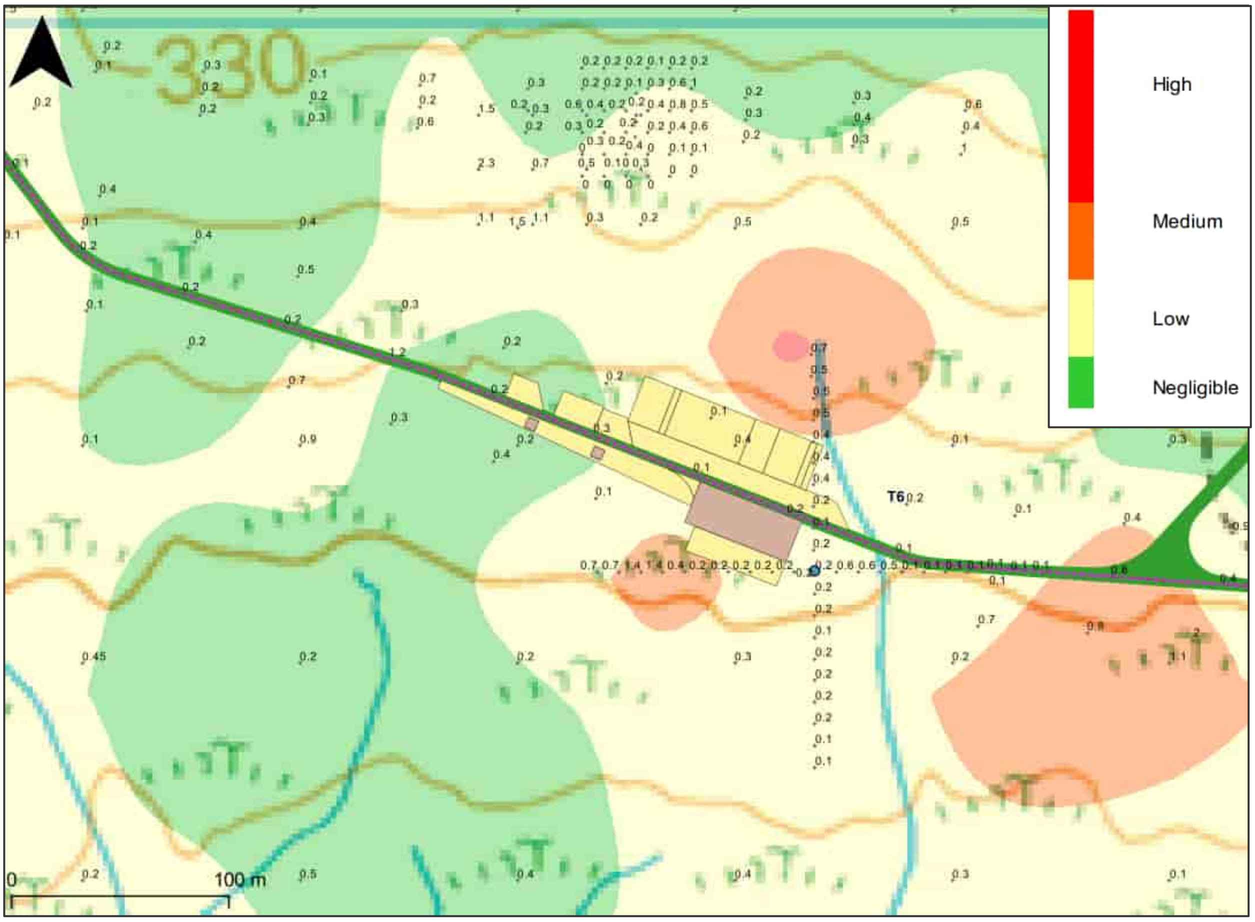
Location Specific Mitigation:

Following further intrusive site investigation post-consent, the risk ranking should be re-evaluated. The risk should remain negligible due to the shallow/level slope angle of terrain.

There shall be no temporary storage or stockpiling of material in the vicinity of turbine T05 where peat depth is >0.5m;

Existing drainage ditches and hydrological regime should be maintained and prevented from blocking leading to increased power water pressures in surrounding peatland;

Location ID	Other Asset Impact Scale	Environment Impact	Contributory Factors (Probability/Exposure		Risk Ranking **Residual Risk**
T06	**2 Upslope from T10 Infrastructure**	**(4-2)=2 Modified due to shallow & isolated peat soil**	Peat Depth 0-0.5m	1	=5x2=10 **Low**
			Slope Angle 4-10º	3	
			Factor of Safety (FoS)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	**Negligible**
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	



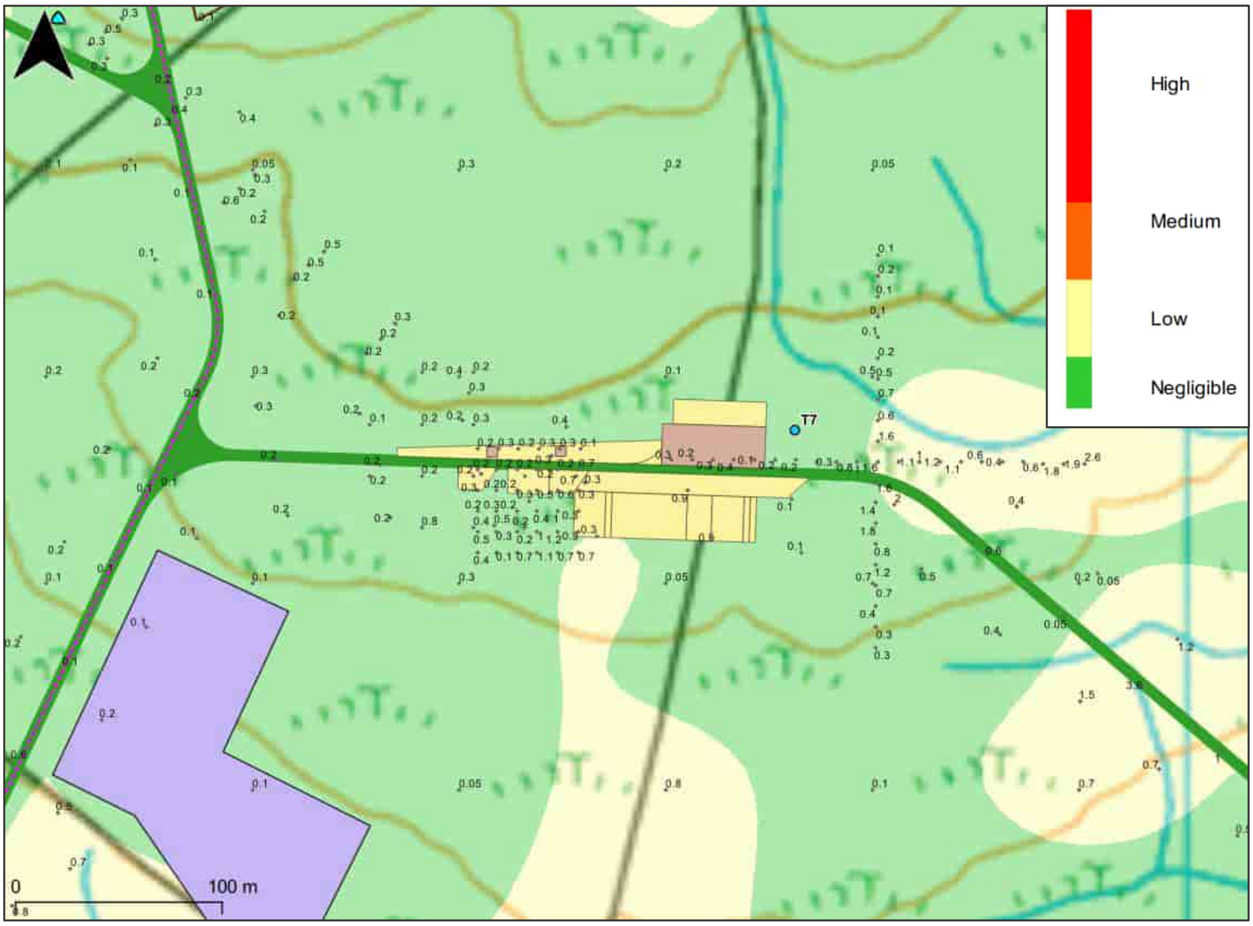
T06 Location — GIS Risk Mapping Extract (Unmitigated Risk Zonation)

Location Specific Mitigation:

Peat is thin soil in isolated pockets or absent at this location due to the higher elevation on the slope system. Following further intrusive site investigation post-consent, the risk ranking should be re-evaluated. The risk of peat slide should remain negligible due to the thin and isolated peat soils. Although in close proximity to source zone for a tributary watercourse the impact scale has been reduced due to the limited peat accumulations.

The location is adjacent to an area which has been subject to intense artificial drainage providing a slight elevation to the risk level. The nature of the thin peat soil however means that this factor has a diminished impact on the risk of peat slide at this location.

Location ID	Other Asset Impact Scale	Environment Impact	Contributory Factors (Probability/Exposure		Risk Ranking <u>Residual Risk</u>
T07	1	1	**Peat Depth 0.5-1.0m**	3	=5x1=5 **Low**
			Slope Angle 0-4°	1	
			Factor of Safety (FoS)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	**<u>Negligible</u>**
			Hydrology	2	
			Previous Instability	1	
			Land Management	1	



T07 Location — GIS Risk Mapping Extract (Unmitigated Risk Zonation)

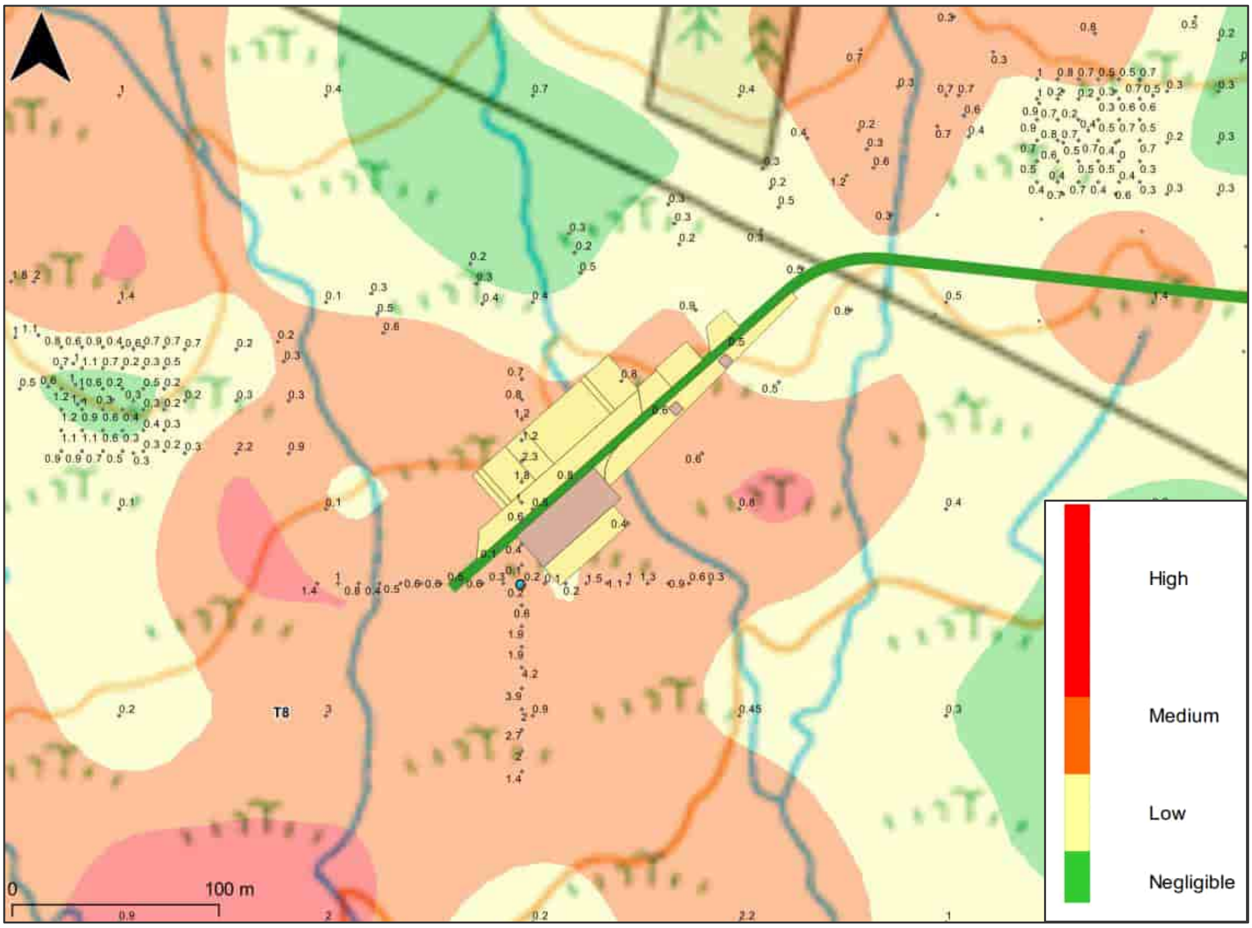
Location Specific Mitigation:

Following further intrusive site investigation post-consent, the risk ranking should be re-evaluated. The risk of peat slide should remain negligible due to the very shallow sloping terrain.

There shall be no temporary storage or stockpiling of material in the vicinity of turbine T07 where peat depth is >0.5m;

Existing drainage ditches and hydrological regime should be maintained and prevented from blocking leading to increased power water pressures in surrounding peatland to the east;

Location ID	Other Asset Impact Scale	Environment Impact	Contributary Factors (Probability/Exposure		Risk Ranking Residual Risk
T08	1	3	**Peat Depth 0.5-1.0m**	3	=5x3=15 **Medium**
			Slope Angle 0-4°	1	
			Factor of Safety (FoS)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	**Low**
			Hydrology	2	
			Previous Instability	1	
			Land Management	1	



T08 Location — GIS Risk Mapping Extract (Unmitigated Risk Zonation)

Location Specific Mitigation:

Low volume construction techniques should be employed for suitable infrastructure at T08 to leave peat in place and reduce the risks.

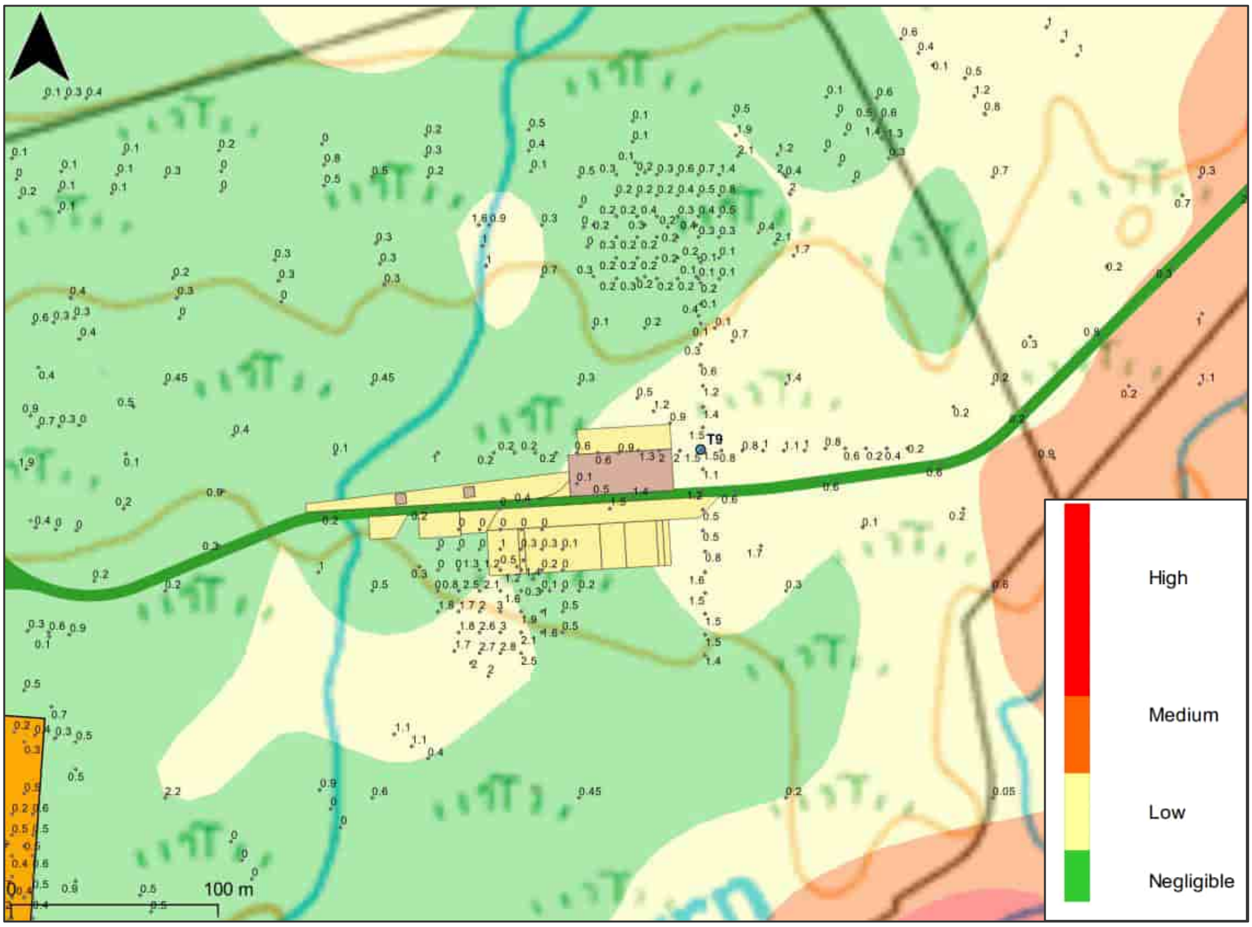
T08 is upslope from the confluence of three minor tributaries which flow into the Polhay/Marbrack Burn. Downslope watercourse protection measures should be considered as a precaution at this location. This may include catch fencing or soil reinforcement and retaining structures for the duration of construction.

Following further intrusive site investigation post-consent, the risk ranking should be re-evaluated.

No temporary storage or stockpiling of material in the vicinity of turbine T10 where peat depth is >0.5m;

Existing drainage ditches and hydrological regime should be maintained and prevented from blocking leading to increased power water pressures in surrounding peatland;

Location ID	Other Asset Impact Scale	Environment Impact	Contributary Factors (Probability/Exposure		Risk Ranking <u>Residual Risk</u>
T09	1	2	**Peat Depth 0.5-1.0m**	3	=5x2=10 **Low**
			Slope Angle 0-4^{o}	1	
			Factor of Safety (FoS)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	**<u>Negligible</u>**
			Hydrology	2	
			Previous Instability	1	
			Land Management	1	



T09 Location — GIS Risk Mapping Extract (Unmitigated Risk Zonation)

Location Specific Mitigation:

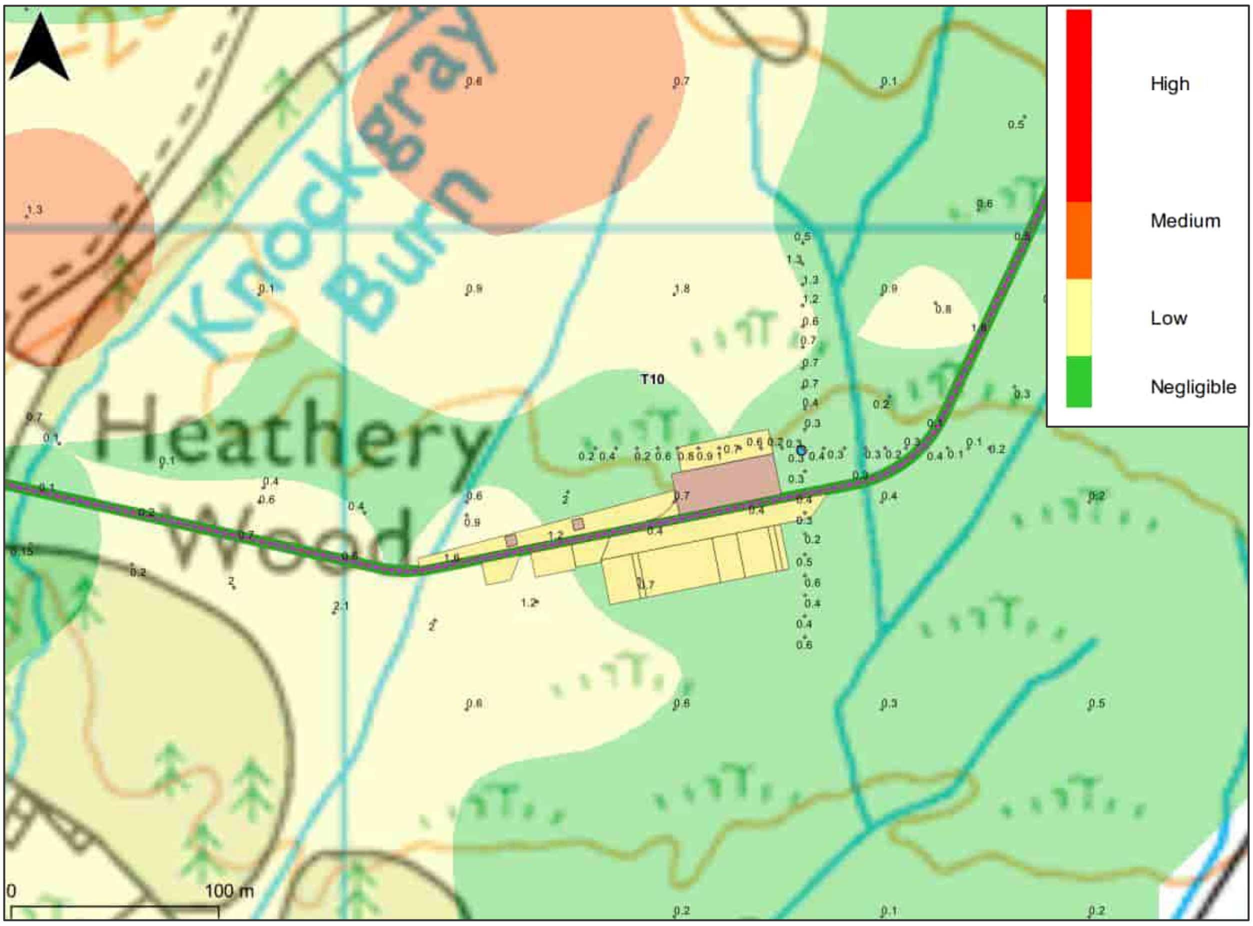
Low volume construction techniques should be employed for suitable infrastructure at T09 to leave deposits in place and reduce risks.

Following further intrusive site investigation post-consent, the risk ranking should be re-evaluated.

No temporary storage or stockpiling of material in the vicinity of turbine T09 where peat depth is >0.5m;

Existing drainage ditches and hydrological regime should be maintained and prevented from blocking leading to increased power water pressures in surrounding peatland;

Location ID	Other Asset Impact Scale	Environment Impact	Contributary Factors (Probability/Exposure		Risk Ranking <u>Residual Risk</u>
T10	**1**	**1**	**Peat Depth 0.5-1.0m**	3	=5x1=5 **Low**
			Slope Angle 0-4º	1	
			Factor of Safety (FoS)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	**Negligible**
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	



T10 Location — GIS Risk Mapping Extract (Unmitigated Risk Zonation)

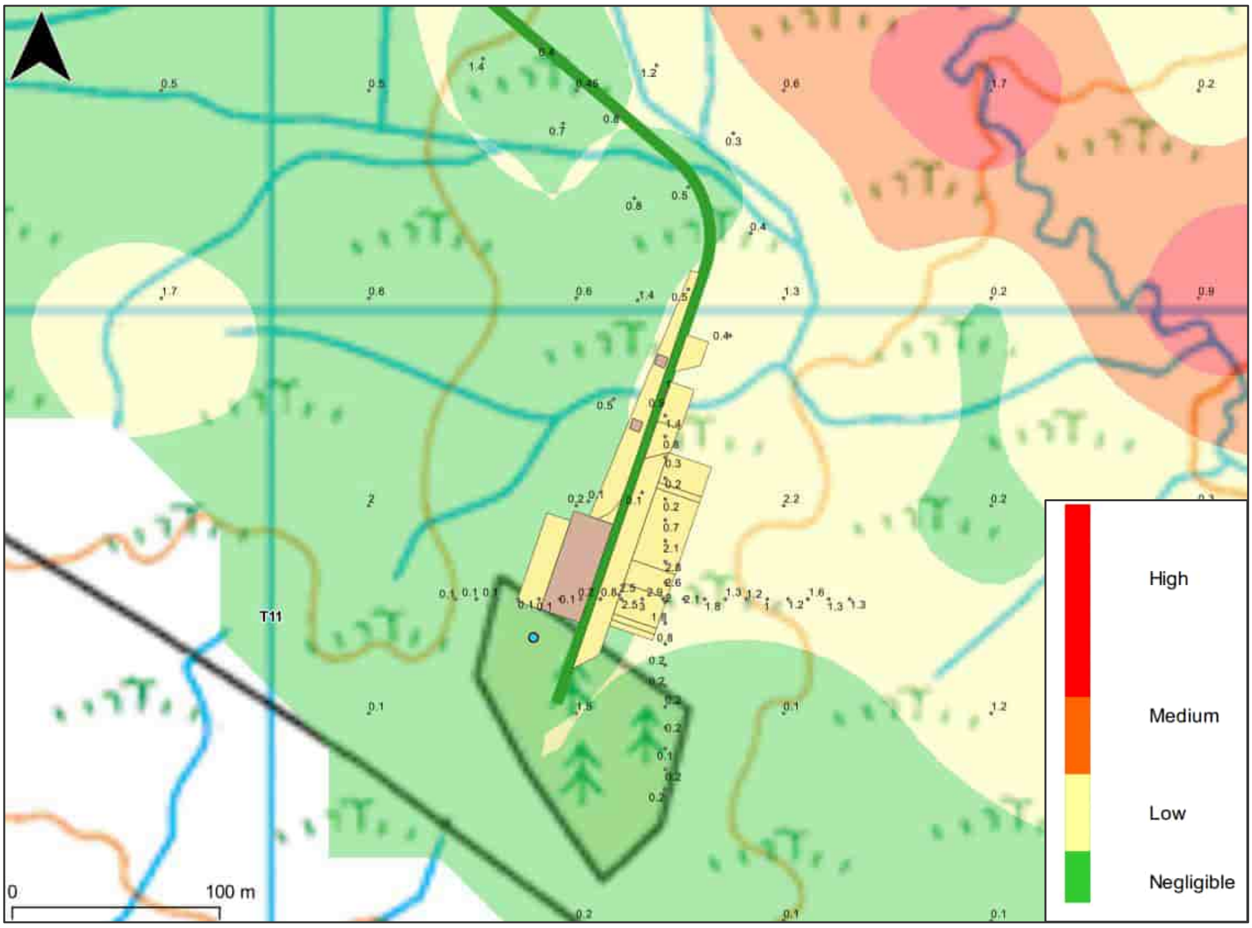
Location Specific Mitigation:

Following further intrusive site investigation post-consent, the risk ranking should be re-evaluated. The risk of peat slide should remain negligible due to the very shallow sloping terrain and distance from main tributary watercourse which is not directly downslope from this location.

No temporary storage or stockpiling of material in the vicinity of turbine T10 where peat depth is >0.5m;

Low volume construction techniques should be employed on the approach access to reduce impact on peat near to the Knockgray Burn. Robust watercourse protection measures will be required at the main water crossing. Existing drainage ditches and hydrological regime should be maintained and prevented from blocking leading to increased power water pressures in surrounding peatland to the south west;

Location ID	Other Asset Impact Scale	Environment Impact	Contributory Factors (Probability/Exposure		Risk Ranking <u>Residual Risk</u>
T11	1	1	**Peat Depth 1.0-2.0m**	5	=7x1=7 **Low**
			Slope Angle 0-4°	1	
			Factor of Safety (FoS)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	**<u>Negligible</u>**
			Hydrology	2	
			Previous Instability	1	
			Land Management	1	



T11 Location — GIS Risk Mapping Extract (Unmitigated Risk Zonation)

Location Specific Mitigation:

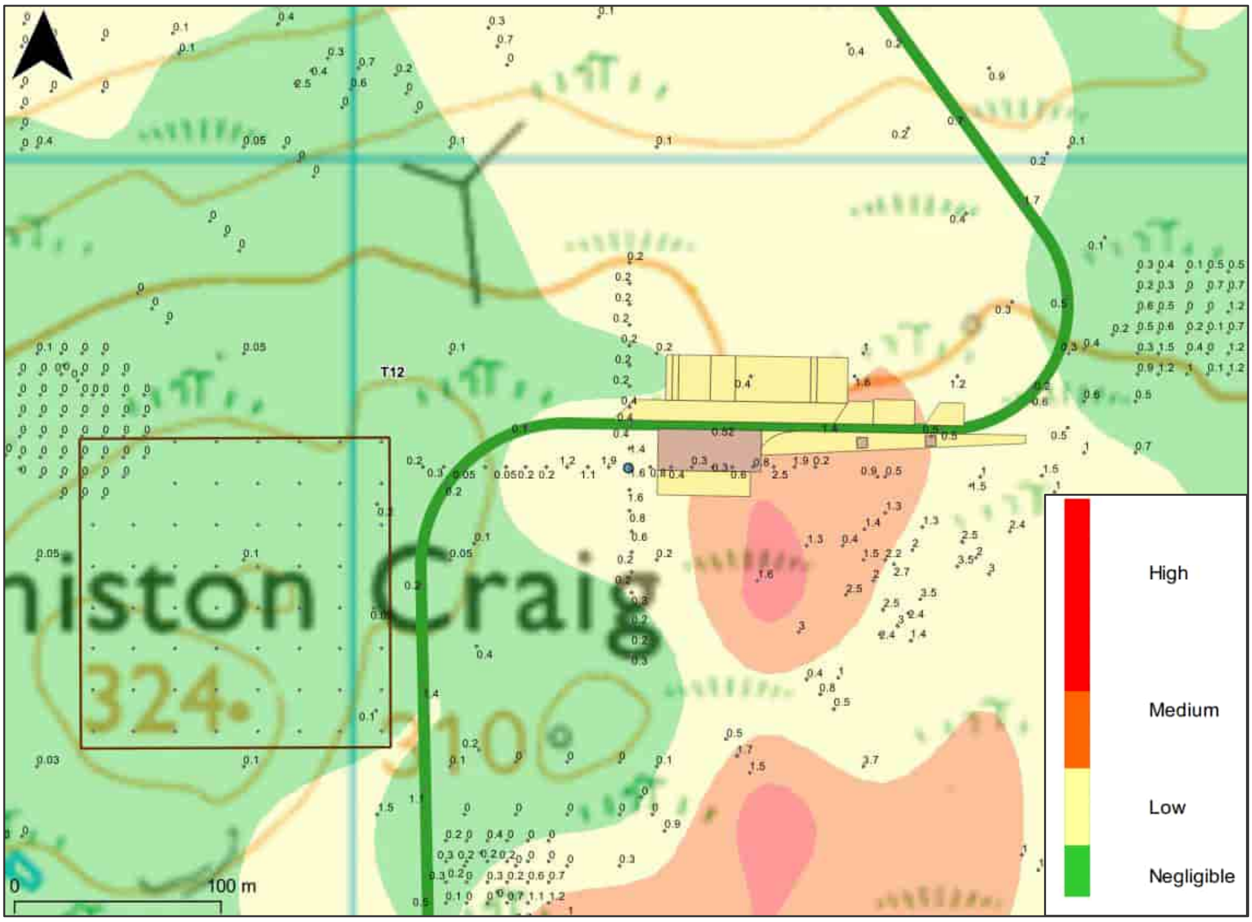
Following further intrusive site investigation post-consent, the risk ranking should be re-evaluated. The risk of peat slide should remain negligible due to the very shallow sloping terrain and distance from main tributary watercourse. Artificial drains are few at the location although were not assessed to be major features or likely to act as a major pathway or trigger to peat movement at this location.

No temporary storage or stockpiling of material in the vicinity of turbine T11 where peat depth is >0.5m;

Low volume construction techniques should be employed on the approach access to reduce impact on peat.

Existing drainage ditches and hydrological regime should be maintained and prevented from blocking leading to increased power water pressures in surrounding peatland;

Location ID	Other Asset Impact Scale	Environment Impact	Contributary Factors (Probability/Exposure		Risk Ranking Residual Risk
T12	1	2 - 3 (Hardstand area is on boundary of watercourse receptor to south and deeper peat)	**Peat Depth 0.5-2.0m**	3-4	=3x2=6 Ranging to: =4x3=12 **Low/Med**
			Slope Angle 0-4º	1	
			Factor of Safety (FoS)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	**Low**
			Hydrology	1	
			Previous Instability	1	
			Land Management	1	



T12 Location — GIS Risk Mapping Extract (Unmitigated Risk Zonation)

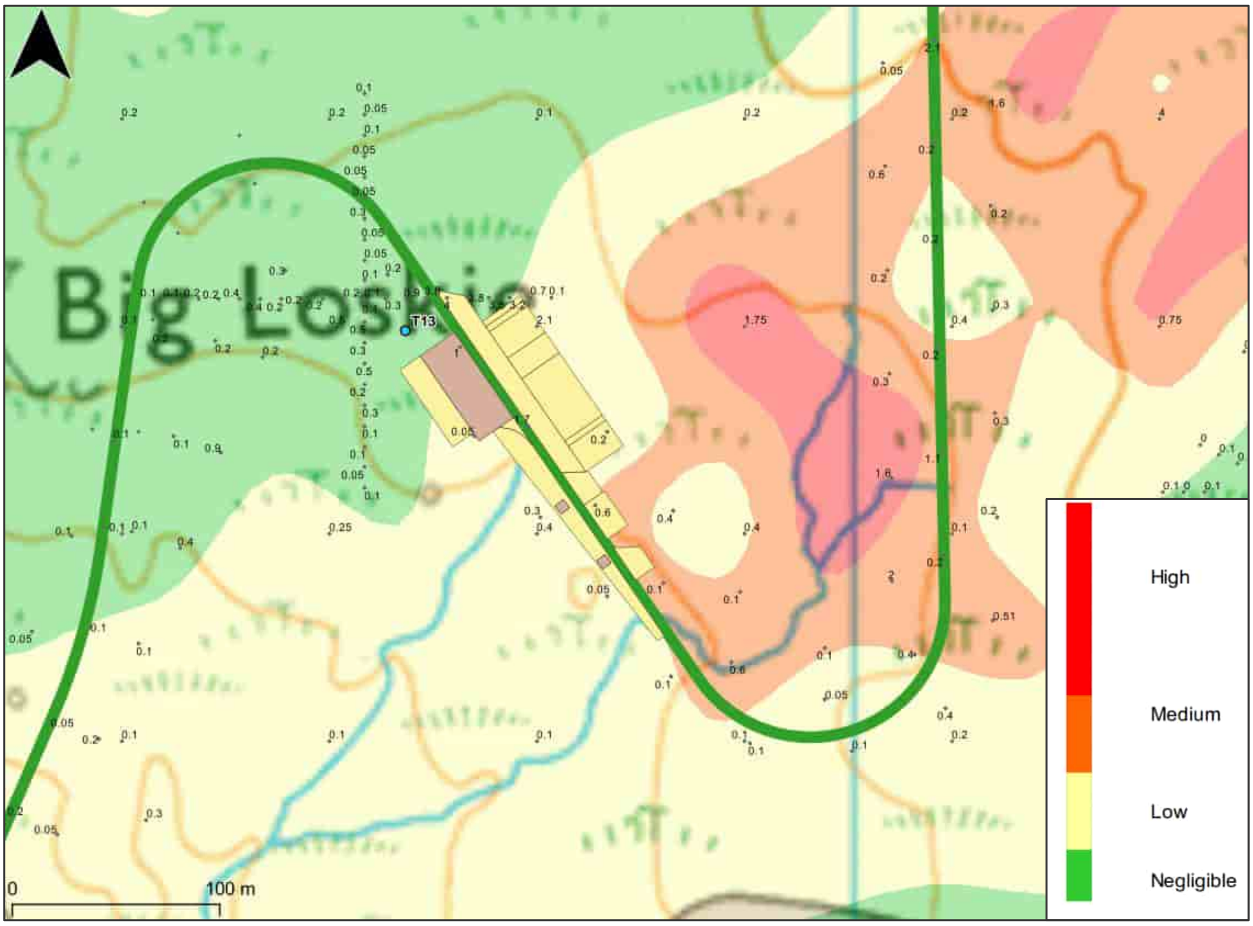
Location Specific Mitigation:

Low volume construction techniques should be employed for suitable infrastructure at T12 to leave deposits in place and reduce risks.

Following further intrusive site investigation post-consent, the risk ranking should be re-evaluated.

No temporary storage or stockpiling of material in the vicinity of turbine T12 where peat depth is >0.5m;

Location ID	Other Asset Impact Scale	Environment Impact	Contributary Factors (Probability/Exposure		Risk Ranking Residual Risk
T13	1	1	**Peat Depth 1.0-2.0m**	5	=8x1=8 **Low**
			Slope Angle 4-10º	3	
			Factor of Safety (FoS)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	**Negligible**
			Hydrology	1	
			Previous Instability	1	
			Land Management	1	



T13 Location — GIS Risk Mapping Extract (Unmitigated Risk Zonation)

Location Specific Mitigation:

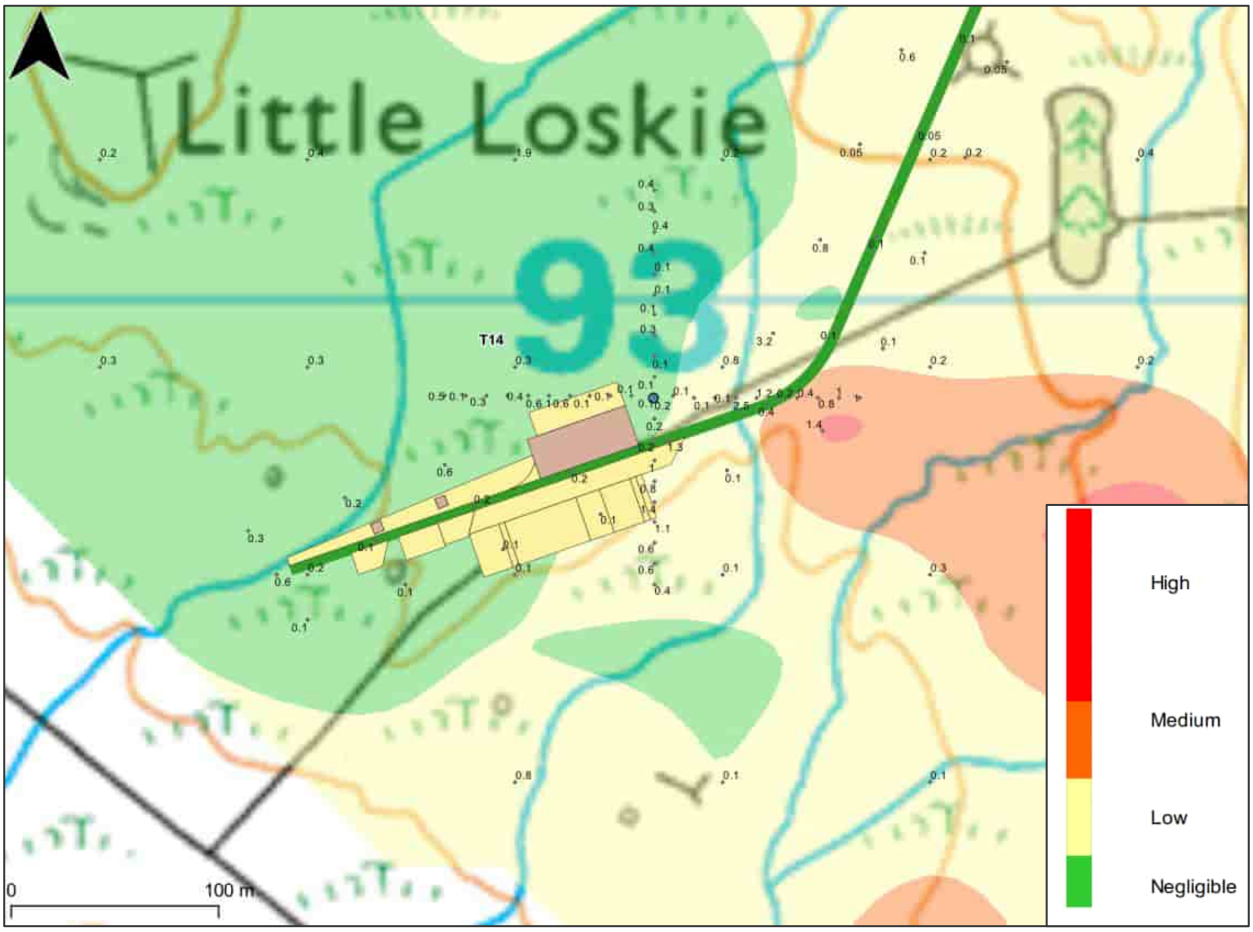
Low volume construction techniques should be employed for suitable infrastructure at T13 to leave deposits in place and reduce risks. This is particularly important on the approach access which crosses a deep zone of peat.

Following further intrusive site investigation post-consent, the risk ranking should be re-evaluated.

No temporary storage or stockpiling of material in the vicinity of turbine T13 where peat depth is >0.5m;

Existing drainage ditches and hydrological regime should be maintained and prevented from blocking leading to increased power water pressures in surrounding peatland;

Location ID	Other Asset Impact Scale	Environment Impact	Contributary Factors (Probability/Exposure		Risk Ranking Residual Risk
T14	1	2	Peat Depth 0-0.5m	1	=2x2=4 **Negligible**
			Slope Angle 0-4^{o}	1	
			Factor of Safety (FoS)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	**Negligible**
			Hydrology	2	
			Previous Instability	1	
			Land Management	1	

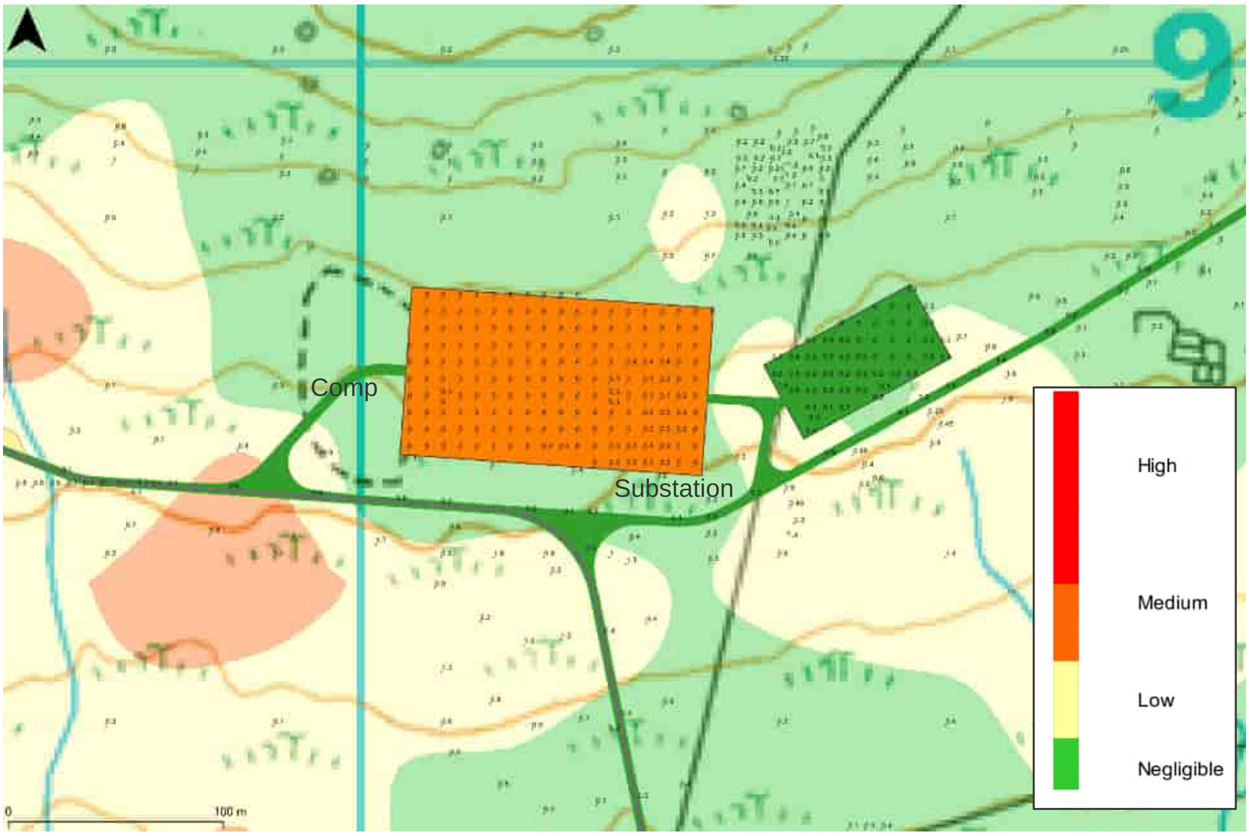


T14 Location — GIS Risk Mapping Extract *(Unmitigated Risk Zonation)*

Location Specific Mitigation:

Peat is predominantly absent at this location. Following further intrusive site investigation post-consent, the risk ranking should be re-evaluated. The risk of peat slide should remain negligible due to the thin peat soils. The location is not majorly affected by artificial drainage.

Location ID	Other Asset Impact Scale	Environment Impact	Contributary Factors (Probability/Exposure		Risk Ranking <u>Residual Risk</u>
Compound Substation	1	1	**Peat Depth 0-1.0m**	2	=7x1=7 **Low**
			Slope Angle 4-10º	3	
			Factor of Safety (FoS)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	**<u>Negligible</u>**
			Hydrology	2	
			Previous Instability	1	
			Land Management	1	



Construction Compound and Substation — GIS Risk Mapping Extract *(Unmitigated Risk Zonation)*

Location Specific Mitigation:

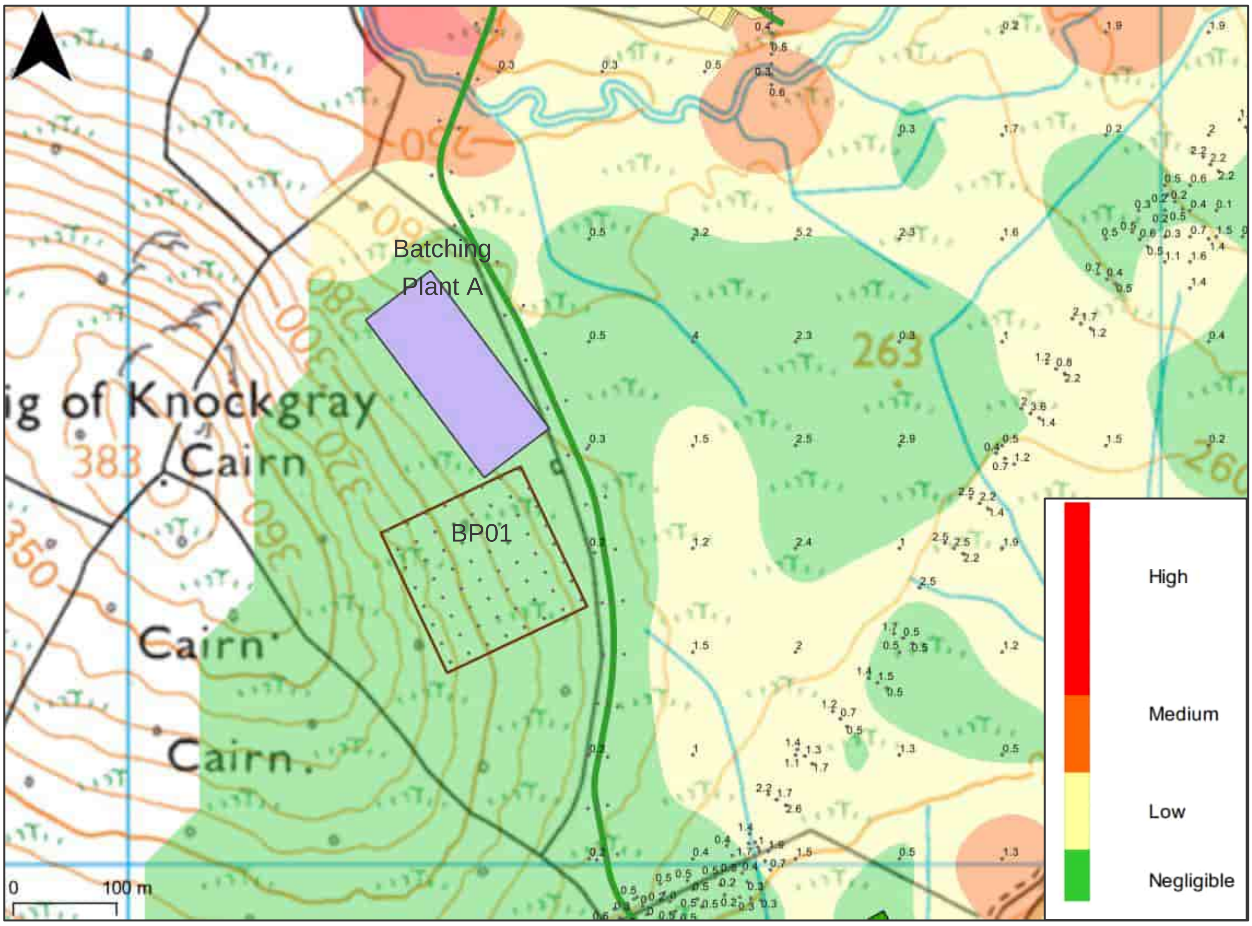
Low volume construction techniques should be employed to leave deposits in place and reduce risks. This would be focussed on the temporary compound structure.

Following further intrusive site investigation post-consent, the risk ranking should be re-evaluated.

No temporary storage or stockpiling of material where peat depth is >0.5m;

Existing drainage ditches and hydrological regime should be maintained and prevented from blocking leading to increased power water pressures in surrounding peatland;

Location ID	Other Asset Impact Scale	Environment Impact	Contributory Factors (Probability/Exposure		Risk Ranking Residual Risk
Borrow Pit BP01 & Batching Plant A	1	1	**Peat Depth 0-0.5m**	1	=5x1=5 **Negligible**
			Slope Angle 10-15º	5	
			Factor of Safety (FoS)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	**Negligible**
			Hydrology	1	
			Previous Instability	1	
			Land Management	1	

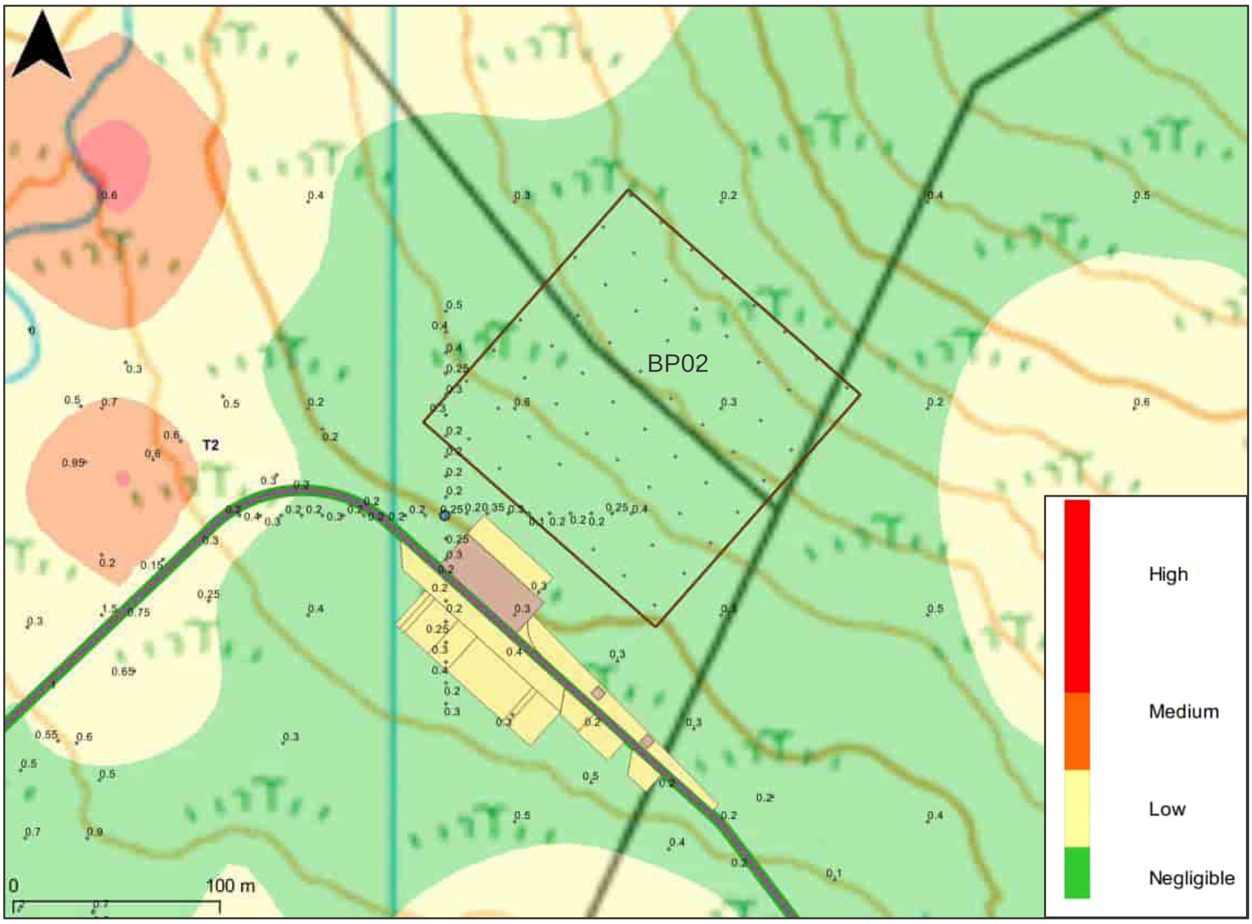


Borrow Pit BP01 — GIS Risk Mapping Extract *(Unmitigated Risk Zonation)*

Location Specific Mitigation:

Peat is predominantly absent at this location. Following further intrusive site investigation post-consent, the risk ranking should be re-evaluated. The risk of peat slide should remain negligible due to the thin peat soils. The location is not majorly affected by artificial drainage.

Location ID	Other Asset Impact Scale	Environment Impact	Contributory Factors (Probability/Exposure		Risk Ranking <u>Residual Risk</u>
Borrow Pit BP02	1	1	**Peat Depth 0-0.5m**	1	=5x1=5 **Negligible**
			Slope Angle 10-15º	5	
			Factor of Safety (FoS)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	<u>**Negligible**</u>
			Hydrology	1	
			Previous Instability	1	
			Land Management	1	

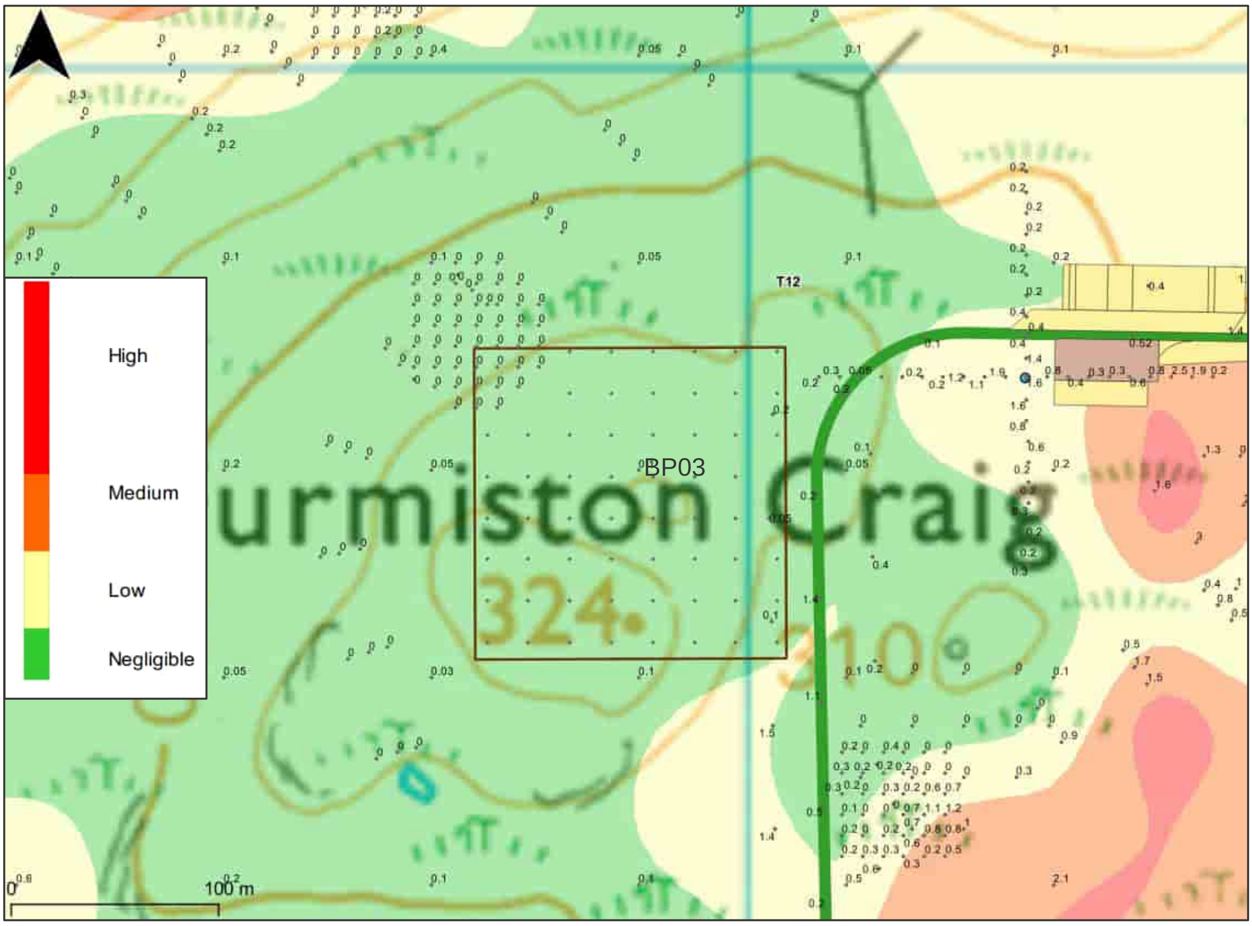


Borrow Pit BP02 — GIS Risk Mapping Extract *(Unmitigated Risk Zonation)*

Location Specific Mitigation:

Peat is predominantly absent at this location. Following further intrusive site investigation post-consent, the risk ranking should be re-evaluated. The risk of peat slide should remain negligible due to the thin peat soils. The location is not majorly affected by artificial drainage.

Location ID	Other Asset Impact Scale	Environment Impact	Contributory Factors (Probability/Exposure)		Risk Ranking <u>Residual Risk</u>
Borrow Pit BP03	1	1	**Peat Depth 0-0.5m**	5	=5x1=5 **Negligible**
			Slope Angle 10-15º	3	
			Factor of Safety (FoS)	1	
			Peat cracking / Infiltration	1	
			Groundwater Flow	1	**<u>Negligible</u>**
			Hydrology	1	
			Previous Instability	1	
			Land Management	1	



Borrow Pit BP03 — GIS Risk Mapping Extract *(Unmitigated Risk Zonation)*

Location Specific Mitigation:

Peat is predominantly absent at this location. Following further intrusive site investigation post-consent, the risk ranking should be re-evaluated. The risk of peat slide should remain negligible due to the thin peat soils. The location is not majorly affected by artificial drainage.

4.9.1 Table 4.8 below summarises the risk ranking for each turbine location with the principal contributory factors stated.

Table 4.8: Risk Ranking Summary

Location ID	Risk Ranking	Residual Risk	Factors
T01	Low	Negligible	Thin Peat Soils Present
T02	Negligible	Negligible	Thin Peat Soils Present
T03	Low	Negligible	Peat Depth, Nearby Watercourse
T04	High	Low	Peat Depth, Sloping Terrain, Nearby Main Watercourse/PWS
T05	Negligible	Negligible	Peat Depth
T06	Low	Negligible	Peat Depth, Few Hydrological Factors
T07	Low	Negligible	Peat Depth, Land Management (Drains)
T08	Med	Low	Peat Depth, Few Hydrological Factors, Nearby Watercourse
T09	Low	Negligible	Peat Depth, Sloping Terrain, Land Management (Drains)
T10	Low	Negligible	Peat Depth, Few Hydrological Factors
T11	Low	Negligible	Peat Depth, Few Hydrological Factors, Nearby Main Watercourse
T12	Low/Med	Low	Peat Depth, Sloping Terrain
T13	Low	Negligible	Thin Peat Soils Present
T14	Negligible	Negligible	
Construction Compound/Subs	Low	Negligible	Sloping Terrain, Few Hydrological Factors
Borrow Pit BP01	Negligible	Negligible	Slope Angle
Borrow Pit BP02	Negligible	Negligible	Slope Angle
Borrow Pit BP03	Negligible	Negligible	Slope Angle
Batching Plant	Negligible	Negligible	None – No peat recorded
TC01, TC02A, TC02B	Negligible / Low	Negligible	Peat absent with shallow depth recorded at TC02B however area is predominantly level / low angle terrain

Source: Natural Power

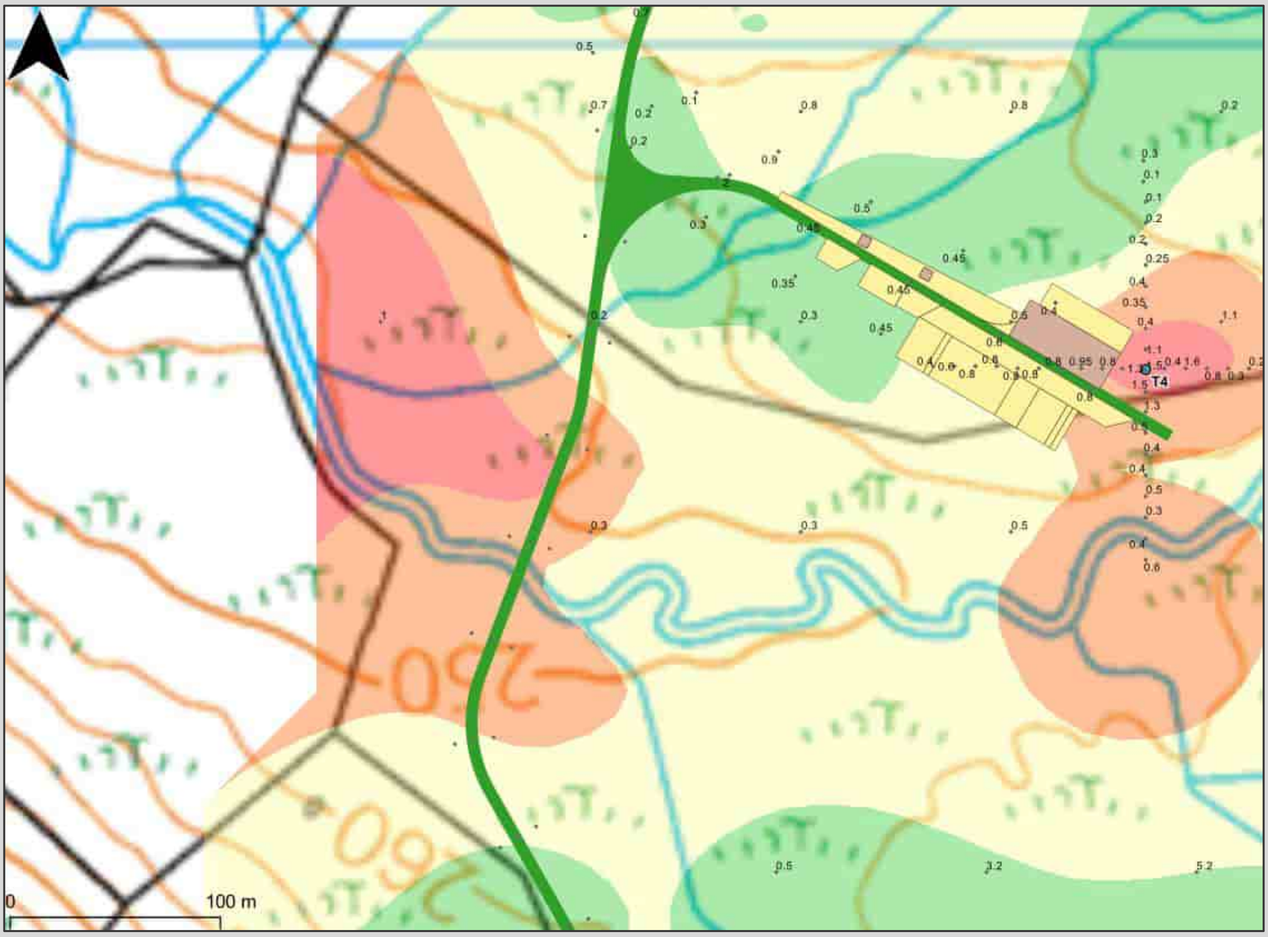
4.9.2 The risk assessment reflects the probability of peat material failing in a large-scale slide and entering the surface watercourse and being entrained to an offsite receptor without any mitigation. The assessment also considers potential for peat slides to affect existing infrastructure. Across all turbines the risk is assessed to be a low to negligible level with application of targeted control measures. Discussion on potential run-out of peat slide/failure events is provided in Section 4.9.

4.10.1 The alignment and position of proposed access tracks have been assessed using the same methodology applied to the main infrastructure locations. Access tracks predominantly traverse shallow peat soils with negligible to low risk of peat slide. Through the GIS risk modelling and screening process several discrete track sections however are highlighted for elevated peat slide risk and warrant further analysis here.

Table 4.9: Access Track Sections at Elevated Risk

Track Element

Track Section including Benloch Burn Crossing – Medium Risk



Contributory Factors to Elevated Peat Slide Risk:

- Peat Depth Patches of 0-0.5m and 0.5-1.0m
- Slope Angle 4-10º
- Proximity to main watercourse including crossing point.

Required Control Measures

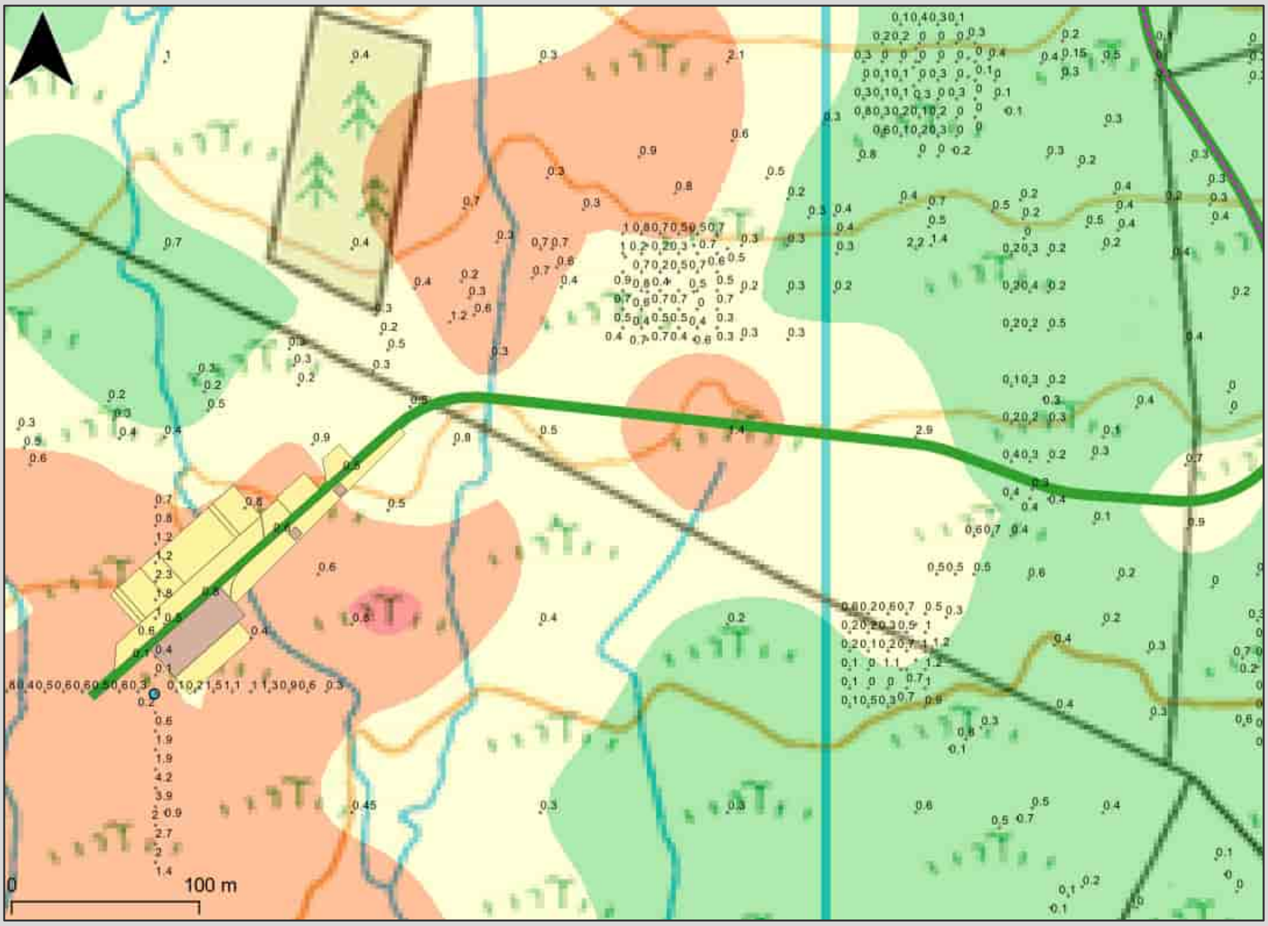
The following control measures are required in order to reduce the risk level to negligible:

- Cross track drainage which prevents any ponding or build-up of groundwater pressure within the peat upslope or beneath the access infrastructure. Where possible existing drainage systems should be utilised and maintained (including artificial drains);
- No stockpiling or surcharging of the peatland near watercourse crossing or on areas of deep peat.
- A system of ongoing monitoring throughout the construction phase should be in effect to monitor any movement in the peat. A rapid reaction strategy should be developed to ensure measures can be deployed to protect the watercourse in the event of any movement. This may include installation of downslope retaining systems to prevent peat material entering the watercourse and robust watercourse protection measures at the crossing point.

Source: Natural Power

Table 4.10: Access Track Sections at Elevated Risk

Track Element
Track Section T6 – Low Risk – Medium Risk



Contributory Factors to Elevated Peat Slide Risk:

- Peat Depth some areas 1.0-2.0m
- Slope Angle 4-10º
- Proximity to tributary of main watercourse including crossing point
- Prevalence of artificial drains

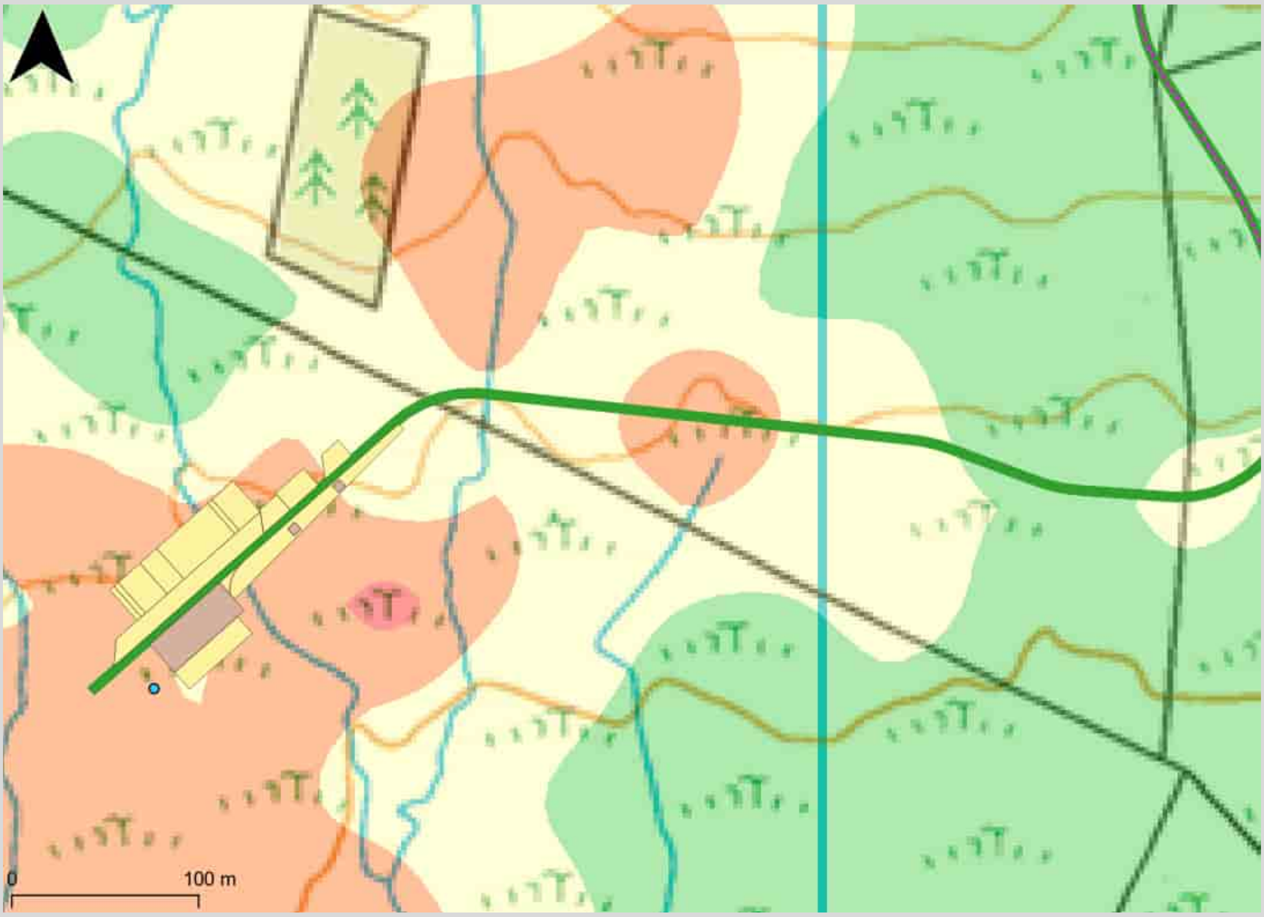
Required Control Measures

The following control measures are required in order to reduce the risk level to negligible:

- Cross track drainage which prevents any ponding or build-up of groundwater pressure within the peat upslope or beneath the access infrastructure. Where possible existing drainage systems should be utilised and maintained (including artificial drains);
- No stockpiling or surcharging of the peatland near the water crossing or on areas of >0.5m of peat
- A system of ongoing monitoring throughout the construction phase should be in effect to monitor any movement in the peat. A rapid reaction strategy should be developed to ensure measures can be deployed to protect the watercourse in the event of any movement. This may include installation of downslope retaining systems to prevent peat material entering the watercourse and robust watercourse protection measures at the tributary crossing point.

Source: Natural Power

Table 4.11: Access Track Sections at Elevated Risk

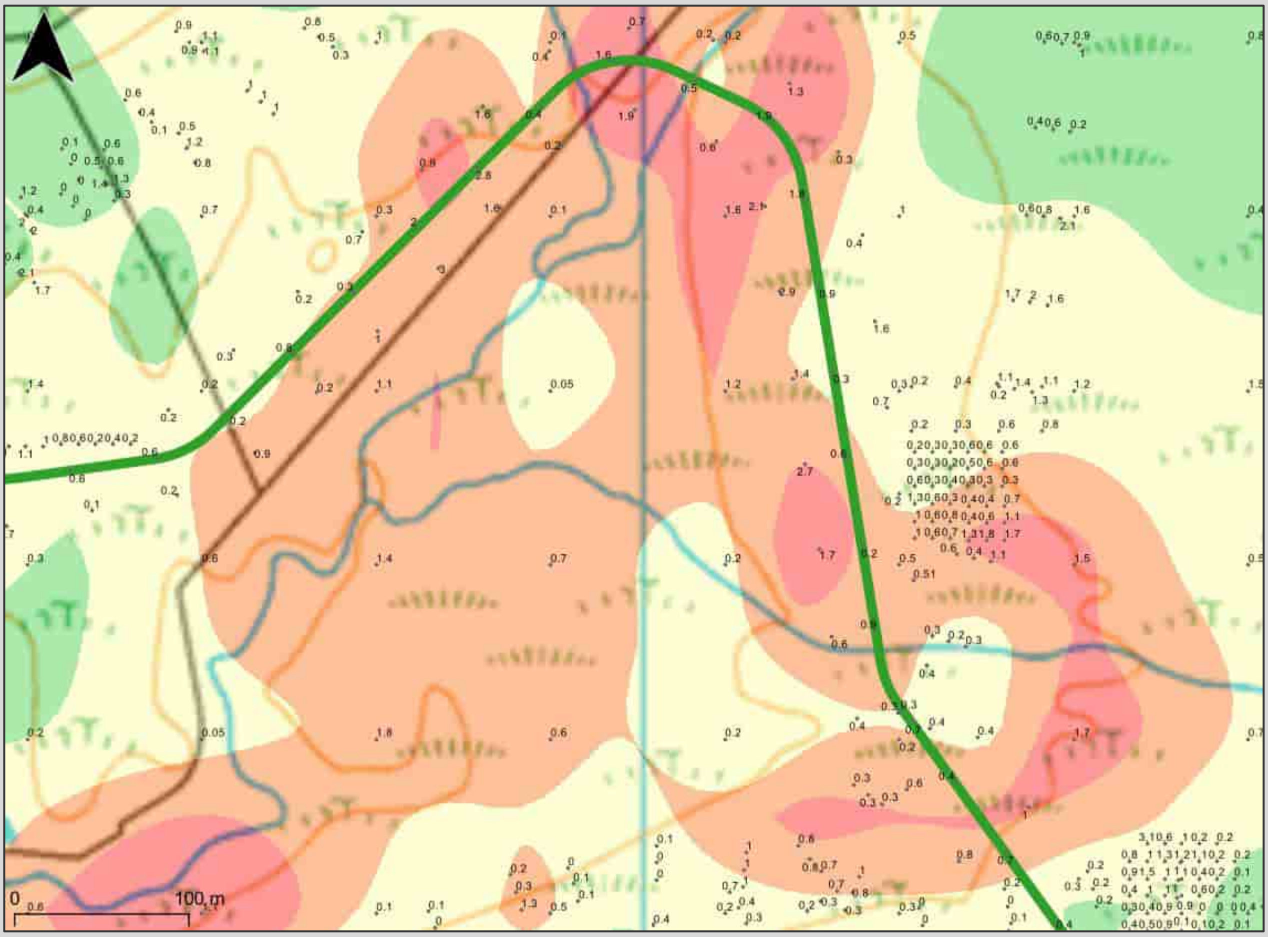
Track Element
Track Section T8 Spur – Medium Risk

Contributory Factors to Elevated Peat Slide Risk: • Peat Depth 0.5-1.0m • Slope Angle 4-10º • Proximity to tributary of main watercourse including crossing point
Required Control Measures
The following control measures are required in order to reduce the risk level to low: • Cross track drainage which prevents any ponding or build-up of groundwater pressure within the peat upslope or beneath the access infrastructure. Where possible existing drainage systems should be utilised and maintained (including artificial drains); • Adopt low volume conduction technique (e.g. floating tracks) if slope geometry allows; • No stockpiling or surcharging of the peatland along this specific access track section; • A system of ongoing monitoring throughout the construction phase should be in effect to monitor any movement in the peat. A rapid reaction strategy should be developed to ensure measures can be deployed to protect the watercourse in the event of any movement.

Source: Natural Power

Table 4.12: Access Track Sections at Elevated Risk

Track Element

Track Section T09 – T12 – Medium - High Risk



Contributory Factors to Elevated Peat Slide Risk:

- Peat Depth 0.5-3.0m (isolated pockets of deep peat only)
- Slope Angle generally 2-5 º with zones 4-10º
- Proximity main watercourse including crossing point of Marbrack Burn
- Prevalence of artificial drains

Required Control Measures

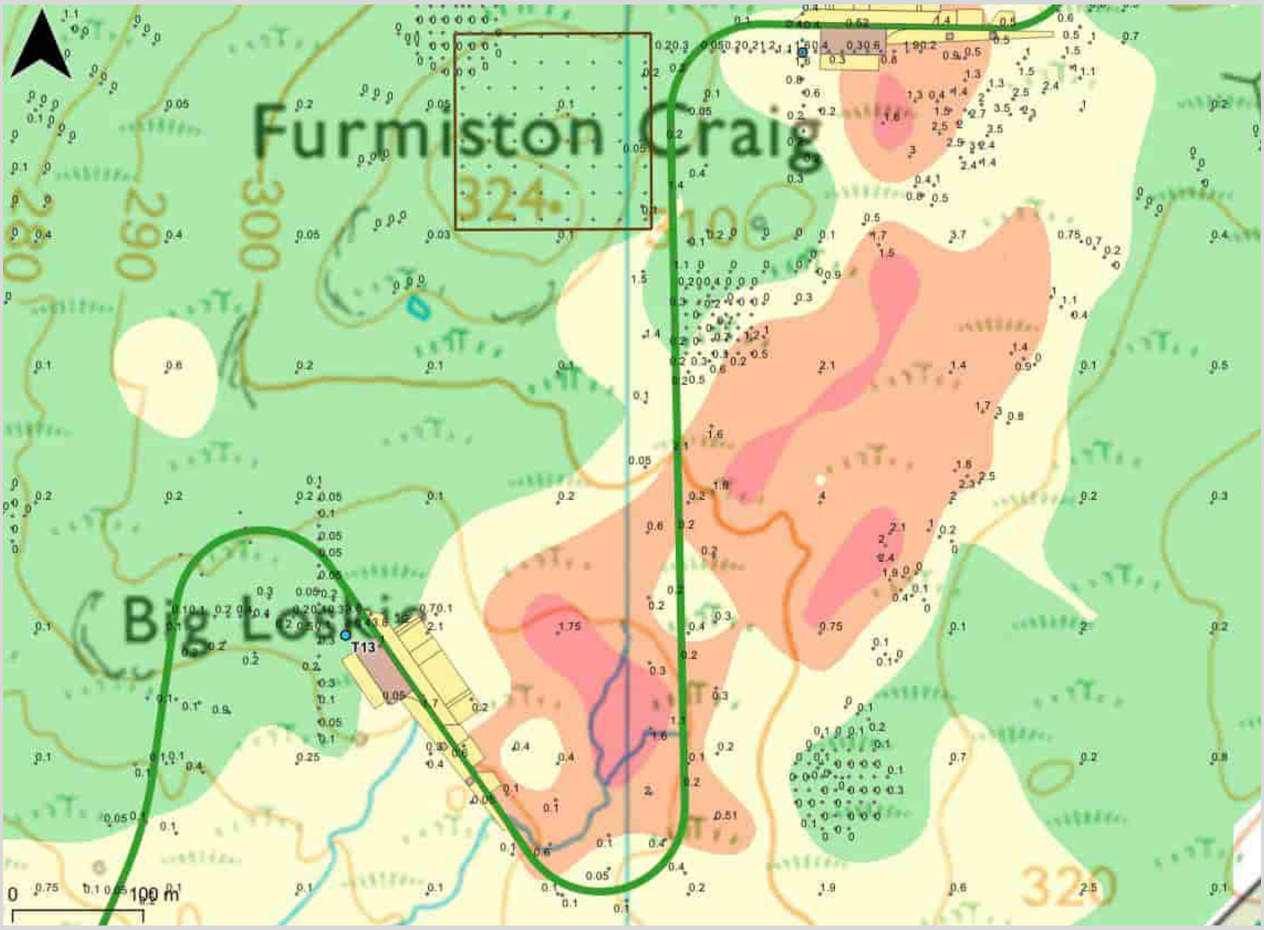
The following control measures are required in order to reduce the risk level to low:

- Cross track drainage which prevents any ponding or build-up of groundwater pressure within the peat upslope or beneath the access infrastructure. Where possible existing drainage systems should be utilised and maintained (including artificial drains);
- No stockpiling or surcharging of the peatland along this specific access track section;
- A system of ongoing monitoring throughout the construction phase should be in effect to monitor any movement in the peat. A rapid reaction strategy should be developed to ensure measures can be deployed to protect the watercourse in the event of any movement. This may include installation of downslope retaining systems to prevent peat material entering the watercourse and robust watercourse protection measures at the crossing point.

Source: Natural Power

Table 4.13: Access Track Sections at Elevated Risk

Track Element
Track Section T12 – T13 – Medium Risk



Contributory Factors to Elevated Peat Slide Risk:

- Peat Depth 0.5-1.0m (isolated pockets of deep peat only)
- Slope Angle 4-10º
- Proximity of tributaries to main watercourse including crossing point close to T14

Required Control Measures

The following control measures are required in order to reduce the risk level to low:

- Cross track drainage which prevents any ponding or build-up of groundwater pressure within the peat upslope or beneath the access infrastructure. Where possible existing drainage systems should be utilised and maintained (including artificial drains);
- No stockpiling or surcharging of the peatland along this specific access track section;
- A system of ongoing monitoring throughout the construction phase should be in effect to monitor any movement in the peat. A rapid reaction strategy should be developed to ensure measures can be deployed to protect the watercourse in the event of any movement. This may include installation of downslope retaining systems to prevent peat material entering the watercourse and robust watercourse protection measures at the crossing point.

Source: Natural Power

4.11.1 The assessment considers environmental receptors (main watercourses) to be the primary focus of the risk assessment. Minor or ephemeral watercourses have been assessed not to be primary receptors or unlikely to transmit peat slide material to offsite receptors, these have been excluded. Where relevant onsite proposed infrastructure and additional assets (water supplies) have been assessed.

4.11.2 Notwithstanding the point above, this report examines the terrain and the potential evolution of any triggered peat slide event. The determination has been that entrained peat flows would primarily be channelled along the main watercourses downslope of proposed infrastructure.

Source: OS 1:25,000, Natural Power

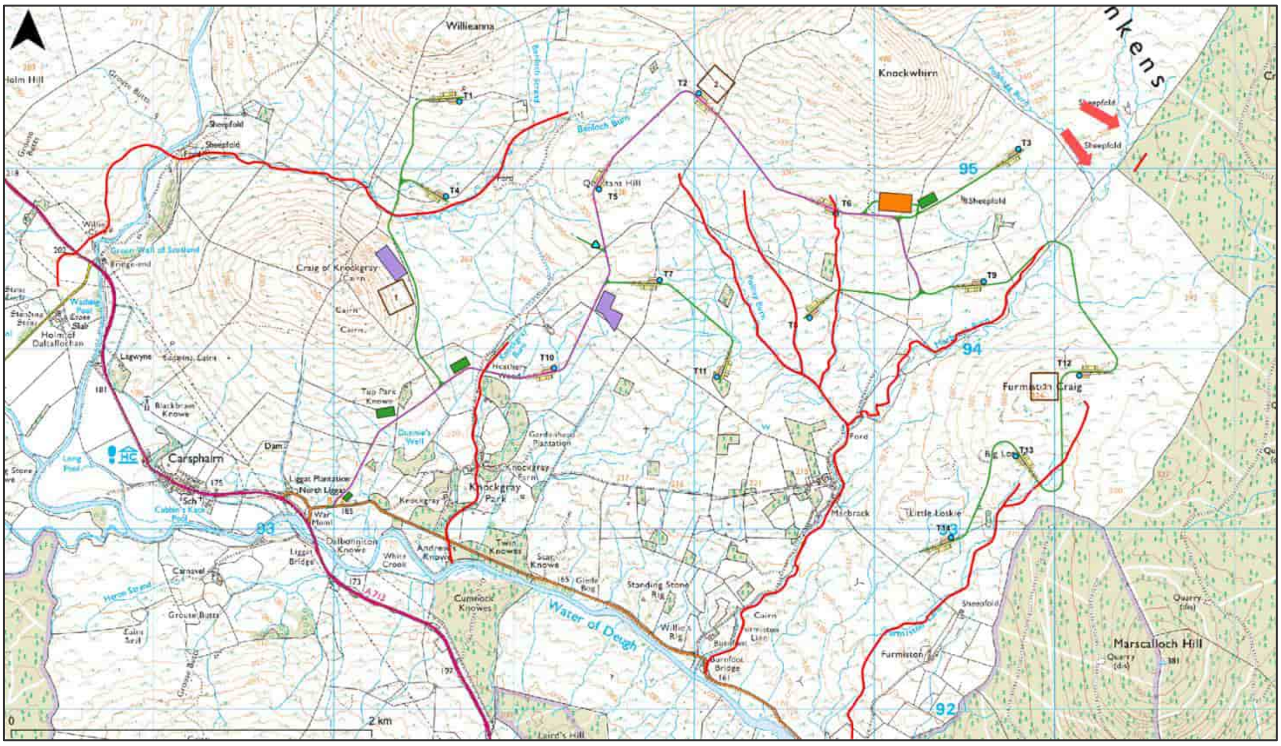


Figure 4.16: Primary Peat Slide Pathways & Indicative Peat Depth

4.11.3 The risk of run out and significant damage to the wider hydrological environmental is deemed low, providing the relevant control measures outlined in his report are implemented at the site.

4.12.1 The preliminary risk register for development wide hazards are listed in Table 4.9 below. Key. Control measures for the hazards have also been identified. A geotechnical risk register should be utilised on an individual turbine basis throughout the construction phase and amended accordingly as new information is received.

Table 4.14: Preliminary Geotechnical Risk Register

Hazard	Cause	Consequence
Naturally, induced **peat slide**	High rainfall, and increased surface water infiltration leading to build up of pore water pressure	Instability of peat deposits and underlying superficial deposits around earthworks; Contamination of natural watercourses and damage to hydrological systems; Harm to personnel and damage to plant / equipment; Destruction of built infrastructure

Hazard	Cause	Consequence
Mitigation	Due consideration given to prevailing ground and weather condition when scheduling construction works. i.e. avoid opening new excavation during heavy precipitation and ensure sufficient drainage measures are in place to support construction activities. Ensure a contingency is in place to concentrate on more suitable construction activities during wet weather. The drainage design should be such that its construction is in sequence: providing necessary drainage to new areas of excavation and construction in advance of works. i.e. ensure cut-off ditches are in place prior to opening new excavation. The drainage design should as far as practicable preserve the natural hydrological regime and should not inundate areas with run-off which were previously not subjected to such affects. Monitoring detailed weather forecast with site specific weather station; Monitoring (visual) regular site inspection to detect early indications of ground movement (tension cracks, groundwater issues). Ensuring rapid reaction strategy is in place for the construction phase which will in the first instance focus on alerting those at risk and then protecting sensitive receptors	
Construction related **peat slide**	Concentrated loads placed at the top of slope system or on marginally stable peat deposits	Contamination of natural watercourses and damage to hydrological systems including private water supplies; Rapid ground movement and mobilisation of material down slope of construction operations; Harm to personnel, plant and equipment; Destruction of temporary or permanent construction works;
Mitigation	Robust and strict controls on the phasing and pace of construction must be in place. This would be most effectively managed through the construction method statement and peat management plan. Plant operatives should be briefed in detail regarding the side-casting and stockpiling of materials. Medium to high-risk areas and deep peats areas would be demarked as a warning not to stockpile any materials and control the risk. Ensure the peat depth contour mapping is available and has a high visibility during the construction phase; A programme of frequent inspections should be implemented during excavation and access track construction works. This should be carried out by suitably experienced and qualified personnel. Where stockpiles are placed in suitable areas, these should be closely monitored through the use of high accuracy GPS level and visual survey. Private Water Supply quality monitoring and alert system in the event of any release of peat material to the main watercourse system	
Construction related **peat slide (drainage disruption)**	Uncontrolled surface water flows	Rapid erosion around and within temporary and permanent earthworks leading to a destabilising effect on peat slopes, loss of toe support and or increase

Hazard	Cause	Consequence
		of pore pressures through increased rates of infiltration.
Mitigation	Detailed drainage design undertaken with sufficient capacity to buffer the effects of short periods of high intensity rainfall, though the implementation of buffer/ settlement ponds to collect surface run-off and release at a slower rate. The positioning of such elements should be at locations at low risk of peat instability and away from areas of deep peat. Geotechnical supervision of major de-watering operations should be in place to ensure outflows are not being directing into terrain at higher risk of peat instability. Due consideration should be given to prevailing ground and weather conditions when scheduling construction works.	
Construction related **peat slide (earthworks)**	Inadvertent removal of toe support to slope system	Localised instability associated with temporary and permanent earthworks; Harm to personnel and equipment/plant through mass movement of peat and spoil; Long term ground movements/ creep, causing deterioration and damage to temporary and permanent earthworks; Contamination of natural watercourses and damage to hydrological systems from peat material mobilised down slope;
Mitigation	Avoidance action during geotechnical design stage; Routine geotechnical inspection; Contingency plans for slope stabilisation measures. This could involve the provision of engineered toe support to affected slopes comprising gabion style retaining structures. These should be focussed towards areas of highest risk and protection of sensitive receptors including watercourses and source areas.	
Construction related **peat slide (earthworks)**	Increased subsurface groundwater flow and 'piping' failure beneath natural peat deposits, temporary and permanent earthworks	Localised instability associated with temporary and permanent earthworks; Triggering of mass movement of peat material down slope causing harm to personnel, plant and equipment.
Mitigation	Ensure geotechnical design prevents blockages of groundwater flow. This may be achieved through the use of free draining fills and ensuring temporary and permanent earthworks do not cause the build-up of groundwater pressures. A programme of geotechnical inspections should be implemented throughout construction phase. Ensuring focus extends beyond immediate areas of construction, both up-slope and down-slope to detect any unforeseen effects on stability.	
Bearing Capacity Failure (Peat Surface)	Increased loading of low shear strength deep peat deposits	Localised instability and settlement associated with temporary and permanent earthworks;

Hazard	Cause	Consequence
		Triggering of mass movement of peat material down slope causing harm to personnel, plant and equipment; Contamination of natural watercourses and damage to hydrological systems from peat material mobilised down slope;
Mitigation	Due consideration given to the prevailing ground and weather conditions when scheduling site works; Ensure detailed peat depth contour plan to be used in construction planning and design; Use of appropriate plant machinery (low ground pressure and long reach to avoid over loading peat deposits); A programme of geotechnical inspections will be implemented during excavation works; Geotechnical monitoring post-construction.	
Artificial Peat Failure (Storage Areas)	Mass movement of temporary storage mounds and bunds	Localised instability and settlement associated with temporary and permanent earthworks. Triggering of mass movement of peat material down slope causing harm to personnel, plant and equipment.
Mitigation	Storage site selection and stockpile design by a suitably qualified and experienced geotechnical engineer; In general, the temporary storage of peat in a single dedicated would be avoided wherever possible; Peat storage height shall not exceed 1m; Routine maintenance and inspection of peat storage mounds; Additional mitigation measures as described in standalone Peat Management Plan for proposed development. Employ low volume construction methods which where practicable seek to leave peat deposits Insitu. i.e. floating type infrastructure	
Creep, long term settlement of structures	Tracks or hardstand founded on peat and or poor or variable foundation soils	Ongoing settlement and damage of infrastructure, e.g. damage to access track running surface.
Mitigation	Contingency of routine maintenance of infrastructure and drainage elements to ensure longer term issues do not cause a build-up of effects leading to higher level consequences e.g. larger scale instability.	

Source: Natural Power

5. Conclusions

It will be possible to manage the risk of peat slide down to a residual low level across the Proposed Development. There exist predominantly shallow peat soils with discrete areas of deeper peat at the Proposed Development. The following construction related factors to peat slide are highlighted for consideration:

- Movement can occur following over-loading of peat slopes, e.g. by placement of fill, stockpiling and end-tipping directly onto peat slopes;

- Suitability of drainage measures and the prevailing groundwater conditions are also key factors to consider during construction. Increasing pore water pressures within peat deposits decreases the stability of a slope;
- In extreme events, peat can act as a viscous fluid and travel over very shallow slopes. The re-working or excessive handling of peat can reduce the shear strength to residual levels and hence lead to 'liquid' peat behaviour;
- The rate of construction can have a major influence on the stability of peat land environments. Rapid loading and limited time for excess pore pressure dissipation can also decrease the stability state of peat slopes;
- Excavation across a side slope, a convex slope / break in slope can induce peat failure;
- Therefore, the most significant but highly unlikely impact is death or injury to site personnel. More likely is damage of the environment and disruption to the proposed infrastructure leading to time and cost impacts.

5.0.2 The peat depths across the site are in the majority <0.5m. It should be noted that where peat probes indicate shallow depths of 0.1m to 0.5m that the deposits are likely to be composed of a topsoil and mineral subsoil. Peat accumulations therefore have been proven to be isolated and in discrete locations.

5.0.3 The mean un-drained shear strength determined across the Development is (30kPa). This indicates peat of low shear strength. A conservative characteristic value of 14kPa has been used in the slope stability modelling (representing the minimum recorded value).

5.0.4 The risk rankings produced in this report are a combination of the overall likelihood with the potential environmental/impact effect of a peat instability event. With increased proximity to watercourses exposure of such an event is vastly increased as watercourses act as a sensitive off-site receptor and can carry peat debris to further offsite receptors. In addition, where relevant the position of proposed internal site infrastructure and assets has been considered.

5.0.5 The initial risk rankings are based on the risk of peat failure occurring without appropriate mitigation and control measures in place during construction. It should be highlighted that through geotechnical risk management, strict construction management and implementation of relevant control measures, this shall reduce the risk of peat failure across the development to residual low levels.

5.0.6 The risk assessment should be reviewed prior to construction and further refined following intrusive ground investigation and detailed infrastructure design.

6. Recommendations

6.0.1 The peat slide risk assessment cites key control measures which are required to reduce the risk of peat slide to residual (low) levels. However, there should be wider consideration of these measures across all areas of the proposed development which may be influenced by the proposed construction. This is critical where infrastructure may impact terrain and slope conditions beyond the proposed working areas.

- A detailed intrusive ground investigation would be carried out (post-consent) and as part of the pre-construction phase of development. This investigation would seek to further characterise the peat deposits with emphasis on in-situ shear strength testing and targeted undisturbed sampling and laboratory testing. All peat samples recovered should be classified in accordance with the Von Post system, (Hobbs, 1986) and current British and Eurocode standards for site investigation. Further investigation of the peat sub-soil interface would also be carried out.
- Groundwater level information would be collated as part of any future ground investigation;
- The results of a detailed ground investigation should be assessed with respect to refining the peat stability assessment at infrastructure locations where peat slide risk is elevated. All pertinent control measures and mitigation measures should be revised, and their implementation supervised following the results of the ground investigation and construction design phase of works;

- Continued assessment and monitoring throughout the construction phase of works and at suitable intervals post construction should be implemented to ensure the control measures are suitable and are providing adequate mitigation against peat instability;
- Construction practices should be managed through the Construction Method Statement (CMS) and within the wider context of the Construction Environmental Management Plan (CEMP). The CMS should be prepared by the appointed principal contractor and reviewed by a suitably experienced geotechnical engineer who has read and understood this report. The following general recommendations are provided in line with the, Good practice during wind farm construction, (2019) guidance:
  - Avoid peat arisings being placed as local concentrated loads on peat slopes without first establishing the stability condition of the ground and slope system. Stockpiling on areas of deep peat and in close proximity to steep slopes should be avoided.
  - Avoidance of uncontrolled and concentrated surface water discharge onto peat slopes as this may act as contributory factor to failure. All water discharged from excavations during construction phase should be directed away from all areas identified as susceptible to peat failure and should managed by a suitably designed site drainage management plan.
  - All excavations where required should be adequately supported to prevent collapse and the destabilising peat deposits adjacent to excavations.
  - A system of daily reporting should be established during construction and utilised to monitor the geotechnical performance of slopes including peat, sub-soil and bedrock. This should be implemented and undertaken by a suitable experienced and qualified geotechnical engineer. Post construction this monitoring procedure should be curtailed to allow for annual or ad-hoc inspection as required.

6.1.1 MacCulloch, (2006) advises that a 'floating' type road construction which leaves the peat deposits in situ may be advantageous with respect to preventing peat failure. This method of construction has a lower impact on the internal groundwater flow within the peat land. However, there are cases where groundwater flow within the peat can be detrimentally affected. The following control measures should be implemented as part of the design and construction of 'floating' access track:

- Prevent the rupture of vegetation surface of the peat by avoiding the use of large sharp rock fill;
- Prevent the overloading and subsequent shearing of the peat throughout construction and use of the 'floating' track;
- Monitoring of the long-term settlement of the 'floating' track is necessary to predict the effects of reducing permeability within the peat and hence increasing groundwater pressures beneath the track construction. Through ongoing monitoring additional drainage relief measures can be implemented when conditions for peat failure are predicted;
- Do not position 'floating' access track on or adjacent to convex side slopes.

An additional control on the construction and use of 'floating' track is through the strict management of construction traffic loading. This may involve staggering the timing between heavy traffic to prevent cyclic loading over short time periods reducing the shear strength of the peat. In order to assess the maximum loading rate or timing between heavy construction traffic it may be necessary to monitor the vertical deformation of the 'floating' track sections following loading and recording the time taken for recovery of vertical deformation. The use of simple settlement plates and survey pegs can be used to achieve this. The frequency of trafficking for heavy loads must then be timed to allow deformation of the 'floating' road to recover its deformation.

6.1.2 MacCulloch (2006) generally advises that in order to prevent injury or an environmental incident, it is important that there is a robust procedure in place should it become apparent that a peat failure is imminent.

6.2.1 Across the Proposed Development Area not affected by deep peat; the construction of proposed access tracks should be considered by excavation and replacement method, MacCulloch, (2006). Excavated peat is removed and targeted for suitable re-use. Aggregate would be used to form the subgrade and running surface of the track.

6.2.2 For 'Cut/Fill' track construction the risk of peat failure is therefore focussed on the peat deposits adjacent to the access track and the placement of peat arisings. In these areas the following control measures are listed by MacCulloch, (2006):

- Careful excavation of peat deposits by appropriate machine excavator to limit localised peat failures which can occur on the edge of the track excavation. This is in order to prevent a minor failure triggering retrogressive peat failure affecting a larger area of peat adjacent to the track;
- Temporary drainage systems followed by establishment of a permanent drainage network. Silt traps and small retaining structures may be required especially in proximity to water crossings to prevent siltation and blockage of watercourses;
- Ongoing monitoring and on demand maintenance when silt traps require emptying and temporary drainage reinstated if blocking occurs. This will assist in maintaining hydrology baseline conditions;
- The permanent drainage system must direct surface water flow away from the 'cut' track to prevent peat failure within the track bunds;

6.3.1 It has been identified that there is a requirement for the excavation of peat soils and superficial deposits during construction of the wind farm. Initially the vegetated peat layer and any topsoil should be stripped and temporarily stockpiled away from areas of deep peat and instability risk. The design of this stockpile must be agreed by a suitably qualified geotechnical engineer. When working in areas of deep peat (i.e. >0.5m) no peat or overburden should be stored on such deposits as this may lead to instability. The following options for peat storage may be considered:

- Dedicated peat storage areas designed under the advisement of a suitable qualified geotechnical engineer and conform to up-to-date regulations and waste directives.
- Re-use of peat in dressing-off of batters on access tracks, finishing of cable trenching works, and the landscaping of turbine bases. Peat must be re-used to ensure stability and its long-term sustainability i.e. the prevention of drying of desiccation.
- Excavated glacial till and weathered rock may be used as backfill to turbine bases should material be deemed geotechnically suitable. All related works must be carried out in accordance with an agreed CEMP and conform to site restoration plans.
- For in-situ and undisturbed peat, site vehicle movements must be minimised across such areas throughout construction and post construction. Observation and monitoring for settlement, deformation, or signs of failure along access tracks and critical working areas must be implemented. This may be achieved with a network of settlement plates and survey markers which can be periodically re-surveyed, and any differential movements identified. It is recommended that all earthworks are designed in accordance with current national standards. Such measures would be focused on zones of deep peat and areas at elevated peat slide risk.

6.3.2 The following risk mitigation is recommended with regards to peat storage:

- Storage site selection and stockpile design would be undertaken by a suitably qualified and experienced engineer;
- Temporary storage of peat in a single dedicated area shall be avoided;
- Peat storage on areas of low / negligible peat slide risk only
- Peat storage height shall not exceed 0.5m without dedicated stability assessment;
- Routine maintenance and inspection of peat storage areas would be undertaken;

7. References

BS EN 1997-1:2004, EC7: Geotechnical Design, Part 1: General Rules.

BS EN 1997-2:2007, EC7: Geotechnical Design, Part 2: Ground Investigation and Testing.

British Geological Survey, 1:50,000 Digital Data.

British Geological Survey, Borehole Database.

British Standards Institute (2009). BS6031:2009 Code of practice for Earthworks.

Barnes, G.E., (2000), Soil Mechanics, Principles and Practice, 2nd Edition, Palgrave Macmillan.

Scottish Executive (2017), Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments Second Edition. http://www.gov.scot/Publications/2017/04/8868.

Hobbs, N. B. (1986). Mire morphology and the properties and behaviour of some British and foreign peats. Quarterly Journal of Engineering Geology, London, 1986, vol. 19, pp.7-80.

SEPA http://map.sepa.org.uk/

National Library of Scotland, http://maps.nls.uk/os/.

Clayton, C.R.I. (2001). Managing Geotechnical Risk. Institution of Civil Engineers, London.

Carling, P.A., (1986), Peat slides in Teesdale and Weardale, Northern Pennines, July 1983: description and failure mechanisms. Earth Surface Processes and Landforms, 1986 – Wiley.

Farrell, E.R. & Hebib, S. 1998. The determination of the geotechnical parameters of organic soils. Proceedings of International Symposium on Problematic Soils, IS-TOHOKU 98, Sendai, Japan, 33–36.

Von Post, L. & Granland, E., 1926 Peat Resources in Southern Sweden, Sverges geoligiska undersokning.

Scottish Government, Scottish Natural Heritage, SEPA (2017) Peatland Survey, Guidance on Developments on Peatland.

Smith, I, Smith's Elements of Soil Mechanics, 8th Edition, ISBN: 978-1-4051-3370-8

Hobbs, N. B. (1986). Mire morphology and the properties and behaviour of some British and foreign peats. Quarterly Journal of Engineering Geology, London, 1986, vol. 19, pp.7-80.

Good Practice During Wind Farm Construction, A joint publication by: Scottish Renewables, Scottish Natural Heritage, Scottish Environmental Protection Agency, Forestry Commission Scotland, Historic Environment Scotland, Marine Scotland Science, AEECoW, 4th Edition, 2019.

MacCulloch, F. (2006). Guidelines for the Risk Management of Peat Slips on the Construction of Low Volume/Low Cost Roads over Peat.

Hanrahan, E.T., Dunne, J.M. & Sodha, V.G. 1967. Shear strength of peat. Proceedings of the Geotechnical Conference, Oslo, 1, 193–198.

Rowe, R., and Mylleville, B. L. J., (1996) A geogrid reinforced embarkment on peat over organic silt: a case history. Canadian Geotechnical Journal, 1996, 33(1): 106-122.

Landva, A.O. 1980a. Geotechnical behaviour and testing of peat. PhD thesis, Laval University, Quebec.

Rowe, R., MacLean, M.D., and Soderman, K.L., (1984), Analysis of a geotextile-reinforced embankment constructed on peat. Canadian Geotechnical Journal. 21, 563 -576 (1984).

Hunger, O. & Evans, S.G. 1985. An example of a peat flow near Prince Rupert, Britis Columbia. Canadian Geotechnical Journal, 22, 246–249.

Dykes, A.P. & Kirk, K.J. 2006. Slope instability and mass movements in peat deposits. In Martini, I.P., Martinez Cortizas, A. & Chesworth, W. (eds) Peatlands: Evolution and Records of Environmental and Climate Changes. Elsevier, Amsterdam, 377–406.

Warburton, J., Higgit, D. & Mill, A.J. (2003), Anatomy of a Pennine peat slide, Northern England. Earth Surface Processes and Landforms, 28, 457–473.

Skempton, A.W., DeLory, F.A., 1957. Stability of natural slopes in London clay. Proceedings 4th International Conference on Soil Mechanics and Foundation Engineering, vol. 2, pp. 378 – 381.

Hutchinson, J.N., 1988, General Report: morphological and geotechnical parameters of landslides in relation to geology and hydrogeology. In Bonnard, C. (Editor), Proceedings, Fifth International Symposium on Landslides, A.A.Balkema, Rotterdam, Vol.1, pp. 3-36.

Applied Ground Engineering Consultants (2004). Derrybrien Wind Farm Final Report on Landslide of October 2003.

Boylan, N,. Jennings, P., & Long, M., (2008) Peat slope failure in Ireland, Quarterly Journal of Engineering Geology and Hydrogeology 2008; V. 41; p. 93-108.

Dykes, A.P. & Warburton J. (2008) Characteristics of the Shetland Isles (UK) peat slides of 19 September 2003. Landslides 2008 vol. 5 pp. 213-226.

Nichol, D, Doherty, G.K & Scott, M.J (2007) A5 Llyn Ogwen peat slide, Capel Cruig, North Wales. Quarterly Journal of Geology and Hydrogeology Vol 40, pp 293-299.

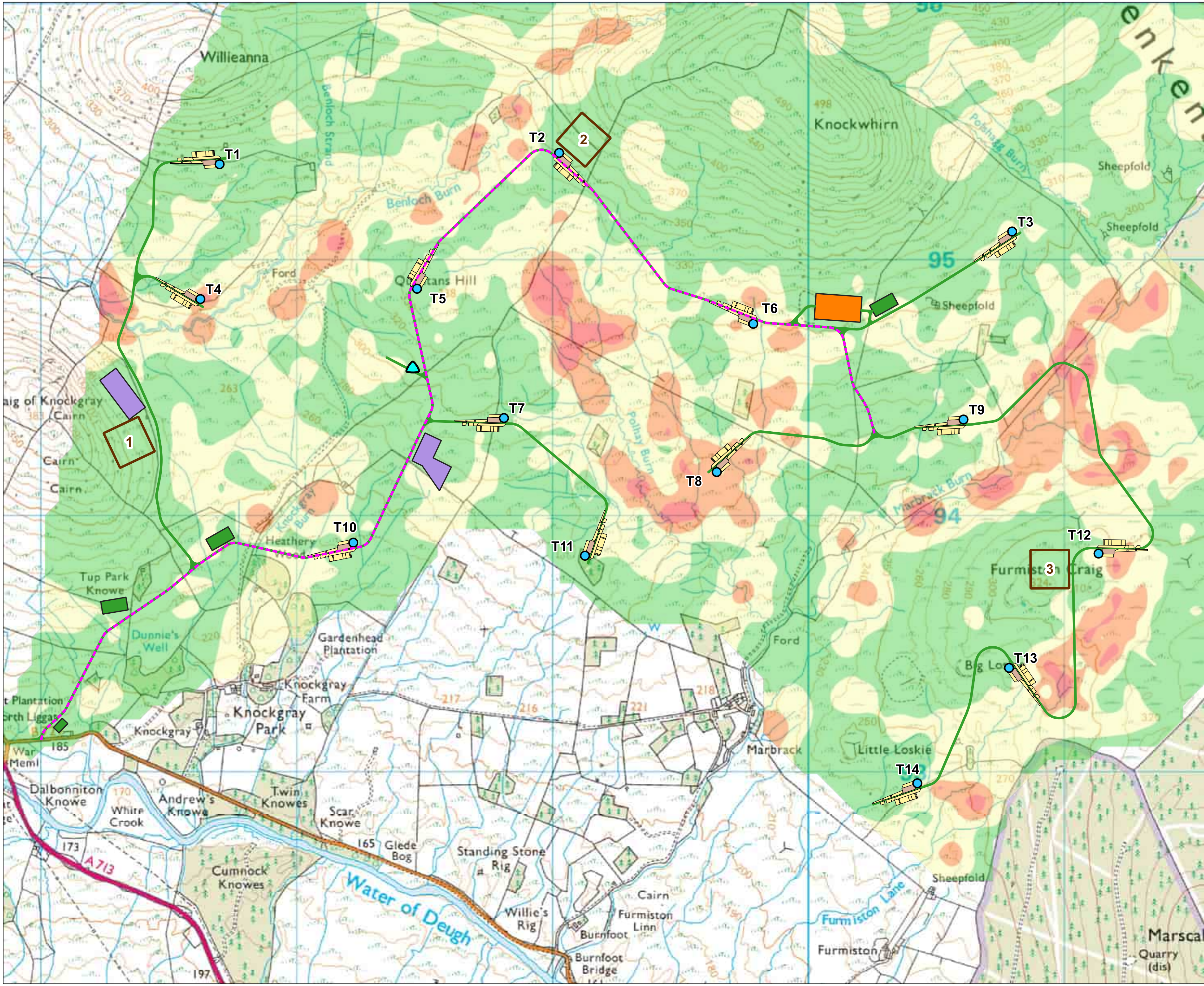
8. Glossary

Term	Definition
Acrotelm	The thin aerobic zone at the surface of the mire usually fibrous and containing the majoring of groundwater flow through the peat mass, underlain by the thick anaerobic zone called the catotelm, usually a higher degree of humification and lower shear strength.
Bog Burst / Flow	Failure of a raised bog (i.e. bog peat) involving the break-out and evacuation of (semi-) liquid basal peat. A flow is formed of highly humified basal peat from a clearly defined source area.
Bulk Density	The normal in situ density of a soil, i.e. its mass divided by its volume.
Catotelm	see acrotelm.
Consolidation	The process by which a soil decreases in volume.
Construction Method Statement	(CMS), a detailed written description of how a particular construction activity will be carried out safely and in an environmentally compliant manner.
Diamicton	Glacially derived soil which is poorly sorted and contains soil particles ranging in size from clay to boulders.
Geographical Information System (GIS)	Form of technology capable of capturing, storing, retrieving, editing, analysing, comparing and displaying spatial environmental information.
Geo-hazard	Geological hazard, either natural or man-made, which threatens either humans or the environment in which they live.
Geo-membrane	Non-porous sheet that has a very low permeability (in engineering terms impermeable) usually formed of polyethylene.
Geo-textiles	Man-made fabrics, generally made from plastics but also may be made from natural materials, used in construction.
Groundwater	Water located beneath the ground surface in soil pore spaces and in the fractures of rock formations.
GWDTE	Ground Water Dependent Terrestrial Ecosystem
Ground Investigation	Specialist intrusive phase of site investigation with associated monitoring, testing and reporting to a national standard.
Hagg	Natural gully or weathering structure in surface of peat mass.
Hazard	Something with a potential for adverse consequences / harm.
Humification	The process of decomposition of a peat soil.
Hydrological regime	The statistical pattern of a river's constantly varying flow rate.
Mitigation	The limitation of undesirable effects / impact of a particular event.
Mitigation Measures	Actions in place to limit the undesirable effects / impact of a particular event.
Peat Slide	Failure of a blanket bog involving sliding of intact peat and the mineral substrate material or immediately above the contact with the underlying mineral soil substrate.
Peat debris slide	Shallow translational failure of a hillslope with a mantle of blanket peat in which failure occurs by shearing wholly within the mineral substrate and at a depth below the interface with the base of the peat such that the peat is only a secondary influence on the failure.
Permeability	The rate at which water and air moves through a soil.

Term	Definition
Pore water	The water filling the voids between grains of soil
Primary consolidation	The process by which a soil decreases in volume through the expulsion of internal pore water
Overland flow	Water passing rapidly over or through the surface layer of soil.
Peat	A largely organic substrate formed of partially decomposed plant material
Precipitation	Deposition of moisture including dew, hail, rain, sleet and snow.
PWS	Private Water Supply
Risk	The combination of the probability of an event and the magnitude of its consequences
Residual Risk	The risk remaining after mitigation measures have been undertaken.
Rockhead	The upper surface of rock mass beneath the superficial soil cover.
Runoff	Surface runoff is the flow of water over the surface that can result due to the surrounding soils lacking the capacity to infiltrate further water or due to the surface water flowing off infrastructure such as access tracks and hardstands.
Secondary Consolidation	The compression of a soil that takes place after primary consolidation due to creep, compression of organic matter etc.
Sedimentation	The tendency for particles in suspension to settle out of the fluid in which they are entrained.
Site Investigation	The overall process of discovery of information concerning a site, the appraisal of data, assessment and reporting. Can include desk, non-intrusive and intrusive investigation.
Shear strength	The maximum shear stress which a material can withstand without rupture/ failure
Shear vane	In situ test using a x4 blade steel vane pushed into the ground and rotated to provide an indication to the undrained shear strength of a soil.
Superficial Deposits	Young, sediments and soil deposits occurring at the surface.
Surcharge	An additional mass of material or load applied to an existing soil or structure
Topography	The physical features of a geographical area.
Undisturbed Sample	A sample of soil whose condition is sufficiently close to the actual condition of the soil in situ to be used to approximate the properties of the soil in the ground.
Water resources	The supply of groundwater and surface water in a given area.

Source: Natural Power

APPENDIX A



Legal:
Natural Power Consultants Ltd take no responsibility for the accuracy of data provided by third parties.

Map Legend:

- Quantans Thoroughfare Track
- Proposed turbine

Proposed cranepad and hardstanding

- Permanent
- Temporary
- Proposed anemometry mast
- Proposed track
- Proposed Borrow Pit

Proposed

- Probe Location

Ancillary Infrastructure

- Batching Plant
- Substation
- Temp Compound

Notes:
Peat Depth Interpolation: based on ordinary kriging method.

Rev	Description	By/Ch	Date

Status: FINAL

Project: Quantans Hill Wind Farm

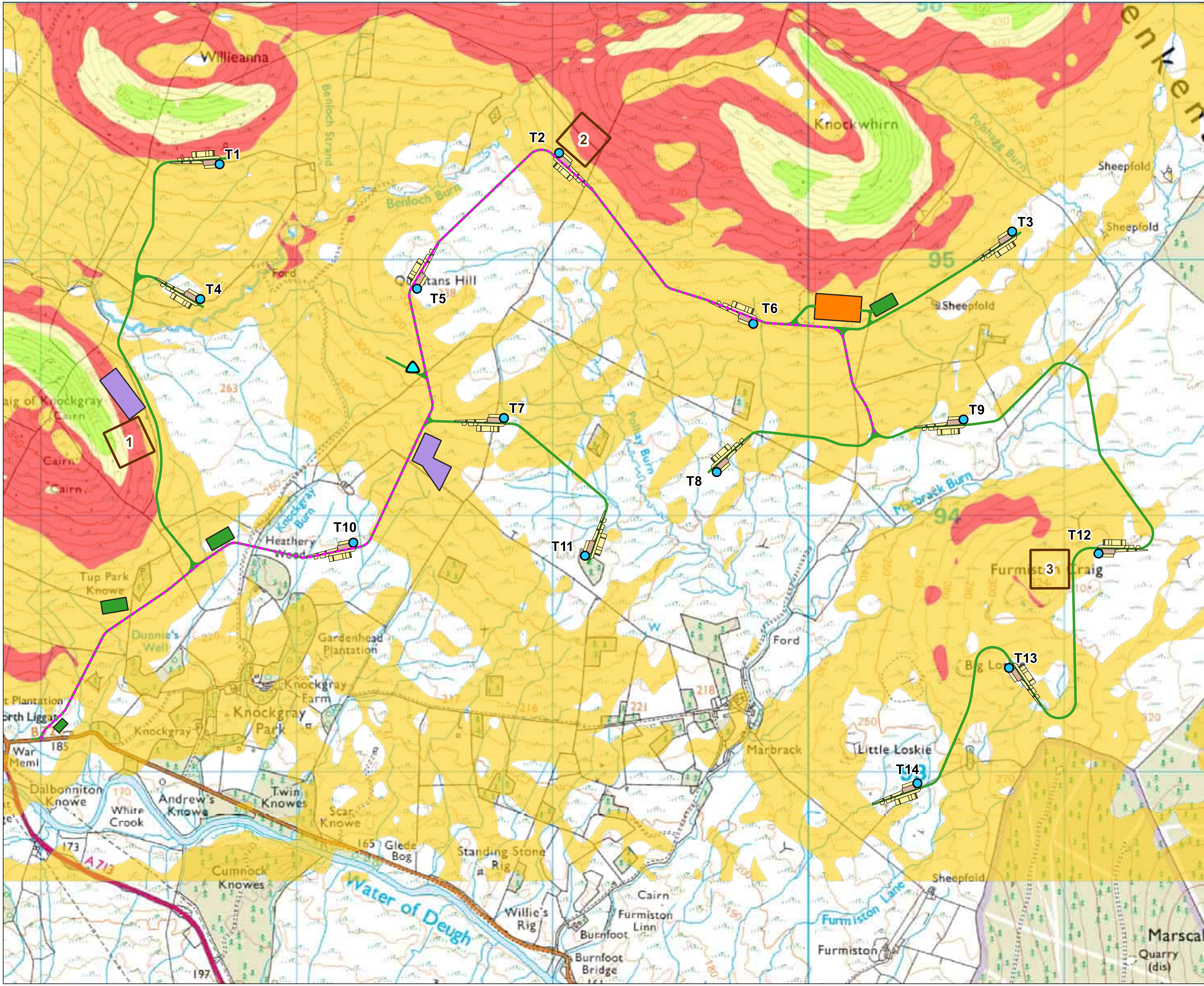
Client: Vattenfall

Drawing Title: Peat Depth Map

Drawn: CM	Checked: MA	Approved: GG
Scale: AS SHOWN @ A3	Date: 07/07/2022	

Natural Power Consultants
The Green House, Forrest Estate, Dalry
Castle Douglas, DG7 3XS, UK
Tel: +44(0)1644 430 008
Fax: +44(0)845 299 1236
Email: sayhello@naturalpower.com
www.naturalpower.com

Drawing No. 13736UKC_PSRA_001 | Revision: E



Legal:
Natural Power Consultants Ltd take no responsibility for the accuracy of data provided by third parties.

Map Legend:

- Quantans Thoroughfare Track
- Proposed turbine

Proposed cranepad and hardstanding

- Permanent
- Temporary
- Proposed anemometry mast
- Proposed track
- Proposed Borrow Pit

Ancillary Infrastructure

- Batching Plant
- Substation
- Temp Compound

Notes:
Digital terrain & slope model (DTM) based on Ordnance Survey OS Terrain 5 (5m grid contours). Major contours shown every 10m

Rev	Description	By/Ch	Date

Status: FINAL

Project: Quantans Hill Wind Farm

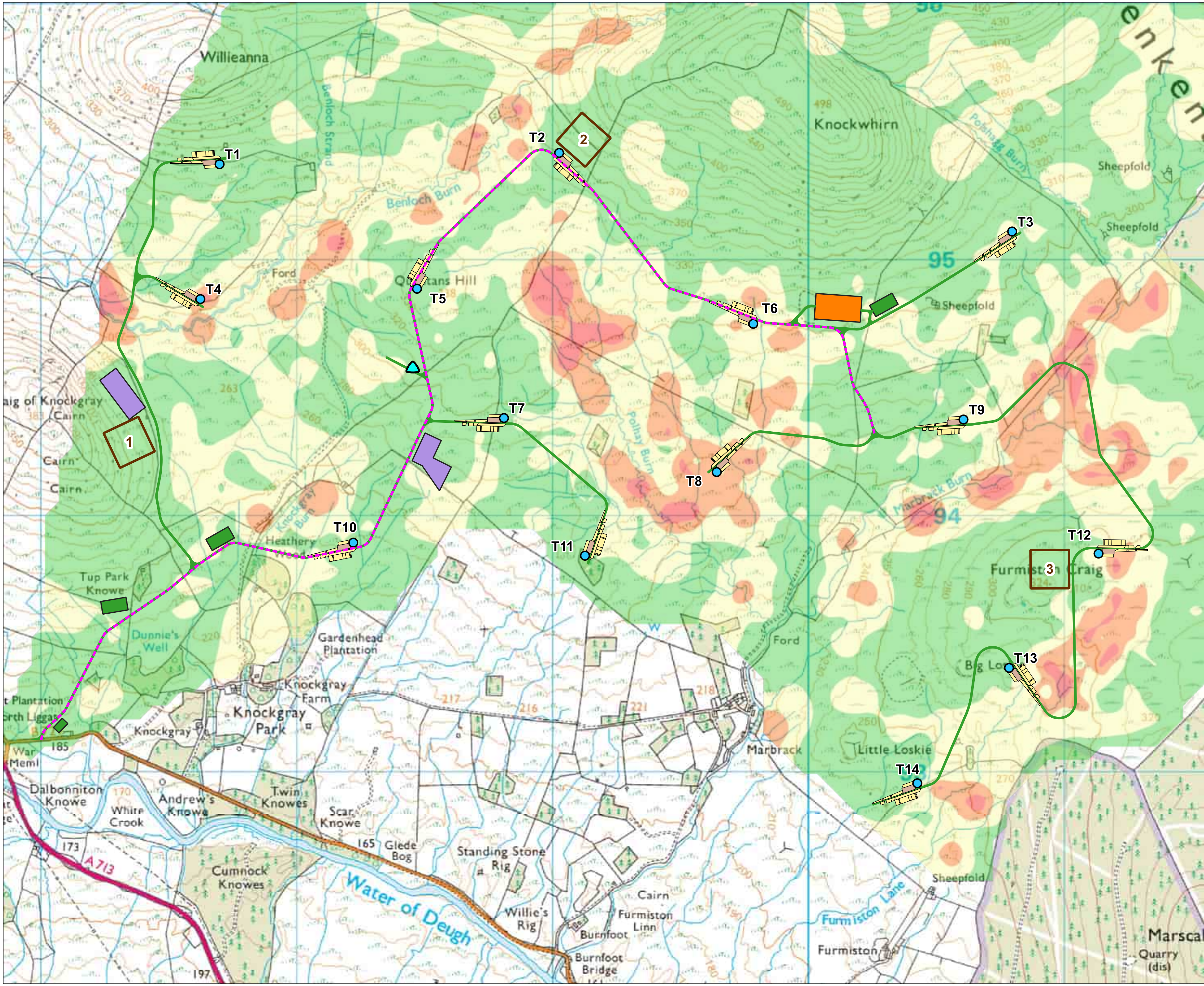
Client: Vattenfall

Drawing Title: Slope Angle Map

Drawn: CM	Checked: MA	Approved: GG
Scale: AS SHOWN @ A3	Date: 07/07/2022	

Natural Power Consultants
The Green House, Forrest Estate, Dalry
Castle Douglas, DG7 3XS, UK
Tel: +44(0)1644 430 008
Fax: +44(0)845 299 1236
Email: sayhello@naturalpower.com
www.naturalpower.com

Drawing No. 13736UKC_PSRA_002 | Revision: E



Legal:
Natural Power Consultants Ltd take no responsibility for the accuracy of data provided by third parties.

Copyright: Based upon Ordnance Survey data with the permission of the Controller of Her Majesty's Stationary Office © Crown Copyright. Aerial Imagery © Google Earth Professional 2020

Map Legend:

- Quantans Thoroughfare Track
- Proposed turbine

Proposed cranepad and hardstanding

- Permanent
- Temporary
- Proposed anemometry mast
- Proposed track
- Proposed Borrow Pit

Ancillary Infrastructure

- Batching Plant
- Substation
- Temp Compound

High

Medium

Low

Negligible

Notes:
Initial GIS based model for uncontrolled risk of peat slide based on methodology set out in accompanying peat slide risk assessment. Additional qualitative and quantitative assessment included within the main report with detailed control measures.

Rev	Description	By/Ch	Date

Status: FINAL

Project: Quantans Hill Wind Farm

Client: Vattenfall

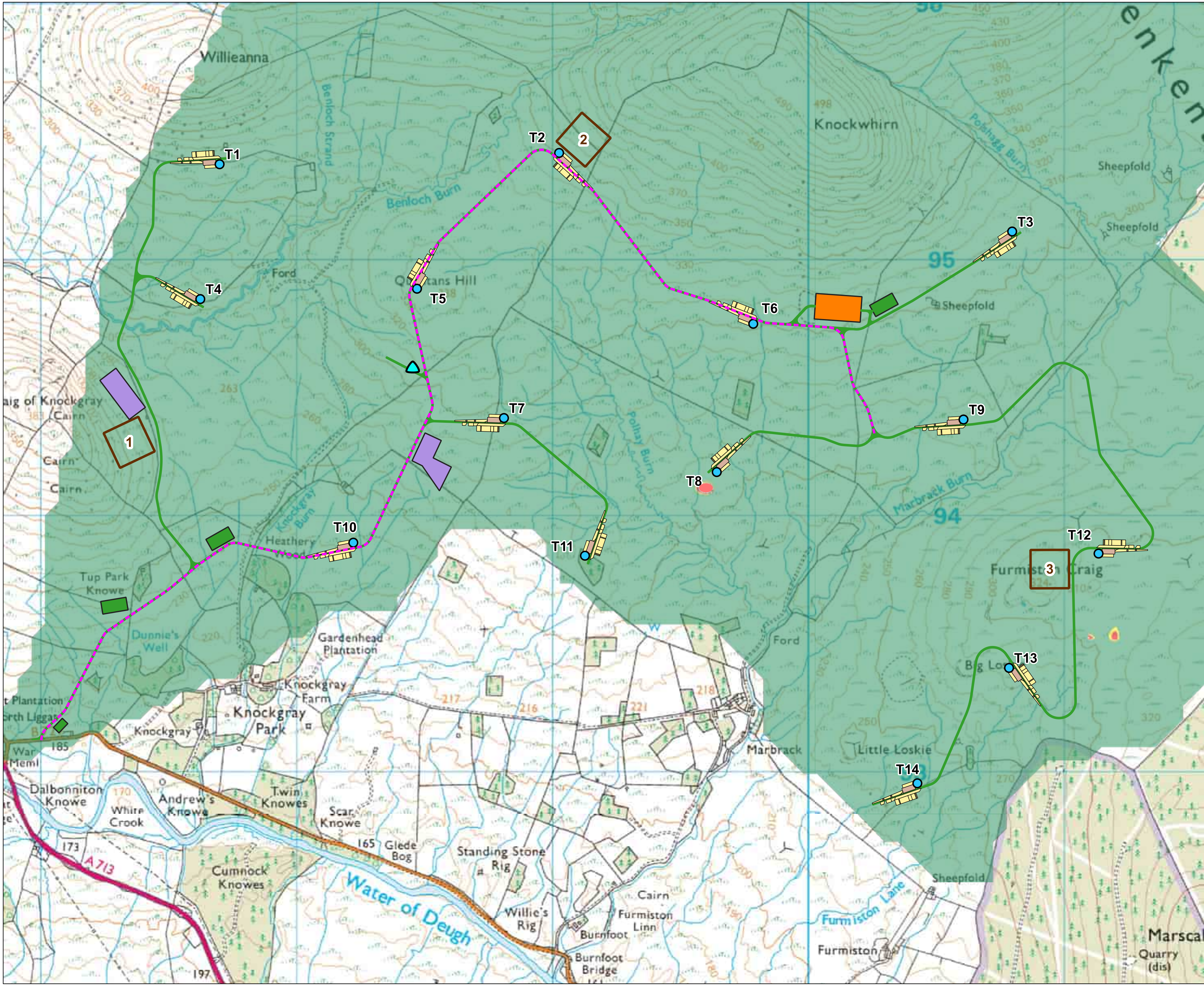
Drawing Title: Peat Slide Risk Map

Drawn: CM | Checked: MA | Approved: GG

Scale: AS SHOWN @ A3 | Date: 07/07/2022

Natural Power Consultants
The Green House, Forrest Estate, Dalry
Castle Douglas, DG7 3XS, UK
Tel: +44(0)1644 430 008
Fax: +44(0)845 299 1236
Email: sayhello@naturalpower.com
www.naturalpower.com

Drawing No. 13736UKC_PSRA_003 | Revision: E



Legal:
Natural Power Consultants Ltd take no responsibility for the accuracy of data provided by third parties.

Map Legend:

- Quantans Thoroughfare Track
- Proposed turbine

Proposed cranepad and hardstanding
- Permanent
- Temporary
- Proposed anemometry mast
- Proposed track
- Proposed Borrow Pit

Ancillary Infrastructure
- Batching Plant
- Substation
- Temp Compound

Notes:
Factor of Safety against Peat Slide - Infinte Slope Model - 20kPa Surcharge Condition

Rev	Description	By/Ch	Date

Status: FINAL

Project: Quantans Hill Wind Farm

Client: Vattenfall

Drawing Title: Peat Slide Factor of Safety

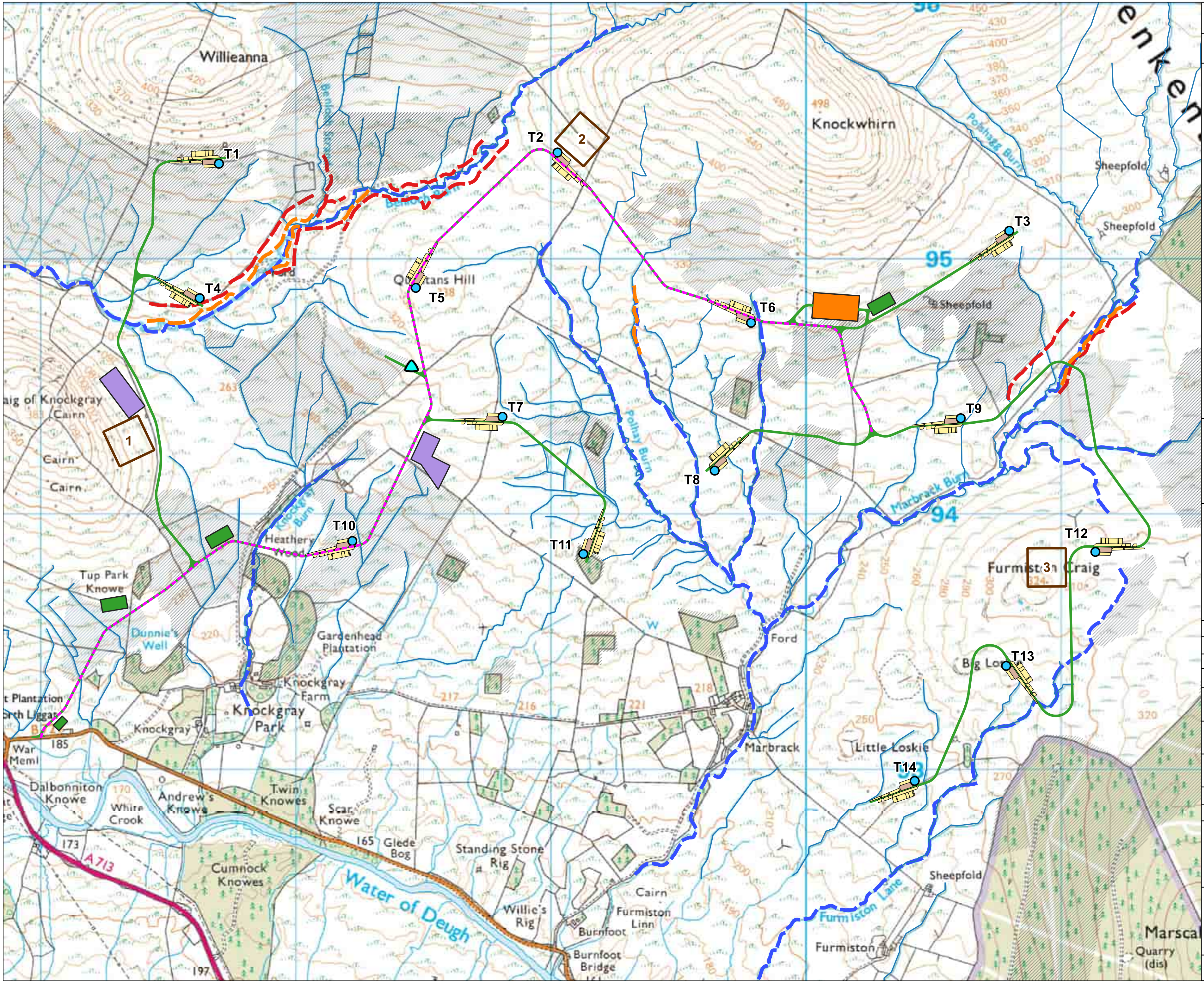
Drawn: CM	Checked: MA	Approved: GG

Scale: AS SHOWN @ A3 | Date: 07/07/2022

Natural Power Consultants
The Green House, Forrest Estate, Dalry
Castle Douglas, DG7 3XS, UK
Tel: +44(0)1644 430 008
Fax: +44(0)845 299 1236
Email: sayhello@naturalpower.com
www.naturalpower.com

natural power

Drawing No. 13736UKC_PSRA_004 | Revision: E



Legal:
Natural Power Consultants Ltd take no responsibility for the accuracy of data provided by third parties.

Map Legend:

- Quantans Thoroughfare Track
- Proposed turbine

Proposed cranepad and hardstanding
- Permanent
- Temporary
- Proposed anemometry mast
- Proposed track
- Proposed Borrow Pit

Ancillary Infrastructure
- Batching Plant
- Substation
- Temp Compound
- Forestry/Woodland
- Artificial Drainage Area
- Concave Slope Break
- Convex Slope Break
- Minor Watercourse
- Main Watercourse (Receptor)

Notes:

Rev	Description	By/Ch	Date

Status: FINAL

Project: Quantans Hill Wind Farm

Client: Vattenfall

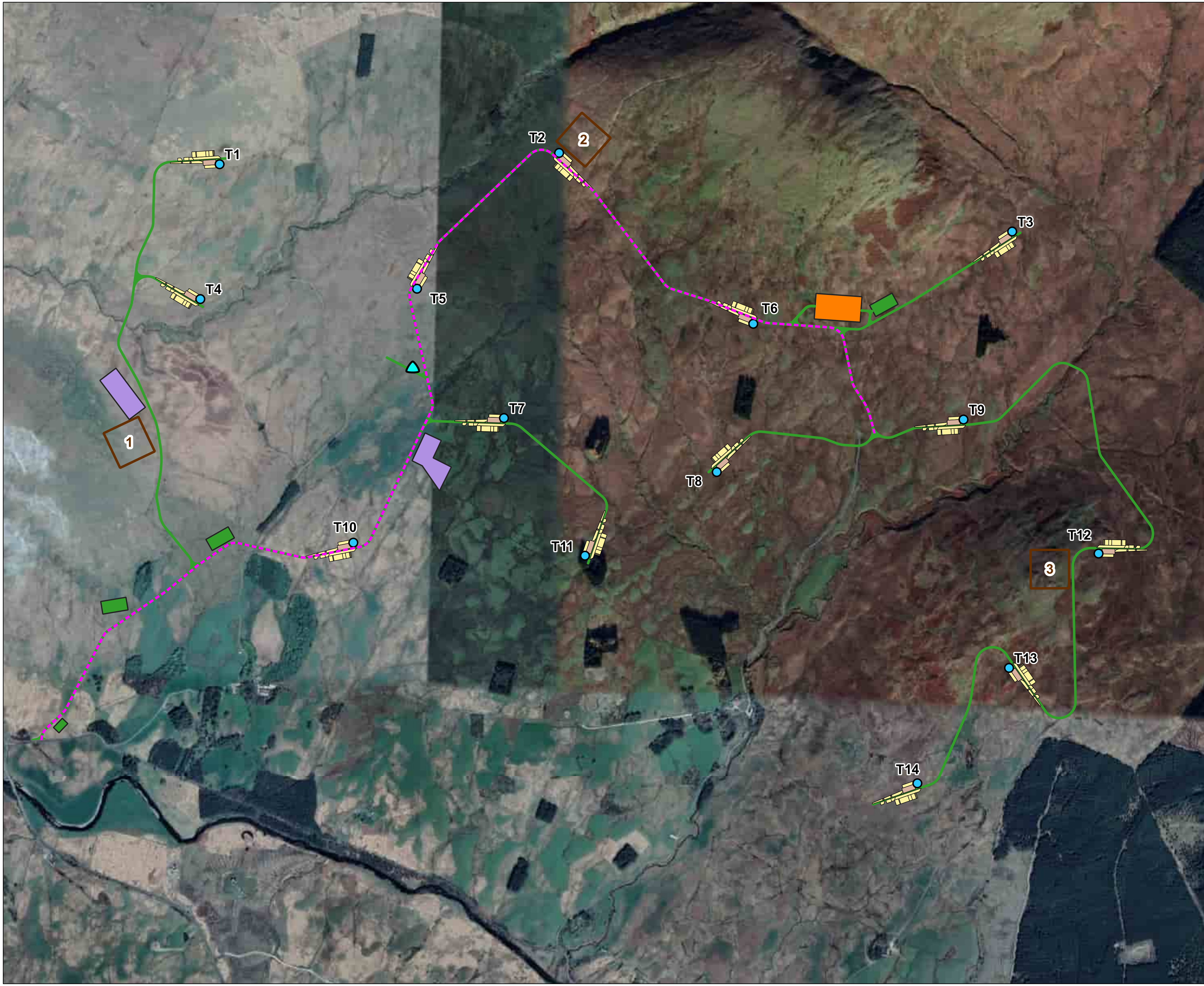
Drawing Title: Geomorphology

Drawn: CM	Checked: MA	Approved: GG

Scale: AS SHOWN @ A3 | Date: 07/07/2022

Natural Power Consultants
The Green House, Forrest Estate, Dalry
Castle Douglas, DG7 3XS, UK
Tel: +44(0)1644 430 008
Fax: +44(0)845 299 1236
Email: sayhello@naturalpower.com
www.naturalpower.com

Drawing No. 13736UKC_PSRA_005 | Revision: E



Map Legend:

- Quantans Thoroughfare Track
- Proposed turbine

Proposed cranepad and hardstanding
- Permanent
- Temporary
- Proposed anemometry mast
- Proposed track
- Proposed Borrow Pit

Ancillary Infrastructure
- Batching Plant
- Substation
- Temp Compound

Notes:

Rev	Description	By/Ch	Date

Status: FINAL

Project: Quantans Hill Wind Farm

Client: Vattenfall

Drawing Title: Aerial Photo Map

Drawn: CM | Checked: MA | Approved: GG

Scale: **AS SHOWN @ A3** | Date: 07/07/2022

Natural Power Consultants
The Green House, Forrest Estate, Dalry
Castle Douglas, DG7 3XS, UK
Tel: +44(0)1644 430 008
Fax: +44(0)845 299 1236
Email: sayhello@naturalpower.com
www.naturalpower.com

natural power

Drawing No. 13736UKC_PSRA_006 | Revision: E

Creating a better environment

naturalpower.com
sayhello@naturalpower.com

For full details on our ISO and other certifications, please visit our website.

Document history

Author	Sam Wainwright	27/08/2021
Checked	Emma Bryder	09/09/2021
Approved	Kelly Wyness	25/10/2021

Client Details	
Contact	Matt Bacon
Client Name	Vattenfall Wind Power Ltd

Issue	Date	Revision Details
A	28/10/2021	First draft submission
B	03/11/2021	Updated
C	16/12/2021	Released
D	22/06/2022	Update and Released

Appendix 8.3

Peat Management Plan

Contents

A8.1. INTRODUCTION 2
Regulatory Requirements 2
Disclaimer 2
A8.2. SITE CONTEXT 3
A8.3. APPROACH TO DESIGN 3
A8.4. PEAT SURVEY RESULTS 3
A8.5. PEAT EXTRACTION & RE-USE 4
Peat Handling Prior to Construction 5
Excavation 5
Design Assumptions 5
Access Tracks – Excavation & Replacement 5
Access Tracks - Floating Construction 6
Access Tracks – Dimensions 6
Turbine Foundations 6
Crane Pads & Hardstands 6
Additional & Ancillary Infrastructure 6
Excavation Volumes 7
Re-use Volumes of Excavated Peat 8
Re-use Volume Estimate 9
Temporary Storage 9
A8.6. REINSTATEMENT METHODOLOGIES 9
Access Tracks 9
Cable Trenches 10
Wind Turbine Foundations 10
Crane Pads & Hardstands 10
Ancillary Infrastructure 11
Borrow Pits 11
A8.7. MONITORING 11
References 11

Glossary

Refer to Chapter 8: Hydrology, Geology and Hydrogeology in Volume 2 of the EIAR for the Glossary.
List of Abbreviations

List of Abbreviations

Refer to Chapter 8: Hydrology, Geology and Hydrogeology in Volume 2 of the EIAR for the List of Abbreviations.

A8.1. INTRODUCTION

A8.1.1. This Peat Management Plan (PMP) provides information and guidance on the environmentally compliant re-use and management of excavated peat across the Proposed Development and should be read in conjunction with Chapter 8; Geology, Hydrology and Hydrogeology of the Environmental Impact Assessment Report (EIAR).

A8.1.2. The information presented in this plan should be used to inform the wider assessments carried out for the Proposed Development. The study has drawn on information collected as part of a peat study, including desk-based study followed by a phase one and phase two peat depth surveying exercise. The PMP as outlined in this document estimates the total volumes of excavated peat likely to be produced by the Proposed Development and outlines suitable reuse methods in line with regulatory requirements and industry good practice methods.

A8.1.3. This strategy should be adopted to allow peat to be managed in a sustainable manner, minimising excavation via the adoption of appropriate construction methods. Targeted re-use of peat as part of the reinstatement works shall also be a primary consideration.

Regulatory Requirements

A8.1.4. This document addresses the following requirements in line with the Scottish Environment Protection Agency (SEPA) Regulatory Position Statement – Developments on Peatland:

- Prevention – The best management option for waste peat is to prevent its production; and
- Re-use – Developers should attempt to re-use as much of the peat produced on site as possible.

A8.1.5. In general, the following guidance has fed into the design assumptions and subsequent selection of appropriate construction methods based on the distribution of peat depths across the site:

- Developments on Peatland: Guidance on the assessment of peat volumes, re-use of excavated peat and the minimisation of waste (A joint publication by Scottish Renewables, Scottish Natural Heritage (SNH), SEPA, Forestry Commission Scotland, 2012);
- Guidance on Developments on Peatland – Peatland Survey 2017. Scottish Government, SNH, SEPA;
- Floating Roads on Peat (Forestry Civil Engineering & SNH, 2010); and
- Good Practice During Wind Farm Construction (A joint publication by Scottish Renewables, SNH, SEPA, Forestry Commission Scotland, 2019), Version 4; and
- Scottish Government, SNH, SEPA (2017) Peatland Survey. Guidance on Developments on Peatland, on-line version only.

Disclaimer

A8.1.6. The information presented in this report is based on the results of peat surveys carried out by Natural Power between 2020 and 2021. 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.

A8.1.7. The PMP 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.

A8.1.8. 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 development layout and peat depth data averaged across discrete areas of the 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.

A8.1.9. The accuracy of these predictions may be improved though further detailed site investigation (post consent). It is therefore important that the PMP remains a live document throughout pre-construction and construction phases and is encapsulated within a wider Construction Environmental Management Plan (CEMP). The PMP and volumetric assessments can be updated as more accurate information becomes available.

A8.1.10. Further details on the best practice measures to re-use the excavated peat and peaty soils at the development are discussed in the following sections.

A8.2. SITE CONTEXT

A8.2.1. Information concerning the hydrology and hydrogeology of the Proposed Development Area, including a summary of the distribution of mapped soil types are presented in Chapter 8 Geology, Hydrology and Hydrogeology of the EIAR, which this technical appendix supports.

A8.2.2. The following figures presented as part of the EIAR should be viewed in conjunction with this PMP:

- Figure 8.4: Carbon and Peatland Soils;
- Figure 8.5: Predominant Soils; and
- Figure 8.6: Peat Dept Interpolation.

A8.2.3. It is also recommended this PMP be read in conjunction with Technical Appendix (TA) 8.2: Peat Stability Risk Assessment (PSRA).

A8.3. APPROACH TO DESIGN

A8.3.1. The Applicant has sought to minimise the potential impacts on peat through an iterative design process, optimising the distribution and orientation of the proposed infrastructure following the completion of each phase of surveying. The avoidance of peat as part of the design evolution was identified as a key objective from the outset. Examples of where additional targeted peat surveys resulted in the repositioning of infrastructure to avoid peat are as follows:

- Repositioning of T13 to avoid a pocket of deeper peat to the southeast of the proposed location;
- Repositioning of T11 to avoid a pocket of deeper peat to the northeast of the proposed location;
- Repositioning of T12 to avoid a pocket of deeper peat to the east of the proposed location; and
- Avoidance of an area of deep peat on the interfluve between the Benloch Burn and Knockgray Burn catchment, east of Craig of Knockgray.

A8.3.2. Where the results of detailed design indicate that micro-siting within the allocated micro-siting distance could achieve a reduction in the requirement for peat excavation, this would be investigated by the Principal Contractor and where possible, implemented following approval with the Environmental Clerk of Works (ECoW), Dumfries & Galloway Council (D&GC) and the Scottish Environment Protection Agency (SEPA).

A8.4. PEAT SURVEY RESULTS

A8.4.1. Surveys have been carried out to investigate peat depth and extent across the Proposed Development. Peat depth information has been collated to support the volumetric calculations provided in this document and has subsequently been used to consider and minimise any potential impact on the peatland environment.

A8.4.2. Investigations were undertaken to ensure a high resolution and focussed assessment maximises the understanding of the impacts of the Proposed Development on the local peatland environment by improving the efficacy of the volumetric calculations provided in this PMP. The completion of a focussed assessment also provides the opportunity to microsite infrastructure away from areas of deeper peat.

A8.4.3. Peat deposits can exist in one of three forms:

- Fibrous – non-plastic with a firm structure and is only slightly altered by decomposition;
- Pseudo-fibrous – peat in this form still has a fibrous appearance but is much softer and more plastic than fibrous peat. The change is due to more prolonged sub-mergence in airless water rather than to decomposition; and
- Amorphous – decomposition has destroyed the original fibrous vegetation structure such that it has virtually become organic clay.

A8.4.4. Peat deposits can also be characterised into two layers:

- The ‘acrotelm’ is the upper layer and has a relatively high hydraulic conductivity and therefore has variable water content. This layer comprises a thin surface layer of active vegetation; and
- The ‘catotelm’ is the lower layer, permanently below the water table, which has a small hydraulic conductivity and is often at a higher state of humification and lower tensile capacity.

A8.4.5. In total, 6,246 locations were surveyed for peat depth across the Proposed Development. The surveys consisted of completing phase 1 peat depth investigations across a 100 m grid of the Proposed Development Area to inform the design of infrastructure, this was completed in October 2020. Follow up surveys took place during March, July and October 2021 and involved the collection of peat cores and detailed phase 2 peat depth surveys at key infrastructure locations, as well as the collection of geotechnical information at turbines and other key infrastructure locations. An additional survey took place in May 2022 to collect information at the proposed Substation.

A8.4.6. Table A8.4.1 provides a summary of the peat depths recorded during the peat surveys and an interpolated peat depth map (Figure 8.6 of the EIAR) shows the distribution of peat depths in relation to infrastructure elements.

Table A8.4.1: Peat Depth Survey

Peat Depth (m)	Results	% of Points
<0.5	3953	61.5
≥0.5 - <1.0	1320	20.5
≥1 - <2	770	12.0
≥2 - <3	262	4.1
≥3 - <4	86	1.3
≥4	33	0.5
Total	**6424**	**100**

Source: Natural Power

A8.4.7. Table A8.4.1 shows that the highest proportion (60 %) of recorded peat depths fell within the <0.5 m range, with the next highest proportion (21%) within the ≥0.5 – <1.0 m range. The areas of deep peat (greater than 0.5 m) are constrained to a few discrete locations within the Proposed Development Area, namely on the interfluve between the Knockgray Burn and Benloch Burn, just east of Craig of Knockgray hill as well as the summit of Quantans Hill and in the far east of the Proposed Development area, northeast of Furmiston Craig. In all cases, these locations also correspond with the identification of Class 1 peat (SNH, 2016)

A8.4.8. Cores were collected and analysed at eight proposed turbine locations that were identified to be within deeper areas of peat from the initial 100 m grid peat survey. Cores were logged in accordance with the Von Post Scale of Humification and the results are presented in A8.4.2.

A8.4.9. Table A8.4.2 demonstrate that the peat deposits at the Proposed Development are generally characterised as soft to very soft, dark brown, pseudofibrous (occasionally amorphous), plastic peat with Von Post classification codes ranging from H2 to H7. There were very few natural exposures of the peat identified during the surveys. Photos collected at a few locations are presented in Photographs A8.1 below.

Source: Natural Power

Photographs A8.1: Photographs obtained during peat surveys at Quantans Hill. The left shows boulder strewn ground near Furmiston Craig. The right photo shows a soil exposure near Knockwhirn demonstrating matrix support glacial subsoil with an organic soil horizon above

Table A8.4.2: Peat core sampling summary

Turbine ID	Peat Depth	Von Post Class	Description
(1)Deep peat east of T09	0.00-0.20	H6/B2	Soft, black, amorphous, plastic PEAT
	0.20-1.00	H5/B4	Very soft, black, pseudofibrous, plastic PEAT
	1.00-1.90	H6/B3	Very soft, dark brown, pseudofibrous, plastic PEAT
(2)Deep peat east of T02	0.00 – 1.60	H5/B2	Soft, dark brown pseudofibrous to plastic PEAT
	1.60-1.70	-	Sandy CLAY
(3)Access to T04	0.00-0.40	H4/B3	Firm, dark brown, fibrous, plastic PEAT
	0.40-2.00	H6/B2	Soft, dark brown, pseudofibrous, plastic PEAT (1.00-2.00 wood fragments, refused, no subsoil retrieved)
(4)Access to T12	0.00-0.20	H6/B3	Soft, dark brown, pseudofibrous, plastic PEAT
	0.20-0.50	H7/B4	Very soft, dark brown, amorphous, plastic PEAT
	0.50-0.60	-	Clayey, SAND
(5)Deep peat south of T11	0.00-1.00	H6/B2	Soft, dark brown, pseudofibrous, plastic PEAT
	1.00-1.40	H7/B3	Very soft, dark brown, pseudofibrous, plastic PEAT
	1.40-2.00	H7/B4	Very soft, dark brown, amorphous, plastic PEAT
	2.00-2.90	H7/B3	Very soft, black, amorphous plastic PEAT with 10% wood fragments
(6)Deep peat east of T13	0.00-1.40	H7/B2	Soft, dark brown, pseudofibrous/amorphous, plastic PEAT (refusal on cobbles)
(7)Deep peat east of T14	0.00-1.00	H4/B3	Soft, dark brown, pseudofibrous, plastic PEAT
	1.00-1.70	H5/B3	Very soft, dark brown, pseudofibrous, plastic PEAT
(8)T10	0.00-0.10	H2/B2	Soft, brown, fibrous, spongy PEAT
	0.10-0.20	H4/B3	Soft, dark brown, pseudofibrous, plastic PEAT
	0.20-0.30	-	Firm, dark grey, peaty CLAY

A8.5. PEAT EXTRACTION & RE-USE

A8.5.1. In order to quantify the volume of peat that may be excavated and re-used across the Proposed Development, the infrastructure layout has been analysed using a comprehensive peat depth dataset. The proposed 14 wind turbine layout has been appraised to obtain an estimate of the size and extent of the infrastructure footprint. The peat depth dataset comprises a total of 6,246 individual peat probe points.

A8.5.2. The volumetric analysis of excavated peat volumes incorporates the mean peat depths of existing survey data. Peat depth measurements of less than 0.5 m have been categorised as peaty soils, with deep peat deposits being >0.5 m in depth. Therefore, where depths are less than 0.5 m, these will be excluded from final peat excavation calculations.

A8.5.3. The estimation of peat extraction and re-use volumes relies on a series of design assumptions that may vary on a small scale according to discrete changes in ground conditions. Volumetric calculations should be re-evaluated if more detailed intrusive site investigation data becomes available. Design assumptions with regards to the likely access track construction methods have also been taken. The design of the detailed site layout should be confirmed with a comprehensive site investigation.

A8.5.4. There are elements of proposed infrastructure which are to be located on areas of potentially Class 1 peatland. NatureScot defines Class 1 peatland as "all vegetation cover indicates priority peatland habitat; all soils are carbon-rich soils and deep peat". Micro-siting of infrastructure will therefore take into account vegetation cover, peat depth, hydrology, and peat quality. Areas most strongly displaying evidence of Class 1 peatland will be avoided as far as reasonably possible during micro-siting, considering all other constraints.

Peat Handling Prior to Construction

A8.5.5. The principles of appropriate handling of acrotelmic and catotelmic peat so that it is suitable for reuse are presented below. Fundamentally, the intention is to minimise excavation volumes:

- Through the utilisation of all the data collected to date and ongoing throughout the construction process, the Principal Contractor will implement methods to minimise the volumes of excavated peat. Appropriate handling and storage of excavated materials will be undertaken such that their integrity and subsequent reuse is maintained;
- An Environmental Clerk of Works (ECoW) will be employed and, prior to works commencing in each area, a walkover with engineers will be carried out to identify any areas of sensitive habitat or deep peat;
- The Principal Contractor will be required to ensure that excavated peat is reused on site in landscaping and re-profiling works, to minimise visual impacts and facilitate habitat and ecological restoration, improvement and enhancement;
- The results of the ground investigation, including groundwater level information, should be assessed with respect to refining the peat stability assessment at infrastructure at highest risk. All pertinent control measures and mitigation measures should be revised, and their implementation supervised following the results of the ground investigation and construction design phase of works. Current stability mitigation measures are set out in this PMP as well as in Technical Appendix 8.2: PSRA; and
- A programme of geotechnical inspections will be implemented during excavation works.

Excavation

A8.5.6. Prior to any excavation, the Principal Contractor will produce a detailed method statement identifying where and how excavated peat will be used in reinstatement or landscaping works. Specific requirements for the excavation, handling, storage and reinstatement of peat will be outlined in the above method statement. The method statements will consider peat layering and the potential impacts on downstream hydrological receptors and also the potential for instability issues with the excavated material.

A8.5.7. The principal requirements are outlined below:

- All excavations where required should be monitored and measures taken to prevent collapse and the destabilising of peat deposits adjacent to excavations;
- A system of daily reporting of excavations will be established during construction and utilised to monitor the geotechnical performance of slopes including peat, sub-soil and bedrock. This would be implemented and undertaken by a suitable, experienced and trained member of the site team;
- A system of daily reporting of excavations should be established during construction and utilised to monitor the geotechnical performance of slopes including peat, sub-soil and bedrock. This should be implemented and undertaken by a suitable, experienced and trained member of the site team;
- Where possible, areas of peat within the footprint of excavation will have the top layer of vegetation stripped off as turf prior to construction. When excavating areas of peat, excavated turves should remain as intact as possible. Peat turves will be stored to promote the retention of structure prior to use in reinstatement;
- Underlying catotelmic peat will then be removed and stored separately and kept damp;
- Excavated peat turves and catotelmic peat will be handled through careful excavation to reduce the risk of cross contamination between distinct horizons and to maximise the potential for reuse;
- Care will be taken when stripping and removing topsoil and peat turves and appropriate storage methods will be used on site, i.e. excavated material will be stored in separate horizons and turves will be placed on top of excavated peat to minimise desiccation and oxidation. They would be placed in a manner to maximise coverage in a “checkerboard” pattern; and
- Classification of excavated materials will depend on their identified re-use in reinstatement works. At this site it is anticipated that the material to be excavated will comprise peat (which may be sub-divided into amorphous peat (catotelmic), fibrous peat (acrotelmic)) and turf.

Design Assumptions

A8.5.8. Detailed designs relating to proposed infrastructure (turbine foundations, access tracks, hardstands) are not considered within this Section. These details remain to be confirmed at the detailed design stage post-consent.

Access Tracks – Excavation & Replacement

A8.5.9. Excavate and replace (‘cut’) type construction of tracks, passing places and turning areas are proposed for the majority of the proposed new track. This is owing to the generally shallow nature of the peat and peat soils present within the Proposed Development Area. A small length of track is intended to be floated north of Turbine 13.

A8.5.10. The cut and fill 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 access track landscaped verges on either side of the track or utilised in appropriate landscaping across the development infrastructure.

A8.5.11. Excavate and replacement track construction sequences shall be designed in accordance with local ground conditions and following a detailed site investigation. A general good practice construction sequence has been provided below and has been adapted and informed by NatureScot (2017):

- The route of the cut / fill access track shall be marked out on the ground well ahead of the construction activity. This will allow for advanced checks of any newly developed or unforeseen constraints;
- As part of this process, the most sensitive sections of the access track route shall be defined. This will include water crossings, flush zones, slopes and steep slopes. These defined zones shall become established management zones where specific mitigation measures and construction techniques shall be implemented to minimise impacts during the construction phase;
- Where possible, the construction of the cut tracks shall avoid periods of wet weather (when soils and peat deposits are particularly susceptible to deformation and when there is an increased risk of run-off carrying unacceptable levels of sediment). Similarly, the construction of access tracks shall, where possible, avoid periods of very dry weather; when there is a high risk of excavated and exposed peat soils drying out;
- The cut access track construction shall typically proceed in an uphill direction, thus allowing drainage to be managed with a greater degree of control. The access track side and cut-off ditches shall generally be constructed first. It shall be ensured that these discharge to a suitable buffered watercourse in line with hydrological assessment and relevant drainage controls. It shall be important to ensure that surface water run-off is directed away from the track formation layer. This will act to reduce disturbance by the prevention of waterlogging and erosion;
- A progressive construction method shall typically be adopted whereby the cut track is excavated to a suitable formation and upfilled to the track running surface. Following this, the newly constructed track verges will be restored with peat and vegetation from the next advancing section of track under construction. The sequence of excavation, up-fill and restoration will be managed to minimise the time between excavation and restoration as far as is practicable; and
- Plant machinery shall work where practicable from the section of access track most recently completed. The re-use of peat turves and peat from newly excavated sections onto the verges of the most recently completed

section of track will act to reduce the overall disturbance of excavated peat. Excavators with long reach arms are also beneficial in reducing vehicle manoeuvres over peat deposits. Excavation, handling, storage and reinstatement of peat will follow the principles outlined in Sections detailed in this PMP.

Access Tracks - Floating Construction

A8.5.12. The design of the tracks has been made considering peat depths across the site and floating track has been incorporated to minimise excavated peat. Most site tracks proposed are of the excavate and replace type, however a small area of track approximately 200 m in length will be floated (Track section 29 in Table A8.5.5) in the area north of T13.

A8.5.13. An example construction sequence for floating roads adapted from the NatureScot publication is provided below. This sequence of construction may need to be adapted to localised ground conditions, which may only become fully evident following a detailed site investigation:

- Mark out the alignment of the road and install advance drainage ahead of construction where necessary;
- Clear the intended floating road area of major protrusions such as rocks, trees, and scrub vegetation down to ground level leaving any residual stumps and roots in place;
- Leave the local surface vegetation and soils in place if possible. In many cases the existing vegetation and root system may be the strongest layer in the soil system providing increased tensile strength at surface, and care shall be taken to preserve the integrity of this layer;
- Any local hollows or depressions along the route alignment shall be infilled with a suitable lightweight fill such as tree brash, logs or a combination of lightweight fill and suitable materials. Similarly, a brash mat and fascines (bundles of brash material) may be adopted to form the initial surface across uneven ground surface;
- Broken vegetation surfaces and very wet areas with high fines content, may need to be covered with a separator grade geo-membrane to prevent contamination of the aggregate layers. This geotextile may be covered with a thin regulating layer of aggregate prior to installing the main geo-grid;
- Geo-grids are placed by hand along the alignment of the road, directly onto the prepared area with a simple overlapping arrangement generally in accordance with the relevant manufacturer's specification. A minimum transverse overlap is normally set at 400 mm. However, this may need to be increased depending on the amount of displacement and transverse tension caused by un-even terrain. Again, this should be specified by the geo-grid manufacturer;
- Place the first layer of aggregate material onto the geo-grid, this shall be a suitable 'well graded material' that will be able to achieve a sound interlock with the geo-grid. The final specification of the aggregate grading shall be dictated by the chosen geo-grid mesh size. Care shall always be taken to avoid damage to the geo-grids; and
- The degree of compaction required will be dictated by the local ground conditions along the route alignment. Across exceptionally soft areas of peat there may be a requirement not to apply mechanical vibratory compaction and instead rely on compaction of aggregate through trafficking of wheels and tracks of the construction plant alone.

Access Tracks – Dimensions

A8.5.14. There is approximately 14 km of new access track required to link infrastructure within the Proposed Development Area. Proposed access tracks have been assumed to accommodate a 7 m running width from the site entrance to the substation (proposed "spine road"), and 5 m running width for all other tracks ("spurs"); drainage will add up an additional 2 m, giving a total construction width of 9 m and 7 m respectively.

A8.5.15. Turning areas and passing places have been omitted from excavation calculations as it is assumed that any peat excavated as part of their construction would be accommodated along the periphery of these infrastructure elements, used to form landscaped verges.

A8.5.16. Electrical cabling is typically laid in trenches adjacent to the access track network, which requires excavation, laying and backfilling. Peat excavated from cable trenching is normally replaced at its point of origin and is therefore not considered as a peat excavation loss.

Turbine Foundations

A8.5.17. During turbine construction, peat is excavated to the substrate to accommodate the concrete foundation and for a working area surrounding the foundation footprint. The surface working area of the wind turbine foundation excavation has been assumed to be 23.05 x 23.05 m square excavation into which a reinforced concrete gravity base will be constructed. The excavation areas will therefore be 531.30 m^2 with a total working area of 934.52 m^2.

A8.5.18. It should be noted that although excavation areas for crane pad areas and foundations will likely overlap, to provide a conservative assessment, peat volumes are calculated for both areas separately.

A8.5.19. Excavation and handling methodologies as discussed above in the peat handling prior to construction and excavation sections will be employed particularly at turbines with deeper peat.

Crane Pads & Hardstands

A8.5.20. The hardstand will be 20 m in width and 50 m in length, plus a small area of 3 m by 15 m. This equates to a permanent land take of 1045 m^2 per crane pad, and is the value which is used for excavation volume calculation. Additional excavation will be required for laydown areas, which are not included as part of this assessment as these areas will be reinstated following the completion of construction.

Additional & Ancillary Infrastructure

A8.5.21. The proposed accessible ancillary infrastructure associated with the Proposed Development consists of six borrow pits, a substation and operations compound, including battery storage area, and several temporary construction compounds.

A8.5.22. The estimations of the excavated peat volumes and any subsequent reinstatement have been calculated based on the design information available at the time of writing:

- 1 x Substation, including operations compound and battery storage area: 180 m x 100 m (18,000 m^2);
- 1 x Met Masts: 600 m^2;
- 6x Borrow Pits (indicative working area):
  - BP1: 22,500 m^2;
  - BP2: 22,500 m^2;
  - BP3: 22,500 m^2;

A8.5.23. For the construction compounds and concrete batching plants, due to the temporary nature of the works, only the topsoil will be stripped and replaced with terram and crushed rock placed. Therefore no peat extraction will be required. For the purposes of this document, it is also assumed that no peat will be reused or incorporated in each of the six borrow pits within the Proposed Development. This is because no existing peat deposits within the borrow pit locations was indicated by peat depth surveys (depths were ~<0.5 m).

Excavation Volumes

A8.5.24. The estimate of excavated peat volume has been completed following a desk-based appraisal of the Proposed Development layout supplemented by digital terrain analysis. There has been further refined spatial analysis of the peat depth data set using GIS software. According to latest statutory guidance, peat soil is an organic soil which contains more than 60 per cent of organic matter and exceeds 50 centimetres in thickness. Therefore, for the purposes of these calculations, and as a result of the information collected on site, depths recorded to be less than 0.5 m are considered to be peaty soils. Depths recorded to be greater than 0.5 m are considered to be peat, with the upper 0.5 m being acrotelmic peat and depths beyond 0.5 m considered to be catotelmic peat.

A8.5.25. The following sequence of tables (Tables A8.5.3 to A8.5.6) provide a summary of the indicative peat extraction volume calculation for each infrastructure element. Table A8.5.7 provides a summary of total peat extractions from the Proposed Development. The relevant design assumptions are also confirmed within each table.

Table A8.5.3: Wind Turbine Foundations (Working area = 934.52m²)

WTG ID	Mean Peat Depth (m)	Peat Excavation Volume (m^3)		Total Peat Excavation Volume (m3)
		Acrotelmic Peat	Catotelmic Peat	
1	0.16	0	0	0
2	0.26	0	0	0
3	0.80	467	285	752
4	0.60	467	90	557
5	0.56	467	60	527
6	0.33	0	0	0
7	0.62	467	113	581
8	1.12	467	579	1047
9	0.86	467	340	807
10	0.50	0	0	0
11	1.05	467	516	983
12	0.60	467	95	562
13	0.64	467	134	602
14	0.49	0	0	0
	Total	**4203**	**2213**	**6418**

Table A8.5.4: Crane Pads & Hardstands (Working Area = 1045 m²)

WTG ID	Mean Peat Depth (m)	Peat Excavation Volume (m^3)		Total Peat Excavation Volume (m^3)
		Acrotelmic Peat	Catotelmic Peat	
1	0.16	0	0	0
2	0.26	0	0	0
3	0.8	523	318	841
4	0.60	523	101	623
5	0.56	523	67	590
6	0.33	0	0	0
7	0.62	523	127	649
8	1.12	523	648	1170
9	0.86	523	380	902
10	0.50	0	0	0
11	1.05	523	577	1100
12	0.60	523	106	628
13	0.64	523	150	673
14	0.49	0	0	0
	Total	**4703**	**2474**	**7177**

Table A8.5.5: Site Access Tracks (Running width = 7 m – 9 m)

Track Section	Approx. Length (m)	Mean Peat Depth (m)	Peat Excavation Volume (m^3)		Total Peat Excavation Volume (m^3)
			Acrotelmic Peat	Catotelmic Peat	
1	452	0.335	0	0	0
2	435	0.378	0	0	0
3	958	0.270	0	0	0
4	269	0.404	0	0	0
5	294	0.653	1029	315	1344
6	710	0.304	0	0	0
7	461	0.551	2075	212	2287
8	365	0.593	1643	304	1947
9	424	0.335	0	0	0
10	345	0.481	0	0	0
11	484	0.875	1694	1271	2965
12	238	1.050	833	916	1749
13	518	0.361	0	0	0
14	184	0.500	0	0	0

Track Section	Approx. Length (m)	Mean Peat Depth (m)	Peat Excavation Volume (m^3)		Total Peat Excavation Volume (m^3)
			Acrotelmic Peat	Catotelmic Peat	
15	588	0.686	2646	982	3628
16	228	0.353	0	0	0
17	211	0.258	0	0	0
18	346	0.336	0	0	0
19	121	0.311	0	0	0
20	410	0.411	0	0	0
21	241	0.581	1085	176	1260
22	867	0.500	0	0	0
23	273	0.308	0	0	0
24	590	0.451	0	0	0
25	266	0.383	0	0	0
26	349	0.271	0	0	0
27	557	0.727	1950	887	2836
28	257	1.068	900	1022	1922
29	202	0.867	0	0	0
30	545	0.531	1908	120	2027
31	575	0.491	0	0	0
32	844	0.571	2954	422	3376
33	375	0.131	0	0	0
34	380	0.496	0	0	0
		Total	**18714**	**6627**	**25341**

Table A8.5.6: Ancillary Infrastructure & Borrow Pits

WTG ID	Mean Peat Depth (m)	Peat Excavation Volume (m^3)		Total Peat Excavation Volume (m^3)
		Acrotelmic Peat	Catotelmic Peat	
Substation	0.04	0	0	0
Met Mast	0.25	0	0	0
Borrow Pit 1	0.10	0	0	0
Borrow Pit 2	0.26	0	0	0
Borrow Pit 3	0.09	0	0	0
	Total	**0**	**0**	**0**

Table A8.5.7: Total Peat Extraction (Indicative)

Construction Element	Peat Excavation Volume (m^3)		Total Peat Excavation Volume (m^3)
	Acrotelmic Peat	Catotelmic Peat	
Wind Turbine Foundations	4205	2213	6418
Crane Pads & Hardstands	4703	2474	7177
On-site Access Tracks	18714	6627	25341
Ancillary Infrastructure	0	0	0
Total Peat Excavation (m^3)	**27622**	**11314**	**38936**

Re-use Volumes of Excavated Peat

A8.5.26. In order to estimate the volume of peat that could be re-used as part of construction and restoration, Natural Power has applied their experience from the construction management of wind farms across an array of upland peat sites. Table A8.5.8 below provides an approximate total volume of peat that could be accommodated across the site. The following additional design assumptions salient to the re-use of excavated peat are highlighted below:

- The uppermost 0.5 m of excavated peat at all infrastructure locations will be accommodated in the finishing and landscaping of each infrastructure element;
- For the turbine foundations the peat re-use potential is considered to be within the excavation area around the protruding concrete foundation to a depth of 0.75 m;
- For crane hardstand areas and the substation compound it is assumed that peat can be used for reinstatement around the two peripheral edges to a height of 0.75 m with a batter extending up to 3.5 m;
- Batter slopes of reinstated verges must be considered in a manner that maintains slope stability, local topography and hydrology. The final design of the reinstated verges and batter angles will be agreed with SEPA as part of the detailed design, with reuse volumes below based on batters with a depth of 0.75 m and width of up to 3.5 m. Ideally a batter slope of 1:4 would be required to maintain stability but the reinstatement values provided are indicative for the purposes of this assessment and will vary according to the prevailing ground conditions. Similar widths are considered for dressing the track edges of floating tracks to allow for visual continuity between the track and surrounding peatland.
- Within the borrow pits, it is not expected that there will be any possibility for re-use of peat due to the likely absence of peat within each BP as indicated by peat probing surveys;
- The formulation of a detailed construction method statement shall incorporate detailed construction design and sequencing for the reinstatement purposes that will allow refinement of the excavation volumes presented in this document. These plans shall draw on detailed site investigation information gathered prior to the commencement of construction; and
- Appropriate signage shall also be considered to warn about potential soft ground hazards. The safety measures shall be maintained for as long as the hazard remains, which may be several years following construction. Typically, vegetation re-growth and natural stabilisation of the wetland areas would be anticipated within approximately two years following reinstatement. Ongoing periodic monitoring of the progress of restoration would be required to ensure fencing is maintained until the wetland is fully established.

A8.5.27. During the excavation and re-use of peat deposits the two layered structure of the 'acrotelm' and underlying 'catotelm' shall be preserved as far as is practicable. This approach will aid in the successful re-vegetation and prevent drying and desiccation of the peat. Where the catotelmic peat becomes separated, appropriate measures shall be in place to ensure this material is stabilised prior to re-use. This will be verified by a suitably qualified geotechnical engineer.

A8.5.28. 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.

Re-use Volume Estimate

Table A8.5.8: Estimate of Peat re-use volumes

Construction Element	Peat Excavation Volume (m^3)	Potential Peat Re-use Volume (m^3)	Surplus (+) or Capacity (-) (m^3)
Wind Turbine Foundations	6418	10167	-3749
Crane Pads & Hardstands	7177	1286	5891
Access Tracks	25341	37700	-12359
Ancillary Infrastructure	0	396	-396
Total	**38936**	**49549**	**-10613**

A8.5.29. Comparing the total capacity for peat re-use with total volume of excavated peat, it is indicated that the Proposed Development will have sufficient capacity to accommodate all excavated peat on site. This is demonstrated by the surplus of capacity of 10,600 m^3 of peat that could be re-used across areas of proposed infrastructure.

A8.5.30. Where factors which contribute to the bulking of the peat deposit are mitigated the total volume of excavated peat may be reduced through:

- Reduction of peat handling with re-use of peat undertaken as close as possible to the excavation site;
- Maintaining the integrity of the excavated peat mass including preservation of the surface acrotelm layer as far as is practicable; and
- Prevent the drying and desiccation of excavated peat deposits through timely re-vegetation and preservation of the surface hydrology systems.

Temporary Storage

A8.5.31. Consideration for the storage of peat has been undertaken with input gathered from the Scottish Renewables Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and Minimisation of Waste.

A8.5.32. The temporary storage of excavated peat shall seek to minimise disturbance of deposits by minimising haul distance between temporary peat storage sites and re-use areas. Stored peat would also be covered with turves in a manner to maximise coverage. In general, it shall be a priority to avoid a single site temporary peat storage area. A progressive construction method which re-cycles peat through excavation and timely re-instatement shall be adopted. However, some elements may require storage of peat prior to re-instatement at the end of the construction phase.

A8.5.33. **The areas and locations identified for temporary storage shall be identified only after site investigation, and a full topographic survey**. Determining factors are associated with the peat stability, sensitive receptors, drainage and pollution prevention. Areas of deeper peat (>1.0 m) and sensitive areas including Groundwater Dependent Ecosystems (GWDTE) shall be avoided for dedicated temporary storage areas. It will be a priority to ensure that a future detailed site investigation provides information on the suitability of these temporary peat storage areas including the topographic profile, groundwater regime, and geotechnical properties of deposits underlying the temporary storage sites. Furthermore, it may be necessary to undertake further peat stability calculations based on finalised placement of temporary peat storage areas.

A8.5.34. Owing to the position of the site within an upland setting with consequentially high rainfall, it is anticipated that watering the stored peat through natural precipitation will be sufficient for the peat to remain damp, thus preventing drying out and desiccation and allowing the vegetation layer and seed bank to be sustained. This is an important element in the restoration of the landscape, providing continuity with surrounding local vegetation upon reinstatement. For the duration of the temporary storage it shall be necessary to periodically monitor the condition of the stored peat and ensure the stability is maintained should be undertaken by a suitably qualified geotechnical engineer. During prolonged dry spells artificial wetting could be undertaken, however, this will be done under the agreement and supervision of the ECoW and Principal Contractor with appropriate mitigation in place to ensure the protection of the stored peat, as well as any nearby receptors such as watercourses or GWDTE.

A8.6. REINSTATEMENT METHODOLOGIES

A8.6.1. Prior to commencing the construction excavation works, consideration will be given to methods for handling and holding the excavated materials, particularly peat. Haulage distances for the excavated material will be kept to a minimum in order to reduce the potential impact on the peat structure. Peat has the potential to lose structural integrity upon excavation particularly when double handled or moved around the site. Peat handling can also increase the bulking factor of the material which has the overall effect of increasing the volume of peat which will need to be re-used across the site. The following paragraphs discuss the reinstatement measures that can be adopted for the main infrastructure components associated with the development.

Access Tracks

A8.6.2. Where cut and fill tracks are required in areas of peaty soils, it is recommended that turves should be ‘rolled back’ to allow for the bank to be cut at an appropriate angle, then rolled back over to cover the exposed cut face. Reinstatement will be completed as soon as possible following construction to minimise the risk of turf drying. Restoration will be carried out as track construction progresses.

A8.6.3. In order to obtain the best results, the previously stripped soils, vegetated layers or turves will be brought back over the verges of constructed tracks within as short a time period as reasonably practicable, to give the seed bank and vegetation the best chance of an early regeneration. Where reasonably practicable, turves and topsoil will be matched to the adjacent habitat.

A8.6.4. If storage is required, the soils will be correctly stored. This provides the seedbank and vegetation the best chance of early regeneration. If temporary storage of excavated materials is required, then material will be stored safely, and the method of storage will be reasonably minimised in order to reduce areas of additional disturbance. If soils are to be stored for any length of time, then these designated areas will be agreed with the ECoW prior to the storage of any material. Consideration will also be given to periodically wetting the vegetation layers during prolonged dry spells in order to prevent desiccation.

A8.6.5. The soil and peat material that is utilised for the track edge reinstatement will not be spread too thinly. If the material is spread too thinly then there is a tendency for it to dry out and crack, particularly during prolonged dry periods. This subsequently means that the soil/peat material will be unstable because the root system has not had an opportunity to establish. This is very much dependent upon the time of year that the work is taking place and also the altitude. These factors affect the growing performance of the vegetated turf. Early reinstatement will be undertaken as this provides for the most beneficial results.

A8.6.6. Care will also be taken to minimise excessive material being used during the re-profiling and reinstatement of the track verges. In addition, excess peat will also not be used for reinstatement of track edges where it can lead to additional loss of habitat by smothering the existing adjacent vegetation and preventing re-growth of the vegetation next to the tracks. The addition of excessive materials may cause instability at the track edges and increase the risk of the creation of sediment laden runoff.

A8.6.7. During the construction works, in areas where the spreading of seed rich materials or natural re-growth are considered to be impractical, not plausible or ineffective, then consideration should be given to re-seeding methods. The seed type and mix will be agreed by NatureScot and the Local Planning Authority (the seed bank mix will be of local native species). If vegetation re-establishment is observed to be failing during the post-construction monitoring stage, the potential for using re-seeding methods will be considered and discussed in consultation with NatureScot and the local planning authority.

A8.6.8. The fundamental aspects of track reinstatement are summarised as follows:

- Consider haulage methods and specified storage locations in relation to areas being worked. Haulage distances to storage locations will be minimal;
- Vegetated turves and topsoil will be stripped with care and stored correctly i.e. separated in horizons and vegetation stored vegetation side up in a checkerboard pattern on top of stockpiled peat;
- For track reinstatement peat will be placed back in the correct horizon order and topsoil containing the seed bank will be on the top. If vegetated turves have been previously stripped, then these will be placed on top to maximise vegetation growth potential;
- Reinstatement of verges will be completed as soon as practical to minimise turf drying i.e. reinstatement can take place whilst track construction continues;
- Peat soil will not be spread too thinly during verge reinstatement in order to prevent cracking/drying out and excessive amounts of peat will also not be used as this can lead to unstable surfaces, effect drainage, loss of habitat via smothering of adjacent vegetation and create sediment laden runoff;
- Natural regeneration of vegetation is the preferred option for reinstatement and restoration, however, if required, following consultation with NatureScot, re-seeding using a native species mix may be considered; and
- Lateral water loss from track edge peat “cliffs” will be minimised. This can be achieved through appropriate re-profiling and reinstatement of the track verges at an angle that blends into the surrounding landscaping as well as placing vegetated turves onto the verges. Consideration will be given to the placement of turves in a checkerboard fashion should there be insufficient turves available. This will be considered in greater details as part of the detailed track design.

Cable Trenches

A8.6.9. The reinstatement and storage of any excavated materials for the cable trenches will involve replacement of previously stripped soils, vegetated layers or turves. Timing of trench reinstatement works will also consider adjacent construction activities which may disturb any reinstatement works already carried out.

A8.6.10. The amount of time between the excavation of the trench and subsequent reinstatement following cable laying will be minimised as much as practically possible. The reason for this is that the longer the stripped turves are stored for, the more they will degrade and become unsuitable for successful reinstatement. Reinstatement will take place as soon as possible, trenches which are left open for a long period of time have a tendency to act as conduits for surface water runoff, thus potentially leading to increased sediment loading due to erosion. This could potentially affect the sites watercourses and lead to the occurrence of a pollution event.

A8.6.11. The type of vegetation used for reinstatement will not differ significantly from the adjacent area. The fundamental aspects of cable trench reinstatement are summarised as follows:

- Cable trenches will be constructed to the relevant detailed design specifications;
- Most cable trenches will be constructed adjacent to access tracks, i.e. reducing construction impacts on virgin ground;
- As a general principal, reinstated areas will be not be re-disturbed. This will be avoided where practical although this is not always possible due to construction sequencing;
- Stripping, storage and reinstatement of excavated materials will be as per best practice;
- Time between trench excavations and reinstatement will be planned to reduce the potential for stored turf layers to dry out and decompose; and
- Natural regeneration of vegetation is the preferred option for reinstatement and restoration.

Wind Turbine Foundations

A8.6.12. Where practical the peat turves and topsoil will be stored around the perimeter of the foundation excavation. A plan showing where the material is to be stored will also be created prior to the works commencing. In areas where storage of the peat turves or excavated material adjacent to the works is not possible, then the material will be taken to the nearest agreed storage areas as soon as possible.

A8.6.13. The turbine foundations will be backfilled with the excavated material. Not all excavated material will be suitable for backfilling or reinstatement. The previously stripped and stored soils and vegetated layers or turves will likely be spread over the area disturbed by turbine foundation construction. Where turbine bases are constructed in peat, reinstatement will involve laying subsoil peat on the backfilled area and then placing the vegetated peat turves on top. Reinstatement will be carried out as soon as practically possible following completion of foundation construction to minimise the risk of turves/vegetated layers drying out.

A8.6.14. The fundamental aspects of turbine foundation reinstatement are summarised as follows:

- Construction works will be carried out to the detailed specification of the turbine foundation design and to permit adequate temporary works. Excessive peat excavation will be minimised.
- Stripping, storage and reinstatement of excavated materials will be as per best practice;
- A detailed plan of where excavated material will be stored will be created;
- Subsoil/peat will be spread over the backfilled area during reinstatement. Peat turves will then be placed on top to encourage natural re-growth of the vegetation;
- Time between turbine foundation excavation and reinstatement will be planned to reduce the potential for stored turf layers to dry out and decompose; and
- Natural regeneration of vegetation is the preferred option for reinstatement and restoration.

Crane Pads & Hardstands

A8.6.15. Reinstatement of the crane hardstands will not occur due to the following factors:

- Re-use of crane hardstands following construction is likely;
- In the past crane hardstands have been reinstated using a layer of peat following construction. On many sites this layer has been stripped back within 2-3 years of operation to allow maintenance works to take place; and
- When the peat has been stripped back, it mixes with the stone from the hardstanding, thus contaminating the peat layer and making it unsuitable for re-use for reinstatement.

A8.6.16. Due to the requirement for hardstands to remain in place, and the use of crane hardstands during maintenance activities, levels of vegetation re-growth are liable to be low if crane hardstands are covered.

A8.6.17. The area around the crane hardstand and any exposed batters will be reinstated with previously stripped soils, vegetated layers and turves, using the same methods to those described for track reinstatement.

Ancillary Infrastructure

A8.6.18. With the exception of the met mast, substation, operations compound and proposed battery storage facility, all temporary construction areas will be removed and reinstated as quickly as possible following construction. Following removal of temporary site accommodation, storage, equipment and materials, all areas will then be reinstated. The temporary hardstanding surface will be lifted prior to re-soiling to aid with drainage and re-generation. Installation of a geo-grid base/geotextile during construction of the compound would help to facilitate removal of the hardstanding if this is required.

A8.6.19. The reinstatement will involve reprofiling/landscaping to ensure that the reinstated area blends in with the surrounding area. Suitable materials i.e. topsoil and peat will then be replaced over the area in appropriate horizons i.e. in the correct order. The material used for the reinstatement works (often that which was excavated for the temporary construction area), will be stored and managed adjacent to the temporary construction areas but away from watercourses and other sensitive receptors.

A8.6.20. It is highly probable that the temporary construction areas, such as the temporary compounds and/or batching plants, will be required for the full duration of the construction period. Therefore it is unlikely that any stripped turves would be suitable for reinstatement as the vegetation is likely to decompose if stored for the duration of the construction programme in anticipation of reinstatement of the temporary construction areas. Therefore, it is likely that stripped turves would be used in suitable alternative locations as part of reinstatement elsewhere in the Development rather than reused in situ.

A8.6.21. As such, vegetation in the vicinity of the temporary construction areas will be allowed to regenerate naturally. Natural regeneration could take several years and is dependent upon the type of adjacent vegetation and the altitude of the location. Re-seeding will be considered if required. In the event that re-seeding is required, the seed type and mix will be agreed in consultation with NatureScot and the local planning authority. In addition, temporary fencing of the areas to prevent grazing by deer will also be considered in order to help accelerate the re-vegetation process.

A8.6.22. The fundamental aspects of temporary construction reinstatement is summarised as follows:

- Areas will be re-profiled/landscaped to ensure they blend in with the surrounding area;
- Topsoil/peat will then be spread over the area in its appropriate horizons;
- Material used for the reinstatement will be stored appropriately where practical adjacent to the temporary construction area;
- Stripped turves may dry out due to the length of time they are stored (compound required for duration of construction period) therefore will be used in suitable locations elsewhere in the Development; and
- Natural regeneration of vegetation is the preferred option for reinstatement and restoration. However, if required, following consultations with NatureScot, re-seeding using a native species mix will be considered.

Borrow Pits

A8.6.23. There will be no peat reinstatement within the borrow pits. Associated soil handling, storage and general management details are presented within Technical Appendix 8.7: Borrow Pit Appraisal.

A8.7. MONITORING

A8.7.1. The success of construction and the subsequent re-use of peat across the site will be monitored to ensure that effects on the peatland environment are appropriately understood and subsequently reduced via any remedial works that can be undertaken. The details of any required 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 in-place mitigation and reinstatement measures are effective and that the site is not having a significant adverse impact upon the local and/or wider environment;
- Indicate whether further investigation is required and, where pollution is identified or unsuccessful reinstatement, the need for additional mitigation measures to prevent, reduce or remove any impacts on the environment; and
- Understand the long-term effects of the site on the natural environment.

A8.7.2. 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.

A8.7.3. 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.

References

British Geological Survey. 2020. Onshore Geoindex. Available at http://mapapps2.bgs.ac.uk/geoindex/home.html?layer=BGSBoreholes (accessed 30/09/2020)

Centre for Ecology & Hydrology. 2020. FEH Web Service https://fehweb.ceh.ac.uk/ (Accessed 30/09/2020)

NatureScot & Forest Land Scotland. 2010. Floating Roads on Peat.

NatureScot. 2016. Carbon and Peatland Map dataset. Available at http://soils.environment.gov.scot/maps/thematic-maps/carbon-and-peatland-2016-map/ (accessed 30/09/2020)

Scottish Environment Protection Agency. 2010. Regulatory Position Statement – Developments on Peat.

Scottish Renewables, NatureScot, SEPA, FLS. 2012. Developments on Peatland: Guidance on the assessment of peat volumes, re-use of excavated peat and the minimisation of waste.

Scottish Government, NatureScot, SEPA, FLS. 2020. Good Practice During Wind Farm Construction. Version 4.

NatureScot, SEPA. 2017. Peatland Survey. Guidance on Developments on Peatland, on-line version only.

Scotland's Soils. 2020. National Soil Map of Scotland. http://soils.environment.gov.scot/maps/soil-maps/national-soil-map-of-scotland/ (Accessed 30/09/2020)

Document history

Author	Sam Wainwright	20/08/2021
Checked	Emma Bryder	09/09/2021
Approved	Katherine Arthur	19/10/2021

Client Details	
Contact	Matthew Bacon
Client Name	Vattenfall Wind Power Ltd.

Issue	Date	Revision Details
A	26/10/2021	First draft submission
B	16/12/2021	Released
C	22/06/2022	Update and Released

Appendix 8.4

Private Water Supply Risk Assessment

Contents

	Contents	1
	Glossary	2
	List of Abbreviations	2
A8.1	Introduction	2
	Scope of Works	2
	Disclaimer	2
	Policy & Guidance Context	3
A8.2	Methodology	3
	Desktop Assessment	3
	Consultation with Residents	3
	Screening of Supplies	3
	Site Surveys	4
	Method for Risk Assessment	4
	Impact Significance Matrix	5
A8.3	Desktop Assessment	6
A8.4	Consultation & Initial Screening	6
A8.5	Risk Assessment	6
	Standard Good Practice Mitigation	6
	Emergency Contingency Measures	7
	Private Water Supply Monitoring Programme	7
	Additional Mitigation	7
	Hazards	8
A8.6	Results	8
A8.7	Conclusion	10
Appendix A - Assessment Summaries		11
Appendix B - Knockgray Water Feasibility Assessment		20

Glossary

Refer to Chapter 8: Hydrology, Geology and Hydrogeology in Volume 2 of the EIAR for the Glossary.

List of Abbreviations

Refer to Chapter 8: Hydrology, Geology and Hydrogeology in Volume 2 of the EIAR for the List of Abbreviations.

A8.1 Introduction

A8.1.1. A Private Water Supply Risk Assessment (PWSRA) has been carried out for private water supplies (PWS) that may be affected during the construction and operation of the Proposed Development. As outlined in the Environmental Impact Assessment Report (EIAR) the Proposed Development will comprise the construction of 14 wind turbine generators (WTG) and associated infrastructure including access tracks, borrow pits and permanent and temporary compounds, as well as, potentially, an up to 50MW battery storage energy system. The project is situated within the Dumfries & Galloway Council (D&GC) district area.

A8.1.2. The purpose of this PWSRA is to ascertain risk to any PWS as a result of construction and operation of the Proposed Development.

A8.1.3. Chapter 8: Hydrology, Geology & Hydrogeology of the EIAR, for which this document forms a technical appendix, identified a potentially Minor/Negligible risk to PWS under the terms of Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 associated with the construction and operational effects of the Proposed Development. Risk to the Scottish Water Raw Water supply are discussed and mitigated separately in Technical Appendix 8.6: Pollution Prevention and Incident Plan (PPIP).

Scope of Works

A8.1.4. The aim of this report is to provide details regarding the identification and potential impact of the Proposed Development on the quality, quantity and continuity of private water supplies within 3 km of the Proposed Development Area, and where appropriate, to provide recommendations for potential mitigation measures.

A8.1.5. The assessment has adopted a phased approach evaluating risk through the formulation of a Source-Pathway-Receptor conceptual model.

Disclaimer

A8.1.6. This document should be considered live and, as such, changes may be necessary should new information be received. The information presented in this document is based on that provided by DGC as well the Applicant. Should additional information come to light, it is recommended that a revised risk assessment is carried out, if deemed necessary. The results of the assessment are based on desk-based analysis and responses to a PWS questionnaire from local residents. On-site investigation has been undertaken for a few properties as part of this assessment.

A8.1.7. This report details the findings of the risk assessment based on the information provided by the Applicant, the relevant Planning Authority, and information obtained via the return of completed questionnaires and is as accurate as this information will allow.

A8.1.8. It must also be acknowledged that the information presented in this report does not exclude the Applicant or nominated Principal Contractor from carrying out further site inspections ahead of works to confirm sensitivities and to ensure that the mitigation included in this document is adequate to maximise protection to the water supplies.

Policy & Guidance Context

A8.1.9. The main legislative drivers, relevant to the assessment are:

- The Water Framework Directive (2000/60/EC):
  - The WFD aims to protect and enhance the quality of surface freshwater (including lakes, rivers and streams), groundwater, groundwater dependent ecosystems, estuaries and coastal waters.
  - The key objectives of the WFD relevant to this assessment are:
    - To prevent deterioration and enhance aquatic ecosystems; and
    - To establish a framework of protection of surface freshwater and groundwater.
- The Water Intended for Human Consumption (Private Supplies) (Scotland) Regulations 2017:
  - These regulations aim to ensure the provision of clean, safe drinking water and to deliver significant health benefits to those using Type A private water supplies; and
  - It is the responsibility of the local authorities to enforce and regulate private water supplies.
- The Private Water Supplies (Scotland) Regulations 2006:
  - These regulations aim to ensure the provision of clean, safe drinking water and to deliver significant health benefits to those using private water supplies (Type B supplies); and
  - It is the responsibility of the local authorities to enforce and regulate private water supplies.
- The Water Quality (Scotland) Regulations 2010:
  - These regulations relate to managing water quality failures on a private water supply. The Regulations are attributable to the domestic distribution or its maintenance in premises where water is supplied to the public.
- Scottish Environment Protection Agency (SEPA), Land Use Planning Guidance Note 31 (2017): Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems, Version 3:
  - SEPA guidance on how excavations should be considered to support planning applications;
  - Guidance requires quantitative assessments to abstractions where certain infrastructure is within 100 m and 250 m buffers; and
  - Whilst specific to planning phase, guidance is a useful tool to help assess risk to groundwater abstractions.
- SEPA, Groundwater Protection Policy for Scotland, V3 (2009).
  - Provides a mechanism to protect groundwater quality by minimising the risks posed by point and diffuse sources of pollution and maintain the groundwater resource by authorisation abstractions and by influencing developments, which could affect groundwater quality.
  - Outlines the objectives for protecting groundwater related to specific activities and also describes the interaction of this measures with the planning system.

A8.2 Methodology

A8.2.1. The PWSRA has been undertaken based on the following methodology:

- Completion of a high-level desktop assessment to put the hydrological and hydrogeological setting of the project into context;
- Based on the information provided in response to the questionnaires, screening out of supplies that are considered unlikely to be affected by the Proposed Development;
- Where supplies could be affected by the Proposed Development, residents were contacted via the submission of a questionnaire to confirm the location and nature of their supply;
- Preparing a risk assessment to determine the potential effects of the Proposed Development on the quality and quantity of the water serving the supply; and
- Identification of any additional measures, that should be included as part of the environmental documentation prepared by the Applicant or nominated Principal Contractor, to avoid and mitigate against any potential adverse effects resulting from the Proposed Development.

A8.2.2. Further details on the above steps are provided in the following sections.

Desktop Assessment

A8.2.3. The desktop assessment was completed using the following secondary data sources:

- Geological and hydrogeological information obtained from The British Geological Survey[1];
- Monthly precipitation and climate data from The Met Office[2]; and
- Scotland's Environment[3].

A8.2.4. Details of the existing site conditions can be found detailed within the Baseline Condition Sections of Chapter 8: Hydrology, Geology and Hydrogeology in Volume 2 of the EIAR.

Consultation with Residents

A8.2.5. Upon completion of the Desktop Assessment, contact was then sought from residents of the properties identified by DGC as potentially connected to a PWS within 3 km of the Proposed Development Area boundary. This process involved sending residents a letter, questionnaire and map aiming to obtain information regarding their supply:

- The letter explained the nature of the works and the purpose of the assessment;
- The questionnaire asked residents to provide details on their supply. This also included asking permission for Natural Power to undertake an inspection should the risk assessment conclude a potential risk to the quality and/or quantity of water serving the supply; and
- A map showing the location of the property was also included with residents asked to indicate the location of their supply.

A8.2.6. The addresses of properties to contact were compiled by contacting the Environmental Health Team at DGC who responded by email providing a list of property addresses and basic supply type information. Whilst basic checks were undertaken using Ordnance Survey mapping as well as aerial imagery to identify any properties which could be using a PWS within the vicinity of the Proposed Development, it was otherwise assumed that the list of properties and source locations provided by DGC was accurate and up-to-date.

Screening of Supplies

A8.2.7. Following receipt of the information provided by residents in their responses, a screening exercise was completed. This was based on the position of the provided PWS information in relation to the work areas associated with the Proposed Development.

[1] BGS. 2021. https://mapapps2.bgs.ac.uk/geoindex/ (accessed13/08/2021)

[2] Met Office. 2021. https://www.metoffice.gov.uk/ (accessed 13/08/2021)

[3] Scotland's Environment. 2021. https://www.environment.gov.scot/ (accessed 13/09/2021)

A8.2.8. The screening exercise excluded properties where no hydrological or hydrogeological connectivity is likely to exist. These were determined through considering the following;

- Surface water catchment boundaries and channel networks;
- Properties of the mapped superficial and bedrock geology;
- Dominant land use; and
- Topographical considerations.

A8.2.9. If a response was not received, then professional judgement was applied as to the type of supply and its possible position. This was based on a review of the surrounding supply information and hydrological and hydrogeological conditions. Where little or no information is provided, a 'worst case scenario' approach has been adopted to provide a conservative assessment. Where assumptions have been made, these are stated clearly.

Site Surveys

A8.2.10. In some instances, hydrology surveys were required to obtain more information on a PWS abstraction, or the location of infrastructure. Surveys were undertaken with the express permission of the landowner and PWS user.

A8.2.11. Surveys comprised discussion of the location of PWS infrastructure with PWS users, visual inspection of infrastructure and source zones and investigations to determine the precise route of infrastructure between the abstraction and the property it serves.

A8.2.12. Surveys were undertaken at Marbrack and Knockgray in February 2021. The results are presented in later sections of this PWSRA.

Method for Risk Assessment

A8.2.13. A methodology for risk assessment of private water supplies is contained within the Private Water Supplies Technical Manual[4]. Due to the nature of the works proposed for the Proposed Development, it was deemed impractical to use the methodologies set out in this guidance as this would have required taking into account 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 will be important for determining the baseline qualities of the supply, they are inappropriate for determining the risk to the private water supplies posed from the construction of the Proposed Development.

A8.2.14. The framework adopted in this PWSRA is based on Natural Power's experience, however, the guidance has been utilised where possible, when trying to establish the varying factors which influence the baseline conditions of the supplies. Such an approach has been adopted on numerous projects and meets the expectations of regulators and stakeholders.

A8.2.15. The risk assessment considered the type of hazard associated with the Proposed Development, release and exposure potential and severity of impact. The Source-Pathway-Receptor conceptual model has been used as the underlying transfer mechanism to assess the risk posed by the construction and operational activities. In this model:

- Source refers to the source of the potential risk hazard;
- Pathway refers to the mechanisms by which the hazard is transmitted to the receptor; and
- Receptor refers to anything or anyone that could be adversely affected by the hazard (including supply source and associated infrastructure).

[4] Scottish Executive .2006. *Private Water Supplies Technical Manual.* Available at http://www.privatewatersupplies.gov.uk/private_water/files/Full%20Doc.pdf (accessed 05/08/2021)

A8.2.16. Where hydrological connectivity or linkage 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.

A8.2.17. Quality of water in individual properties may vary depending on that property's infrastructure, for example type of pipework, filters etc. Where a response to the letter and questionnaire was received, enough information has been provided to determine the risk to the property's supply source and external infrastructure.

A8.2.18. The risks to the hydrological and hydrogeological environment during construction vary based on the location of each source and how that source is fed i.e. groundwater spring, borehole or surface water abstractions. As a result, the assessment of risk of contamination to PWS due to activities associated with the construction works will consider the following:

- Type of private water supply and likely disruption potential;
- Distance from water source and known supply infrastructure to the nearest point of construction; and
- Position of the source in relation to the construction works in terms of topography and catchment influence zones.

A8.2.19. The risk assessment considers the type of hazard associated with the Proposed Development and the probability and severity of an impact occurring based on topographical and hydrological relationships between the supply and construction activities and the severity of such an impact based on a combination of the probability and severity values.

Hazard Identification

A8.2.20. The key hazards acting as potential sources of pollution were identified as activities undertaken during the construction, operation, decommissioning and restoration of the Proposed Development. These are presented in Section A8.5, Risk Assessment.

Hydrogeological Considerations

A8.2.21. The hydrogeological assessment component of the risk identification is based on the following assumptions;

- That the PWS extraction boreholes have sufficiently engineered headworks to protect it from local surface contamination;
- That the hydraulic gradient transmits through flow in the direction of the extraction boreholes from the nearest point of the Proposed Development infrastructure; and
- Local groundwater permeability values are reflective of the regional averages for the wider bedrock aquifer.

A8.2.22. This component is primarily concerned with the impact of water quality reduction within water supply boreholes and includes groundwater boreholes extracting from bedrock aquifers and shallow wells extracting from superficial aquifers. This may also be applicable to springs under certain circumstances.

A8.2.23. As outlined in the Baseline Condition Sections of Chapter 8: Hydrology, Geology and Hydrogeology of the EIAR, the solid geology underlying the site is not considered to have a significant water resource potential owing to the low primary permeability of the indurated sedimentary bedrock. Groundwater flow is therefore generally expected to occur within the upper weathered bedrock zone / through discontinuities and in the superficial sediments. Flow pathways are therefore likely to be constrained by topography, apart from deeper fractures, which may be independent of such factors.

Hydrological Considerations

A8.2.24. The hydrological assessment component of the risk identification is based on the following assumptions:

- Any overland flow discharge from construction activity will do so in the direction of the extraction point unless the abstraction point is situated >30 m elevation above the construction activity (including any access tracks etc); and
- Where abstraction is directly from a surface watercourse, attenuation, dispersion and dilution of contaminants in flow is assumed to be absent for up to a 5 km flow distance. Therefore, the downgradient distance between the supply and the infrastructure is estimated from the nearest point of the utilised watercourse to the infrastructure.

A8.2.25. This component is primarily concerned with the impact of water quality reduction at PWS sources (surface water abstraction points from surface waters and also from springs).

Significance Criteria

A8.2.26. The potential impact to PWS has been assessed in relation to the probability of an impact occurring on the receiving environment and the receiving environment's sensitivity to change. The probability has also been classified as high, likely, low or unlikely based on professional judgement, as shown in Table A8.2.1. The sensitivity of any impacts on the quality and quantity of water serving the PWS is influenced by the type of supply and its source location within the catchment in relation to construction activities.

Table A8.2.1: Probability of Impact

Probability	Definition
Likely	Abstraction is downstream or downgradient from construction works for surface water abstractions within same hydrological catchment (<50 m). Groundwater source is likely to be in direct hydrogeological connectivity and close proximity (<50 m) downgradient of construction works.
Possible	Abstraction is downstream or downgradient from construction works for surface water abstractions within same hydrological catchment (>50 m and <250 m). Groundwater source is located >50 m and <250 m in direct hydrogeological connectivity downgradient from construction works. Construction works crossing land between source and property, specifically within 50 m of supply source or infrastructure. For example, pipe routing from supply and property is unconfirmed and there is the possibility that works may cause disruption. Supply infrastructure details between source and property are not known (residents unable or unwilling to provide information).
Unlikely	Surface water source is >250 m downstream of construction works. Groundwater source is >250 m in direct hydrogeological connectivity downgradient of construction works. However it is still assumed that the area falls within the total recharge zone for the source. Groundwater source is located up-gradient of construction works.
Remote	Surface water abstraction is not in hydrological connectivity with the construction working areas. Groundwater source is not within the hydrogeological catchment of the construction works. Surface water abstraction is situated upstream of the construction works.

A8.2.27. As outlined above the potential impacts on the private water supplies have been assessed by taking into account the type of supply and its distance from water source to the nearest point of construction and the source position in relation to topographic and catchment influence zones. The severity of potential change to that supply is defined below in Table A8.2.2.

Table A8.2.2: Magnitude of change to private water supply

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

Impact Significance Matrix

A8.2.28. The probability and severity of the potential impacts are combined to define the significance of the impact, as shown in Table A8.2.3. 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 severity of effects may be unclear and professional judgement remains the most effective manner for identifying the potential significance.

A8.2.29. 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.

Table A8.2.3: Combined risk

Probability of Impact	Magnitude of Impact			
	Major	Moderate	Minor	Insignificant
Likely	Very High	High	Medium	Low
Possible	High	Medium	Low	Very Low
Unlikely	Medium	Low	Very Low	Negligible
Remote	Low	Very Low	Negligible	Negligible

A8.3 Desktop Assessment

A8.3.1. 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.

A8.3.2. Information concerning the environmental setting of the Proposed Development and the surrounding area which contains the PWS is presented in Chapter 8: Hydrology, Geology and Hydrogeology of the EIAR. Based on the assessment, the following conceptualisation is presented that will be used to assess potential risks to PWS.

A8.3.3. The desktop assessment indicates the presence of two main groundwater systems; a shallow system that is largely dependent on surface water runoff and a deeper system heralding from the underlying bedrock. Shallow supplies may compromise catch pits and collection systems that obtain water over large areas which are topographically constrained. Supplies obtaining water from the underlying geology will be constrained by the nature and extent of tectonic features or fractures and be less constrained by topography. Under such circumstances, fractures will be a preferential flow pathway and may not conform to inferred surface water catchment area. In the cases of the PWS considered, it's possible that recharge to abstraction points may be via a combination of both systems.

A8.4 Consultation & Initial Screening

A8.4.1. Consultation with DGC identified 91 PWS situated within a 3 km buffer of the Proposed Development. As outlined in Section 8.2, the locations of the properties and source locations were then reviewed to determine whether any potential hydrological or hydrogeological connectivity could exist between the Proposed Development Area and the PWS. Following the initial screening of the PWS to determine whether such connectivity could exist between the supply recharge area / PWS property and infrastructure associated with the Proposed Development, direct consultation through a questionnaire was undertaken with the 14 properties listed below in Table A8.4.1.

A8.4.2. A summary of the PWS consultation is provided in Table 8.5.4 below.

Table A8.4.1: Summary of properties consulted during this PWSRA

ID	PWS Name	Type	Source	Nearest Infrastructure to Proposed Development boundary	
				Source	Property
20	Craigengillan	A	Groundwater Spring	2.4 km	2.5 km
25	Kensglen	B	Groundwater Spring	1.1 km	1.3 km
30	Burnfoot	B	Borehole	1.2 km	1.2 km
40	Furmiston*	B	Borehole	0.6 km	0.6 km
53	Marbrack & Marbrack Cottage*	B	Groundwater Spring	0.2 km	0.8 km
54	Marscalloch	B	Spring & Borehole	1.4 km	1.6 km
56	Moorbrock	B	Watercourse	2.6 km	2.6 km
59	Nether Loskie	B	Spring & Borehole	1.1 km	1.2 km
71	Holm of Daltallochan	B	Groundwater Spring	2.1 km	1.8 km
72	Lagwyne	B	Groundwater Spring	0.6 km	1.5 km
77	Knockgray Cottage & Stables Cottage	B	Surface Water**	0.2 km	0.8 km
79	Knockgray & Knockgray Farm *	B	Groundwater Spring	0.1 km	0.5 km
81	Burniston	B	Groundwater Spring	1.2 km	1.2 km
91	Polwhirn	B	Well	1.2 km	1.3 km

**Properties are financially involved with the Quantans Hill Wind Farm scheme*

***Abstraction is taken from an overspill from the Scottish Water raw water main taken from the Benloch Burn*

A8.5 Risk Assessment

A8.5.1. The nature of the potential risk to the PWS is manifested in either a reduction in volume or reduction in quality of the water feeding the supply.

A8.5.2. Risk management techniques involve managing one or more of the components in the Source-Pathway-Receptor chain. Standard Good Practice Mitigation measures would be embedded within construction activity risk assessments and method statements to minimise potential risks to receptors. In the event that the implementation of these practices does not minimise the risk to a receptor to an acceptable level, additional mitigation would be required with the protective measures specific to the circumstance of each receptor.

A8.5.3. Standard Good Practice mitigation as well as any additional mitigation requirements are presented in the following sections, with the risk assessment assuming the successful implementation of all measures proposed.

A8.5.4. See also CMS/CEMP for further mitigations and contingency measures.

Standard Good Practice Mitigation

Silt Laden Runoff

A8.5.5. For temporary and permanent on-site drainage systems, the following good practice guidance shall be used:

- Drainage shall incorporate sustainable drainage principles and include clean and treated water separation;
- When working within PWS catchments, where required, silt mitigation measures should be installed prior to works commencing and ensure that these are maintained for the duration of the works;
- Trenching or excavation activities in open land should be restricted during periods of intense rainfall;
- Temporary bunding should be provided as required, to reduce the risk of sediment transport to the natural drainage system;
- Direct drainage into existing watercourses must be avoided to avoid sediment and runoff from disturbed ground being routed directly to the watercourses;
- Settlement/attenuation ponds and silt fences should be provided adjacent to the drains to avoid pollution and sedimentation of watercourses;
- Access track construction materials should be free draining, strong, durable and well graded;
- The movement of construction traffic should be controlled to minimise soil compaction and disturbance;
- Clearly define permitted access routes;

- Vehicle movements off the defined tracks/routes should be avoided/minimised where possible;
- Water shall not be permitted to run down the length of the site access road; and
- Geotextile membranes should be laid underneath clean aggregate that is free from fines.

Fuels and Oils

A8.5.6. The delivery, storage, transfer, handling and use of hydrocarbons often presents one of the greatest hazard sources to PWS. In addition to the good practice guidance, there are documents such as:

- Construction Industry Research and Information Association (CIRIA), 'Environmental Good Practice On Site (C650)' (2005); and
- CIRIA, 'Control of Water Pollution from Construction Sites (C532)' (2001).

A8.5.7. It is recommended that good practice is considered in relation to fuel management in adherence to relevant Pollution Prevention Guidance (PPG) or Guidance for Pollution Prevention (GPP) including re-fuelling (PPG7) and storage and disposal of waste oils (GPP8) and the requirements under The Water Environment (Controlled Activities) (Scotland) Regulations 2011. In line with the measures above, measures for bulk delivery and transfer of oils and fuels should be carried out under supervision, and designated personnel must be trained in spill response measures.

Surveillance and Site Audits

A8.5.8. A programme of inspections and audits should be conducted on a regular and routine basis. As a minimum, the following elements will be included in this programme:

- Watercourses below working areas;
- Surface water and sedimentation run-off mitigation;
- Materials storage (fuels, oils, chemicals);
- Contingency controls;
- Waste management;
- Management controls;
- Emergency response and incidents; and
- Environmental issues (litter, dust, noise etc.).

A8.5.9. During the construction phase, regular visual inspections of all receiving watercourses should be carried out in conjunction with reviews of environmental mitigation controls.

A8.5.10. Further details of Standard Good Practice Mitigation to be adopted by the Proposed Development is presented in Chapter 8: Hydrology, Geology & Hydrogeology of the EIAR.

Emergency Contingency Measures

Spill Response

A8.5.11. Spill kits and response materials will be available within the identified high-risk vehicles and plant working within water supply catchments and at designated locations across the construction site where hazardous materials are stored. The locations of key spill kit supply stores should be marked on a site location plan included within key documentation, which should also include a specific spill response procedure.

Specialist Contractors

A8.5.12. The Principal Contractor will have a contingency plan involving the procurement of specialist oil and fuel pollution contractors who can deal with major incidents and those incidents which site personnel are not able to deal with.

Temporary Alternative Supply

A8.5.13. In the unlikely event that a PWS is impacted by activities associated with the Proposed Development, contingency supply arrangements will be ready for implementation under these circumstances. This will include ensuring that alternative sources of potable drinking water and water for general use will be provided should it be required.

Private Water Supply Monitoring Programme

A8.5.14. Where a requirement is identified through risk assessment, a programme of water supply monitoring would be undertaken at the relevant water supply source and the water supply user point of consumption. Monitoring would be undertaken in compliance with the PWS Technical Manual[4] as well as any other relevant guidance.

A8.5.15. The monitoring program would include chemical quality and quantity, with the list of parameters likely to be (but not limited to) those identified in Table C *Route Monitoring* from Schedule 2 of The Private Water Supplies (Scotland) Regulations 2006. A suitable period of pre-construction baseline monitoring would be completed, with further monitoring during construction and post-construction phases if required.

A8.5.16. Further details on the monitoring program would be provided post-consent as part of the sites Pollution Prevention Plan (PPP) or Construction Environmental Management Plan (CEMP).

Additional Mitigation

Site Investigation & Demarcation

A8.5.17. Where required, additional site investigation would be undertaken by the nominated Principal Contractor to confirm the positioning of a PWS abstractions or associated infrastructure. Any PWS infrastructure would be demarcated and construction access / activities within 100 m would be avoided.

A8.5.18. Pollution prevention measures employed as part of Standard Good Practice mitigation would also consider the findings of additional investigation i.e. avoid positioning discharge points immediately upgradient of PWS abstractions.

A8.5.19. The Environmental Clark of Works (ECoW) would carry out daily inspections of any implemented standard good practice mitigation used near a PWS source and will make recommendations for improvement if required.

Permanent Alternative Supply

A8.5.20. It has not been possible through site design to avoid a detriment impact to PWS at the domestic properties known as Knockgray and the associated business, Knockgray Farm, which are financially involved in the Proposed Development. With the landowner's agreement, the Applicant will provide a permanent alternative potable water source and associated supply infrastructure would be provided for Knockgray and Knockgray Farm as well as the adjacent properties, Knockgray Cottage and Stables Cottage prior to construction. The source of the alternative supply would not be at risk from the Proposed Development and quality standards would be comparable or better to that currently provided by the existing supplies.

A8.5.21. A Feasibility Study (Appendix B) has been undertaken to determine the suitable alternative supply options for Knockgray Cottage, Stables Cottage and Knockgray and Knockgray Farm. The proposal to provide an alternative supply as well as the feasibility study was discussed with D&GC in June 2021. In the case of Knockgray Cottage & Stables Cottage, there may also be a preference for a controlled severance of the old supply line and subsequent reinstatement of a new supply line from the original abstraction, which would remain unaffected by the Proposed

Development. The provision of this alternative potential option would be at the preference of the landowner, but would also be subject to mitigation that would be outlined in the CEMP / Private Water Supply Monitoring Plan. This mitigation would ensure the provision of a wholesome supply with no detriment to quantity or quality. The final mitigation would also be subject to agreement from SEPA and D&GC.

Private Water Supply Monitoring Plan (PWSMP)

It is recommended that prior to construction a Private Water Supply 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 to the properties which may be affected by the Proposed Development.

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.

The PWS water monitoring programme will be aligned with the CEMP including wider surface water or groundwater monitoring programme related to the site 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 PWSMP will also include a pollution response plan and contingency measures that would detail responsibilities and lines of communication between Construction Contractors, PWS Users and other stakeholders. Contingency measures would 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.

Hazards

A8.5.22. 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[5] guidance documents and are presented below'

- Excavation and operation of borrow pits;
- Excavation and operation of tracks, roads and hardstanding areas (including compounds);
- Construction and operation of temporary concrete batching facilities;
- Excavation of turbines foundations and their subsequent operation;
- Excavation of trenches for turbine power collector cabling;
- Construction of temporary site compounds and laydown areas; and
- Construction of the permanent site operations and maintenance and substation compound and proposed battery energy storage facility.

A8.5.23. The completion of the construction elements listed above will require additional activities to be undertaken which may also lead to potential impacts, these activities include;

- Surface water drainage and de-watering;
- Transport, storage and handling of fuels and oils;
- Use of machinery and plant;
- Felling and tree removal;
- Wastewater management
- Peat management; and
- Concrete works.

A8.5.24. 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 or battery energy storage facility[6]. Other point source pollution may include the pouring of concrete foundations, or specific discharges from damaged or inadequate drainage networks

A8.5.25. 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 8 of the EIAR.

A8.6 Results

A8.6.1. This section details the results of the risk assessment based on the methodology presented in Section A8.2. Table A8.6.1 details the summary of potential risks taking into account all of the mitigation measures provided in Section A8.4. Where required, recommendations for specific mitigation are provided for individual supplies. Detailed assessment summaries for each supply are presented in Appendix A.

[5] Full list of relevant CIRIA guidance documents in Table 8-1, of Chapter 8 of the EIAR

[6] In the case of the battery energy storage facility and substation, mitigation through design will ensure that these infrastructure elements do not pose a potential source of contamination. Nonetheless and for the purpose of this assessment, they are still considered as potential hazard sources.

Table A8.6.1: Risk Assessment Summary

ID	PWS Name	Abstraction Type	Risk Assessment Assuming Implementation of Standard Good Practice			Additional Mitigation Requirements	Risk Assessment Assuming Implementation of Ad. Mitigation		
			Probability	Mag. Of Change	Combined Risk		Probability	Mag. Of Change	Combined Risk
20	Craigengillan	GW Spring	Remote	Insignificant	Negligible	Not required	-	-	-
25	Kensglen	GW Spring	Unlikely	Insignificant	Negligible	Not required	-	-	-
30	Burnfoot	Borehole	Unlikely	Insignificant	Negligible	Not required	-	-	-
40	Furmiston	Borehole	Unlikely	Minor	Very Low	Not required	-	-	-
53	Marbrack & Marbrack Cottage	GW Spring	Possible	Moderate	Medium	• Further investigation by PC prior to construction; • Demarcation of supply and infrastructure and appropriate design of standard good practice mitigation to avoid potential for impact; • Establishment of a program of inspection and monitoring as part of the PWSMP.	Possible	Minor	Low
54	Marscalloch	GW Spring & Borehole	Unlikely	Insignificant	Negligible	Not required	-	-	-
56	Moorbrock	Surface Watercourse	Remote	Insignificant	Negligible	Not required	-	-	-
59	Nether Loskie	GW Spring & Borehole	Unlikely	Insignificant	Negligible	Not required	-	-	-
71	Holm of Dalt.	Groundwater Spring	Remote	Insignificant	Negligible	Not required	-	-	-
72	Lagwyne	GW Spring	Remote	Insignificant	Negligible	Not required	-	-	-
77	Knockgray Cottage & Stables Cottage	Surface Watercourse*	Likely	Moderate	High	• Provision of a permanent alternative supply prior to construction (borehole or re-routed supply pipeline). Further details are presented in Appendix B, of this Technical Appendix.	Unlikely	Insignificant	Negligible
79	Knockgray Farm	GW Spring	Likely	Moderate	High				
81	Burniston	GW Spring	Unlikely	Insignificant	Negligible	Not required	-	-	-
91	Polwhirn	Well	Unlikely	Insignificant	Negligible	Not required	-	-	-

**Abstraction is taken from an overspill from the Scottish Water raw water main taken from the Benloch Burn*

A8.7 Conclusion

A8.7.1. A Private Water Supply Risk Assessment (PWSRA) has been carried out for supplies that may be affected during the construction and operation of the Proposed Development.

A8.7.2. 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 3 km buffer of the Proposed Development. Following an initial review, consultation was undertaken with residents through the issuing of questionnaires to ascertain further information on their PWS. A site walkover was then undertaken to further investigate selected PWS.

A8.7.3. 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.

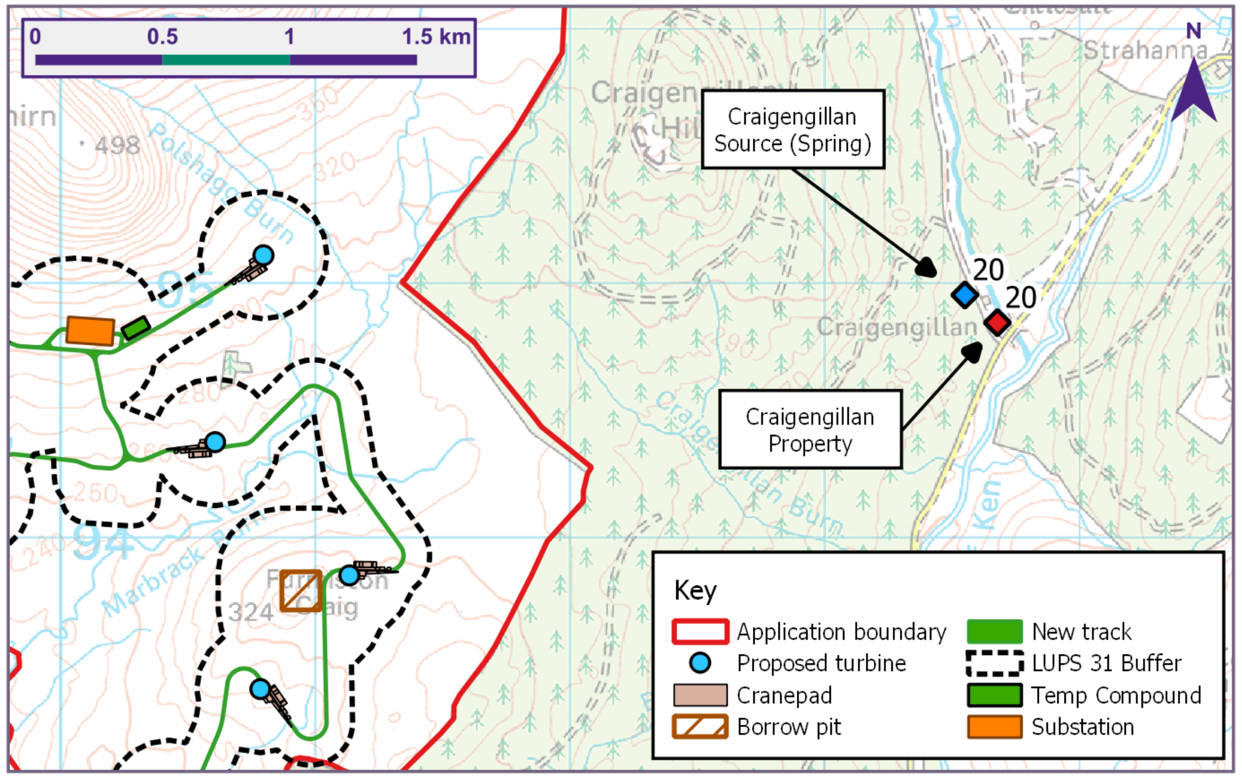
A8.7.4. The PWS has been evaluated based on the information provided to determine the risks based on the prescribed matrix scenarios. Where required, in order to minimise the risk of the Proposed Development construction activities potentially impacting the PWS supply, mitigation measures have been outlined which should be implemented by the Applicant and nominated Principal Contractor.

A8.7.5. The assessment concludes that following implementation of mitigation, there remains a low risk to Marbrack and Marbrack Cottage, with all other PWS demonstrating a combined risk rating of Negligible, including Knockgray Cottage and Stables Cottage as well as Knockgray and Knockgray Farm after mitigation.

A8.7.6. The identified risk is deemed to arise due to the downslope location of the source in relation to the proposed turbine. The main perceived risk to the supply is that construction activities (i.e. runoff or discharges) have the potential to impact the quantity of quality of water at the supply. Specific mitigations have been prescribed for this which includes identification and demarcation of the supply and the design of standard good practice mitigation to avoid discharging immediately upgradient of the PWS. Water quantity and quality monitoring for Marbrack and Marbrack Cottage is also recommended.

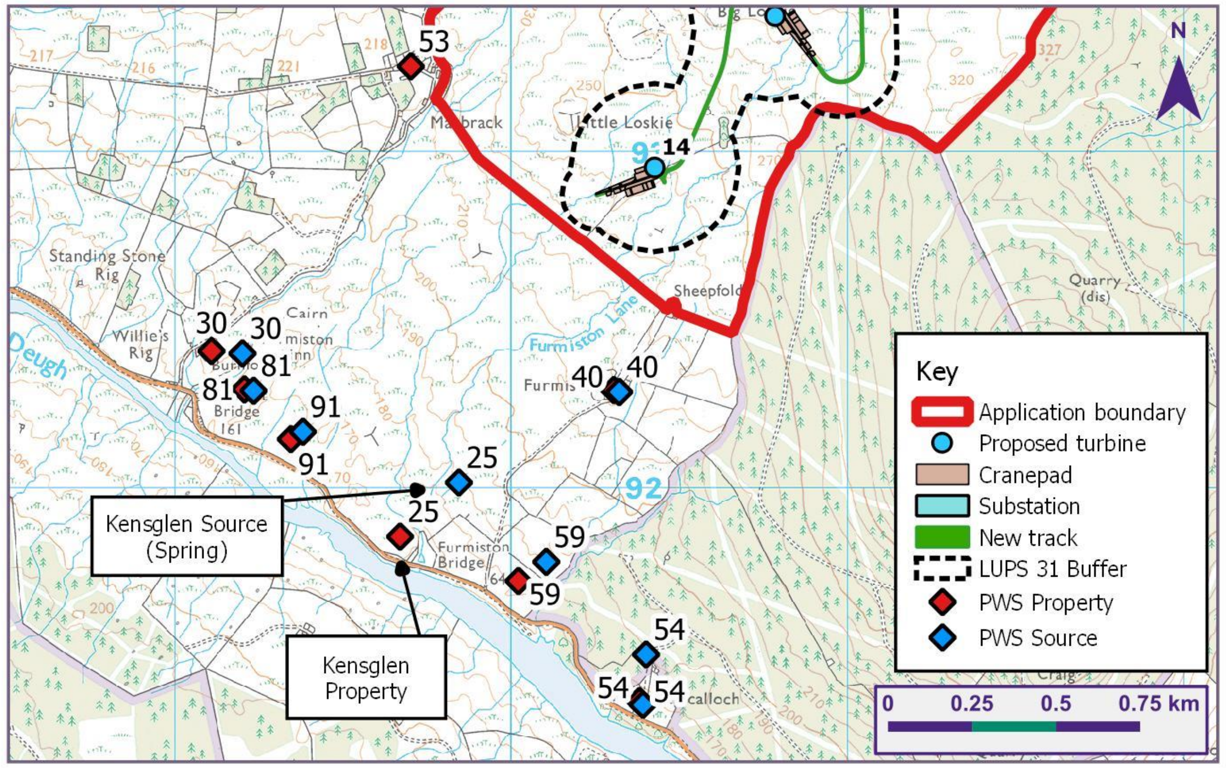
Appendix A - Assessment Summaries

Craigengillan (20)	
Supply Type	Groundwater Spring
Supply Use	Domestic / Agriculture
Shared Supply	Yes (Craigengillan & Craigengillan Cottage)



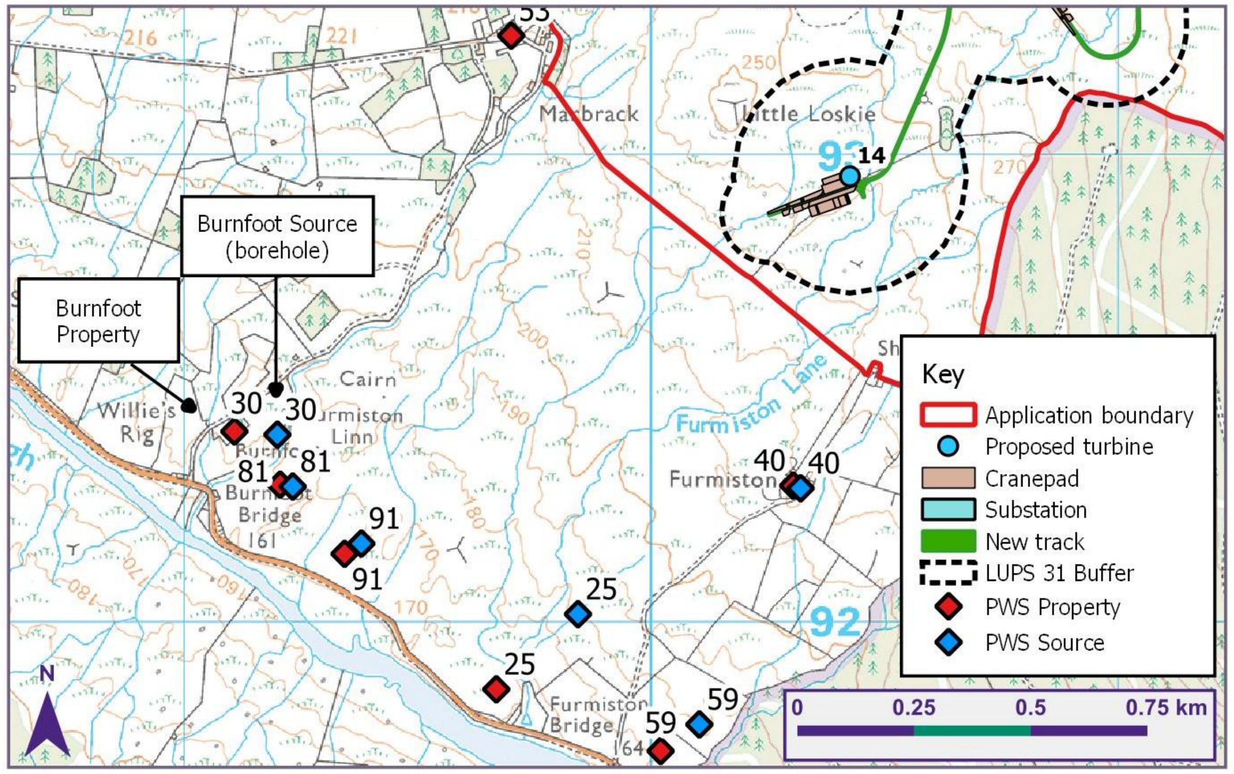
Risk Assessment Notes	• Groundwater spring abstraction situated within the vicinity of the PWS properties; • Abstraction ~2.4 km from nearest infrastructure (access track); • Development infrastructure situated on interfluve of upper PWS catchment boundary, but overland flow or topographically constrained groundwater unlikely to provide pathway to PWS source; • The bedrock geology is characterised as a low productivity aquifer with storage and transport of water constrained to weathered zones and discontinuities.
Additional Mitigation	None Required
Probability	Remote
Magnitude	Insignificant
Combined Risk	Negligible

Kensglen (25)	
Supply Type	Groundwater Spring
Supply Use	Domestic
Shared Supply	No



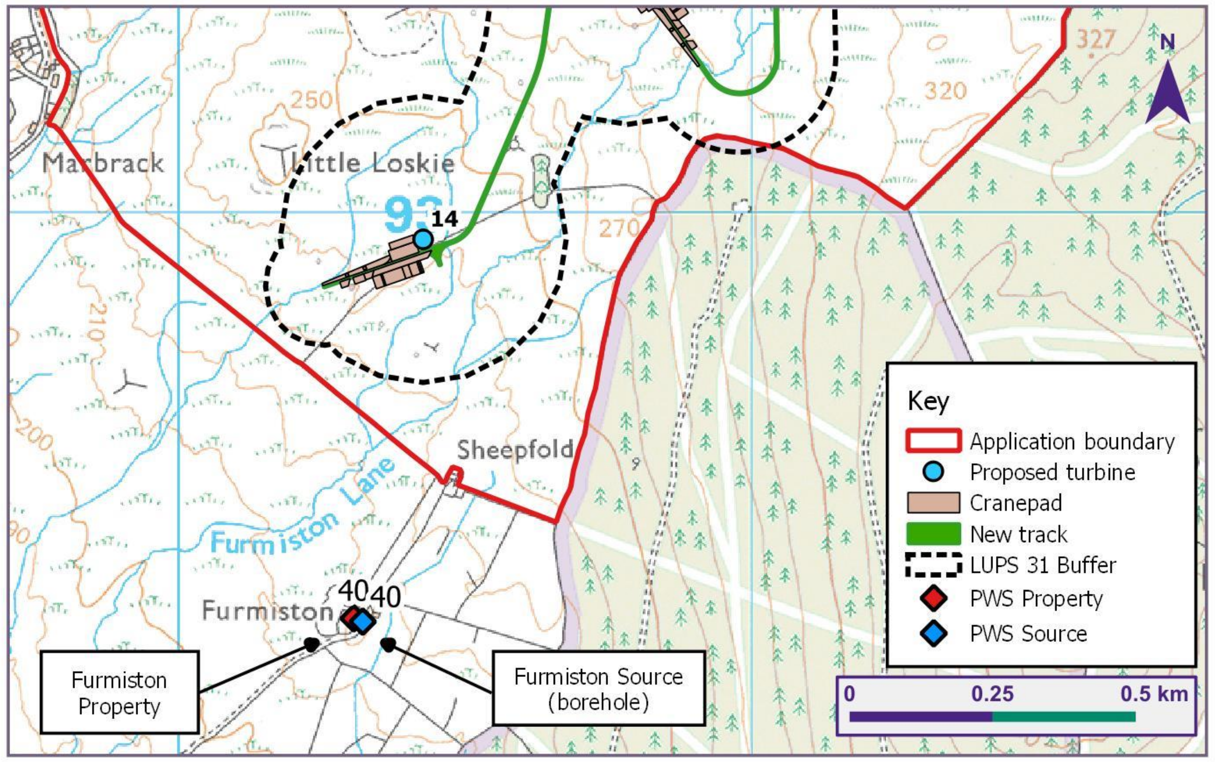
Risk Assessment Notes	• Groundwater spring abstraction situated 150 m northeast of PWS property; • Abstraction ~1.1 km from nearest infrastructure (cranepad); • Development infrastructure situated in PWS catchment boundary, but overland flow or topographically constrained groundwater will follow riparian corridors and is unlikely to provide pathway to PWS abstraction; • The bedrock geology is characterised as a low productivity aquifer with storage and transport of water constrained to weathered zones and discontinuities.
Additional Mitigation	None Required
Probability	Unlikely
Magnitude	Insignificant
Combined Risk	Negligible

Burnfoot (30)	
Supply Type	Borehole
Supply Use	Domestic
Shared Supply	Unknown



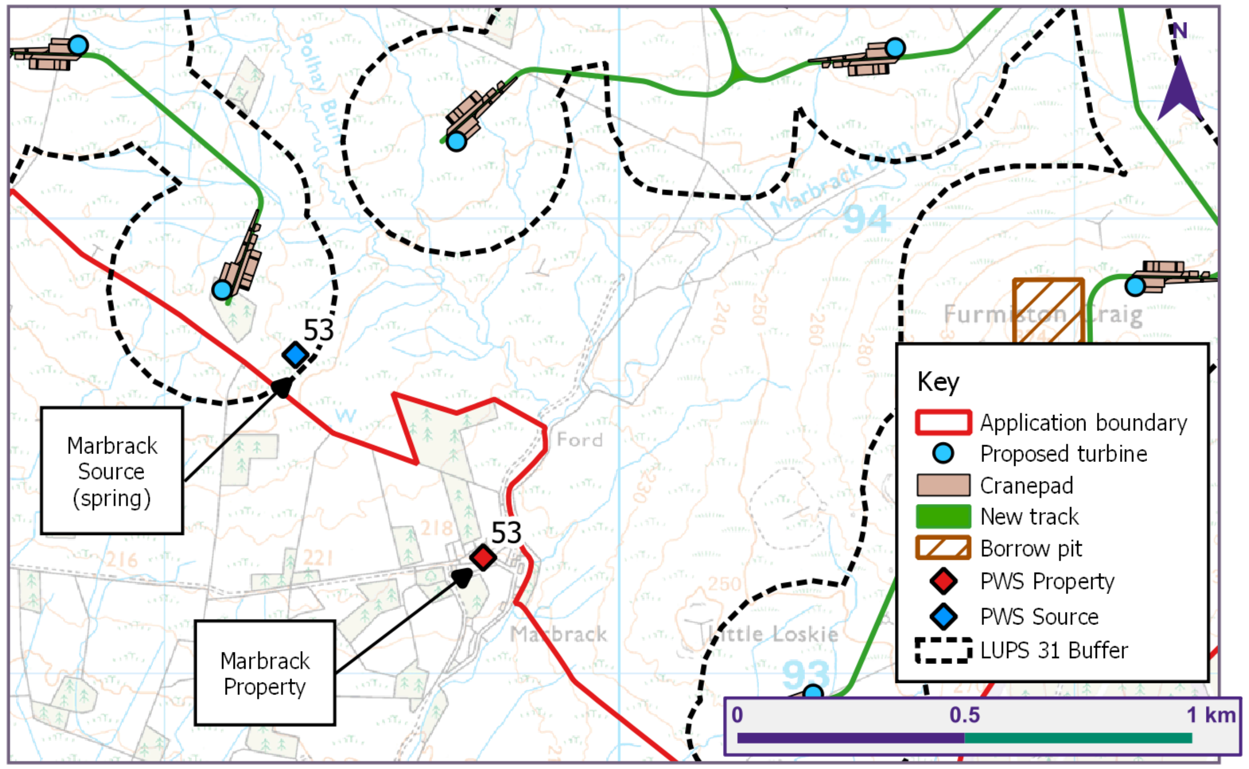
Risk Assessment Notes	• Groundwater borehole situated adjacent to the PWS property; • Abstraction ~1.2 km from nearest infrastructure (cranepad); • Development infrastructure situated upper PWS catchment boundary, but overland flow or topographically constrained groundwater will follow riparian corridors and is unlikely to provide pathway to PWS abstraction; • The bedrock geology is characterised as a low productivity aquifer with storage and transport of water constrained to weathered zones and discontinuities.
Additional Mitigation	None Required
Probability	Unlikely
Magnitude	Insignificant
Combined Risk	Negligible

Furmiston (40)	
Supply Type	Borehole
Supply Use	Domestic
Shared Supply	Unknown



Risk Assessment Notes	• Groundwater borehole situated adjacent to the PWS property; • Abstraction ~0.6 km from nearest infrastructure (cranepad); • Development infrastructure situated upper PWS catchment boundary, but overland flow or topographically constrained groundwater will follow riparian corridors and is unlikely to provide pathway to PWS abstraction; • The bedrock geology is characterised as a low productivity aquifer with storage and transport of water constrained to weathered zones and discontinuities.
Additional Mitigation	None Required
Probability	Unlikely
Magnitude	Minor
Combined Risk	Very Low

Marbrack (53)	
Supply Type	Groundwater Spring
Supply Use	Domestic
Shared Supply	Yes (Marbrack and Marbrack Cottage)



Field Inspection Notes	• Field inspection of the PWS was undertaken in February 2021. The weather during the visit was dry and bright. The weather prior to the visit had been snowy. • The abstraction is a shallow spring / well situated within topographic re-entrant. The area around and upgradient of the spring is dominated by hummocky moraines. • The water level within the well was near to surface level, with the ground around the well being saturated. • Abstraction feeds a small header tank at NX 59368 93544 via buried pipework, before then discharging through further buried pipework to the PWS property. • PWS User indicated water often discoloured with peat, with some issues in the past associated with the water being very acidic. • Topography between the spring and proposed infrastructure is undulating and is not suggestive of an obvious overland flow pathway. • Habitat communities' provide evidence of diffuse groundwater emergence / surface water flow convergence between moraines. • Flow likely to be derived from a combination of topographically constrained surface water or shallow groundwater.

Marbrack (53)

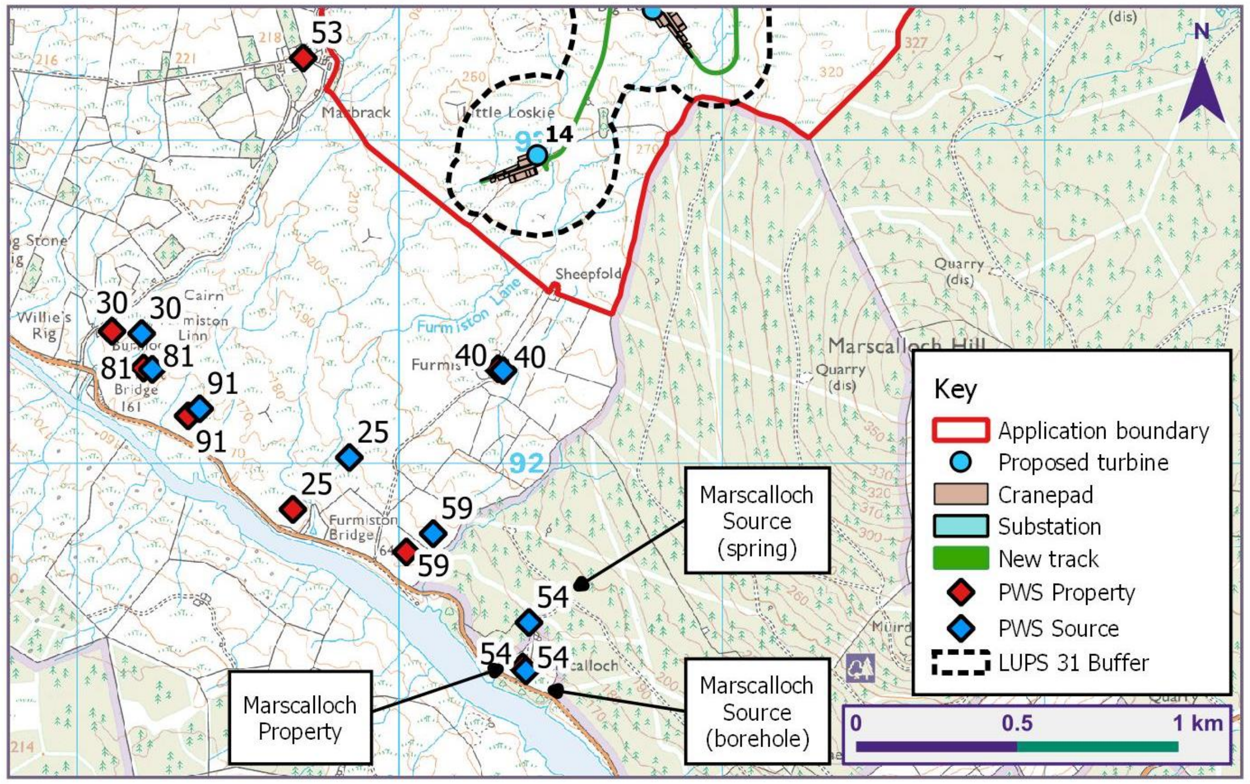
Marbrack PWS Abstraction

Marbrack PWS Header Tank

Risk Assessment Notes	• Groundwater spring situated ~600 m northeast of the PWS properties; • Abstraction ~200 m from nearest infrastructure (cranepad) and is therefore inside the LUPS31 250 m buffer for excavations >1 m (turbine) and so more detailed assessment, including a walkover was undertaken; • The bedrock geology is characterised as a low productivity aquifer with storage and transport of water constrained to weathered zones and discontinuities.
Probability	Possible
Magnitude	Moderate
Combined Risk	Medium
Additional Mitigation	• Further investigation by PC prior to construction; • Demarcation of supply and infrastructure and appropriate design of standard good practice mitigation to avoid potential for impact. This would include the redirection of any overland surface water discharges away from the PWS abstraction; • Establishment of a program of inspection and monitoring.
Probability*	Possible
Magnitude*	Minor
Combined Risk*	Low

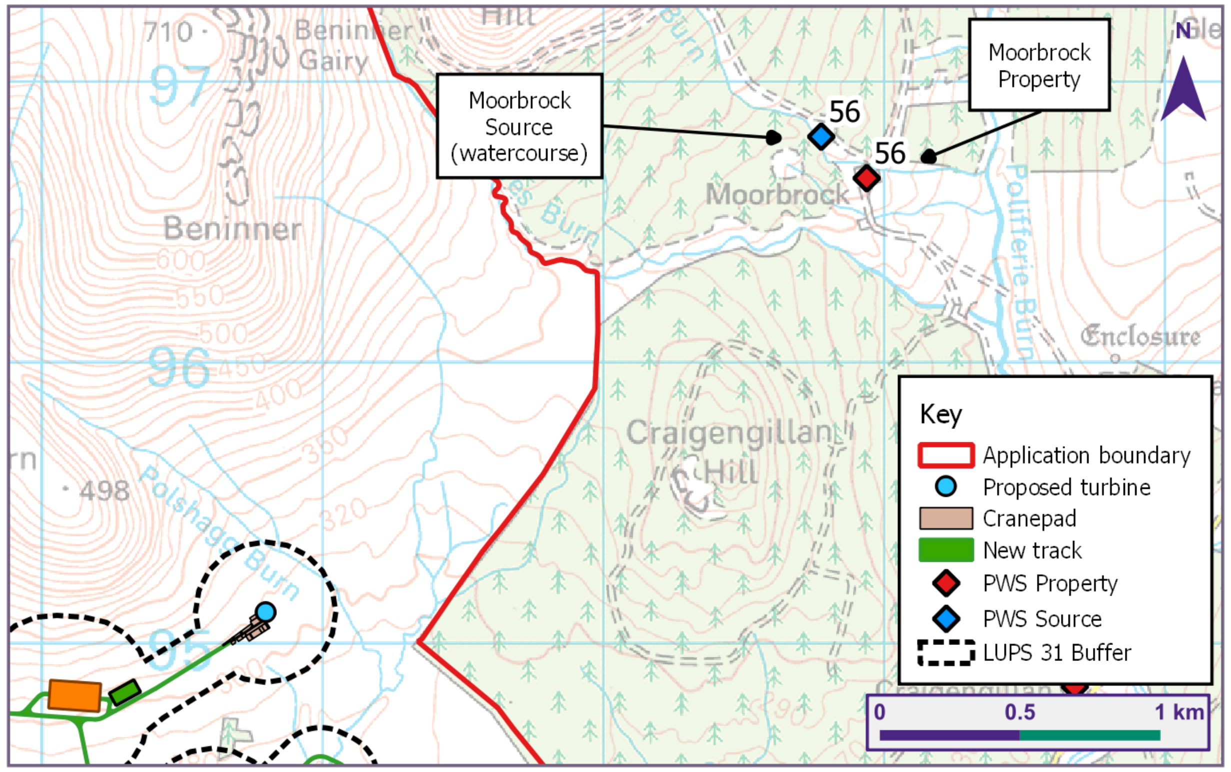
*Revised risk assessment assuming implementation of additional mitigation.

Marscalloch (54)	
Supply Type	Borehole & Groundwater Spring
Supply Use	Domestic
Shared Supply	No



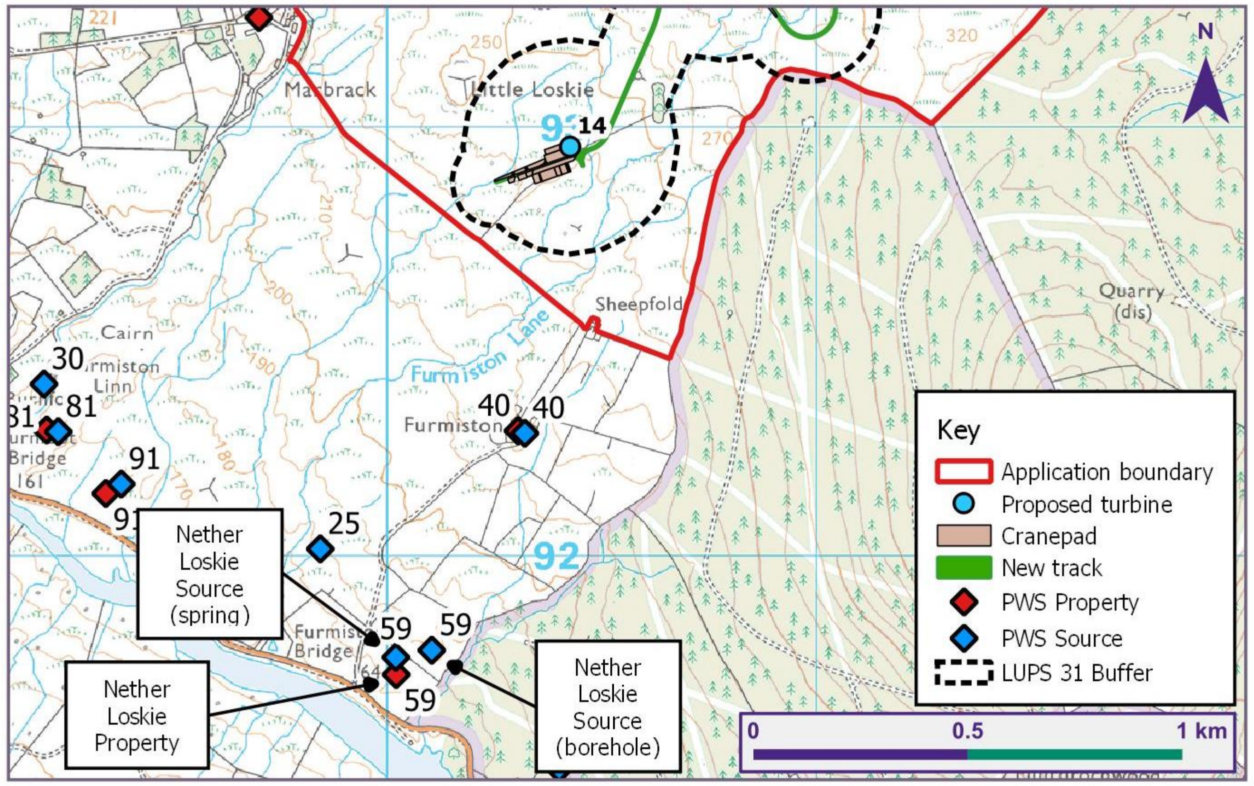
Risk Assessment Notes	• Groundwater borehole situated adjacent to the PWS property; • Groundwater spring situated 150 m norther west of PWS property; • Spring abstraction ~1.4 km and borehole is 1.6 km from nearest infrastructure (cranepad); • Development infrastructure situated upper PWS catchment boundary, but overland flow or topographically constrained groundwater will follow riparian corridors and is unlikely to provide pathway to PWS abstractions; • The bedrock geology is characterised as a low productivity aquifer with storage and transport of water constrained to weathered zones and discontinuities.
Additional Mitigation	None Required
Probability	Unlikely
Magnitude	Insignificant
Combined Risk	Negligible

Moorbrock (56)	
Supply Type	Surface Watercourse
Supply Use	Domestic
Shared Supply	No



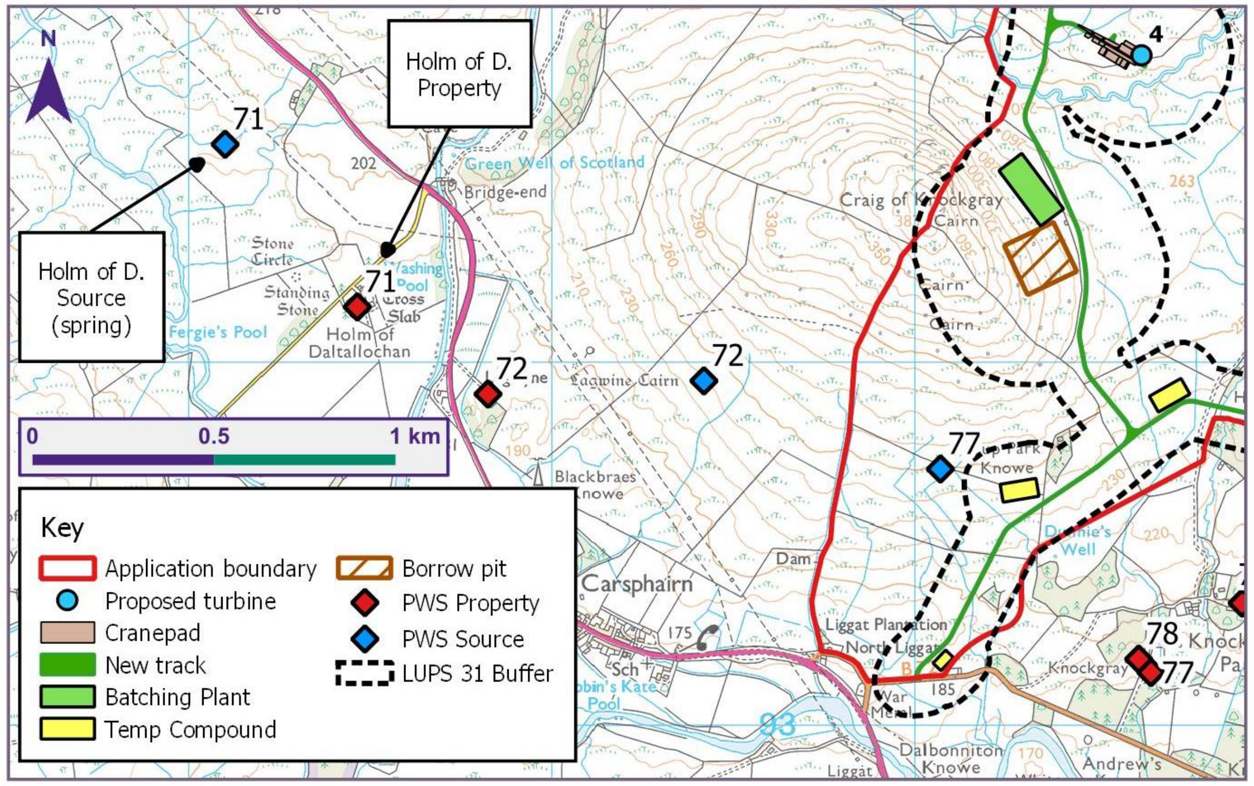
Risk Assessment Notes	• Abstraction point from stream indicated ~200 m northwest of PWS property; • Abstraction source ~2.6 km from nearest infrastructure (access track); • Development infrastructure is not situated within surface water catchment, with no pathway, hydrological connection or pollutant linkage identified.
Additional Mitigation	None Required
Probability	Remote
Magnitude	Insignificant
Combined Risk	Negligible

Nether Loskie (59)	
Supply Type	Groundwater Spring & Borehole
Supply Use	Domestic
Shared Supply	No



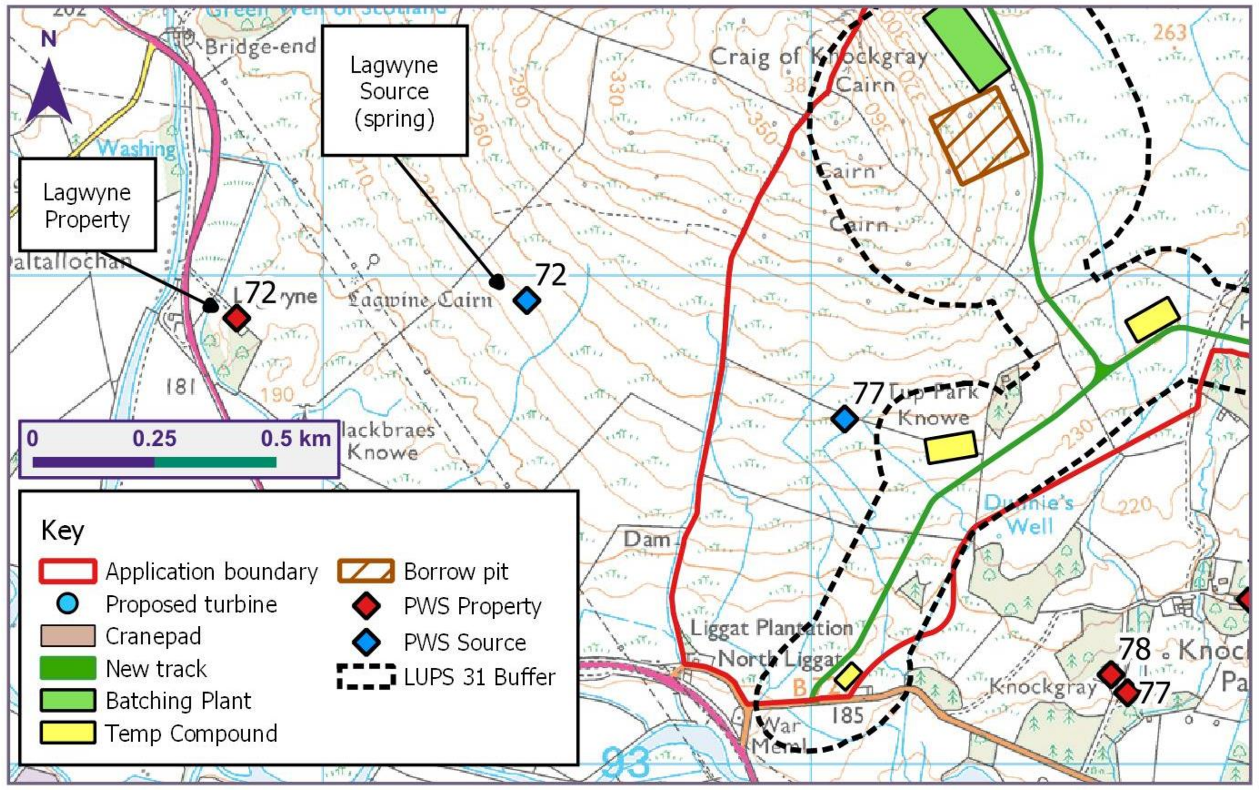
Risk Assessment Notes	• Groundwater spring situated adjacent to the PWS property; • Groundwater borehole situated 150 m northeast of PWS property; • Spring abstraction ~1.1 km and borehole is 1.2 km from nearest infrastructure (cranepad); • Development infrastructure situated upper PWS catchment boundary, but overland flow or topographically constrained groundwater will follow riparian corridors and is unlikely to provide pathway to PWS abstractions; • The bedrock geology is characterised as a low productivity aquifer with storage and transport of water constrained to weathered zones and discontinuities.
Additional Mitigation	None Required
Probability	Unlikely
Magnitude	Insignificant
Combined Risk	Negligible

Holm Of Daltallochan (71)	
Supply Type	Groundwater Spring
Supply Use	Domestic & Agriculture
Shared Supply	Yes – Bridge End Farm



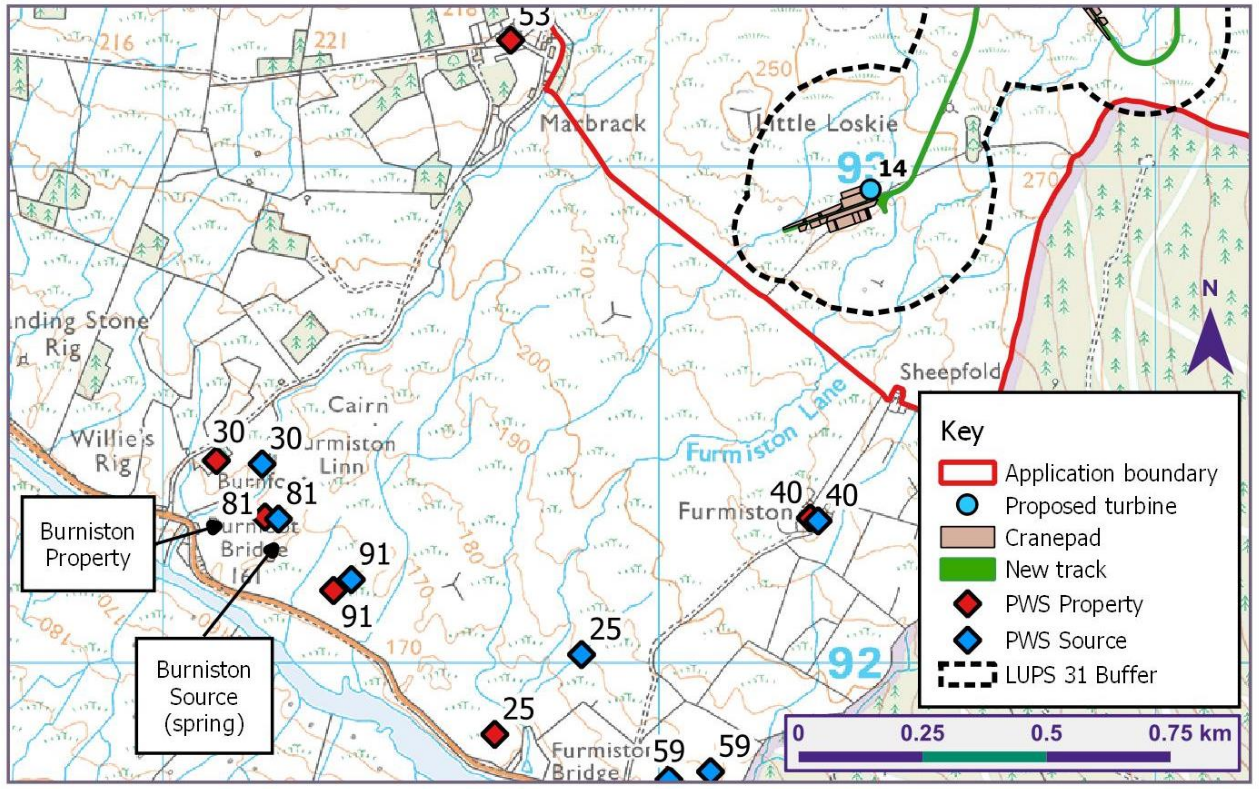
Risk Assessment Notes	• Groundwater spring situated 0.7 km northwest of PWS property; • Spring abstraction ~2.1 km from nearest infrastructure (borrow pit); • Confirmed location of source by resident suggests Development infrastructure in separate hydrological and hydrogeological catchment.
Additional Mitigation	None Required
Probability	Remote
Magnitude	Insignificant
Combined Risk	Negligible

Lagwyne (72)	
Supply Type	Groundwater Spring
Supply Use	Domestic
Shared Supply	No



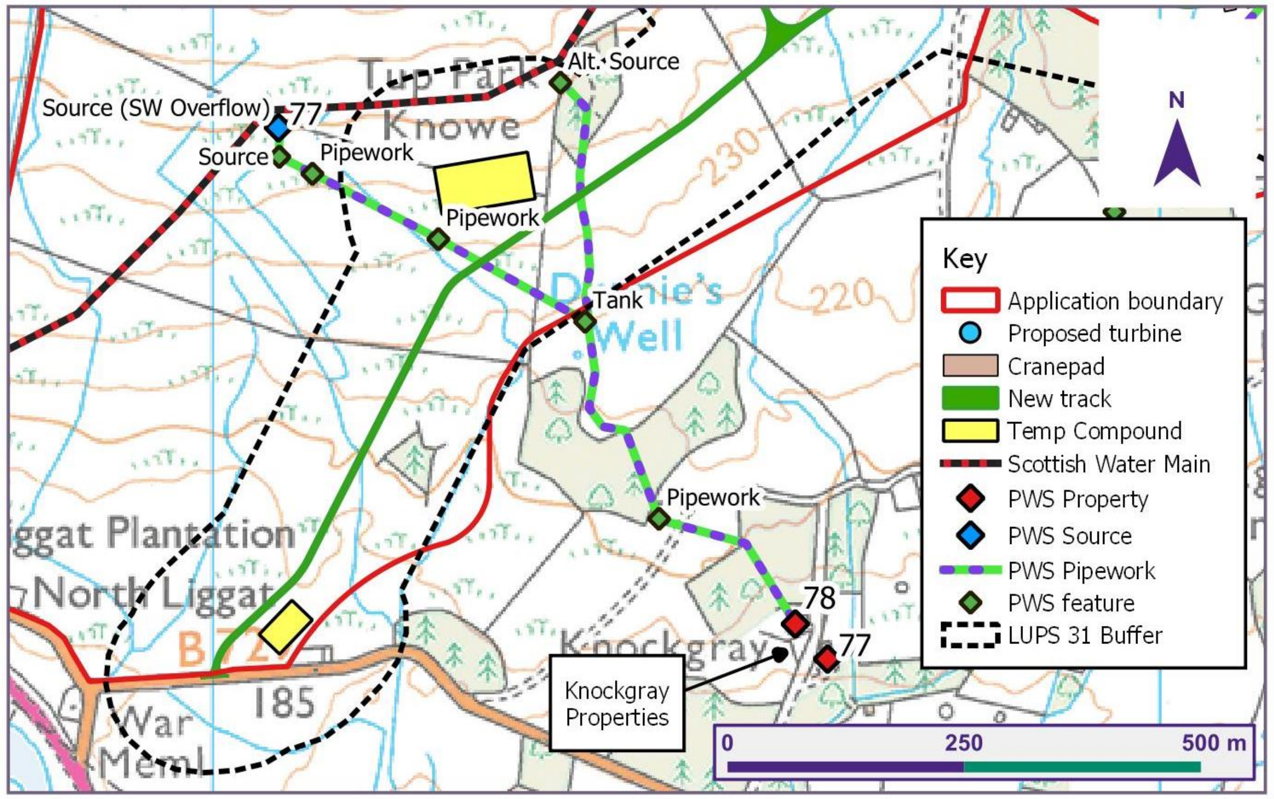
Risk Assessment Notes	• Groundwater spring situated 0.6 km east of the PWS property; • Spring abstraction ~0.8 km from nearest infrastructure (compound); • Development infrastructure situated cross / downgradient hydrogeological catchment. Development infrastructure not within hydrological catchment; • The bedrock geology is characterised as a low productivity aquifer with storage and transport of water constrained to weathered zones and discontinuities.
Additional Mitigation	None Required
Probability	Remote
Magnitude	Insignificant
Combined Risk	Negligible

Burniston (81)	
Supply Type	Groundwater Spring
Supply Use	Domestic
Shared Supply	No



Risk Assessment Notes	• Groundwater spring situated adjacent to the PWS property; • Spring abstraction ~1.2 km from nearest infrastructure (cranepad); • Development infrastructure situated upper PWS catchment boundary, but overland flow or topographically constrained groundwater will follow riparian corridors and is unlikely to provide pathway to PWS sources; • The bedrock geology is characterised as a low productivity aquifer with storage and transport of water constrained to weathered zones and discontinuities.
Additional Mitigation	None Required
Probability	Unlikely
Magnitude	Insignificant
Combined Risk	Negligible

Knockgray Cottage & Stables Cottage (77 & 78)	
Supply Type	Surface Watercourse
Supply Use	Domestic
Shared Supply	Yes (Knockgray Cottage and Stables Cottage)



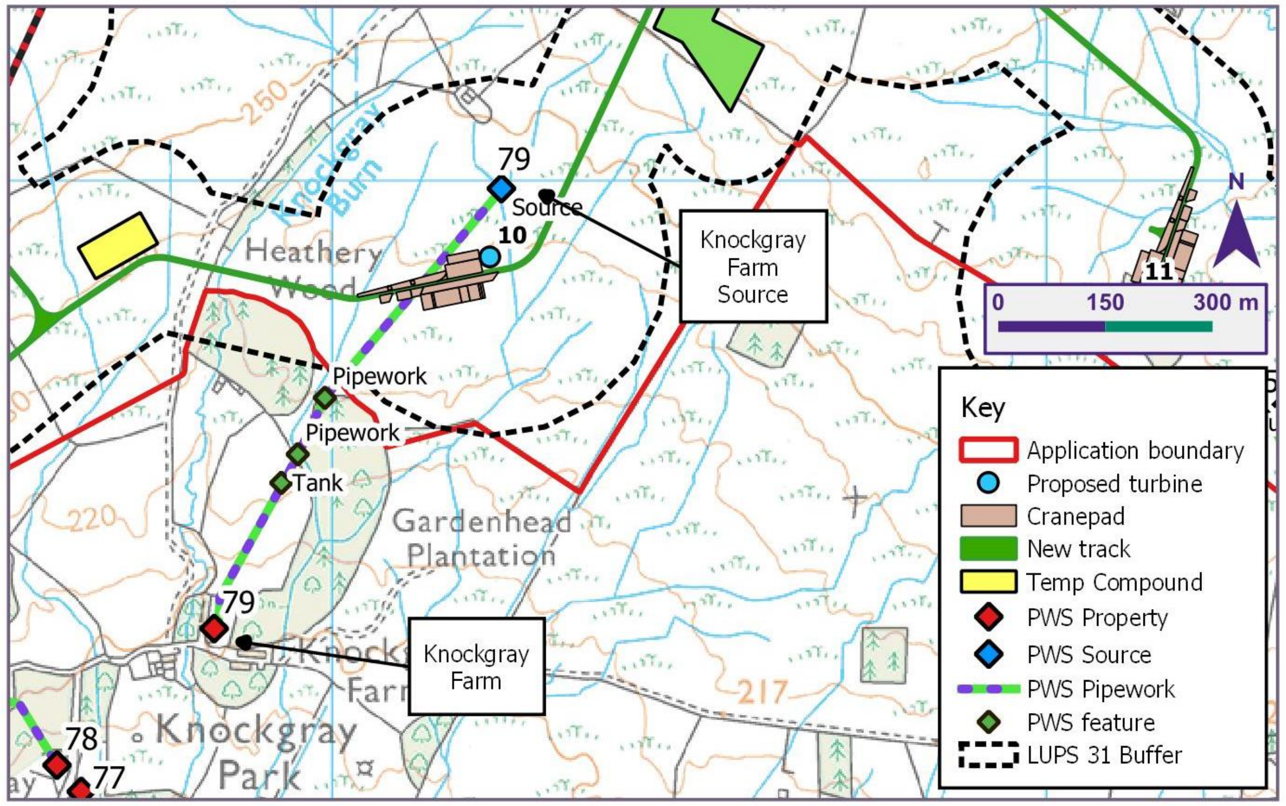
Field Inspection Notes	• Field inspection of the PWS was undertaken in February 2021. The weather during the visit was dry and bright. The weather prior to the visit had been snowy, with thawing conditions. • The abstraction is taken from the Scottish Water raw water supply pipe which originates in the Benloch Burn. Raw water is siphoned off from a settling tank and diverted into a header tank. • Abstraction feeds a header tank at NX 57394 93501 via buried pipework, before then discharging through further buried pipework to the PWS properties. • The pipework is MDPE and is shallow buried. The line of the pipework is marked by numerous vents. The pipe crosses under all existing tracks. • PWS User indicated issues with quantity or quality is rare however an older alternative point which was and still can be siphoned off exists ~0.8 km east along the raw water main.

Knockgray Cottage & Stables Cottage (77 & 78)

Scottish Water Settling Tank	Knockgray Header Tank
Risk Assessment Notes	• Abstraction from the Scottish Water raw water settling tank overspill ~0.7 km west of the PWS property. Risks to the origin of the raw water supply from the Benloch Burn are considered separate to this assessment (see Technical Appendix 8.6 PPIP). • Abstraction ~160 m from nearest infrastructure (compound), and pipework is bisected by proposed access track and overlain by compound. • Proposed infrastructure would not influence abstraction from raw water pipe or overspill from settling tank, however it would bisect the existing supply pipework. Owing to the proposed positioning of the compound and thoroughfare track very close to the line of the delivery pipework it is likely that significant disruption to supply would be experienced.
Probability	Likely
Magnitude	Moderate
Combined Risk	High
Additional Mitigation	• Provision of a permanent alternative supply prior to construction (new borehole or re-routed supply pipeline, depending on PWS User preference). See Appendix B.
Probability*	Unlikely
Magnitude*	Insignificant
Combined Risk*	Negligible

*Assuming implementation of additional mitigation.

Knockgray & Knockgray Farm (79)	
Supply Type	Groundwater Spring
Supply Use	Domestic & Agricultural
Shared Supply	No



Field Inspection Notes

- Field inspection of the PWS was undertaken in February 2021. The weather during the visit was dry and bright. The weather prior to the visit had been snowy.
- The abstraction is a groundwater spring set in a level area of open moorland. The upgradient topography gently slopes, before becoming level at the spring creating a "catch-pit" feature encouraging flow convergence.
- Anecdotal information confirms the spring was excavated several meters into the peat. Water level in the spring is noted to be at the surface and is ~0.5 m above the level of water in an adjacent watercourse.
- The abstraction feeds a header tank at NX 57930 93577 via buried pipework, before then discharging through further buried pipework to the PWS property.
- The pipework is understood to be a combination of plastic and cast iron, with a short section exposed at NX 57953 93617 as it spans a drainage ditch.
- PWS User indicated issues with quantity or quality are rare, but the water level can drop during prolonged periods of dry weather and can also suffer from peat discolouration.

Knockgray & Knockgray Farm (79)

Knockgray Farm PWS Source

Water level within spring showing abstraction pipe

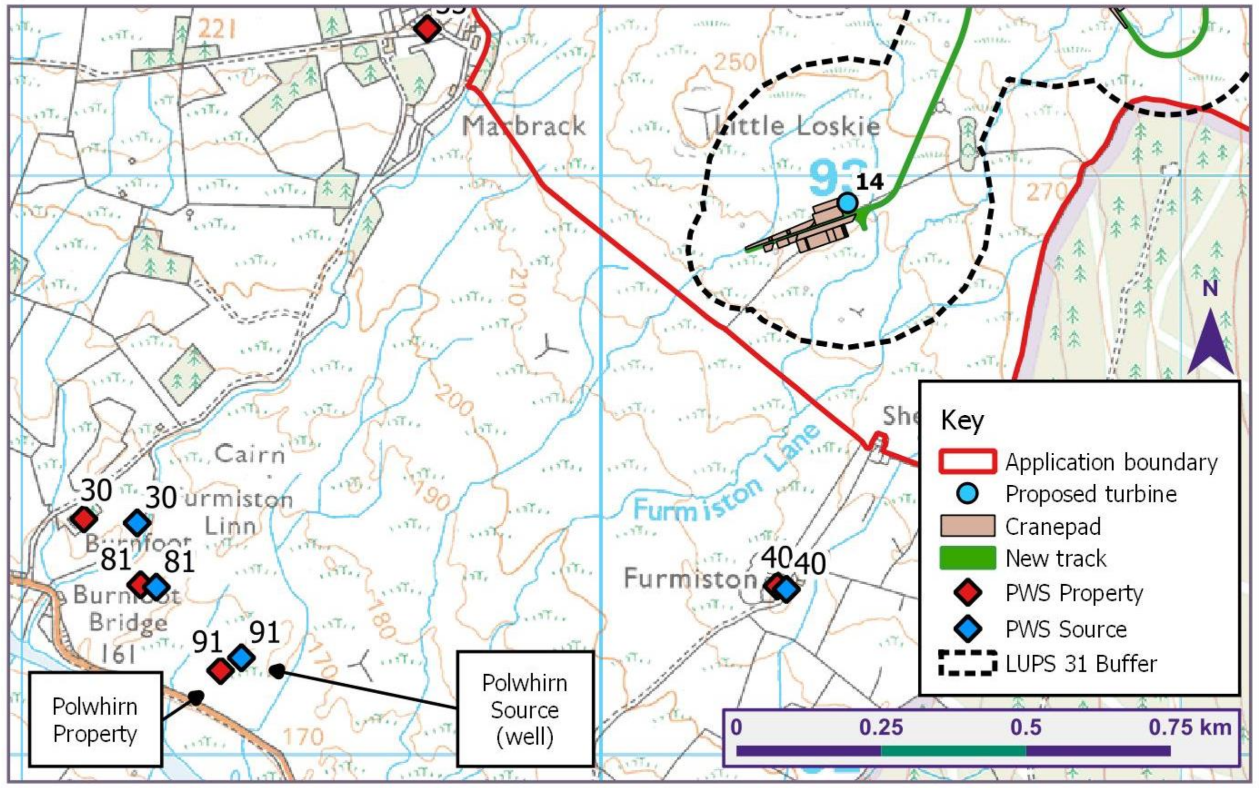
View from the PWS Source towards property

Header tank between PWS Source and Property

Risk Assessment Notes	• Groundwater spring ~0.7 km north of PWS property. • Abstraction ~ 65 m from nearest infrastructure (turbine), and pipework is overlain by proposed turbine, cranepad and access track. • Bedrock groundwater permeability is low, however local topography combined with possible diffuse near-surface groundwater emergence is sufficient to maintain supply, • Proposed infra. would bisect supply and potentially alter recharge to abstraction.
Probability	Likely
Magnitude	Moderate
Combined Risk	High
Additional Mitigation	• Provision of a permanent alternative supply prior to construction (see Appendix B)
Probability*	Unlikely
Magnitude*	Insignificant
Combined Risk*	Negligible

*Assuming implementation of additional mitigation.

Polwhirn (91)	
Supply Type	Well
Supply Use	Domestic
Shared Supply	No



Risk Assessment Notes	• Groundwater well situated adjacent to the PWS property; • Abstraction ~1.2 km from nearest infrastructure (cranepad); • Development infrastructure situated upper PWS catchment boundary, but overland flow or topographically constrained groundwater will follow riparian corridors and is unlikely to provide pathway to PWS abstarction; • The bedrock geology is characterised as a low productivity aquifer with storage and transport of water constrained to weathered zones and discontinuities.
Additional Mitigation	None Required
Probability	Unlikely
Magnitude	Insignificant
Combined Risk	Negligible

Appendix B - Knockgray Water Feasibility Assessment

Appendix 8.5

Flood Risk Appraisal

Document history

Author	Sam Wainwright	14/01/2021
Checked	Emma Bryder	08/09/2021
Approved	Emily Galloway	08/09/2021

Client Details	
Contact	Matt Bacon
Client Name	Vattenfall Wind Power Ltd.

Issue	Date	Revision Details
A	19/11/2021	First submission
B	16/12/2021	Released
C	23/06/2022	Update and Released

Glossary

Refer to Chapter 8: Hydrology, Geology and Hydrogeology in Volume 2 of the EIAR for the Glossary.
List of Abbreviations

List of Abbreviations

Refer to Chapter 8: Hydrology, Geology and Hydrogeology in Volume 2 of the EIAR for the List of Abbreviations.

Contents

A8.1	INTRODUCTION	2
A8.2	LEGISLATIVE AND POLICY CONTEXT	2
A8.3	SITE INFORMATION	3
A8.4	FLOOD RISK	5
A8.5	CONSTRUCTION / POST CONSTRUCTION INFLUENCE	6
A8.6	FLOOD RISK MITIGATION	7
A8.7	NATURAL FLOOD MANAGEMENT STRATEGY	9
A8.8	CONCLUSION	14

A8.1 INTRODUCTION

A8.1.1. Natural Power have been commissioned by Vattenfall Wind Power Ltd to undertake a Flood Risk Appraisal (FRA) to support the Environmental Impact Assessment Report (EIAR) for the proposed Quantans Hill Wind Farm (Proposed Development). The Proposed Development will be sited on open moorland around Quantans Hill, north-east of the village of Carsphairn in Dumfries and Galloway.

Purpose of the Assessment

A8.1.2. The overall aim of this FRA is to provide sufficient justification to regulators and other stakeholders that the Proposed Development is appropriate and in line with planning and national policy requirements regarding flood risk. The objectives of the FRA are:

- To provide information required to support the EIAR in terms of flood risk and to establish whether the Proposed Development is likely to be affected by current or future flooding;
- To inform the mitigation options for the Proposed Development presented within the EIAR, Chapter 8 Geology, Hydrology and Hydrogeology; and
- To identify and evaluate potential enhancement measures which could be integrated within the design of the Proposed Development or associated land and habitat management plans which would contribute towards reducing cumulative flood risk.

A8.1.3. Specific comment was made by the Scottish Environment Protection Agency (SEPA) in a scoping response to the Scoping Application for the Proposed Development (ECU00002097) which highlighted the requirement for detailed consideration of the on-site and downstream flood risk. The purpose of this document is also to satisfy this request.

Structure of the Assessment

Section 8.1 – Introduction

Section 8.2 – Legislative and Policy Context

Section 8.3 – Site Information

Section 8.4 – Flood Risk

Section 8.5 – Construction / Post-Construction Influence

Section 8.6 – Flood Risk Mitigation

Section 8.7 – Natural Flood Management

Approach and Methods

A8.1.4. Information from online resources, field surveys undertaken by Natural Power Hydrologists and third party anecdotal information has been used to develop an initial conceptual understanding of the potential for the Proposed Development and surrounding areas to be impacted by flooding.

A8.1.5. The possibility that an area might be affected by flooding is considered in terms of the potential likelihood for a flood of particular magnitude to occur in any given year and is expressed as the annual exceedance probability (AEP): 50%, 20%, 10%, 3.33%, 2%, 1%, 0.5% and 0.1% (equivalent to the 2, 5, 10, 30, 50, 100, 200 and 1000-year return periods). It is important to note that a low probability does not preclude the event happening in the following year. The hydrological methods and approaches used to derive this required information are presented in the sections below.

Proposed Development

A8.1.6. The Proposed Development may comprise the following elements:

- Up to 14 wind turbines, each with a concrete foundation and adjacent crane hardstanding and laydown area;
- A substation, battery energy storage system, and permanent operations facility with concrete foundation;
- Up to six borrow pits (as well as minor areas of stone abstraction from track cuttings);
- 3x temporary construction compounds;
- 1x meteorological mast;
- 1x temporary concrete batching facility;
- Access tracks linking infrastructure elements; and
- 31x permeant watercourse crossings.

A8.2 LEGISLATIVE AND POLICY CONTEXT

The Flood Risk Management (Scotland) Act 2009

A8.2.1. In Scotland, the framework for delivering a more sustainable approach to flood risk management has been implemented through the Flood Risk Management (Scotland) Act 2009 (the Act) transposed from the European Directive 2007/60/EC (the Flood Directive). This Act provides a framework to manage flood risk in a sustainable and co-ordinated method to scales on a local and national basis.

A8.2.2. Following a perceptible increase in wet summers and wetter winters, the duties of the Act and the responsibilities of SEPA, Scottish Water and local authorities to work together and integrate to manage flood risk where the benefits of intervention will have the greatest benefit.

Scottish Planning Policy

A8.2.3. The aim of Scottish Planning Policy (SPP), first published in 2010 (and revised in 2014), is to ensure that flood risk is taken into account at all stages in the planning process and is given the due consideration it requires for it to be appropriately addressed.

A8.2.4. The guiding principles of SPP aim to promote:

- A precautionary approach to flood risk from all sources, including coastal, watercourse (fluvial), surface water (pluvial), groundwater and any other sources. Consideration of the predicted effects of climate change should also be taken into account;
- Flood avoidance by safeguarding flood storage and conveying capacity, and situating development away from functional floodplains and medium to high risk areas;
- Flood reduction by assessing flood risk and, where appropriate, undertake natural and structural management measures, including flood protection, restoring natural features and characteristics, enhancing flood storage capacity, avoiding the construction of new culverts and opening existing culverts where possible; and
- Avoid increased surface water flooding through requirements for Sustainable Drainage Systems (SuDS) and minimising the area of impermeable surfaces.

A8.2.5. Within the SPP, a risk framework approach identifies flood risk at three main categories:

1. **Little or no risk area** – annual probability of flooding less than 0.1% (i.e. one in 1000 year flood). No constraints to development due to flood risk.
2. **Low to medium risk area** – annual probability between 0.1% and 0.5% (i.e. between one in 1000 and 200 year floods). Usually suitable for most development.
3. **Medium to high risk area** – annual probability greater than 0.5% (i.e. one in 200 year flood). Generally not suitable for essential civil infrastructure such as hospitals, fire stations, emergency depots etc. The policy for development on functional floodplain applies. Land raising may be acceptable but would be subject to specific criteria, and should not contribute to a loss in the capacity of the functional floodplain.

A8.2.6. If built development is permitted, appropriate measures to manage the flood risk will be required and the loss of flood storage capacity mitigated to produce a neutral or better outcome. Residential, institutional, commercial and industrial development within built-up areas may be acceptable if flood prevention measure to the appropriate standard already exist, are under construction or are planned as part of a long-term development strategy.

Climate Change

A8.2.7. At present the general approach to climate change is to increase design flows by 20% as per SEPA's Technical Flood Risk Guidance for Stakeholders (Reference: SS-NFR-P-002) (2019). This assessment follows standard practice and therefore an uplift factor of 20% has been applied to the design peak flow estimates.

Flood Risk Management Act

A8.2.8. The Flood Risk Management (Scotland) Act was enabled in law in June 2009. The main aim of the Act is to promote a sustainable framework for managing flood risk, and to improve the coordination of flood risk management bodies at both a national and local level.

Flood Risk: planning advice

A8.2.9. The Scottish Government Flood Risk: planning advice provides guidance to local authorities on building in areas where there is a risk of flooding, and should be referred to as a starting point in defining the responsibilities of local authorities and developers. Guidance is set out to ensure that future built development is not located in areas with a significant risk of flooding, including functional flood plains. However, there are circumstances where development would benefit from selecting designs, forms of construction and materials which may help to minimise the effects of a flood event on the property.

Dumfries & Galloway Council Local Development Plan

A8.2.10. The adopted Dumfries and Galloway Council (D&GC) Local Development Plan (LDP2)[1] outlines new development and planning polices which are used to determine planning applications. *Policy IN7: Flooding and Development* details the key policy principles related to flood risk;

"The avoidance principle is the most sustainable form of flood management, in accordance with the policy principle for managing flood risk of SPP and the Flood Risk Management (Scotland) Act 2009. Where proposed development could lead to an unacceptable on-site or off-site flood risk, as defined by the Risk Framework in SPP, then it will not be permitted. Where a proposed development could lead to an unacceptable flood risk, it may be that a Flood Risk Assessment (FRA) is able to clarify to the satisfaction of the Council and SEPA that the level of risk both on and off site would be acceptable. For any site a Drainage Impact Assessment (DIA) may be required to ensure that surface water flows are properly taken into account in the development design. Consideration should be given to pluvial flows especially those which exceed the capacity of the proposed drainage systems. Design of development must avoid flood risk from exceedance flows. (See also Policy IN8 for Surface Water Drainage and SuDS.)

In order to satisfy the Council in respect of FRAs and DIAs, parties will be expected to provide independent verification of their professional competence, unless it is clear that this is not required."

A8.2.11. Policy IN7 is supported by *Flooding and Development Supplementary Guidance*[2] which provides more details on roles and responsibilities for flooding and planning, matters to consider for planning proposals and guidance for Flood Risk Assessment (FRA). Two of the overreaching principles outlined within the document are for Developers to aspire to reduce the flood risk of the existing development and to incorporate principles of sustainable flood management.

Policy IN8: Surface Water Drainage and Sustainable Drainage Systems details requirements for the appropriate and proportionate use of Sustainable Drainage Systems (SuDS) and how they should be incorporated into the design of developments. Policy IN8 is supported by *Surface Water Drainage and Sustainable Drainage Systems (SuDS) Supplementary Guidance*[3].

Solway Local Flood Risk Management Plan

A8.2.12. The Solway Local Flood Risk Management Plan[4] (LFRMP) is a key tool for local authorities in southern Scotland in delivering the objectives of the Flood Risk Management (Scotland) Act 2009. The document outlines areas identified as being vulnerable from flooding and presents actions to manage and reduce flood risk.

A8.2.13. Whilst not currently identified as one of the named potentially vulnerable areas (PVAs) the settlement of Carsphairn, situated to the south-west of the Proposed Development was highlighted as an additional area where flood management and mitigation measures would also be implemented. A flood study[5] was undertaken for the valley basin surrounding Carsphairn and made a series of recommendations including a cost benefit analysis for various flood mitigation options, including direct deference as well as catchment management (natural flood management).

A8.2.14. Following the publication of phase 1 of the flood risk management strategy[6] covering the next LFRMP cycle covering 2021 to 2027, Carsphairn has been identified as a PVA (02/14/17). The second phase of consultation associated with the provisional PVAs is expected in late 2021. The extent of the provisional PVA covers the Water of Deugh around Carsphairn as well as the entirety of the Knockgray Burn, Marbrack Burn and Polhay Burn.

A8.3 SITE INFORMATION

A8.3.1. Information on the baseline environment for the Proposed Development has been taken from Section 8.6, of Chapter 8 Geology, Hydrology and Hydrogeology from the EIAR for Quantans Hill Wind Farm. Hydrological walkover surveys were completed at the Proposed Development in November 2020, February 2021, and March 2021. A summary of the information relevant to flooding and hydrology is presented in the below sections.

Environmental Setting

A8.3.2. The Proposed Development is located in a rural upland setting characterised by open moorland, historically primarily used for rough grazing for agriculture, however more recently also includes areas of upland afforestation. The topography of the Proposed Development generally slopes south, with topographic highs attained in the north at Knockwhirn (498 m Above Ordnance Datum [AOD]), Dunool (541 m AOD) and Black Beninner (710 m AOD) with 62% of the Proposed Development application boundary being >300 m AOD. The southern part of the Proposed Development is more topographically subdued.

A8.3.3. The standard annual average rainfall (SAAR) for the Proposed Development ranges from 1,563 mm to 1,808 mm[7] with the wettest months being January and October.

A8.3.4. There is a legacy of land management across much of the Proposed Development, particularly in the south and central areas and is illustrated through the existence of land drainage features including grips and drainage ditches. These drainage ditches provide a network of drainage and will act both to reduce shallow groundwater and

[1] D&GC. 2019. Local Development Plan 2. Available at https://www.dumgal.gov.uk/ldp2 (acc. 04/02/21).

[2] D&GC. 2020. Flooding and Development – Supplementary Guidance. Available at https://www.dumgal.gov.uk/ldp2 (acc. 04/02/21).

[3] D&GC. 2020. Surface Water Drainage and Sustainable Drainage Systems (SuDS) – Supplementary Guidance. Available at https://www.dumgal.gov.uk/ldp2 (acc. 04/02/21).

[4] D&GC. 2016. Solway Local Plan District - Local Flood Risk Management Plan.

[5] Kaya Consulting Ltd. 2015. Carsphairn Flood Study. KC778.

[6] SEPA. 2020. Solway Local Plan District (LPD 14). Draft Flood Risk Management Strategy 2021-2027.

[7] Flood Estimation Handbook. 2021. Catchment Descriptors for the catchments within the proposed Development.

enhance the runoff rate of direct rainfall discharging off the Proposed Development in the watercourses. Some of these artificial ditches are mapped on the 1:25,000 and 1:10,000 scale Ordnance Survey map.

Source: Natural Power

Figure 1: Photograph of the Benloch Burn catchment demonstrating the upland moorland character of the Proposed Development area.

Geology and Hydrogeology

A8.3.5. Bedrock and superficial geology are shown in Figure 8.2 and 8.3 of the EIAR.

A8.3.6. The 1:50,000 scale British Geological Survey (BGS) map[8,9] for the Proposed Development indicates the underlying bedrock comprises of steeply dipping sandstone, siltstone and conglomerate wacke formations. The various bedrock units follow the regional bedding structure characteristic of south west Scotland with fault lines orientated SW to NE. In the north of the Proposed Development the bedrock is Kirkcolm Formation, with Glenwhargen Formation in the centre and Portpatrick Formation in the south. An intrusive granite pluton is situated on the northern boundary of the Proposed Development. The Leadhills Fault also bisects the site running from the SW to the NE running parallel with the Benloch Burn.

A8.3.7. Overlying the bedrock is a combination of late Quaternary glacial deposits (hummocky moraine and glacial till) and more recent accumulations of peat. The distribution of these is with hummock moraines and peat in the south of the Proposed Development, with glacial till in the north. Alluvial sands and gravels are also mapped adjacent to the Benloch Burn.

A8.3.8. The greywackes that underly the Proposed Development are highly indurated with well cemented matrix and are consequently considered a low productivity aquifer. Groundwater will be confined to tectonic features or near surface weathered zones[10]. Given the limited potential for infiltration into the bedrock, the overlying superficial deposits may host a shallow perched groundwater. The productivity of these units will be governed by the proportions of sands, gravels and clays and will be most productive within alluvial sediments. Shallow groundwater is likely to be discontinuous and will generally follow the topography. The base flow index values and standard percentage runoff values for the Proposed Development are 0.289 to 0.354 for the former and 50.7 to 55.1 for the latter. This suggests that contributions to runoff from stored sources such as groundwater are low, with over half of the rainfall during a storm event contributing to streamflow.

Hydrology

A8.3.9. Watercourses and catchment areas situated within and in the immediate vicinity of the Proposed Development are presented in Figure 8.1 of the EIAR.

A8.3.10. The Proposed Development is situated within the catchment of the Water of Deugh, which is part of the wider Water of Ken catchment. The Benloch Burn discharges into the Water of Deugh upstream of Carsphairn, with the other catchments (Knockgray Burn, Polhay Burn, Marbrack Burn, Furmiston Lane and Polshagg Burn) which all confluence with the Deugh downstream of Carsphairn, north of Kendoon Loch.

A8.3.11. The watercourses situated within the Proposed Development exhibit typical upland stream morphology with heavily vegetated and occasionally unstable riparian zones, with channels often incised into the superficial deposits. In their upper reaches, watercourses are steep and linear as they descend from the higher ground in the north, becoming more sinuous as the slope angle relents. Bed material encountered in surveys ranged from watercourses with peat and vegetation to beds of gravels, cobbles and small boulders. Photographs illustrating this typical stream morphology are presented in Photo Insert 8.5.1 below.

Source: Natural Power

Photo 5.1: Photographs illustrating the typical morphology of the watercourses situated within the Proposed Development

A8.3.12. The catchments situated within the Proposed Development are all ungauged. The nearest catchments with flow gauging information are Afton Water (~15 km to the north east) and the Dee Catchment (~17 km to the south west). Modelled design flows for each catchment area are presented in Section 8.9 of this FRA.

A8.3.13. Further details of the various hydrological catchments are presented in Section 8.6 of Chapter 8 Geology, Hydrology and Hydrogeology from the EIAR for Quantans Hill Wind Farm.

[8] BGS. 1998. 1:50,000 Scale Solid Sheet 9W New Galloway.

[9] BGS.1994. 1:50,000 Scale Solid Sheet 8E Loch Doon.

[10] BGS. 1988. 1:625 Scale Hydrogeology of Scotland Map.

Design Flows

A8.3.14. No flow gauging information is available for any of the watercourses situated within the Proposed Development. In the absence of any site specific values, runoff volumes for stated flood return periods have been calculated following prescribed methodology for ungauged catchments. Catchment descriptors were derived from the FEH Web Service[11] and used for calculating peak flows for the identified catchments. Catchment descriptors relevant to the calculation of peak flows are presented below in table 8.5.1.

Table 5.1: Catchment descriptors used in the calculation of design flow estimates

Catchment	Area (km²)	SPRHOST	BFIHOST	SAAR	FARL
Benloch Burn	4.160	50.61	0.353	1808	1
Knockgray Burn	0.867	55.17	0.289	1613	1
Polhay Burn	2.125	50.79	0.348	1680	1
Marbrack Burn	5.810	53.03	0.321	1759	1
Furmiston Lane	1.140	50.19	0.354	1563	1

Source: FEH Webservice

A8.3.15. Peak flows (up to 200 year + climate change (CC)) have been estimated for the key catchments described above using the FEH Rainfall-Runoff method[12], Institute of Hydrology 124 (IH124)[13] method for small catchments and ReFEH2.2. The generation of peak flows using multiple methodologies follows standard good practice and allows for a precautionary and conservative assessment, where the higher flow values will be adopted for use when considering the hydrology of the Proposed Development. The Q200+CC is the 200-year return period flow plus a 20% mark up for climate change (CC) as per SEPA Land Use Planning Guidance CC1 (LUPS-CC1) (2019) *Climate change allowances for flood risk assessment in land use planning*.

A8.3.16. The software package Flood Modeller was used for the derivation of peak flows using the FEH Rainfall-Runoff method. The critical storm duration for each catchment was calculated separately to provide catchment specific design estimates. In the absence of adequate flood data, no refinement could be made to the time to peak (Tp) and SPR parameters. For ReFEH2.2, the default application parameters were used.

A8.3.17. The estimated peak runoff rates for the 2 year to 200 year (+CC) calculated using the IH124 Method and ReFEH2.2 are presented below in Tables 8.5.2 and 8.5.3.

Table 5.2: Estimated peak runoff for site-catchments calculated using the IH124 method.

Catchment	Estimated peak runoff ($m^3 s^{-1}$) for stated return period							
	2 (QBAR)	5	10	25	50	100	200	200+CC
Benloch Burn	5.15	6.29	8.05	10.26	12.30	14.91	18.02	21.62
Knockgray Burn	1.34	1.64	2.10	2.68	3.21	3.89	4.71	5.65
Polhay Burn	2.62	3.20	4.09	5.21	6.25	7.58	9.17	11.00
Marbrack Burn	7.44	9.07	11.61	14.80	17.74	21.51	26.01	31.21
Furmiston Lane	1.35	1.64	2.10	2.68	3.22	3.90	4.71	5.65

Source: Natural Power

Table 5.3: Estimated peak runoff for site-catchments calculated using ReFEH2.2

Catchment	Estimated peak runoff ($m^3 s^{-1}$) for stated return period							
	2	5	10	25	50	100	200	200+CC
Benloch Burn	6.28	8.88	10.79	14.04	15.74	18.35	21.53	25.83
Knockgray Burn	1.54	2.19	2.66	3.48	3.92	4.59	5.41	6.49
Polhay Burn	3.04	4.34	5.27	6.91	7.77	9.09	10.74	12.88
Marbrack Burn	8.86	12.35	14.90	19.32	21.61	25.14	29.44	35.32
Furmiston Lane	1.47	2.10	2.56	3.38	3.82	4.50	5.36	6.43

Source: Natural Power

A8.4 FLOOD RISK

Flood Risk Screening

A8.4.1. Information regarding flood risk has been obtained from the flood risk maps produced by SEPA[14]. Table 8.5.4 provides a summary of the potential sources of flood risk and the requirement for further assessment. An extract of the SEPA Flood Map is also shown in Figure Insert 8.5.1.

Table 5.4: Flood Risk Screening table for the Proposed Development

Source of Flood Risk	Assessment Notes	Flood Risk Review
Fluvial (river)	Watercourses within catchment indicates a risk of flooding	Assessment Required
Pluvial (surface water)	Surface water flooding is indicated to occur within the catchment	Assessment Required
Coastal	The Proposed Development is situated in an inland and upland location	Negligible
Groundwater	The site is not mapped within an area vulnerable to groundwater flooding	Low*
Sewers / Drainage	Other than artificial ditches for agriculture, there are no drainage or sewage networks	Negligible
Infrastructure Failure	There are no significant bodies of water storage within the Proposed Development catchments	Negligible

**The embedded mitigation within the design and drainage techniques for both site tracks and other excavations would ensure that flows from shallow groundwater are managed such as not to present a flood risk. Flooding from this source is therefore not considered further.*

Source: SEPA Flood Map[11]

[11] Flood Estimation Handbook (FEH) Webservice. Available at https://fehweb.ceh.ac.uk/ (accessed 15/02/2021)

[12] Kjelden et al. 2008. Dissemination of the revitalised FSR/FEH rainfall-runoff method. Science Project SCO400299.

[13] Marshall & Bayliss. 1994. Flood estimation for small catchments. IoH Report 124. Wallingford.

[14] SEPA. 2021. SEPA Flood Map. Available at https://map.sepa.org.uk/floodmap/map.htm (accessed 15/07/2021)

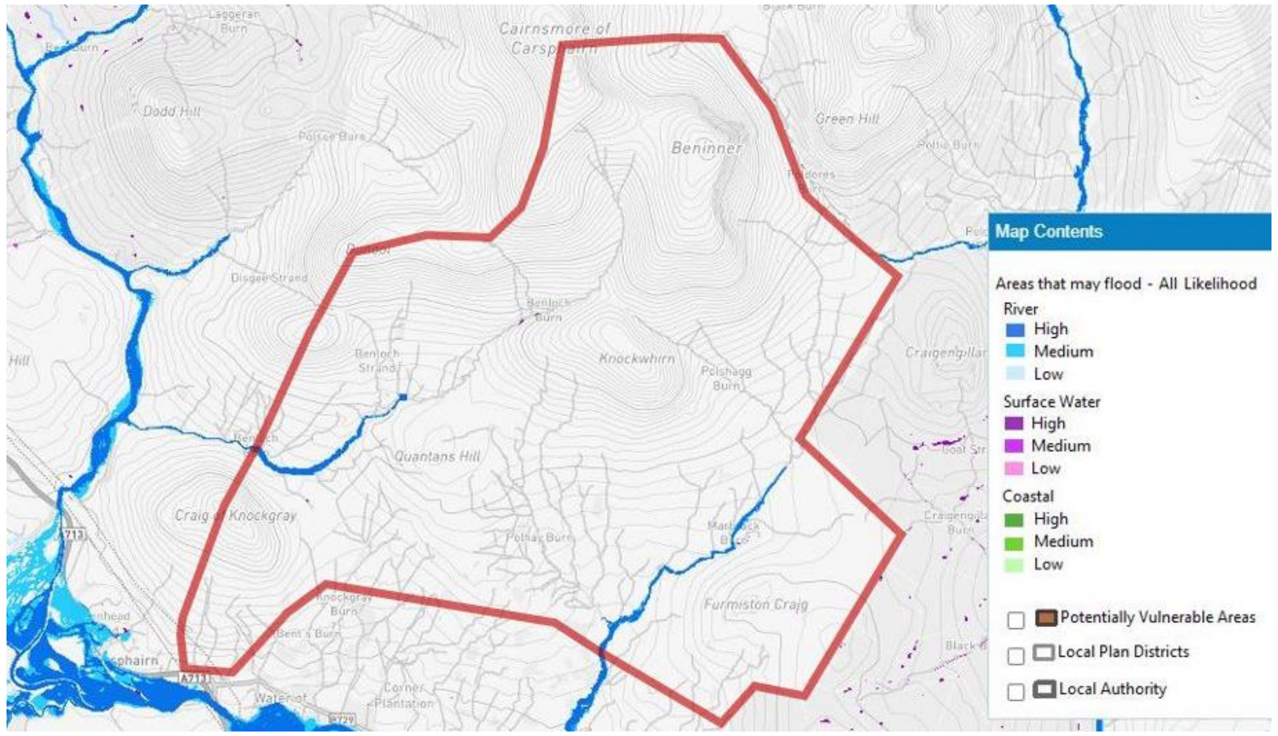


Figure Insert 5.1: Flood risk map [14] with the Proposed Development boundary overlain (Scale 1:38,000). Carsphairn is situated south west of the Proposed Development.

A8.4.2. As identified within Table 8.5.1, river (fluvial) and surface water (pluvial) is the only flood risk source identified. These are further discussed in the sections below.

Flood Risk Sources

Flood risk for areas within, adjacent to or downstream of the Proposed Development are considered below in the following sections.

Fluvial Flooding Sources

A8.4.3. Flood information available on the SEPA Flood Map indicates that the middle to lower catchment areas for the Benloch Burn and Marbrack Burn have a high likelihood of fluvial (watercourse) flooding in any given year. Isolated areas of medium risk are also identified at the confluence between the Marbrack and Polhay Burn. It is noted in all cases that flood inundation areas indicated do not extend much beyond the riparian corridor. No other tributaries of the catchments shown on Figure 8.5.1 have been highlighted as being at a risk of fluvial flooding.

A8.4.4. Downstream of the Benloch Burn after its confluence with the Water of Deugh around Carsphairn, the base of the glen has extensive areas at a high risk of flooding encompassing road networks, residential properties and farmland. At the confluence of the Marbrack Burn and the Water of Deugh ~3 km downstream of Carsphairn flood inundation envelope for the Marbrack Burn widens more significantly as it reaches the base of the Glen and is mapped as medium and high risk.

A8.4.5. The overall fluvial derived flood risks within the Proposed Development Area are considered to be low and constrained to riparian zones. It is acknowledged that there is the potential for fluvial flooding further downstream.

Pluvial Flooding Sources

A8.4.6. The SEPA Flood Map indicates that only a few very minor areas of the Proposed Development are at risk of surface water flooding. Whilst not shown on the map, it's possible that other pluvial flood risk areas may exist with small depressions and hollows in the central and southern part of the Proposed Development adjacent to the Polhay Burn.

A8.4.7. Areas of high and medium risk of pluvial flooding are situated immediately adjacent to the Water of Deugh downstream of Carsphairn.

Flooding from Sewers & Artificial Drainage

A8.4.8. There are no sewers or engineered surface water drainage features within the Proposed Development catchments. An abstraction is present within the Benloch Burn owned and managed by Scottish Water for the purposes of providing a water supply to Carsphairn.

A8.4.9. There is extensive evidence of artificial drainage associated with land management across the Proposed Development. There is the potential that this artificial drainage could cause some localised flooding by increasing runoff rates to the main watercourses within the catchments. At the time of the site visits there was only minor volumes of flow within the artificial drainage channels and occasional ephemeral standing water was observed across the Proposed Development.

Cumulative Flood Risks

A8.4.10. Without appropriate drainage mitigation being in place the Proposed infrastructure has the potential to increase flood risk especially to vulnerable areas downstream of the Proposed Development by altering existing runoff and flow regimes.

Anecdotal Flood Risk Information

A8.4.11. Information from field surveys and online resources do not suggest that the Proposed Development area is prone to flooding. However there is anecdotal evidence of flooding for downstream areas around Carsphairn, which was flooded when the Water of Deugh overtopped the banks flooding the village in December 2013 and again in 2015[5].

A8.5 CONSTRUCTION / POST CONSTRUCTION INFLUENCE

A8.5.1. The Proposed Development will introduce physical changes which have the potential to alter the local hydrological regime. During the construction phase and during the operational phase, the specific hydrological response could be altered resulting in changes to the flood risk for on and off-site areas.

A8.5.2. The predicted effects arising from the construction and operation of the Proposed Development include:

- Changes in the runoff rate and runoff volume; and
- Modification of surface drainage patterns.

A8.5.3. These potential impacts are discussed in further detail in the below sections. Embedded mitigation aimed at minimising any of these associated impacts are discussed in Section 8.6.

Changes in Runoff

A8.5.4. Turbine bases, adjacent hardstand areas and access tracks will act as impermeable areas, restricting the natural movement of water within the hydrological environment, potentially resulting in increased rates of runoff into the onsite and downstream catchments. Whilst not completely impermeable, temporary infrastructure such as compounds and laydown areas may exhibit a reduced infiltration capacity compared to un-altered grasslands. The compound and substation will also incorporate roof drainage further contributing to runoff.

A8.5.5. The movement of construction traffic within the Proposed Development is likely to cause localised compaction of the ground surface, leading to changes in both the hydrological and hydrogeological regime. The impacts of compaction are likely to be highly localised but will damage the vegetation and result in a reduction in the soil permeability and rainfall infiltration, thereby increasing the potential for flood risk and erosion as well as altering groundwater flows and levels.

A8.5.6. The installation of temporary and permanent drainage networks associated with tracks and other infrastructure are likely to promote overland flow as opposed to vegetated grasslands, which as a result of increased roughness would have slower runoff rates and encourage infiltration.

A8.5.7. Localised increases in runoff could cause issues for downstream flood storage capacity and/or pollution incidents. Increases in the volume of runoff entering watercourses could also cause erosion and sedimentation, therefore having detrimental effects on surface water hydrology.

Modification of Surface Drainage Patterns

A8.5.8. The interception of diffuse overland flow by the Proposed Development infrastructure and associated drainage may disrupt the natural drainage regime of the area, concentrating flows and potentially diverting flows from one catchment to another. This may have implications for water quality or quantity (including Private and Public Water Supplies) and on flood issues downstream of the Proposed Development.

A8.5.9. The positioning of infrastructure within the flood inundation envelope also has the potential to exacerbate on-site and downstream flood issues by potentially constraining flood extents.

A8.5.10. As well as potentially negative effects, construction may also positively effect surface drainage patterns through the blocking of artificial ditches during habitat restoration and therefore modifying the existing rainfall-runoff response.

A8.6 FLOOD RISK MITIGATION

Mitigation by Design

A8.6.1. The design of the Proposed Development has undergone an iterative evolution process in an attempt to minimise impacts on the water environment as much as possible. Details of this are presented in Chapter 2: Design Evolution of the EIAR.

A8.6.2. Setback distances form part of the design process, aiming to maximise the distance permanent infrastructure could be situated from hydrological receptors. Where possible, all permanent infrastructure elements including turbines, tracks, and compounds have been positioned a minimum distance of 50 m from watercourse shown on a 1:50,000 scale Ordnance Survey (OS) map, and a minimum of 10 m from smaller "minor" watercourses not shown. The identification of minor watercourses was through a combination of field surveys and identification on the 1:10,000 scale OS map. For the Benloch Burn (which is designated as a DWPA), a setback distance of 100 m was applied to comply with Scottish Water protection guidelines[15]. The exception to this is for watercourse crossings.

A8.6.3. In addition to setback distances, the extent of infrastructure has also been minimised within hydrological catchments of high sensitivity. As identified in Section 8.3, the settlement of Carsphairn has been flooded on several occasions in recent history and as such should be a considered a key cumulative flood risk receptor associated with the Proposed Development. However, the design of the infrastructure and its distribution across the Proposed Development catchments has sought to minimise its extent within the Benloch Burn (as presented in Table 8.5.4), which is the only catchment which could contribute to flooding within Carsphairn, as all of the other Proposed Development catchments discharge into the Water of Deugh downstream of the village. Embedded mitigation has therefore minimised the potential cumulative flooding impact for Carsphairn.

A8.6.4. The extents of impermeable (or those of extremely low permeability such as hardcore) infrastructure elements are presented below in Table 8.5.4 and provided with context to the size of the wider catchment within which they are positioned. Catchment areas are calculated based on the intersection of the watercourse with the Proposed Development boundary. Infrastructure dimensions and extents are taken from Technical Appendix 8.4: Peat Management Plan. Where discrete infrastructure elements such as turbines are situated on catchment boundaries, they are assumed as being wholly within the catchment calculations to provide a conservative assessment.

Table 8.5.4: Proposed impermeable infrastructure[16] extents within onsite catchments

Catchment (and area /km^2)	Infrastructure	Area of New Impermeable Surfaces (km^2)	Area of New Impermeable Surfaces (% of Catchment area)
Benloch Burn (4.1)	• Turbine base (impermeable)	0.014	0.34 %
Knockgray Burn (0.8)	• Cranepad (impermeable)	0.015	1.99 %
Polhay Burn (2.1)	• Track (impermeable)	0.121	5.79 %
Marbrack Burn (5.8)	• Substation (impermeable)	0.065	0.01 %
Furmiston Lane (1.1)	• Met mast (impermeable)	0.010	1.53 %

A8.6.5. As noted within Table 8.5.4, the proportion of impermeable surfaces planned within each catchment is generally negligible compared to the overall catchment extent. Notwithstanding, any impacts associated with increased runoff would be mitigated through embedded design of appropriate drainage, including sustainable drainage systems (SUDS) and good practice mitigation.

Watercourse Crossings

A8.6.6. The layout of the turbines and on-site tracks and the access route was designed in line with good practice guidelines and the number of crossings of watercourses have been minimised where possible. As a result, up to 31 new watercourse crossings are required and are inclusive of numerous minor artificial /ephemeral drain crossings. Further details are presented in Technical Appendix 8.1: Water Crossing Assessment, with the locations of these shown in Figure 8.1 Hydrology Overview.

A8.6.7. Some of the main watercourses are shown to be at risk of flooding however the flood risk zones are close to the main channels as a result of the steep valleys. The crossings should be designed so that their presence does not increase flood risk down gradient by having adequate capacity and by avoiding any structure within the channel or flood zone. Soffit levels for such crossings will be designed to provide 0.6 m freeboard above the 0.5 AEP flood as per SEPA Guidance. In the cases of crossings over the Benloch Burn (13) and the Marbrack Burn (23), the positioning of crossings have been to balance environmental sensitivity and engineering constraints. For the former, the positioning of the crossing in the lower catchment was to avoid the requirement for channel adjacent works upstream of the Scottish Water intake. In the case of the crossings on the Marbrack Burn, the use of multiple crossings higher in the catchment was preferred as a result of the larger flood inundation envelope in the lower catchment, with the upper tributaries being more incised and easier to span.

A8.6.8. All of the crossings of main watercourses will also allow for appropriate ecological passage and would comply with good practice guidelines for crossing construction.

A8.6.9. Watercourse crossings will be the subject of detailed design within a Construction Method Statement (CMS) to be submitted to SEPA and the local authority (as appropriate) prior to commencement of construction. In cases where there is overlap with any medium flood risk areas, detailed investigation and modelling would be undertaken to ensure compliance with design and flood prevention standards. A monitoring programme for maintenance of crossings (to prevent blockages and flooding) will be provided within the CMS.

[15] Scottish Water. 2021. SW List of Precautions for Drinking Water Assets – Wind Farms EdE.

[16] Impermeable infrastructure includes turbine foundations, crane pads, access tracks, the substation platform area and the met mast foundation. Temporary infrastructure such as laydown areas are not included. Whilst less permeable than undisturbed grassland, borrow pits will enable some infiltration and have also not been included.

A8.6.10. Where it is necessary to cross watercourses or flowing drains, appropriately designed crossings and culverts will be installed, and licensed where appropriate, in consultation with SEPA (see Good Practice Mitigation below).

Sustainable Drainage Systems

A8.6.11. In general the risk of flooding (including cumulative flood risk) will be mitigated through the use of SuDS (sustainable drainage systems). In terms of flood risk, the principle aim of SuDS is to minimise the volume and speed of runoff arising from the Development.

A8.6.12. More specifically, this will be achieved through a detailed plan which will support this document and be developed and agreed with SEPA and D&G Council. The plans will detail site drainage design and will include “soft engineering” and habitat enhancement measures, along with standard measures (e.g. ponds, swales, cross drains). These plans will be provided in an updated version of this document following the nomination of the Construction Contractor and completion of detailed design.

SuDS Best Practice

A8.6.13. The leading current best practice guidance document - The SuDS Manual (CIRIA Report C753) - promotes sustainable water management through the use of SuDS. There are four main attributes of a successful SuDS, as described in the SUDS Manual:

- control of runoff quantity;
- management of runoff quality;
- creating improved amenity; and
- promoting biodiversity.

A8.6.14. The SuDS Manual identifies a “management train” for runoff (also a preference hierarchy):

- Prevention – the use of good site design and housekeeping measures on individual sites to prevent runoff and pollution (e.g. minimise areas of hard standing);
- Source Control – control of runoff at or very near its source (such as the use of rainwater harvesting);
- Site Control – management of water from several sub-catchments (including routing water from roofs and car parks to one/several large soakaways for the whole site); and
- Regional Control – management of runoff from several sites, typically in a retention pond or wetland.

A8.6.15. The priority for SuDS is to deal with the water at source and pass as little water forward as possible to be managed by downstream systems.

Proposed Discharge Arrangements

A8.6.16. With reference to The SuDS Manual, and with particular reference to large, distributed sites such as wind farms, the hierarchy of preferred management options for surface water runoff from development sites prioritises methods such as re-use, through to infiltration and discharges to ground and surface waters, with discharge to sewers being least preferred.

A8.6.17. As the main source of surface water runoff from the wind farm will be site tracks and hardstanding at turbines, there is no realistic means for capturing and recycling water in these areas. Infiltration tests have not yet been carried out, however, given the setting of the Proposed Development within peatlands with poor drainage, there is unlikely to be potential for infiltration on a large scale. Finally, as the Proposed Development is remote from any piped drainage infrastructure, this is would not be a possible measure. On this basis, the most appropriate methods are determined to be discharges to surface water and groundwater.

SuDS Principles

A8.6.18. The following design criteria (where applicable) has been applied in developing the SuDS strategy and would inform the Construction Site Licence application, as well as OCEMP the detailed design and construction of the drainage system

A8.6.19. SuDS to be constructed prior to, or at the same time as the access roads, turbine foundations, and other elements of the Proposed Development which they are designed to serve;

- Minimise any change to the hydrology and groundwater conditions at the site;
- Where physically possible, replicate the natural drainage and hydrological characteristics of the area;
- Minimise sediment loads in the runoff, through use of infiltration and settling ponds, with particular attention being given to the construction phase of the project;
- Maintain the existing hydrology regimes at the site;
- Avoid high flow velocities - energy dissipation devices such as check dams and multiple outflow structures should be used to avoid scour and re-suspension of sediment; and
- Provide for successive reinstatement of vegetation along the site tracks.

Description of Proposed SUDS

The layout of the SuDS system would conform with both the principles outlined above, whilst meeting any engineering constraints including topography and gradient. Following further investigation and as part of the detailed design process, a drainage strategy would be prepared prior to construction and would present the layout of sustainable drainage features across the Proposed Development. A descriptive summary of these features are presented below.

The following drainage features would be adopted for site tracks;

- Clean water diversion ditches – these would be located up-slope of the footprint of the works, to intercept natural overland flow and allow it to be directed through or past the works site without entraining sediment or other pollutant. Where feasible, these interception ditches would include crosstrack culverts leading to dispersion structures on the down-slope side of the tracks, to allow the water to return as close as possible to its natural path. In certain locations, it would be more appropriate to direct the water laterally towards outfalls at watercourses. For most track lengths, there would be a mixture of these two techniques;
- Site tracks drainage - Where the down-slope side of the road is at or around grade, the track drainage would be located on the down-slope side of the road, and the road cross-fall would be towards that side of the road. Where the road is in a cut and fill configuration, the track drainage would be on the upslope side of the road, with the cross-fall towards that side. The road drainage ditches would be sized to accommodate the runoff anticipated, – generally to be located on one side of the road, but on both if there is a short section with no cross slope;
- Silt traps and check dams – silt traps and check dams would be used in the roadside ditches to preserve appropriate long-fall slopes and avoid scour;
- Cross drains – where the roadside ditches are on the up-slope side of the road, regular cross drains would be used to take the flow towards the down-slope side and out to silt control devices and back onto the hillside;
- The sizing of the ditches, and the spacing of the cross-road drains, would take account of the up-slope catchments, as well as the longitudinal slope of the drains; and
- Settlement ponds – where roadside ditches cannot discharge back to the hillside, they would direct flow into settlement devices, (with secondary screening treatments) prior to discharge into the watercourse.

Permanent facilities such as the substation buildings would include measures to recycle roof water, and to infiltrate surface water back to the adjacent substrate. Temporary facilities such as laydown areas would be constructed of open graded rockfill which would minimise runoff and allow rainwater to infiltrate and follow natural flow paths.

The borrow pits would each be graded so as to contain the runoff from disturbed surfaces and active workings. The drainage would be designed with a buffer sump pond and pump system so as to return settled water (via sediment control measures) at the greenfield runoff rate.

Drainage provisions for construction of turbine foundations and the associated hardstandings and crane pads would feature similar provisions to those described above for tracks and for worked areas such as borrow pits.

Design Specification

The open drains, cross-road culverts, infiltration systems and watercourse crossings would all be designed to function adequately up to their nominated capacity (e.g. 1:30 or 1:200 AEP rainfall/flowrate conditions, including appropriate allowances for climate change). In the event of rainfall or flow conditions that exceed the design conditions, water would pond upstream of crossings and flow out of constructed ditches. The nature of this site (particularly with relatively gentle topography) would allow water to be retained in depressions and to find ready alternative flow paths in these conditions. The most sensitive time for water quality impacts to occur would be during the one or two years following construction, as vegetation is re-established and compacted surfaces consolidate. In this period, silt controls should be maintained to ensure that water quality is preserved in the existing natural drainage systems.

Maintenance Requirements

All surface water drainage and pollution control features associated with the site would remain private and would be maintained by the wind farm operator.

Standard Good Practice Mitigation

A8.6.20. Mitigation undertaken at the construction stage involves both management and monitoring. Good Practice Mitigation is presented within Section 8.7 of Chapter 8 of the EIAR, Geology, Hydrology and Hydrogeology.

Additional Considerations

A8.6.21. The impermeable nature of the underlying bedrock and low permeability of the overlying peat and glacial till within the Proposed Development Area will naturally encourage high rainfall-runoff rates (as indicated in Section 8.5). Therefore, the addition of the Proposed Development infrastructure will not significantly alter the existing baseline hydrological regime and is likely to have a minimal effect on the existing rainfall-runoff scenario.

A8.6.22. As discussed, the settlement of Carsphairn has been flooded on several occasions in recent history and as such should be a considered a key cumulative flood risk receptor associated with the Proposed Development. However, the design of the infrastructure and its distribution across the Proposed Development catchments has sought to minimise its extent within the Benloch Burn (as presented in Table 8.5.4), which is the only catchment which could contribute to flooding within Carsphairn, as all of the other Development catchments discharge into the Water of Deugh downstream of the village. Embedded mitigation through minimising infrastructure in this catchment has greatly reduced the potential cumulative flooding impact for Carsphairn.

A8.6.23. The Proposed Development is considered to be ‘Essential Infrastructure’ and located in the ‘little or no flood risk’ category (i.e. <0.5% AEP) and therefore in accordance with SEPAs Guidance and Scottish Planning Policy is considered entirely suitable in land use development terms.

A8.6.24. As part of the wider habitat and land management proposals for the Proposed Development, it is anticipated that Natural Flood Management can be successfully integrated in a manner to not only ensure that greenfield runoff rates are maintained following the construction of the Proposed Development but also used to contribute positively to flood risk management. Details outlining the approach to Natural Flood Management and the types of measures that could be utilised are presented in Section 8.7.

A8.7 NATURAL FLOOD MANAGEMENT STRATEGY

Introduction

A8.7.1. With projected climate change expected to increase the frequency and severity of floods in the future there will be an increasing pressure on flood risk management to maintain current levels of flood protection as well as reducing future flood risk. Traditional approaches to flood management, such as direct defences in the form of hard engineered flood walls, are not considered sustainable. Therefore, a more holistic approach of managing land and water throughout the river catchment is required.

A8.7.2. Natural flood management (NFM) is based on a catchment wide approach and is typically aimed at measures that work with natural features and processes to slow and reduce flood water runoff. In addition to benefits to flooding, NFM approaches often contribute to improvements in biodiversity, water quality, and carbon storage. While it is recognised that NFM is unlikely to provide a total solution to flood risk on its own, it can be used alongside more traditional approaches to help reduce the height of flood defences and/or extend their life.

Rationale

A8.7.3. The Flood Study[5] undertaken for Carsphairn identified NFM as a potential management option which could be used to manage flood risk within surrounding upland catchment areas. Whilst this FRA has identified that cumulative flood risk posed to Carsphairn from the Proposed Development is extremely limited as the majority of the on-site catchments discharge into the Water of Deugh downstream of the village, the implementation of new habitat and land management protocol represents a significant opportunity to contribute to local flood risk reduction.

Natural Flood Management Project Approach

A8.7.4. The process of developing a NFM project is described in the SEPA NFM Handbook[17] and its delivery as part of the Proposed Development is as follows:

- Establishment of aims / criteria for flood risk reduction;
- Identification of opportunity areas for NFM;
- Collation of NFM measures which could be implemented in opportunity areas; and
- Review and ranking of measures in opportunity areas which could be implemented.

A8.7.5. Hydrological modelling and quantitative assessment would be undertaken for measures in opportunity areas where the aims / criteria for flood risk reduction could be achieved. This assessment, along with an options appraisal balancing benefits, feasibility and cost would be presented at a later date once the project has been consented.

Natural Flood Management Project Aims

A8.7.6. The overall aim of a NFM Project at Quantans Hill Wind Farm would be to demonstrate that a tangible benefit to flood risk reduction (at any scale) can be feasibly achieved whilst balancing the environmental and social elements. The desired effect on flooding is to:

- Reduce the downstream flood peak thus reducing the scale and impact of the flood; and/or
- Delay the arrival of the flood peak downstream, thus increasing the time available to prepare.

[17] SEPA. 2015. Natural Flood Management Handbook. Available at https://www.sepa.org.uk/media/163560/sepa-natural-flood-management-handbook1.pdf (accessed 15/02/2021).

A8.7.7. For these objectives. the scale at which the aim is considered is vital. The implementation of NFM measures at the Proposed Development are unlikely to provide a tangible contribution to flood risk reduction in the wider Water of Ken catchment, however these measures may alter the hydrology of the on-site catchments (or parts of the catchment) in a way that reduces local impacts and associated risk.

Identification of NFM Opportunity Areas

A8.7.8. Any project's aims are scale dependent, focusing primarily on reducing runoff and delaying the downstream flood peak following rainfall for catchments within and immediately adjacent to the Proposed Development. Downstream networks are the primary receptors, with the highest importance allocated on the basis of historic flood risk, number of properties at risk and their associated significance.

A8.7.9. As outlined in Section 8.4, the areas within, immediately adjacent to and downstream impacted by flood risk are predominantly adjacent to the watercourses, with additional risk to Carsphairn. This section also identified that as a result of the low infiltration rates and sloping nature of the upland ground, the majority of streamflow is derived from runoff as opposed to stored sources, with over half the runoff during a rainfall event contributing to flow. Slope angles at the Proposed Development vary, being generally between 5-15° but typically >25°, up to a maximum of 75° on the higher slopes. Land management practice also result in a complex network of artificial drainage infrastructure facilitating runoff. It is also highlighted that under the WFD RBMPs, all of the watercourses are classified as having Poor status on account of barriers to fish migration (Section 8.6, Chapter 8, Geology, Hydrology and Hydrogeology).

A8.7.10. SEPA prepared natural flood management maps as a requirement of Section 20 of the Flood Risk Management (Scotland) Act 2009. The SEPA identification of NFM potential has considered there is a medium to high potential for runoff reduction within the Proposed Development boundary.

A8.7.11. As the position of the Proposed Development infrastructure could pose a constraint in the positioning and implementation of NFM measures, opportunity mapping has not been defined at this stage. Detailed hydrological / hydraulic modelling or opportunity identification using GIS could be undertaken post-consent following the finalising of Development infrastructure. An example of this process is shown in Figure Insert 8.5.2.

Source: Natural Power

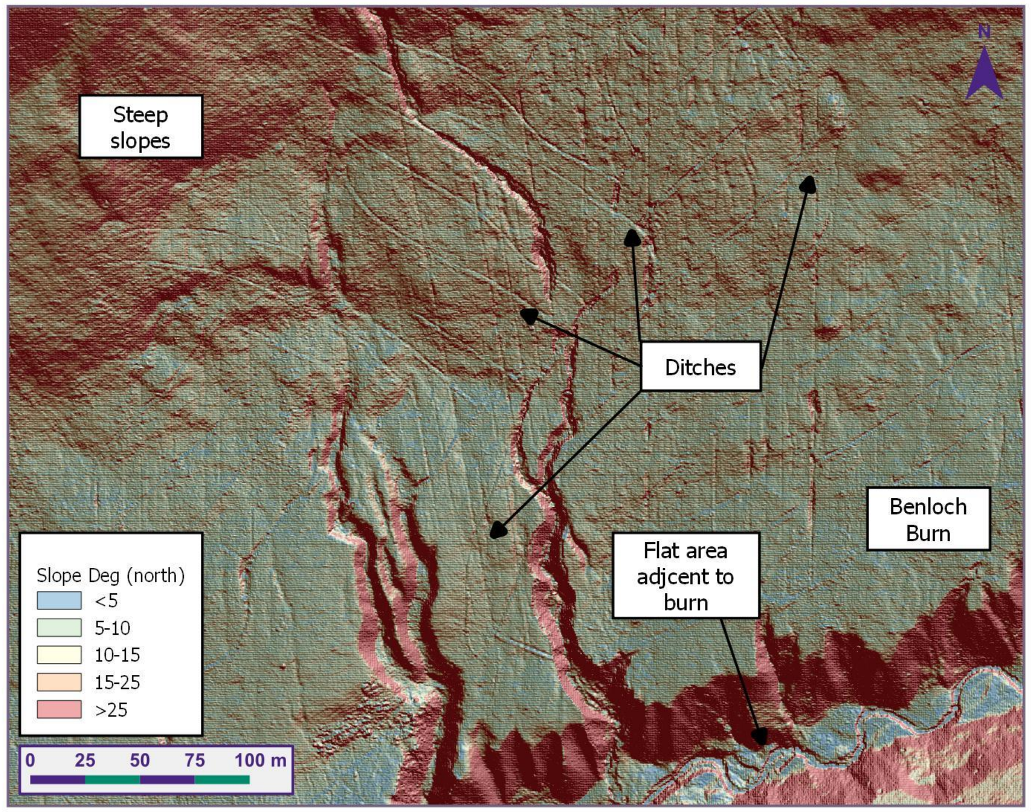


Figure 5.2: Example of how GIS will be used to identify opportunity areas for NFM within the Proposed Development. Example above shows linear ditches on higher angled slopes within the Benloch Burn which could be blocked as a NFM measure.

Natural Flood Management Measures

A8.7.12. Natural Flood Management (NFM) measures can be broadly grouped into the following:

River Reach and Floodplain Storage (RRFS) – measures that seek to enhance the mainstream and flood plain flood behaviour. Includes floodplain and riparian woodland, instream structures and washlands / offline storage ponds.

Runoff Reduction (RR) – measures that aim to minimise the runoff from the upstream catchments and reduce the volume and rate of flow entering the watercourses. Includes changes in land and soil management practices, agricultural and drainage modification.

Sediment Management (SM) – measures that aim to increase the channel conveyance and/or reduce the problematic sediment loads that can reduce channel conveyance. Includes sediment traps, river bank restoration and finally river morphology and floodplain restoration.

A8.7.13. As outlined in Section 8.3, over 60% of the application boundary is situated above 300 m AOD, with slope angles being steepest in headwater catchments in the north, and more subdued in the south. The character of the Proposed Development area and its constituent hydrological features will influence the spatial distribution of potential measures. Owing to the upland setting and absence of any floodplain, any associated NFM measures such as floodplain restoration have not been considered.

A8.7.14. Further details of the potential NFM measures that are relevant to the upland hydrology of the Proposed Development area are presented in the sections below.

RRFS: Woodland Creation

A8.7.15. Woodland creation refers to the planting and management of trees and woodland throughout the catchment and contribute to flood management through greater water use than open grassland, increasing the rate of infiltration and increasing catchment "roughness". The use of woodland creation in upland catchments proves particularly successful for the latter of these effects, with academic studies demonstrating increases in soil infiltration being up to 60 times[18]. Other studies have also demonstrated the planting of a small catchment (~10 km^2) could reduce flood peaks by 50%-30% for small and large floods respectively[19].

A8.7.16. The riparian areas which could be planted, the species planted and density of planting would be designed to avoid conflicting with existing land use as well as future use as part of the Proposed Development. An example of upland riparian planting is shown in Photo Insert 8.5.2.

Source: Natural Power

Photo Insert 5.2: Photograph demonstrating riparian planting as part of a NFM measure in an upland catchment

RRFS: Instream-Structures

A8.7.17. In the context of NFM, instream structures refers to the use of woody material in the watercourse to increase the hydraulic roughness of the channel, encouraging out of bank flow and therefore reducing the volume of water in the river. Although use less frequently, other materials such have boulders have also been used. Studies from small catchments used modelling to demonstrate flow velocities could be reduced by as much as 2.1 m s behind the dams and could slow the flood peak by up to 15 minutes over a 0.5 km reach for a 1 in 100 year flood event[20].

A8.7.18. It is acknowledged that in some instances, the use of instream structures may not be appropriate as these may alter the aquatic habitat and morphology of the river. These could also act as barriers to fish and other species. The watercourses situated within the vicinity of Proposed Development are noted as having "Poor" status under RBMP WFD objectives.

RRFS: Wetlands and Offline Storage

A8.7.19. Offline storage as part of NFM relates to the use of storage areas set aside in riparian corridors used as flood storage features. These can be both specifically constructed storage features or artificial wetlands with the intention of providing additional depression storage and therefore attenuating peak runoff.

A8.7.20. Studies have shown offline storage areas to be most effective around floodplains, however there is limited evidence suggesting these could be effective at a small scale, altering local runoff regimes.

RR: Land and Soil Management

A8.7.21. Whilst catchment scale effects are uncertain, changing land management practices has been shown to increase infiltration and decrease runoff rates. This type of management is particularly effective in reducing flood risk for farms or small communities. Techniques include changes in the use of machinery, grazing intensity and ditch (grip) blocking (discussed above). Other land management techniques include repairing damaged river banks.

RR: Ditch (Grip) Blocking

A8.7.22. Upland ditches or grips were traditionally created to drain upland areas and convey flows to watercourses more quickly. As well as improving the land's agricultural value, the upland grips have also resulted in catchments with more flashy flow regimes as well as causing substantial degradation of peat bogs. While the action of ditch blocking will increase the storage of water in the short term, the creation of additional pools, hollows and barriers will reduce the discharge rate and at a small scale (20 km^2 catchments) has been shown to be effective at reducing peak flows[21].

A8.7.23. Targeting restoration at steeper, smoother grips is likely to have the greatest impact on downstream peak flow reduction particularly if used in combination with revegetation of exposed soil / peat surfaces[21]. Examples of ditch blocking are shown in Photographs 8.5.3.

Source: Natural Power

Photo Insert 5.3: Example ditches which could be blocked for runoff reduction at Quantans Hill (left). The photo on the right shows ditch blocking within an upland catchment in southern Scotland.

[18] Carroll et al. 2004. Can tree shelterbelts on agricultural land reduce flood risk? Soil Use and Management. Vol. 20 (3), pp357-259.

[19] Nisbett & Thomas. 2006. The role of woodland in flood control: a landscape perspective. Published in Proceedings of the 14th annual IALE (UK) 2006 conference on Water and the Landscape, Davies, B., and Thompson, S (Eds.) IALE (UK), Oxford. pp118-125

[20] Thomas & Nisbett. 2007. An Evaluation of the Impact of Large Woody Debris in Watercourses on Flood Flows. Final Report to Forestry Commission (Wales) on Robinwood Project

[21] Allott et al. 2019. Peatland Catchments and Natural Flood Management. Report to the IUCN UK Peatland Programme's Commission of Inquiry on Peatlands Update.

SM: Overland Sediment Traps[22]

A8.7.24. This involves the creation of containment areas where sediment laden runoff is detained to allow sediment to settle out of the runoff.

SM: River-bank Restoration

A8.7.25. This involves the restoration or protection of river banks suffering from unnaturally high levels of erosion. There are many techniques ranging from the installation of fencing to prevent livestock poaching the banks, allowing the river bank to re-vegetate and stabilise naturally to direct re-vegetation by planting.

Appraisal of Potential Measures

A8.7.26. An appraisal of the potential NFM measures that could be implemented within the vicinity of the Proposed Development has been undertaken and in line with the framework prescribed by the NFM Handbook, has considered each type of measure with consideration for the specific environmental, financial and feasibility constraints associated with each catchment and are summarised below:

- Opportunities for improvement are present as a result of on-site and immediately downstream areas at risk of flooding;
- The SEPA identification of NFM potential has considered the following measures suitable:
  - High to medium potential for runoff reduction for all catchments;
  - No potential for floodplain storage; and
  - The opportunities for sediment management are dependent upon the morphological conditions of the river stretches.
- Predominant land cover consists of semi-improved grassland and minor areas of mature coniferous woodland. Artificial drainage ditches are present in all catchments;
- Land-use is predominantly rough grazing. Planting of woodland in the Polhay and Marbrack catchments is ongoing across an area of ~60 Ha. It is also understood that planting is also planned for the Furmiston Lane catchment;
- The soils are defined as being permanently wet and overlay low permeability bedrock; and
- All upstream watercourses are classed as having a Poor overall status under the requirements of the WFD. The Benloch Burn contains a water abstraction managed by Scottish Water and is considered of high resource value.

A8.7.27. Each potential management measure has been appraised for suitability of use within each catchment and follows the principles of SEPA's NFM Handbook. A suitability rating of low, medium and high has been suggested and is based on the feasibility for delivery, the potential for hydrological benefit as well as any environmental, land management and social constraints. Further information on each of these criteria are presented below in Table 8.5.5.

Table 5.5: Criteria for assigning NFM suitibility

Assessment Consideration	Suitability Rating		
	Low	Medium	High
Feasibility / Engineering	Likely to be unfeasible from a cost and engineering perspective. Timescales for implementation or benefit realisation may be unrealistic	Feasibility is possible from an engineering perspective or may have considerable cost. Potential for realistic timeframe on implementation / benefit realisation	Likely to be feasible from an engineering and financial perspective. Likely to be implemented in a realistic timeframe that would allow benefit realisation
Land Management Constraints	Would not be acceptable to land managers/users due to impairment of current land use	Potential to be acceptable to land managers but may require extended negotiations	Likely to be acceptable to land managers and users
Hydrological Benefit	Very limited to no realistic hydrological benefit (flood / runoff reduction or improvements in water quality)	Potential for some limited hydrological benefit for the immediate catchment	Likely to have some hydrological benefit for the immediate catchment
Environmental Constraints	Likely to incur impacts on flora and fauna, soils, water quality and water resources	Potential for some impacts on local environmental constraints	Unlikely to incur any unacceptable impacts upon hydrological receptors
Social Constraints	Likely to incur impacts upon the landscape, cultural heritage or other social aspect	Potential for some impacts on social constraints	Unlikely to incur any unacceptable impacts upon social constraints

Source: Natural Power

A8.7.28. The potential suitability of each NFM measure has been considered for each catchment based on the results of site surveys and the overall suitability rating based on the based on the feasibility for delivery, the potential for hydrological benefit as well as any environmental, land management and social constraints. The results are presented below in Table 8.5.6.

Table 5.6: Appraisal of NFM Measures in the catchments at the Proposed Development

NFM Measure	Suitability Rating	Appraisal Notes
Benloch Burn (4.1 km²)		
RRFS Woodland Creation	Medium	• Whilst feasible, consideration would be needed to ensure no impacts on the Scottish Water intake.
RRFS Instream Structures (woody debris)	Medium / Low	• Instream structures not acceptable upgradient of Scottish Water intake. • Landscape open moorland so use of woody debris would not emulate surrounding habitat. Suitability would be increased downstream of intake if riparian planting was utilised. May become more appropriate following the completion of woodland planting proposals.
RRFS Wetlands and Offline Storage	Low	• Creation of wetlands or offline storage areas not acceptable upgradient of Scottish Water intake. • Catchment morphometry is steep and unlikely to be able to accommodate offline storage areas or wetlands in other areas.

[22] The previous study by Kaya Consulting Ltd (Carsphairn Flood Study) considered sediment management as part of a detailed hydraulic model of Carsphairn. The general conclusion of that study was that sediment removal could provide a small degree of flood level reduction (circa 100mm) at the 1:200 year flow. The study recognised that sediment deposition would likely continue necessitating the need for regular sediment removal.

NFM Measure	Suitability Rating	Appraisal Notes
RR Land & Soil Management	Medium	• Depending upon the activity, improvements in land and soil management would be acceptable above Scottish Water intake. • Whilst feasible with limited effects on the environment, the remote nature of the catchment means that modifications to practices are unlikely to achieve a hydrological benefit in terms of flood and runoff reduction.
RR Ditch Blocking	High	• Extensive network of artificial drains and ditches within the upper catchment. Current land-use is largely for rough grazing. The adoption of this measure should not negatively impact grazing livestock. • Scottish Water have indicated that ditch blocking would be acceptable in the catchment during informal discussions.
SM Sediment Traps	Low	• Creation of sediment traps would not be acceptable upgradient of Scottish Water intake • Given the use of the catchment discharge for water supply suggests water quality is generally good, it is unlikely that sediment traps would provide any meaningful hydrological benefit.
SM Riverbank Restoration	Low	• High energy upland environment means that erosion levels are high and riverbank protection would require considerable investment and is unlikely to achieve a realistic hydrological benefit in terms of flood and runoff reduction. • The use of stock fencing could be used in combination with other NFM measures such as woodland creation (if acceptable).
Knockgray Burn (0.8 km²)		
RRFS Woodland Creation	High / Medium	• Whilst feasible, much of the lower catchment is arable land used for pasture grazing. Planting is unlikely to be acceptable by the landowner in areas of improved grassland. • Areas proximal to watercourses already contain some forestry. The upper catchment is open moorland / bog and would be more suitable however consideration of future planned land use (proposed wind farm) would be needed.
RRFS Instream Structures (woody debris)	High / Medium	• Areas of existing and planned riparian woodland would be suitable for instream structures (woody debris). • The limited spatial extent of woodland in the would limit the hydrological benefit in terms of flood and runoff reduction.
RRFS Wetlands and Offline Storage	Medium / Low	• Much of the lower catchment is arable land used for pasture grazing. • While possible in the upper catchment, the limited spatial extent of suitable areas compared to the total catchment area would limit the hydrological benefit in terms of flood and runoff reduction.
RR Land & Soil Management	Medium	• Levels of agricultural activities are high within the lower catchment. • The engagement of the landowner the diversity of measures implemented would dictate the hydrological benefits.

NFM Measure	Suitability Rating	Appraisal Notes
RR Ditch Blocking	High / Medium	• The upper catchment exhibits an extensive network of artificial drains and ditches that would be suitable for blocking. In these areas the current land-use is for rough grazing. The adoption of this measure should not negatively impact grazing livestock. • The occurrence of peatland in some areas would also have added environmental benefit.
SM Sediment Traps	Low	• Creation of sediment traps unlikely to emulate the surrounding environment, which is predominantly improved / unimproved grassland. • Sediment export is likely to be low on account of the dominance of grazing land use.
SM Riverbank Restoration	Low	• The upper catchment does not contain watercourses of a size suitable to benefit from restoration. Constituent peatland has been identified in the HMP for restoration. The lower catchment is on a steeper gradient but its regularly accessed by grazing livestock. • The use of stock fencing could be used in combination with other NFM measures such as woodland creation.
Polhay Burn (2.1 km²) & Marbrack Burn (5.8 km²)		
RRFS Woodland Creation	High	• Afforestation of central catchment area is recently complete. The more subdued gradients of the catchment and lower altitude would make additional planting feasible. • Consideration of future planned land use as a proposed Wind Farm would be needed.
RRFS Instream Structures (woody debris)	Medium	• Areas of existing and planned riparian woodland would be suitable for instream structures (woody debris). • The area of forest where these measures would be implemented would dictate the hydrological benefit.
RRFS Wetlands and Offline Storage	Medium / Low	• The majority of both catchment areas are subdued topographically apart from around interfluves where gradients are steeper. In lower catchment areas ground conditions are already water saturated due to low permeability bedrock. • The implementation of these measures to an extent that would generate a hydrological benefit would require significant modification of the landscape and potential loss of habitat. Whilst this is unlikely to be acceptable to regulatory bodies, there is potential for some environmental benefit through wetland habitat creation on the lower section of the Marbrack Burn with potential for hydrological benefit.
RR Land & Soil Management	Medium / Low	• Agriculture is mainly rough grazing. The engagement of the landowner and the diversity of measures implemented would dictate the hydrological benefits.
RR Ditch Blocking	High	• Artificial drains and ditches are extensive within the Polhay and Marbrack catchment areas. Current land-use is for rough grazing. The adoption of this measure should not negatively impact grazing livestock.

NFM Measure	Suitability Rating	Appraisal Notes
SM Sediment Traps	Low	• Creation of sediment traps are unlikely to emulate the surrounding environment, which is predominantly unimproved grassland. • Sediment export is likely to be low as a result of the limited potential for soil erosion in the catchments (i.e. grazing livestock only, no ploughing).
SM Riverbank Restoration	Medium / Low	• The lower sections of the Marbrack and Polhay catchment areas are noted to be subdued topographically, with small areas of riparian flood plain and sinuous channels. • Potential for stock fencing and green bank works would increase bank stability facilitating vegetation establishment.
Furmiston Lane (1.1 km^2)		
RRFS Woodland Creation	Medium	• Riparian planting would be feasible however potential for some conflict given the accessibility of the catchment and its use for rough grazing.
RRFS Instream Structures (woody debris)	Medium / Low	• The use of instream structures (woody debris) would not emulate current land use. • Potential for increased suitability if planned woodland planting as well as riparian woodland as part of NFM was implemented.
RRFS Wetlands and Offline Storage	Low	• The gradient of the catchment is likely to limit opportunities for where offline storage and wetlands could be utilised. • The catchment is also one of the most visible and as such the creation of these features over an extent that would create a hydrological benefit is unlikely to be acceptable from a landscape and visuals perspective.
RR Land & Soil Management	Medium	• Agriculture is mainly rough grazing. The engagement of the landowner and the diversity of measures implemented would dictate the hydrological benefits.
RR Ditch Blocking	High	• Artificial drains and ditches are extensive within the Furmiston Lane catchment. Current land-use is for rough grazing. The adoption of this measure should not negatively impact grazing livestock.
SM Sediment Traps	Low	• Creation of sediment traps are unlikely to emulate the surrounding environment, which is predominantly unimproved grassland. • Sediment export is likely to be low as a result of the limited potential for soil erosion in the catchments (i.e. grazing livestock only, no ploughing).
SM Riverbank Restoration	Low	• High energy upland environment means that erosion levels are high and riverbank protection would require considerable investment and is unlikely to achieve a realistic hydrological benefit in terms of flood and runoff reduction. • The use of stock fencing could be used in combination with other NFM measures such as woodland creation.

Source: Natural Power

A8.7.29. The appraisal has identified a medium, medium / high and high suitability for several NFM measures in the various catchments within the vicinity of the Proposed Development. These include woodland creation, the use of instream structures, ditch blocking and the implementation of land and soil management measures. In addition to these, there are likely to be discrete locations across the Proposed Development where other measures such as the creation of wetlands / offline storage as well as riverbank restoration could be implemented.

A8.7.30. It should be noted the appraisal is indicative, identifying NFM measures which should be considered in more detail following consent. This would include a cost benefit analysis, as well as determining the potential percentage reduction in flow for specific flood return periods for each of the identified catchment areas.

Implementation

A8.7.31. Following the consent of the Proposed Development, a detailed assessment of the potential NFM measures would be undertaken in combination with local landowner and stakeholder engagement. This would include hydrological modelling as part of the outline and detailed design to determine the likely benefit that the implemented measures would provide on reducing flood risk to the Proposed Development and areas of flood risk immediately downgradient.

A8.7.32. Following the completion of this assessment and agreement of the Proposed NFM measures with all relevant stakeholders (including SEPA, D&G Flooding Team and Scottish Water), the NFM strategy would be implemented. It is hoped that engagement with the local community would facilitate involvement in both the planning and implementation phases of the NFM strategy.

A8.7.33. The long-term management and maintenance of the NFM measures will need to be agreed with the landowner/land manager on whose land the NFM measure has been implemented. The nature of the management agreement will be dependent on the financial mechanisms being used to deliver the measure.

A8.8 CONCLUSION

A8.8.1. Natural Power has carried out a Flood Risk Appraisal in relation to the Environmental Impact Assessment Report (EAIR) in support of the proposed Quantans Hill Wind Farm.

A8.8.2. In accordance with Scottish Planning Policy and best practice / regulatory flood risk guidance, all other potential sources of flood risk have been evaluated which could affect the Proposed Development area, and how changes to the Proposed development area could affect nearby flood risk.

A8.8.3. The FRA has demonstrated that only a few very small areas of the Proposed Development area have the potential to be affected by fluvial flood risk, which are constrained to discrete areas of proposed infrastructure at watercourse crossing locations positioned within the 0.5% AEP (1:200 year) inundation envelope. As discussed in this FRA and also within Technical Appendix 8.1: Water Crossing Assessment, watercourse crossings in these locations would be designed to accommodate 0.5% AEP flows (plus an uplift for Climate Change) maintaining a minimum freeboard of 0.6 m.

A8.8.4. The effects of increased runoff from the wider Proposed Development infrastructure has been minimised using embedded mitigation. These include minimising the extent of impermeable surfaces within catchment areas draining the Proposed Development and also the maintenance of suitable set-back distances between infrastructure and watercourses to encourage infiltration where possible.

A8.8.5. It was also noted that the settlement of Carsphairn, which is situated downstream of one of the catchment's drainage, the Proposed Development area, has a history of flooding. Embedded mitigation including minimising the extent of infrastructure within the Benloch Burn combined with the successful implementation of standard good practice mitigation will ensure that runoff from proposed infrastructure does not adversely impact downstream flood risk.

A8.8.6. An initial feasibility appraisal undertaken to determine the suitability for Proposed Development to incorporate Natural Flood Management measures as part of the embedded design has also been undertaken. The appraisal has identified that a holistic catchment based approach using a variety of appropriate methods has the potential to positively contribute to flood risk management. This includes ditch blocking as well as the riparian planting, and other measures appropriate for afforested areas. Following the consent of the Proposed Development, a more detailed assessment of the potential NFM measures would be undertaken in combination with local landowner and stakeholder engagement.

Document history

Author	Sam Wainwright	04/08/2021
Checked	Emma Bryder	09/09/2021
Approved	Kelly Wyness	23/11/2021

Client Details	
Contact	Matthew Bacon
Client Name	Vattenfall Wind Power Ltd

Issue	Date	Revision Details
A	04/08/2021	First draft submission
B	23/11/2021	Update
C	10/12/2021	Final Draft
D	16/12/2021	Released
E	23/06/2022	Update and Released

Appendix 8.6

Pollution Prevention and Incident Plan

Contents

	Contents	1
	Glossary	2
	List of Abbreviations	2
A8.1	Introduction	2
	Background and Objectives	2
	Approach	3
	Project Description	4
	Primary Pollution Sources	5
	Primary Pathways & Receptors	5
A8.2	Management Arrangements	5
	Roles and Responsibilities	5
	Work Control Procedures	6
	Induction, Training and Competence	7
	Coordination, Communication and Liaison	7
A8.3	Pollution Prevention Plan	8
	Introduction	8
	Pollution Prevention Controls and Mitigation Measures	9
	Construction Environmental Management Plan (CEMP)	9
A8.4	Pollution Incident Plan	9
	Introduction	9
	Key Principles	9
	Incident Response, Remediation and Monitoring	10
	Incident Reporting	11
	Response Training and Testing	11
A8.5	Contingency	11
	Spill Kits	11
	Specialist Contractor(s)	11
	Scottish Water Emergency Planning	11
A8.6	Monitoring Plan	12
	Introduction	12
	Guiding Principles	12
	Surveillance Inspections and Site Audits	12
	Water Monitoring	12
Appendix A – Scottish Water List of Precautions Document		16

Appendix B – PPIP Schedule of Mitigation 17
Appendix C – Spill Response Flow Chart 18
Appendix D – Incident Categories 19
Appendix E – Scottish Water SHOUT Poster 20

Glossary

Refer to Chapter 8: Hydrology, Geology and Hydrogeology in Volume 2 of the EIAR for the Glossary.
List of Abbreviations

List of Abbreviations

Refer to Chapter 8: Hydrology, Geology and Hydrogeology in Volume 2 of the EIAR for the List of Abbreviations.

A8.1 Introduction

Background and Objectives

A8.1.1. The Applicant is proposing to develop a wind farm (the Proposed Development) at Quantans Hill, north of Carsphairn, in Dumfries and Galloway. Location and layout plans are shown in the Figures supporting the EAIR.

A8.1.2. The aim of this Pollution Prevention and Incident Plan (PPIP) is to describe the control measures that will be adopted to protect water resources in the Benloch Burn catchment, specifically the Scottish Water public water and the support mitigation proposals outlined in Chapter 8 (Hydrology, Geology and Hydrogeology) of the Environmental Impact Assessment Report (EIAR).

A8.1.3. In developing the PPIP, special consideration has been given to the presence of the Benloch Burn catchment and the supporting water delivery pipework connecting the intake to Carsphairn village. The surface water intake is situated on the Benloch Burn and is designated as a Drinking Water Protected Area (DWPA) under The Water Environment (Drinking Water Protected Areas) (Scotland) Order 2013. The Benloch Burn is the sole supply for the water treatment works (WTW) that provides a potable water supply to Carsphairn village.

A8.1.4. Both the Applicant and Scottish Water have identified the protection of water quality as being of paramount importance. A key objective of this PPIP is therefore to identify and outline best practice measures to be adopted during the construction phase of the Proposed Development to prevent pollution of surface and ground water environments and to protect the water supply interests of Scottish Water.

A8.1.5. This PPIP has been developed in consultation with Scottish Water.

Approach

A8.1.6. The PPIP is based on and informed by the following primary concepts;

- The principles of pollution prevention;
- The pollutant linkage concept; and
- Stakeholder consultation.

A8.1.7. These concepts are discussed in further detail below.

Principles of Pollution Prevention

A8.1.8. In the development and implementation of this plan, due regard has and will be given to the principles of pollution prevention including the following;

- Avoiding and eliminating risk where practical;
- Evaluation of unavoidable residual risk;
- Addressing risk at source;
- Adaption of work to local situation;
- Substitution of activities, substances, and systems of work for options with fewer hazards;
- Provision of risk mitigation and contingency; and
- Provision of training and instruction.

A8.1.9. These principles have been used to develop a risk prevention approach to activities described in Section 8.3 below.

Pollutant Linkage Concept

A8.1.10. A key risk assessment and management tool that has been used to inform the PPIP is the pollutant linkage concept. Many environmental risk assessments rely on assessing the likely presence and significance of a potential pollutant linkage. The source-pathway-receptor model is traditionally used to conceptualise the risk.

A8.1.11. For a risk to exist there must be a hazard source, a receptor that may be impacted and a pathway connecting them. Where a source-pathway-receptor relationship exists, a potential pollutant linkage therefore also exists. If a source, a pathway or a receptor is absent, no linkage exists and there is no likelihood of a hazard impacting a receptor.

A8.1.12. At any given site there may be several potential linkages, and a hazard source may pose a risk to one or more receptors by one or more pathways. Similarly, a receptor may be at risk from one or more hazard sources. A key risk management technique is to break any potential pollutant linkages i.e. removing the source.

A8.1.13. Risk is often described as the likelihood of harm being realised from a hazard and may be expressed as a function of the likelihood x severity. Another risk management protocol that has been adopted in the formulation of this plan has therefore been to identify and assess measures that would reduce both the likelihood of residual risks occurring and minimising the environmental impact in the event of an incident.

PPIP Status

A8.1.14. This PPIP only applies to the construction phase of the Proposed Development within the Benloch Burn. Subsequent plans will be developed for the operational and decommissioning phases of Quantans Hill Wind Farm.

A8.1.15. All construction works carried out by the Applicant and their contractors on the Proposed Development site shall be conducted in accordance with this PPIP and approved Risk Assessments and Method Statements (RAMS), and approved CEMP. Any changes to the construction works which (i) are not included in the RAMS and (ii) may potentially have a materially detrimental impact on water quality will be discussed and agreed with Scottish Water in advance of such amended works being carried out. Any surface water monitoring (presented in Section 8.6) below shall be pre-agreed with Scottish Water.

A8.1.16. If Scottish Water or the Construction Site Manager report that, as a result of the construction works, a pollution event has occurred that may negatively impact the water quality of the Benloch Burn or compromise the ability of Scottish Water to deliver potable water sourced from its catchment, then only such part of the construction works to which the pollution event related shall temporarily cease pending remedy of the situation. In such an event, the Applicant and appointed contractors will work with Scottish Water to take such action as may be necessary to remedy the situation in a timely way, including (but not limited to) the provision of a temporary potable water supply. In the event of a dispute, SEPA will be consulted to determine the level of risk to the water supply.

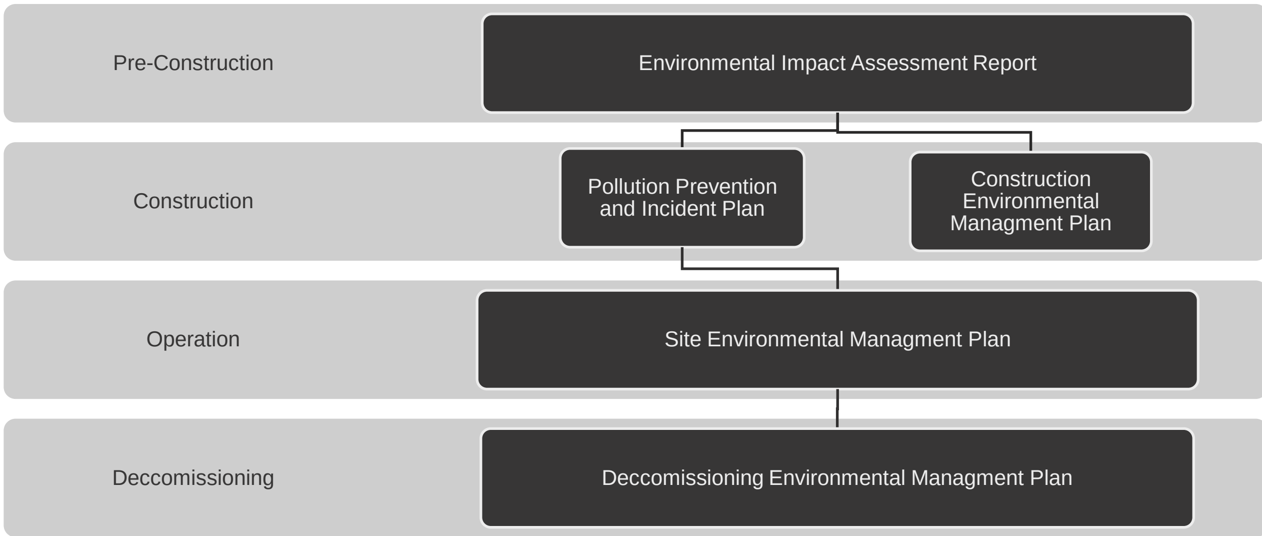
Structure and Scope of the PPIP

A8.1.17. The PPIP is comprised of the following sub-plans;

- **Pollution Prevention Plan**; this describes the controls and mitigation to be adopted in connection with the wind farm construction activities in order to prevent or mitigate potential adverse effects on the quality of surface or groundwater on the site;
- **Pollution Incident Plan**; describes the arrangements to be followed in the event of a pollution incident and outlines protocols to be adopted in relation to the response, investigation, reporting and clean-up of pollution incidents; and
- **Monitoring Plan**; describes the environmental and pollution control monitoring arrangements to be adopted in relation to surface and groundwater and in the context of the PPIP.

A8.1.18. The scope of this PPIP does not including addressing the risks associated with the decommissioning or operation phases of the Proposed Development; these will be addressed separately in an Operation and Decommissioning Environmental Management Plan for the site in compliance with any consent conditions.

A8.1.19. Relationships between key environmental documents and phases of the wind farm are outlined below.



A8.1.20. This PPIP will be used to inform the Construction Environmental Management Plan (CEMP).

A8.1.21. Chapter 8 of the EIAR identifies predicted construction effects including impacts on surface water quality and flows, and also outlines mitigation and enhancement measures. Detailed site-specific prevention and mitigation measures will be captured in approved RAMS generated for the main wind farm construction activities at the time of construction.

Project Description

A8.1.22. The Proposed Development is situated immediately north of Carsphairn in Dumfries and Galloway, southwest Scotland. The Proposed Development will comprise of 14 wind turbines and associated infrastructure including crane pad hardstanding, temporary construction compound, substation, access tracks and borrow pits. The existing land use of the Proposed Development Area is rough grazing for agriculture.

A8.1.23. Only a small proportion of the Proposed Development area falls within the Benloch Burn DWPA. In addition to the Benloch Burn DWPA, a supply pipe owned and managed by Scottish Water associated with the delivery of abstracted water from the Benloch Burn to Carsphairn bisects the Proposed Development area. An illustration of the Benloch Burn and the Scottish Water supply pipe and positioning of proposed infrastructure within or adjacent to these is presented below.

Source: Natural Power

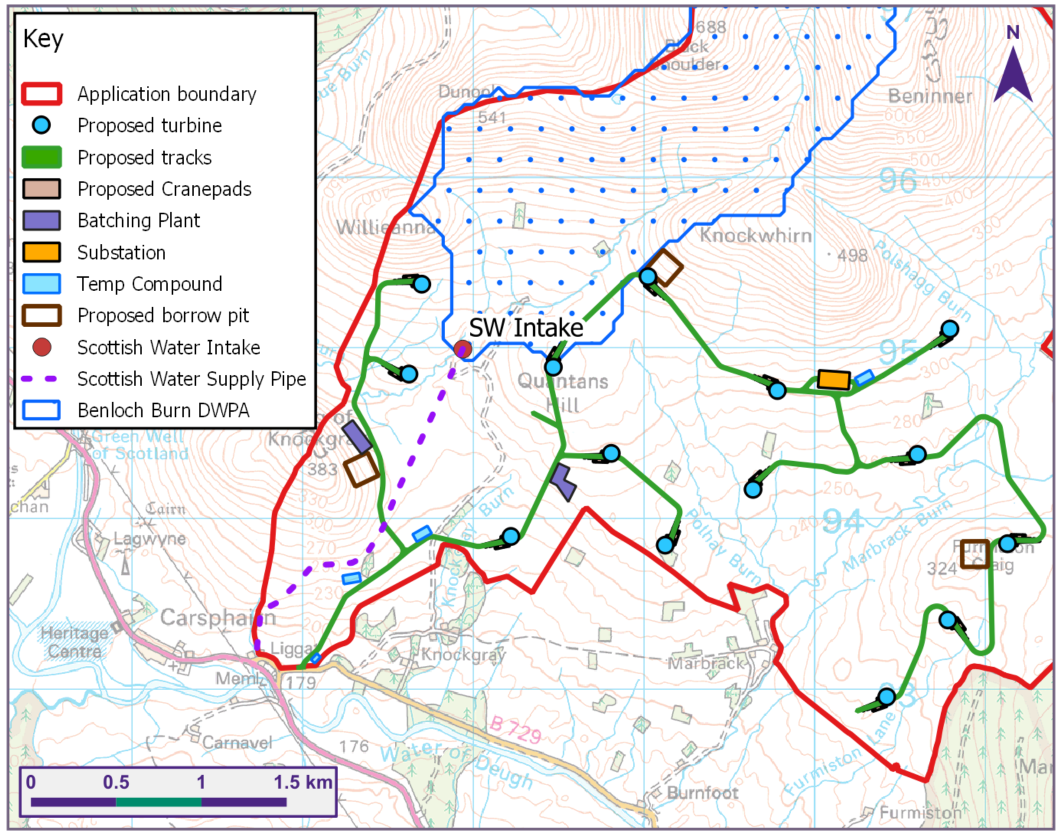


Figure Insert 8.1: Scottish Water intake in the Benloch Burn and position of supply pipework to Carsphairn village.

A8.1.24. As discussed within Chapter 8 of the EIAR and illustrated in the figure above, the extent of any proposed infrastructure within the Benloch Burn upgradient of the Scottish Water intake **has been minimised as far as possible**, being constrained to only a short section of new track. Moreover, proposed turbines 1, 4, 5 and 2 have been specifically re-positioned to avoid being within the direct footprint of the likely Benloch Burn DWPA catchment area of the Scottish Water intake.

A8.1.25. Table 8.6.1 outlines the infrastructure situated within or adjacent to the Benloch Burn DWPA that are illustrated in Figure Insert 8.1.

Table 8.6.1: Summary of infrastructure situated within the vicinity of the Benloch Burn DWPA

Infrastructure Element	Distance from DWPA catchment boundary	Distance from Intake	Notes
Turbine 1	180 m	450 m	Outside catchment. No pathway between infrastructure and intake
Turbine 4	300 m	350 m	Outside catchment. No pathway between infrastructure and intake
Turbine 5	<50 m	550 m	On catchment boundary. Unlikely to have a pathway between infrastructure and intake
Access Track (T5 to T2)	**In catchment**	530 m to 1.1km	In catchment. Potential for pathway between infrastructure and intake
Borrow Pit 2	<50 m	1.2 km	On catchment boundary. Unlikely to have a pathway between infrastructure and intake

A8.1.26. As identified within Table 8.6.1, the majority of infrastructure positioned within the vicinity of the Scottish Water Raw Water Intake situated in the Benloch Buirn DWPA are not in a location that could be hydrologically connected as a result of topography and likely flow paths. Mitigation and management measures outlined in this PPIP are relevant to infrastructure situated within or on the catchment boundary of the Benloch Burn DWPA.

Primary Pollution Sources

A8.1.27. The potential pollution sources relevant to this PPIP which could be introduced as a result of the construction of the Proposed Development include;

- Soils - exposed subsoils, borrow pits, peat / topsoil stockpiles and excavated soil stockpiles
- Fuels / Oils / Chemicals
- Concrete & Cement
- Silt laden waters – runoff

A8.1.28. It is highlighted that additional pollution sources which are unrelated to construction of the Proposed Development and which have the potential to affect water quality are already present within the Benloch Burn DWPA. These include sources associated with historic and ongoing land-use such as agriculture and land drainage modification and the environmental setting such as underlying geology. As well as the local pressures, additional sources of pollution are posed by diffuse atmospheric particulate deposition (acidification) and the effects of climate change. Whilst these pollution sources are outwith the scope of this PPIP, the potential for these to be exacerbated by construction activities has been given due consideration.

Primary Pathways & Receptors

A8.1.29. Poor construction and surface water management may result in the degradation of the hydrological environment. Pollutants may reach hydrological receptors through soil, or overland or through groundwater. Full details of the various potential hydrological pathways and receptors are outlined in Chapter 8 of the EAIR. The primary receptor considered by this PPIP is the Benloch Burn DWPA, Scottish Water Raw Water Intake and associated Infrastructure.

A8.2 Management Arrangements

A8.2.1. This section describes the environmental management arrangements to be adopted in connection with the PPIP and covers roles and responsibilities, work control arrangements, inductions, training and competence and coordination, and communication.

Roles and Responsibilities

The key roles and responsibilities in relation to environmental management are described in the following sub-sections.

The Applicant

A8.2.2. the Applicant is ultimately responsible for the effective resourcing of the Proposed Development through appropriate instructions and commissions, to ensure the environmental requirements identified in the PPIP are undertaken and for ensuring that construction activities comply with the requirements of the PPIP. The Applicant may designate appropriate personnel to act on their behalf.

A8.2.3. The Applicant will have responsibility for:

- Overall environmental performance of the Proposed Development including management of complaints and non-compliances;
- Ensure that the appointed contractor(s) have adequately trained and competent personnel and resources to implement their responsibilities under this PPIP and that arrangements are made to monitor compliance;
- Maintaining regular liaison between all parties on site to allow adequate precautions to be taken to minimise the impact on the environment;
- Ensuring water quality monitoring and site environmental inspections are performed and all issues raised are addressed promptly; and
- Conducting regular site meetings and discussing any water quality and pollution issues arising, ensuring suitable resolution as appropriate.

A8.2.4. The Applicant, through their appointed Construction Contractor, will promote environmental aims and behaviours through the development and application of best practice to ensure that in carrying out works the environmental controls are maintained. A list of relevant legislation and good practice guidance documents are presented in Chapter 8 of the EIAR.

Construction Contractor (the appointed Contractor)

A8.2.5. The appointed Construction Contractor(s) for the works associated with the Proposed Development will prepare written Method Statements for all construction works that have the potential to give rise to pollution of surface or groundwater. The Method Statements will be based upon task specific Risk Assessments to prevent pollution and to incorporate environmental mitigation and control measures where required.

A8.2.6. The Construction Contractor will appoint a **Construction Site Manager** who will be responsible for the implementation and maintenance of the Construction Environmental Management Plan (CEMP) as outlined in section 8.3 below and for issuing Permits to Work following the review of RAMS. The CEMP will be issued to / approved by Scottish Water, SEPA & NatureScot prior to construction activities commencing on-site.

A8.2.7. The **Construction Site Manager's** responsibilities will include;

- Complying with the CEMP and ensuring any related activities are adequately resourced;

- Compliance with and ensuring that there are adequately trained and competent personnel with sufficient resources to implement the objectives of this PPIP;
- Consideration and assessment of all environmental risks and takes steps to prevent or mitigate any incidents during the construction stage of the Proposed Development;
- Carrying out Risk Assessments and identification of prevention and mitigation controls to be implemented during the construction of the Proposed Development as document in activity Method Statements;
- Acting as the primary point of contact for and overall day to day responsibility for the management of environmental issues associated with the Proposed Development;
- Reviewing RAMS and documentation prepared by sub-contractors;
- Implementation of any agreed program of environmental mitigation work;
- Ensuring environmental inductions are carried out for all personnel working on site and that appropriate meetings / tool box talks are held as required with attendance records maintained;
- Establishing pollution incident response arrangements that are adequately resourced and tested;
- Ensuring that all environmental incidents and near misses are reported in line with the agreed escalation procedure and those investigations are carried out where required and that corrective and preventative actions raised are closed out;
- Ensuring that environmental inspections and non-compliance monitoring and reporting are undertaken, including for all subcontractor activities; and
- Reporting monthly on-site statistics, key information on performance indicators relating to environmental management and pollution control.

Construction Project Staff

A8.2.8. The Construction Site Manager, or other relevant appointed individual, will manage the induction process that all construction staff will be required to attend before being permitted to work on site, including sub-contractors, plant and delivery drivers, and environmental consultants. This will ensure that the staff working on the project understand that they have:

- A duty of care to protect the environment;
- Responsibility for reporting any environmental incidents, near misses or concerns;
- Responsibility for complying with the approved RAMS;
- They have the required training, qualifications, and certification (if required) to be employed to carry out specialised environmental tasks; and
- Especial awareness of the Benloch Burn's DWPA status and the location of relevant assets such as the Intake and watermain.

Environmental / Ecological Clark of Works (ECoW)

A8.2.9. An Environmental / Ecological Clark of Works (ECoW) will be appointed during the construction phase. The responsibilities of the ECoW in relation to the PPIP will include;

- Ensuring that all mitigation measures and commitments are implemented properly and effectively;
- Reviewing site inductions and providing information regarding site environmental aspects;
- Considering and advising on the environmental / ecological impact implications of any micro-siting proposals;
- Assisting and advising construction management team members in reviewing Contractor's environmental documentation with particular emphasis on RAMS, CEMP, environmental regulations and management of environmental risk;
- Carrying out regular inspections of the construction site including monitoring of implementation and maintenance of pollution control / mitigation measures;
- Advising the Construction Site Manager and their contractors on compliance with statutory environmental requirements; and
- Attending progress and coordination meetings.

Scottish Water Environmental Representative (SWER)

A8.2.10. The Applicant will appoint an appropriately experienced and qualified professional to act on behalf of Scottish Water. The SWER will have responsibility for monitoring compliance with the PPIP during construction. The SWER will be responsible for;

- Monitoring and inspection of all construction related activities to the extent agreed with Scottish Water to minimise the potential for pollution;
- Reviewing and approving Method Statements and associated Environmental Risk Assessments for all activities with the potential to cause pollution;
- Providing advice in connection with pollution prevention and control;
- Highlighting public water supply operational concerns and informing site working practices to mitigate potential impacts on the delivery of Scottish Water water supply obligations;
- Liaising with the Construction Project Management, Scottish Water, the ECoW, or any other stakeholder representative as directed by the Construction Site Manager;
- Reporting to Scottish Water as may be required on a day to day basis and formally on, at minimum, a six weekly basis or otherwise agreed or required.

Technical Specialist Advisors

A8.2.11. Other technical specialists may be employed during construction and can provide advice on the following:

- Undertaking any necessary pre-construction surveys and supervising the implementation of specific mitigation measures, where required;
- Undertaking any required monitoring related to their specialism;
- Providing reports and maintaining contact with relevant stakeholders, as required; and
- Providing specific advice with respect to any issues that arise.

Work Control Procedures

A8.2.12. The Construction Site Manager shall ensure that all site works will be undertaken in accordance with an approved Method Statement and associated Environmental Risk Assessment, and CEMP as applicable. These will include (but not be limited to);

- Site investigations and survey works;
- Borrow pit operations;
- Establishment of temporary site compounds and laydown areas;
- Construction and upgrade of access roads

- Watercourse crossing and installation of culverts and bridges;
- Construction of turbine base foundations and hardstanding;
- Delivery, assembly and erection of turbines;
- Installation of cable trenches
- Removal of temporary infrastructure and reinstatement;
- Surface water and sediment management;
- Management of waste;
- Wastewater (sewerage and foul waters) management;
- Delivery and storage of fuels, oils and chemicals[1];
- Refuelling[2]; and
- Contingency and emergency response.

A8.2.13. Method Statements will;

- Describe how specific task/operation will be carried out;
- Include an Environment Risk Assessment for the task/operation identifying the significant environmental effects relevant to the works;
- Identify the requirements for environmental mitigation and control or the need for a task/operation specific procedure;
- Incorporate and document the environmental controls into the Method Statements, including a list or description of pollution / mitigation controls;
- Provide for control and treatment of any discharge or run-off;
- Provide a map of adequate description illustrating the location of the activity / operation;
- Provide drawings to support the Method Statement where required; and
- Take into account Scottish Water's *List of Precautions to protect drinking water and Scottish Water assets during windfarm construction and operational activities* (Appendix A).

Induction, Training and Competence

Site Induction

A8.2.14. The Construction Site Manager shall ensure that all contractor employees, sub-contractors, suppliers, and all other visitors to the site are made aware of the content of this document that is applicable to them. Accordingly, environmental specific topics shall be included in the site induction.

A8.2.15. As a minimum, and working with the ECoW, the Construction Site Manager will provide the following information to all inductees:

- Identification of the main environmental risks at the site:
  - Public water supply and fishery interests;
  - Species and / or habitat protection requirements;
  - Any other areas of environmental sensitivity (ecological, archaeological, hydrological, hydrogeological or geological) as demarcated on site or on the constraints map;
  - Key drainage issues on site and the implications of contaminating surface water and groundwater;
  - Pollution prevention (e.g. silt mitigation and protection of the water environment); and
  - Waste management.
- Work control arrangements, including duty to comply with agreed RAMS and Permit to Work procedures;
- Outline requirements of key RAMS such as construction runoff management, storage and handling of fuels;
- Environmental Incident and Emergency Response Procedures; and
- Identification of specific environmental risks associated with environmentally sensitive construction operations.

A8.2.16. The Applicant have an evaluation pre-qualification process, which will ensure that the appointed Construction Contractor has the requisite environmental awareness and competence to undertake the works in what is a highly sensitive area. This will include evaluation of similar and previous work done and of the competence of individuals whose primarily responsibility is for care of the environment as part of the construction of the Proposed Development.

Training

A8.2.17. Where it is identified that there is a need for additional environmental awareness training, the Construction Contractor will provide appropriate training for their staff to ensure full awareness of any specialist areas, over and above the requirements of the site induction.

A8.2.18. The training will include (but is not limited to);

- General environmental awareness;
- Environmental emergency preparedness and response; and
- As required training on specific environmental issues.

A8.2.19. Registers will be maintained by the relevant consultant or contractor to demonstrate when personnel have been provided with appropriate training and when they require refresher talks or additional courses.

A8.2.20. Basic talks on relevant environmental and sustainability topics will be provided by the Construction Contractor via toolbox talks to raise awareness of particular issues and may be supported by the ECoW. Typical topics as identified from CIRIA C692 *Environmental Good Practice on Site* include the following;

- Oil / diesel storage;
- Refuelling;
- Scottish Water Catchment Sensitivity;
- Environmental nuisances i.e. noise, dust etc;
- Water Pollution Prevention;
- Importance of Water Management;
- Emergency Plans;
- Spill Prevention and Response;
- Material handling and storage;
- Pumping and over-pumping; and
- Washing down plant and machinery.

Coordination, Communication and Liaison

A8.2.21. Environmental meetings will be scheduled and established between Construction Site Manager (or delegate), ECoW, SWER and any other relevant stakeholder for the purposes of monitoring progress and documenting actions required to ensure compliance with the PPIP.

A8.2.22. The Construction Site Manager will provide monthly (or otherwise agreed) monitoring and progress reports to Scottish Water or the SWER. The progress report will include;

[1] No storage of fuels, oils or chemicals (or other hazardous material) will be permitted within the Benloch Burn DWPA catchment.

[2] No refuelling will be permitted within the Benloch Burn DWPA catchment.

- Progress and summary of key issues during the reporting period;
- Observations / comments in relation to inspections and environmental monitoring;
- Details of any significant environmental incidents or near misses resulting from the work, corrective actions taken or organisations notified; and
- Recommended actions to comply with the PPIP where non-compliance or pollution control concerns are identified.

A8.2.23. The Construction Site Manager will hold regular liaison meetings, which will be held with representatives of key stakeholder organisations as required. Key issues covered will include;

- Review of inspection and monitoring reports;
- Environmental mitigation deployed and performance assessment;
- Environmental incidents and near misses;
- Specific topics (i.e. surface water discharges);
- Consents and permits (i.e. abstraction or discharge permits);
- Community liaison (including complaints); and
- Significant changes to working methods or procedures.

A8.2.24. A variety of mechanisms will be used to communicate environmental information. Advances in technology as well as access to online information in remote areas through mobile network upgrades should be monopolised as much as possible to improve accessibility to environmental information and minimise the need for printed material.

A8.2.25. A summary of the key communication channels are presented below in Table 8.6.2.

Table 8.6.2: Communication Methods for General and Specific Information

Communication Method	Details
Site Induction	• All contractors attending the site shall receive a site specific induction that describes the key site risks and how they are managed. • This would be done online prior to attendance on-site and would include an element of assessment to ensure key information has been understood. • The sensitivity of the Benloch Burn and other Scottish Water assets will be highlighted, and emergency response procedures detailed.
Interactive Information	• Notice boards are proven means of communication. Key topics would be summarised including information presented in the site induction. • To consolidate the information presented on notice boards QR codes would be presented with each topic and would enable information to be downloaded and taken away so that site contractors can access the information at any time.
Meetings	• The Construction Contractor would hold a weekly site meeting that all contractors must attend. • The meeting would be held virtually using an accessible online platform and can be recorded and distributed to all contractors involved in discussed works.
Reports	• Reports, such as non-conformance reports, will be used to communicate the findings of audits and reviews. • Reports would also be prepared by the ECoW as well as any technical specialist involved with specific works i.e. water monitoring
Toolbox Talks / Videos	• Toolbox talks would be conducted on-site or virtually and would be used to communicate any training or raise awareness of a specific environmental issue. • The Construction Contractor would be responsible for ensuring a catalogue of previous toolbox talks was available for all stakeholders.

A8.3 Pollution Prevention Plan

Introduction

A8.3.1. The following generic controls and mitigation measures will be adopted during the construction phase of the Proposed Development in connection with the potential sources of pollution identified in Chapter 8 of the EIAR. The scope covers issues that are relevant to activities which will be undertaken within the Benloch Burn DWPA catchment;

- Site investigation drilling and excavations;
- Surface water, erosion and sediment run-off management controls;
- Watercourse crossing and culvert installation;
- Construction, upgrading and maintenance of roads and tracks;
- Construction of cable trenches, turbines bases and crane hardstandings;
- Delivery, storage, handling and use of chemical and oils;
- Use of vehicles, plant and equipment;

or in areas adjacent to Scottish Water assets (i.e. the water delivery pipe):

- Construction / establishment of site compound, control building and substation*;
- Refuelling*;
- Waste management*;
- Wastewater management (sewerage and foul waters)*;
- Borrow pit operation*; and
- Concrete batching*.

A8.3.2. Activities noted with an asterisk (*) are relevant to the wider site, but owing to embedded design avoiding the positioning of infrastructure away from sensitive receptors including the DWPA and Scottish Water assets are not relevant to this PPIP.

A8.3.3. It is further highlighted that no forestry removal will be undertaken within the Benloch Burn DWPA. Moreover, issues in relation to the management of environmental nuisances such as noise, dust, litter do not fall within the scope of the PPIP, but will require consideration in the CEMP.

A8.3.4. As the Proposed Development area exceeds 4 Ha and contains a road or track length in excess of 5 km, prior to construction a relevant license will be required under the Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended) from SEPA. Whilst no longer specifically regulated by SEPA, the license will require a Pollution Prevention Plan (PPP) to be prepared and implemented for when the license is live. The principles of this PPIP will feed into the PPP once prepared post-consent.

Pollution Prevention Controls and Mitigation Measures

A8.3.5. Pollution prevention controls are mitigation measures incorporated into design specifications and Method Statements. In common with good practice, the Applicant in association with the Construction Contractor will adopt the principles of prevention detailed in Section 8.1.

A8.3.6. In selecting mitigation measures, the following factors will be considered;

- What works are going to be done, when and by whom and the practically of the proposals;
- The effectiveness of the proposed measures in addressing potential impacts;
- The timescales for the mitigation measures to become effective and the durability/longevity of the measures;
- Means of monitoring the effectiveness of the measures;
- Means of maintaining, removing and restoring the mitigation measures; and
- The cost-benefit of the proposed measures.

A8.3.7. Generic mitigation measures to avoid adverse environmental effects to meet regulatory and legislative requirements for the main activities identified in Paragraph A8.3.1 and A8.3.2 are summarised in the PPIP Schule of Mitigation, presented in Appendix B.

A8.3.8. Specific mitigation measures will be confirmed by the Construction Contractor following a review of the on-site proposals and incorporated into site-specific Method Statements, which will include a map, a diagram or sketch where appropriate to illustrate potential pollution linkage components. An example of this using a combination of preliminary survey works, OpenSource(v3) LIDAR data and the current proposed infrastructure layout is presented in Figure Insert 8.6.2.

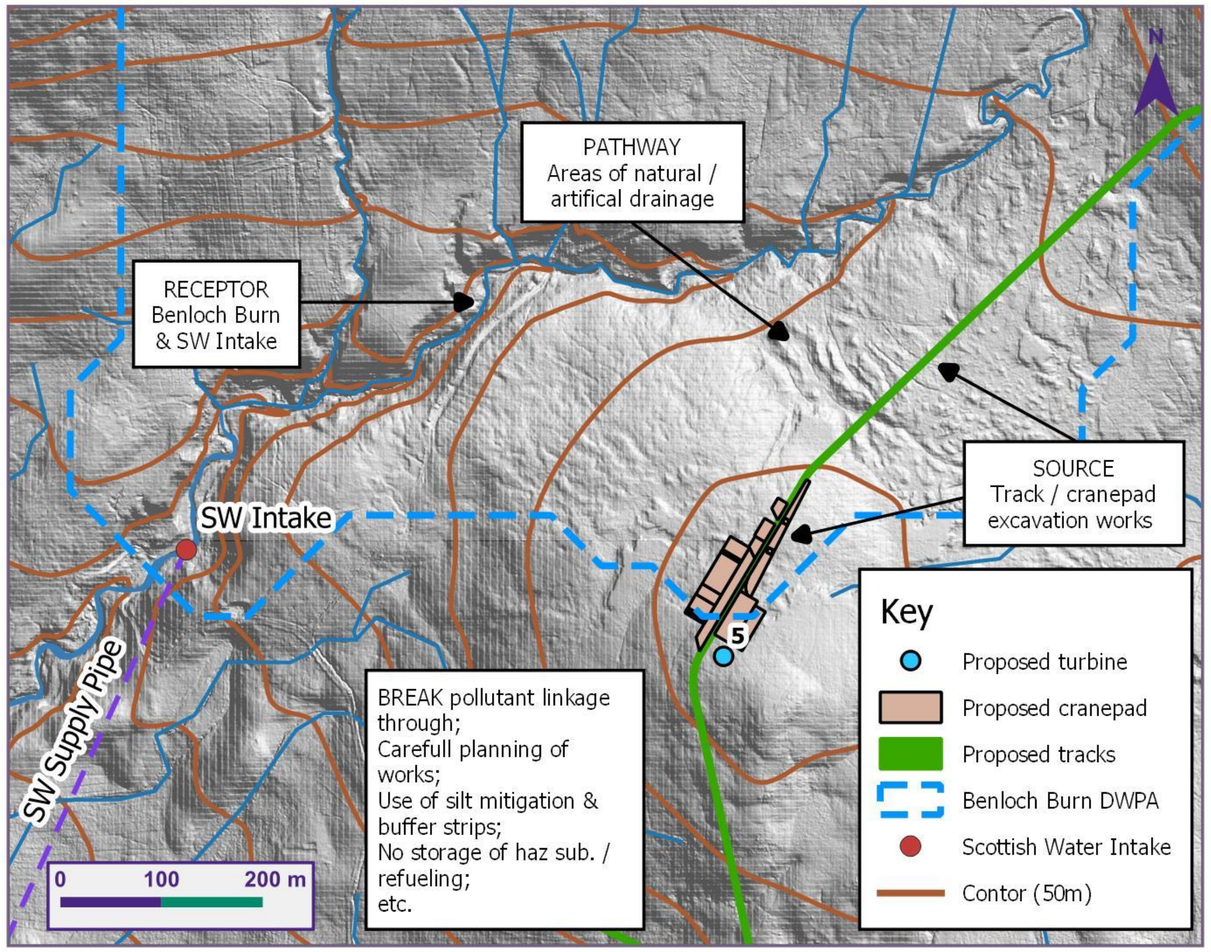
A8.3.9. Method Statements and associated environmental Risk Assessments for all activities with the potential to cause pollution will be reviewed by the SWER.

Construction Environmental Management Plan (CEMP)

A8.3.10. Chapter 8 of the EAIR outlines all of the mitigation relevant to the hydrology of the Proposed Development. The mitigation in the EIAR will be presented within the CEMP that the Applicant and Construction Contractor will prepare prior to construction. The CEMP will at a minimum record details of all site environmental management arrangements, relevant environmental regulations and associated permits or consents. It will also contain relevant site environmental issues and associated mitigation controls, emergency, incident and near miss procedures and monitoring / audit review arrangements. These may also include bio-security measures to prevent cross-catchment transfer of invasive species (if present) both within the site catchments and also where machinery or vehicles have been brought from elsewhere off-site.

A8.3.11. Upon completion of construction, the Construction Contractor will identify and record any residual environmental management issues to be incorporated into the Operation and Decommissioning Environmental Management Plan.

Source: Natural Power



LIDAR Data Presented under Open Government Licence (V3).

Figure Insert 8.6.2: Example of source-pathway-receptor conceptualisation in development risk management and mitigation.

A8.4 Pollution Incident Plan

Introduction

A8.4.1. The main potential for environmental incidents during construction on sites will generally be in relation to fuel/oil/chemical spills and sediment contaminated runoff (during periods of inclement weather). To a lesser extent, incidents may also arise from borrow pit activities, concreting activities, waste management failures, particularly in relation to a lack of a “Duty of Care”, incidents relating to sewerage effluent disposal, oil water interceptors, incidents relating to protected habitats and species and incidents involving environment nuisance.

Key Principles

A8.4.2. During construction an incident response procedure will be adopted. Incident response procedures will adhere to the principles of **Stop, Contain, Notify, Clean-up** as outlined in GPP 22. This is;

- **Stopping** or eliminating any ongoing pollution incident, spill or leak at the source;

- **Containing** any pollution incident, spill or leak using pollution control materials and equipment;
- **Informing** SWER and relevant emergency contacts at the earliest possible opportunity; and
- **Clean–up** employing specialist contractors if required.

A8.4.3. It is important that Scottish Water and SEPA are informed of any pollution incident as early as possible to ensure the integrity and safety of any public water supply asset. However, stopping and containing a pollution incident is a key priority in the case of an ongoing pollution event.

A8.4.4. All site operators and visitors will be suitably informed and trained in site pollution incident response procedures. It is expected that any pollution incidents will be identified by site operatives, the appointed ECoW, and the water quality monitoring methodology outlined in Section 8.6.

Incident Response, Remediation and Monitoring

A8.4.5. The CEMP will include an Emergency Response Plan (ERP), which will detail management arrangements for any potential environmental emergency. The Construction Contractor shall submit the ERP to the Applicant for review, who will approve it for review by SWER and any other stakeholder as appropriate. The ERP will include emergency contact details for Scottish Water and SEPA.

A8.4.6. The Construction Contractor will ensure the ERP requirements are communicated to all personnel on-site. As identified in Section 8.2, this will be done through a combination of Site Inductions and preparation of interactive material which will be made available in electronic format and thus increase its accessibility.

- The ERP will incorporate incident response, remediation and monitoring; and
- Environment incident reporting and investigation.

A8.4.7. Whilst the Construction Contractor will align procedures to their management system, minimum procedural requirements for each of these incident components are described below. In the event of an environmental incident the following actions would be undertaken;

Assess Safety

A8.4.8. Prior to any environmental clean-up, personnel must ensure safety of themselves and others before tackling the incident. Other requirements include:

- Attend to any injured personnel and make the area safe;
- Identify safety risks and take corrective action where required;
- Identify spilled/leaked substance and select the appropriate PPE; and
- In the event of an incident involving protected habitats or species, the area should be stabilised, isolated and left undisturbed.

Stop at Source

A8.4.9. Upon discovery of a pollution incident, the source must be identified, all work with the potential to contribute to the incident will be stopped, and any spill or leak must be eliminated.

A8.4.10. A spill or leak should only be dealt with if it is safe to do so, and injured personnel should be attended to as a priority.

A8.4.11. All other immediate risks must be identified, these may include fire, explosion, or harmful fumes and substances. Appropriate Personal Protection Equipment (PPE) should be used where appropriate when attending a spill or leak.

Containment

A8.4.12. Containment must ensure that any ongoing spill or leak does not enter soils, groundwater or watercourses. This will involve:

- The deployment of pollution control equipment, including spill kits, drip trays, or bunds of earth or sand;
- Checking that any pollutant has not reached drains, watercourses or other sensitive receptors; and
- Covering all drains to ensure that any pollutant does not enter the drainage system and migrate off-site.

A8.4.13. **Spill kits** – pollution control equipment will be available within all construction compounds, the site office, control compound, and in all works vehicles. Spill kits will be suitable for the type of pollutants expected to be present on the site. Locations of site spill kits will be marked on the site location plan within the RAMS and communicated during site inductions.

A8.4.14. Site based spill kits will include suitable PPE, absorbent pads, socks, boom and cushions, sealant putty slab or mats and approved hand held dispersant sprayer. Submersible skirt containment booms will also be held within the site compound.

A8.4.15. Contaminated spill material will be disposed of in accordance with the Construction Contractor's RAMS, and spill kit material will be replaced immediately from stock retained on site. Following any pollution incident, the Construction Site Manager will assess quantities of remaining spill kit stocks on site.

Notification of Scottish Water & SEPA

A8.4.16. The Construction Site Manager will act as a central point of contact for all identified pollution incidents. The Construction Site Manager will inform the ECoW as quickly as possible upon discovery of any spill or leak. The ECoW will advise on any other response requirements and contact key emergency contacts as required. Emergency contact details will be listed within the Construction Contractor's RAMS, this list will be adopted and updated throughout construction as required. In principle, emergency contacts will include:

- SWER;
- The relevant local authority;
- Local Fire Service;
- SEPA Pollution Hotline (0800 80 70 60); and
- Any specialist contractors.

A8.4.17. During any pollution incident, the following details will be provided when notifying emergency contacts;

- Name and contact details;
- Location of the source of the pollution incident;
- Substances involved (Including details on volumes);
- Any other immediate hazards;
- Status and safety of personal, equipment and assets;
- Any relevant information from water quality monitoring activities (including locations of elevated concentrations);
- Any receptors impacted; and
- The potential for linkage of pollutants to receptors.

Clean-up & remediation

A8.4.18. The Construction Site Manager will determine whether clean up and remediation following a pollution event should be undertaken by trained personnel. Clean up will commence once a spill or leak has been stopped and contained at the source.

- Residual pollutants on hardstanding, equipment and machinery, or natural ground will be cleaned using safe and suitable methods. Liquids can generally be soaked up using absorbent materials;
- Pollutants present in water will be removed using appropriate absorbent materials such as booms, pads, or wood chips. These materials will be replaced until pollutants have degraded; and
- Contaminated materials will be removed and placed in designated storage facilities. Removal will be undertaken by approved waste management contractors in compliance with regulatory requirements.

Monitoring

A8.4.19. Residual contamination has the ability to migrate and continue to cause pollution after an initial spill or leak has been contained at the source. This must be considered after any pollution incident and it may become necessary to implement additional monitoring accordingly to ensure receptors are protected.

A8.4.20. Additional monitoring will only be undertaken upon confirmation from investigations that the cause of the changes in recorded parameters exceeding agreed trigger levels or observations from the ECoW has been caused by construction activities.

A8.4.21. Additional water quality monitoring will comprise of the increased collection of in-situ and extractive samples from all locations impacted. Samples will be collected for a duration until such time that the data indicates a return to pre-incident levels.

A8.4.22. A summary indicative spill and incident response flow chart is presented in Appendix C.

Incident Reporting

A8.4.23. All environmental incidents will be investigated to establish the underlying cause of the incident. Environmental incidents and near misses will be documented by the Construction Site Manager who will submit these to the Applicant as required. Whilst the Construction Contractor will align the proforma to their management requirements, as a minimum the following information will be recorded;

- Name and contact details of the individual reporting the incident;
- Date, time and location of the incident (if known);
- Notifications;
- Response/corrective actions;
- Root cause of incident;
- Measures to prevent a recurrence;
- Responsibilities; incident owner and sign off; and
- Type of incident (list of indicative incident types presented in Appendix D).

A8.4.24. Additional reporting requirements for SEPA are likely to be defined under the terms of the Construction Site License.

Response Training and Testing

A8.4.25. All personnel working on the Proposed Development will receive basic spill response training as part of the site induction. Personnel with responsibilities for dealing with environmental incidents and/or handling hazardous liquids with the potential to cause pollution will receive specialist spill response training. Records of spill response training shall be documented and maintained by the Construction Site Manager and made available for inspection.

A8.4.26. The ECoW will be responsible for periodic testing of emergency procedures, including spill response. Records of emergency response training will be documented and retained on site for review.

A8.5 Contingency

Spill Kits

A8.5.1. Spill kits/spill response materials will be available within all site vehicles, at the construction compound and at designated locations across the Proposed Development where oils, fuels or potential polluting chemicals are located, stored or used near sensitive receptors. The location of the spill kits will be marked on the plans provided in the CEMP and updated in the site specific RAMS.

A8.5.2. Contents of vehicle spill kits as a minimum will contain absorbent pads, putty, protective gloves and absorbent socks. These kits will be used as first response for the containment and clean-up of small spills.

A8.5.3. Site based spill kits will be used to stop, contain and clean-up spills and will contain the following materials; suitable PPE, absorbent pads, socks, boom and cushions, sealant putty or matts. Submersible skirt containment booms will be held at the site compound.

A8.5.4. Any contaminated materials generated from spill response will be quarantined and disposed of in accordance with Duty of Care Regulations and the CEMP. Spill kit material will be replaced immediately from a permanent stock of spill kit retained on the site. Following an incident the Construction Site Manager or delegate will assess quantities of remaining spill response materials to ensure retained stock levels are adequate.

Specialist Contractor(s)

A8.5.5. The Construction Contractor will have a contingency plan involving the procurement of specialist contractors to deal with major incidents involving highly polluting liquids and/or material that the site personnel are not able to deal with. The specialist contractor performing this service will be made familiar with the logistics of the site through the induction process and be available to respond on a 24 hr/365-day basis. Contact details for the specialist contractor will be detailed in the CEMP.

Scottish Water Emergency Planning

A8.5.6. In the event that an incident occurs that has the potential to impact water quality of the Benloch Burn or Scottish Water assets, the Construction Contractor (Construction Site Manager) must notify Scottish Water immediately. The Construction Contractor will be aware of the Scottish Water Emergency Planning (Operational Incident Reporting Procedure) requirements, which specify the notification process for an operational incident.

A8.5.7. Scottish Water staff contacted will be responsible for escalating the incident within Scottish Water via the 24/7 Business Alert System; this will ensure activation of Scottish Water emergency procedures and coordination of response.

A8.5.8. In accordance with the Scottish Water notification process, attempt will be made to contact at least one of the Scottish Water contacts as detailed in Table 8.6.3 below.

Table 8.6.3: Sequence of notification for incdient reporting to Scottish Water

Asset Affected	Sequence	Scottish Water Contact
Water Supply Assets (Benloch Burn, Intake or Supply Pipe)	First	SW Contact Agreed at Pre-planning stage
	Second	Catchment Liaison Officer
	Third	Water Operations Area Team Leader
	Forth	Water Operations Team Manager
	Fifth	Water Operations Area Team Manager

A8.5.9. In the event that a Scottish Water contact cannot be reached, the Scottish Water Contact Centre number will be used.

A8.5.10. Scottish Water SHOUT posters (Appendix E) will be populated throughout the Proposed Development during construction. These will also be communicated to all site personnel through inductions or other communications.

A8.5.11. The pollution hotline for SEPA will also be utilised in notifying them of an incident in addition to Scottish Water.

A8.6 Monitoring Plan

Introduction

A8.6.1. This section describes the pollution control monitoring protocols that will be adopted including the sampling and inspections of site watercourses and issues to be covered during routine surveillance inspections.

A8.6.2. The intention of the monitoring plan is to provide quantitative data to audit compliance with the recommendations provided in this PPIP and other environmental management documentation. The upmost intention of the details provided in Sections 8.3 and 8.4 are to ensure that water quality is protected and at the forefront of the environmental management measures to be implemented.

A8.6.3. A proactive approach to water quality monitoring and the provision of data to the Client, site teams and Scottish Water will provide the data to demonstrate compliance with this PPIP but to also highlight any further steps that may need to be undertaken.

Guiding Principles

A8.6.4. The proposed monitoring methodology has been derived based on the following:

- Consideration of the potential natural and anthropogenic influences on the hydrological environment;
- Consideration of the specific sensitivities of the Benloch Burn;
- Consideration of all other of on-site and downstream receptors; and
- Consideration of the DWPA and sensitivities identified in Chapter 8 of the EIAR to inform monitoring parameters and monitoring frequency.

Surveillance Inspections and Site Audits

A8.6.5. Surveillance inspections and site audits will be undertaken on a regular and routine basis. The Construction Site Manager, or delegate, and ECoW will be responsible for undertaking and documenting site surveillance inspections and audits. Issues that will be covered include;

- Watercourses below working areas;
- Mitigation and pollution control measures;
- Surface water and sediment run-off;
- Hazardous materials (oils, fuels, chemicals, etc);
- Waste;
- Wastewater (sewerage and foul water);
- Management controls (inductions);
- Compliance assessments (PPIP, Method Statements, Permits, Consents etc);
- Emergency response, incidents and complaints;
- Environmental nuisance.

A8.6.6. Throughout the construction phase daily visual inspections will be undertaken of watercourses and environmental mitigation controls below working areas by the Construction Contractor, which will be supplemented by inspections by the ECoW or other specialist personnel. Records of inspections will be retained and made available to Scottish Water upon request.

Water Monitoring

A8.6.7. The Applicant will commission a water quality sampling program which would comprise of visual, in-situ sampling using a handheld meter and extractive sampling. It is also recommended that for the Benloch Burn, continuous monitoring methods also be used.

A8.6.8. Further details are presented below.

Monitoring Locations

A8.6.9. Indicative monitoring locations for water monitoring been identified below in Table 8.6.4 and are illustrated in Figure Insert 8.6.3. The locations would be validated following further site reconnaissance to confirm suitability in terms of safe access, habitat quality and proximity to Proposed Development construction activities.

A8.6.10. An upstream monitoring location, situated in a position up-catchment that will not be impacted by the Proposed Development is included as a control location.

Table 8.6.4: Indicative Water Monitoring Locations

Location ID	Watercourse	National Grid Ref	Method
SW1	Benloch Burn		Visual, In-situ, Extractive & Continuous
SW2 (CTRL)	Benloch Burn		Visual, In-situ, Extractive & Continuous

Source: Natural Power

Monitoring Methods

Visual Monitoring

A8.6.11. During construction the ECoW will carry out visual checks, at a frequency dictated by their presence on site, of the watercourses and water management measure for the following:

- Oils;
- Scum;
- Turbidity; and
- Algal blooms.

A8.6.12. On days the ECoW is not on site, it is possible that the Site Manager or other nominated personnel carries out the visual monitoring.

Source: Natural Power

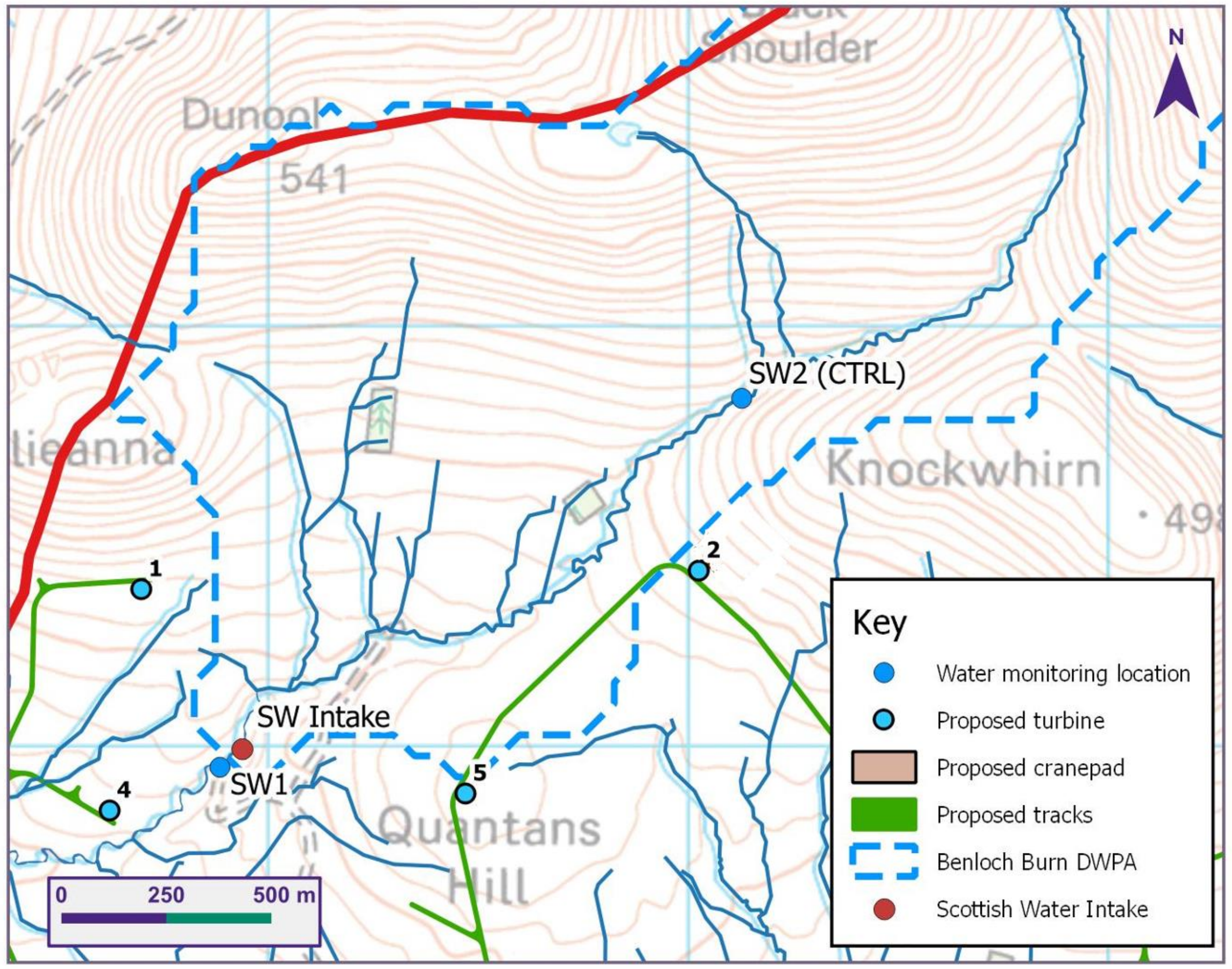


Figure Insert 8.6.3: Indicative PPIP Water Monitoring Locations

A8.6.13. Visual inspections will include an assessment from the riverbank and drainage management features to record the condition of the water/runoff, with photographic records taken, facing upstream and downstream of the monitoring point, for reference.

A8.6.14. Where any higher risk activities are being undertaken that may result in a pollution incident in the vicinity of nearby watercourses, such as concrete pouring, stockpiling of materials, refuelling, felling and any in-channel works, visual inspections will be focussed in these areas and immediately downstream by the ECoW, during the supervision of these works.

A8.6.15. If any of the visual inspection checks during construction indicate a potential pollution incident, onsite sampling will be undertaken at these specific locations to help identify the source and type of contamination and inform the corrective/remedial actions.

A8.6.16. Aside from the detail above during the construction phase of the development, visual information will be collected during each phase of the water quality monitoring programme. Visual field monitoring will include the following:

- Date and time of monitoring and name of person undertaking monitoring;
- Construction activities occurring in the catchment areas of the monitoring location;
- Rainfall (as recorded at on-site rain gauge) and weather conditions preceding and during monitoring;
- Observations of flow rate (high, moderate, or low compared to baseline/steady state at comparative time of year) and any visual/olfactory observations on water quality or potential pollution;
- Whether any samples have been taken for laboratory analysis; and
- Whether site management are to be informed of pollution concerns.

A8.6.17. A pro-forma will be developed prior to the commencement of monitoring to ensure consistency of data recording and ease of reporting.

In-situ Monitoring

A8.6.18. In-situ monitoring will utilise handheld water quality monitoring units which are capable of instantaneously analysing the specific quality indicator parameters. These include pH (Units), Specific Conductivity (mS/cm), Dissolved Oxygen (mg/L), Temperature (Deg. C) and Turbidity (NTU).

A8.6.19. In-situ monitoring would be carried out monthly at the locations specified in Table 8.6.4.

A8.6.20. All monitors will be calibrated on a regular basis in order to maintain accuracy of the data being recorded. All calibrations will be undertaken in line with the procedures set out in the operating manual, using supplier approved buffer solutions which act as reference benchmarks for the parameters listed above.

Extractive Sampling

A8.6.21. Sampled water would be collected dispatched to a UKAS accredited laboratory which will analyse the collected water samples for the parameters including (but not limited to);

- Alkalinity (µeq);
- Colour (PtCo);
- Total Organic Carbon (mg/L);
- Dissolved Organic Carbon (mg/L);
- Total Suspended Solids (mg/L);
- Aluminium (µg/L);
- Iron (µg/L);
- Manganese (µg/L); and
- Total Petroleum Hydrocarbons.

A8.6.22. All samples will be dispatched to the laboratory within 24hrs of collection, under chilled conditions accompanied with the relevant chain of custody documentation.

Continuous (automated) Monitors

A8.6.23. Subject to there being an appropriate signal, continuous telemetered monitors will be installed to allow for real time data collection to be reported immediately via a web-based service. The base for telemetry will be confirmed following a site walkover to identify where there is a suitable signal.

A8.6.24. Continuously monitored parameters (15 minute frequency) would be Turbidity (NTU), Specific Conductivity (mS/cm), pH (Units) and Temperature (Deg. C).

Monitoring Frequency and Duration

A8.6.25. Monitoring will involve the analysis of water quality prior to, during and after construction all being carried out by or on behalf of the Applicant. Coupled monitoring methods would run simultaneously, with in-situ and extractive monitoring undertaken on a monthly basis. Continuous monitors would bolster in-situ methods, providing water quality information every 15 minutes.

A8.6.26. All monitoring methods would be undertaken for a 12 month period prior to construction starting, in order to establish the baseline hydrochemical characteristics of the catchment across a full annual cycle.

A8.6.27. Monitoring during the construction phase would be identical to methods use during the 12 month baseline phase and would continue on a monthly basis until constructions works ceased.

A8.6.28. The requirement for ongoing monitoring will be reviewed at the end of construction in order to determine the period which post-construction monitoring should continue until.

A8.6.29. Where water quality concerns are identified by Scottish Water, additional (more frequent) samples at these and other locations within the catchment may need to be collected. If particular activities warrant more intensive monitoring, the Applicant will commit to additional monitoring, the scope of which would be agreed on a case by case basis.

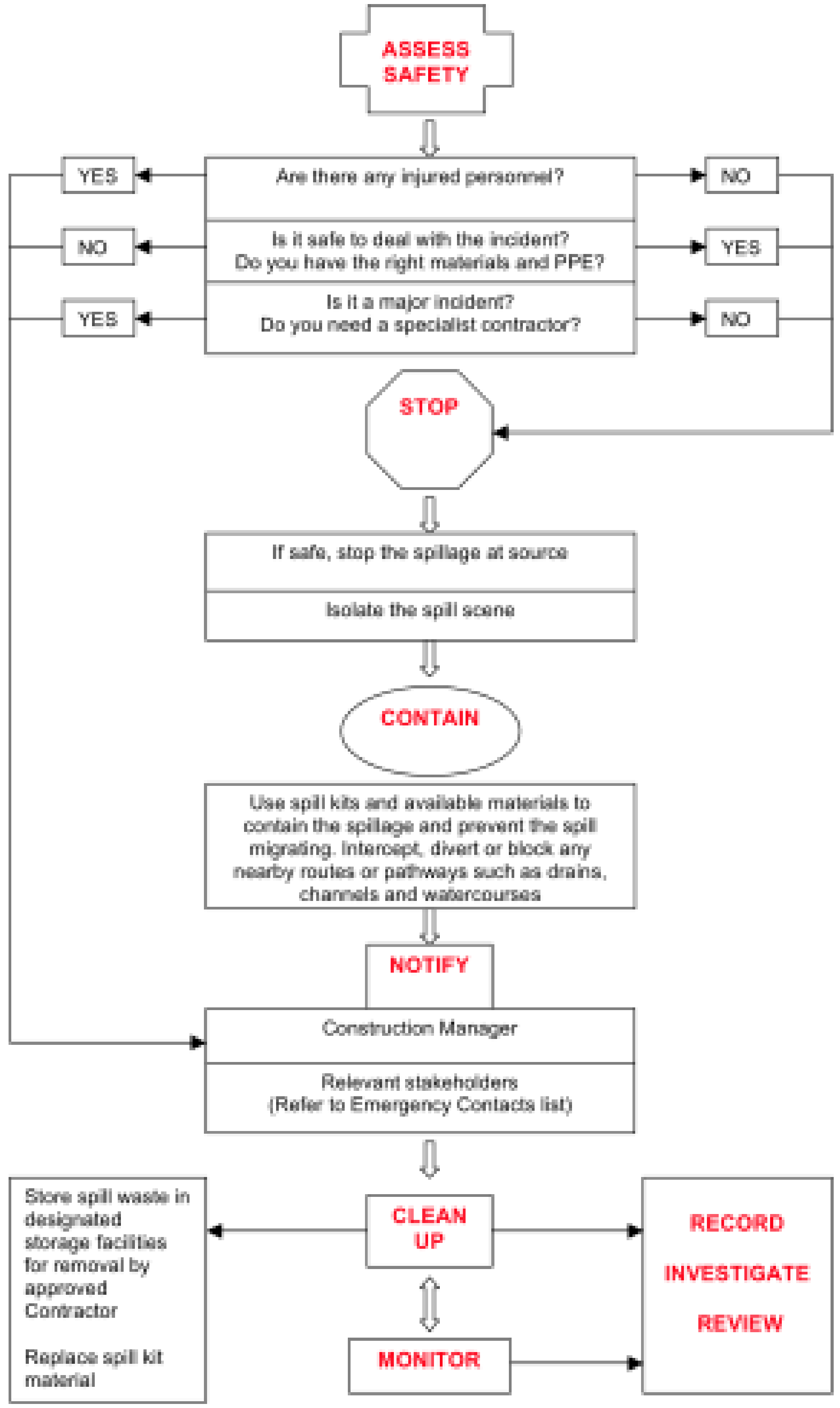
Additional Considerations

A8.6.30. It should be noted that monitoring requirements presented within this PPIP are only relevant to the Benloch Burn DWPA. To monitoring environmental compliance of the wider Proposed Development, monitoring will be required within the other catchment areas that could be affected by construction. Details of this monitoring would be presented within a Water Monitoring Plan, that will support the CEMP and be prepared prior to Construction.

Appendix A – Scottish Water List of Precautions Document

Appendix B – PPIP Schedule of Mitigation

Appendix C – Spill Response Flow Chart



Appendix D – Incident Categories

Category 1 (Major) Incident

A major environmental incident will generally be non-routine and large scale for example, but not limited to the following;

- Persistent or extensive effect on water quality (e.g. major spillage to controlled water);
- Persistent or extensive contamination of land (e.g. major spillage requiring extensive remediation)
- Persistent or extensive effects on air quality
- Destruction or major damage to important aquatic or terrestrial wildlife habitat
- Destruction or major impact on protected and/or important fauna and flora
- Major impact on properties
- Major adverse effect on amenity value of an area or an import recreation activity
- Serious health risk to the public

Category 2 (Significant) Incident

A significant environmental incident for example, but not limited to the following;

- Significant but local effect on water quality
- Significant but localised contamination of land
- Significant effect on local air quality
- Localised damage to important aquatic or terrestrial wildlife habitat
- Significant effect on fauna and flora
- Significant adverse effect on a recreational activity or event
- Minor heath risk to public

Category 3 (Minor) Incident

A minor environmental incident involves on or more of the following criteria;

- Limited effect on water quality around discharge / spillage
- Minimal contamination of land (no overall effect on the use of quality of the land)
- Minimal effect on air quality
- Limited effect on local ecosystem
- Minor impact on aesthetic quality]

Category 4 (Insignificant) Incident

Where an incident has been verified (i.e. a spillage) and has occurred, but been contained and as a result there is no environmental impact to air, land or water.

Near-miss

Where no incident has occurred, but a failing in the environmental management system and / or non-compliance with the PPIP has caused a near miss event or a condition that if left unattended could result in an incident.

Appendix E – Scottish Water SHOUT Poster

Quantans Hill Wind Farm

Borrow Pit Assessment

7th July 2022

1267678

Vattenfall Wind Power Ltd

Document history

Author	Chris McCulla, Geotechnical Engineer	01/12/2021
Checked	Sam Fisher, Geotechnical Engineer	03/12/2021
Approved	Gavin Germaine, Principal Geotechnical Engineer	07/07/2022

Client Details	
Contact	Matthew Bacon
Client Name	Vattenfall Wind Power Ltd
Address	St Andrew's House, Haugh Lane, Hexham, Northumberland, NE46 3QQ

Issue	Date	Revision Details
A	01/12/2021	First Issue
B	09/12/2021	Second Issue
C	07/07/2022	Third Issue – Reduction in borrow pit locations

Local Office:

The Green House
Forrest Estate Dalry
Castle Douglas
DG7 3XS
SCOTLAND
UK
Tel: +44 (0) 1644 430 008

Reg No: SC177881

Registered Office:

The Natural Power Consultants Limited
The Green House
Forrest Estate, Dalry
Castle Douglas, Kirkcudbrightshire
DG7 3XS

VAT No: GB 243 6926 48

Contents

1. Borrow Pit Appraisal Background 1
   - 1.1. Introduction 1
   - 1.2. Scope of assessment 1
2. Site Information 2
   - 2.1. Location & Development Proposal 2
   - 2.2. Historical Setting 2
   - 2.3. Superficial Geology 2
   - 2.4. Solid Geology 3
3. Engineering Ground Conditions 5
4. Borrow Pit Areas 7
   - 4.1. Required Rock Volumes 10
5. Example Borrow Pit Working Methodology 12
   - 5.1. Access 12
   - 5.2. Borrow Pit Design 12
   - 5.3. Overburden Soils Management 12
   - 5.4. Extraction of Rock 13
   - 5.5. Processing (Loading and Haulage Operations) 13
   - 5.6. Reinstatement 13
   - 5.7. Plant and Machinery Considerations 14
   - 5.8. Drainage Considerations 14
   - 5.9. Waste Management Strategy 14
6. References 16

1. Borrow Pit Appraisal Background

1.1. Introduction

Assessment has been made into availability of on-site aggregate from three proposed borrow pit areas. The borrow pit search areas have been selected based on engineering suitability of the geological units, topography, and proximity to the proposed wind farm infrastructure.

This search has taken account of hydrological, hydrogeological, and wider environmental sensitivities as far as is possible during the planning stage. Rock fill requirements have been estimated based on the proposed scale of construction (x14 No. wind turbines & ancillary infrastructure).

The size and location of the proposed borrow pits at this stage is indicative. Assessment is based on desktop assessment and site reconnaissance. The borrow pit search areas should be confirmed following detailed intrusive investigation carried out during the post consent (pre-construction) phase.

1.2. Scope of assessment

Potential borrow pit areas were initially reviewed using British Geological Survey (BGS) map data and the onshore Geoindex[1]. This information was reviewed alongside analysis of aerial imagery from various online sources to confirm the most appropriate location.

Technical personnel involved in peat surveys and civil infrastructure design have been consulted as part of this study to ensure, as far as possible that this desktop assessment accurately reflects physical ground conditions of the site. Key Information sources used to inform the borrow pit assessment include the following:

- Google Earth Professional, imagery 1985- 2022;
- Bing Maps Aerial Imagery, © Microsoft 2022;
- Peat Survey – Peat Depth Mapping;
- Constraints Mapping including constraints over multiple sources;
- Water course data and available data from hydrological Surveys undertaken by Natural Power;
- Slope assessment from high resolution topographic DTM data;
- British Geological Survey Mapping[1];
- Historical Mapping from National Library of Scotland Online database[2];
- Photographic records of site from hydrological and peat surveys;

A variety of parameters have been assessed;

- Geomorphological mapping and terrain feature identification including terrain aspect, slope, hydrology and anticipated bedrock conditions;
- Slope analysis GIS analysis based on high resolution topographic data;

The findings have been compiled into this report, which is aimed at confirming locations, approximate working areas, and estimates for volume of construction aggregate.

[1] https://mapapps2.bgs.ac.uk/geoindex/home.html

[2] https://maps.nls.uk/geo/

2. Site Information

2.1. Location & Development Proposal

The Proposed Development is located within Dumfries and Galloway, approximately 2.8 km northeast of the village of Carsphairn. The site is located in upland moorland mainly used for sheep farming with some isolated coniferous plantations. The site entrance is 1 km east of the village of Carsphairn, located at NGR [257127E, 593136N]. The site is accessed via the A713 and minor road (B729).

The Proposed Development will consist of the erection, operation, and subsequent decommissioning of up to 14 wind turbines. The Proposed Development includes associated turbine foundations and transformers, hardstanding areas for erecting cranes at each turbine location, a series of on-site tracks connecting each turbine, underground cables linking the turbines to the grid connection, an on-site substation, a construction compound, three borrow pit search areas, and a new access into the Site.

Full details are presented in Chapter 3 of the main EIAR.

2.2. Historical Setting

Historical mapping for the site has been reviewed from the National Library of Scotland archive. Indications are that the Site area has largely been unchanged and dedicated to upland farming and estate agricultural practices since the mid 1800’s.

Full details are presented in Chapter 8 of the main EIAR.

2.3. Superficial Geology

Peat: Forms isolated accumulations in discrete areas of the development. Across the majority of the development peat is absent or represented by thin peaty soils. Soil conditions have been heavily modified by artificial drainage and overgrazing. Areas of peat accumulation are thus now only focussed within topographic depressions and occasionally in close proximity to water courses. The peat encountered across the development is typically dark brown, plastic, pseudo-fibrous with limited amorphous material due to the low depths encountered. Von Post classes are H2 – H7.

Glacial Till: Beneath the peat and spatially variable in extent, a variety of glacial deposits are understood to be present. These materials are remnants from the last glacial retreat. All are erosional, transported sediments of glacial diamicton; sands, gravels and fine soil mixtures. The lithics within these deposits are understood to be sourced from the surrounding country bedrock formations. Glacial deposits can be deposited under a wide variety of conditions including lodgement (ice contact), glacio-fluvial (sub / en – glacial), ablation (melt-out) and in-situ weathering processes.

Source: British Geological Survey, NERC © 2022

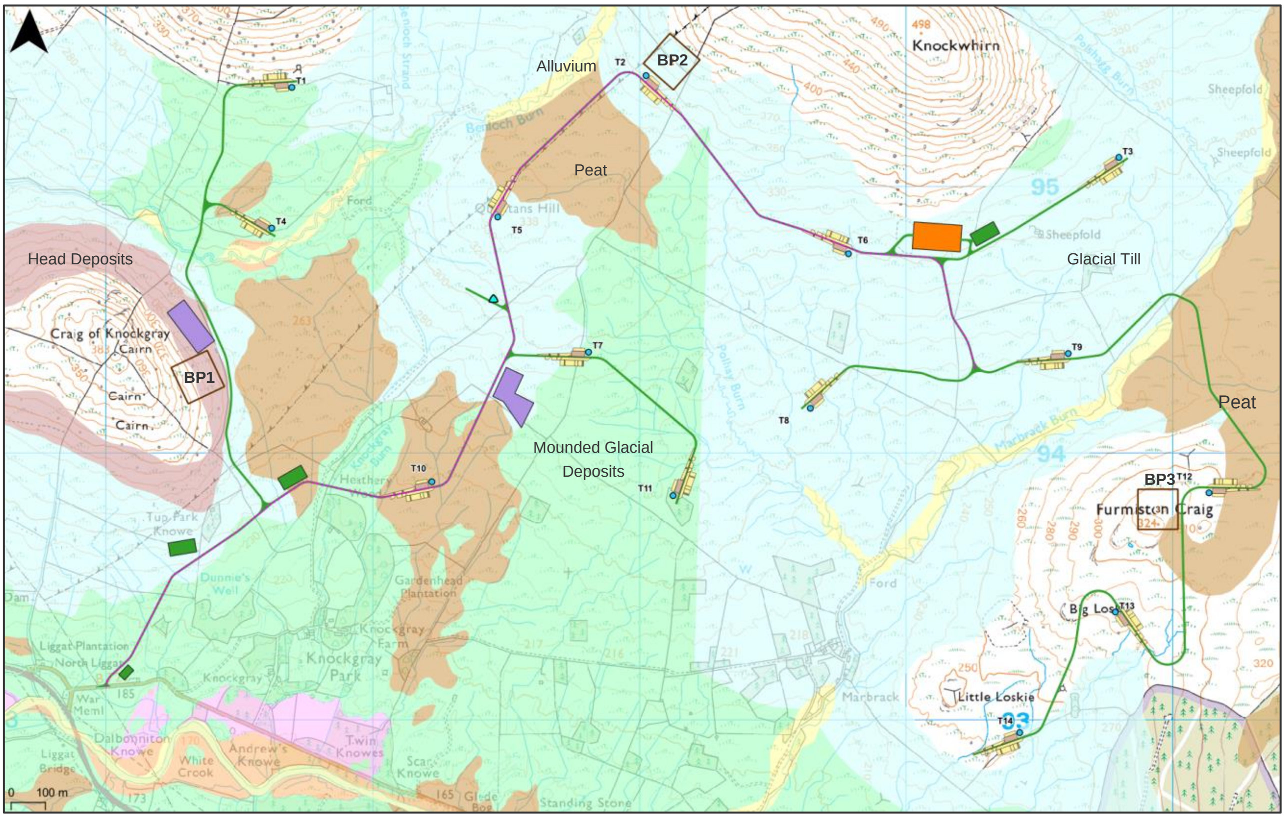


Figure 2.1: 1:50,000 Superficial Geological Map Extract

Peri-glacial: head deposits may also be obscured by the blanket peat. These polymict deposits comprise clay, sand and gravel in proportions which depend on the upslope provenance of material. These deposits are poorly sorted and poorly stratified and formed during the post-glacial period predominantly by solifluction (down slope freeze / thaw transport and deposition) and / or hill wash and soil creep. Sand and gravel may exist locally with lenses of silt, clay or peat and organic material. Some of these processes were possibly visible north of the development and off site on higher elevations.

Alluvium: may be present across parts of the site in proximity and restricted to watercourses. These deposits generally comprise differing proportions of clay, silt, sand and gravel, all transported and deposited under relatively recent fluvial environmental conditions.

2.4. Solid Geology

The 1:50,000 scale British Geological Survey map data indicates the development to be underlain by the bedrock from the Ashgill and Caradoc Formations of the lower Ordovician (449-458MA). The sedimentary bedrock is part of the Portpatrick formation with some outcrops of the Kirkholm and Glenwhargen formation. Minor igneous intrusions are present comprising granite and microdiorite although these lithologies are not thought to be coincident with proposed infrastructure. Regional and contact metamorphism of the sedimentary lithologies can be expected across the northwester zone of the site which may have imparted schistosity, mineralisation and induration.

Source: British Geological Survey, NERC © 2022

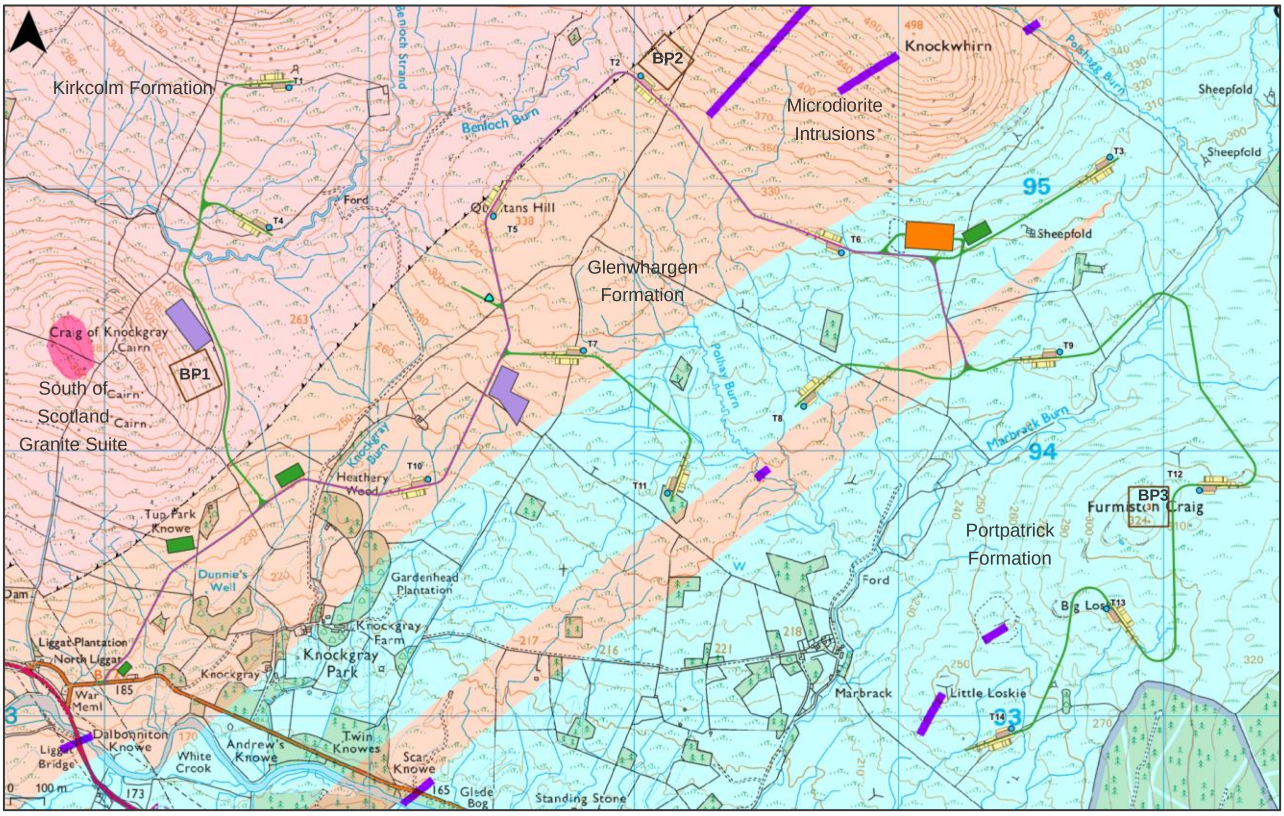


Figure 2.2: 1:50,000 Solid Geological Map Extract

2.4.1. Landslides/Geohazards

The BGS Onshore Geoindex shows no record of historic landslides located within the site boundary or surrounding local area. A separate peat slide risk assessment has been devised for the site (Ref: TA8.2 – Peat Slide Risk Assessment) and has categorised the peat slide risk as low to negligible across the three proposed borrow pit locations.

3. Engineering Ground Conditions

The British Geological Survey[2] (BGS) describe the engineering properties of the greywacke sandstone subcropping the borrow pit search areas as:

- *Strong to very strong thinly to very thickly bedded medium to widely jointed foliated fine-grained SLATE with well-marked fissility along foliations (cleavage planes). Weathers to clayey gravel. Low to very low permeability flow through discontinuities.*
- *This rock type usually provides very good foundation conditions, depending on nature and thickness of the weathered zone.*
- *Highly weathered rock may be excavatable by hard digging. In fresher material ripping or blasting is required depending on joint/bedding spacing and orientation.*
- *Engineered fill: Suitable as general granular fill if tabular nature of excavated material can be dealt with satisfactorily.*

As with all developments it is important to determine intact rock strength, spacing, orientation and nature of discontinuities (including water flows) and nature/depth of weathered zone materials during a thorough intrusive site investigation during the post consent phase.

Where possible it is preferential to reuse excavated material from the road and crane pad construction within the wind farm to reduce construction footprint and the number and extent of borrow pits required.

It is highlighted that a detailed assessment of the quantity and quality of the rock excavated during the road construction should be considered during the ground investigation and detailed geotechnical design phase.

Following the desktop assessment, three designated borrow pit search areas are proposed. Table 3.1 provides a summary of the locations, the anticipated rock fill material class and relevant site observations.

[2] https://www.bgs.ac.uk/map-viewers/geoindex-onshore/

Table 3.1: Proposed Borrow Pit Locations

ID	Location	Anticipated Material Class	Local Geology	Site Observations
BP1	Western slopes of Craig of Knockgray [257346, 594271]	Based on the information available the exact nature of the material remains uncertain due to the potential for non-argillaceous (clay bearing) (greywacke) and argillaceous (siltstone) units to be present, together with the influence of the metamorphic aureole. Further assessment (ground investigation and testing) shall be required to confirm the aggregate suitability based on its composition and testing results. If the nature results to be non-argillaceous it may be suitable for use as structural fill, Type 1 and potentially concrete aggregate.	Located at the boundary between the thin to medium bedded greywacke/sandstone and thick siltstone of the Kirkcolm Formation and the medium to thick bedded greywacke/sandstone often pebbly of the Glenwhargen Formation. Section may pass over the Leadhills Fault. The materials within this section are expected to have been affected by the metamorphic aureole and possibly faulting which could mean a variation in material properties throughout the section; contact metamorphism may increase or decrease the resistance to fragmentation and weathering depending on the initial rock composition.	Borrow pit positioned on southern slopes of Craig of Knockgray, and bedrock is evident at shallow depth/surface. Further north on Craig of Knockgray slopes are steeper, and rock is evident as crags / outcrops - slope angles here, plus proximity to infrastructure, may limit development here, however, it is anticipated that rock would be granitic, and likely of high re-use potential.
BP2	Knockwhirn close to Turbine T03 [259141, 595459]	Assuming non-argillaceous units are present, and the effect of the fault does not impact the rock properties, the material is likely to be suitable for use as general fill (class 1) structural fill (6N), capping (6F), Type 1 and potentially concrete aggregate. However appropriate assessment required to confirm rock type and suitability for use.	Medium to thick bedded greywacke/sandstone often pebbly of the Glenwhargen Formation. Possibly located close to Leadhills Fault, which may render a variation in the material properties.	No rock evident at proposed borrow pit, but slope angles, position within site and anticipated geology render this a good option for a borrow pit location.
BP3	Furmiston Crag [260949, 593782]	Assuming non-argillaceous units are present , it is likely to be suitable for use as general fill (class 1) structural fill (6N), capping (6F), Type 1 and potentially concrete aggregate. However appropriate assessment required to confirm rock type and suitability for use.	Massive thick-bedded greywacke/sandstone with rare siltstone units of the Portpatrick Formation.	Rock evident at proposed borrow pit at Furmiston Crag. Slope angles, position within site and anticipated geology render this a reasonable option for a borrow pit location. Depending on position in respect to crag, some positions may be more visible than other. Also noted that significantly elevated area with respect to other turbines in surrounding area.

Source: Natural Power / RJ Mcleod

4. Borrow Pit Areas

Three-potential borrow pit search areas have been identified as part of this study, as shown in Figure 4.1 below.

Source: Bing Aerial

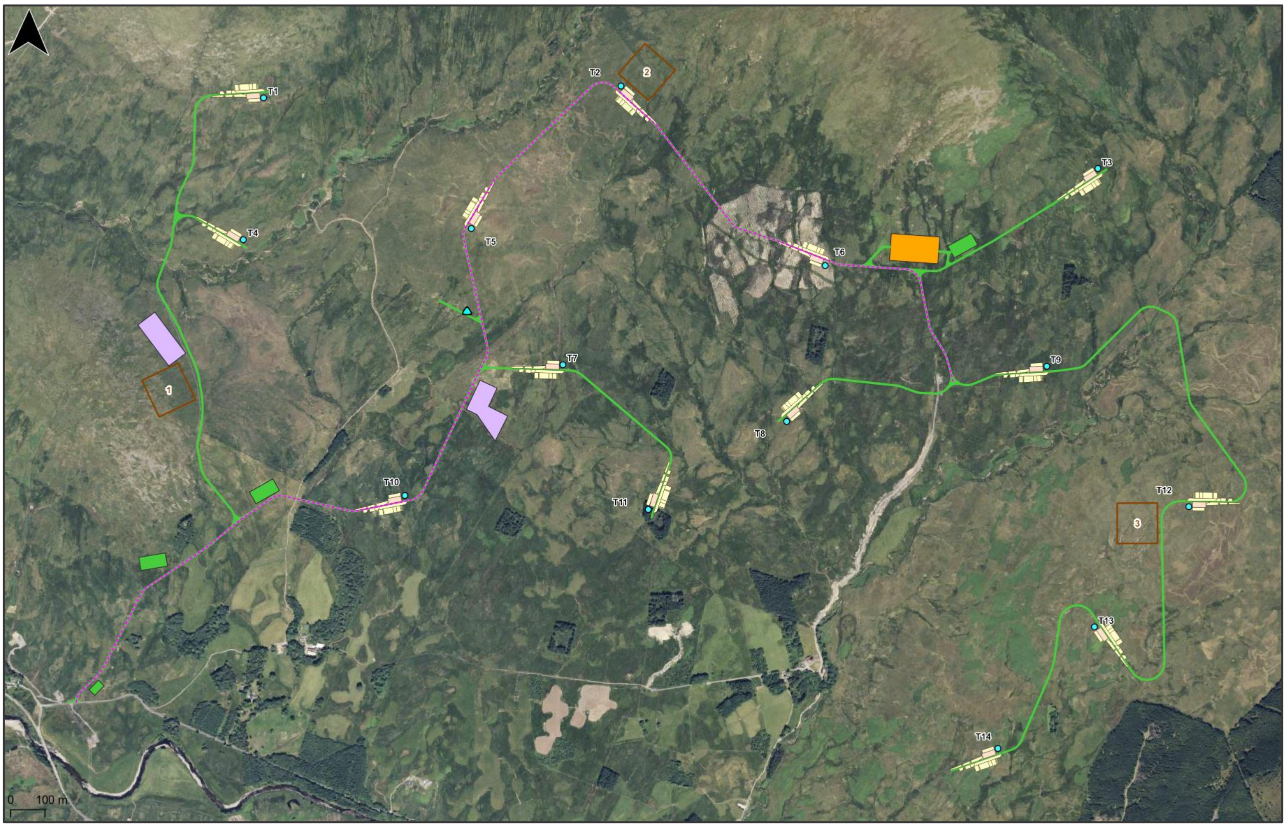


Figure 4.1: Borrow Pit Search Area Locations 1-3

Figures 4.2 below provide outline indicative scenarios for each borrow pit working area. No detailed design has been carried out at this stage. The following assumptions would be applied:

- Overburden shall be stored in peripheral bunds at a safe distance from the working area. Bunds shall be no more than 1m in height with 1in1.5 slope batters. The final location and geometry of temporary storage bunds shall be confirmed by a qualified geotechnical engineer during construction.
- Cut rock faces shall not exceed 70 degrees and, furthermore, may need to be shallower where weathered material or unfavourable discontinuity orientations are encountered.
- Cut rock faces shall not exceed 10m height without a horizontal bench 5m wide.
- The slope stability of borrow pit workings (cut faces, storage bunds and backfilled materials) would be verified and monitored by a qualified geotechnical engineer during opening, working and restoration phases.
- The perimeter of the borrow pit shall incorporate appropriate edge protection suitable personnel and vehicles when adjacent or downslope from access tracks;
- The floor of the borrow pit shall slope away from the working face at a grade of 1in100.
- Initial 0.3m of ground is assumed as unsuitable overburden material at this stage.

Consideration of the construction logistics have been factored into the location rationale: Three smaller borrow pit excavations are understood to be in preference over a larger single extraction location, these will be supplemented by aggregate extracted from road cuttings.

Source: Natural Power

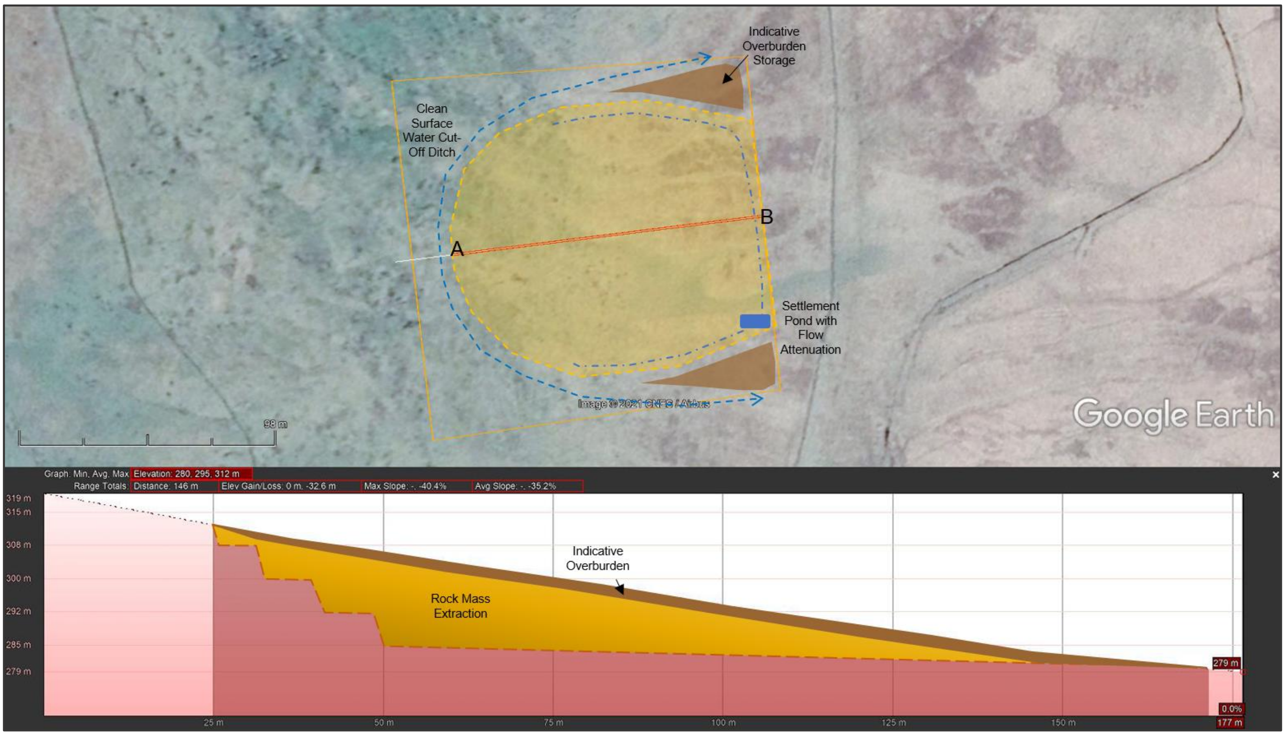


Figure 4.2: Indicative BP1 Working Area –1.4Ha – Rock Volume ~ 65,000m^3 Overburden Volume ~ 4,100m^3

Source: Natural Power

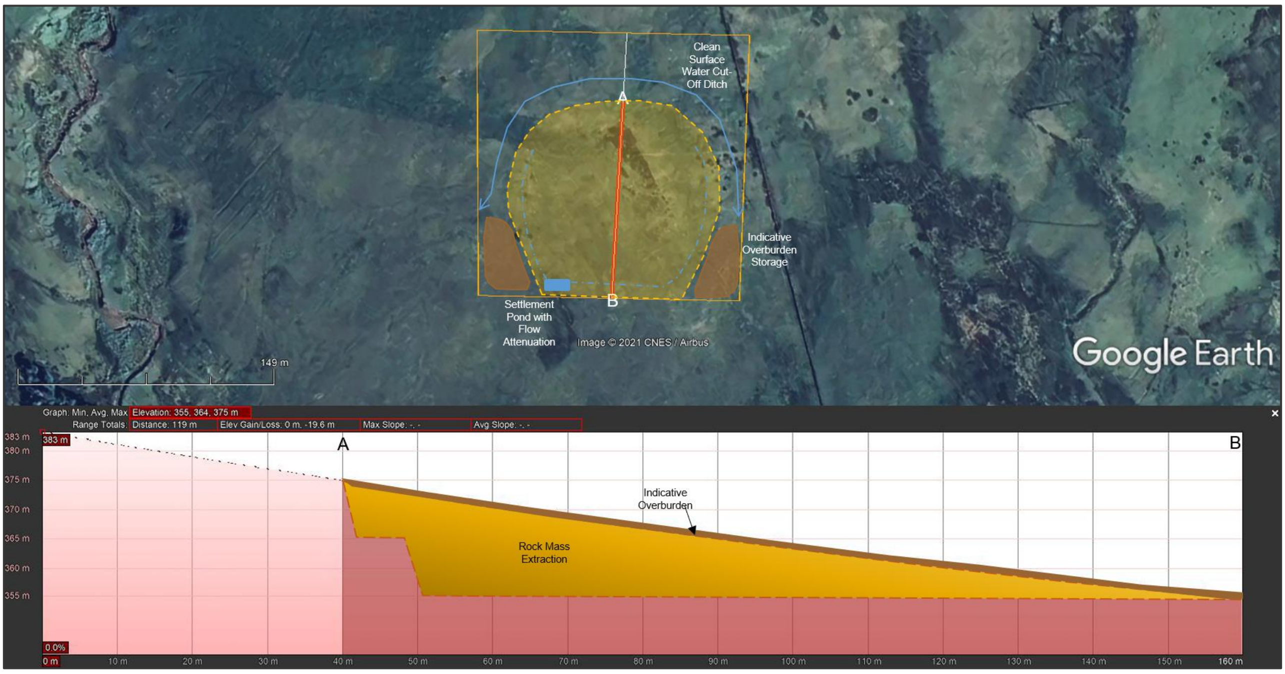


Figure 4.3: Indicative BP2 Working Area - 1.1Ha - Rock Volume ~ 45,000m^3 Overburden Volume ~ 3,300m^3

Source: Natural Power

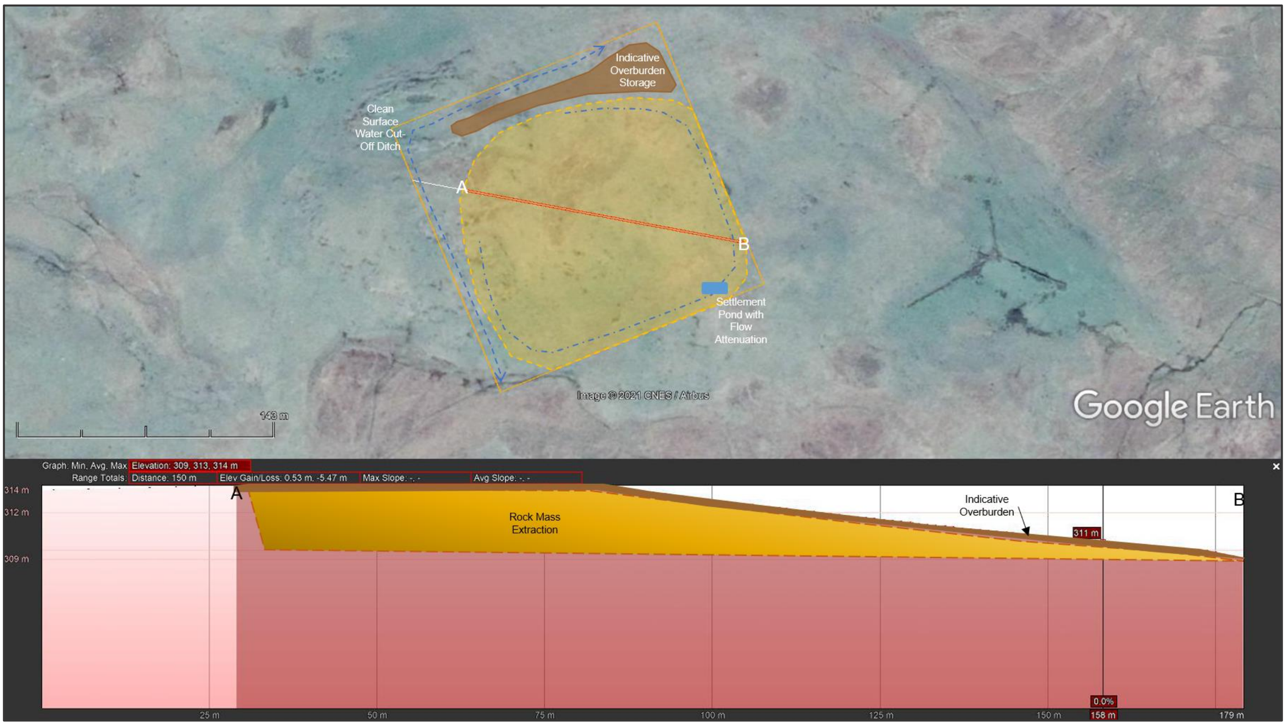


Figure 4.4: Indicative BP3 Working Area – 1.6Ha - Rock Volume ~ 21,000m^3 Overburden Volume ~ 4,900m^3

Source: Natural Power

4.1. Required Rock Volumes

An initial estimate of required rock volumes has been calculated in order to ascertain the scale of required on-site extraction. It should be noted that blade laydown and work areas around crane hardstands have been included within the hardstanding footprint. The volumes shall be further assessed during the detailed design phase. Table 4.1 below summarises the volume assumption and calculation. All total volumes are rounded to nearest 500m^3.

Table 4.1: Indicative construction aggregate volumes

Item	Development Footprint Area calc.		Total Site Area	Material Requirements	Total Volumes
14 Turbines	Hardstanding	Hardstand of 5,500m^2 per turbine	77,000m^2	Hardstandings are designed to provide a cut/fill balance. A maximum of 0.55m of fill has been assumed, sourced from borrow pits.	~42,500m^3
14 Turbines	Turbine Foundations	Assumption of 14. turbines with 27.5m diameter base, 1m depth of structural fill below concrete. Assume concrete components sourced offsite.	n/a - within hardstanding	Each turbine base needs ~600m^3 of structural fill.	~8,500m^3
Site tracks	New tracks 14.65 km	5.0m running surface with around 9.0m footprint. (assumption that cut track construction is adopted).	3.85m^2 track cross section	0.55m depth road makeup material sourced from borrow pits.	~56,500m^3
Site tracks	Passing places. Assuming a spacing of 500m between spaces. (Approximate 30 spaces)	Each place has a running width of 5.0m a base width of 6.0m and a length of 26.0m.	3m^2 cross section 78m^3 each	0.55m depth road makeup material sourced from borrow pits.	~2,500m^3
Temporary Construction Compounds & Ancillary Facilities			64,800m^2 Area	Assuming 0.55m of overburden material to be replaced by fill material from borrow pits.	35,500m^3
				Indicative requirements of stone to be won on-site	145,500m^3
				Indicative availability from onsite borrow pits	**131,000m^3**

Source: Natural Power

An initial estimate for the potential volume of rock excavatable from the proposed on-site borrow pits has been calculated. The results from this are shown in Table 4.2.

Table 4.2: Borrow Pit Volumes

Borrow Pit	Maximum working Area (m^2)	% of indicative search area	Indicative rock yield (m^3)
BP1	13,700	60%	65,000
BP2	11,300	50%	45,000
BP3	16,200	70%	21,000
		Total Volume:	**131,000**

Source: Natural Power

The size and geometry of the final excavation will be defined post consent with a comprehensive intrusive geotechnical site investigation.

The approximate working area (%) represents the scale of borrow pit excavation that is required to meet the minimum yield rock fill requirements. The working areas are smaller than the initially defined borrow pit extent. Therefore, there is likely going to be an optimisation of the borrow pit design within the confines of the identified area. Final proposed borrow pit designs would be subject to individual local planning authority mineral extraction license applications.

The material management strategy will reuse the volume of stone won from track cuttings in preference to stone extracted from onsite borrow pits to reduce the footprint and impact of the wind farm on the natural landscape.

During the ground investigation phase is it important that intrusive investigation is targeted both at potential borrow pit locations and at key points along the access track to ensure the thickness of the weathered layer, depth to engineering rock head and rock quality from the access track cuttings are confirmed to be adequate for reuse on site.

5. Example Borrow Pit Working Methodology

5.1. Access

Access to the borrow pit locations during construction will be from within the wider wind farm development site. Therefore, no public roads are to be used during the proposed borrow pit development.

5.2. Borrow Pit Design

Detailed borrow pit designs will be required to be completed by the appointed contractor prior to commencing operations. The final geometry of the borrow pits will be dictated by the bedrock geological conditions, with benching and rock cuttings designed to ensure stability. General recommendations for borrow pit design would specify a maximum single lift face height of 10m with a maximum face angle of 70 degrees. This would be subject to inspection by a suitably experienced geotechnical engineer.

The borrow pit floor will be designed for a shallow gradient to allow adequate drainage away from the working area. A perimeter fence and/or adequate edge protection will be erected around each borrow pit working area, and a cut-off drain also installed. This shall reduce the surface water accumulation within the borrow pit excavation and safeguard against sediment loaded run-off.

5.3. Overburden Soils Management

The upper most vegetated shallow soil layer will be stripped from the borrow pit excavation in a progressive movement up the slope as the excavation extends. As the excavation becomes larger and expands laterally into the terrain, the shallow soils and overburden shall be stripped and stored to build up the peripheral bunds. These bunds will also provide a cut-off for water coming down the slope to be diverted to ensure no ingress of additional water into the excavation area. The bunds shall be limited in their height and side slope angle such that they are stable for the duration of the operations, typically 1m height and 1in1.5 side slopes. The stability of bunds should be monitored and away from terrain where slope failure could be triggered. This should be reviewed by an experienced geotechnical engineer throughout the construction of the borrow pit. The bund will also provide limited screening to the area on the three sides whilst the excavation is taking place. The placement area for the material will need to be assessed and confirmed as suitable for loading by a suitably experienced and qualified geotechnical engineer. The stockpiles and bunds should not be in the vicinity of any watercourses peripheral drains or wet flushes, to prevent erosion, pollution and instability.

The underlying sub-soils will be removed in strips ahead of the working face and placed a minimum of 3 m back from the excavated face or, if required, will be stripped and stored separately in a secure area until the excavation is complete and the overburden soils can be utilised for the restoration of the borrow pit area. Any peat excavated will be stored separately from overburden, separated and moisture content preserved.

Where possible, stockpiled overburden materials would be used in re-instating the site borrow pits and tracks. It is also highlighted that spoil from other working areas such as turbine bases may also be used to achieve the restoration profile. Overburden shall only be removed over the area necessary for safe removal of the rock to prevent affecting land out-with the extraction area. It should be noted that overburden volumes can only be estimated following intrusive site investigation works.

A suitable fence and or protection barrier will be installed around the proposed borrow pit excavation areas on the slope to ensure the safety of both people working within the excavation area and anyone who may be within the proposed development area. Full details will be provided as part of the detailed Construction Method Statement.

5.4. Extraction of Rock

The potential borrow pit locations are distributed across the Proposed Development to allow for phased build-out of the proposed infrastructure and in order to reduce the impact of adopting one single large borrow pit excavation.

Due to the nature of the rock, the excavation is likely to be achieved through ripping, hydraulic breaking and possible blasting. An assessment of blasting times should be undertaken to allow adequate notice of on-site vibrations. Typical pattern of blasting includes the use of drilled holes on a grid layout. A progressive system of blasting could be adopted from the borrow pit proposed entrances towards the rock face created. Blasting operations where required will be specified by an appointed specialist contractor.

All workings should conform to relevant legislations including PAN 50, the principles of The Quarries Regulations 1999, the Groundwater Regulations 1998, HSE and Scottish Environment Protection Agency (SEPA) codes of practices and guidelines. The site drainage should consider any possible negative effects on site tracks and surrounding infrastructure.

Where appropriate temporary interception bunds and drainage ditches shall be constructed upslope of the borrow pit to minimise surface run-off ingress. These cut off ditches shall be of minimal length, depth and gradient, and silt traps and buffer strips shall be utilised to minimise erosion, sedimentation and peak flows.

Once the rock material has been excavated forming a working face the borrow pit can be extended by continued advancing face excavation. This would usually be at approximately 70 degrees to the horizontal to maintain a stable working face whilst maximising rock recovery. This angle may need to be changed if unstable rock is encountered or alternatively if the rock is of good stability and the face can be made steeper.

5.5. Processing (Loading and Haulage Operations)

Rock extracted from both borrow pits or road cuttings is likely to require crushing for secondary fragmentation and screening to gain a suitable aggregate size and prevent weathered material from sterilizing the pay rock. Primary fragmentation shall be used to achieve a suitable material size. This would be utilised for direct truck loading straight to the point of use. In this way the effects of a processing plant may be minimised.

Where processing is required a mobile in borrow pit plant setup should be positioned close to the working face to allow direct loading. Load and haul methodology shall then be used to transport the stone to the required point of use.

5.6. Reinstatement

The proposed borrow pits' reinstatement would be to generate a rough vegetated slope profile grading into the existing ground level of the surrounding terrain. The borrow pit faces would be reinstated to blend with the existing topography. The re-instated profile shall be at an acceptable level with as minimal change as possible from the existing profile using materials produced from on-site excavations leaving no more than 2 m "sub-vertical" exposed rock faces visible around the margins.

Restoration blasting may be implemented following appropriate design and stability considerations. This includes inclined blasting at the borrow pit face edges to achieve a shallower restoration rock face profile to a maximum top slope angle of 35º. This angle shall become increasingly gentle towards the borrow pit entrance, typically achieving slopes of 10º – 15º.

Shallow soils and overburden from the relevant borrow pit locations would then be used to reinstate the final surface of the excavation to allow natural re-vegetation with local vegetation. Loosened rock from the restoration blasts shall be used to partially buttress against the lower few metres of the resultant rock face to form a blended transition with the borrow pit floor.

The reinstatement would take place immediately following completion on the borrow pit but this should be completed within the construction period of the wind farm. All restoration works should be carried out to the approval of an appointed Environmental Clerk of Works (ECoW).

The geological interest of potential bedrock exposures should not be discounted. Where possible opportunities for local and national bodies with interest in the geological setting of the site should be provided with access to study and document any significant features uncovered by the borrow pit workings.

5.7. Plant and Machinery Considerations

To extract the rock a large excavator with a ripping tooth and rock breaker attachment is anticipated to be required across each location. This is likely to be supported by a fleet of articulated dumper trucks to load out the rock to the construction areas. A bulldozer may be required for grading and levelling, and an articulated loading shovel may also be used to feed dumper trucks and crushers from stockpiles.

Dependent on the material excavated, a mobile crushing plant is likely to be required and will be located within or adjacent to each borrow pit working area, close to the point of extraction for processing and grading as necessary.

The plant and labour will be provided by the chosen construction contractor who would also be responsible for the safe operation and maintenance of machinery. The construction contractor may re-deploy these resources across the wind farm site and varying borrow pit locations as required. The contractor will provide full method statements and risk assessment to personnel with respect to safe methods of working and emergency procedures.

5.8. Drainage Considerations

Surface drainage shall be diverted around the working area wherever possible to prevent contamination of natural run-off by suspended solids. Temporary low bunding and/or catch ditches shall be created as required. Any peat storage bunds shall provide a source of particulates from which run-off may temporarily pick up sediment, catch ditches should be created as necessary with the drainage feeding into the drainage design of the wind farm. Detailed mitigation measures to prevent siltation shall be included in the final design.

Rainfall, surface and groundwater entering the borrow pit shall be contained in a temporary sump location within the excavation. The borrow pit floor should be graded appropriately to aid drainage. Excess water should be pumped out of the pit and discharged to local drainage channels with appropriate silt removal measures prior to discharge. A SEPA discharge consent should be sought with respect to this element of the borrow pit development. All on site surface water discharges should be carried out in an environmentally compliant manner.

All drainage shall be in accordance with The Water Environment (Controlled Activities) (Scotland) Regulations 2005 which provides best practice guidelines for a number of activities to prevent pollution of groundwater sources. If authorisations are required for process plant operation or consents to discharge then applications will be made by the principal contractor to the Scottish Environment Protection Agency (SEPA).

5.9. Waste Management Strategy

It is anticipated that there will be minimal waste materials produced by the borrow pit development. Any un-useable rock and superficial deposits shall be temporarily stockpiled during construction and utilised as part of the borrow pit restoration scheme.

Any solid waste items associated with the development e.g. those materials associated with plant maintenance and operation or blasting (if required), shall be removed from the site and disposed of at a licensed waste disposal facility. The principal contractor shall be responsible for all waste generation and procedures in response to ground contamination from the construction project. Construction method statements shall be issued by the principal contractor detailing procedures in the event of a fuel or oil spillage.

Where appropriate, given the semi-remote nature of the site, Planning Advice Note 50: Controlling the Environmental Effects of Surface Mineral Workings will be adhered to. There are to be no movements of material away from the wind farm area as all material is solely for use in the wind farm construction.

Operational impacts form noise and dust should be controlled by the specification of appropriate extraction methods and processing plant. Best Practice Guidance – The Control of Dust and Emissions from Construction and Demolition Sites (2006) shall be considered as part of the CMS.

6. References

The Institute of Quarrying. http://www.quarrying.org/.html

The Scottish Government (2000). PAN 50 Annex D: Controlling the Environmental Effects of Surface Mineral Workings. February 2000.

British Geological Survey Onshore GeoIndex https://mapapps2.bgs.ac.uk/geoindex/home.html

British Geological Survey Engineering Geology Viewer: http://mapapps.bgs.ac.uk/engineeringgeology/home.html

British Geological Survey Lexicon of Named Rock Units: https://webapps.bgs.ac.uk/lexicon/lexicon

National Library of Scotland online viewer: https://maps.nls.uk/

Creating a better environment

naturalpower.com
sayhello@naturalpower.com

For full details on our ISO and other certifications, please visit our website.

Appendix 9.1

Settings Assessment

Document history

Author	AOC Archaeology	06/12/2021

Client Details	
Contact	Matthew Bacon
Client Name	Vattenfall Wind Power Ltd

Issue	Date	Revision Details
A	14/12/2021	Released

APPENDIX 9.1 SETTINGS ASSESSMENT

Contents

Introduction 1

Minor Effects 12

Negligible Effects 13

This page is intentionally blank.

APPENDIX 9.1 SETTINGS ASSESSMENT

9.1.1 Introduction

This assessment has considered the potential for impacts upon the setting of all designated assets within 5 km of the Site as well as the potential for impacts upon the setting of all nationally important designated assets (namely Scheduled Monuments, Category A Listed Buildings and Inventory Gardens and Designed Landscapes) within 10 km of the Site and which lie within the ZTV. Consideration has also been given to the potential for impacts upon the setting of non-designated assets which Dumfries and Galloway Council considered to be of national importance where they lie within 10 km of the Site and within the ZTV. Where such assets within the Study Area fell outwith the ZTV, these were reviewed against the information known about their contextual characteristics and against mapping information to identify any assets where views of the Proposed Development in views towards the asset may significantly impact on their settings.

There is one aircraft crash site designated as a Protected Place within the Proposed Development Area. There are no World Heritage Sites within the 10 km Study Area. In addition, there are 16 Scheduled Monuments, one Listed Building of Category A status, seven Listed Buildings of Category B status, five Listed Buildings of Category C status, one Landscape Park designated as being of Regional Significance by the Dumfries and Galloway HER and four non-designated asset designated as being of National Significance by the Dumfries and Galloway HER within the relevant Study Areas. Setting assessment site visits were undertaken in April 2021.

Assets identified as requiring assessment by statutory consultees have been discussed individually within the main body of Chapter 9.

A summary of the findings of the settings assessment is presented in Conclusion Table 9.6. A summary discussion for each of the assets or asset groups subject to assessment is provided within this Appendix and has been informed by site visits, ZTV modelling, photomontages and wireframes (Figures 001.tif to 021.tif) as appropriate.

Table 9.1.1**: Summary of settings assessment**

Asset No	Name of Landscape Area or Asset	Designation	No of Turbines Visible	Distance to Turbines	Main Factors Affecting Setting	Relative Sensitivity	Magnitude of Impact	Level of Operational Effect
Assets discussed in Chapter 9								
17	Benniner, Bristol Blenheim Mk IV, Registration No. P4848	Protected Aircraft Crash Site	5	1.73	The crash site location in the valley between the hill of Benniner and Green Hill allows an observer to appreciate and understand the possible factors behind the crash of this aircraft.	High	Minor	Negligible
19	Woodhead lead mines and smelter, Carsphairn	Scheduled Monument	14	4.25 km	Woodhead lead mines' setting is associated with the location of the ore and the track that leads to it. The mines with associated workers houses are a relatively self-contained monument although it is probably also associated with the settlement of Carsphairn and the road network beyond for access of material, personnel and supplies to the mine and for taking mined and processed ore and personnel out of the mines.	Medium	Low	Minor
23	Earlston Castle	Scheduled Monument	14	8.96 km	Earlston Castle overlooks the valley of the Water of Ken to the west.	High	Low	Minor
24	Cairn Avel, cairn 800m S of Carsphairn	Scheduled Monument	14	2.69 km	Cairn Avel's primary setting overlooks the valley of the Water of Deugh to the north.	High	Low	Minor
25	Holm of Daltallochan, stone circle & standing stone	Scheduled Monument	6	2.39 km	The setting of the Holm of Daltallochan is within the low lying agricultural lands to the northwest of Carsphairn.	High	Low	Minor

Asset No	Name of Landscape Area or Asset	Designation	No of Turbines Visible	Distance to Turbines	Main Factors Affecting Setting	Relative Sensitivity	Magnitude of Impact	Level of Operational Effect
26	Holm of Daltallochan, cross slab	Scheduled Monument	3	2.13 km	Although tradition states that this cross slab was found at Asset 25, historical records give its location as within the gardens of the Holm of Daltallochan Farmhouse. Its setting is within the river valley to the north of Carsphairn and the track leading northeast to southwest from the A713. This setting is not associated with or towards the Proposed Development.	Medium	Negligible	Negligible
27	Stroanfreggan Bridge, cairn	Scheduled Monument	8	3.76 km	Stroanfreggan Bridge Cairn’s setting is within the valley and landscape to the southeast of the Proposed Development. A view to the valley between the hills on the Proposed Development Area may also be another setting aspect although the distance and sightline is away from the location of the proposed turbines within the Proposed Development Area.	High	Low	Minor
30	Stroanfreggan Craig, fort, Smittens Bridge	Scheduled Monument	11	3.07 km	Stroanfreggan Craig Fort is associated with high upland grazing on shoulders of land in its immediate vicinity. There are good commanding views along the north to south Water of Ken river valley and along the east to west aligned Stroanfreggan Burn which lies to the south of the fort. The fort lies at a strategic point of the confluence	High	Low	Minor

Asset No	Name of Landscape Area or Asset	Designation	No of Turbines Visible	Distance to Turbines	Main Factors Affecting Setting	Relative Sensitivity	Magnitude of Impact	Level of Operation al Effect
					of these to water course. The Proposed Development would be behind or on the periphery of these views along these key setting elements.			
31	Craigengillan, cairn	Scheduled Monument	14	1.66 km	Craigengillan Cairn is within and surrounded by forestry which has slightly mutilated its periphery according to the NRHE. It sits on a slight slope overlooking the north to south river valley and away from the Proposed Development.	High	Low	Minor
32	Dundeugh Castle	Scheduled Monument	8	4.92 km	Dundeugh Castle is an overgrown mound with a section of L shaped wall still upstanding surrounded by modern forestry. Prior to the plantation of the modern forestry Dundeugh Castle would have occupied a commanding position over the north to south Water of Deugh river valley and a crossing point now occupied by a modern bridge.	Medium	Negligible	Negligible
79	Lagwine Cairn	HER National Asset	1	1.78 km	Partially robbed cairn on a southwest facing slope; although the central core is assessed as intact.	High	Negligible	Minor
89	Knockgray Policies	Landscape Park of Regional Significance	14	1.02 km	Knockgray Policies setting is along the northwest to southeast Water of Deugh and its associated valley. Visually it can be best appreciated	High	Low	Minor

Asset No	Name of Landscape Area or Asset	Designation	No of Turbines Visible	Distance to Turbines	Main Factors Affecting Setting	Relative Sensitivity	Magnitude of Impact	Level of Operation al Effect
					from across the valley to the southwest. This view will be backclothed by turbines within the Proposed Development and therefore do not impinge this view of Knockgray Policies from across the valley to the southwest.			
217	Craigengillen (viewpoint from Scottish Dark Skies Observatory)	Inventory Garden and Designed Landscape	0-7	12.42 km	A maximum of 7 turbines will be visible from the core of the Inventory Garden and Designed Landscape at Craigengillan. However there will be no turbines visible from the majority of the GDL and no turbines will be visible from the location of the Scottish Dark Skies Observatory situated at Asset 217. Within the GDL turbines will not be visible until the observer has moved 780 m to the northwest of this the specific coordinated of the Scottish Dark Skies Observatory at Asset 217.	High	Negligible	Neutral
218	Little Auchrae, Farmstead	HER Asset of National Significance	14	2.72 km	The remains of the Little Auchrae farmstead are comprised of two unroofed buildings with four enclosures and large field systems clustered around the buildings. The setting of this asset is within this agricultural landscape within good pastureland predominantly on north to northwest facing slopes	Medium	Low	Minor

Asset No	Name of Landscape Area or Asset	Designation	No of Turbines Visible	Distance to Turbines	Main Factors Affecting Setting	Relative Sensitivity	Magnitude of Impact	Level of Operational Effect
					overlooking the north to south Water of Ken.			
219	Round Craigs, landscape containing cairns, clearance cairns, cultivation remains and burnt mounds.	HER Asset of National Significance	14	3.73 km	This is an asset comprising of several multi period features within a specific upland landscape overlooking the north to south Water of Ken and Stroanfreggan Burn to the south and east. These features range from probable prehistoric burial cairns to clearance cairns, some of which have been assessed as dating to the post-medieval period.	High	Low	Minor
220	Culmark Hill Cairn	HER Asset of National Significance	14	4.55 km	Asset 220 sits on a prominent east to west aligned ridge with view to the Water of Ken which is aligned northeast to southwest. The Proposed Development would be visible in the west of this primary setting but does not impinge upon it.	High	Low	Minor
221	Bardennoch-Garryhorn Archaeologically Sensitive Area	HER Archaeologically Sensitive Area	14	1.63 km	Asset 221 contains multi-period archaeological remains within its boundary and is focussed on the northwest to southeast aligned ridgeline and slopes made by Bardennoch Hill and Braidenoch Hill. This ridge of hills overlooks the Water of Deugh near Carsphairn. The southwest facing ridgeline overlooks the northwest to southeast aligned Polmaddy Burn	High	Low	Minor

Asset No	Name of Landscape Area or Asset	Designation	No of Turbines Visible	Distance to Turbines	Main Factors Affecting Setting	Relative Sensitivity	Magnitude of Impact	Level of Operation al Effect
					which is currently not visible from Asset 221 due to modern forestry plantations.			
222	Stroanfreggan Archaeologically Sensitive Area	HER Archaeologicall y Sensitive Area	14	2.27 km	Asset 221 contains multi-period archaeological remains within its boundary overlooking the north to south Water of Ken to the west and Stroanfreggan Burn to the south.	High	Low	Minor
223	Polharrow Burn Archaeologically Sensitive Area	HER Archaeologicall y Sensitive Area	14	5.96 km	The features within the boundary of Asset 223 include a prehistoric cairn, the remains of clearance cairns, isolated enclosures and deserted farmsteads with extensive field systems. Other traces of upland agricultural practices and traces of minor industrial activity have been recorded within this area.	High	Negligible	Minor
18	Polmaddy, medieval and post-medieval settlement	Scheduled Monument	14	5.30 km	The setting of Polmaddy is associated with the Old Pack Road, the agricultural fields and the water supplies associated with the burn to the south of the SM.	Medium	Low	Minor
33	Braidenoch Hill, cross slabs	Scheduled Monument	5	3.14 km	Asset 33 is overgrown and the cross slabs were not located. However, it’s setting is associated with the Old Park Road on reverse, western slopes and away from the Proposed Development.	Medium	Negligible	Negligible

Asset No	Name of Landscape Area or Asset	Designation	No of Turbines Visible	Distance to Turbines	Main Factors Affecting Setting	Relative Sensitivity	Magnitude of Impact	Level of Operation al Effect
34	High Bridge of Ken	Listed Building - Category B	11	3.14 km	High Bridge of Ken's setting is within a west to east aligned valley of the Water of Ken and fulfils the role of crossing the water of Ken at this point. The location of the bridge in the valley limits views north and northwest to the Proposed Development.	Medium	Low	Minor
35	Smeatons Bridge over Water of Ken	Listed Building - Category B	3	2.92 km	Smeatons Bridge setting is within a north to south aligned valley of the Water of Ken and fulfils the role of crossing the water of Ken at this point.	Medium	Low	Minor
36	Carsphairn Parish Church, Church of Scotland	Listed Building - Category C	13	2.09 km	Carsphairn Parish Church's primary setting is within Carsphairn and the valley in which Carsphairn is located; the church can be best viewed and appreciated within this valley and its associated settlement; principally from the modern A713.	Medium	Low	Minor
37	Carsphairn Parish Churchyard and McAdam Mausoleum	Listed Building - Category B	13	2.12 km	The sightline of the Mausoleum is along a slight SSW to NNE axis through its entrance to a decorated, albeit blocked doorway in its interior, northern wall. This sightline is to the west of the Proposed Development and does not intersect with it.	Medium	Low	Minor
38	Dalshangan Stables	Listed Building - Category C	14	3.99 km	Dalshangan Stables is a complex of four ranges of farm buildings around a courtyard accessed under	Medium	Low	Minor

Asset No	Name of Landscape Area or Asset	Designation	No of Turbines Visible	Distance to Turbines	Main Factors Affecting Setting	Relative Sensitivity	Magnitude of Impact	Level of Operation al Effect
					a tower. This access and the alignment of the courtyard is southwest to northeast; this view is away from the Proposed Development to its southeast. The stables are functional buildings around this courtyard.			
39	Dalshangan Dovecot	Listed Building - Category C	14	4.15 km	Dalshangan Dovecot is a functional building which can be appreciated visually from the southeast and away from views to the Proposed Development.	Medium	Negligible	Negligible/
40	Holm of Daltailochan	Listed Building - Category B	4	2.23 km	The primary elevation faces northwest, and this view (and its reciprocal) is not impinged upon by the Proposed Development.	Medium	Negligible	Negligible/
41	Galloway Hydroelectric Power Scheme, Kendoon North Dam	Listed Building - Category B	14	2.38 km	Kendoon North Dam’s setting is associated with the Water of Ken, the artificial reservoir created by the dam and the production of hydroelectric power.	Medium	Negligible	Negligible/
42	Galloway Hydroelectric Power Scheme, Kendoon South Dam	Listed Building - Category C	5	3.75 km	Kendoon South Dam’s setting is associated with the water of Ken, the artificial reservoir created by the dam and the production of hydroelectric power.	Medium	Negligible	Negligible/
43	Galloway Hydroelectric Power Scheme, Kendoon Surge Tower	Listed Building - Category C	4	5.03 km	Kendoon Surge Tower’s setting is associated with the Water of Ken, the artificial reservoir created by the	Medium	Negligible	Negligible/

Asset No	Name of Landscape Area or Asset	Designation	No of Turbines Visible	Distance to Turbines	Main Factors Affecting Setting	Relative Sensitivity	Magnitude of Impact	Level of Operation al Effect
					dams and the production of hydroelectric power.			
44	Galloway Hydroelectric Power Scheme, Kendoon Power Station and Valve-House: Power Station	Listed Building - Category B	5	5.17 km	Kendoon Power Station's setting is associated with the Water of Ken, the artificial reservoir created by the dams and the production of hydroelectric power.	Medium	Negligible	Negligible/
45	Galloway Hydroelectric Power Scheme, Kendoon Power Station and Valve-House: Valve House	Listed Building - Category B	5	5.62 km	Kendoon Valve House' setting is associated with the Water of Ken, the artificial reservoir created by the dams and the production of hydroelectric power.	Medium	Negligible	Negligible/

9.1.3 Minor Effects

The Category B Listed High Bridge of Ken (Asset 34, List No. LB3627) is situated 3.14 km southeast of the nearest turbine. High Bridge of Ken's setting is within a west to east aligned valley of the Water of Ken and the bridge fulfils the role of crossing the Water of Ken at this point. This setting contributes to an understanding and appreciation of the functional role of the bridge but the asset is less sensitive to changes in the wider landscape and is judged to have Medium relative sensitivity to changes to its setting. The location of the bridge in the valley limits views north and northwest to the Proposed Development and the Proposed Development would impinge upon the relationship of the asset to key elements of setting described above. In AOC Archaeology Group's professional opinion, and given evidence gathered, there would be a **Low** magnitude of impact by the Proposed Development on Asset 34, the resulting effect on Asset 34 would be **Minor** and not significant.

The Category B Listed Smeaton's Bridge, Water of Ken (Asset 35, List No. LB3628) is situated 2.92 km southeast of the nearest turbine. Smeatons Bridge setting is within a north to south aligned valley of the Water of Ken and the bridge fulfils the role of crossing the Water of Ken at this point. This setting contributes to an understanding and appreciation of the functional role of the bridge but the asset is less sensitive to changes in the wider landscape and is judged to have Medium relative sensitivity to changes to its setting. The Proposed Development would be beyond this valley setting and would not alter the ability to understand or appreciate the bridge's functional setting. In AOC Archaeology Group's professional opinion, and given evidence gathered, there would be a **Low** magnitude of impact by the Proposed Development on Asset 35, the resulting effect on Asset 35 would be **Minor** and not significant.

The Category C Listed Carsphairn Parish Church (Asset 36, List No. LB3677) is situated 2.09 km southwest of the nearest turbine. Carsphairn Parish Church's primary setting is within Carsphairn village and the valley in which Carsphairn is located; the church can be best viewed and appreciated within this valley and its associated settlement; principally from the modern A713 immediately to the north. The village and valley setting of the church contribute to an understanding and appreciation of it, but it is less sensitive to changes in the wider landscape. It is judged to have Medium relative sensitivity to changes to its setting. The Proposed Development would be located beyond this this setting and would not alter the asset's baseline setting such that there would be a reduction in the ability to understand, appreciate and experience the contribution that setting makes to the significance of the asset. In AOC Archaeology Group's professional opinion, and given evidence gathered, there would be a **Low** magnitude of impact by the Proposed Development on Asset 36, the resulting effect on Asset 36 would be **Minor** and not significant..

The Category C Listed Carsphairn Parish Churchyard and McAdam Mausoleum (Asset 37, List No. LB3678) is situated 2.12 km southwest of the nearest turbine. The churchyard dates from the late 17th to the early 18th century while the McAdam Mausoleum dates from 1838. The sightline of the Mausoleum is along a slight south-southwest to north-northeast axis through its entrance to a decorated, albeit blocked doorway in its interior, northern wall. The rubble walled churchyard is associated with the Category C Listed Carsphairn Parish Church (Asset 36 List No. LB3677). This churchyard can be best appreciated from the south with Carsphairn Parish Church backclothing this view. The asset's main setting relationships are with the church and the surrounding village and it is these relationships which contribute to an understanding and appreciation of their significance. The asset is less sensitive to changes in the wider landscape and is judged to have Medium relative sensitivity to changes to its setting. The sightline from the mausoleum would be to the west of the Proposed Development and would not intersect with it. The Proposed Development would be visible to the northeast and it would be located beyond the key elements of setting identified here and would not reduce the ability of those key elements to contribute to an understanding, appreciation and experience of the asset. Therefore, in AOC Archaeology Group's professional opinion, and given evidence gathered, there would be a **Low** magnitude of impact by the Proposed Development on Asset 37, the resulting effect on Asset 37 would be **Minor** and not significant.

The Category C Listed Dalshangan Stables (Asset 38, List No. LB3679) is situated 3.99 km south of the nearest turbine. Dalshangan Stables is a complex of four ranges of farm buildings around a courtyard accessed under a tower. This access and the alignment of the courtyard is southwest to northeast. The stables are functional buildings around this courtyard. The main elements of setting which contribute to an understanding and appreciation of the asset are the relationships of the individual buildings to one another and their relationship the immediate surround agricultural land and the established transport route to the west. It is less sensitive to change in the wider landscape and on balance is judged to have Medium relative sensitivity to changes to its setting. The principal elevation and access to the asset is away from the Proposed Development to its southeast and as such would not feature in this view Further the Proposed Development would not intervene in the relationships between individual elements of the asset nor would it affect its relationship between the immediately surrounding agricultural land or transport routes. Therefore, in AOC Archaeology Group's professional opinion, and given evidence gathered, there would be a **Low** magnitude of impact by the Proposed Development on Asset 39, the resulting effect on Asset 39 would be **Minor** and not significant.

The Scheduled monument at Polmaddy, medieval and post-medieval settlement (Asset 18, List No. SM5391) is situated 5.30 km south of the nearest turbine. Polmaddy sits on ground that slopes gently south and southwest to the steeper river of the burn. This burn surrounds it on the west and southern sides. Although the burn enters a steep valley along the southern boundary, low-lying agricultural meadows on the south and southwest area of the SM would have ensured easy and regular access to water supplies for the settlement. Water mills on the higher ground of Polmaddy utilised the water supply nearby and the burn that surrounded the settlement to grind the grain for the grounds harvested in the surrounding fields. The Old Pack Road that crosses Asset 18 would also have ensured adequate communication links for this rural settlement and there is an inn along the Old Pack Road that would have provided accommodation for people passing through Polmaddy. Therefore the setting of Polmaddy is associated with the Old Pack Road, the agricultural fields and the water supplies associated with the burn to the south of the SM. The asset is sensitive to changes that would affect these relationships but less sensitive to changes in the wider landscape and on balance is judged to be of Medium relative sensitivity to changes to its setting. The Proposed Development would be at a reasonably considerable distance from the village and would not impinge upon the ability to understand the relationship between the village and its associated communication routes, water sources and agricultural resources. As such, in AOC Archaeology Group's professional opinion and evidence gathered it is considered that there would be a Low magnitude of impact, the resulting effect on Asset 18 would be **Minor** and not significant.

9.1.5 Negligible Effects

The Scheduled Monument at Braidenoch Hill, cross slabs (Asset 33, List No. SM1105) is situated 3.14 km south of the nearest turbine. The landscape of Braidenoch Hill is slightly overgrown and therefore it was not possible to specifically locate the low-lying cross slabs during the walkover survey conducted by AOC Archaeology Group though the area was visited. These cross slabs are believed to date from the 8th or 9th centuries and they are thought to be associated with the transport routes of the Old Park Road; pilgrims would probably have utilised this route and have seen the cross slabs during their pilgrim. As such the setting of the slabs is associated with the road and the ridge line and they are considered to be Medium relative sensitivity to changes in the wider landscape. The Old Park Road is situated on the reverse, western slopes of Braidenoch Hill and away from the Proposed Development. Although ZTV analysis suggests five turbines would be visible from Asset 33, wireline analysis (Figure 012.tif) suggests that no turbines of the Proposed Development would be visible. Therefore, in AOC Archaeology Group's professional opinion and evidence gathered it is considered that there would be at worse a **Negligible** magnitude of impact by the Proposed Development on Asset 33, the resulting effect would be **Negligible** and not significant.

The Category C Listed Dalshangan Dovecot (Asset 39, List No. LB3680) is situated 3.99 km south of the nearest turbine. Dalshangan Dovecot is a functional building which can be appreciated visually from the southeast and its setting relates to house and estate which it would have served. On balance it is judged to be of Medium relative sensitivity to changes to its setting. The Proposed Development would not be included in the views from the southeast and would not affect the key setting relationships. Therefore, in AOC Archaeology Group's professional opinion, and given evidence gathered, it is considered that there would be a **Negligible** magnitude of impact by the Proposed Development on Asset 39, the resulting effect on Asset 39 would be **Negligible** and not significant.

The Category B Listed Holm of Daltailochan (Asset 40, List No. LB3681) is situated 2.23 km west of the nearest turbine. The primary elevation of this 18th century farmhouse faces northwest. Elements of setting which contribute to an understanding and appreciation of the asset include the immediately surrounding agricultural land which the farmstead would have been sited to exploit along with the adjacent water course of Water of Deugh and Carsphairn Lane and the transport route to the east. It is judged to have Medium relative sensitivity to changes to its setting. The Proposed Development would not impinge upon views to or frum the primary elevation of the farmhouse nor would it affect the key setting relationships set out above. Therefore, in AOC Archaeology Group's professional opinion, and given evidence gathered, it is considered that there would be a **Negligible** magnitude of impact by the Proposed Development on Asset 40, the resulting effect on Asset 40 would be **Negligible** and not significant.

Galloway Hydroelectric Power Scheme at Kendoon has five designated assets within 10 km of the Proposed Development Area; the Category B Listed Galloway Hydroelectric Power Scheme, Kendoon North Dam (Asset 41, List No. LB51691) is situated 2.38 km south of the nearest turbine, the Category C Listed Galloway Hydroelectric Power Scheme, Kendoon South Dam (Asset 42, List No. LB51692) is situated 3.75 km south of the nearest turbine, the Category C Listed Galloway Hydroelectric Power Scheme, Kendoon Surge Tower (Asset 43, List No. LB51693) is situated 5.03 km south of the nearest turbine, the Category B Listed Galloway Hydroelectric Power Scheme, Kendoon Power Station and Valve-House: Power Station (Asset 44, List No. LB51694) is situated 5.17 km south of the nearest turbine and he Category B Listed Galloway Hydroelectric Power Scheme, Kendoon Power Station and Valve-House: Valve House (Asset 45, List No. LB51694) is situated 5.62 km south of the nearest turbine. These designated assets are associated with the production of hydroelectric power and have been considered together as a group. These assets are less sensitive to changes in the wider landscape and deemed to be of Medium relative sensitivity to changes to its setting. The Proposed Development would not affect the key setting relationships identified here and would not diminish the ability to understand, appreciate and experience the contribution that setting makes to the significance of the asset. Therefore, in AOC Archaeology Group's professional opinion, and given evidence gathered, it is considered that there would be a **Negligible** magnitude of impact by the Proposed Development on Assets 41 to 45, the resulting effect on Assets 41 to 45 would be **Negligible** and not significant.

Appendix 9.2

Plates

Document history

Author	AOC Archaeology	06/12/2021

Client Details	
Contact	Matthew Bacon
Client Name	Vattenfall Wind Power Ltd

Issue	Date	Revision Details
A	14/12/2021	Released

Plate 1: View of the Proposed Development Area looking southwest from the northern portion

Plate 2: View southwest towards Furmiston Farm

Plate 3: View of drainage ditches in northern portion of the Proposed Development Area

Plate 4: View southwest of dry stone wall property division along the Marbrack Burn

Plate 5: View north of track leading into the Proposed Development Area from Marbrack Farm

Plate 6: View of Asset 169

Plate 7: View northeast of Asset 164

Plate 8: View of Asset 170

Plate 8: View east of Asset 23

Plate 9: View east of Asset 165

Plate 10: View of Asset 166

Plate 11: View west of Asset 24

Plate 12: View southeast of Asset 25

Plate 13: View southeast of Asset 27

Plate 14: View northeast of Asset 30

Document history

Author	AO Archaeology	28/06/2022

Client Details	
Contact	Matthew Bacon
Client Name	Vattenfall Wind Power Ltd

Appendix 9.3

Asset Gazetteer Report

Asset Number	1
Site Name	Cemetery Wood, Knockgray
Type of Site	FUNERARY ENCLOSURE; PLANTATION
NMRS Number	
HER Number	MDG26898
Status	Not Designated
Easting	257399
Northing	593786
Parish	Carsphairn
Council	Dumfries And Galloway
Description	Significance = Local A burial ground which was chosen by Captain Clark Kennedy of Knockgray for his burial ground prior to his death in 1894. It was subsequently used as a burial plot for the Kennedys of Knockgray. Today this burial ground is relatively overgrown, though is evidently still cared for. It is surrounded by a plantation of coniferous woods. Headlands Archaeology, Quantans Hill Wind Farm: Environmental Statement; Walkover Survey dates: 2nd, 3rd, 4th, 5th and 10th July 2013

Asset Number	2
Site Name	Quantans Hill
Type of Site	FIELD SYSTEM (PERIOD UNASSIGNED), SHEEPFOLD (PERIOD UNASSIGNED)
NMRS Number	NX59SE 33
HER Number	MDG13636
Status	Not Designated
Easting	258200
Northing	594130
Parish	Carsphairn
Council	Dumfries And Galloway
Description	Canmore ID: 159683 Significance = Local A field-system annotated 'Old Fence' and a Sheep Ree are depicted on the 1st edition of the OS 6-inch map (Kirkcudbrightshire 1853, sheet 5). The sheepfold is shown on the current edition of the OS 1:10000 map (1980). Information from RCAHMS (AKK) 15 September 1999. Field system and sheepfold shown on first edition Ordnance Survey map still visible on recent aerial photography. Information from DGC (AJN) 29 April 2016

Asset Number	3
Site Name	Big Loskie
Type of Site	FIELD SYSTEM; SHEEP FOLD
NMRS Number	NX69SW 52
HER Number	MDG15848
Status	Not Designated
Easting	260550
Northing	593250
Parish	Carsphairn
Council	Dumfries And Galloway
Description	Canmore ID: 177485

Significance = Local

NX 60554 93255) Irregular-shaped area of relict field systems surrounding the current drystone enclosure containing trees at Loskie. Due to the highly irregular nature, a GIS polygon or shapefile would be the most accurate way to give precise dimensions and shape (please see Figure 3). The field system measures 323m N-S by 189m E-W overall. It is faintly apparent in aerial photos as a series of heavily weathered, low curvilinear earthen dykes, but proved very difficult to see on the ground due to waterlogged ground and vegetation. The area does not appear to have been recently grazed. Contains a 15m/dia drystone animal enclosure in the centre.

(NX 60368 93356) Located c.250m NW of Loskie A, this field system is subcircular in plan, measuring 180m N-S x 164m E-W. As with Loskie East, above, it is very difficult to see on the ground due to vegetation and waterlogged blanket peat in the vicinity but is faintly apparent in aerial photos as a heavily weathered series of low earthen dykes.
Information from OASIS ID: archascu1-391099 (A Rees) 2020

A field-system annotated 'Old Fences' and three sheepfolds, two of which are annotated 'Sheep Ree' and one 'Old Sheep Ree' are depicted on the 1st edition of the OS 6-inch map (Kirkcudbrightshire 1853, sheet 5). Two enclosures are shown on the current edition of the OS 1:10000 map (1980).
Information from RCAHMS (AKK) 15 September 1999.

Elements still visible on recent aerial photography (Getmapping 2013).
Information from DGC (AJN) 29 April 2016

Asset Number	4
Site Name	Marbrack Burn
Type of Site	Enclosure (Period Unassigned), Wall (Period Unassigned)
NMRS Number	NX69SW 54
HER Number	MDG15850
Status	Not Designated
Easting	260330
Northing	594810
Parish	Carsphairn
Council	Dumfries And Galloway

Description	Canmore ID: 177487 Significance = Local First Edition Survey Project (FESP) Two enclosures and a short length of wall annotated 'Old Fences' are depicted on the 1st edition of the OS 6-inch map (Kirkcudbrightshire 1853, sheet 5), but they are not shown on the current edition of the OS 1:10000 map (1980). Information from RCAHMS (AKK) 15 September 1999. The two enlosures, along with a sheep fold to the east that is also depicted on the first edition map, are still visible on recent aerial photographs. The short length of wall is not visible, but the area is covered in bracken so it may still survive. Information from DGC (AJN) 11 October 2013

Asset Number	5
Site Name	Marbrack Burn
Type of Site	ENCLOSURE (PERIOD UNASSIGNED), SHEEPFOLD (PERIOD UNASSIGNED)
NMRS Number	NX69SW 55
HER Number	MDG15851
Status	Not Designated
Easting	260000
Northing	594800
Parish	Carsphairn
Council	Dumfries And Galloway
Description	Canmore ID: 177488 Significance = Local One enclosure or field annotated 'Old Fences' and an attached sheepfold annotated 'Sheep Ree' are depicted on the 1st edition of the OS 6-inch map (Kirkcudbrightshire 1853, sheet 5). One enclosure and a sheepfold are shown on the current edition of the OS 1:10000 map (1980). Information from RCAHMS (AKK) 15 September 1999.

Asset Number	6
Site Name	Knockwhirn
Type of Site	BUILDING (PERIOD UNASSIGNED)
NMRS Number	NX69NW 6
HER Number	MDG3918
Status	Not Designated
Easting	260400
Northing	595100
Parish	Carsphairn
Council	Dumfries And Galloway

Description	Canmore ID: 64328 A short distance E of a triskel sheep shelter which lies just within the N end of a circular area of c 3/4 acre, outlined by a low stone circumference, is an oval stone and turf walled house 7m by 5m over 1.5m wide walls, with a faintly turf outlined annexe attached to the S end. F Newall and W Lonie 1987

Asset Number	7
Site Name	Knockwhirn
Type of Site	BUILDING
NMRS Number	
HER Number	MDG3918
Status	Not Designated
Easting	260473
Northing	595210
Parish	Carsphairn
Council	Dumfries And Galloway
Description	Significance = Regional/Local NX69NW 6 604 951 Building A short distance E of a triskel sheep shelter which lies just within the N end of a circular area of c 3/4 acre, outlined by a low stone circumference, is an oval stone and turf walled house 7m by 5m over 1.5m wide walls, with a faintly turf outlined annexe attached to the S end. F Newall and W Lonie 1987

Asset Number	8
Site Name	Polhay Burn
Type of Site	ENCLOSURE; MOUND; BUILDING
NMRS Number	
HER Number	MDG3474
Status	Not Designated
Easting	259364
Northing	594530
Parish	Carsphairn
Council	Dumfries And Galloway
Description	Significance = Regional/Local NX59SE 28 593 945 Building; enclosure; mound Some 70m ENE of bridge piers carrying a 3m wide stone track over the Polhay Burn and close to a triskel sheep shelter is a round ended turf house 15m by 6.5m containing a room 8m by 7m with a small 2m wide cell at the S end. Nearby is a turf walled oval enclosure, possibly a

store, crossed by one leg of the sheep shelter, and some 5m long, beside a slightly hollowed mound c.4m across.
F Newall and W Lonie 1987

Asset Number	9
Site Name	Polhay Burn
Type of Site	Building (Period Unassigned), Enclosure (Period Unassigned), Mound (Period Unassigned)
NMRS Number	NX59SE 28
HER Number	
Status	Not Designated
Easting	259293
Northing	594500
Parish	Carsphairn
Council	Dumfries And Galloway
Description	NX59SE 28 593 945 Some 70m ENE of bridge piers carrying a 3m wide stone track over the Polhay Burn and close to a triskel sheep shelter is a round ended turf house 15m by 6.5m containing a room 8m by 7m with a small 2m wide cell at the S end. Nearby is a turf walled oval enclosure, possibly a store, crossed by one leg of the sheep shelter, and some 5m long, beside a slightly hollowed mound c.4m across. F Newall and W Lonie 1987

Asset Number	10
Site Name	Willieanna
Type of Site	STRUCTURE; CLEARANCE CAIRN
NMRS Number	NX59NE 1
HER Number	
Status	Not Designated
Easting	257576
Northing	595350
Parish	Carsphairn
Council	Dumfries And Galloway
Description	Awaiting Description from the HER Canmore ID: 63839 NX59NE 1 569 952 to 575 953. NX 576 953, NX 576 955 & NX 570 953: Rectangular structure 8.23m E-W x 5.49m. Group of 10 small cairns on S slope of hill. A 10.0m diameter ring cairn. Group of 11 small cairns and 5.49m diameter ring cairn. Also another 5.49m diameter ring cairn by shepherd's cairn near square tree wind break on SW approach to Willieanna (cf NT05SE 3). M L Ansell 1969

On the extensive S and SW facing slopes of Willieanna are two distinct areas of field clearance cairns.

Centred NX 569 952. Over fifty clearance cairns extend over an area of approximately 8.0 hectares between 244- 290m OD. Randomly spaced, they range from circular to oval in shape and average 4.0m in diameter and 0.4m high. No discernible field plots were found nor any ring-like features, although some of the larger cairns have had their centres robbed or disturbed.

NX 575 953. Approximately 15 clearance cairns extend over an area of about 2.0 hectares beween 304m to 319m OD. They are of similar shape and dimensions to the other group, and again no field plots or ring-like features were found.

The only structure located is at NX 5769 9532, and this is sub-square in shape, 11.0m x 10.0m, with slightly bowed 2.0m wide wall footings, mostly of turf. There is no discernible entrance and the interior is turf covered and featureless. Its age and exact purpose is unknown, and it has no obvious association with the clearance areas.

Visited by OS (JRL) 31 October 1978

References
Ansell, M. (1969f) 'Willieanna, ring and small cairns', Discovery Excav Scot, 1969. Page(s): 32

Asset Number	11
Site Name	Benloch Strand
Type of Site	FARMSTEAD (PERIOD UNASSIGNED), FIELD SYSTEM (PERIOD UNASSIGNED)
NMRS Number	NX59NE 10
HER Number	MDG15549
Status	Not Designated
Easting	258056
Northing	595400
Parish	Carsphairn
Council	Dumfries And Galloway
Description	A farmstead annotated 'Ruins of', comprising two small unroofed buildings and one enclosure, and a large enclosure or field annotated 'Old Fence' are depicted on the 1st edition of the OS 6-inch map (Kirkcudbrightshire 1853, sheet 5). Two enclosures are shown on the current edition of the OS 1:10000 map (1981). Information from RCAHMS (AKK) 15 September 1999.

Asset Number	12
Site Name	Polshagg Burn
Type of Site	SHEEP FOLD
NMRS Number	
HER Number	MDG26169
Status	Not Designated
Easting	261156
Northing	595105

Parish	Carsphairn
Council	Dumfries And Galloway
Description	Significance = Other NX 6115 9510 A rectangular sheep enclosure, with three offshoot walls, annotated 'sheep ree', is depicted on the 1st edition of the OS 6-inch map (Kirkcudbrightshire 1853, sheet 5) and on the current edition of the OS digitial Mastermap (2006). It is visible on recent (2010) aerial photographs in open ground. Information from DGC [AJN] 11 October 2013

Asset Number	13
Site Name	Polshagg Burn
Type of Site	SHEEP FOLD
NMRS Number	
HER Number	MDG26170
Status	Not Designated
Easting	261404
Northing	595354
Parish	Carsphairn
Council	Dumfries And Galloway
Description	Significance = Local NX 6140 9535 A circular sheep enclosure, with three offshoot walls, annotated 'sheep ree', is depicted on the 1st edition of the OS 6-inch map (Kirkcudbrightshire 1853, sheet 5,) and on the current edition of the OS digitial Mastermap (2006) with a polygonal enclosure added to the south. It is visible on recent (2010) aerial photographs in open ground. Information from DGC [AJN] 11 October 2013

Asset Number	14
Site Name	Beninner
Type of Site	FIELD BOUNDARY?; ENCLOSURE?
NMRS Number	
HER Number	MDG26171
Status	Not Designated
Easting	261073
Northing	596086
Parish	Carsphairn
Council	Dumfries And Galloway
Description	Significance = Other

NX 6107 9607

Two sections of old field or enclosure boundary, meeting at a ninety degrees corner, shown on the first edition Ordnance Survey map of 1853 as 'Old Fences', and still standing in open ground on the south-eastern shoulder of Beninner.
Information from DGC [AJN] 11 October 2013

Asset Number	15
Site Name	Cairnsmore Of Carsphairn
Type of Site	MARKER CAIRN (PERIOD UNASSIGNED)
NMRS Number	NX59NE 2
HER Number	MDG13437
Status	Not Designated
Easting	259461
Northing	597990
Parish	Carsphairn
Council	Dumfries And Galloway
Description	A modern cairn on the summit of Cairnsmore of Carsphairn, depicted and annotated on the latest OS 1:10000 scale map (1981). Information from RCAHMS (DE) February 2000 Significance = Other

---

Asset Number	16
Site Name	Cairnsmore Of Carsphairn
Type of Site	MARKER CAIRN (PERIOD UNASSIGNED)
NMRS Number	
HER Number	MDG3438
Status	Not Designated
Easting	259450
Northing	597999
Parish	Carsphairn
Council	Kirkcudbrightshire
Description	Significance = Unknown About one chain NE of the triangulation station on Cairnsmore of Carsphairn is the remains of a cairn locally said to have been erected by Col Colby in 1814. Name Book 1849 A marker cairn, with no evidence of antiquity. Visited by OS (JRL) 30 January 1978. (Thomas Frederick Colby went on to be head of the Ordnance Survey. He was particularly active in SW Scotland in 1813-4.)

Asset Number	17
Site Name	Beninner
Type of Site	Aircraft Crash Site
NMRS Number	
HER Number	MDG13042
Status	PMRA Protected Place
Easting	261211
Northing	596792
Parish	Carsphairn
Council	Dumfries And Galloway

Description

Source https://aviation-safety.net/wikibase/209893
Accessed: 200915

Date: 08-NOV-1939
Time: day
Type: Bristol Blenheim Mk IV
Owner/operator: Special Duties Flt Royal Air Force (Special Duties Flt RAF)
Registration: P4848
C/n / msn:
Fatalities: 1 / Occupants: 1
Other fatalities: 0
Aircraft damage: Written off (damaged beyond repair)
Location: Ben Inner, near Carsphain, Kircudbrightshire - United Kingdom
Phase: En route
Nature: Military
Departure airport: RAF Perth, Scone, Perthshire
Destination airport: RAF St. Athan, Cardiff, South Glamorgan

Narrative: Bristol Blenheim Mk.IV P4848, Special Duties Flight, RAF Perth: Written off (destroyed) 8/11/39 when crashed on Ben Inner, near Carsphairn, Kircurbrightshire. Pilot - Flight Lt Kenneth Norman Masters Eyres (Service Number 34234) - killed.

During 8/11/39 the Special Duties Flight, a unit which was testing radio and radar equipment among other things for the Air Ministry Research Establishment, were ferrying 5 aircraft (4 Blenheims and 1 Battle) from Perth to RAF St Athan. The Battle landed at Blackpool due to poor weather while three of the Blenheims arrived safely at St Athan. The last aircraft, P4848, had not landed at any airfield and was reported as overdue.

The crash site was located more than a week later on 17/11/39 on the lower slopes of Ben Inner near Carsphairn. A guard was provided by No.4 AOS at West Freugh while “the special installation” was recovered by personnel from Air Ministry Research Establishment. The special installation was probably a Mk.II Airborne Interception Radar which was first fitted to Blenheims for testing during November 1939.

Note that, officially, according to the Air Ministry file on this accident (File AIR 81/1646), Blenheim P4848 was on charge with 32 MU RAF St. Athan (as per link #2), quote: "Blenheim P4848, 32 Maintenance Unit; aircraft accident, 8 November 1939; Flight Lieutenant K N M Eyres: killed".

Sources:

1. Royal Air Force Aircraft P1000-P9999 ()James J. Halley Air Britain 1978
2. National Archives (PRO Kew) File AIR 81/1646:
https://discovery.nationalarchives.gov.uk/details/r/C16359685
3. http://www.rcawsey.co.uk/Acc1939a.htm

4. https://www.cwgc.org/find-war-dead/casualty/2455872/eyres,-kenneth-norman-masters/
5. http://www.aircrashsites-scotland.co.uk/blenheim_beninner.htm
6. https://www.peakdistrictaircrashes.co.uk/crash_sites/scotland/bristol-blenheim-p4848-beninner/
7. http://www.wtdwhd.co.uk/Beninner.html
8. http://www.scottishhills.com/html/modules.php?name=Forums&file=viewtopic&p=24305

Significance = Regional/Local

NX 612 968
Aircraft wreck

Blenheim Mk IV. No. P4848 of SD Flight, crashed 08/11/39. Very scattered.
Information from D Smith's 'High Ground Wrecks'.
Dumfries and Galloway SMR: Information entered 09/11/2000

Together with several other aircraft, Bristol Blenheim P4848 departed from RAF Perth (Scone) en route to RAF St Athan. This was one of the MOD's experimental aircraft, and was used for testing onboard electronics such as radio and radar.

Although the other Blenheims in the flight arrived safely at RAF St Athan, Blenheim P4848 failed to arrive. Ultimately, this aircraft was declared missing and a search was mounted to attempt to locate it. However, it took several days for the crash site to be located. The aircraft had crashed at Beninner [map] by Carsphairn in Dumfries and Galloway.

The pilot was killed in the crash, and is buried at Stranraer.
Flt Lt Kenneth Norman Masters Eyres, 34234, Pilot, RAF.
(Buried, Section G, Class 1, Grave 104, Stranraer (Glebe) Cemetery.)
http://www.aircrashsites-scotland.co.uk/blenheim_beninner.htm (Accessed 8 August 2014)

Asset Number	18
Site Name	Polmaddy,medieval and post-medieval settlement
Type of Site	Secular: enclosure; farmstead; field system; house; kiln; settlement, including deserted and dep
NMRS Number	
HER Number	
Status	Scheduled Monument
Easting	259026
Northing	587842
Parish	Carsphairn
Council	Dumfries And Galloway
Description	SM5391

The monument consists of the remains of the deserted village of Polmaddy, documented from the early 16th century AD.
The remains take the form of an extensive complex of fields bounded by drystone walls and containing many small cairns and, on the lower land beside the Polmaddy Burn, an area of open fields marked by traces of rig and furrow cultivation. Along the lower edge of the dry ground are the lower wall courses of several small farm building groups, characterised by rectangular houses, five kilns (three with attached barns), byres and barns. In addition there are the lower walls of a watermill, mill-pond and lade system, and foundations of a more substantial building which was once an inn. A pack-horse road runs from N to S through the E edge of the area, past the inn.
The area to be scheduled is irregular, bounded on the SE, S and SW by the N bank of the

Polmaddy Burn, on the NW, N and NE by existing fences (which are themselves excluded from scheduling). The area to be scheduled excludes the small area of the bank of the burn, which is steep and fenced off, at the W end of the modern footbridge which gives access to the site.

Accompanying map.

Asset Number	19
Site Name	Woodhead lead mines and smelter,Carsphairn
Type of Site	Industrial: house, associated office; kiln, furnace, oven; mines, quarries; non-ferrous metals; tip,
NMRS Number	
HER Number	
Status	Scheduled Monument
Easting	253133
Northing	593687
Parish	Carsphairn
Council	Dumfries And Galloway
Description	SM5184

The monument consists of the remains of a complex of lead mines and smelter, of mid-19th century date. The surface remains include a well-preserved smelter together with its stone flues and chimneys, blocks of workers' housing, and waste heaps scattered over a substantial area. There are extensive undergound workings.

The area to be scheduled includes all the elements mentioned above, together with intervening land within which evidence of the construction and use of the site may survive, and is outlined in red on the attached map.
Statement of National Importance

The monument is of national importance because of the survival of the relatively complete remains of a lead smelter with twin stone flues and chimneys in association with the remains of associated lead mines. Stone flues occur at smelters in the English lead fields, but these are the only Scottish examples. The mines were conducted on a large scale for the Scottish lead-mining industry, during the mid 19th century. The survival of the remains of workers? housing adds to the significance of the monument.

Asset Number	20
Site Name	Donald's Isle, Loch Doon, settlement 750m SSW of Lamdoughty Farm
Type of Site	Secular: hall; settlement, including deserted and depopulated and townships
NMRS Number	
HER Number	
Status	Scheduled Monument
Easting	249440
Northing	596550
Parish	Straiton
Council	East Ayrshire

Description

SM8616

The monument consists of the excavated remains, and site of, a medieval settlement with two substantial drystone buildings, and evidence for several other more fragmentary structures. The site was situated on a natural island, which has altered in its extent with changing water levels. The monument is now usually submerged, due to the level of the loch being artificially raised, and is only visible at times of extreme low water.

The remains of two rectangular buildings stand on the highest point of Donald's Isle. The buildings are of drystone construction with walls 0.8m thick, standing to a maximum height of 0.8m. The larger building measures 14m by 3.6m internally and has an entrance in the middle of its W side, and may represent a 13th or 14th century hall house.

Attached to this structure on the north is a secondary walled structure, and further to the north there is evidence of a timber building in the form of a horse-shoe setting of stones and many flat-headed iron nails. The smaller drystone building measures 6m by 3m internally and has an entrance in its W end. A setting of stones, apparently springing from the NW corner of the main structure, enclosed the complex except on the SW.

Access to the island was probably gained on the NW where a passageway has been cleared through the boulders of the beach deposit. Excavations carried out between 1933 and 1936 showed that the buildings may overlie earlier structures. Although substantially excavated, further archaeological deposits may be expected to survive.

The area to be scheduled is circular in shape, with a diameter of 60m to include the two upstanding drystone structures, the associated drystone walls, the causeway, and an area around it, within which associated remains are expected to survive, as marked in red on the accompanying map extract.
Statement of National Importance

The monument is of national importance as the site of a relatively well-preserved 13th or 14th-century domestic site which has the potential to contribute further to our understanding of such medieval domestic structures, their social history and material culture. The site is undefended apart from its island location, and represents a rare survival of what must have been a relatively common settlement type.

Bibliography
RCAHMS records the monument as NX 49 NE 1.

References:
Ansell, M. (1969) 'Donald's Isle, Medieval complex and Mesolithic materials', Discovery and Excavation, Scotland, 1969, 12.

Blaeu, J. (1654) Theatrum Orbis Terrerum, sive Atlas Novus, Vol. 5; Scotice et Hibernia, Amsterdam, (The northern part of Carrick).

Fairbairn, A. (1937) Excavation of a medieval site on Donald's Isle, Loch Doon, Ayrshire', Proc Soc Antiq Scot, 71, 1936-7, 323-33.

RCAHMS (1983) The Royal Commission on the Ancient and Historical Monuments of Scotland. The archaeological sites and monuments of North Carrick, Kyle and Carrick District, Strathclyde Region, The archaeological sites and monuments of Scotland series no 17, Edinburgh, 29, No. 205.

Truckell, A. E. and Williams, J. (1967) 'Medieval pottery in Dumfriesshire and Galloway', The Dumfriesshire Galloway Natur Hist Antiq Soc, 3rd Ser, 44, 1966-7, 173.

Asset Number 21

Site Name	Loch Doon Castle, original site & remains of, 570m NE of Craigmalloch
Type of Site	Secular: castle
NMRS Number	
HER Number	
Status	Scheduled Monument
Easting	248813
Northing	594758
Parish	Straiton
Council	East Ayrshire
Description	SM8619

The monument consists of the original island site and partial remains of Loch Doon castle. It is situated on a small island, known as Castle Island, at the S end of Loch Doon. The site is usually submerged with only the tops of the walls of the castle visible.

The castle was documented in 1306 when it fell to the English, marking the elimination of the last Bruce stronghold in the SW. The castle was again documented in 1333 when it was one of the few strongholds still held for David II.

The castle dates from the late 13th-century castle and has an extremely unusual eleven-sided curtain wall constructed of high quality ashlar masonry. In the first half of the 16th-century a small tower was added to the inside of the west wall. The castle was dismantled and rebuilt on the shore of the loch c1935, in advance of increasing water levels.

However, the wall core of the curtain wall was left on Castle Island, and archaeological deposits are also likely to have survived. Several dugout canoes were discovered on the island in the early 19th-century.

The area to be scheduled is circular in shape, with a diameter of 100m to include the upstanding masonry and an area around it, within which associated remains are expected to survive: as marked in red on the accompanying map extract.

Statement of National Importance
The monument is of national importance as the remains of a 13th-century castle which has the potential to contribute to our understanding of medieval defensive and domestic structures, their social history and material culture. Its importance is further enhanced by the association of the castle with the Bruce family and its involvement in the Wars of Independence.

References
Bibliography
RCAHMS records the monument as NX 49 SE 1.

Bibliography:
Cruden, S. (1960) The Scottish castle, Edinburgh, 50-4.

MacGibbon, D. and Ross, T. (1887-92) The castellated and domestic architecture of Scotland from the twelfth to the eighteenth centuries, 5v, Vol. 3, 96-106, Edinburgh.

NSA (1845) The new statistical account of Scotland by the ministers of the respective parishes under the superintendence of a committee of the society for the benefit of the sons and daughters of the clergy, 15v, Edinburgh, Vol. 5 (Ayr), 337.

RCAHMS (1983) The Royal Commission on the Ancient and Historical Monuments of Scotland. The archaeological sites and monuments of North Carrick, Kyle and Carrick District, Strathclyde Region, The archaeological sites and monuments of Scotland series no 17, Edinburgh, 25, No. 174.

Asset Number	22
Site Name	Loch Doon Castle
Type of Site	Secular: castle
NMRS Number	
HER Number	
Status	Scheduled Monument
Easting	248411
Northing	595014
Parish	Straiton
Council	East Ayrshire
Description	SM90203

The monument consists of the rebuilt remains of Loch Doon Castle, surviving as a substantial stone structure. The castle is located on the west side of Loch Doon, 4km south of Dalmellington.

The castle dates from the late 13th century, and has an extremely unusual eleven-sided curtain wall constructed of high quality ashlar masonry, with the entrance in the north. The entrance was through a large pointed arch entry, with evidence of double doors and a portcullis. In the first half of the 16th century a small tower was added to the inside of the west wall. The re-erected remains do not include this later work.

The castle was documented in 1306 when it fell to the English, marking the elimination of the last Bruce stronghold in the south-west. The castle was again documented in 1333 when it was one of the few strongholds still held for David II. Loch Doon Castle was supposedly destroyed by fire during the reign of James V. In the 19th century the castle was quarried for stone, used in the construction of a nearby shooting lodge. The castle was dismantled and rebuilt 400m to the northwest on the shore of the loch in 1935, when the water level was raised for a hydro-electric scheme. All the architectural carved stonework was reconstructed, while the wall core of the curtain wall was left on Castle Island. There is no potential for below-ground archaeology associated with the rebuilt castle beyond evidence of the reconstruction work.

The scheduled area comprises of only the upstanding fabric of the rebuilt castle walls and their associated foundations, as marked in red on the accompanying map.

Statement of National Importance
The monument is of national importance as an unusual example of a polygonal castle of enclosure. This castle played an important strategic role in the Wars of Independence. The surviving architecture, albeit reconstructed, has the potential to inform an understanding of high-quality castellated architecture and planning of the late 13th century. This importance is further reinforced by the fact that this form of castle plan is out of place in lowland Scotland, and is more usually associated with the Gaelic west. This is a rare example of an early 20th century large-scale conservation project, which indicates the considerable importance attached to the fabric of the monument at that time.

References
Bibliography
RCAHMS records the monument as NX49SE1.

References:
Cruden S 1960, THE SCOTTISH CASTLE, Edinburgh, 50-4.

Dunbar J G 1966, THE HISTORIC ARCHITECTURE OF SCOTLAND, London, 24-5.

Grieg S 1940, VIKING ANTIQUITIES IN SCOTLAND, Viking antiquities in Great Britain and Ireland Part II, Oslo, 153-4.

MacGibbon D and Ross T 1887-92, THE CASTELLATED AND DOMESTIC ARCHITECTURE OF SCOTLAND FROM THE TWELFTH TO THE EIGHTEENTH CENTURIES, 5v, Edinburgh, Vol. 3, 96-106.

McCormick A 1947, GALLOWAY, THE SPELL OF ITS HILLS AND GLENS, Glasgow, 18, 57, 96-8, 219.

NSA 1845, THE NEW STATISTICAL ACCOUNT OF SCOTLAND BY THE MINISTERS OF THE RESPECTIVE PARISHES UNDER THE SUPERINTENDENCE OF A COMMITTEE OF THE SOCIETY FOR THE BENEFIT OF THE SONS AND DAUGHTERS OF THE CLERGY, 15v, Edinburgh, Vol.5 (Ayr), 337.

RCAHMS 1983, THE ARCHAEOLOGICAL SITES AND MONUMENTS OF NORTH CARRICK, KYLE AND CARRICK DISTRICT, STRATHCLYDE REGION, The Archaeological Sites and Monuments of Scotland Series No. 17, 25, No. 174, Edinburgh,

Stevenson J B 1985, EXPLORING SCOTLAND'S HERITAGE: THE CLYDE ESTUARY AND CENTRAL REGION, Exploring Scotland's heritage series, Edinburgh, 69, No. 35.

Stevenson J B 1995, EXPLORING SCOTLAND'S HERITAGE: GLASGOW, CLYDESIDE AND STIRLING, Exploring Scotland's Heritage series, Edinburgh, No. 37, 92-3, 2nd ed.

Swan J 1837, SWAN'S VIEWS OF THE LAKES OF SCOTLAND, 2v, Glasgow.

Asset Number	23
Site Name	Earlston Castle
Type of Site	Secular: castle
NMRS Number	NX68SW 1
HER Number	
Status	Scheduled Monument
Easting	261274
Northing	584029
Parish	Dalry (Dumf & Galloway)
Council	Dumfries And Galloway
Description	SM1118

From NX68SW 1/Canmore ID 64287

NX68SW 1 61268 84022.

(NX 6126 8402) Earlstoun Castle (NR).

OS 6" map (1957)

Earlstoun Castle (N Tranter 1965), now in a poor state of repair, is a typical laird's house of late 16th or early 17th century date. It is L-planned, with a main block of three storeys and a garret; the rubble walls are 4ft thick and the gables are not crowstepped. Low extensions have been added at an early date to both gables and curtain walls have enclosed a courtyard, but little of these now remain. Some windows have been enlarged and altered, and beneath a first-floor window on the S side of the main block is a stone dated 1655; this is shown by MacGibbon and

Ross (1889) on the E addition, now ruinous, to the erection of which the date apparently refers.

In the 16th century Earlstoun belonged to the Sinclairs, passing to the Gordons in the late 16th or early 17th century when this house would be erected, probably on the site of an earlier stronghold.

RCAHMS 1914, visited 1911

Earlstoun Castle (name verified by Capt Forbes, Earlstoun Lodge, Dalry), is unoccupied and is now part of a group of farm outbuildings. It is in a good state of repair externally and the 1655 datestone and the moulded window frames are well preserved. The "low extensions" are visible as turf-covered footings and parts of the curtain wall are still evident. Surveyed at 1:2500.

Visited by OS (TRG) 16 February 1978

The castle has now fallen into a state of disrepair and the internal structures are in danger of giving way. The upper floors have collapsed, leaving walls wthout proper lateral ties. The owners now wish to stabilise the structure and reinstate the missing floors. Before this work took place, GUARD undertook a standing building recording.

The castle is an L-shaped tower house, built in greywacke rubble with sandstone dressings. The dressings sit proud of the rubble masonry, suggesting that the building was originally harled. The smaller wing of the castle comprises a turnpike stair and turret stair and two rooms. The principal wing has three stories and an attic. The interior walls are of rubble masonry and between 0.6m and 1.2m thick. The ground floor is barrel-vaulted and has two rooms. The first floor runs the entire length of the wing. This was the main hall and has 4 window openings, which have been enlarged at some point. There are still the remains of finely-carved woodwork, including panelling, rails, skirting and a cornice. The interior panelling and design was changed on a number of occasions, including around 1660. The second floor is accessed through the turret stair through a panelled passageway, since destroyed. This floor is divided into two rooms by a timber-panelled partition. There has been much alteration work, including the windows, which have been enlarged. Another window has been filled in with rubble masonry. This floor has remnants of wooden panelling and a plasterwork ceiling. The attic is accessed through the turret stair. A wall in the attic was heightened by 0.45m in order to facilitate the fastening of pendant posts to stabilise the rafters. No flooring in the attic has survived.

C Francoz 2005

Watching Brief (7 March 2011 - 17 March 2011)

GUARD Archaeology Limited were commissioned by ARP Lorimer to undertake an archaeological watching brief during the installation of services at Earlstoun Castle, St John's Town of Dalry, Dumfries and Galloway (NGR: NX 61268 84022). The work was undertaken between the 7th and 17th March 2011 and revealed no features or artefacts of archaeological significance.

Archive: RCAHMS and WoSAS
Funder: ARPL Architects Ltd
GUARD Archaeology Ltd 2011
Information also reported in Oasis (guardarc1-100643) 15 November 2012

References
Arabaolaza and Thomson, I and R. (2011) 'Earlstoun Castle, Dumfries and Galloway (Dalry parish), watching brief', Discovery Excav Scot, New, vol. 12, 2011. Cathedral Communications Limited, Wiltshire, England. Page(s): 59
Coventry, M. (2008) Castles of the Clans: the strongholds and seats of 750 Scottish families and clans. Musselburgh. Page(s): 230,272,532 RCAHMS Shelf Number: F.5.21.COV
MacGibbon and Ross, D and T. (1887-92) The castellated and domestic architecture of Scotland from the twelfth to the eighteenth centuries, 5v. Edinburgh. Page(s): Vol.3, 521-3 RCAHMS

Shelf Number: F.5.21.MAC
Maxwell-Irving, A M T. (2000) The Border towers of Scotland: their history and architecture: the West March. [S.l.]. Page(s): 126-9 Fig 198 RCAHMS Shelf Number: F.5.21.MAX
Maxwell-Irving, A M T. (2014) The Border towers of Scotland 2: their evolution and architecture. [S.l.]. Page(s): 128-9 Pl.2.20 RCAHMS Shelf Number: F.5.21.MAX
RCAHMS. (1914) The Royal Commission on the Ancient and Historical Monuments and Constructions of Scotland. Fifth report and inventory of monuments and constructions in Galloway, II, county of the Stewartry of Kirkcudbright. Edinburgh. Page(s): 83-5, No.155 fig.66 RCAHMS Shelf Number: A.1.1.INV(5).R
Tranter, N. (1962-70) 'The fortified house in Scotland'. Edinburgh. Page(s): Vol.3, 109-10 RCAHMS Shelf Number: F.5.21.TRA

Asset Number	24
Site Name	Cairn Avel,cairn 800m S of Carsphairn
Type of Site	Prehistoric ritual and funerary: cairn (type uncertain)
NMRS Number	NX59SE 2
HER Number	
Status	Scheduled Monument
Easting	255941
Northing	592461
Parish	Carsphairn
Council	Dumfries And Galloway
Description	SM1006

From NX59SE 2/Canmore ID: 63868

NX59SE 2 5594 9245.

(NX 5593 9245) Cairn Avel (NR)

OS 6" map (1957)

Cairn Avel, a long cairn, is about 118ft E by S to W by N. For about 50ft from the W end, the cairn has been so completely demolished that this area rises only 1ft above ground level, though the edge is obvious. Presumably this part of the cairn has been used for building the nearby walls, one of which runs along the N side of the cairn. The rest of the monument remains as a fine steep-sided cairn of bare stones 10ft high. The width at the E end is about 73ft but at the NE corner the cairn material extends about 10ft outside the steeply rising point of the cairn at a gentler pitch. As the ground dips into a hollow at this corner, this extension of the cairn may be a platform foundation for the main cairn, on the other hand it may be that the cairn has been much robbd round this corner, and the original width of the cairn was about 83 ft. The sides of the cairn taper westwards to about 30ft across at the W end. Three slabs, set on their edges and projecting 1ft high, may be parts of a peristalith. Two slabs are at the W end about 3 ft within the cairn edge, and the other is 5ft within the S edge 27ft to the E. These stones suggest a strictly trapezoidal plan with squared W end, though the cairn edge at the W end is now rounded in plan. The E end of the cairn is curiously irregular, being concave towards the SE corner, and it has not obviously been robbed.

A S Henshall 1972, visited 1962; RCAHMS 1914

NX 5594 9245 A long cairn as described and planned by Miss Henshall. Surveyed at 1:10 000.

Visited by OS (BS) 15 February 1978

References
Henshall, A S. (1972a) The chambered tombs of Scotland, vol. 2. Edinburgh. Page(s): 447, KRK 6 RCAHMS Shelf Number: E.7.1.HEN
RCAHMS. (1914) The Royal Commission on the Ancient and Historical Monuments and Constructions of Scotland. Fifth report and inventory of monuments and constructions in Galloway, II, county of the Stewartry of Kirkcudbright. Edinburgh. Page(s): 64, No.94 RCAHMS Shelf Number: A.1.1.INV(5).R

Asset Number	25
Site Name	Holm of Daltallochan,stone circle & standing stone
Type of Site	Prehistoric ritual and funerary: standing stone; stone circle or ring
NMRS Number	NX59SE 4; NX59SE 10
HER Number	
Status	Scheduled Monument
Easting	255310
Northing	594233
Parish	Carsphairn
Council	Dumfries And Galloway
Description	SM1029

From NX59SE 4/Canmore ID: 63878
NX59SE 4 5528 9422.
(NX 5528 9422) Stone Circle (NR).
OS 6" map (1957)

This stone circle, in a low-lying meadow, and around a slight elevation, consists of 13 irregularly-shaped masses of whinstone rock and boulders, varying in size as exposed, from 2ft to 7ft 3 ins in length. They are nearly all displaced (except one large mass which stands just E of N) and lie prostrate, several being considerably overgrown with turf. The setting is an irregular oval, 81ft NNE-SSW by 59ft. It narrows towards the SSW, where the outline is slightly concave, as if some of the stones had been moved from their original positions.

RCAHMS 1914, visited 1911; F R Coles 1895

Though Coles' stylised plan broadly fits Burl's compound ring category, it is listed only as a possible stone circle and described as unconvincing.
A Burl 1976

This setting of 13 stones cannot be classified with any certainty. The stones, as stated, vary greatly in size and shape and though all appear artificially placed they rest without any apparent regard for grading, orientation or visual effect. No socket depressions are evident. Coles' plan bears little relation to the present setting which forms a crude oval measuring 24.0m N-S by 20.0m E-W.
Surveyed at 1:10 000.
Visited by OS (JRL) 27 February 1978

References
Burl, {H} A {W}. (1976a) The stone circles of the British Isles. London and New Haven. Page(s): 42, 203, 205, 360 RCAHMS Shelf Number: E.7.BUR
Coles, F R. (1895b) 'The stone circles of the Stewartry of Kirkcudbright', Proc Soc Antiq Scot, vol. 29, 1894-5. Page(s): 310-11 fig.7
RCAHMS. (1914) The Royal Commission on the Ancient and Historical Monuments and

Constructions of Scotland. Fifth report and inventory of monuments and constructions in Galloway, II, county of the Stewartry of Kirkcudbright. Edinburgh. Page(s): 65, No.97 RCAHMS Shelf Number: A.1.1.INV(5).R

From NX59SE 10/Canmore ID:63858

NX59SE 10 5539 9420.

There is a standing stone in the same field as, and about 110 yds SE of, stone circle NX59SE 4 (at NX 552 942). It is 3ft 10 ins high and is almost rectangular in section, measuring 2ft x 1ft 5 ins and facing directly towards the circle.

RCAHMS 1914, visited 1911

NX 5539 9420. This whinstone standing stone is as described, and is situated on level ground against a modern dry stone dyke. Its direction from the stone circle is approximately ESE and it is clearly visible from it.

Surveyed at 1:10 000.

Visited by OS (JRL) 27 February 1978

References

RCAHMS. (1914) The Royal Commission on the Ancient and Historical Monuments and Constructions of Scotland. Fifth report and inventory of monuments and constructions in Galloway, II, county of the Stewartry of Kirkcudbright. Edinburgh. Page(s): 65, No.98 RCAHMS Shelf Number: A.1.1.INV(5).R

Asset Number	26
Site Name	Holm of Daltallochan,cross slab
Type of Site	Crosses and carved stones: cross slab
NMRS Number	NX59SE 9
HER Number	
Status	Scheduled Monument
Easting	255520
Northing	594167
Parish	Carsphairn
Council	Dumfries And Galloway
Description	SM1106

From NX59SE 9/Canmore ID: 63883
EARLY MEDIEVAL CARVED STONES PROJECT
Holm of Daltallochan, Carsphairn, Kirkcudbrightshire, cross-slab
Measurements: H 0.84m, W 0.38m, D 0.12m
Stone type: sandstone
Place of discovery: NX 5552 9416

Evidence for discovery: it was found at the farm of Holm of Daltallochan, but local tradition holds that it came from the Cairn of Daltallochan (63857) to the NNW of the farm, when the cairn was robbed of its stones in 1849.

Present location: in the garden of Holm of Daltallochan farm.

Present condition: good.

Description:

One broad face of this irregularly shaped slab is firmly incised with an outline cross with a circle at the centre of the cross-head.

Date: early medieval.

References: ECMS pt 3, 480; Craig 1992, vol 2, 306-10.

Desk-based information compiled by A Ritchie 2019

Field Visit (31 July 1911)

99. Cross-slab, Daltallachan.—Standing on the east side of the approach to the farm-house of Holm of Daltallochan is a slab (fig. 59) incised with a cross, having a circular boss 2 inches wide in the centre, and arms expanding from 3 inches at the point of intersection to 5 inches at the edge of the stone. The shaft also broadens to the foot, which is rounded. The extreme length of the cross is 2 feet 5 inches, and its breadth across the arms 1 foot 2 inches. This cross was brought to its present position from the neighbouring farm of Garryhorn, whence it is said to have come from the cairn of Daltallochan (No. 106).

Visited by RCAHMS 31st July 1911.

Desk Based Assessment (1 May 1974)

Ordnance Survey Archaeology Division Revision Programme

NX59SE 9 55521 94162.

In the garden at the side of the farmhouse of Holm of Daltallachan, (NX 554 941) is an irregular sandstone slab, 2ft 9ins high by 1ft 3ins wide, on which is incised a Latin cross with slightly expanded arms; the bottom of the shaft is joined by a curved line, and there is a circle at the centre between the arms.

It was brought to its present position from Garryhorn farm, and M'Diarmid states that it originally was found about 1850, at the bottom of the Cairn of Daltallachan (NX59SE 1).

Information from OS (IF) 1 May 1974

C L Curle 1964; W R M'Diarmid 1880; RCAHMS 1914, visited 1911

Field Visit (27 February 1978)

NX 5551 9415 The cross incised slab is set on end in a shrubbery of the farm garden. The tradition of it originally being found at the Cairn of Daltallachan is still current, but local information confirms that within living memory it has always stood at its present site.

The Latin cross is very similar to those at Braidenoch Hill (see NX59SE 3) which Truckell dates as 10th-11th Century.

Visited by OS (JRL) 27 February 1978

References
Curle, C L. (1964) 'Some little known early christian monuments in the West of Scotland', Proc Soc Antiq Scot, vol. 95, 1961-2. Page(s): 226
M'Diarmid, W R. (1880) 'Notes on cairns, a stone circle, and an incised stone in Carsphairn, Kirkcudbrightshire', Proc Soc Antiq Scot, vol. 14, 1879-80. Page(s): 284-5
RCAHMS. (1914) The Royal Commission on the Ancient and Historical Monuments and

Constructions of Scotland. Fifth report and inventory of monuments and constructions in Galloway, II, county of the Stewartry of Kirkcudbright. Edinburgh. Page(s): 65, No.99 RCAHMS Shelf Number: A.1.1.INV(5).R

Asset Number	27
Site Name	Stroanfreggan Bridge,cairn
Type of Site	Prehistoric ritual and funerary: cairn (type uncertain)
NMRS Number	NX69SW 4
HER Number	
Status	Scheduled Monument
Easting	264013
Northing	591418
Parish	Dalry (Dumf & Galloway)
Council	Dumfries And Galloway
Description	SM1043

From NX69SW 4/Canmore ID: 64370

NX69SW 4 6401 9142.

(NX 6401 9142) Stroanfreggan Cairn (NR)

OS 6" map (1957)

Stroanfreggan Cairn, situated at the edge of a bank on low-lying ground, is a large circular cairn, 73 ft N-S by 76 ft transversely. It has been much used as a quarry and in 1910 a cist was found at a point 25 ft in from the E arc of the perimeter. This measured 3 ft 5 ins x 2 ft x 2 ft 3 ins internally, beneath a cover stone, 5 x 4 ft. The sides were formed by four large slabs the joints between which were eked with smaller stones and luted with clay. It contained a plano-convex flint knife, now in the NMAS. The periphery of the cairn has been marked by large boulders, 2-3 ft in length and 1 1/2-2ft in height of which three only remain, while the beds from which others have been removed are distinct. Some loose soil lying in the neighbourhood yielded four small chippings of flint and bone fragments mixed with charcoal in 1910. Flints, clay luting and a fragment of thin bronze, possibly from a bifid razor, from this cairn, are in Dumfries Museum.

RCAHMS 1914, visited 1911; J Corrie 1911; R W Feachem 1963; A E Truckell 1964

The remains of Stroanfreggan Cairn, name verified, are generally as described. Heavily robbed, it measures 26.5m in overall diameter and survives 1.6m high on its S side. The cist, in situ and sunk into the floor of the cairn, is only partially visible beneath its cover stone (A on plan). Three set stones (B, C and D) and three probable socket holes (E, F and G) suggest an intermittent kerb. The socket holes average 0.8m by 0.6m and are 0.3m deep. A stone (H) of similar proportions to the kerb stones is embedded in the central area of the cairn to the W of the cist. Its significance is not evident.

Surveyed at 1:10 000.

Visited by OS (JRL) 7 October 1978.

References
Corrie, J. (1911) 'Notice of the discovery of a Stone-Age cist in a large cairn at Stroanfreggan, Parish of Dalry, Kirkcudbrightshire', Proc Soc Antiq Scot, vol. 45, 1910-11. Page(s): 428-34

Feachem, R. (1963b) A guide to prehistoric Scotland. 1st. London. Page(s): 79-80 RCAHMS Shelf Number: E.2.FEA
RCAHMS. (1914) The Royal Commission on the Ancient and Historical Monuments and Constructions of Scotland. Fifth report and inventory of monuments and constructions in Galloway, II, county of the Stewartry of Kirkcudbright. Edinburgh. Page(s): 88, No.160 RCAHMS Shelf Number: A.1.1.INV(5).R
Truckell, A E. (1964a) 'The archaeological collections of the Society', Trans Dumfriesshire Galloway Natur Hist Antiq Soc, 3rd, vol. 41, 1962-3. Page(s): 58

Asset Number	28
Site Name	The King's Cairn,chambered cairn and cairn to W of Water of Deugh
Type of Site	Prehistoric ritual and funerary: cairn (type uncertain); chambered cairn
NMRS Number	NS50SE 1
HER Number	
Status	Scheduled Monument
Easting	255421
Northing	601154
Parish	Carsphairn
Council	Carsphairn
Description	SM1046

The monument consists of two cairns, separated by some distance and set in clearings in forestry planting.

The larger cairn, the King's Cairn, is circular on plan. It has been robbed to the level of the chambers, and was cleared and excavated in 1928. It is of the Bargrennan group, with a diameter of 19m. It contains two chambers at least, each being 3m long and lying on the same NW-SE axis.

The second cairn lies 330m to the SW. It is round, 10m across and 0.7m high, with a small modern cairn on its E side. It appears to be unexcavated.

The area to be scheduled is in two parts, corresponding to the clear area at each cairn. At the King's Cairn, a circle 30m in diameter, and at the SW cairn a circle 20m in diameter, to include the cairns and a small area around each in which evidence relating to their construction and use may survive, as marked in red on the accompanying map.

Statement of National Importance
The monument is of national importance as a pair of cairns in close proximity, one of which may be unexcavated. Each has the potential to provide information about prehistoric burial practices and ritual beliefs, and comparison between the two may be illuminating as regards the variety of cairn-building practised in the late Neolithic and early Bronze Age periods.

References
Bibliography
The monument is recorded in RCAHMS as NS 50 SE 5 and NS 50 SE 1.

From NS50SE 1/Canmore ID: 43493

NS50SE 1 5542 0114.

(NS 5542 0114) Chambered Cairn (NR).

OS 6" map (1958)

The robbed remains of 'The King's Cairn' a Bargrennan-type, chambered, round cairn which was cleared by Curle in 1928 having been previously robbed to chamber-level. It still remains to this level, the centre being an untidy mass of small stones and boulders although the greater part of the cairn is turf-covered. It measures 70ft across and stands 1 to 2 ft high except toward the SE where it reaches a maximum height of 4ft.

A relatively modern wall encircles the cairn a little outside its edge.

RCAHMS 1914; A O Curle 1930; A S Henshall 1972.

The King's Cairn - name unconfirmed, is generally as described and measures overall 19.5m N-S by 18.5m transversely.

The remains of two chambers at least 3.0m long and on the same NW-SE axis, comprise standing slabs and walling of large stones. The E wall of the southern chamber is neatly corbelled to a height of 0.9m. Over the N chamber are two overlapping roofing slabs and a third which appears to be a modern placing. Further chamber or passage detail on the same axis, and shown on the plan is now largely obscured by tumble.

Surveyed at 1:10 000.

Visited by OS (JRL) 25 October 1978.

References
Curle, A O. (1930) 'Examination of a chambered cairn by the Water of Deugh, Stewartry of Kirkcudbright', Proc Soc Antiq Scot, vol. 64, 1929-30. Page(s): 272-5
Henshall, A S. (1972a) The chambered tombs of Scotland, vol. 2. Edinburgh. Page(s): 455-6, KRK 13 RCAHMS Shelf Number: E.7.1.HEN
RCAHMS. (1914) The Royal Commission on the Ancient and Historical Monuments and Constructions of Scotland. Fifth report and inventory of monuments and constructions in Galloway, II, county of the Stewartry of Kirkcudbright. Edinburgh. Page(s): 63-4, No.91 RCAHMS Shelf Number: A.1.1.INV(5).R

Asset Number	29
Site Name	The King's Cairn,chambered cairn and cairn to W of Water of Deugh
Type of Site	Prehistoric ritual and funerary: cairn (type uncertain); chambered cairn
NMRS Number	NS50SE 5
HER Number	
Status	Scheduled Monument
Easting	255210
Northing	600890
Parish	Carsphairn
Council	Carsphairn
Description	SM1046

The monument consists of two cairns, separated by some distance and set in clearings in forestry planting.

The larger cairn, the King's Cairn, is circular on plan. It has been robbed to the level of the chambers, and was cleared and excavated in 1928. It is of the Bargrennan group, with a diameter of 19m. It contains two chambers at least, each being 3m long and lying on the same NW-SE axis.

The second cairn lies 330m to the SW. It is round, 10m across and 0.7m high, with a small modern cairn on its E side. It appears to be unexcavated.

The area to be scheduled is in two parts, corresponding to the clear area at each cairn. At the King's Cairn, a circle 30m in diameter, and at the SW cairn a circle 20m in diameter, to include the cairns and a small area around each in which evidence relating to their construction and use may survive, as marked in red on the accompanying map.

Statement of National Importance
The monument is of national importance as a pair of cairns in close proximity, one of which may be unexcavated. Each has the potential to provide information about prehistoric burial practices and ritual beliefs, and comparison between the two may be illuminating as regards the variety of cairn-building practised in the late Neolithic and early Bronze Age periods.

References
Bibliography
The monument is recorded in RCAHMS as NS 50 SE 5 and NS 50 SE 1.

From NS50SE 5/Canmore ID: 43497

NS50SE 5 5521 0089.

(NS 5521 0089) Cairn (NAT)

OS 6" map (1958)

This circular cairn, somewhat dilapidated and apparently unexcavated, measures about 30ft in diameter and 2ft 6 ins high.

RCAHMS 1914, visited 1911

This badly robbed and much spread cairn is situated on the crest of a S-facing slope in a forestry clearing. It is approximately 10.0m in overall diameter and 0.7m high, with a small shepherd's cairn constructed on its E side.

Surveyed at 1:10 000.

Visited by OS (JRL) 31 October 1978

References
RCAHMS. (1914) The Royal Commission on the Ancient and Historical Monuments and Constructions of Scotland. Fifth report and inventory of monuments and constructions in Galloway, II, county of the Stewartry of Kirkcudbright. Edinburgh. Page(s): 63, No.90 RCAHMS Shelf Number: A.1.1.INV(5).R

Asset Number	30
Site Name	Stroanfreggan Craig,fort,Smittens Bridge
Type of Site	Prehistoric domestic and defensive: fort (includes hill fort and promontory fort)
NMRS Number	
HER Number	
Status	Scheduled Monument
Easting	263690

Northing	592071
Parish	Dalry (Dumf & Galloway)
Council	Dumfries And Galloway
Description	SM1095

From NX69SW 5/Canmore ID: 64376
NX69SW 5 63700 92064.
(NX 6371 9207) Camp (NR).
OS 6" map (1957)

This fort occupies the most prominent point of Stroanfreggan Craig. The main enclosure, which occupies the actual summit, measures about 140 ft by 125 ft within a ruinous wall, spread to 25 ft. This is covered by other walls to the NE, NW and SW; the tangential wall going downhill from the outer rampart on the W is a comparatively modern dyke (RCAHMS MSS., visited 1951).
The general appearance of this fort is comparable with that at Trusty's Hill (NX55NE 2) (R W Feachem 1963). Truckell considers this to be a Dark Age work, with no evidence of Iron Age origins.
RCAHMS 1914, visited 1911; A E Truckell 1963

This fort probably of entirely Iron Age date is generally as described, with double stone walls around the N and W sides enclosing an outcropping and featureless interior of 50.0m E-W by 38.0m N-S. Both walls around the N and W sides and a perimeter wall along the cliff-faced SE side have been robbed to base level. The inner wall was probably up to 5.0m broad, and the outer, varying from 5.0 to 10.0m distant, averages 3.0m broad. The only facing material visible is an intermittent line of stones around the NE arc of the outer wall, though the vast quantities of outward tumble from the inner wall probably obscures further detail.
Entrance may have been gained by a steep approach up a natural hollow from the S, or from a possible side entrance along the cliff edge on the E side. The tumbled south wall of the fort appears to continue along the cliff edge away to the E of the main work; however this is possibly a later dyke.
Surveyed at 1:10 000.
Visited by OS (JRL) 22 October 1978.

Field Visit (14 August 1951)
RCAHMS Marginal Land Survey
This site was included within the RCAHMS Marginal Land Survey (1950-1962), an unpublished rescue project. Site descriptions, organised by county, are available to view online - see the searchable PDF in 'Digital Items'. These vary from short notes, to lengthy and full descriptions. Contemporary plane-table surveys and inked drawings, where available, can be viewed online in most cases - see 'Digital Images'. The original typecripts, notebooks and drawings can also be viewed in the RCAHMS search room.
Information from RCAHMS (GFG) 19 July 2013.

Note (20 December 2013 - 23 May 2016)
Atlas of Hillforts of Britain and Ireland
This fort occupies a local summit at the lower SW end of Stroanfreggan Craig, which is a rocky ridge that falls away sharply along its SE flank. The defences comprise two stone ramparts set between 5m and 10m apart, both of which are heavily robbed. The inner, however, has probably been in the order of 5m in thickness and encloses a D-shaped area on the summit measuring about 50m from ENE to WSW parallel with the edge of the crag by 38m transversely. The ends of the outer apparently rest on the edge of the crag. The entrance has probably been on the S, where a steep gully between the outcrops provides access to the interior rocky interior. Elements of the defences have been incorporated into the lines of more recent stone dykes, one of which can be seen approaching the fort along the edge of the crag from the from the ENE and another dropping down the slope on the W.
Information from An Atlas of Hillforts of Great Britain and Ireland – 23 May 2016. Atlas of Hillforts SC0263

References
Feachem, R. (1963b) A guide to prehistoric Scotland. 1st. London. Page(s): 131 RCAHMS Shelf Number: E.2.FEA
RCAHMS. (1914) The Royal Commission on the Ancient and Historical Monuments and Constructions of Scotland. Fifth report and inventory of monuments and constructions in Galloway, II, county of the Stewartry of Kirkcudbright. Edinburgh. Page(s): 87-8, No.159 fig.67 RCAHMS Shelf Number: A.1.1.INV(5).R
RCAHMS. (1950-9) Marginal Land Survey (unpublished typed site descriptions), 3 volumes. Page(s): v2 RCAHMS Shelf Number: A.1.1.MAR
Truckell, A E. (1963b) 'Dumfries and Galloway in the Dark Ages: some problems', Trans Dumfriesshire Galloway Natur Hist Antiq Soc, 3rd, vol. 40, 1961-2. Page(s): 95

Asset Number	31
Site Name	Craigengillan,cairn
Type of Site	Prehistoric ritual and funerary: cairn (type uncertain)
NMRS Number	
HER Number	
Status	Scheduled Monument
Easting	262696
Northing	594489
Parish	Carsphairn
Council	Dumfries And Galloway
Description	SM2238

From NX69SW 1/Canmore ID: 64336
NX69SW 1 6269 9448.
(NX 6270 9448) Cairn (NR)
OS 6" map (1957)

This circular cairn, on the crest of the moorland, measures 77ft in diameter N-S by 82ft and is 10ft high. At the base is a kerb of large rounded boulders, contrasting with the angular fragments of stone on the surface. Two walls have been erected to form a sheep shelter on top of the cairn.
RCAHMS 1914, visited 1911

NX 6269 9448. The cairn is generally as described, though is now surrounded by forestry ploughing which has mutilated the periphery. On the W edge, two large contiguous stones, one partially buried and the other 1.2 x 0.6 x 0.6m may be part of a kerb but no others are now evident.
Surveyed at 1:10 000.
Visited by OS (JRL) 20 October 1978.

References
RCAHMS. (1914) The Royal Commission on the Ancient and Historical Monuments and Constructions of Scotland. Fifth report and inventory of monuments and constructions in Galloway, II, county of the Stewartry of Kirkcudbright. Edinburgh. Page(s): 64, No.95 RCAHMS Shelf Number: A.1.1.INV(5).R

Asset Number	32
Site Name	Dundeugh Castle

Type of Site	Secular: castle
NMRS Number	NX68NW 1
HER Number	
Status	Scheduled Monument
Easting	260105
Northing	588037
Parish	Carsphairn
Council	Dumfries And Galloway
Description	SM2476

From NX68NW 1/Canmore ID: 64244
NX68NW 1 6010 8802.
(NX 6010 8802) Dundeugh Castle (NR) (Remains of)
OS 6" map (1957)

Nothing remains of Dundeugh Castle except for a few feet of broken walling, suggesting that it was originally L-shaped on plan, the main block measuring 26'8" x 17'2" over 3ft thick walls, with a W wing, for the staircase, 12'7" x 7'. The latter is now represented by a mass of debris. It is doubtful if the main part was ever vaulted. Judging by the plan this castle possibly dates from the 16th century.
Some 7ft SW of the L-shaped ruin are indications of another building measuring 35ft x 21ft 8ins over 3ft 3 ins thick walls. Nothing remains above ground but a fragment of walling at the E and W ends, so its date and purpose are uncertain.
RCAHMS 1914, visited 1911

Dundeugh Castle, (name verified), is situated on level ground above the E bank of the Water of Deugh and within mature afforestation. The remains are poorly preserved, overgrown and forestry planted. Only the SE angle walls and the E wall of the N wing are partially extant, the overall 'L' shape being detectable only in amorphous buried outline. The S wall of the N wing is best preserved and is 2.0m high, of rough faced blocks and rubble pinning, and 1.0m wide. The other extant walls are again 1.0m wide but are tumbled to a maximum height of 0.8m.
No trace of a separate structure to the SW was found; the afforestation may have removed all surface indication.
Visited by OS (JRL) 14 March 1978

References
Coventry, M. (2008) Castles of the Clans: the strongholds and seats of 750 Scottish families and clans. Musselburgh. Page(s): 230 RCAHMS Shelf Number: F.5.21.COV
Maxwell-Irving, A M T. (2000) The Border towers of Scotland: their history and architecture: the West March. [S.l.]. Page(s): 125-6 RCAHMS Shelf Number: F.5.21.MAX
Maxwell-Irving, A M T. (2014) The Border towers of Scotland 2: their evolution and architecture. [S.l.]. Page(s): 100 RCAHMS Shelf Number: F.5.21.MAX
RCAHMS. (1914) The Royal Commission on the Ancient and Historical Monuments and Constructions of Scotland. Fifth report and inventory of monuments and constructions in Galloway, II, county of the Stewartry of Kirkcudbright. Edinburgh. Page(s): 62, No.86 RCAHMS Shelf Number: A.1.1.INV(5).R

Asset Number	33
Site Name	Braidenoch Hill,cross slabs
Type of Site	Crosses and carved stones: cross slab
NMRS Number	NX59SE 67
HER Number	

Status	Scheduled Monument
Easting	257085
Northing	590984
Parish	Carsphairn
Council	Dumfries And Galloway
Description	SM1105

From NX59SE 67/Canmore ID: 319600

Note: Canmore Record has coordinates of 257070, 590830

EARLY MEDIEVAL CARVED STONES PROJECT

Braidenoch Hill 2, Kirkcudbrightshire, cross-slab fragment
Measurements: H 0.72m, W 0.24, D 0.17m
Stone type: whinstone
Place of discovery: NX 5709 9081
Evidence for discovery: first recorded in 1911 lying on the south-west slope of Braidenoch Hill.
Present location: still on the hillside.
Present condition: the top right portion of the cross-head is missing, but the rest of the carving is in good condition.

Description:
The cross is deeply incised: an equal-armed cross with expanded arms and a central circle, with the lower arm set on a wide shaft.

Date: eighth or ninth century.

Primary references: RCAHMS 1914, no 100; Craig 1992, vol 2, 303-4.
Desk-based information compiled by A Ritchie 2019
Field Visit (1 August 1911)
100. Cross-slabs, Braidenoch Hill.

Lying on the south-west slope of Braidenoch Hill, near the top and some 300 yards south of the actual summit, are two incised crosses, the one complete though broken in two, and the other a fragment. About them lie several other blocks seemingly of quarried whinstone. Their position is most easily found from the north-west wall of the field, which starts from the side of Braidenoch cottage standing north-east and south-west in the valley below, with which they are in line. The crosses are similar in design. The most complete (fig. 60) measures 13 inches in length, is equal-armed and hollow angled, with arms 5 inches in length, expanding from 3 inches to 5 inches, and with a boss in the centre 1 1/2 inches in diameter. The cross-head is set on a shaft 17 inches in length, expanding downwards from 2 to 3 inches. The slab on which this cross is incised measures 3 feet 3 inches in length, 12 1/2 inches in breadth at the upper end, 17 inches at base, and 7 inches in thickness. It is broken across near where the head joins the shaft. The second stone measures 2 feet 2 inches in length, 9 inches in width, and 6 1/2 inches in thickness.

Both stones are of the Silurian sandstone of the district. These relics are probably in or near their original sites, high up on a hillside over 900 feet above the sea-level, and adjacent to an old bridle-path, the " packman's road."

Visited by RCAHMS 1st August 1911.

Desk Based Assessment (8 November 1976)

Ordnance Survey Archaeology Division Revision Programme

NX59SE 3 5707 9083.

(NX 5709 9081) Stone Crosses (NAT) (Ruins of).

OS 6" map (1957)

There are two slabs (NX59SE 3 and NX59SE 67) bearing incised crosses, some 300 yds S of the summit of Braidenoch Hill; one is complete though broken in two, and the other a fragment. They are probably on or near their original sites, near an old bridle path.

The large slab measures 3ft 3 ins x 17 ins at base and 7 ins thick; it is broken where the crosshead joins the shaft. The cross measures 13 ins in length, is equal-armed and hollow angled, with arms 5 ins in length expanding from 3 ins to 5 ins, and with a boss in the centre 1 1/2 ins in diameter. The cross-head is set on a shaft 17 ins long expanding downwards from 2 to 3 ins.

The second stone measures 2 1/2 ins x 9 ins x 6 1/2 ins and bears a cross similar in design to that described above. Truckell dates them as 10th-11th century.

Information from OS 8 November 1976.

RCAHMS 1914, visited 1911; A E Truckell 1963

Field Visit (21 February 1978)

NX 5707 9083. The incised slabs are as described. They rest amongst a random spread of large stones on a SW- facing slope of rough pasture and rock outcrop. They are almost portable and there is no obvious reason for their occurrence here, but perhaps they were carved by an itinerant craftsman.

Surveyed at 1:10 000.

Visited by OS (JRL) 21 February 1978.

Visited by OS (JRL) 10 March 1978

Field Visit (July 1998)

NX 570 908 (centre) An area of 1000 acres surrounding Braidenoch Hill was inspected and numerous previously unrecorded sites were located.

A full report has been lodged with the NMRS.

Sponsor: Scottish Woodlands Ltd.

T Ward 1998

These crosses were noted during a pre-afforestation survey of Braidenoch Hill. No new details were recorded.

T Ward and M Brown (Biggar Museum Trust) July 1998; NMRS MS 959/3, no.7

References

RCAHMS. (1914) The Royal Commission on the Ancient and Historical Monuments and Constructions of Scotland. Fifth report and inventory of monuments and constructions in Galloway, II, county of the Stewartry of Kirkcudbright. Edinburgh. Page(s): 65-6, No.100 RCAHMS Shelf Number: A.1.1.INV(5).R

Truckell, A E. (1963b) 'Dumfries and Galloway in the Dark Ages: some problems', Trans Dumfriesshire Galloway Natur Hist Antiq Soc, 3rd, vol. 40, 1961-2. Page(s): 89-90

Ward, T. (1998b) 'Braidenoch (Carsphairn parish), pre-afforestation survey', Discovery Excav Scot, 1998.

Asset Number	34
Site Name	HIGH BRIDGE OF KEN
Type of Site	Road Bridge (Period Unassigned)
NMRS Number	
HER Number	
Status	Listed Building - Category B
Easting	261954
Northing	590211
Parish	Dalry (Dumf & Galloway)
Council	Dumfries And Galloway
Description	LB3627

Earlier 18th century bridge, possibly of earlier origin spanning Water of Ken at narrow ravine on Dalry/Carsphairn parish borders. 2 semi-circular arches separated by wide spandrel, long abutments, narrow carriageway. Arch to N spans main flow of river; subsidiary flood arch to S; both approximately 24 ft spans. Squared granite springers rise from natural rocky outcrops, squared voussoirs, rubble spandrel, soffits, abutments and parapet, latter with dressed granite coping.

Statement of Special Interest
Bridge spans Dalry/Carsphairn parish boundaries.

Asset Number	35
Site Name	SMEATONS BRIDGE OVER WATER OF KEN
Type of Site	Road Bridge (Period Unassigned)
NMRS Number	
HER Number	
Status	Listed Building - Category B
Easting	263295
Northing	591881
Parish	Dalry (Dumf & Galloway)
Council	Dumfries And Galloway
Description	LB3628

Circa 1830. Bridge over Water of Ken near Smeatons Farm on Dalry/Carsphairn parish borders. Single depressed-arch bridge with splayed abutments; 42 ft span. Dressed granite voussoirs and springers; rendered rubble soffits. Rubble spandrels, abutments, parapets and terminal piers. Dressed granite coping to parapet and piers.

Statement of Special Interest
Very similar to Glaisters Bridge in Balmaclellan parish.

Asset Number	36
Site Name	CARSPHAIRN PARISH CHURCH, CHURCH OF SCOTLAND
Type of Site	Church (Period Unassigned), War Memorial(S) (19-20th Century)
NMRS Number	NX59SE 63
HER Number	MDG19886
Status	Listed Building - Category C
Easting	256258
Northing	593168
Parish	Carsphairn
Council	Dumfries And Galloway
Description	LB3677

1815. Rectangular hall church with added apse to E end, late 19th/early 20th century. Mid 20th century vestry and porch to W. Pointed harled walling, polished red sandstone margins. 3-bay nave with round-arched windows, round-arch tracery, leaded panes. Small open bellcote to E gable. Slate roofs.

INTERIOR: Nave divided by cast-iron columns which support roof. Pointed-arch chancel-arch, apse with stained glass windows. Interior remodelled 20th century.

Statement of Special Interest
Ecclesiastical building in use as such. Church repaired 1830's. B group because of important churchyard monuments.

References
Brooke, C J. (2000) Safe sanctuaries: security and defence in Anglo-Scottish border churches 1290-1690. Edinburgh. Page(s): 358 RCAHMS Shelf Number: F.5.31.BRO

Asset Number	37
Site Name	CARSPHAIRN PARISH CHURCHYARD AND McADAM MAUSOLEUM
Type of Site	Churchyard (Period Unassigned)
NMRS Number	
HER Number	MDG19887
Status	Listed Building - Category B
Easting	256238
Northing	593154
Parish	Carsphairn
Council	Dumfries And Galloway
Description	LB3678

Rubble walled churchyard with many good late 17th/early 18th century carved gravestones. The McAdam mausoleum 1838: square rubble walled burial enclosure; bolection moulded eaves band, flat coping. Small central pediment over entrance with iron grille gate. Inscription in tympanum records this as the burial place of the McAdams of Waterhead, ancestors of John Loudon McAdam, roadmaker. Inside an heraldic panel, presumably of 17th/18th century date is resited within a 19th century architrave, the lintel of which is dated 1838.

Statement of Special Interest
B group with Carsphairn Parish Church.

References
Bibliography
Inv 102-105.

Asset Number	38
Site Name	DALSHANGAN STABLES
Type of Site	Stables
NMRS Number	
HER Number	
Status	Listed Building - Category C
Easting	259610
Northing	589045
Parish	Carsphairn
Council	Dumfries And Galloway
Description	LB3679

Earlier 19th century. 4 ranges of single storey and loft farm buildings around courtyard, with later tower and entrance pend, dated 1865 on tower. Single storey ranges of painted rubble grouped around cobbled courtyard, roofed partly in slate, partly with corrugated iron. 3-stage tower rises above depressed-arch pend in centre of E range. Hammer dressed rubble with polished red sandstone margins. String courses separating 1st and 2nd stages. Clock faces to compass points at 3rd stage. Deep plain parapet with ball finials at angles. Tower now roofless and in poor condition (1986).

Asset Number	39
Site Name	DALSHANGAN DOVECOT
Type of Site	Dovecot (Period Unassigned)
NMRS Number	
HER Number	
Status	Listed Building - Category C
Easting	259504
Northing	588899
Parish	Carsphairn
Council	Dumfries And Galloway
Description	LB3680

Later 19th century cylindrical dovecot. Rubble walling with polished rusticated margins. Single doorway, slit windows. Timber bracketted eaves, conical slate roof; slate-hung piended dormer as flight hole. No nest boxes surviving.

Statement of Special Interest

Though modest in scale, freestanding dovecots are a rarity in Stewartry and Dalshangan is an unusually late example.

Asset Number	40
Site Name	HOLM OF DALTAILOCHAN
Type of Site	Farmhouse (Period Unassigned), Farmstead (Period Unassigned)
NMRS Number	
HER Number	
Status	Listed Building - Category B
Easting	255504
Northing	594152
Parish	
Council	
Description	LB3681

Later 18th century. 2-storey, wide 3-bay painted coursed rubble farmhouse with dressed margins. Central gabled porch with skewputts and Gothic side windows. Sash and case windows, 12-pane glazing. Slate roof, hefty coped end stacks, octagonal cans. 2 full-height projecting bays to rear, rendered. Sundial with metal face on square granite pillar.

Asset Number	41
Site Name	GALLOWAY HYDROELECTRIC POWER SCHEME, KENDOON NORTH DAM
Type of Site	Dam (Period Unassigned)
NMRS Number	
HER Number	
Status	Listed Building - Category B
Easting	260585
Northing	590581
Parish	Carsphairn
Council	Dumfries And Galloway
Description	LB51691

James Williamson with Sir Alexander Gibb consulting engineers; Merz and McLellan, electrical engineers, 1936. Long shallow V-section concrete arch and gravity dam with single control tower to left (N) and elevated roadway to crest on piers over fixed spillway to right (S) ensuite with stepped eaves course to left (N). Concrete parapet to roadway, with some larger piers forming buttress to downstream (E) face. Control tower spanning walkway to left (S) with chamfered upper corners tall narrow round headed opening to base with single rounded headed window above, metal covering to doorway (2009). Small valve-house directly beneath to base (E) of dam in reinforced concrete.

Statement of Special Interest
Kendoon North Dam is an important component of phase II of the highly influential Galloway scheme, providing water storage capacity for Kendoon power station (see separate listing). The dam regulates the flow of the Water of Deugh to create Kendoon Loch by diverting water from

the Deugh back over the watershed to the outlet at the South Dam (see separate listing) from where water is conveyed to Kendoon power station (see separate listing). The shallow curved-plan form of the dam is part of a striking Modernist design and is echoed in the curved top to the spillway. The modern appearance of the dam clearly ties it stylistically and functionally to the power station at Kendoon (see separate listing). The design is a clear synthesis between functional and aesthetic concerns and is characteristic of the view of hydroelectricity in this period as a modern and dynamic industry.

The development of the Galloway Hydroelectric Scheme predates the 1943 Hydroelectric (Scotland) Act which formalised the development of Hydroelectricity in Scotland and led to the founding of the North of Scotland Hydroelectric Board. Those developments which predated the 1943 act were developed by individual companies as a response to particular market and topographic conditions. The completion of a number of schemes (including Galloway, Grampian and those associated with Alcan ' see separate listings) without a national strategic policy framework is groundbreaking as is the consistency of high quality aesthetic and engineering design across all of the schemes.

The Galloway scheme was influential on the future development of hydropower in Scotland. After initial opposition to the parliamentary act granting powers for the completion of the scheme it was approved with a number of safeguards on the landscape and amenity of the area. This necessitated the high quality design of both power stations and dams which characterises the Galloway scheme. This condition also proved influential during the drafting of the Hydroelectric (Scotland) Act of 1943 where the visual impact of future schemes was a primary concern.

Sir Alexander Gibb and Partners was a pioneering engineering company, responsible for a number of high profile works in Scotland, including the Kincardine Bridge (see separate listing). The company was founded by Alexander Gibb in 1921 and quickly became the UK's largest firm of consulting engineers with numerous international clients. Gibb was personally involved in the design and construction of the Galloway scheme, and the pioneering nature of the Galloway development is due, in large part, to his abilities as an engineer. Merz and McLellan were pioneering British electrical engineers and developed a high profile practice, working on a number of power stations across Britain, including Dunstan B, as well as completing hydroelectric work in Italy in the 1980s.

(Listed 2011 as part of Hydroelectric Power Thematic Survey)

References
Bibliography
Peter Payne, The Hydro: a study of the development of the major hydro-electric schemes undertaken by the North of Scotland Hydro-Electric Board, 1988, p. 25; Emma Wood, The Hydro Boys ,2002, p. 51; Anon The Galloway hydro-electric development, Reprint of papers presented to the Institution of Civil Engineers, 22 February 1938; George Hill, Tunnel and Dam; The Story of the Galloway Hydros, 1984.

Asset Number	42
Site Name	GALLOWAY HYDROELECTRIC POWER SCHEME, KENDOON SOUTH DAM
Type of Site	Outlet Valve (20th Century)
NMRS Number	
HER Number	
Status	Listed Building - Category C
Easting	261317
Northing	589312
Parish	Carsphairn

Council	Dumfries And Galloway
Description	LB51692

James Williamson with Sir Alexander Gibb consulting engineers; Merz and McLellan, electrical engineers; 1936. Long shallow v-section concrete arch and gravity dam with single control tower to centre and elevated roadway to crest on piers over fixed spillway to right (E) and ensuite with stepped eaves course to left (W). Concrete parapet to roadway, with larger piers to terminal bays forming buttress to downstream (S) face and curved wave-wall to base of dam. Control tower spanning walkway with chamfered upper corners tall narrow round headed opening to base with single rounded headed window above, metal covering to doorway (2009).

Statement of Special Interest
Kendoon South dam is an important component of phase II of the highly influential Galloway scheme, providing water storage capacity for Kendoon Power station (see separate listing). The curved plan form of the dam is part of a striking modern design and is echoed in the curved top to the spillway and sweeping curves of wave-walls. The modern appearance of the dam clearly ties it stylistically and functionally to the power station at Kendoon (see separate listing). The design is a clear synthesis between functional and aesthetic concerns and is characteristic of the view of hydroelectricity in this period as a modern and dynamic industry.

The development of the Galloway Hydroelectric Scheme predates the 1943 Hydroelectric (Scotland) Act which formalised the development of Hydroelectricity in Scotland and led to the founding of the North of Scotland Hydroelectric Board. Those developments which predated the 1943 act were developed by individual companies as a response to particular market and topographic conditions. The completion of a number of schemes (including Galloway, Grampian and those associated with Alcan ' see separate listings) without a national strategic policy framework is groundbreaking as is the consistency of high quality aesthetic and engineering design across all of the schemes.

The Galloway scheme was influential on the future development of hydropower in Scotland. After initial opposition to the parliamentary act granting powers for the completion of the scheme it was approved with a number of safeguards on the landscape and amenity of the area. This necessitated the high quality design of both power stations and dams which characterises the Galloway scheme. This condition also proved influential during the drafting of the Hydroelectric Development (Scotland) Act of 1943 where the visual impact of future schemes was a primary concern.

Sir Alexander Gibb and Partners was a pioneering engineering company, responsible for a number of high profile works in Scotland, including the Kincardine Bridge (see separate listing). The company was founded by Alexander Gibb in 1921 and quickly became the UK's largest firm of consulting engineers with numerous international clients. Gibb was personally involved in the design and construction of the Galloway scheme, and the pioneering nature of the Galloway development is due, in large part, to his abilities as an engineer. Merz and McLellan were pioneering British electrical engineers and developed a high profile practice, working on a number of power stations across Britain, including Dunstan B, as well as completing hydroelectric work in Italy in the 1980s.

(Listed 2011 as part of Hydroelectric Power Thematic Survey)

References
Bibliography
Peter Payne, The Hydro: a study of the development of the major hydro-electric schemes undertaken by the North of Scotland Hydro-Electric Board, 1988, p. 25; Emma Wood, The Hydro Boys ,2002, p. 51; Anon The Galloway hydro-electric development, Reprint of papers presented to the Institution of Civil Engineers, 22 February 1938; George Hill, Tunnel and Dam; The Story of the Galloway Hydros, 1984.

Appendix 9.3: Asset Gazetteer

Asset Number	43
Site Name	GALLOWAY HYDROELECTRIC POWER SCHEME, KENDOON SURGE TOWER
Type of Site	Surge Tower (20th Century)
NMRS Number	
HER Number	
Status	Listed Building - Category C
Easting	260716
Northing	587930
Parish	Dalry (Dumf & Galloway)
Council	Dumfries And Galloway
Description	LB51693

Sir Alexander Gibb consulting engineers; Merz and McLellan, electrical engineers, 1936. Tall cylindrical steel surge tower. Riveted plate steel with advanced eaves course. Integrated with 2 large pipes to base.

Statement of Special Interest
The Kendoon surge tower is an iconic feature in the landscape and relatively unusual amongst a building type which is predominantly subterranean or semi-subterranean. The surge tower protects the integrated penstocks from sudden surges of water, which, instead of bursting the pipes or damaging turbines is accommodated by the hollow interior of the tower. In extreme floods the water could overtop the tower.

The surge tower makes a significant contribution to the landscape from a prominent site on an area of sloping ground surrounded by a wide bowl of hills. The striking cylindrical feature is a bold statement set against a natural backdrop of mature woodland. The bold form is characteristic of the dynamic modern view which was taken of hydroelectricity during this period.

The development of the Galloway Hydroelectric Scheme predates the 1943 Hydroelectric (Scotland) Act which formalised the development of Hydroelectricity in Scotland and led to the founding of the North of Scotland Hydroelectric Board. Those developments which predated the 1943 act were developed by individual companies as a response to particular market and topographic conditions. The completion of a number of schemes (including Galloway, Grampian and those associated with Alcan ' see separate listings) without a national strategic policy framework is groundbreaking as is the consistency of high quality aesthetic and engineering design across all of the schemes.

The Galloway scheme was influential on the future development of hydropower in Scotland. After initial opposition to the parliamentary act granting powers for the completion of the scheme it was approved with a number of safeguards on the landscape and amenity of the area. This necessitated the high quality design of both power stations and dams which characterises the Galloway scheme. This condition also proved influential during the drafting of the Hydroelectric (Scotland) Act of 1943 where the visual impact of future schemes was a primary concern.

Sir Alexander Gibb and Partners was a pioneering engineering company, responsible for a number of high profile works in Scotland, including the Kincardine Bridge (see separate listing). The company was founded by Alexander Gibb in 1921 and quickly became the UK's largest firm of consulting engineers with numerous international clients. Gibb was personally involved in the design and construction of the Galloway scheme, and the pioneering nature of the Galloway development is due, in large part, to his abilities as an engineer. Merz and McLellan were pioneering British electrical engineers and developed a high profile practice, working on a number of power stations across Britain, including Dunstan B, as well as completing hydroelectric work in Italy in the 1980s.

(Listed 2011 as part of Hydroelectric Power Thematic Survey)

References
Bibliography
Peter Payne, The Hydro: a study of the development of the major hydro-electric schemes undertaken by the North of Scotland Hydro-Electric Board, 1988, p. 25; Emma Wood, The Hydro Boys, 2002, p. 51; Anon The Galloway hydro-electric development, Reprint of papers presented to the Institution of Civil Engineers, 22 February 1938; George Hill, Tunnel and Dam; The Story of the Galloway Hydros, 1984.

Asset Number	44
Site Name	GALLOWAY HYDROELECTRIC POWER SCHEME, KENDOON POWER STATION AND VALVE-HOUSE
Type of Site	Power Station
NMRS Number	
HER Number	
Status	Listed Building - Category B
Easting	260536
Northing	587787
Parish	Dalry (Dumf & Galloway)
Council	Dumfries And Galloway
Description	LB51694

Sir Alexander Gibb consulting engineer; Merz and McLellan, electrical engineers; dated 1934. Symmetrical 10-bay, 2-storey rectangular-plan Classical Modern power station with lower terminal bays to left (S). Painted reinforced concrete. Full height pilasters with recessed parapet above. Slightly advanced door surround with large vehicular opening and steel shutter. Inscribed above: THE GALLOWAY WATER POWER SCHEME, KENDOON POWER STATION, 1934. Large full-height rectangular multi-pane windows; regular fenestration to lower block with pedestrian doors at ground floor.

Multi-pane glazing in metal frame windows. Flat platform roof behind parapet with integrated cast-iron rainwater goods.

INTERIOR: plain interior with large roller crane on steel girders supported by corniced concrete piers. Engineered steel roof trusses.

VALVE-HOUSE: 4-bay, single storey rectangular-plan painted concrete valve-house. Recessed deep base course and eaves course. Large multi-pane rectangular windows, bi-partite to centre.

Statement of Special Interest
Kendoon power station is a significant example of a hydroelectric power station and was an important part of phase II of the highly influential Galloway Hydropower Scheme. The power station comprises two turbines with water from the Deuch and Blackwater reservoirs (see separate listings). The penstocks which feed water in are protected from sudden surges of water by the nearby surge tower (see separate listing) The Galloway scheme was a significant technological achievement and the first example of run of the river technology to be successfully utilised on a large scale in Scotland.

The architectural design of Kendoon is a combination of the necessary engineering requirements of a large commercial power station and a finely detailed modernist classical design. The stark roofline and rhythmic articulation of the façade characterise the modern, dynamic attitude with which hydroelectricity was viewed in this period.

The development of the Galloway Hydroelectric Scheme predates the 1943 Hydroelectric (Scotland) Act which formalised the development of Hydroelectricity in Scotland and led to the founding of the North of Scotland Hydroelectric Board. Those schemes which predated the 1943 act were developed by individual companies as a response to particular market and topographic conditions. The completion of a number of schemes (including Galloway, Grampian and those associated with Alcan ' see separate listings) without a national strategic policy framework is groundbreaking as is the consistency of high quality aesthetic and engineering design across all of the schemes.

The Galloway scheme was influential on the future development of hydropower in Scotland. After initial opposition to the parliamentary act granting powers for the completion of the scheme it was approved with a number of safeguards on the landscape and amenity of the area. This necessitated the high quality design of both power stations and dams which characterises the Galloway scheme. This condition also proved influential during the drafting of the Hydroelectric (Scotland) Act of 1943 where the visual impact of future schemes was a primary concern.

Sir Alexander Gibb and Partners was a pioneering engineering company, responsible for a number of high profile works in Scotland, including the Kincardine Bridge (see separate listing). The company was founded by Alexander Gibb in 1921 and quickly became the UK's largest firm of consulting engineers with numerous international clients. Gibb was personally involved in the design and construction of the Galloway scheme, and the pioneering nature of the Galloway development is due, in large part, to his abilities as an engineer. Merz and McLellan were pioneering British electrical engineers and developed a high profile practice, working on a number of power stations across Britain, including Dunstan B, as well as completing hydroelectric work in Italy in the 1980s.

(Listed 2011 as part of Hydroelectric Power Thematic Survey)

References
Bibliography
Peter Payne, The Hydro: a study of the development of the major hydro-electric schemes undertaken by the North of Scotland Hydro-Electric Board, 1988, p. 25; Emma Wood, The Hydro Boys,2002, p. 51; Anon The Galloway hydro-electric development, Reprint of papers presented to the Institution of Civil Engineers, 22 February 1938; George Hill, Tunnel and Dam; The Story of the Galloway Hydros, 1984.

Asset Number	45
Site Name	GALLOWAY HYDROELECTRIC POWER SCHEME, KENDOON POWER STATION AND VALVE-HOUSE
Type of Site	Valve House (Period Unassigned)
NMRS Number	
HER Number	
Status	Listed Building - Category B
Easting	260565
Northing	587791
Parish	Dalry (Dumf & Galloway)
Council	Dumfries And Galloway
Description	LB51694

Sir Alexander Gibb consulting engineer; Merz and McLellan, electrical engineers; dated 1934. Symmetrical 10-bay, 2-storey rectangular-plan Classical Modern power station with lower terminal bays to left (S). Painted reinforced concrete. Full height pilasters with recessed parapet above. Slightly advanced door surround with large vehicular opening and steel shutter.

Inscribed above: THE GALLOWAY WATER POWER SCHEME, KENDOON POWER STATION, 1934. Large full-height rectangular multi-pane windows; regular fenestration to lower block with pedestrian doors at ground floor.

Multi-pane glazing in metal frame windows. Flat platform roof behind parapet with integrated cast-iron rainwater goods.

INTERIOR: plain interior with large roller crane on steel girders supported by corniced concrete piers. Engineered steel roof trusses.

VALVE-HOUSE: 4-bay, single storey rectangular-plan painted concrete valve-house. Recessed deep base course and eaves course. Large multi-pane rectangular windows, bi-partite to centre.

Statement of Special Interest
Kendoon power station is a significant example of a hydroelectric power station and was an important part of phase II of the highly influential Galloway Hydropower Scheme. The power station comprises two turbines with water from the Deuch and Blackwater reservoirs (see separate listings). The penstocks which feed water in are protected from sudden surges of water by the nearby surge tower (see separate listing) The Galloway scheme was a significant technological achievement and the first example of run of the river technology to be successfully utilised on a large scale in Scotland.

The architectural design of Kendoon is a combination of the necessary engineering requirements of a large commercial power station and a finely detailed modernist classical design. The stark roofline and rhythmic articulation of the façade characterise the modern, dynamic attitude with which hydroelectricity was viewed in this period.

The development of the Galloway Hydroelectric Scheme predates the 1943 Hydroelectric (Scotland) Act which formalised the development of Hydroelectricity in Scotland and led to the founding of the North of Scotland Hydroelectric Board. Those schemes which predated the 1943 act were developed by individual companies as a response to particular market and topographic conditions. The completion of a number of schemes (including Galloway, Grampian and those associated with Alcan ' see separate listings) without a national strategic policy framework is groundbreaking as is the consistency of high quality aesthetic and engineering design across all of the schemes.

The Galloway scheme was influential on the future development of hydropower in Scotland. After initial opposition to the parliamentary act granting powers for the completion of the scheme it was approved with a number of safeguards on the landscape and amenity of the area. This necessitated the high quality design of both power stations and dams which characterises the Galloway scheme. This condition also proved influential during the drafting of the Hydroelectric (Scotland) Act of 1943 where the visual impact of future schemes was a primary concern.

Sir Alexander Gibb and Partners was a pioneering engineering company, responsible for a number of high profile works in Scotland, including the Kincardine Bridge (see separate listing). The company was founded by Alexander Gibb in 1921 and quickly became the UK's largest firm of consulting engineers with numerous international clients. Gibb was personally involved in the design and construction of the Galloway scheme, and the pioneering nature of the Galloway development is due, in large part, to his abilities as an engineer. Merz and McLellan were pioneering British electrical engineers and developed a high profile practice, working on a number of power stations across Britain, including Dunstan B, as well as completing hydroelectric work in Italy in the 1980s.

(Listed 2011 as part of Hydroelectric Power Thematic Survey)

References
Bibliography
Peter Payne, The Hydro: a study of the development of the major hydro-electric schemes undertaken by the North of Scotland Hydro-Electric Board, 1988, p. 25; Emma Wood, The Hydro Boys,2002, p. 51; Anon The Galloway hydro-electric development, Reprint of papers

presented to the Institution of Civil Engineers, 22 February 1938; George Hill, Tunnel and Dam; The Story of the Galloway Hydros, 1984.

Asset Number	46
Site Name	KNOCKNALLING BARN
Type of Site	Barn (Period Unassigned)
NMRS Number	
HER Number	
Status	Listed Building - Category A
Easting	259645
Northing	584846
Parish	Kells
Council	Dumfries And Galloway
Description	LB9746

Probably of mid 19th century construction. Very fine rectangular hay and winnowing barn perforated throughout bay rows of regularly spaced triangular vents. Rubble walling with squared quoins, thick slates forming the triangular vents, slate roofs. S portion of barn built up on foundation of earlier building. To E and W walls; near full-height depressed-arch rough-voussoired openings, that to W now blocked. To gable walls, pointed-arch dovecot openings with timber doors, to S with 4 flight holes.

Statement of Special Interest
Knocknalling barn is remarkable for the generous provision of triangular ventilators to all sides, few similar examples are known to exist. B group with Knocknalling House and Knocknalling Stableyard.

Asset Number	47
Site Name	Benloch Burn
Type of Site	Enclosure (Period Unassigned)
NMRS Number	NX59NE 15
HER Number	MDG15554
Status	Not Designated
Easting	259869
Northing	596338
Parish	Carsphairn
Council	Dumfries And Galloway
Description	Canmore ID: 177175

First Edition Survey Project (FESP)

An enclosure is depicted on the 1st edition of the OS 6-inch map (Kirkcudbrightshire 1853, sheet 5) and on the current edition of the OS 1:10000 map (1981).

Information from RCAHMS (AKK) 15 September 1999.

Asset Number	48
Site Name	Little Loskie
Type of Site	Sheep Shelter (19th Century)
NMRS Number	NX69SW 96
HER Number	
Status	Not Designated
Easting	260176
Northing	593108
Parish	Carsphairn
Council	Dumfries And Galloway
Description	Canmore ID: 365033 Field Visit (27 November 2019 - 13 February 2020) Coarse drystone sheep shelter with three walls radiating from a central point at approximately 120-degree intervals. Overall c.59m N-S x 62m E-W and 1.65m high, gradually tapering down to c. 0.20m at each end. Information from OASIS ID: archascu1-391099 (A Rees) 2020

Asset Number	49
Site Name	Furmiston
Type of Site	Sheep Shelter (19th Century)
NMRS Number	NX69SW 95
HER Number	
Status	Not Designated
Easting	260445
Northing	592761
Parish	Carsphairn
Council	Dumfries And Galloway
Description	Canmore ID: 365035 Field Visit (27 November 2019 - 13 February 2020) Coarse drystone sheep shelter with three walls radiating from a central point at approximately 120-degree intervals. Overall c.53m N-S x 43m E-W and 1.3m high, badly denuded in places, though intact sections remain overall. Information from OASIS ID: archascu1-391099 (A Rees) 2020

Asset Number	50

Site Name	Furmiston
Type of Site	Head Dyke (19th Century)
NMRS Number	NX69SW 94
HER Number	
Status	Not Designated
Easting	260212
Northing	592731
Parish	Carsphairn
Council	Dumfries And Galloway
Description	Canmore ID: 365032 From NX 6046 9253 to NX 6065 9245 to NX6011 9170 Field Visit (27 November 2019 - 13 February 2020) A series of two drystone dykes which meet at right angles – the main dyke runs E-W from NX 60452 92547 to NX 59791 93148 and is 1.5m high. A second dyke branches off at NX 60214 92733 in a northerly direction, before gently curving to the east and terminating at NX 60832 93027. Information from OASIS ID: archascu1-391099 (A Rees) 2020

Asset Number	51
Site Name	North Liggat
Type of Site	Area of rig and furrow
NMRS Number	
HER Number	
Status	Not Designated
Easting	256880
Northing	593175
Parish	Carsphairn
Council	Dumfries And Galloway
Description	An area of approximately 0.5 ha of rig and furrow on a small island of dry land next to the roadside at North Liggat. This rig and furrow runs northwest to southeast and, from the width of the furrows, appears to be post-medieval in date. Headlands Archaeology, Quantans Hill Wind Farm: Environmental Statement; Walkover Survey dates: 2nd, 3rd, 4th, 5th and 10th July 2013

Asset Number	52
Site Name	Cemetery Wood Dyke
Type of Site	Dyke
NMRS Number	

HER Number	
Status	Not Designated
Easting	257611
Northing	593870
Parish	Carsphairn
Council	Dumfries And Galloway
Description	Stone dyke, aligned roughly east west. Only lower two courses of stones upstanding it then disappears either beneath vegetation or completely removed. Headlands Archaeology, Quantans Hill Wind Farm: Environmental Statement; Walkover Survey dates: 2nd, 3rd, 4th, 5th and 10th July 2013

Asset Number	53
Site Name	Quantans Hill structures
Type of Site	Curvilinear dyke and structure
NMRS Number	
HER Number	
Status	Not Designated
Easting	258185
Northing	594785
Parish	Carsphairn
Council	Dumfries And Galloway
Description	Curvilinear dyke, approximately 0.7 m wide, can be traced for 25 m. Roughly 22 m to the north is a possible building or sheep bucht, 5 m by 2 m. Headlands Archaeology, Quantans Hill Wind Farm: Environmental Statement; Walkover Survey dates: 2nd, 3rd, 4th, 5th and 10th July 2013

Asset Number	54
Site Name	Quantans Hill clearance
Type of Site	Area of clearance cairns
NMRS Number	
HER Number	
Status	Not Designated
Easting	258587
Northing	594420
Parish	Carsphairn
Council	Dumfries And Galloway
Description	Area of approximately 12 clearance cairns from 0.7 m to 1.5 m in diameter and up to 0.3 m high. These piles of partially turf covered small subangular stones are in an area of improved grazing it appears as a natural meadow but this will be as a result of the early agricultural management of this area.

Headlands Archaeology, Quantans Hill Wind Farm: Environmental Statement;
Walkover Survey dates: 2nd, 3rd, 4th, 5th and 10th July 2013

Asset Number	55
Site Name	Knockwhirn clearance cairns
Type of Site	Area of clearance cairns
NMRS Number	
HER Number	
Status	Not Designated
Easting	260115
Northing	594892
Parish	Carsphairn
Council	Dumfries And Galloway
Description	Area of approximately 16 clearance cairns on slopes below an area of natural scree. The stones have been piled into cairns up to 3 m in diameter and 0.6m high. Some of the cairns are piled around natural large rock outcrops. Headlands Archaeology, Quantans Hill Wind Farm: Environmental Statement; Walkover Survey dates: 2nd, 3rd, 4th, 5th and 10th July 2013

Asset Number	56
Site Name	Marbrack clearance cairns 1
Type of Site	Area of clearance cairns
NMRS Number	
HER Number	
Status	Not Designated
Easting	260000
Northing	594160
Parish	Carsphairn
Council	Dumfries And Galloway
Description	Area of approximately 5 clearance cairns the largest of which is 1.75 m by 1 m, these piles of small subangular stones are largely turf covered and they are located in an area of dryer ground which appears as improved grazing possibly as a result of the early agricultural improvements. Headlands Archaeology, Quantans Hill Wind Farm: Environmental Statement; Walkover Survey dates: 2nd, 3rd, 4th, 5th and 10th July 2013

Asset Number	57
Site Name	Marbrack clearance cairns 2

Type of Site	Area of clearance cairns
NMRS Number	
HER Number	
Status	Not Designated
Easting	260113
Northing	594370
Parish	Carsphairn
Council	Dumfries And Galloway
Description	Area of three clearance cairns one of which is approximately 6m by 5 m and 0.4 m high, a second cairn is 2 m by 1 m and there are two further small clearance cairns in the area approximately 0.6 m diameter. It is possible that the largest of these cairns is a funerary monument due to its unusually large size amongst the other clearance cairns of the lower slopes however due to the number of other clearance cairns in the area it is presumed it is also clearance. This cannot be clarified without the excavation of the cairn. Headlands Archaeology, Quantans Hill Wind Farm: Environmental Statement; Walkover Survey dates: 2nd, 3rd, 4th, 5th and 10th July 2013

Asset Number	58
Site Name	Furmiston Craig grouse butts
Type of Site	Line of grouse butts
NMRS Number	
HER Number	
Status	Not Designated
Easting	260820
Northing	594025
Parish	Carsphairn
Council	Dumfries And Galloway
Description	A line of grouse butts orientated north west to south east up the west slope of Furmiston Craig. These butts are linear sections of wall constructed of irregular boulders and although in a state of disrepair in some cases stand to a height of 4 courses. To the immediate east of at least one of these grouse butts are the foundation remains of a horseshoe structure 3.5 m by 3 m. It seems most probable that this is the remains of an earlier style of grouse butt. Headlands Archaeology, Quantans Hill Wind Farm: Environmental Statement; Walkover Survey dates: 2nd, 3rd, 4th, 5th and 10th July 2013

Asset Number	59
Site Name	FURMISTON BRIDGE
Type of Site	FIELD SYSTEM
NMRS Number	
HER Number	MDG13625
Status	Not Designated

Easting	259920
Northing	592000
Parish	Carsphairn
Council	Dumfries And Galloway
Description	Significance = Unknown NX59SE 34 5992 9200 A field-system annotated 'Old Fences' is depicted on the 1st edition of the OS 6-inch map (Kirkcudbrightshire 1853, sheet 9), but it is not shown on the current edition of the OS 1:10000 map (1980).Information from RCAHMS (AKK) 13 September 1999

Asset Number	60
Site Name	FURMISTON BRIDGE
Type of Site	STRUCTURE
NMRS Number	
HER Number	MDG13627
Status	Not Designated
Easting	259600
Northing	592200
Parish	
Council	Dumfries And Galloway
Description	Significance = Unknown NX59SE 36 5960 9220 One unroofed structure annotated 'Old Sheep Ree' is depicted on the 1st edition of the OS 6-inch map (Kirkcudbrightshire 1853, sheet 9), but it is not shown on the current edition of the OS 1:10000 map (1980).Information from RCAHMS (AKK) 13 September 1999.

Asset Number	61
Site Name	LAGWYNE
Type of Site	FARMSTEAD
NMRS Number	
HER Number	MDG13633
Status	Not Designated
Easting	255822
Northing	593910
Parish	
Council	Dumfries And Galloway
Description	Signicance = Unknown NX59SE 30 5581 9391

A farmstead, comprising one roofed, one partially roofed, one unroofed building annotated 'Ruin', and two enclosures is depicted on the 1st edition of the OS 6-inch map (Kirkcudbrightshire 1853, sheet 5). One roofed building and one enclosure are shown on the current edition of the OS 1:10000 map (1980).
Information from RCAHMS (AKK) 15 September 1999.

The farmstead of Lagwine is first shown on Ainslie's map of 1791, though an un-named farmstead is shown at this location on Roy's map of 1755.
Information from DGC (AJN) 17 September 2013

Asset Number	62
Site Name	LAGWYNE
Type of Site	STRUCTURE; FIELD SYSTEM
NMRS Number	
HER Number	MDG13634
Status	Not Designated
Easting	256199
Northing	594200
Parish	
Council	Dumfries And Galloway
Description	Significance = Local

NX59SE 31 centred on 5610 9420

A field-system annotated 'Old Fences' and one unroofed structure annotated 'Old Sheep Ree' are depicted on the 1st edition of the OS 6-inch map (Kirkcudbrightshire 1853, sheet 5). A length of wall denoted by a pecked line is shown on the current edition of the OS 1:10000 map (1980).
Information from RCAHMS (AKK) 15 September 1999.

The field boundary banks and rig cultivation are clearly visible as upstanding features on recent aerial photographs.
Information from DGC (AJN) 4 March 2013

Asset Number	63
Site Name	LIGGAT BRIDGE
Type of Site	FIELD SYSTEM
NMRS Number	
HER Number	MDG13635
Status	Not Designated
Easting	256700
Northing	592800
Parish	
Council	Dumfries And Galloway

Description	Significance = Unknown NX59SE 32 centred on 5670 9280 A field-system annotated 'Old Fences' is depicted on the 1st edition of the OS 6-inch map (Kirkcudbrightshire 1853, sheet 5), but it is not shown on the current edition of the OS 1:10000 map (1980).Information from RCAHMS (AKK) 15 September 1999.

Asset Number	64
Site Name	CARSPHAIRN, COTTAGES / CRAIGROY; OLDRIG; ELLENSLEA; GLENDYNE
Type of Site	ROW
NMRS Number	
HER Number	MDG15099
Status	Not Designated
Easting	256150
Northing	593220
Parish	
Council	Dumfries And Galloway
Description	Significance = None NX59SE 57 5615 9322.

Asset Number	65
Site Name	POLSUE BURN
Type of Site	STRUCTURE, WALL, SHEEP FOLD
NMRS Number	
HER Number	MDG15556
Status	Not Designated
Easting	256850
Northing	596380
Parish	
Council	Dumfries And Galloway
Description	Significance = Unknown NX59NE 17 5685 9638 One unroofed structure annotated 'Hay Ree' and some lengths of wall, all of which are marked by pecked lines, and an 'Old Sheep Ree' are depicted on the 1st edition of the OS 6-inch map (Kirkcudbrightshire 1853, sheet 5), but they are not shown on the current edition of the OS 1:10000 map (1981).Information from RCAHMS (AKK) 15 September 1999.

Asset Number	66

Appendix 9.3: Asset Gazetteer

Site Name	POLSUE BURN
Type of Site	STRUCTURE; SHEEP FOLD
NMRS Number	
HER Number	MDG15557
Status	Not Designated
Easting	257140
Northing	596600
Parish	
Council	Dumfries And Galloway
Description	Significance = Unknown NX59NE 18 5714 9660 Two unroofed structures, one of which is annotated 'Old Sheep Ree' are depicted on the 1st edition of the OS 6-inch map (Kirkcudbrightshire 1853, sheet 5), but they are not shown on the current edition of the OS 1:10000 map (1981).Information from RCAHMS (AKK) 15 September 1999.

Asset Number	67
Site Name	POLSUE BURN
Type of Site	SHEEP FOLD
NMRS Number	
HER Number	MDG15558
Status	Not Designated
Easting	257340
Northing	596650
Parish	
Council	Dumfries And Galloway
Description	Significance = Unknown NX59NE 19 5734 9665 The pecked outline of an unroofed structure annotated 'Old Sheep Ree' is depicted on the 1st edition of the OS 6-inch map (Kirkcudbrightshire 1853, sheet 5), but it is not shown on the current edition of the OS 1:10000 map (1981).Information from RCAHMS (AKK) 15 September 1999.

Asset Number	68
Site Name	POLSUE BURN
Type of Site	SHEEP FOLD
NMRS Number	
HER Number	MDG15559
Status	Not Designated

Easting	257570
Northing	597100
Parish	
Council	Dumfries And Galloway
Description	Significance = Unknown NX59NE 20 5757 9710 A single unroofed structure annotated 'Old Sheep Ree' is depicted on the 1st edition of the OS 6-inch map (Kirkcudbrightshire 1853, sheet 5), but it is not shown on the current edition of the OS 1:10000 map (1981).Information from RCAHMS (AKK) 15 September 1999.

Asset Number	69
Site Name	POLSUE BURN
Type of Site	SHEEP FOLD, BUILDING?
NMRS Number	
HER Number	MDG15560
Status	Not Designated
Easting	257670
Northing	597220
Parish	
Council	Dumfries And Galloway
Description	Significance = Unknown NX59NE 21 5767 9722 A single unroofed structure annotated 'Sheep Ree' is depicted on the 1st edition of the OS 6-inch map (Kirkcudbrightshire 1853, sheet 5). One unroofed structure is shown on the current edition of the OS 1:10000 map (1981).Information from RCAHMS (AKK) 15 September 1999.

Asset Number	70
Site Name	CRAIGENGILLAN BURN
Type of Site	FIELD SYSTEM, SHEEP FOLD
NMRS Number	
HER Number	HERref
Status	Not Designated
Easting	262850
Northing	594200
Parish	
Council	Dumfries And Galloway
Description	Significance = Unknown NX69SW 53 6285 9420

A small field-system annotated 'Old Fences' and a sheepfold annotated 'Old Sheep Ree' are depicted on the 1st edition of the OS 6-inch map (Kirkcudbrightshire 1853, sheet 5). The sheepfold is shown on the current edition of the OS 1:10000 map (1980).Information from RCAHMS (AKK) 15 September 1999.

Asset Number	71
Site Name	FURMISTON
Type of Site	BOUNDARY BANK
NMRS Number	
HER Number	MDG17317
Status	Not Designated
Easting	260100
Northing	592500
Parish	
Council	Dumfries And Galloway
Description	Significance = Unknown

NX69SW 86 centred on 601 925

A boundary dyke marked by pecked lines and annotated Old Fence is depicted on the 1st edition of the OS 6-inch map (Kirkcudbrightshire 1853, sheet 5), but it is not shown on the current edition of the OS 1:10000 map (1980).Information from RCAHMS (SAH) 23 November 2001

Asset Number	72
Site Name	CARSPHAIRN PRIMARY SCHOOL
Type of Site	SCHOOL
NMRS Number	
HER Number	MDG17324
Status	Not Designated
Easting	256196
Northing	593197
Parish	
Council	Dumfries And Galloway
Description	Significance = None

NX59SE 61.00   56195 93195.NX59SE 61.01   56211 93193   Schoolhouse

Carsphairn has provided education for its children for over 250 years, appointing its first schoolmaster in 1723. We can deduce from old maps that the original building was situated on the roadside. The present site was developed in the 1850s, with a single-room school and schoolhouse being built. The main classroom in the present building was the original school, and had places for 56 pupils. In 1906 an extension was built – now the entrance and staff room area – to accommodate 32 infant pupils!

In 1990, when the school roll rose to 33, the old part of the school was completely refurbished and an additional class base and kitchen were built.
Carsphairn Primary Handbook DGC February 2012

Asset Number	73
Site Name	CARSPHAIRN SCHOOLHOUSE
Type of Site	SCHOOL HOUSE
NMRS Number	
HER Number	MDG17325
Status	Not Designated
Easting	256212
Northing	593192
Parish	
Council	Dumfries And Galloway
Description	Significance = None

NX59SE 61.01   56211 93193.NX59SE 61.00   56195 93195

Primary school.

Asset Number	74
Site Name	CARSPHAIRN, GENERAL
Type of Site	VILLAGE
NMRS Number	
HER Number	MDG23203
Status	Not Designated
Easting	256170
Northing	593210
Parish	
Council	Dumfries And Galloway
Description	Significance = None

NX 56177 93225

Planned village founded c. 1780 due to transportation routes.
L Philip, 2005

The above date may be correct for the planned village, but it should be noted that Carsphairn parish, with attendant church, was established in 1640.
Information from DGC (AJN) 18 September 2013

Asset Number	75

Site Name	CARSPHAIRN, CAIRNSMORE HOUSE
Type of Site	MANSE
NMRS Number	
HER Number	MDG23311
Status	Not Designated
Easting	256300
Northing	593132
Parish	
Council	Dumfries And Galloway
Description	Significance = None

NX59SE 64 56300 93132 (Centred on)

Cairnsmore House is depicted on current Ordnance Survey GIS vector map. On OS GIS Epoch 2 map the same building is annotated as Carsphairn Manse. Information from RCAHMS (LKFJ), March 2002.

Asset Number	76
Site Name	WILLIEANNA
Type of Site	STRUCTURE, CLEARANCE CAIRN
NMRS Number	
HER Number	MDG3437
Status	Not Designated
Easting	256900
Northing	595200
Parish	
Council	Dumfries And Galloway
Description	Significance = Regional/Local

NX59NE 1 569 952 to 575 953.

NX 576 953, NX 576 955 & NX 570 953: Rectangular structure 8.23m E-W x 5.49m. Group of 10 small cairns on S slope of hill. A 10.0m diameter ring cairn. Group of 11 small cairns and 5.49m diameter ring cairn. Also another 5.49m diameter ring cairn by shepherd's cairn near square tree wind break on SW approach to Willieanna (cf NT05SE 3).
M L Ansell 1969

On the extensive S and SW facing slopes of Willieanna are two distinct areas of field clearance cairns.
Centred NX 569 952. Over fifty clearance cairns extend over an area of approximately 8.0 hectares between 244- 290m OD. Randomly spaced, they range from circular to oval in shape and average 4.0m in diameter and 0.4m high. No discernible field plots were found nor any ring-like features, although some of the larger cairns have had their centres robbed or disturbed.
NX 575953. Approximately 15 clearance cairns extend over an area of about 2.0 hectares beween 304m to 319m OD. They are of similar shape and dimensions to the other group, and again no field plots or ring-like features were found.
The only structure located is at NX 5769 9532, and this is sub-square in shape, 11.0m x 10.0m,

with slightly bowed 2.0m wide wall footings, mostly of turf. There is no discernible entrance and the interior is turf covered and featureless. Its age and exact purpose is unknown, and it has no obvious association with the clearance areas.
Visited by OS (JRL) 31 October 1978

Asset Number	77
Site Name	KNOCKGRAY
Type of Site	FINDSPOT
NMRS Number	
HER Number	MDG3467
Status	Not Designated
Easting	257800
Northing	593300
Parish	
Council	Dumfries And Galloway
Description	Significance = N/A

NX59SE 20 578 933.

A leaf-shaped flint arrowhead from Knockgray farm (NX 578 933), measuring 2 1/4 ins x 1 in was shown to the members of the Dumfries and Galloway Natur Hist and Antiq Soc in 1882 and 1886 by Mr James Davidson, Summerville.
Trans Dumfriesshire Galloway Natur Hist Antiq Soc 1884; 1888; J M Corrie 1930

Asset Number	78
Site Name	BENNAN HILL
Type of Site	CLEARANCE CAIRN
NMRS Number	
HER Number	MDG3468
Status	Not Designated
Easting	256800
Northing	592200
Parish	
Council	Dumfries And Galloway
Description	Significance = Regional/Local

NX59SE 21 568 922.

NX 568 922. Group of ten stony mounds at 850 ft contour (cf NT05SE 3).
M L Ansell 1966

Several clearance and debris mounds were found along the N slopes of Bennan Hill between 700-750 ft OD. They are all associated with deserted farmsteads of relatively recent date and have no independent significance. Mr Ansell (Rannoch, Gatehill Rd, Dalry) confirms these are the mounds in question.

Visited by OS (JRL) 25 April 1978

Asset Number	79
Site Name	LAGWINE CAIRN
Type of Site	CAIRN
NMRS Number	
HER Number	MDG3478
Status	HER National Asset
Easting	256066
Northing	593987
Parish	
Council	Dumfries And Galloway
Description	Significance = National

NX59SE 6 5606 9398.

(NX 5606 9398) Lagwine Cairn (NR)
OS 6" map (1957)

Lagwine Cairn was originally a large circular cairn about 78ft in diameter. It is now reduced to a ridge of stone crossing the centre, about 50ft long, 30ft broad, and 4ft high.
RCAHMS 1914, visited 1911

Lagwine Cairn, name confirmed, lies on a level shelf at the foot of a SW-facing hillslope. It has been heavily robbed (possibly during the con- struction of a nearby sheepfold); however a 1.5m high central core of small stone survives. Its original dimensions of 30.0m E-W by 25.0m N-S are indicated by a spread of stone and in some places a ragged and irregular rim of earth and stone. There is no evidence of a kerb and the centre appears to be undisturbed.
Resurveyed at 1:2500.
Visited by OS (JRL) 24 February 1978

Asset Number	80
Site Name	CUMNOCK KNOWES
Type of Site	MOUND, CROSS INCISED STONE
NMRS Number	
HER Number	MDG3480
Status	Not Designated
Easting	257680
Northing	592510
Parish	
Council	Dumfries And Galloway
Description	Significance = Regional/Local

NX59SE 8 5768 9251.

(NX 5768 9251) Stone (NR)
OS 6" map (1853)

A stone, measuring some 3 x 1 1/2ft and bearing a cross carved in relief, formerly erect, is now lying on one of the southernmost of the knolls called Crumnock Knowes. The spot is traditionally said to have been a place of worship.
Name Book 1849

This stone, which was at the entrance to Dalshangan House in 1911, is now in the garden of Broughton House, Kirkcudbright. The plain-stemmed cross (which Truckell suggests may be of 10th-11th century date) is 24 ins long, imperfect at the base where the stem seems to have expanded; the lateral arms also expand outwards.
Coles notes "a somewhat suspicious-looking mound" at the OS site.
RCAHMS 1914, visited 1911; J Williams 1969; A E Truckell 1963; F R Coles 1895

The Cumnock Knowes are now forestry planted and nothing of archaeological significance was noted on perambulation of the area.
Visited by OS (JRL) 21 February 1978

A rounded hillock,was located at given NGR. The First Edition OS depicts a stone here and the 1849 Name Book describes a cross incised stone here, traditionally a place of worship . No built features were noted on the hillock which was planted with mature forestry at time of visit.
(Site visit 11/05/00)
Dumfries and Galloway SMR: Information entered 11/05/2000

Asset Number	81
Site Name	GOAT CRAIG HILL
Type of Site	FINDSPOT
NMRS Number	
HER Number	MDG3913
Status	Not Designated
Easting	262600
Northing	595200
Parish	
Council	Dumfries And Galloway
Description	Significance = N/A

NX69NW 1 626 952.

On 4th November 1913, James M'Ilwraith who was cleaning surface drains on Craigengillan farm found a hoard of 2,225 silver, English, Scottish, Irish, Anglo-Gallic and foreign coins, mainly of Edward I-II. (The finder handed over 2,209 coins to the Scottish exchequer and 13 more were subsequently picked up). The coins were contained in a typical 14th century pottery jug which was found broken. The date of deposit was probably about 1330. The find spot was a marshy hollow on Goat Craig Hill (Goat Graig Name NX 626952). The jug and 22 of the coins are in the NMAS.
G Macdonald 1914; J Williams 1970

Asset Number	82
Site Name	CRAIGENGILLAN

Type of Site	STRUCTURE?; CAIRN?
NMRS Number	
HER Number	MDG3930
Status	Not Designated
Easting	262800
Northing	594900
Parish	
Council	Dumfries And Galloway
Description	Significance = None

NX69SW 13 628 949.

NX 628949. There are at least 58 small cairns in groups NW, N, NE and E of Craigengillan cairn (NX69SW 1). A ring cairn, 38 ft outside diameter, 21 ft inside diameter, lies close to these groups (cf NT05SE 3).
There are also four rectangular structures dug out of the ground and surrounded by turf-covered stone embankments; sizes are 33 x 10 ft, 33 x 14 ft, 49 x 12 ft and 26 x 13 ft.
M L Ansell 1966

This entire area has been forestry-ploughed and there are no recognisable remains of any of the above features.
Visited by OS (JRL) 20 October 1978

Asset Number	83
Site Name	FURMISTON
Type of Site	CAIRN
NMRS Number	
HER Number	MDG3968
Status	Not Designated
Easting	260470
Northing	592370
Parish	
Council	Dumfries And Galloway
Description	Significance = Other

NX69SW 7 6047 9237.

(NX 6047 9237) Cairn (NR)
OS 6" map (1849)

The remains of this ancient cairn are hardly visible, its stones having been removed for other purposes.
Name Book 1849

The site falls on a pastured hummock in an undulating marshy area. There is no trace of cairn material and no local knowledge of the cairn. Visited by OS (JRL) 20 October 1978

Asset Number	84
Site Name	KIRKTON OF CAIRSPHAIRN BURGH / TANTALALLOCHOLME
Type of Site	BURGH
NMRS Number	
HER Number	MDG8643
Status	Not Designated
Easting	256000
Northing	593000
Parish	
Council	Dumfries And Galloway
Description	Significance = None NX 560 930 Carsphairn is cited by Pryde (The burghs of Scotland: a critical list, 1965) as a burgh. No date is given for its establishment. Information from DGC (AJN) 29 August 2007

Asset Number	85
Site Name	CRAIGENGILLAN BURN
Type of Site	SHEEP FOLD
NMRS Number	
HER Number	MDG25434
Status	Not Designated
Easting	262974
Northing	594217
Parish	
Council	Dumfries And Galloway
Description	Significance = Other NX 6297 9421 A circular enclosure, with three offshoot walls, annotated 'sheep ree', is depicted on the 1st edition of the OS 6-inch map (Kirkcudbrightshire 1853, sheet 9) and on the current edition of the OS digitial Mastermap (2006) with two offshoot walls. Information from DGC [AJN] 1 March 2011

Asset Number	86
Site Name	CRAIGENGILLAN HILL
Type of Site	SHEEP FOLD
NMRS Number	
HER Number	MDG25437

Status	Not Designated
Easting	262028
Northing	595184
Parish	
Council	Dumfries And Galloway
Description	Significance = Other

NX 6202 9518

Circular sheep enclosure with two out-shot walls, shown on the first edition Ordnance Survey map of 1853, on the south-western flank of Craigengillan Hill. It is shown on the current digital OS mapping as still standing within forestry, but reduced to an S-shaped feature.
Information from DGC (AJN) 1 March 2011

Asset Number	87
Site Name	CRAIGENGILLAN BURN
Type of Site	SHEEP FOLD
NMRS Number	
HER Number	MDG25438
Status	Not Designated
Easting	262079
Northing	594636
Parish	
Council	Dumfries And Galloway
Description	Significance = Other

NX 6207 9464

Rectangular sheep enclosure, possibly overlying a circular one, with a single out-shot wall to the north-east, shown on the first edition Ordnance Survey map of 1853, and still partly shown on current digital OS mapping, within forestry.
Information from DGC (AJN) 1 March 2011

Asset Number	88
Site Name	KNOCKGRAY, (FORMERLY KIRKINNER CHURCHYARD)
Type of Site	CROSS
NMRS Number	
HER Number	MDG25692
Status	Not Designated
Easting	257663
Northing	593157
Parish	
Council	Dumfries And Galloway

Description	Significance = Regional A second free standing cross from the churchyard at Kirkinners on the Machars, about 5' high, illustrated by Stuart, and seen by Allen, also from this churchyard, was found at Knockgray House, Carsphairn (NX 576 931) in 1969, after being lost for a considerable period. It had been purchased by Capt. Clark Kennedy in the late 1880's from Walter Armstrong, an antiquarian from Kirkcowan. Williams 1969 The artistic style on the cross is unlike that of the 'Whithorn School', and exhibits more Scandinavian elements, of the Mammen/Jellinge style, which would indicate a date in the late 10th or early 11th century. Information from DGC [AJN] 12 March 2012.

Asset Number	89
Site Name	KNOCKGRAY POLICIES
Type of Site	LANDSCAPE PARK
NMRS Number	
HER Number	MDG25538
Status	Landscape Park of Regional Significance
Easting	257840
Northing	593260
Parish	
Council	Dumfries And Galloway
Description	Significance = Regional To the north-west lies Cemetery Wood, a plantation created in 1894 around the family burial ground.

Asset Number	90
Site Name	LAGWYNE
Type of Site	FIELD BOUNDARY, CAIRNFIELD
NMRS Number	
HER Number	MDG26013
Status	Not Designated
Easting	256595
Northing	594057
Parish	
Council	Dumfries And Galloway
Description	Significance = Regional/Local NX centred on 5662 9402 A field-system annotated 'Old Fences' is depicted on the 1st edition of the OS 6-inch map (Kirkcudbrightshire 1853, sheet 5). A length of wall denoted by a pecked line is shown on the

current edition of the OS 1:10000 map (1980).

The field boundary banks shown on the first edition Ordnance Survey map of 1853 are clearly visible as upstanding features on recent aerial photographs, along with at least 19 small cairns to the south of them.
Information from DGC (AJN) 4 March 2013

Asset Number	91
Site Name	CARSPHAIRN
Type of Site	RIDGE AND FURROW
NMRS Number	
HER Number	MDG26014
Status	Not Designated
Easting	256260
Northing	593772
Parish	
Council	Dumfries And Galloway
Description	Significance = Other

NX 5625 9377

Patches of rig and furrow cultivation are visible on recent aerial photographs on areas of slightly raised, better drained ground to the north of Carsphairn village. There are indications of boundary banks enclosing them.
Information from DGC (AJN) 4 March 2013

Asset Number	92
Site Name	FURMISTON
Type of Site	FARMSTEAD
NMRS Number	
HER Number	MDG26155
Status	Not Designated
Easting	260316
Northing	592293
Parish	
Council	Dumfries And Galloway
Description	Significance = Unknown

NX 6031 9229

A farmstead of two parallel long buildings is depicted on the 1st edition of the OS 6-inch map (Kirkcudbrightshire 1853, sheet 9). They still appear on recent aerial photographs.

This farmstead is shown as 'Tormiston' on Roy's map of 1755. It is still in current use.
Information frpom DGC (AJN) 23 September 2013

Asset Number	93
Site Name	MARBRACK
Type of Site	FARMSTEAD
NMRS Number	
HER Number	MDG26156
Status	Not Designated
Easting	259739
Northing	593258
Parish	
Council	Dumfries And Galloway
Description	Significance = Unknown NX 5973 9326 A farmstead of U-shaped grpoups of buildings is depicted on the 1st edition of the OS 6-inch map (Kirkcudbrightshire 1853, sheet 9). They still appear on recent aerial photographs. This farmstead is shown as 'Muirbraeck' on Roy's map of 1755, and as 'Morbrack' on Blaeu's map of 1654. It is still in current use. Information from DGC (AJN) 23 September 2013

Asset Number	94
Site Name	CARNAVEL
Type of Site	FARMSTEAD
NMRS Number	
HER Number	MDG26157
Status	Not Designated
Easting	256365
Northing	592715
Parish	
Council	Dumfries And Galloway
Description	Significance = Unknown NX 5636 9271 A farmstead of two parallel buildings with a further building to the north-west is depicted on the 1st edition of the OS 6-inch map. They still appear on recent aerial photographs. This farmstead is shown as 'Carncathert' on Roy's map of 1755, and as 'Corneffel' on Blaeu's map of 1654. It is still in current use. Information from DGC (AJN) 23 September 2013

Asset Number	95
Site Name	KNOCKGRAY
Type of Site	FARMSTEAD
NMRS Number	
HER Number	MDG26159
Status	Not Designated
Easting	257886
Northing	593327
Parish	
Council	Dumfries And Galloway
Description	Significance = Unknown

NX 5380 9592

A farmstead of two parallel long buildings with a further buildings to the west is depicted on the 1st edition of the OS 6-inch map. They still appear on recent aerial photographs.

This farmstead is shown as 'Knock Gray' on Roy's map of 1755, and as 'N.Knokgrey' on Blaeu's map of 1654. It is still in current use.
Information from DGC (AJN) 23 September 2013

A late 19th century source referes to a towerhouse forming part of the earlier farmstead at Knockgray. It may be that which is depicted on Blaeu's map.
Information from DGC (AJN) 28 June 2014

Asset Number	96
Site Name	MINNICK BURN
Type of Site	SHEEP FOLD
NMRS Number	
HER Number	MDG26172
Status	Not Designated
Easting	262116
Northing	596865
Parish	
Council	Dumfries And Galloway
Description	Significance = Other

NX 6211 9686

A sheep enclosure with two out-shot walls, and a small square enclosure on its north-western side annotated 'sheep ree', is depicted on the 1st edition of the OS 6-inch map (Kirkcudbrightshire 1853, sheet 5,) and on the current edition of the OS digitial Mastermap (2006) with a curving wall added to the west. It is visible on recent (2010) aerial photographs in a clearing in forestry.
Information from DGC [AJN] 11 October 2013

Asset Number	97
Site Name	SOMS KNOWE
Type of Site	SHEEP FOLD
NMRS Number	
HER Number	MDG26175
Status	Not Designated
Easting	262810
Northing	596530
Parish	
Council	Dumfries And Galloway
Description	Significance = Other NX 6281 9653 The much reduced remains of a squared sheep enclosure abutting a field boundary wall, depicted on the 1st edition of the OS 6-inch map (Kirkcudbrightshire 1853, sheet 5,) are visible on recent (2010) aerial photographs. Information from DGC [AJN] 11 October 2013

Asset Number	98
Site Name	CRAIGENGILLAN
Type of Site	BURNT MOUND?
NMRS Number	
HER Number	MDG27135
Status	Not Designated
Easting	262834
Northing	594578
Parish	
Council	Dumfries And Galloway
Description	Significance = Regional NX 6284 9458 Large circular grass-covered mound, approximately 8m in diameter and 1.6m high, adjacent to a small burn. Noted during a site visit to Craigengillan cairn. Not tested for burnt stones. Information from DGC (AJN) and HES (MMR) 22 February 2019

Asset Number	99
Site Name	Grey Stone
Type of Site	Grey Stone
NMRS Number	
HER Number	

Status	Not Designated
Easting	256223
Northing	593263
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	100
Site Name	Well
Type of Site	Well
NMRS Number	
HER Number	
Status	Not Designated
Easting	256252
Northing	593210
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	101
Site Name	Named wells (1st OS)
Type of Site	Wells
NMRS Number	
HER Number	
Status	Not Designated
Easting	258963
Northing	597793
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	102
Site Name	Sheep ree
Type of Site	Sheep ree
NMRS Number	
HER Number	
Status	Not Designated

Easting	257604
Northing	597221
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	103
Site Name	Sherpherd's cairn (1st OS)
Type of Site	Shepherd's cairn
NMRS Number	
HER Number	
Status	Not Designated
Easting	257709
Northing	596662
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	104
Site Name	Sheep ree
Type of Site	Sheep ree
NMRS Number	
HER Number	
Status	Not Designated
Easting	256515
Northing	595310
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	105
Site Name	Sheep ree
Type of Site	Sheep ree
NMRS Number	
HER Number	
Status	Not Designated
Easting	258632

Northing	593139
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	106
Site Name	Sheep ree
Type of Site	Sheep ree
NMRS Number	
HER Number	
Status	Not Designated
Easting	259084
Northing	593068
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	107
Site Name	Rig
Type of Site	Rig
NMRS Number	
HER Number	
Status	Not Designated
Easting	258088
Northing	593773
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	108
Site Name	Sheep shelter
Type of Site	Sheep shelter
NMRS Number	
HER Number	
Status	Not Designated
Easting	259420
Northing	594539

Parish	
Council	Dumfries And Galloway
Description	

Asset Number	109
Site Name	Covenanter site? (placename)
Type of Site	Covenanter site? (placename)
NMRS Number	
HER Number	
Status	Not Designated
Easting	256072
Northing	593351
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	110
Site Name	Rig
Type of Site	Rig
NMRS Number	
HER Number	
Status	Not Designated
Easting	262814
Northing	596500
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	111
Site Name	Clearance cairns?
Type of Site	Clearance cairns?
NMRS Number	
HER Number	
Status	Not Designated
Easting	262859
Northing	596491
Parish	

Council	Dumfries And Galloway
Description	

Asset Number	112
Site Name	Mill pond
Type of Site	Mill pond
NMRS Number	
HER Number	
Status	Not Designated
Easting	256421
Northing	593286
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	113
Site Name	Hay ree
Type of Site	Hay ree
NMRS Number	
HER Number	
Status	Not Designated
Easting	257503
Northing	592313
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	114
Site Name	Stone (1st OS)
Type of Site	Stone (1st OS)
NMRS Number	
HER Number	
Status	Not Designated
Easting	257686
Northing	592533
Parish	
Council	Dumfries And Galloway

Description

Asset Number	115
Site Name	Hay ree (1st OS)
Type of Site	Hay ree (1st OS)
NMRS Number	
HER Number	
Status	Not Designated
Easting	257902
Northing	592635
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	116
Site Name	Sheepfold
Type of Site	Sheepfold
NMRS Number	
HER Number	
Status	Not Designated
Easting	260625
Northing	592959
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	117
Site Name	Sheep ree
Type of Site	Sheep ree
NMRS Number	
HER Number	
Status	Not Designated
Easting	260582
Northing	593118
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	118
Site Name	Sheep ree
Type of Site	Sheep ree
NMRS Number	
HER Number	
Status	Not Designated
Easting	260799
Northing	592568
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	119
Site Name	Sheep ree
Type of Site	Sheep ree
NMRS Number	
HER Number	
Status	Not Designated
Easting	260477
Northing	592539
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	120
Site Name	Sheep ree (1st OS)
Type of Site	Sheep ree (1st OS)
NMRS Number	
HER Number	
Status	Not Designated
Easting	260692
Northing	592050
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	121
Site Name	Sheep ree
Type of Site	Sheep ree
NMRS Number	
HER Number	
Status	Not Designated
Easting	260463
Northing	591791
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	122
Site Name	Enclosure
Type of Site	Enclosure
NMRS Number	
HER Number	
Status	Not Designated
Easting	258360
Northing	597389
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	123
Site Name	Cairn?
Type of Site	Cairn?
NMRS Number	
HER Number	
Status	Not Designated
Easting	257639
Northing	596682
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	124
Site Name	Sheepfold
Type of Site	Sheepfold
NMRS Number	
HER Number	
Status	Not Designated
Easting	256986
Northing	596081
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	125
Site Name	Pen
Type of Site	Pen
NMRS Number	
HER Number	
Status	Not Designated
Easting	257105
Northing	594862
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	126
Site Name	Sheep shelter
Type of Site	Sheep shelter
NMRS Number	
HER Number	
Status	Not Designated
Easting	259910
Northing	592697
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	127
Site Name	Sheep shelter
Type of Site	Sheep shelter
NMRS Number	
HER Number	
Status	Not Designated
Easting	261052
Northing	593983
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	128
Site Name	Sheep shelter
Type of Site	Sheep shelter
NMRS Number	
HER Number	
Status	Not Designated
Easting	261476
Northing	593830
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	129
Site Name	Sheep ree
Type of Site	Sheep ree
NMRS Number	
HER Number	
Status	Not Designated
Easting	260649
Northing	593041
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	130

Site Name	Sheep shelter
Type of Site	Sheep shelter
NMRS Number	
HER Number	
Status	Not Designated
Easting	259589
Northing	592152
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	131
Site Name	Buildings?
Type of Site	Buildings?
NMRS Number	
HER Number	
Status	Not Designated
Easting	260534
Northing	593049
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	132
Site Name	Enclosure
Type of Site	Enclosure
NMRS Number	
HER Number	
Status	Not Designated
Easting	262937
Northing	594637
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	133
Site Name	Sheepfold? (Lidar)

Type of Site	Sheepfold? (Lidar)
NMRS Number	
HER Number	
Status	Not Designated
Easting	260153
Northing	592152
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	134
Site Name	Cairn
Type of Site	Cairn
NMRS Number	
HER Number	
Status	Not Designated
Easting	256781
Northing	593968
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	135
Site Name	Cairn
Type of Site	Cairn
NMRS Number	
HER Number	
Status	Not Designated
Easting	256773
Northing	593984
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	136
Site Name	Cairn
Type of Site	Cairn

NMRS Number	
HER Number	
Status	Not Designated
Easting	256750
Northing	593982
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	137
Site Name	Cairn
Type of Site	Cairn
NMRS Number	
HER Number	
Status	Not Designated
Easting	256727
Northing	594027
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	138
Site Name	Cairn
Type of Site	Cairn
NMRS Number	
HER Number	
Status	Not Designated
Easting	256721
Northing	594053
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	139
Site Name	Cairn
Type of Site	Cairn
NMRS Number	

HER Number	
Status	Not Designated
Easting	256707
Northing	594041
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	140
Site Name	Cairn
Type of Site	Cairn
NMRS Number	
HER Number	
Status	Not Designated
Easting	256708
Northing	594058
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	141
Site Name	Cairn
Type of Site	Cairn
NMRS Number	
HER Number	
Status	Not Designated
Easting	256688
Northing	594052
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	142
Site Name	Cairn
Type of Site	Cairn
NMRS Number	
HER Number	

Status	Not Designated
Easting	256675
Northing	594044
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	143
Site Name	Cairn
Type of Site	Cairn
NMRS Number	
HER Number	
Status	Not Designated
Easting	256671
Northing	594061
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	144
Site Name	Cairn
Type of Site	Cairn
NMRS Number	
HER Number	
Status	Not Designated
Easting	256677
Northing	594023
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	145
Site Name	Cairn
Type of Site	Cairn
NMRS Number	
HER Number	
Status	Not Designated

Easting	256671
Northing	594008
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	146
Site Name	Cairn
Type of Site	Cairn
NMRS Number	
HER Number	
Status	Not Designated
Easting	256662
Northing	593983
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	147
Site Name	Cairn
Type of Site	Cairn
NMRS Number	
HER Number	
Status	Not Designated
Easting	256652
Northing	594025
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	148
Site Name	Cairn
Type of Site	Cairn
NMRS Number	
HER Number	
Status	Not Designated
Easting	256633

Northing	593947
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	149
Site Name	Cairn
Type of Site	Cairn
NMRS Number	
HER Number	
Status	Not Designated
Easting	256504
Northing	594072
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	150
Site Name	Cairn
Type of Site	Cairn
NMRS Number	
HER Number	
Status	Not Designated
Easting	256505
Northing	594099
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	151
Site Name	Cairn
Type of Site	Cairn
NMRS Number	
HER Number	
Status	Not Designated
Easting	256568
Northing	594097

Parish	
Council	Dumfries And Galloway
Description	

Asset Number	152
Site Name	Cairn
Type of Site	Cairn
NMRS Number	
HER Number	
Status	Not Designated
Easting	256591
Northing	594069
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	153
Site Name	Cairn
Type of Site	Cairn
NMRS Number	
HER Number	
Status	Not Designated
Easting	256471
Northing	594111
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	154
Site Name	Cairn
Type of Site	Cairn
NMRS Number	
HER Number	
Status	Not Designated
Easting	256455
Northing	594042
Parish	

Council	Dumfries And Galloway
Description	

Asset Number	155
Site Name	Cairn
Type of Site	Cairn
NMRS Number	
HER Number	
Status	Not Designated
Easting	256477
Northing	593946
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	156
Site Name	Cairn
Type of Site	Cairn
NMRS Number	
HER Number	
Status	Not Designated
Easting	256355
Northing	593991
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	157
Site Name	Cairn
Type of Site	Cairn
NMRS Number	
HER Number	
Status	Not Designated
Easting	256404
Northing	593979
Parish	
Council	Dumfries And Galloway

Description	

Asset Number	158
Site Name	Cairn
Type of Site	Cairn
NMRS Number	
HER Number	
Status	Not Designated
Easting	256405
Northing	594039
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	159
Site Name	Cairn
Type of Site	Cairn
NMRS Number	
HER Number	
Status	Not Designated
Easting	256409
Northing	594095
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	160
Site Name	Cairn
Type of Site	Cairn
NMRS Number	
HER Number	
Status	Not Designated
Easting	256615
Northing	594017
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	161
Site Name	'Grey Stone'
Type of Site	'Grey Stone'
NMRS Number	
HER Number	
Status	Not Designated
Easting	256223
Northing	593263
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	162
Site Name	Kiln? Cairn?
Type of Site	Kiln? Cairn?
NMRS Number	
HER Number	
Status	Not Designated
Easting	260797
Northing	593007
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	163
Site Name	Building
Type of Site	Building
NMRS Number	
HER Number	
Status	Not Designated
Easting	259410
Northing	594517
Parish	
Council	Dumfries And Galloway
Description	

Asset Number	164
Site Name	Hut circle (possible)
Type of Site	Hut circle (possible)
NMRS Number	
HER Number	
Status	Walkover Site
Easting	260639
Northing	593452
Parish	
Council	Dumfries And Galloway
Description	Possible hut circle with rim of stones. 3m x 3m.

Asset Number	165
Site Name	Cairn
Type of Site	Cairn
NMRS Number	
HER Number	
Status	Walkover Site
Easting	260590
Northing	594460
Parish	
Council	Dumfries And Galloway
Description	Possible cairn or clearance cairn 1m x 1m.

Asset Number	166
Site Name	Upright stone
Type of Site	Upright stone
NMRS Number	
HER Number	
Status	Walkover Site
Easting	260702
Northing	594977
Parish	
Council	Dumfries And Galloway
Description	Possible standing stone 0.5m high.

Asset Number	167
Site Name	Clearance cairn
Type of Site	Clearance cairn
NMRS Number	
HER Number	
Status	Walkover Site
Easting	260650
Northing	595086
Parish	
Council	Dumfries And Galloway
Description	Possible clearance cairn 1.5m x 1.5m.

Asset Number	168
Site Name	Clearance cairn
Type of Site	Clearance cairn
NMRS Number	
HER Number	
Status	Walkover Site
Easting	260656
Northing	595078
Parish	
Council	Dumfries And Galloway
Description	Possible clearance cairn 1m diameter.

Asset Number	169
Site Name	Cist (possible)
Type of Site	Cist (possible)
NMRS Number	
HER Number	
Status	Walkover Site
Easting	260641
Northing	595100
Parish	
Council	Dumfries And Galloway
Description	Possible burial cist. Sub-rectangular. Rounded edges. 1.5m x 1.5m.

Asset Number	170
Site Name	Cist (possible)
Type of Site	Cist (possible)
NMRS Number	
HER Number	
Status	Walkover Site
Easting	260637
Northing	595092
Parish	
Council	Dumfries And Galloway
Description	Possible burial cist. 1.5m. Partially hidden by turf.

Asset Number	171
Site Name	Clearance cairn
Type of Site	Clearance cairn
NMRS Number	
HER Number	
Status	Walkover Site
Easting	260647
Northing	595112
Parish	
Council	Dumfries And Galloway
Description	Sub-circular.2m diameter.

Asset Number	172
Site Name	Clearance cairn
Type of Site	Clearance cairn
NMRS Number	
HER Number	
Status	Walkover Site
Easting	260665
Northing	595115
Parish	
Council	Dumfries And Galloway
Description	Irregular.2m x 2m.

Asset Number	173

Site Name	Clearance cairn
Type of Site	Clearance cairn
NMRS Number	
HER Number	
Status	Walkover Site
Easting	260627
Northing	595178
Parish	
Council	Dumfries And Galloway
Description	2m diameter.

Asset Number	174
Site Name	Clearance cairn
Type of Site	Clearance cairn
NMRS Number	
HER Number	
Status	Walkover Site
Easting	260624
Northing	595178
Parish	
Council	Dumfries And Galloway
Description	1.5m diameter

Asset Number	175
Site Name	Clearance cairn
Type of Site	Clearance cairn
NMRS Number	
HER Number	
Status	Walkover Site
Easting	261056
Northing	595469
Parish	
Council	Dumfries And Galloway
Description	Overgrown. 2m diameter.

Asset Number	176
Site Name	Mound (natural)

Type of Site	Mound (natural)
NMRS Number	
HER Number	
Status	Walkover Site
Easting	261326
Northing	593098
Parish	
Council	Dumfries And Galloway
Description	Grassy mound. 10m diameter, 1.5m high. Natural rock geology exposed on east side. Probably natural.

Asset Number	177
Site Name	Bank
Type of Site	Bank
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	261248
Northing	594968
Parish	
Council	
Description	Curvilinear bank extending for c.70m. Confidence: Possible

---

Asset Number	178
Site Name	Enclosure
Type of Site	Enclosure
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	260776
Northing	594844
Parish	
Council	
Description	Enclosure measuring c. 35m N-S by 25m E-W. Confidence: Possible

---

Asset Number	179
Site Name	Hut Circle
Type of Site	Hut Circle
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	260213
Northing	594865
Parish	
Council	
Description	Possible small circular enclosure measureing c. 9m in diameter with smaller, attached enclosure to S. Confidence: Low Confidence

---

Asset Number	180
Site Name	Structure
Type of Site	Structure
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	260067
Northing	594851
Parish	
Council	
Description	Small rectangular structure, oriented NE-SW, measuring 6 by 4m. Confidence: Possible

---

Asset Number	181
Site Name	Enclosure
Type of Site	Enclosure
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	260041
Northing	594843
Parish	
Council	
Description	Oval enclosure measuring 15m NW-SE by 11m.

Confidence: Low Confidence

Asset Number	182
Site Name	Enclosure
Type of Site	Enclosure
NMRS Number	
HER Number	MDG15851
Status	LiDAR Feature
Easting	260006
Northing	594796
Parish	
Council	
Description	Small sub-circular enclosure measuring 8m in diameter. Possibly NX69SW 55/MDG15851/AOC Site 5. Confidence: Probable

---

Asset Number	183
Site Name	Enclosure
Type of Site	Enclosure
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	260624
Northing	594777
Parish	
Council	
Description	Small sub-rectangular enclosure, oriented NE-SW. Measures c. 10m by 8m. Confidence: Low Confidence

---

Asset Number	184
Site Name	Burnt Mound
Type of Site	Burnt Mound
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	260944

Northing	594768
Parish	
Council	
Description	Possible penannular bank measuring c. 5m in diameter lying to immediate NW of small watercourse. Confidence: Low Confidence

---

Asset Number	185
Site Name	Enclosure
Type of Site	Enclosure
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	260879
Northing	594387
Parish	
Council	
Description	Small sub-square enclosure measuring 9m NE-SW by 10m NW-SE. Located 20m to SW of Marbrack Burn. Confidence: Low Confidence

---

Asset Number	186
Site Name	Enclosure
Type of Site	Enclosure
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	260222
Northing	594138
Parish	
Council	
Description	Sub rectaungular enclosure, oriented NNE-SSW. Measures c. 18m by 13m. Confidence: Low Confidence

---

Asset Number	187
Site Name	Bank
Type of Site	Bank

NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	261341
Northing	594134
Parish	
Council	
Description	Curvilinear bank extending for c. around NE, N & NW side of hillock. Confidence: Possible

Asset Number	188
Site Name	Structure
Type of Site	Structure
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	261426
Northing	593756
Parish	
Council	
Description	Sub-rectaungular structure, oriented NW-SE. Measures c. 9m by 5m. Confidence: Low Confidence

Asset Number	189
Site Name	Peat Cutting
Type of Site	Peat Cutting
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	260943
Northing	593408
Parish	
Council	
Description	Rectangular area of peat cutting. Confidence: Probable

Asset Number	190
Site Name	Peat Cutting
Type of Site	Peat Cutting
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	261497
Northing	593380
Parish	
Council	
Description	Rectangular area of peat cutting. Confidence: Probable

---

Asset Number	191
Site Name	Peat Cutting
Type of Site	Peat Cutting
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	261422
Northing	593344
Parish	
Council	
Description	4 Rectangular areas of peat cutting. Confidence: Probable

---

Asset Number	192
Site Name	Enclosure
Type of Site	Enclosure
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	260358
Northing	593350
Parish	
Council	
Description	D shaped enclosure measuring 17m NW-SE by 140m NE-SE.

Confidence: High Confidence

Asset Number	193
Site Name	Farmstead
Type of Site	Farmstead
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	260630
Northing	593076
Parish	
Council	
Description	Cluster of enclosures, fields, areas of rig and furrow and a posible small structure extending across a c. 400m by 300m area. Confidence: High Confidence

---

Asset Number	194
Site Name	Cairn
Type of Site	Cairn
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	260503
Northing	597923
Parish	
Council	
Description	Sub-oval mound oriented NW-SE, measuring 5m by 4m. Confidence: Low Confidence

---

Asset Number	195
Site Name	Hut Circle
Type of Site	Hut Circle
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	260544
Northing	597556

Parish	
Council	
Description	Penannular bank measuring c.6m in external diameter possibly terraced into S facing slope. Confidence: Low Confidence

---

Asset Number	196
Site Name	Platform
Type of Site	Platform
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	260870
Northing	597222
Parish	
Council	
Description	Possible terrace/platform measuring c.8m NE-SW by 9m NW-SE on gentle SE facing slope. Confidence: Low Confidence

---

Asset Number	197
Site Name	Enclosures
Type of Site	Enclosures
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	260531
Northing	597192
Parish	
Council	
Description	2 possible intersecting enclosures. The larger enclosure is a sub rectangular enclosure oriented NE-SW, measuring 120m by 50m. The smaller is a sub oval enclosure oriented NW-SE measuring 50m by 45m. Confidenc: probable

---

Asset Number	198
Site Name	Hut Circle
Type of Site	Hut Circle

NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	261482
Northing	596287
Parish	
Council	
Description	Possible penannular bank measuring c. 10m in exterior diameter. Located on gentle NE facing slope. Confidence: Low Confidence

Asset Number	199
Site Name	Cairn
Type of Site	Cairn
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	261069
Northing	595454
Parish	
Council	
Description	Possible cairn c. 3m diameter. Confidence: Possible

Asset Number	200
Site Name	Cairn
Type of Site	Cairn
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	261042
Northing	595491
Parish	
Council	
Description	Possible cairn c. 2m diameter. Confidence: Possible

Asset Number	201
Site Name	Enclosure
Type of Site	Enclosure
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	259527
Northing	596872
Parish	
Council	
Description	Possible sub-rectangular enclosure measuring 14m NE-SW by 12m NW-SE. Confidence: Low Confidence

---

Asset Number	202
Site Name	Mound
Type of Site	Mound
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	259388
Northing	595922
Parish	
Council	
Description	Small mound c. 5m in diameter. Lies 10m to S. of Benloch Burn. Confidence: Low Confidence

---

Asset Number	203
Site Name	Enclosure
Type of Site	Enclosure
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	259532
Northing	595358
Parish	
Council	
Description	Small sub-circular enclosure measuring c. 6m in diameter.

Confidence; Low Confidence

Asset Number	204
Site Name	Cairns?
Type of Site	Cairns
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	259448
Northing	595367
Parish	
Council	
Description	Around 20 small (c. 1m diameter) mounds visible. Confidence: Low Confidence

---

Asset Number	205
Site Name	Farmstead
Type of Site	Farmstead
NMRS Number	NX59NE 10
HER Number	MDG15549
Status	LiDAR Feature
Easting	258059
Northing	595370
Parish	
Council	
Description	Two sub-rectangular buildings with attached rectangular enclosure to SW. Update of location for Benloch Strand (NX59NE 10) AOC Site 11 Confidence: High Confidence

---

Asset Number	206
Site Name	Cairn?
Type of Site	Cairn?
NMRS Number	NX59NE 1
HER Number	
Status	LiDAR Feature

Easting	257712
Northing	595330
Parish	
Council	
Description	Annular bank c. 11m in diameter. Updated location for Willieanna NX59NE 1. AOC Site 10 Confidence: Probable

---

Asset Number	207
Site Name	Structure
Type of Site	Structure
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	257743
Northing	594798
Parish	
Council	
Description	Sub -rectangular building measuring 9m NE-SW by 6m NW-SE. Located 15m to SE of Benloch Burn. Confidence: Probable

---

Asset Number	208
Site Name	Peat Cutting
Type of Site	Peat Cutting
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	258053
Northing	594693
Parish	
Council	
Description	Two rectangular areas of peat cutting Confidence: Possible

---

Asset Number	209

Site Name	Enclosure
Type of Site	Enclosure
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	258772
Northing	594244
Parish	
Council	
Description	Sub-circular enclosure measuring c. 10m in diameter Confidence: Possible

---

Asset Number	210
Site Name	Peat Cutting
Type of Site	Peat Cutting
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	257642
Northing	594127
Parish	
Council	
Description	Area of peat cutting Confidence: Probable

Asset Number	211
Site Name	Peat Cutting
Type of Site	Peat Cutting
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	259073
Northing	594017
Parish	
Council	
Description	Area of peat cutting Confidence: Probable

Asset Number	212
Site Name	Peat Cutting
Type of Site	Peat Cutting
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	259184
Northing	594031
Parish	
Council	
Description	Area of peat cutting Confidence; Probable

Asset Number	213
Site Name	Enclosure
Type of Site	Enclosure
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	259896
Northing	594062
Parish	
Council	
Description	Irregularly shaped enclosure measuring c. 25m N-S by 20m E-W. Lies to immediate W of drainage channel and may be truncated by this. Confidence: Possible

Asset Number	214
Site Name	Peat Cutting
Type of Site	Peat Cutting
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	259165
Northing	593983
Parish	

Council	
Description	Area of peat cutting Confidence: Probable

Asset Number	215
Site Name	Structure
Type of Site	Structure
NMRS Number	
HER Number	
Status	LiDAR Feature
Easting	259835
Northing	593887
Parish	
Council	
Description	Possible sub-rectangular structure measuring 10m NW-SE by 9m NE-SW. Confidence: Possible

Asset Number	216
Site Name	Benloch Burn
Type of Site	Corn Drying Kiln (Period Unassigned), Field System (Period Unassigned)
NMRS Number	NX59NE 22
HER Number	MDG15561
Status	Not Designated
Easting	256170
Northing	595100
Parish	Carsphairn
Council	Dumfries And Galloway
Description	Canmore ID: 177182 HER Archeaology Interest Region RCAHMS First Edition Survey Project A circular unroofed structure annotated 'Old Cornkiln' and a field-system annotated 'Old Fences' are depicted on the 1st edition of the OS 6-inch map (Kirkcudbrightshire 1853, sheet 5), but they are not shown on the current edition of the OS 1:10000 map (1981). Information from RCAHMS (AKK) 15 September 1999.

Asset Number	217

Site Name	Craigengillen
Type of Site	Inventory Garden and Designed Landscape
NMRS Number	
HER Number	
Status	Inventory Garden and Designed Landscape
Easting	245007
Northing	605098
Parish	Dalmellington, Straiton
Council	East Ayrshire
Description	GDL00111 Pastmap coordinates: 246391, 604198

Craigengillan is a rare example of a complete and unfragmented estate landscape, started in the 16th century and held by one family (McAdam) for almost 400 years. The designed landscape dates from the late 18th/early 19th century and includes a Category A listed mansion house, and stables, formal gardens, a walled garden and a Japanese water garden, added in the early 20th century, incorporating Pulhamite rockwork, rockeries and waterfalls. Garden buildings and notable drystone walling, extensive policy woodland, a rocky gorge and industrial archaeological remnants are also elements of the designed landscape.

Type of Site
A complete designed landscape dating from the latter half of the 18th century, incorporating a Category A listed mansion house, formal gardens, walled garden, Japanese garden, garden buildings and notable drystone walling, extensive policy woodland, rocky gorge, and industrial archaeological remnants.

Main Phases of Landscape Development
The estate at Craigengillan has existed since the 16th century, but the layout of the gardens and designed landscape was carried out in the late 18th/early 19th century. The Japanese Garden, rockeries and waterfalls were added in the early 20th century.

Artistic Interest
Level of interest
Outstanding
The beauty, strength and simplicity of design, which skilfully blends Craigengillan into the wider landscape and the picturesque quality of the gardens and grounds, gives Craigengillan outstanding value as a Work of Art. The Japanese water garden is a fine example of the work of James Pulham & Sons.

Historical
Level of interest
Outstanding
The continuity of ownership and stewardship by the McAdam family over 400 years and the achievements of John Loudon McAdam in particular, together with its more ancient history and archaeological sites, give Craigengillan outstanding Historical value. Visitors in the last century have included the Kaiser, Prince Rainier of Monaco, Somerset Maugham, Neville Chamberlain (when Prime Minister), King Gustav and Queen Helena of Sweden, and Lord Halifax, Viceroy of India.

Horticultural
Level of interest
Outstanding
The ancient and outstanding specimen trees, together with the single largest collection of mosses and ferns in southern Scotland in the Ness Glen, give Craigengillan outstanding Horticultural value. The recent plantings will serve to totally re-instate the estate plantings as they were in their heyday, and will give Craigengillan outstanding arboricultural and

silvicultural value for generations to come.

Architectural
Level of interest
Outstanding
The Category A listed 18th century house, together with the Stable Block, Home Farm, and several unique garden buildings and structures, such as the Ice House, Tunnel and the unique form of drystone walling, give Craigengillan outstanding Architectural value.

Archaeological
Level of interest
Outstanding
The Scheduled Monument of Dalnean Hill and another 22 listed archaeological sites give Craigengillan outstanding Archaeological value.

Scenic
Level of interest
Outstanding
The remarkably intact landscape composition and the site's contribution to the villages of Dalmellington and Bellsbank, and to the approach to Loch Doon give Craigengillan outstanding Scenic value. In a wider landscape context, Craigengillan enriches the local scenery which has been altered by industry and is otherwise fairly barren.

Nature Conservation
Level of interest
Outstanding
The site contains a network of important wildlife habitats and includes two sites of Special Scientific Interest (SSSIs). It forms part of the Western Uplands Environmentally Sensitive Area and includes the Doon Valley Wetlands Listed Wildlife Site. Craigengillan therefore has outstanding Nature Conservation value.

Location and Setting
Craigengillan is located immediately to the southeast of Dalmellington village, with its northern boundary abutting the A713 Ayr-Castle Douglas road. The end of Ness Glen marks the southern boundary, whilst the south-eastern boundary follows the minor public road from the A713 to Loch Doon.
Craigengillan lies 14 miles from the sea, at 170m above sea level at Bogton Loch to the north of the estate, rising to 290m at the summit of Carwaur, and 367m at the top of Auchenroy Hill.
To the north of Craigengillan, between Patna and Dalmellington, the landscape is largely barren treeless moorland. To the east, south and southwest of Craigengillan, lie the heather and tree covered slopes of Auldcraigoch Hill, Bryan's Heights and the Wee Hill of Glenmount. The landscape to the south becomes more rugged with rocky outcrops and the Ness Glen gorge, at the south end of the estate. There are fine panoramic views of the surrounding hills from Craigengillan House and different parts of the gardens and landscape. There are also spectacular views of the rocky gorge through Ness Glen.
Until the 1840s, the landscape around Craigengillan and around the village of Dalmellington was largely agricultural. Stone quarrying took place on the land before ironstone and coal were discovered locally and were mined extensively during the industrial revolution. Although the iron smelting ceased more than 30 years ago, and the coal mining will finish in the next few years, the impact on the local landscape has been considerable. However the landscape is now (2011) recovering and more closely resembles its pre-industrial state. The nearby Conservation Village of Waterside contains many buildings and blast furnaces now listed for their industrial archaeological importance.
Craigengillan was first established as an estate in 1580, encompassing 12,140 hectares and extending to Carsphairn in Dumfries and Galloway. The current estate comprises 1,162 hectares, and the designed landscape covers all of this area, bounded to the north by Dalmellington and the B741 road, to the west by the Forestry Commission of Scotland plantations established on Auldcraigoch Hill, to the south by the end of the Ness Glen, and the east by Bellsbank village and Bellsbank forestry plantation.

Site History

Earlier evidence of occupation on the site include an ancient Bronze Age burial mound on the western shore of Bogton Loch, and the clearly visible medieval field systems and steadings on the Scheduled Monument of Dalnean Hill and at Dalcairney, Auchenroy and Glenhead. Craigengillan was first established in 1580 as the seat of the McAdam family, and it remained in their hands for more than 400 years, until 1999.
Much of the designed landscape structure seen today dates from the latter half of the 18th century. The principal part of the mansion house was built in 1765 and over the next 30 years the fields were enclosed with granite dykes, trees were planted and extensive drainage work undertaken.
John McAdam succeeded to the estate in 1757, and was a great engineer and innovator. He and his kinsman John Louden McAdam became road engineers and invented tarmacadam. John Louden McAdam returned to Scotland from America in 1783, where he had pioneered the 'macadam method' of roadbuilding, building roads slightly higher than ground level to enable them to drain effectively and withstand erosion. Upon his return he embarked on an extensive road and bridge building programme in Ayrshire. John McAdam also used his engineering skills to devise a new method of drystone walling. This involved constructing the wall in sections so that it was much easier to maintain and repair. Together with one of his key estate workers, John McKenzie, he established a school of drystone walling, to which dykers came from all over Scotland to the estate to learn the McAdam method. 'It was said in 1847 that Craigengillan stone dykes were the most extensive and best-built anywhere in the country.' (Moore, 1972).
John McAdam also founded McAdam's Bank in Ayr, and was a patron of the arts who gave early support to Robert Burns, who in turn wrote a poem to McAdam. Armstrong's map of 1775 shows many of the field enclosures, bridges and tree plantings had been completed, as well as the main drive which formed a more direct route to Dalmellington. John McAdam also constructed a dam and sluice gates at the foot of Loch Doon to prevent flooding on the estate. As well as being enthusiastic road builders and engineers, many later McAdams were enthusiastic horse breeders and sportsmen and by 1800 the category A listed stable block was built. During the Boer War the estate shipped 40 horses to South Africa which were used in the Relief of Mafeking.
Quintin McAdam constructed a romantic footpath through the Ness Glen in 1826 with the intention of making the beauty spot accessible to everyone. The glen was described in the 1903 Ordnance Gazetteer of Scotland as 'one of the finest examples in Britain of a true rock gorge'. The mansion house was extended around this time, and the Gothic gatehouse built. The formal gardens were laid out during this period, and the cistern, ice house, tunnels and Ladies' Loch were created. In early Victorian times, probably around 1840, the northeast tower and crowstepped gables were added to Craigengillan House and the model home farm was built.
In 1902, interior designers Jansen of Paris were contracted to remodel much of the interior of Craigengillan House. This is possibly the only documented example of Jansen's work in Scotland. They were considered to be the best designers in France in the early 20th century. The formal gardens were completely redesigned at around this time and the Walled Garden was opened up. The Walled Garden of the early 1800s, as shown on the 1st Edition OS map of 1856, was much reduced in 1900 with the enlargement of the formal gardens. The Japanese water garden was established by James Pulham & Sons in 1904 and extended in 1910. Pulhams also planned and built hothouses within the walled garden in 1914. Much of the immediate policy planting was carried out during this period. This includes many of the conifers which have now outgrown their intended size. Little was done after the early 1900s to alter the designed landscape, apart from the planting of spruce plantations and a limited number of individual hardwoods.
Since 2000, the current owner has planted 27 kilometres of new hedgerows to link the key elements of the designed landscape together by following natural contours. The size and pattern of field boundaries on the organic farm now reflect the medieval fields surviving on the Scheduled Monument of Dalnean Hill.
The gardens are gradually being restored as part of the wider estate management plan. Four kilometres of drystone dykes have been rebuilt according to the old McAdam method. A considerable amount of restoration work has been carried out on the mansion house, stable block and other buildings within the designed landscape. A new loch was created below the house in 2001, two lochs dug out either side of the approach drive and another loch created next to the footpath below Dalcairnie Falls. 27 kilometres of new footpaths have been created. Some of the spruce plantations have been felled and replanted with more historically accurate

species, and many specimen trees and tree roundels have been planted. The curling ponds adjacent to the drive are being re-instated.

Landscape Components
Architectural Features
The core part of Craigengillan House was built in 1765 when it was then called Berbeth. It was then enlarged in the early 19th century and later romanticised with the addition of crowstepped gables. A glazed Gothic arcaded porch was extended along the front and a tall battlemented tower built at the side, both in the early 19th century and possibly by David Hamilton. Exceptional interior work was carried out by Jansen of Paris in 1902 to the main hall, staircase, drawing room, boudoir and morning room.
The late 18th century two-storey Stable Court has an impressive central entrance tower which consists of a round-arched vaulted entrance passage, above which sits a Venetian-style window, a towerblock inset with a clock and crowned by a leaded dome and weathervane.
The remarkable subterranean Ice House situated near the north wing of the house is reachable by ladder and descends eight metres to a two-metre wide vaulted passageway. The ice chamber is at the end of this passage, another four metres below ground. The whole structure is made of dressed stone. The melting ice drained into The Tunnel, another unique piece of construction and engineering, consisting of a two-metre high vaulted roof and a floor with a carved stone channel. The entire structure is built with dressed stone and it runs for 200 metres, draining the main lawn as well as taking the overflow from the water garden.
The Gatehouse at the entrance to Craigengillan and Home Farmhouse were built into the landscape in the late 18th/early 19th centuries. Derelict farm and mill buildings lie adjacent to the farmhouse and there is an unusual ha-ha enclosing a roundel close by that could have been used as a drying green. The two-storey stone-built former gardener's house of Pine Cottage was built around 1860 and has recently been completely renovated. The two ruined (until recently) Glessel Cottages adjacent to Glessel Burn probably date from the early 19th century, although Pont's 1654 map shows a settlement on this area. The westernmost cottage, long known as 'Find Me Out', has an adjoining stone walled garden and animal enclosure. This and the adjacent 'Forget Me Not' cottage have been restored.
Only the base stones remain of the circular Gazebo which occupies a prominent viewpoint position on Corson's Knowe, close to the house and overlooking the River Doon and Dalfarson Park. Just the stone enclosure remains of the Summerhouse above the formal gardens, and there are only traces of the brick foundations of the Observatory in the woodland north of the drive. The Well, a domed stone water cistern dated 1802, set within the upper part of the formal garden, and built to bring water to the stables, is being (2011) restored.
Linn River Bridge is a single rusticated stone-arched bridge carrying the drive over the River Doon. Dalcairney Bridge is a single-arch reddish sandstone bridge which was built in the early 1800s and carries the road over the dramatic falls of Dalcairney Linn. Stone Bridge carries the old drive over the River Doon. It dates from the late 18th century and is of single-span sandstone construction with a partly stepped parapet. Muck Bridge crosses Muck Water next to the Gatehouse at the entrance to Craigengillan and has a cast iron parapet with urns. The new steel and wood Ness Glen Suspension Bridge was built in 2004 at the entrance to Ness Glen to the south of the estate, and is based on a similar bridge at Blair Castle in Perthshire.
There are many Walls, Dykes and Ha-has in the designed landscape at Craigengillan. Many of the field boundaries are stone dykes in varying states of repair. They are built from large granite boulders that were pushed through Loch Doon from Carsphairn by glaciers, before being deposited on the slopes below Ness Glen. Along the line of the original drive between Linn River Bridge and Stone Bridge there is a well-built ha-ha, about 500 metres long, in good condition today with minimal maintenance during the last 100 years.

Drives & Approaches

The original stone drive which was used until 1770 and followed the east bank of the River Doon is clearly visible today. The road engineer John McAdam built the new three-kilometre drive from Dalmellington in 1770 and it remains the same today. The first half of the drive is open in character with views over Bogton Loch and the wetlands. The drive then becomes increasingly wooded and fine specimen trees become more frequent as one progresses towards the house. The specimens include cedar, silver fir, yew, lime, beech, Turkey oak, Wellingtonia and Douglas fir, and some of the wooded areas are underplanted with box and Rhododendron.

Paths & Walks
The Ladies' Walk through the Ness Glen is one of the most spectacular walks in any designed landscape.
The Ness Glen carries the River Doon in its stream stage from Loch Doon to Dalfarson Park. It was described as 'One of the finest examples in Britain of a true rock gorge…' in the Ordnance Survey Gazetteer of Scotland in 1903. The Ordnance Survey Name Book for the 1856 1st Edition maps describes the gorge at length, paying particular attention to the path that had been constructed and the planting that had been done:
"The river side of the low walk is edged with a row of trees, the branches of many of which have been forced by the application of pressure during their early growth, to droop over the water. On the other side trails of ivy and shrubs of the evergreen class and rose bushes have been trained up the rocks for some distance, and thus, by softening the ruggedness of that portion of the glen immediately under the eye of the visitor - affording him a means of contrast with the terrors overhead, whose sublime character might suffer from a close inspection – has been effected the only introduction of art which could in any way have heightened the effect of this imposing scenery."
The stream has cut a 60-metre deep channel through the rock with straight perpendicular sides, barely wider than its own width. The humidity within the gorge supports one of the biggest collections of ferns and mosses in southern Scotland, with vigorous growth draping the trees and cliffsides. The recently restored footpath along the Ladies' Walk follows the original path constructed by Quentin McAdam, 'who conceived the idea of making the beauty spot readily accessible and opening it to the public.' Many new footbridges have been installed to enable the continuation of the walkway and a new Suspension Bridge has been built at the entrance to the glen. A new footpath has been created leading to Dalcairnie Falls and onwards to the summit of Auchenroy.
The drive is used by walkers and there is an old public right of way crossing the estate. The current owner is creating (2011) a new public footpath from the Doon Valley Museum in the centre of Dalmellington through policy woodlands and Dalfarson Park, crossing the River Doon over the Suspension Bridge and then leading up through the Ness Glen to the shores of Loch Doon.

Parkland
The two principal areas of parkland are to the northeast of the house, House Park and Dalfarson Park. The recently constructed Craigengillan Loch was installed in House Park. Both parkland areas show up clearly on Armstrong's map of 1775 and the 1856 OS 1st Edition map, as do parkland areas on Bellsbank Brae and Dalcairnie. New parkland tree planting has been done to re-establish the old parkland pattern. This has been in the form of cedar, lime, oak and Sequoia roundels at Bellsbank Brae, Dalcairnie and in the area known as The Promised Land.

Woodland
The policy woodland borders the drive and extends around the formal gardens. The drive woodland becomes finer as one progresses towards the house, with a fine range of exotic specimen plantings such as Wellingtonia and turkey oak. Around the formal gardens, the policy woodland is dominated by a backcloth of cypresses, cedars, Wellingtonia, yews and maples. Beyond this planting mix and higher up the slope are mature beech, pine and Douglas fir. The woodland is criss-crossed by a network of paths and rides.
There are over 300 hectares of woodland on the estate, in addition to the avenues and individual parkland trees. Of the more recently planted woodland, some small-sized Sitka spruce plantations remain on the estate, but considerable areas of coniferous planting have been cleared and replaced by a traditional native broadleaved and Scots pine mixture.
The 35 acre Craighead Wood to the south of the mansion house was cleared of spruce and replanted in 2004 with hardwoods, predominantly oak, and the old 19th century paths restored. Replanting has been limited to the lower slopes of Craighead in order to retain the views of the skyline ridge, part of the dramatic backcloth to Craigengillan House. A fort of timber construction, the Fort Carrick Outdoor Activities Centre, has been created on the Craighead ridge. In 2009 Galloway Forest Park was designated as the first Dark Sky Park in Britain. Inspired by this, the Scottish 'Dark Sky Observatory' and Visitor Centre is being established within 200 yards of the Fort.
Auchenroy Wood, on the slopes of Auchenroy Hill, was planted in 2004 with a mixture of entirely native species, including oak, yew, hazel, wild cherry, rowan, birch, ash and juniper.

The summit of the hill, knowes and gorges have been left open and large glades established within the outer boundaries. For natural effect, straight lines have been avoided and the upper margins tapered upwards with wild cherry and juniper. Individual tree specimens, including Scarlet and Turkey oaks, Wellingtonias and Grand firs, have been planted within the wood to reflect and extend the influence of the Craigengillan designed landscape.

Over the last 9 years careful tree planting has been carried out with the aim of extending the influence of the core Designed Landscape to the whole estate. This is reflected in the design of the new Auchenroy Wood, the Diamond Wood and the planting of lime avenues and roadside trees right to the A713 and the edge of Dalmellington. 18 new roundels of parkland trees have been created, as show on the enclosed plan. Species chosen are those that mirror those within the immediate parkland around Craigengillan House. They include Wellingtonia, horse chestnut, Atlantic and other cedars, Noble and Grand Firs, oak, beech and lime.

Craigengillan has been selected as one of 60 sites in Britain to plant a Diamond Wood of 80 acres to mark the Queen's Jubilee in 2012. Although the site of the proposed wood is largely outside the boundary of the designed landscape at Shalloch, the Diamond Wood will make an important contribution to the structural backdrop to Craigengillan House. The wood will be approached by footpath from within the designed landscape, passing the dramatic and picturesque Dalcairnie Falls.

A further 120 hectares of broadleaved trees are being planted on Carwaur and Shalloch Hills (2012). The woods have been carefully designed to enhance and extend the designed landscape and to create a mosaic of woodland and hill pasture.

Water Features

Bogton Loch covers more than 60 acres and has a small island called Elisabeth Isle, believed to be a crannog. The loch is a favourite site for birdwatchers and is fringed by extensive reedbeds and wetland that provide a rich and undisturbed habitat for wildlife. Wildflowers include meadowsweet, orchids, valerian, and ragged robin. Salmon and trout pass through the loch, but pike is the predominant fish. Otters are sometimes seen. Shear Loch, the source of the Glessel Burn, is a peaty hill loch fringed with waterliles.

The River Doon runs through Craigengillan for approximately four kilometres and contributes much to the character of the landscape. Loch Doon is the source of the river but is not within the designed landscape. The river Doon enters Craigengillan through the Ness Glen rock gorge. The landscape here is Highland in character with ancient Scots pines, rowans and silver birches on top of the craggy banks. Having passed through the glen, the river runs through the grassland and specimen trees of Dalfarson Park in front of the house, then through woodland, reedbeds and undisturbed wetlands, before reaching the open expanse of Bogton Loch. Now swollen by many small burns the river has developed a lowland landscape character from the loch to the estate boundary, before it continues to the sea, finishing its course by passing under the Brig O'Doon, immortalised by Burns.

Muck Water flows under the bridge at the gatehouse and across the northern edge of the designed landscape. This small river passes through an area known as the Promised Land which was used as an airfield during the First World War. Dalcairnie Burn enters the estate through Dalcairnie Glen, and runs close to the site of Berbeth, the original estate house. It forms a dramatic waterfall at Dalcairnie Linn before running in a series of rapids and pools through a wooded gorge, and then finally meandering through meadow and wetland to Bogton Loch. A tributary of the River Doon, the Glessel Burn enters the southwest corner of the designed landscape via a waterfall, and then flows past the (formerly) ruined Glessel Cottages and former gasworks before meeting the Doon at the mouth of the Ness Glen.

There are several man-made water features including the Japanese water garden (see under Gardens), the three curling ponds to the north of the estate by the drive and Bogton Loch. In 2001 the marshy ground in Mansion Park, in front of the house, was excavated to create the new Craigengillan Loch. The edges have been sown with wildflower seed and the islands planted with willows and lent lilies (Narcissus pseudonarcissus). The Ladies' Loch, also known as Wee Berbeth Loch lies in a fold in the hills to the north of the house, and was constructed sometime between 1775 and 1856. It is not shown on Armstrong's map of 1775, but does appear on the 1st Edition OS map of 1856. There was a boathouse which suggests that the loch was used for recreational purposes. A well-constructed stone culvert runs from the loch to the Home Farmhouse, diverting water from the loch to feed a mill. This suggests the loch had a practical purpose too. The Duck Pond, to the west of the house was also constructed between 1775 and 1856 and was created to provide wildfowling and a water supply to the hothouses and Japanese water garden.

The Gardens
The principal formal garden lies to the southwest of the mansion house and is shaped in a natural amphitheatre. There are several notable ancient trees on the slopes, including sycamore, Scots pine and beech. The stone base of the old Summerhouse lies halfway up the northern slope overlooking the lawns. Lining the steps towards the Summerhouse is an avenue of conifers that has now outgrown its intended effect and is out of proportion with its position. A mature specimen yew tree interrupts the expanse of lawn and forms a focal point in the gardens. There are formal herbaceous borders along the northern side of the lawn. Extensive shrubberies and an informal woodland garden containing a dog cemetery surround the north and western sides of the lawn.
At the western end of the lawn is an Edwardian Japanese water garden, established by James Pulham & Sons in 1904 and extended in 1910, consisting of boulders, specimen shrubs and a series of cascades and interconnecting pools that eventually drain into The Tunnel. The Japanese water garden is currently (2011) under restoration informed by good surviving evidence of natural and Pulhamite rockwork. Further clearance is required to establish the full extent of the water garden. As part of the clearance and restoration, an additional feature and associated footpaths have been discovered north-west of the water garden: a rectangular paved area surrounded by low walls with steps leading down to the lawn.
Closer to the back of the house is a simple parterre arrangement and a sundial, enclosed by one-metre high yew hedging. A network of paths connects the main structural elements of the formal gardens.
To the north and east of the house are more formal lawns, partly edged with Victorian cast iron post and rail fencing, with plantings of Rhododendrons and mixed shrubs, many of which have now outgrown their intended effect. The remaining walled kitchen garden is walled on three sides and still contains the remnants of cold frames, as well as palm, carnation and vine houses. There is also a slate-roofed potting shed built of brick and then rendered.

References

Maps, Plans and Archives
Timothy Pont, Caricta Borealis, 1654
Roy Military Survey of Scotland, 1747-55
Andrew Armstrong, A new map of Ayrshire, comprehending Kyle, Cunningham and Carrick, 1775
1st edition OS 1:10560 (6”), published 1861
1st edition OS 1:2500 (25”), published 1861
2nd edition OS 1:2500 (25”), published 1898

Further information courtesy of the owner (2011):
Craigengillan Designed Landscape: Development and evolution since 2006
Craigengillan: Aims, achievements and future plans for the regeneration of Craigengillan and East Ayrshire
Dark Sky Observatory: Craigengillan, Ayrshire

Printed Sources
Historic Scotland on Behalf of Scottish Ministers, The Statutory List of Buildings of Special Architectural or Historic Interest
Truscott, J. 1988, Private Gardens of Scotland, London: Weidenfeld and Nicholson
Cockburn, H.C., Lord 1889, Circuit journeys by Lord Cockburn, Edinburgh
Davis, M. C. 1991, The Castles and Mansions of Ayrshire, Ardrishaig: privately published
Groome, F. H. 1903, Ordnance Gazetteer of Scotland London : Blackwood, Le Bas & Co.
MacArthur, D. W. 1952, The River Doon, London
Reid, D.L. 2005, Robert Burns' Valley of Doon, Beith
Country Life November 24, 2010, 78-83

Asset Number 218

Site Name Little Auchrae

Type of Site	Farmstead (Period Unassigned), Field System (Period Unassigned)
NMRS Number	NX69SW 50
HER Number	MDG11404
Status	HER National Asset
Easting	263854
Northing	593974
Parish	Carsphairn
Council	Dumfries And Galloway
Description	Canmore ID: 104686 Canmore coordinates: 263870, 593950 RCAHMS First Edition Survey Project A farmstead annotated 'Ruins of', comprising two unroofed buildings and four enclosures, and large field-system are depicted on the 1st edition of the OS 6-inch map (Kirkcudbrightshire 1853, sheet 6). One enclosure and part of the field-system are shown on the current edition of the OS 1:10000 map (1980). Information from RCAHMS (AKK) 15 September 1999.

Asset Number	219
Site Name	Round Craigs
Type of Site	HER Landscape; Cultivation Remains (Period Unassigned); Clearance Cairn(S) (Period Unassigne
NMRS Number	NX69SW 42; NX69SW 21; NX69SW 48; NX69SW 26; NX69SW 27; NX69SW 22; NX69SW 23
HER Number	MDG3944
Status	HER National Asset
Easting	264866
Northing	593742
Parish	Dalry (Stewartry)
Council	Dumfries And Galloway
Description	HER record and centroid for landscape containing cairns, clearance cairns, cultivation remains and burnt mounds. NX69SW 42, Canmore ID: 64373 Cultivation Remains (Period Unassigned) 264800,593800 NX69SW 42 648 938 Rectangular stone foundation 24 x 12ft. M L Ansell 1966 Not located, though there is evidence of post-medieval agricultural activity in this locality. Visited by OS (JRL) 20 October 1978. NX69SW 21, Canmore ID: 64349 Clearance Cairn(S) (Period Unassigned) 264800,593700 NX69SW 21 648 937. NX 648 937. Ring cairn 24 ft outside diameter and 30 small cairns (cf NT05SE 3). M L Ansell 1966 The siting falls on the outcropping summit area of Round Craigs around 305m OD. A maximum of 20 clearance cairns occurring sporadically over a wide area, do not form a distinct group and

are probably of several periods. No 'ring'-like feature was found.
Visited by OS (JRL) 25 October 1978.
References
Ansell, M L. (1966i) 'Stroanpatrick, scooped settlement; ring cairn', Discovery Excav Scot, 1966. Page(s): 33

NX69SW 48, Canmore ID: 83881
Burnt Mound (Prehistoric), Cairnfield (Period Unassigned)
264740,593490
NX69SW 48 6474 9349
A burnt mound within a group of some nine cairns, E of the road.
F Newall and W Lonie 1990.
References
Newall and Lonie, F and W. (1990) 'Survey (Dalry parish, Kirkcudbrightshire and Glencairn and Tynron parishes, Dumfriesshire', Discovery Excav Scot, 1990. Page(s): 11

NX69SW 26, Canmore ID: 64354
Cairn (Period Unassigned)
264510, 593550
NX69SW 26 6451 9355.
NX 6451 9355. A probable burial cairn found during field investigation, is situated on a prominent outcrop at the N edge of an area of field clearance (see NX69SW 20). It measures 8.5m in overall diameter and survives to a maximum height of 1.0m. Its centre has been disturbed; large boulders on the periphery may be a kerb.
Surveyed at 1:10 000.
Visited by OS (JRL) 30 October 1978.

NX69SW 27, Canmore ID: 64355
Burnt Mound (Prehistoric)
264670,593430
NX69SW 27 6467 9343.
NX 6467 9343. A probable burnt mound, found during field investigation, is situated on rising ground beside the marshy headwaters of Little Auchrae Burn at 280m OD. It is 'U' shaped, 9.0m in overall diameter, up to 1.1m high externally and the resulting 'bank' averages 3.5m wide. Probing of the bank revealed blackened earth and possible burnt stone. The open interior is featureless.
Surveyed at 1:10 000.
Visited by OS (JRL) 30 October 1978.

NX69SW 20, Canmore ID: 64348
Cairn (Period Unassigned)(Possible), Clearance Cairn(S) (Period Unassigned)
264500,593400
NX69SW 20 645 934.
NX 644 935. Ring cairn 60ft outside diameter and 37 small cairns (cf NT05SE 3).
M L Ansell 1966
NX 645 934. Over twenty clearance cairns and several linear clearance spreads, extend over an area of approximately 1.5 hectares on the gently undulating SW - facing slopes of the Round Craigs between 274 and 290m OD. They form no coherent pattern or discernible field plots and the cairns range from circular to oval in shape with an average diameter of 4.0m.
No 'ring' feature was found in the area, although a probable burial cairn, 8.5m in diameter lies at the extreme N edge of this cairn group at NX 6451 9355 (see NX69SW 26).
Visited by OS (JRL) 25 October 1978.
References
Ansell, M L. (1966i) 'Stroanpatrick, scooped settlement; ring cairn', Discovery Excav Scot, 1966. Page(s): 33

NX69SW 22, Canmore ID: 64350
Clearance Cairn(S) (Period Unassigned)
264200,593400
NX69SW 22 642 934.
NX 642 934. Ring cairn, 21 ft outside diameter at 850 ft contour, also 17 small cairns (cf NT05SE

3).
M L Ansell 1966
Twelve clearance cairns and several linear clearance spreads extend over approximately 1.0 hectare of gentle SE - sloping pasture around 266m OD. They form no coherent pattern or discernible field plots and the cairns range from circular to oval in shape and average 4.0m in diameter. No 'ring'-feature was found, though one of the larger cairns has a partially robbed centre.
Visited by OS (JRL) 25 October 1978.
References
Ansell, M L. (1966i) 'Stroanpatrick, scooped settlement; ring cairn', Discovery Excav Scot, 1966. Page(s): 33

NX69SW 23, Canmore ID: 64351
Clearance Cairn(S) (Period Unassigned)
264700,593200
NX69SW 23 647 932.
NX 647 932. Small cairnfields totalling forty-four stony mounds; also two rectangular stone foundations 24 x 15 ft and 27 x 15 ft (cf NT05SE 3).
M L Ansell 1966
Over thirty clearance cairns and several linear clearance spreads extend over approximately 2.0 hectares of gently undulating pasture around 274m OD. They form no coherent pattern or discernible field plots and the cairns range from circular to oval in shape and average 4.0m in diameter. Though some may be associated with the late depopulated structures, most appear to be of an earlier period.
Visited by OS (JRL) 25 October 1978.
References
Ansell, M L. (1966i) 'Stroanpatrick, scooped settlement; ring cairn', Discovery Excav Scot, 1966. Page(s): 33

Asset Number	220
Site Name	Culmark Hill
Type of Site	Cairn (Period Unassigned)
NMRS Number	NX68NW 2
HER Number	MDG3845
Status	HER National Asset
Easting	263440
Northing	589550
Parish	Dalry (Stewartry)
Council	Dumfries And Galloway
Description	Canmore ID: 64255 263500, 590200

NX68NW 2 6344 8955.
(NX 6344 8955) Cairn (NR) (Site of)
OS 6" map (1957)

On high ground is the site of a small cairn about 36ft in diameter, which stood 3ft high in 1849.

RCAHMS 1914, visited 1911; Name Book 1849

The turf-covered remains of a round cairn situated on top of a prominent E-W ridge at 850ft OD. Measuring 18.0m in overall diameter and up to 1.0m high, the centre has been heavily robbed but its edges and shape are well defined. No significant features are apparent.

Surveyed at 1:10 000.
Visited by OS (JRL) 14 March 1978

References
Ordnance Survey (Name Book. (1848-1878) Object Name Books of the Ordnance Survey (6 inch and 1/2500 scale). Page(s): Book No.21, 4 RCAHMS Shelf Number: Ref
RCAHMS. (1914) The Royal Commission on the Ancient and Historical Monuments and Constructions of Scotland. Fifth report and inventory of monuments and constructions in Galloway, II, county of the Stewartry of Kirkcudbright. Edinburgh. Page(s): 89, No.163 RCAHMS Shelf Number: A.1.1.INV(5).R

Asset Number	221
Site Name	Bardennoch-Garryhorn Archaeologically Sensitive Area
Type of Site	HER Archaeologically Sensitive Area
NMRS Number	
HER Number	
Status	HER Archaeologically Sensitive Area
Easting	255932
Northing	592368
Parish	
Council	
Description	This area recognizes multi-period archaeological remains featuring in a Heritage Trail promoted by Carsphairn Heritage Group. The high quality monuments are in a spectacular landscape setting. Note: 2013update. In the 1970-80’s the land use of large areas of Carsphairn parish changed from stock rearing on grazed pasture to commercial forestry. The community wasconcerned about population decline and community well–being. Establishing a series of heritage trails was a community initiative.

Asset Number	222
Site Name	Stroanfreggan Archaeologically Sensitive Area
Type of Site	HER Archaeologically Sensitive Area
NMRS Number	
HER Number	
Status	HER Archaeologically Sensitive Area
Easting	264326
Northing	592908
Parish	
Council	
Description	This area recognizes multi-period archaeological remains featuring in a Heritage Trail promoted by Carsphairn Heritage Group.The Southern Upland way passes through the area. Important Mesolithic finds relating to the earliest human occupation of the region have been made in the valley bottom. Note:2013update. In the 1970-80’s the land use of large areas of Carsphairn parish changed

from stock rearing on grazed pasture to commercial forestry. The community was concerned about population decline and community well–being. Establishing a series of heritage trails was a community initiative.

Asset Number	223
Site Name	Polharrow Burn Archaeologically Sensitive Area
Type of Site	HER Archaeologically Sensitive Area
NMRS Number	
HER Number	
Status	HER Archaeologically Sensitive Area
Easting	258478
Northing	586228
Parish	
Council	
Description	The Stewartry Environmentally Sensitive Area was rapidly surveyed for archaeological remains in the 1990s. The resulting report states: “The north side of the Polharrow Burn has a particularly rich and varied archaeological landscape worthy of preservation. An isolated cairn, remains of cairn fields associated with isolated enclosures, deserted farmsteads with extensive field systems, other traces of upland agricultural practices and traces of minor industrial activity are all to be found on this side of the valley. Although many of these monuments are quite common in upland areas, the sum total of the landscape merits protection at a level below scheduling.” This area recognizes these interests.

Asset Number	224
Site Name	Aircraft Wreck
Type of Site	Aircraft Crash Site
NMRS Number	
HER Number	
Status	PMRA Protected Place
Easting	260431
Northing	599063
Parish	Carsphairn
Council	Dumfries And Galloway
Description	03 In 1941, the people of Newmarket raised £5100 as part of the war effort, towards Spitfire Vb, AD540, which was presented to the RAF, and named "Blue Peter", after the 1939 Derby winner. On May 23rd 1942, at 1pm, AD540 took off from RAF Ayr to provide aerial cover to the approaching vessel "Queen Mary" laden with US sevicemen. Flying her on this occasion was Pilot Officer David Hunter Blair. On the way, Blue Peter, and a second Spitfire, piloted by Flight Sergeant Gordon "Matt" Mathers, were directed to investigate a suspected enemy sighting inland. Soon, at an altitude of 20,000ft, Blue Peter was seen to behave erratically, and then descend through the clouds. David Hunter Blair had fallen unconcious due to a fault in the oxygen system, and regained conciousness as the aircraft plunged to a lower altitude. Unable to regain control, he baled out. However, his parachute did not deploy fully before he landed, and he died in the remote valleys of Cairnsmore of Carsphairn in South West Scotland. He was nineteen..... The accident was witnessed by a local farm worker, and David was subsequently

buried with full military honours on the family estate of Blairquhan Castle, some 15 miles from where he had been killed. The wreckage of Blue Peter was buried on site and lay undiscovered until 51 years to the day after it crashed, by a team including members of the Dumfries and Galloway Aviation Group, led by Ralph Davidson, chairman of the Scottish region of The Spitfire Society, and later covered by a team from the BBC children`s programme Blue Peter.

ext by Ralph Davidson, chairman of the Scottish region of The Spitfire Society

ON May 1, 1992, I received a short letter from the late Tony White - Spitfire Society historian and acknowledged expert on the legendary fighter aircraft.
''BLUE PETER.'' This name stood out of Tony White's letter, obviously because of the well-known BBC children's programme, but this was not concerning this long-running series; no, this was in fact the name of a presentation Spitfire which had crashed long ago on the remote hills of Galloway, tragically taking the life of her young pilot, Pilot Officer David Hunter Blair. The letter went on to ask if the Dumfries and Galloway Museum, with which I am associated, had any information on the crash site as the BBC, which had been contacted at an earlier stage by Jake Wilson, an aviation enthusiast, was keen to make a fiftieth anniversary film on their famous Blue Peter namesake; it all began a few weeks later . . .
It was raining when I first saw the valley of Cairnsmore of Carsphairn on that September day in 1992. A BBC production team had travelled north to film the first efforts to try to locate the crash site of AD540 Blue Peter. A witness named Andy Adamson, who had seen the aircraft as a boy on the hillside in 1942, was also with us; and so it went on, the camera filming take after take with Blue Peter presenter John Lesley becoming as wet as the rest of us. After five hours, and with camera equipment beginning to pack up due to the atrocious weather conditions, Bill Locke - producer of Blue Peter - decided he had sufficient film for his purposes. We then began the long journey back down the mountainside. There were none of us sorry to say goodbye to Carsphairn on that day, but I was to return, and soon.
September passed into October with myself and a few associates searching the four-mile length of the valley almost every weekend for any sign of AD540, this usually being in atrocious weather conditions as the area lies at 1200ft above sea-level; the mists and rain usually persisted throughout the day.
As the weeks passed a few of my colleagues became disillusioned and dropped out of the now dwindling search party. It was mid-November now and another fearsome stormy day. I stood at the end of the rough track built by a mining company many years before, which was the only means of getting a car within an hour's walk of the reported crash area. I set off, scrambling down the steep slope to a small stream named Bow Burn, which was my only means of direction to the supposed crash area as it ran through the entire length of the valley floor.
Reaching the burn, I placed two small rocks on top of a large rock as a marker for my return. I struck off northwards. An hour later I was at the ''Roaring Cleugh'' - a fast flow of water which ran from the top of Cairnsmore into the burn. I assembled my metal detector and began to sweep southwards back up the valley. Witnesses had reported wreckage lay south-west from the roaring cleugh.
Two hours later I found myself standing at a little cross with a poppy attached, placed there two weeks earlier as a mark of respect on Remembrance Day. On that day we had taken Tom Gordon with us. He had come forward in response to an article which had been placed in a local newspaper appealing for witnesses to the event 50 years ago. He told us he had been a shepherd in the area in 1949, and he used to scrape mud from the soles of his boots on a heavy piece of metal protruding from the rough turf; this had been seven years after the demise of AD540, but was it Blue Peter? Tom was sure it was. He described it as a piece of metal with holes drilled on its surface.
Now I found myself in bad visibility and knew I would have to hurry to make my way to the car and safety, but with an hour and a half of light still remaining I thought this would not be a problem. I was very wrong.
An hour later I was at the base of the slope beside the Bow Burn which I had followed faithfully, joining it east of the small cross, but where was the large rock? I was positive I hadn't passed it. Decreasing visibility led me to decide I must have passed the marker. I began to head up the slope. I had travelled 200 yards when gradually the realisation hit me - I was lost. Small spruce trees lay scattered around me - they had not been there on my previous descent.
I stopped, and fear began to grip me. I looked back the way I had come - I could see nothing

but the white mist before me. The stream had vanished into the gloom. Having no compass I could not even tell east from west. I started to stumble, to run blindly, the fear welling up inside me. This desolate valley had already claimed a victim in David Hunter Blair - was I to be the next? I began to run faster, then finally I forced myself to stop my blind, headlong flight. Dropping to my knees, I checked the slope and began to hurry in that direction, hoping the stream lay somewhere before me. It was the correct decision. Now as I stood beside the water I had a choice - head south, which meant I had not come upon the marker rock earlier, or north, which meant I had missed it before as I had fought against the driving wind and rain. Again I headed south. A few moments later the marker rock appeared through the gloom. With the last of my strength I found myself on the track. The car was not in sight. I had, in fact, joined the ''road'' about 50 yards down from the car. As I unlocked the door in the pitch darkness and slumped in, I realised just how lucky I had been.

I do believe to this day I was guided to my final decision; this was to be just one of the many strange happenings and coincidences which occurred during the search for Blue Peter.

served to end our excavation attempts.

In mid-January, 1993, the snow was still on the Galloway Hills. I had not returned to the valley of Cairnsmore since my narrow escape. It was not because of fear of repetition; it was simply because of the snow. It never really melts throughout the winter months, so I would have to wait until the spring.

But I would make good use of these winter months. I decided to speak with Jim McGarva, whom I discovered through a series of leads from local people. He still lived in the area in the village of Patna and only a few miles from the crash area. I met with Jim at his cottage in early February.

Jim had been alone in the valley outside the solitary farmhouse which had once stood there and is now a hill-walkers' bothy. Only 19 years old and a shepherd/labourer, he had been working for the farmer digging drainage ditches when he heard the sound of an aircraft.

A small plane suddenly appeared through the storm clouds, spinning gently. As he watched, fascinated, it finally came to earth on Cairnsmore of Carsphairn. He began to run in the direction of the downed plane, about a kilometre away. ''I was looking to pull folk out of it. It was upside down with its tail sticking in the air and it wasn't on fire, just kind of steaming. I could see the cockpit clearly, its glass all broken, but there was nobody inside. It was then I noticed in the distance of Dugland Hill what I thought was smoke and I began to run once again.''

The smoke was, in fact, Hunter Blair's parachute billowing in the wind and was immediately behind the spot where Jim had been working. He never saw it fall as he had been so intent on reaching the aircraft. Had his parachute been fully inflated as he landed on the hillside? Or had he baled out of his doomed aircraft too late to save his life?

After cutting PO Hunter Blair free and covering him with the parachute he then ran the three miles to where his motorcycle was parked and sped off to St Johns Town of Dalry where he informed the local police.

A search party arrived three hours later and the doctor pronounced Hunter Blair was dead. Jim hadn't known how to check for a pulse, and hadn't detected any injury apart from a faint trickle of blood from the nose. Had Blair still been alive? Jim still thinks so to this day and bitterly regrets he could not have done more for him on that hillside.

From my meeting with Jim McGarva I had gleaned a good idea of the location of Blue Peter and in the spring months took video footage of the area he had described. But Jim could not pinpoint it on the film footage. He did identify the location of the downed pilot. A stone sheep pen lay on the slopes of Dugland Hill and Jim noted the spot as a place he had known well, the location being a constant reminder of that fateful day in May 1942; I now knew the location of the downed pilot but where was the crash site of Blue Peter?

Towards the end of April, after another lone, fruitless search, it occurred to me I had never asked Jim how long it had taken him to run from his position at the farmhouse to the downed plane. A telephone call revealed it had taken him 20 minutes. Taking into account this was the speed of a healthy 19-year-old, on my next visit I would try to retrace Jim's path.

Armed with Jim's co-ordinates and timescale, how could I go wrong? Twenty minutes later I stopped walking. I looked around me, but there was no sign of the wreckage - but then I was only looking for a small piece of metal sticking from the hillside, as Tom Gordon had described many months before. I began to sweep in ever-increasing circles willing my metal detector to sing out its song of discovery. Half-an-hour later I once again stood alone with the familiar feeling of disappointment welling up inside me.

On my return to Glasgow a phone call from a colleague brought new hope. Another former

shepherd had been found, who had witnessed the recovery team dragging the broken Spitfire's wings down the hillside in 1942. I quickly dialled the telephone number .
JIM Bell told me: ''Aye, I remember it quite clearly. It was sticking out of Cairnsmore, south of the Roaring Cleugh.'' He went on to say he remembered the wings being dragged down the hillside by horse to Moorbrock Farm for uplift by the RAF. He had been a boy of 14 then but assured me he remembered the incident clearly as if it had been yesterday He also said he would assist me in my search. This was marvellous news! I immediately made arrangements for a search the next weekend.
We stared down into the valley from the track's end. For Jim, after 45 years, it was an emotive sight; for me, a familiar one - I thought by now I knew every boulder and clump of heather on those hillsides. Perhaps I did but I certainly did not know where Blue Peter lay. With Jim's help I very soon would.
From our lofty position over the valley Jim began to point and identify particular areas by name. As I looked at Jim as he spoke of this beautiful valley he had the same look in his eyes that I had seen in Jim McGarva's and Tom Gordon's. A look of pleasure and fondness; the remembrance of youthful years spent in this remote unspoiled countryside. We set off down the slope and soon set a quick pace, Jim with his shepherd's crook striding ahead of me - his 60-plus years melting away as he strode among those once familiar hills.
Two hours later that familiar feeling began to overtake me. Blue Peter had once again kept her secret. Jim apologised profusely. I told him not to worry and we would return the following weekend.
Seven days later, as I stumbled over another unseen rock on Cairnsmore, I called out to Colin Nicol, the third search-party member, that we should go lower down. I had been following a hunch and had remembered at the same time Jim McGarva's words: ''Twenty minutes'', the time it had taken him to go from the farmhouse to the crashed Spitfire. We were coming upon that area now, that much I knew from my previous visits. This was confirmed by the many marker pegs on the hillside - legacies from the many expeditions before.
Then it happened! The moment I had yearned for. I had been walking north up the valley, Colin Nicol to my left, Jim Bell ahead and to my right, our three metal detectors sweeping from left to right, when I glanced up for an instant and there, staring me not three yards ahead, was the unmistakable shape of a piece of aircraft aluminium. Stopping, not believing my eyes, I called on Colin to come and look. We both stared at this piece of aluminium, the rivet holes on its surface staring back at us.
Still motionless, we called on Jim, dear Jim. I don't know what he must have thought as he stopped and looked back at these two men, their eyes out on stalks. The three of us then moved in on this man-made object which lay in the midst of nature itself, each of us not daring to think the unthinkable, that it could be anything else than the long lost Blue Peter Spitfire.
Dropping to our knees we began to scrape the earth and then I saw a part of the Spitfire's Merlin engine sticking through the rough turf. I think we then did a little jig or dance of joy, the elation indescribable. We chattered like excited schoolboys and then realised we had no tools with us to excavate the remains.
Jim Bell came up with the idea of utilising the iron stanchions from an old boundary fence and with these makeshift tools we began to uncover the long lost remains. The first substantial piece which came to the surface was a five-feet section of the trailing edge of the port wing, identified by its serial number. This initially was a surprise to me as I had thought the wings were removed by the recovery team in 1942. Later events were to confirm this had not been the case.
After digging for two hours,we had collected a considerable amount of artefacts, but could do no more as both time and lack of proper tools had served to end our excavation attempts.
We were, however, satisfied we had finally found Blue Peter. We buried her remains once more as secrecy at this point was important, and headed back down the valley to the car. It was only as I was driving down the track it suddenly dawned on me what date it was. I stopped the car and asked Jim and Colin if they knew what this date was. Colin said it was the 23rd of May and then he, too, realised Blue Peter had crashed on the 23rd of May 1942, exactly 51 years ago to the very day.
We had finally found Blue Peter but how were we to retrieve it from the desolate valley? The recovery team in 1942 faced with this very same decision had obviously decided to recover everything salvageable and bury the rest. The answer to our question would come in a few weeks time but there was much work to be done before then. We first had to uncover the wreckage from the long lost burial site.
The following three weekends were spent digging and digging. Many volunteers aided with this

mammoth task. The BBC also came back to film the discovery. Among the many surprising finds at this early stage was the discovery of the aircraft's cannon magazines. Both were found complete with complement of 20mm ammunition (60 rounds per magazine).
Shortly afterwards we found one of the hispano cannons itself, a round still in the breach, the guns never having been fired in anger by Blue Peter's young pilot. It was found later to have a damaged barrel and was probably the reason it had been buried with the rest of the aircraft; the other cannon was never found. The live ammunition was handled very carefully. It was on the third weekend I discovered a second burial site 200 yards further down the valley. The first part to be uncovered at that new location was the broken remains of the starboard wing.
We had already discovered the port wing remains at the original crash point of Blue Peter - it now seemed that the ''wings'' which Jim Bell had witnessed on May 24, 1942, were in fact only the wing tips, which were found near to where PO Hunter Blair had died - these wing parts had once contained the Browning machine guns. Being almost eight feet long it is understandable that these broken parts of the wings had been mistaken for the wings themselves. But how had they landed close to the pilot and nearly a kilometre from the Spitfire itself?
Also found at that second burial site was the oil tank, cockpit section, and lower fuel tank, These had lain in three sites in the same peat bog. Obviously the RAF had buried these parts at that lower point because of the softer ground. However, as the Dumfries and Galloway Museum has had many years' experience in aircraft excavation, they made short work of the aircraft's recovery.
And so in just five short weekends the remains of Blue Peter lay at the second discovery site. Only the aircraft's once mighty Merlin engine now lay at the impact point. All of the other small pieces had been placed in sacks for transportation to the group's museum at Dumfries.
On July 12 the sound of a Sea King helicopter broke the silence of Cairnsmore of Carsphairn. This was to be the means of transporting the remains of Blue Peter from her lonely resting place. David Reid, chairman of the DGAG, had contacted Commander Galloway of the nearby HMS Gannet (Ayr) and asked if it would be possible to airlift the wreckage from the isolated valley.
Cargo nets were dropped from the helicopter and quickly loaded. In all, three loads were transported to the drop-off point at Drumjohn in an area beside the A713 Dumfries to Ayr road. As the Sea King approached for the final airlift I stood beside Jim Bell wondering what his thoughts were; I was sure there had been a tear in his eye as the once mighty engine took to the skies once again - I know there was in mine.
The wreckage was transported to the DGAG museum in Dumfries and now resides there. An extensive collection of the aircraft's artefacts are on show and the Merlin engine has been stripped and will eventually be on show to the public; it is in quite remarkable condition despite its lost years. There remained one more task to complete. From the outset I had decided a memorial should be erected at the point on Dugland Hill where PO Hunter Blair lost his life. With the help of a local man, Walter McCrae, and Colin Nicol the work began. We chose a granite rock which nature itself had provided and was close to the point which Jim McGarva had pointed out on the video film.
The work began in late July and at he same time I contacted the Battle of Britain Memorial Flight based at Conningsby, Lincolnshire, with the request for a flypast of one of their Spitfires as I intended a dedication service should be held on the memorial's completion. Usually a year's notice is required for a flypast but after the forms were returned (in triplicate!) the request was granted for August 28 or 29, ''weather permitting''. This was to coincide with the two-day air show being held at RAF Carlisle (14MU). Imagine my surprise when shortly after receiving this marvellous news I received a telephone call asking if I would like two Spitfires for the flypast!!
It seemed that on August 28, the flight's two Spitfires would be heading to another venue in the south of England after their performance at Carlisle. As there had originally been a selection of two aircraft flying on that tragic day in May 1942 I thought it more appropriate that the flypast should consist of two Spitfires, so the service was scheduled for August 28, 1993.
Work on the memorial pressed ahead at a faster pace. Also as a mark of respect to the most famous of all fighter aircraft, the Supermarine Spitfire, we had agreed earlier that a second memorial plaque should be erected at the aircraft's crash point; this secondary work continued alongside the main work at Dugland Hill; thankfully both memorials were finished on schedule.
Blue Peter was, however, about to give up her last secret on August 26 - two days before the service. Walter McCrae, on a routine sweep with his metal detector around the area of the former farmhouse, detected a slight reading, and on digging at the spot discovered only two

inches below the surface, the gun camera magazine. This was synchronised to the aircraft's guns and was the means of recording possible strikes on enemy targets. It was subsequently sent to the photo reconnaissnace department at RAF Brampton but nothing was revealed on the film's negative. It seems the acidity of the peat would have destroyed it very quickly, but how had it come to be there? It was just another mystery of Blue Peter.
The skirl of the bagpipes echoed across Cairnsmore of Carsphairn two days later as all those who had been involved in the search and recovery gathered around the memorial stone. The inscription was simple and appropriate. It read: ''Near this spot on the 23rd May 1942 P.O. David Hunter Blair aged 19, a Scot from Ayrshire, was mortally wounded after parachuting from Spitfire AD540 Blue Peter. He died that others might live.'' The final inscription was the appropriate ''Lest We Forget'' which signifies not only the loss of one man but the many sacrifices during the Second World War.
James Hunter Blair, the pilot's brother, was positioned at the southern end of the valley at the end of the rough track which had been such a help to us throughout the long search for the remains of his brother's aircraft. Also at that point were Jim McGarva and Tom Gordon, accompanied by other elderly witnesses who could not make the long arduous walk to the memorial stone itself. They were ideally positioned for the flypast as the submitted flight path brought them within a few feet of the aircraft as the pilots began their approach to the valley. It also gave Jim McGarva time to speak to James Hunter Blair with whom he had never spoken. In fact, he had been due to have a meeting with P.O. Blair's parents a few days after the fatal crash in 1942, and to this end he had waited for hours in worsening conditions at the foot of Dugland Hill for their arrival; he eventually presumed weather conditions were severe enough to prevent their visit and he left, only to be told a few hours later that they had indeed arrived and had been shown the spot where their son died. Jim McGarva always regretted not being able to speak with them personally on the loss of their son; the few hours on the track with James Hunter Blair put that to right 51 years later.
''Do not despair for Johnny head in air'' - a line from a famous war poem which I recited at the dedication service, - was followed by a minute's silence in honour of the fallen airman.
You can always hear a Spitfire before you see it, it has such a distinctive sound. Then we saw them, first one then the other overflew our position, disappearing eastwards; the next pass was directly in front of us and they turned and flew away north. In what seemed an instant they returned again from the east, only this time Squadron- Leader Martin flew directly over the memorial stone itself at barely one hundred feet. The hair on my neck stood on end, the joy of seeing Spitfires here in this place which had haunted my dreams for months, the final honour to P.O. Hunter Blair - how absolutely appropriate.
How moving it all was. They returned once again from the east, these one-time tools of war, these beautiful flying machines, only now this time to turn southwards away from us and head back down the valley, past once again the watchful eyes on the track; the tear-laden eyes, as were ours - we, who could
only stand and stare sadly now at those departing silhouettes of a bygone age as the sound of their engines faded in the still air and once again the lonely valley became silent.
We ourselves then turned in silence and began the journey out of the valley of Carsphairn for the last time.

References
http://www.walkscotland.plus.com/Galloway/pages/ngairycrsh/03.htm
Accessd 22nd June 2022

Document history

Author	Rob Shepherd	03/09/2021

Client Details	
Contact	Matthew Bacon
Client Name	Vattenfall Wind Power Ltd

Issue	Date	Revision Details
A	03/09/2021	First draft for client review
B	23/12/2021	Released

Appendix 10.1

Noise Prediction Methodology

Contents

A10.1 NOISE PREDICTION METHODOLOGY 2

REFERENCES 4

List of Abbreviations

List and describe your abbreviations here.

Abbreviation	Description
L_w	Source Sound Power Level
D	Directivity Factor
A_{geo}	Geometrical Divergence
A_{atm}	Atmospheric Absorption
A_{gr}	Ground Effect
A_{bar}	Barrier Attenuation
A_{misc}	Miscellaneous Other Effects
dB	Decibel
m	metre
Hz	Hertz

A10.1 NOISE PREDICTION METHODOLOGY

A10.1.1 The ISO 9613-2 standard is used for predicting sound pressure level for downwind propagation by taking the source sound power level for each turbine in separate octave bands and subtracting a number of attenuation factors according to the following:

Predicted Octave Band Noise Level= L_W+D-A_{geo}-A_{atm}-A_{gr}-A_{bar}-A_{misc}

A10.1.2 These factors are discussed in detail below together with additional terms for taking concave valleys and wind direction into account where required. The predicted octave band levels from each turbine are summed together to give the overall 'A' weighted predicted sound level.

LW - Source Sound Power Level

A10.1.3 The sound power level of a noise source is normally expressed in dB re: 1pW. Noise predictions are based on sound power levels detailed in the noise chapter.

A10.1.4 The octave band noise spectra used for the predictions have been taken from the technical specifications of the turbine with the results shown in the noise chapter.

D – Directivity Factor

A10.1.5 The directivity factor allows for an adjustment to be made where the sound radiated in the direction of interest is higher than that for which the sound power level is specified. In this case the sound power level is measured in a down wind direction, corresponding to the worst case propagation conditions considered here and needs no further adjustment.

A_{geo} – Geometrical Divergence

A10.1.6 The geometrical divergence accounts for spherical spreading in the free-field from a point sound source resulting in an attenuation depending on distance according to:

$$A_{geo} = 20 \times \log(d) + 11$$

- where d = distance from the turbine

A10.1.7 The wind turbine may be considered as a point source beyond distances corresponding to one rotor diameter.

A_{atm} - Atmospheric Absorption

A10.1.8 Sound propagation through the atmosphere is attenuated by the conversion of the sound energy into heat. This attenuation is dependent on the temperature and relative humidity of the air through which the sound is travelling and is frequency dependent with increasing attenuation towards higher frequencies. The attenuation depends on distance according to:

$$A_{atm} = d \times \alpha$$

- where d = distance from the turbine

  α = atmospheric absorption coefficient in dB/m

A10.1.9 Values of 'α' from ISO 9613 Part 1 corresponding to a temperature of 10ºC and a relative humidity of 70%, the values specified in the UK Institute of Acoustics, *A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbines Noise* (IOA GPG), which give relatively low levels of atmospheric attenuation and correspondingly worst case noise predictions, as given below.

Table A10.1: Atmospheric Absorption Coefficients

Octave Band Centre Frequency (Hz)	63	125	250	500	1k	2k	4k	8k
Atmospheric Absorption Coefficient (dB/m)	0.000122	0.000411	0.00104	0.00193	0.0037	0.00966	0.0328	0.117

A_{gr} - Ground Effect

A10.1.10 Ground effect is the interference of sound reflected by the ground with the sound propagating directly from source to receiver. The prediction of ground effects are inherently complex and depend on the source height, receiver height, propagation height between the source and receiver and the ground conditions. The ground conditions are described according to a variable G which varies between 0 for 'hard' ground (includes paving, water, ice, concrete and any sites with low porosity) and 1 for 'soft' ground (includes ground covered by grass, trees or other vegetation). The IOA GPG states that where wind turbine source noise data includes a suitable allowance for uncertainty, a ground factor of G = 0.5 and a receptor height of 4 m should be used.

A_{bar} - Barrier Attenuation

A10.1.11 The effect of any barrier between the noise source and the receiver position is that noise will be reduced according to the relative heights of the source, receiver and barrier and the frequency spectrum of the noise. The barrier attenuations predicted by the ISO 9613 model have, however, been shown to be significantly greater than that measured in practice under down wind conditions. The results of a study of propagation of noise from wind farm sites carried out for ETSU concludes that an attenuation of just 2 dB(A) should be allowed where the direct line of site between the source and receiver is just interrupted and that 10 dB(A) should be allowed where a barrier lies within 5 m of a receiver and provides a significant interruption to the line of site.

A10.1.12 In this case there is topographical shielding between a number of the turbines and receptor locations which may result in a reduction in operational noise levels in practice. The calculated attenuation is presented below for each wind farm.

Table A10.2: Line of Sight Corrections for Quantans Hill (dB)

	Turbine number													
Location	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Bridgend	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Old Burnfoot Cottage	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glendean	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0
Knockgray Cottage	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Marbrack Cottage	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Marscalloch Cottage	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nether Loskie	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Furmiston	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Location	Turbine number 1	2	3	4	5	6	7	8	9	10	11	12	13	14
Kensglen	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Burniston	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Burnfoot	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Marbrack Farm	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bardennoch	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cumnock Knowes	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stables Cottage	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Knockgray	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North Liggate	0	0	0	-2	0	0	0	0	0	0	0	0	0	0
South Liggate	0	0	0	-2	0	0	0	0	0	0	0	0	0	0
The Cabin	0	-2	-2	-2	0	0	0	0	0	0	-2	0	0	0
The Birks	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carsphairn Primary School	0	0	0	-2	0	0	0	0	0	0	0	0	0	0
4 Mcadams Way	0	-2	-2	-2	-2	0	0	0	0	-2	-2	0	0	0
Marbrae	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A10.3: Line of Sight Corrections for Shepherd's Rig (dB)

Location	Turbine number 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Bridgend	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Old Burnfoot Cottage	0	0	-2	0	0	0	0	0	0	0	0	-2	0	0	0	0	0
Glendean	-2	-2	-2	-2	0	0	0	0	0	0	0	0	0	0	0	0	0
Knockgray Cottage	0	0	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Marbrack Cottage	0	0	0	0	0	0	0	-2	0	0	0	0	0	0	0	0	0
Marscalloch Cottage	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	0	-2	-2	0	-2	0	0
Nether Loskie	-2	0	-2	-2	-2	0	0	-2	0	-2	0	-2	0	0	-2	0	0
Furmiston	0	0	-2	0	0	0	0	-2	0	-2	0	-2	0	0	-2	0	0
Kensglen	0	0	-2	0	-2	0	-2	-2	0	-2	0	-2	0	0	-2	0	0
Burniston	0	0	0	0	0	0	0	0	0	0	0	-2	0	0	0	0	0
Burnfoot	0	0	-2	0	-2	0	0	0	0	0	0	-2	0	0	0	0	0
Marbrack Farm	0	0	0	0	0	0	0	-2	0	0	0	0	0	0	0	0	0
Bardennoch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cumnock Knowes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Location	Turbine number 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Stables Cottage	0	0	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Knockgray	-2	0	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North Liggate	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
South Liggate	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
The Cabin	-2	-2	-2	-2	-2	-2	-2	0	0	0	0	0	0	0	0	0	0
The Birks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carsphairn Primary School	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4 Mcadams Way	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	0	-2	0	0	0	0	0
Marbrae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

A_{misc} – Miscellaneous Other Effects

A10.1.13 ISO 9613 includes effects of propagation through foliage, industrial plants and housing as additional attenuation effects. These have not been included here and any such effects are unlikely to significantly reduce noise levels below those predicted.

Concave Ground Profile

A10.1.14 Sound propagation across a concave ground profile, for example valleys or where the ground falls away significantly between the turbine and the receptor, incurs an additional correction of +3 dB(A) to the overall A-weighted noise levels. This correction is implemented in order to take account of the reduced ground effects and, under some rare circumstances, the potential for multiple reflection paths caused by the concave profile.

A10.1.15 A condition is recommended in the IOA GPG for indicating where this correction should be applied:

$$h_m \geq 1.5 \times \left(\frac{\text{abs}(h_s - h_r)}{2}\right)$$

- where h_m is the mean height above ground along the direct path between the source and the receptor, h_s is the absolute source height above ground level and h_r is the absolute receptor height above ground level.

A10.1.16 Whilst this condition is useful at highlighting where the ground profile beneath a source – receptor path may be concave, it is inherently non-robust and can produce false positives. It should therefore be used in conjunction with a visual assessment of the ground profile when determining whether a correction should be applied.

A10.1.17 A computer programme is used to generate the ground profiles beneath each source – receptor path. From these plots it is possible to determine where a correction is appropriate. The results are presented below.

Table A10.4: Concave Ground Profile Corrections for Quantans Hill (dB)

Location	Turbine number 1	2	3	4	5	6	7	8	9	10	11	12	13	14
Bridgend	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Old Burnfoot Cottage	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glendean	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Location	Turbine number 1	2	3	4	5	6	7	8	9	10	11	12	13	14
Knockgray Cottage	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Marbrack Cottage	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Marscalloch Cottage	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nether Loskie	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Furmiston	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Kensglen	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Burniston	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Burnfoot	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Marbrack Farm	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bardennoch	3	3	0	3	3	3	3	3	0	3	3	3	3	3
Cumnock Knowes	3	0	0	0	0	0	0	0	0	0	0	0	3	0
Stables Cottage	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Knockgray	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North Liggate	0	0	0	0	0	0	0	0	0	0	0	0	0	0
South Liggate	0	0	0	0	0	0	0	0	0	0	0	0	0	0
The Cabin	0	0	0	0	0	0	0	0	0	0	0	0	0	0
The Birks	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carsphairn Primary School	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4 Mcadams Way	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Marbrae	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A10.5: Concave Ground Profile Corrections for Shepherd's Rig (dB)

Location	Turbine number 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Bridgend	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Old Burnfoot Cottage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glendean	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0
Knockgray Cottage	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0
Marbrack Cottage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Marscalloch Cottage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nether Loskie	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Furmiston	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kensglen	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Burniston	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Burnfoot	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Marbrack Farm	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bardennoch	3	3	0	3	0	3	0	0	3	0	3	0	0	3	0	3	0
Cumnock Knowes	0	3	0	0	0	0	0	0	0	0	3	0	0	3	0	3	0
Stables Cottage	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0
Knockgray	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0
North Liggate	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0
South Liggate	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0
The Cabin	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0
The Birks	0	0	0	0	0	0	0	0	0	0	3	0	0	3	0	3	0
Carsphairn Primary School	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0
4 Mcadams Way	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0
Marbrae	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0

REFERENCES

ISO 9613-1, Acoustics - Attenuation of sound during propagation outdoors, Part 1: Method of calculation of the attenuation of sound by atmospheric absorption, International Organization for Standardization, 1992

UK Institute of Acoustics, A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbines Noise, May 2013

ETSU W/13/00385/REP, A Critical Appraisal of Wind Farm Noise Propagation, DTI 2000

Wyle Research Report WR 88-19, Measurement and Evaluation of Environmental Noise from Wind Energy Conversion Systems in Alameda and Riverside Counties, October 1988

Appendix 11.1

Abnormal Indivisible Load Route Survey

Document history

Author	T Lockett	24/11/2021
Checked	G Buchan	24/11/2021

Client Details	
Contact	Matthew Bacon
Client Name	Vattenfall Wind Power Ltd

Issue	Date	Revision Details
A	29/07/2020	Draft
B	17/08/2020	Addition of ESDAL Responses
C	24/11/2021	Released

Pell Frischmann

Quantans Wind Farm

Abnormal Indivisible Load Route Survey

November 2021

Revision Record Document2					
Rev	**Description**	**Date**	**Originator**	**Checker**	**Approver**
A	Draft	29/07/2020	J Stirrat	T Lockett	G Buchan
B	Addition of ESDAL Responses	17/08/20	T Lockett	G Buchan	G Buchan
C	Planning Submission	24/11/21	T Lockett	G Buchan	G Buchan

Prepared for:

Vattenfall Wind Power Ltd
St Andrews House
Haugh Lane
Hexham,
Northumberland
NE46 3QQ

Prepared by:

Pell Frischmann
93 George Street
Edinburgh
EH2 3ES

VATTENFALL

Pell Frischmann

Contents

1 Introduction 1
1.1 Purpose of the Report 1
2 Site Background 2
2.1 Site Location 2
2.2 Candidate Turbines 2
3 Access Route Review 4
3.1 Access Routes 4
3.2 Route Constraints 6
3.3 Swept Path Assessment Results and Summary 22
3.4 Weight Review 22
4 Summary 24
4.1 Summary of Access Review 24

Figures

Figure 1: Site Location Plan 2
Figure 2: Superwing Carrier Trailer 3
Figure 3: Tower Trailer 3
Figure 4: Proposed Route – KGV Dock to Site 5

Tables

Table 1: Turbine Dimensions 2
Table 2: Contraint Points 6
Table 3: ESDAL Contacts 23

Appendices

Appendix A - Points of Interest Location
Appendix B - Swept Path Assessments
Appendix C - Weight Review Correspondence

1 Introduction

1.1 Purpose of the Report

Pell Frischmann (PF) has been commissioned by Vattenfall to undertake a desk-based survey of the Abnormal Indivisible Load (AIL) delivery route for wind turbine loads associated with the construction and development of Quantans Wind Farm, located to the east of Carsphairn, Castle Douglas.

The Route Survey Review (RSR) has been prepared to help inform Vattenfall on the issues associated with the development of the site with regards to off-site transport and access for AIL traffic.

The report identifies the key issues associated with AIL deliveries and notes that remedial works, either in form of physical works or as traffic management interventions will be required to accommodate the predicted loads.

The detailed designs of any remedial works are beyond the agreed scope of works between PF and Vattenfall at this point in time.

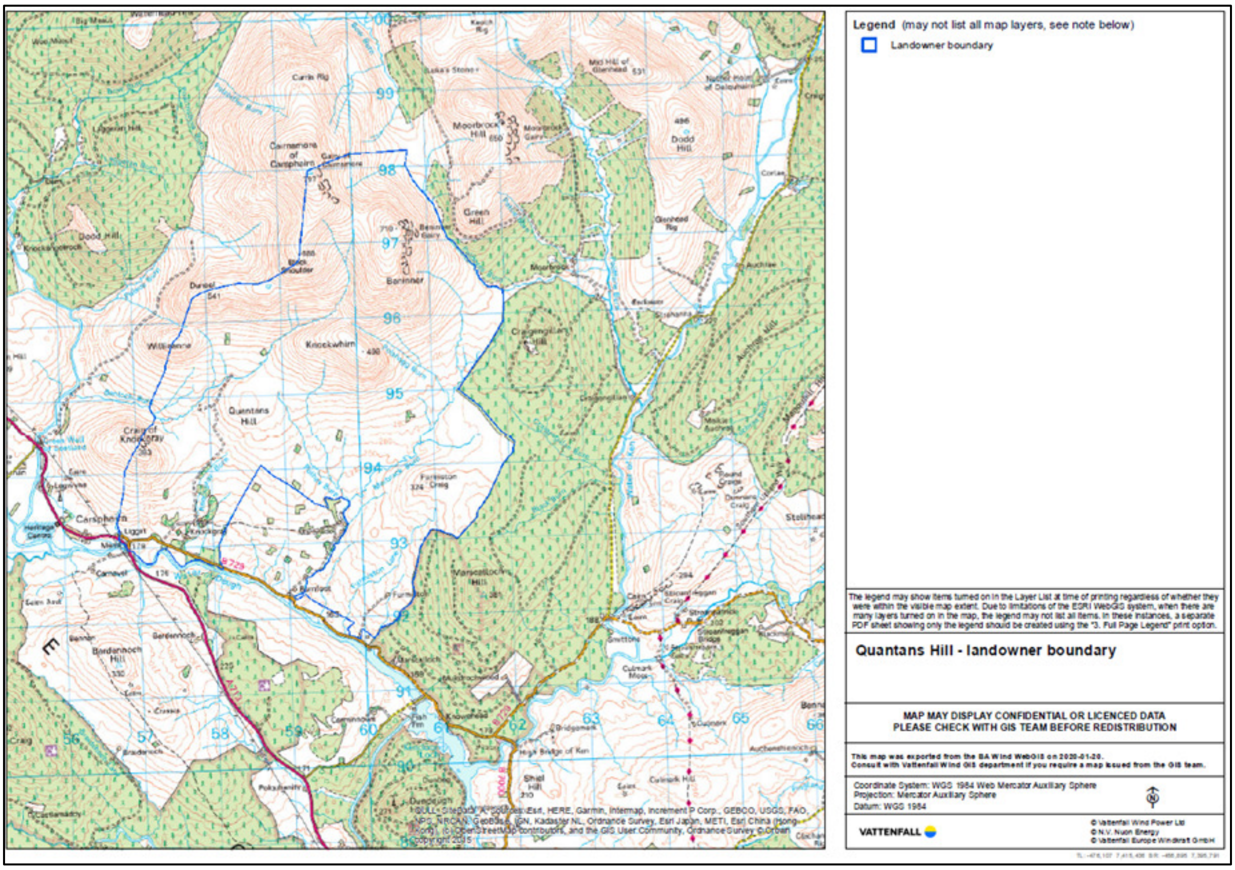
It is the responsibility of the wind farm developer to ensure that the entirety of the proposed access route is suitable and meets with their satisfaction. The developer will be responsible for ensuring that the finalised proposals meet with the appropriate levels of health and safety consideration for all road users is in line with the relevant legislation at the time of delivery.

2 Site Background

2.1 Site Location

The development site is located to the east of Carsphairn, Castle Douglas. Figure 1 illustrates the general site location.

Figure 1: Site Location Plan



2.2 Candidate Turbines

VATTENFALL have indicated that they wish to consider Siemens Gamesa SG170 turbines as the candidate turbine. Worst case tower and hub dimensions have been supplied by Siemens Gamesa and are indicated below in Table 1.

Table 1: Turbine Dimensions

Section	Length (m)	Width (m)	Height (m)	Weight (t)
SG170 Blade	83.500	4.500	3.400	24.600
Tower (Scenario 2+3)	28.820	4.670	4.670	<90.000

Swept path models to review the various constraints have been built. These have assumed the following trailer configurations:

- Blade: 3 axle Superwing Carrier trailer; and
- Mid Tower: 4+7 Load adaptor.

Examples of the types of trailer are illustrated in Figures 2 and 3 below.

Figure 2: Superwing Carrier Trailer

Figure 3: Tower Trailer

3 Access Route Review

3.1 Access Routes

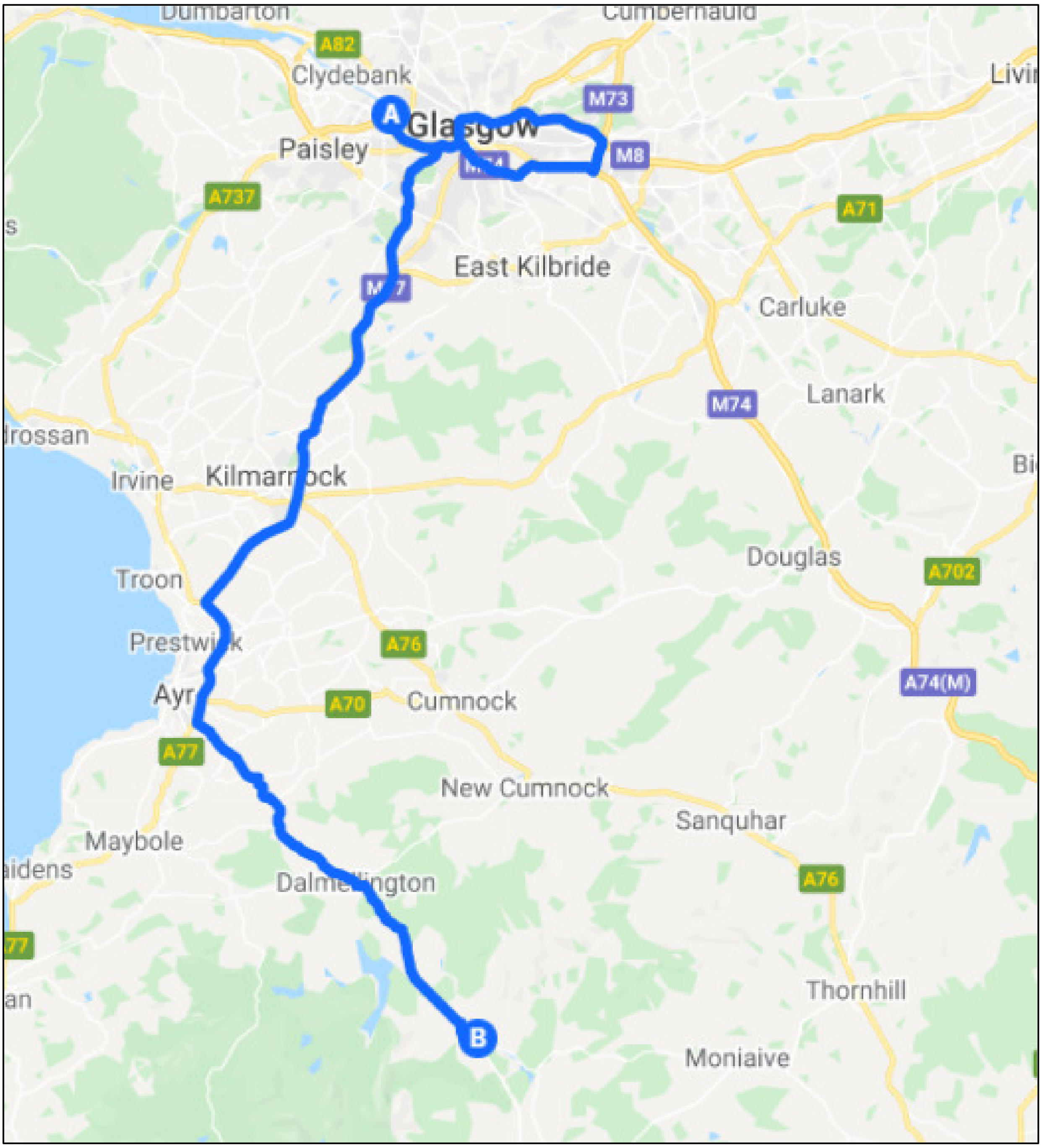
Due to the size of the SG170 components it is not considered possible to transport SG170 components through the Port of Ayr. As such, it is proposed that SG170 components will be transported into KGV Dock, Glasgow.

The proposed route to site is as follows:

- Loads would depart KGV Dock and travel west on Kings Inch Drive before turning left onto Mayo Avenue;
- Loads would join the eastbound M8 and continue to Junction 8;
- Loads would leave the M8 and join the M73 travelling south;
- At Junction 4, loads would join the westbound M74;
- Loads would depart the M74 at Junction 1 and join the M8 westbound before leaving at Junction 22 and join the M77 travelling southbound;
- Loads would continue south onto the A77 to Whitletts Roundabout east of Ayr;
- Loads would depart the A77 at Bankfield Roundabout and turn left onto the A713; and
- Loads would continue south east on the A713 to the proposed site entrance.

The proposed section 1 route is illustrated in Figure 4.

Figure 4: Proposed Route – KGV Dock to Site



3.2 Route Constraints

The constraints noted in the review of the routes from KGV Dock are detailed in Table 2. No consideration of the transport issues within the port or within the development site have been undertaken and this includes the design of the site access junction.

Plans illustrating the location of the constraints and a detailed list of POI are provided in Appendix A.

Table 2: Contraint Points

POI	Key Constraint	Details
1	**KGV Port Access Gate** 	Loads will exit the port via the AIL access gate onto Kings Inch Drive. Loads will oversail the southern verge on exiting the port where vegetation should be trimmed. Loads will cross the central island of the junction where the existing overrun should be utilised and will proceed westbound. Two road signs on the exit splitter island would need to be removed to enable over-sail.
2	**Kings Inch Drive Roundabout 1** 	Loads will proceed ahead taking the second exit onto Kings Inch Drive. Loads will oversail the southern verge on the approach arm where one lighting column should be removed. Load will oversail the north eastern verge and footway on the approach arm. Loads will oversail the southern edge of the central island and southern verge of the exit arm, but no works are required.
3	**Kings Inch Drive Roundabout 2** 	Loads will proceed ahead at the junction, taking the second exit. No physical mitigation works are required however, loads will require access to all lanes.

POI	Key Constraint	Details
4	**Kings Inch Drive / Mayo Avenue Junction** 	Loads will turn left at the junction and will enter the M8 spur road. Loads will oversail the northern central reserve and the northern verge of north lane where escorts should hold oncoming vehicles during load movements. Loads will oversail the splitter island where a bollard will be oversailed. Loads will overrun and oversail the eastern verge where a load bearing surface should be laid in overrun areas and existing utilities protected. One VMS road sign, one road sign, one lighting column and one pedestrian call post should be removed. Vegetation should be cleared back.
5	**M8 Junction 25a Slip Road** 	Loads will continue on the M8 at this location. Loads will oversail the western verge where the blade tip will oversail the safety barrier. Loads will oversail the eastern verge where the ground clearance for loads over the safety barrier should be confirmed during the test run.
6	**M8 / M73 Slip Road** 	Loads will take the slip road and join the M73 at this location. No mitigation is required however, loads will need access to all lanes.
7	**M73 / M74 Bend** 	Loads will proceed ahead at this location. No physical mitigation works are required however, loads will require access to all lanes.

POI	Key Constraint	Details
8	**M77 Slip Road** 	Loads will take the slip road and join the M77 at this location. No mitigation is required however, loads will need access to all lanes.
9	**Dutch House Roundabout** 	Loads will take the first exit at the roundabout. Loads will oversail the western verge of the entry arm on the central reserve and the eastern verge on the exit arm, but no works are required.
10	**Sandyford Toll Roundabout** 	Loads will take the second exit at the roundabout. Loads will oversail the central reserve on the entry arm where the blade tip will oversail the bollards and safety barrier. Loads will oversail the eastern verge where the three lighting columns should be removed. Loads will oversail the eastern splitter island, but no works are required. Loads will oversail the eastern side of the central island where one set of chevron signs should be removed.
11	**A77 Whitletts Roundabout** 	Loads will take the second exit coming from north to south. Loads will oversail the entry arm central reserve where the blade tip will oversail the safety barrier. Loads will oversail the eastern verge where one signal head and pole should be relocated.

POI	Key Constraint	Details
16	**A77 Holmeston Roundabout** 	Loads will continue straight though the roundabout island. Loads will oversail the eastern verge on the entry arm where the guardrail should be removed. Loads will overrun and oversail the central island where one set of chevron signs should be removed, and a load bearing surface laid in overrun areas.
17	**A77 Bankfield Roundabout** 	At the roundabout loads will take the first exit onto the A713. Loads will oversail the entry arm splitter island where one road signs should be removed. Loads will oversail the eastern verge on the entry arm, but no works are required. Loads will oversail the eastern side of the central island where one set of chevron signs should be removed. Loads will oversail the exit arm splitter island where one road sign and one lighting column should be removed. Loads will oversail the eastern verge of the exit arm where one road sign, one lighting column and vegetation should be removed.
18	**A713 Ailsa Hospital Junction** 	In order to minimise mitigation works it is proposed that loads should contraflow through the junction. Loads will oversail two out of the three central traffic islands. It may be necessary to move one traffic signal. The lit traffic sign should be removed from the final traffic island. Loads will oversail the south western verge, but no works are required

POI	Key Constraint	Details
19	**A713 Boneston Bridge** 	***Loads will traverse over Boneston Bridge on approach the bend. This has historically had a weight restriction. A design solution is being prepared by Vattenfall as part of the South Kyle development.*** Vattenfall have provided correspondence from SWECO that the aspiration for the bridge works is to achieve HB45 loading however they have advised that it would be better to assume HB34 loading. It is our understanding that blade loads are suitable for the route. The towers may be subject to design alterations by the manufacturer prior to delivery. It is recommended that once the candidate turbine is chosen and the haulier selected, final loaded design details are provided to SWECO for review and to allow them to confirm that feasibility of the load movements across the bridge.
20	**A713 Craigs Road Bend** 	Loads will continue on the A713 at this location. Following the bridge, on approach to the right-hand bend, loads will oversail the northern verge where the blade tip will oversail the traffic barrier and a set of chevron signs should be removed. Loads will overrun the splitter island where a load bearing surface should be laid along with the removal of four bollards, two road signs and one chevron sign. Loads will overrun and oversail the eastern verge through the right bend where a load bearing surface should be laid. Four chevron signs and one road sign should be removed along with all traffic bollards. Loads will overrun and oversail the verge on the inside of the right bend where a load bearing surface should be laid in overrun areas. Trees, fences and vegetation should be removed. Throughout the route, the tree canopy needs to be trimmed to provide a clear 5m head height. Trimming of the tree canopy can be subject to ecological constraints and it is suggested that early consultation with the Ayrshire Roads Alliance is undertaken to agree cutting times and permits.

POI	Key Constraint	Details
21	**A713 Right Bend North West of Holehouse Cottage** 	Loads will continue on the A713 at this location. On approach to the right bend, loads will oversail the northern verge where two sets of chevron signs on the north should be removed and the bollards oversailed. Loads will oversail the southern verge where vegetation and the fence should be removed.
22	**A713 Right Bend at Holehouse Cottage** 	Loads will continue on the A713 at this location. Loads will oversail the north eastern verge where one utility pole should be removed. Bollards should be oversailed. Loads will oversail the western verge where the vegetation should be trimmed back.
23	**A713 Holehouse Junction** 	Loads will continue on the A713 at this location. Loads will oversail both verges through the bend where the bollards will be oversailed om the western verge. South of the bend loads will overrun and oversail the western verge where loads will overrun and oversail the western verge over the first bend where loads a load bearing surface should be laid in overrun areas. Bollards, fence and vegetation should be removed.

POI	Key Constraint	Details
24, 25	**A713 Holehouse Railway Bridge**  	Loads will continue on the A713 over the railway bridge at this location. Loads will oversail the north eastern verge through the first bend but no works are required. Loads will overrun and oversail the western verge over the first bend where loads a load bearing surface should be laid in overrun areas. Bollards, one road sign, fence and vegetation should be removed. Loads will oversail the south western verge through the second bend where loads will oversail the bollards. Three sets of chevron signs should be removed. Loads will oversail the northern verge through the second bend where the vegetation should be removed. Loads will oversail the southern verge of the third bend, but no works are required.
26	**A713 Bends near Smithston** 	Loads will continue on the A713 at this location. Loads will oversail the north eastern verge before the bend where one chevron sign and one utility pole should be removed. Loads will oversail the south western verge through the bend, but no works are required. Loads will oversail and overrun the north eastern verge after the bend where a load bearing surface should be laid in overrun areas. The drainage ditch should be culverted. Vegetation should be cleared. Traffic bollards and one chevron sign should be removed.
27	**A713 Old Smithston** 	Loads will continue on the A713 at this location. Loads will oversail both verges of the carriageway, however no works are required.

POI	Key Constraint	Details
28	**A713 Carnochan** 	Loads will continue on the A713 at this location. Loads will overrun and oversail the eastern verge where a load bearing surface should be laid in overrun areas. Detailed design is required to confirm whether the verge will require strengthening. Traffic bollards and three sets of chevron signs should be removed. Loads will oversail the eastern verge where the utility pole and vegetation should be removed.
29	**A713 Polnessan** 	Loads will continue on the A713 at this location. Loads will oversail the north eastern verge where loads will oversail the bollards. One road sign and two sets of chevron signs should be removed. Loads will oversail the western verge where vegetation should be cleared.
30	**A713 Polnessan** 	Loads will continue on the A713 at this location. Loads will oversail both verges of the carriageway where the blade tip will oversail the traffic bollards.
31	**A713 Bends South of Polnessan** 	Loads will continue on the A713 at this location. Loads will oversail both verges of the carriageway, but no works are required.

POI	Key Constraint	Details
32	**A713 Bends South of Polnessan** 	Loads will continue on the A713 at this location. Loads will oversail both verges of the carriageway through this location. Loads will oversail the north western verge over the railway bridge where one lighting column should be removed. Loads will overrun and oversail the western verge south of the bridge where a load bearing surface should be laid in overrun areas. One lighting column should be removed.
33	**A713 Patna**  	Loads will continue through the village of Patna. Loads will oversail both verges of the carriageway through this location. Loads will overrun the eastern and western verges where a load bearing surface to be laid in overrun areas. Traffic cushions are located in the road surface. Loads to transit the section with care. Parking should be suspended during load movements through this bend and the following bend.
34	**A713 Waterside Bends** 	Loads will continue on the A713 at this location. Loads are likely to oversail the northern verge through the first bend, but no works are required.
35	**A713 South of Waterside** 	The vertical profile of the road at this location is pronounced and should be reviewed during the test run stage to ascertain if tar wedges will be required to prevent grounding.

POI	Key Constraint	Details
36	**A713 Cutler** 	The vertical profile of the road at this location is pronounced and should be reviewed during the test run stage to ascertain if tar wedges will be required to prevent grounding.
37	**A713 Left Bend West of Burnton** 	Loads will continue on the A713 at this location. Loads are likely to oversail the northern verge through this bend, but no works are required.
38	**A713 Buchan's Bridge** 	Loads will continue on the A713 at this location. Loads will oversail both verges of the carriageway. Loads will oversail the north eastern verge where a set of chevron signs should be removed.
39	**A713 Dalmellington** 	Traffic cushions have been placed on the road surface. Loads to transit the section with care.
40	**A713 Left Bend, Dalmellington** 	Loads will continue on the A713 at this location. Loads will oversail the northern verge where one bollard should be removed. Traffic cushions have been placed on the road surface. Loads to transit the section with care.

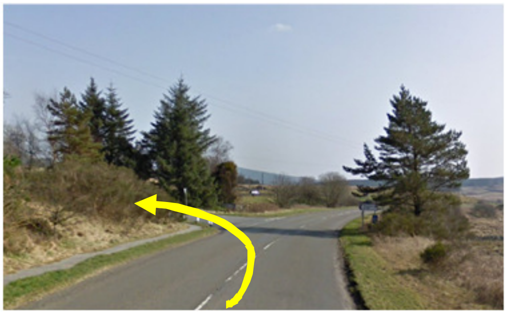
POI	Key Constraint	Details
41	**A713 Dalmellington** 	Loads will continue on the A713 at this location. Loads will oversail the northern verge, but no works are required. Temporary parking restrictions are required to allow loads to utilise the entire carriageway through the section.
42	**A713 North of Kirn Bridge** 	Loads will continue on the A713 at this location. Loads will oversail the north eastern verge where loads will oversail the bollards and one road sign and one set of chevron signs should be removed. Loads will oversail the south western verge where the vegetation should be trimmed.
43	**A713 Kirn Bridge** 	Loads will cross the bridge and continue on the A713. Loads will oversail the north eastern verge where loads will over-sail the stone parapet. Clearance over parapet should be confirmed during the test run. The blade tip will oversail the fence. A set of chevron signs should be removed. Loads will oversail the south western verge over the parapet wall.
44	**A713 West of Snabb Cairn** 	Loads will continue on the A713 at this location. Loads will oversail the north eastern verge where the bollards will be oversailed. One set of chevron signs should be removed. Loads will oversail the western verge where a section of fence should be removed. Vegetation and trees should be cleared.

POI	Key Constraint	Details
45	**A713 North of Mossdale** 	Loads will continue on the A713 at this location. Loads will oversail both verges of the carriageway where the loads will oversail the bollards on the west and one set of chevron signs should be removed. The vertical profile of the road at this location is pronounced and should be reviewed during the test run stage to ascertain if tar wedges will be required to prevent grounding.
46	**A713 Mossdale** 	It is recommended that the vertical clearance through this section is assessed during the test run to ensure adequate ground clearance is available.
47	**A713 Mossdale** 	Loads will continue on the A713 at this location. Loads will oversail both verges of the carriageway where loads will oversail the bollards on the eastern verge.
48	**A713 South of Mossdale** 	Loads will continue on the A713 at this location. Oncoming traffic should be held in advance of this section to improve manoeuvrability. No physical works are required however, loads will oversail both verges of the carriageway.

POI	Key Constraint	Details
49	**A713 at Bryan's Heights** 	Loads will continue on the A713 at this location. Loads will overrun and oversail the north eastern verge on the outside of the right bend where three chevron signs and two telegraph poles should be relocated. A load bearing surface should be laid in overrun areas. The clearances to overhead power lines throughout the route should be reviewed with the utility provider prior to loads moving to ensure that there is sufficient head height and flashover protection for all temperature ranges.
50	**A713 at Bryan's Heights** 	Loads will continue on the A713 at this location. Loads will oversail both verges of the carriageway where one sign should be removed on the western verge and one utility pole on the eastern verge should be removed.
51	**A713 Craig Bridge** 	Loads will continue on the A713 at this location. Loads will oversail both sides of the carriageway where bollards should be oversailed on the north eastern verge north of the bends. Loads will oversail the south eastern verge through the bends where the bollards and fence should be removed.
52	**A713 Glenmuck** 	Loads will continue on the A713 at this location. Loads will oversail both verges of the carriageway where one utility pole should be removed on the north eastern verge.

POI	Key Constraint	Details
53	**A713 Glenmuck** 	Loads will continue on the A713 at this location. Loads will oversail the north eastern verge before the first bend, but no works are required. Loads will oversail the south western verge before the first bend where loads will oversail the bollards. Loads will oversail the northern verge though the left bend where the proximity to the utility stay wire should be confirmed on the test run. Loads will oversail the north eastern verge through the right bend where the bollards should be oversailed. Loads will oversail the south western verge through the right bend where the vegetation should be cleared.
54	**A713 Glenmuck**  	Loads will continue on the A713 at this location. Loads will oversail both verges where the vegetation should be cleared on the western verge.
55	**A713 Carsphairn Splitter Island** 	Loads will continue on the A713 at this location. One island to be flattened. Two bollards should be removed to allow loads to pass.

POI	Key Constraint	Details
56, 57	**A713 Carsphairn**  	Loads will continue on the A713 at this location. North of the first bend loads will oversail the western verge where one lighting column should be removed. Loads will oversail the western verge through the bend where vegetation should be trimmed. Loads will oversail the north eastern verge though the first bend where the fence, bridge parapet and trees should be removed. Loads will oversail both northern buildouts where one road sign should be removed. Parking to be restricted during movements.
58	**A713 Carsphairn Splitter Islands**  	Loads will continue on the A713 at this location. Two islands to be flattened. Three bollards and one lighting column should be removed to allow loads to pass.

POI	Key Constraint	Details
59, 60	**A713 / B729 Junctions**    	Loads will turn left at the A713 / B729 junction and then procced to take another left at the B729 junction. Loads will oversail the south western verge of the A713 where loads will oversail the vegetation and a land search is recommended. Loads will overrun and oversail the inside of the A713 / B729 junction where trees, vegetation and bollards should be removed. Loads will oversail the northern verge of the B729 where trees, stone wall and one utility pole should be removed. Loads will overrun and oversail the southern verge of the B729 where a load bearing surface should be laid. Trees, one utility pole and the stone wall should be removed. Loads will oversail the western verge where loads will oversail the wall. One utility pole should be removed. Loads will overrun and oversail the inside of the B729 junction where a load bearing surface should be laid. Two utility poles, one road sign, vegetation and a stone wall should be removed.
	Proposed Site Entrance	Loads will turn into a proposed site entrance to the north of the B729 Junction subject to conclusion of land negotiations. A new junction should be created to meet both turbine manufacturer and Dumfries & Galloway Council standards.

3.3 Swept Path Assessment Results and Summary

The detailed swept path drawings for the locations assessed are provided in Appendix B for review. The drawings in Appendix B illustrate tracking undertaken for the worst case loads at each location.

The colours illustrated on the swept paths are:

- Grey / Black – OS / Topographical Base Mapping;
- Green – Vehicle body outline (body swept path);
- Red – Tracked pathway of the wheels (wheel swept path); and
- Purple – The over-sail tracked path of the load where it encroaches out with the trailer (load swept path).

Where mitigation works are required, the extents of over-run and over-sail areas are illustrated on the swept path drawings.

Please note that where assessments have been undertaken using Ordnance Survey (OS) base mapping, there can be errors in this data source. Please note that PF cannot accept liability for errors on the mapping data source, be that OS base mapping or client supplied data.

Where indicative road edges have been provided they are for illustration only and all works should be confirmed through a test run or on topographical base plans.

A test run is required to confirm the suitability of the proposed mitigation measures. It is recommended that all proposed mitigation measures are in place prior to the test run at least 2 months in advance of the commencement of deliveries. All works would be required after planning consent has been granted.

3.4 Weight Review

A weight review has been undertaken via the ESDAL (Electronic Service Delivery for Abnormal Loads) contacts database using the Highways Agency website www.esdal.com.

All of the relevant ESDAL contacts are noted in Table 3 and all have been contacted to ascertain if there are any relevant constraints that should be noted.

Table 3: ESDAL Contacts

Organisation	Email Address
Network Rail	abnormalloadscontact@networkrail.co.uk
Historic Rail Estate	rsgbrb@jacobs.com
Scottish Canals	SCAbnormal.Loads@scottishcanals.co.uk
Ayrshire Roads Alliance	abloads@ayrshireroadsalliance.org
Transport Scotland	Paul.winn@transport.gov.scot
Dumfries & Galloway Council	esdal@dumgal.gov.uk
Renfrewshire Council	ei@renfrewshire.gov.uk
Police Scotland	OSDAbnormalLoadsScotland@scotland.pnn.police.uk
ScotlandTranServ	abnormalloadrouting@scotlandtranserv.co.uk
Glasgow City Council	abnormalloads@glasgow.gov.uk
M8 DBFO	m8dbfo.abloads@amey.co.uk
Connect M77/GSO PLC	M77DBFOAbnormalLoads@balfourbeatty.com

* Renfrewshire Council have previously advised that they will not enter into discussions with consultants and will only engage with hauliers immediately prior to loads moving. As such they have not been consulted.

The responses from the ESDAL search are contained in Appendix C.

4 Summary

4.1 Summary of Access Review

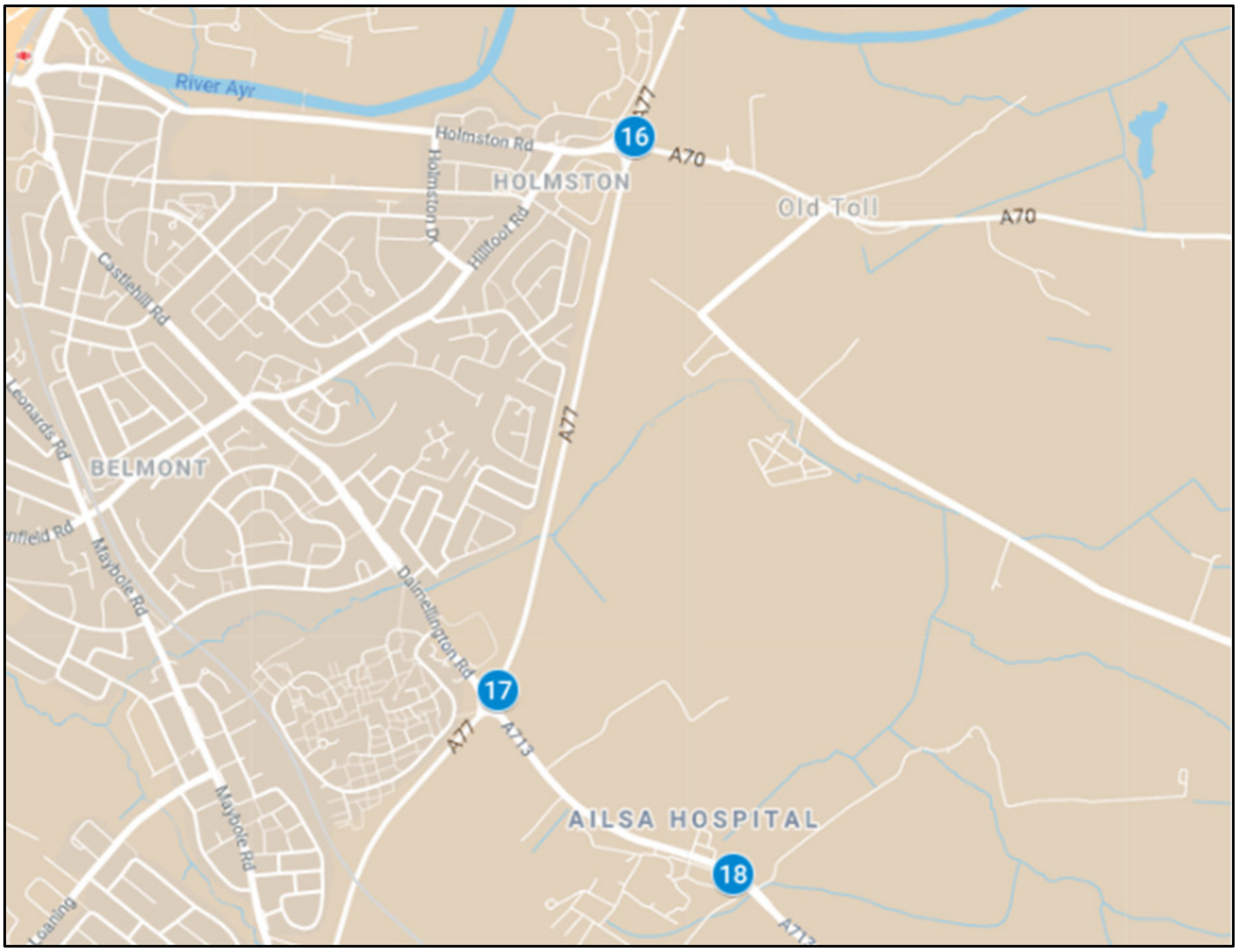
PF has been commissioned by Vattenfall to prepare a Route Survey Report to examine the issues associated with the transport of AIL turbine components to the development site.

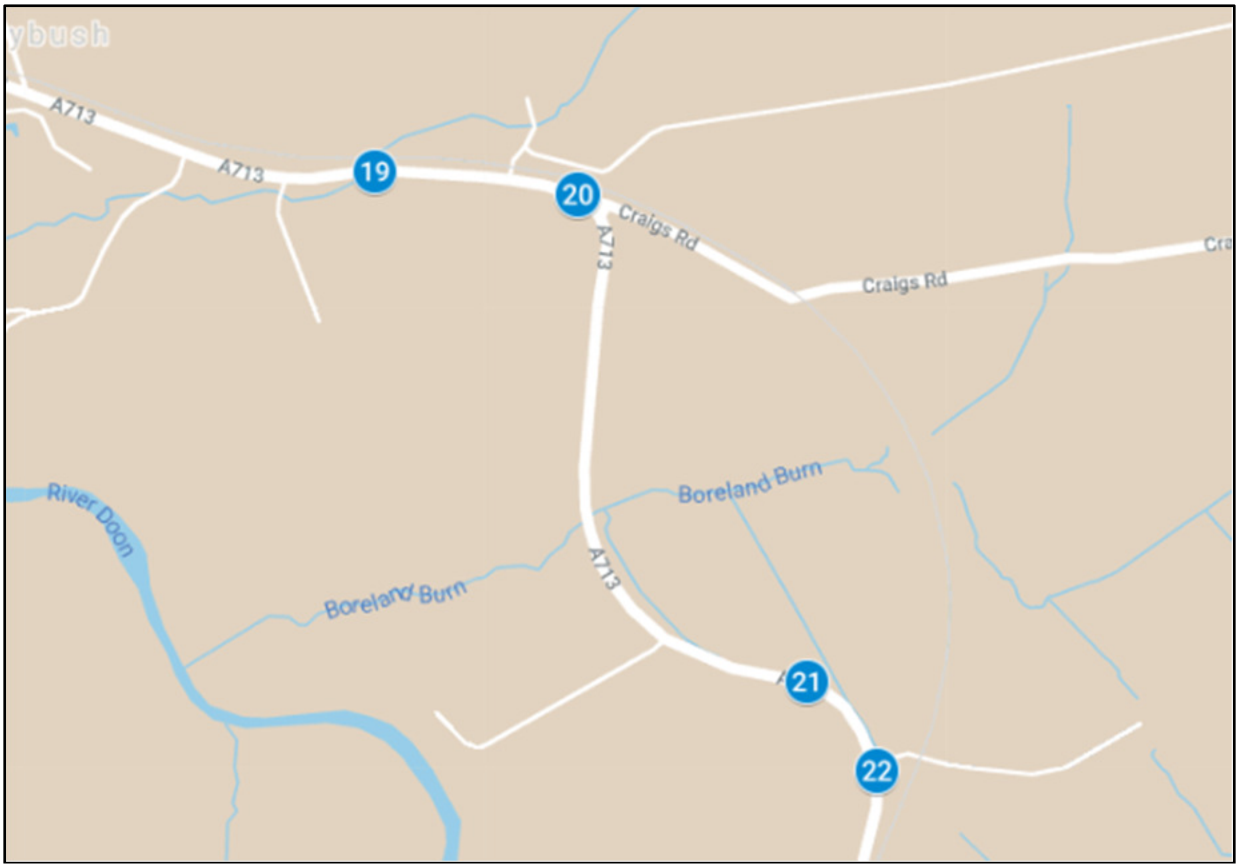
This report identifies the key points and issues associated with the proposed routes and outlines the issues that will need to be considered for successful delivery of components.

The report is presented to Vattenfall for consideration. Various road modifications and interventions are required to successfully access the site. If these are assessed, approved and undertaken, access to the consented wind farm site is considered feasible.

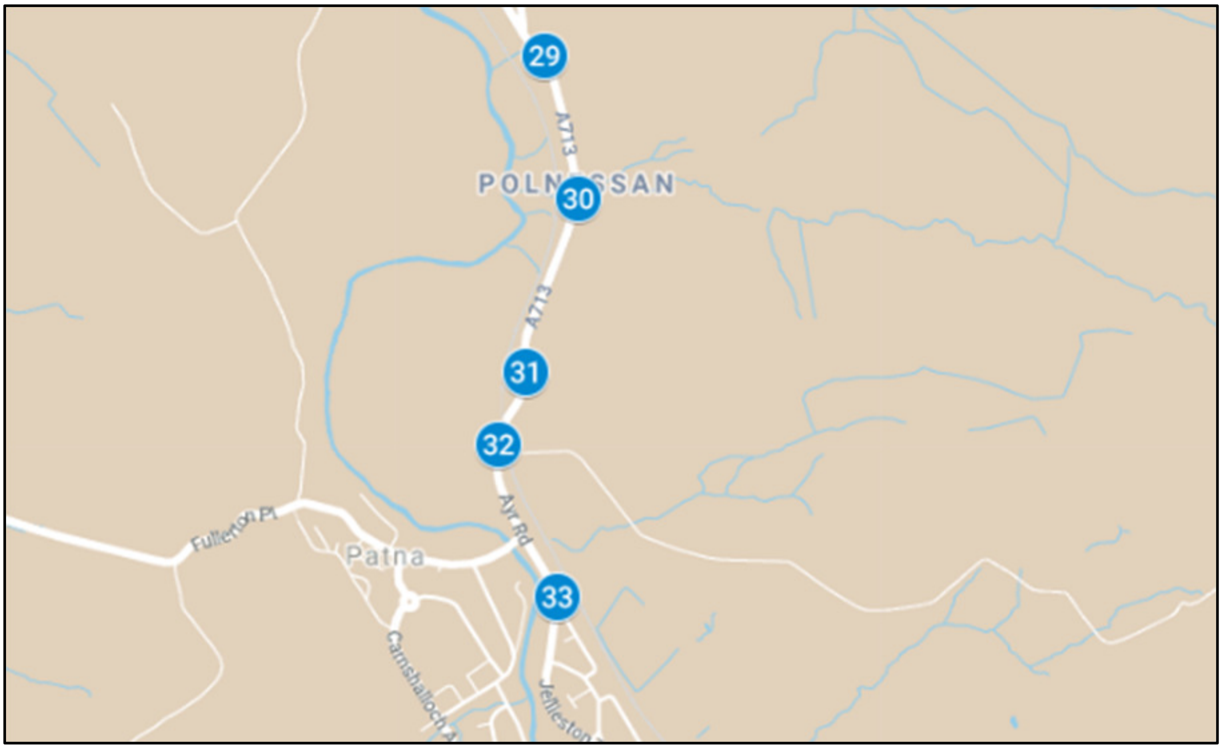
Appendix A
Points of Interest Location

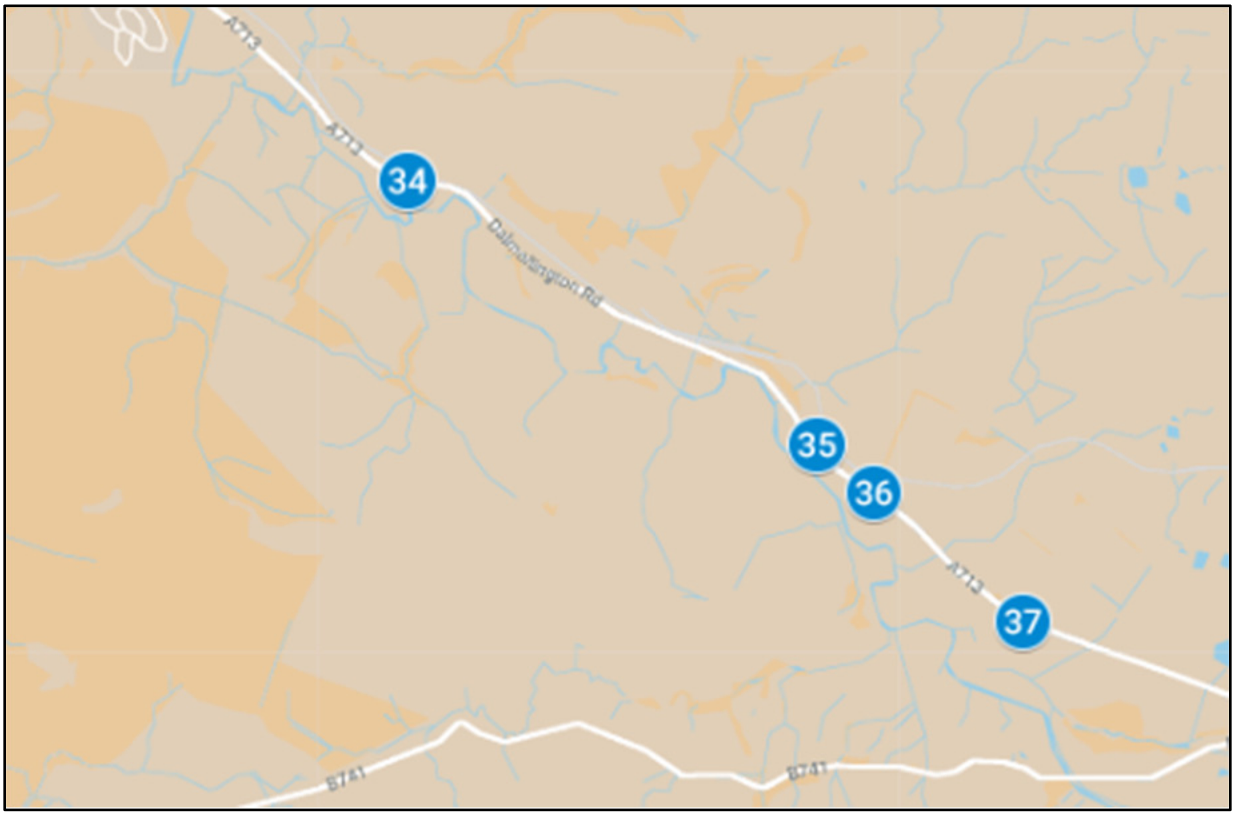
Monkton
Glasgow Prestwick Airport
Prestwick
Mossblown
St Quivox
Auchincruive
A77
A78
A79
A719
B739
B742
B743
Kilmarnock Rd
Shawfarm Rd
Main St
Ayr Rd
East Rd
Heathfield Rd
Prestwick Rd
9
10
11

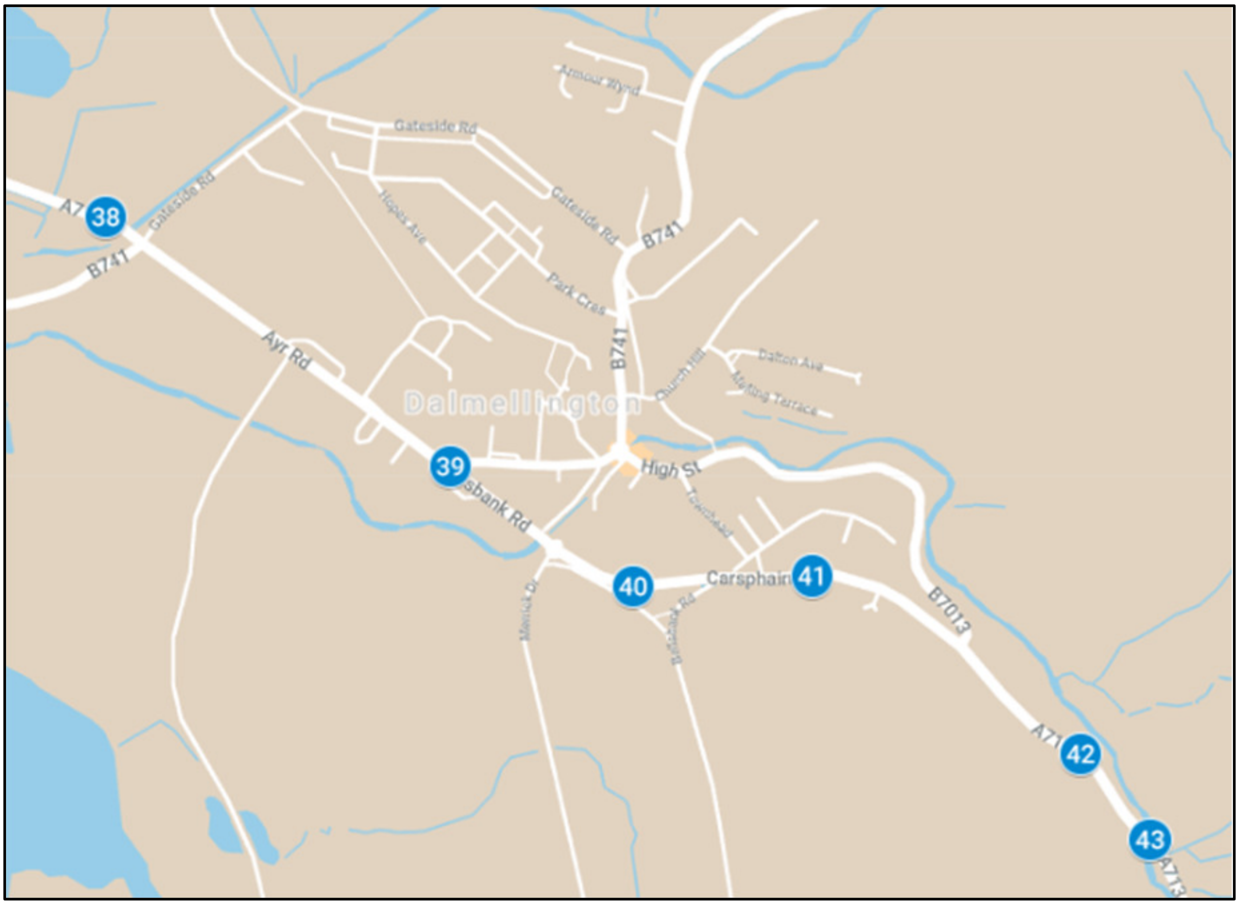

River Ayr
Holmston Rd
16
A77
A70
HOLMSTON
Holmston Dr
Hillfoot Rd
Old Toll
A70
Castlehill Rd
Leonards Rd
BELMONT
A77
nfield Rd
Maybole Rd
Dalmellington Rd
17
A77
A713
AILSA HOSPITAL
Maybole Rd
18
A713
Loaning

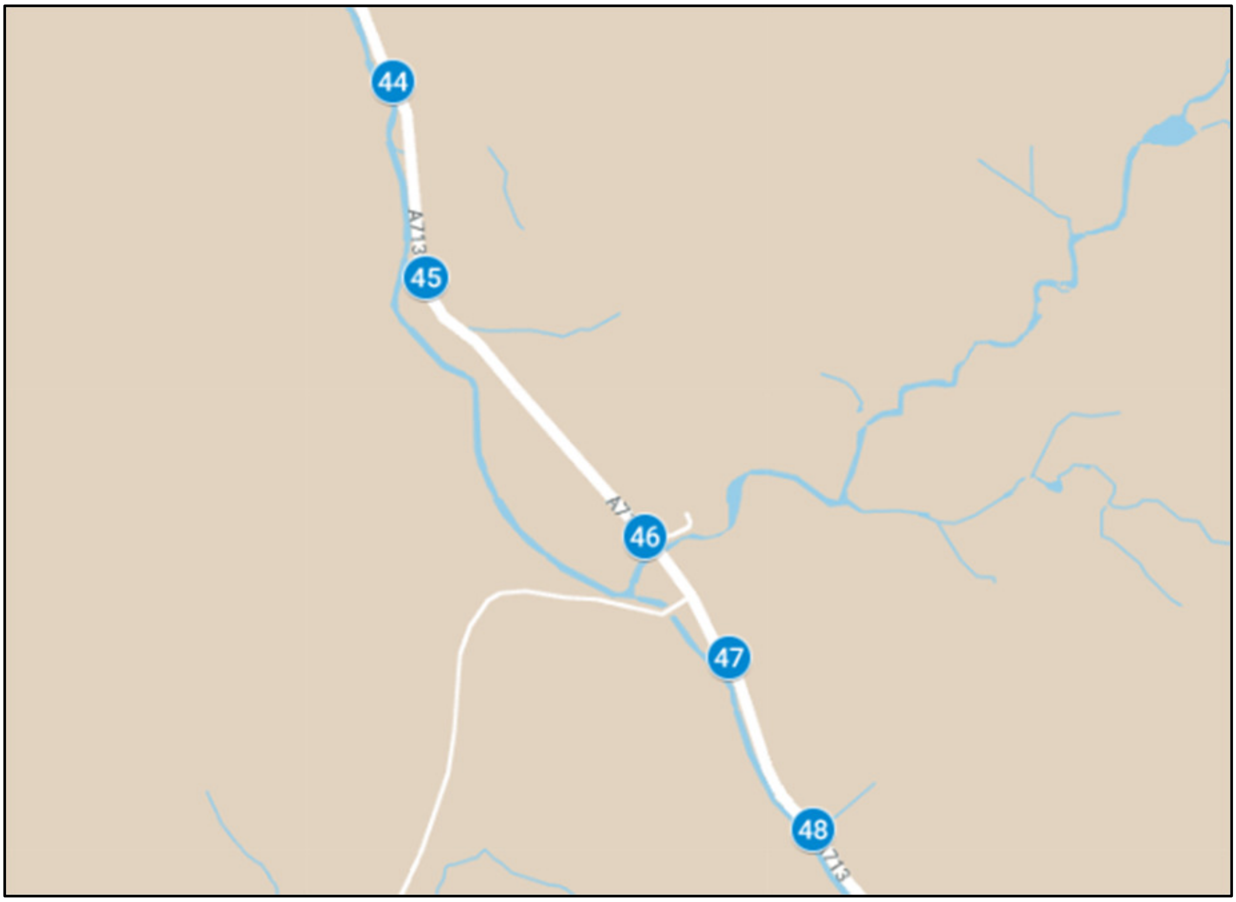

ybush
A713
A713
19
20
Craigs Rd
A713
Craigs Rd
Cra
River Doon
Boreland Burn
Boreland Burn
A713
21
22

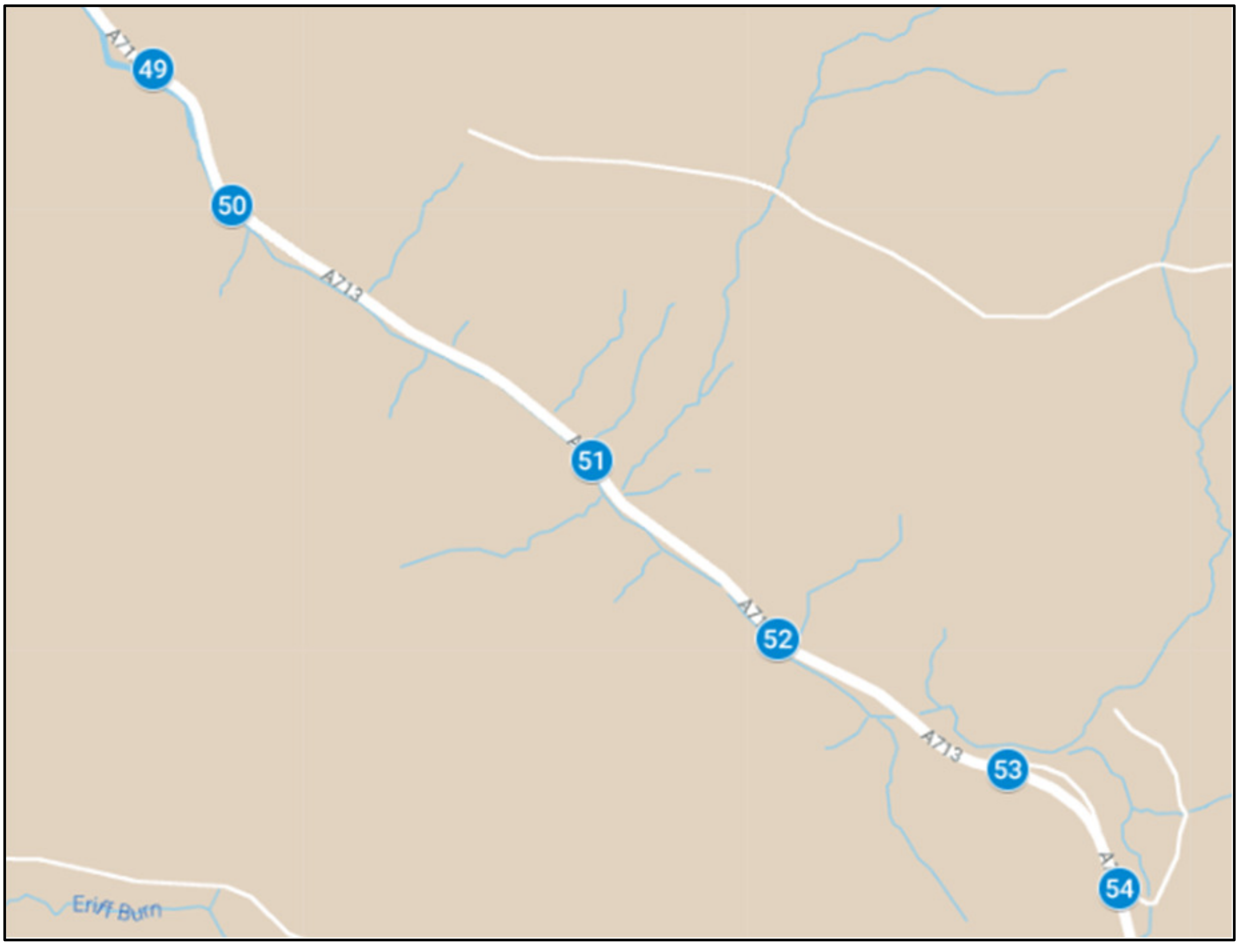

23
24
A713
25
A713
26
A713
27
28
B730
River Doon
River Doon

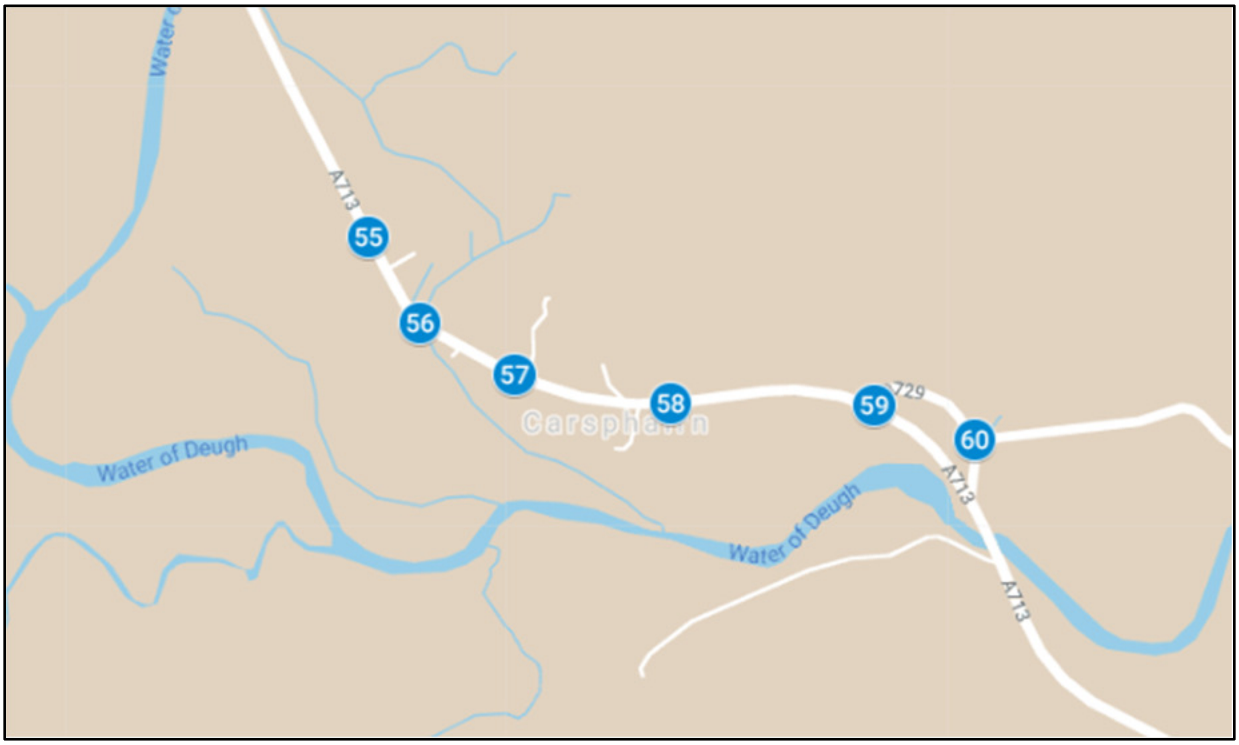

29
A713
POLN SSAN
30
A713
31
32
Ayr Rd
Fullerton Pl
Patna
33
Carnshalloch A
Jellieston


A713
A713
34
Dalmellington Rd
35
36
A713
37
B741
B741

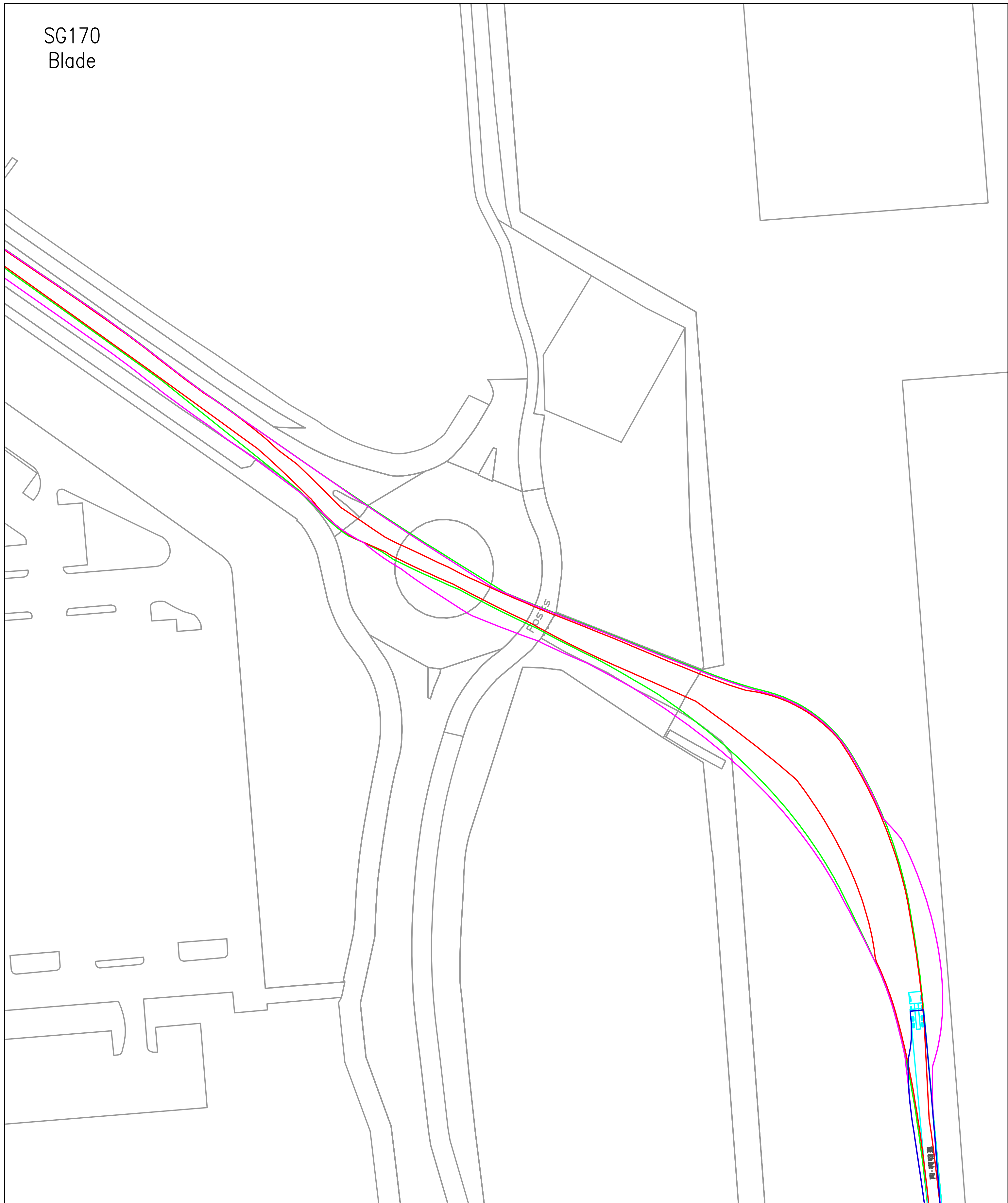

38
Gateside Rd
B741
Gateside Rd
Gateside Rd
Hopes Ave
Park Cres
B741
B741
Ayr Rd
Dalmellington
High St
39
40
Carsphairn
41
B7013
42
43
A713


44
45
46
47
48
A713


49
50
51
52
53
54
A713
Eriff Burn


Water of Deugh
Water of Deugh
A713
A713
A713
55
56
57
58
59
60
Carsphairn
729

Appendix B
Swept Path Assessments



Pell Frischmann

93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over–run | Over–sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: Kings Inch Drive Roundabout 1

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		1

Scale: 1:1000 @ A3

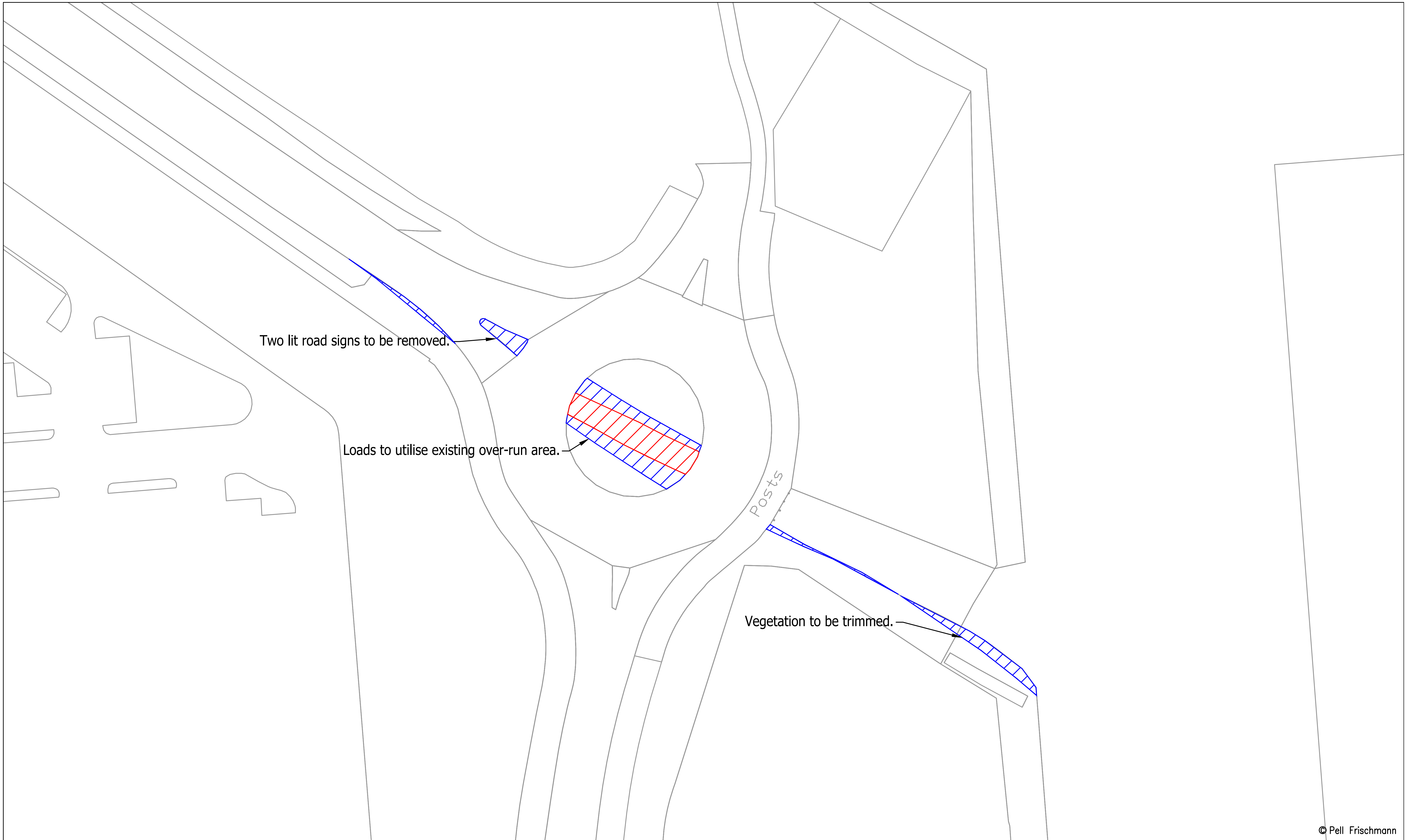
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK01

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: XXX



Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA, Body SPA, Load SPA, Indicative, Over-run, Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: Kings Inch Drive Roundabout 1

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		1

Scale: 1:500 @ A3

File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK01A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: XXX

SG170
Blade

Tower

Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA, Body SPA, Load SPA, Indicative, Over–run, Over–sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: Kings Inch Drive Roundabout 2

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		2

Scale: 1:1000 @ A3

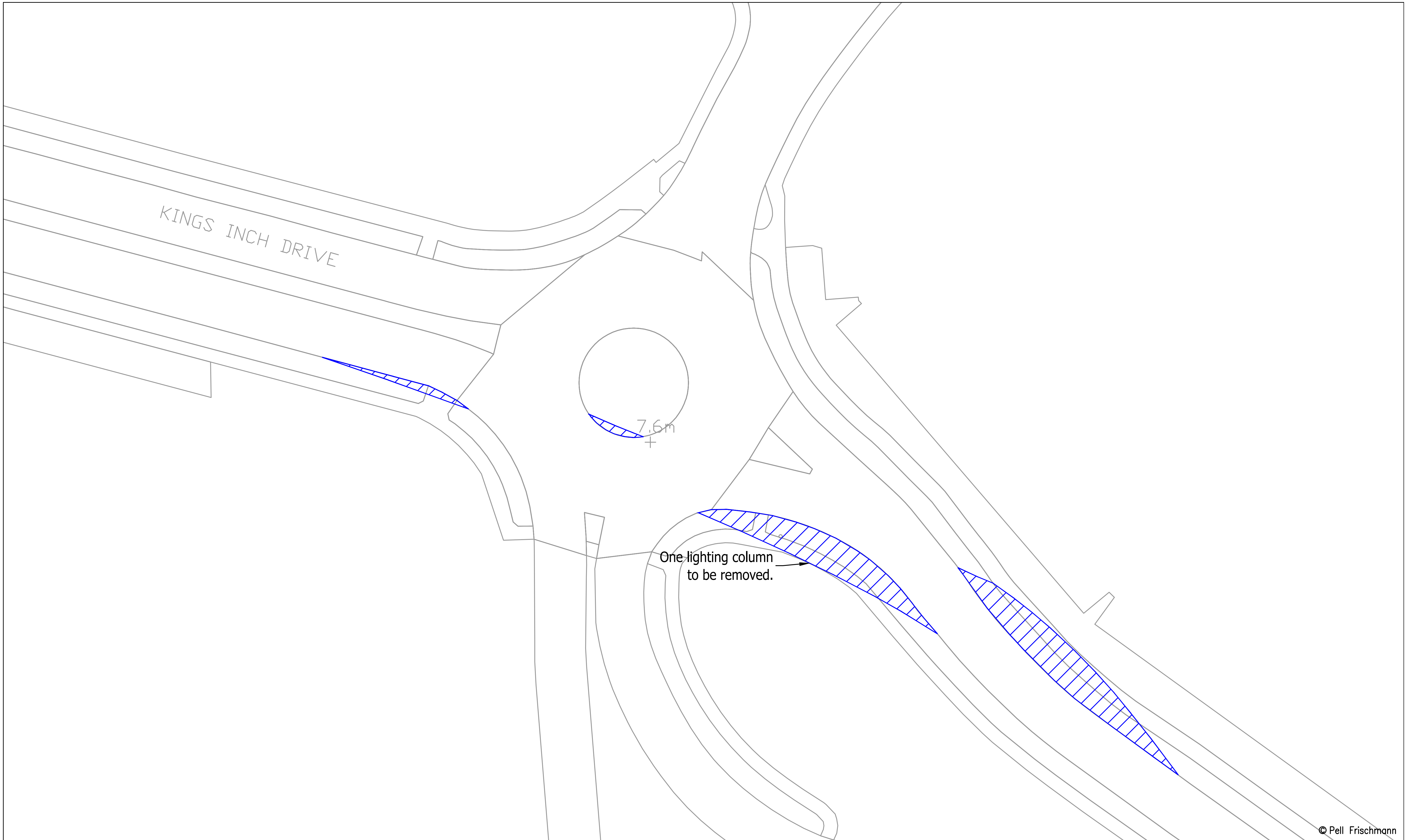
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK02

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: XXX



Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: Kings Inch Drive Roundabout 2

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest	2	

Scale: 1:500 @ A3

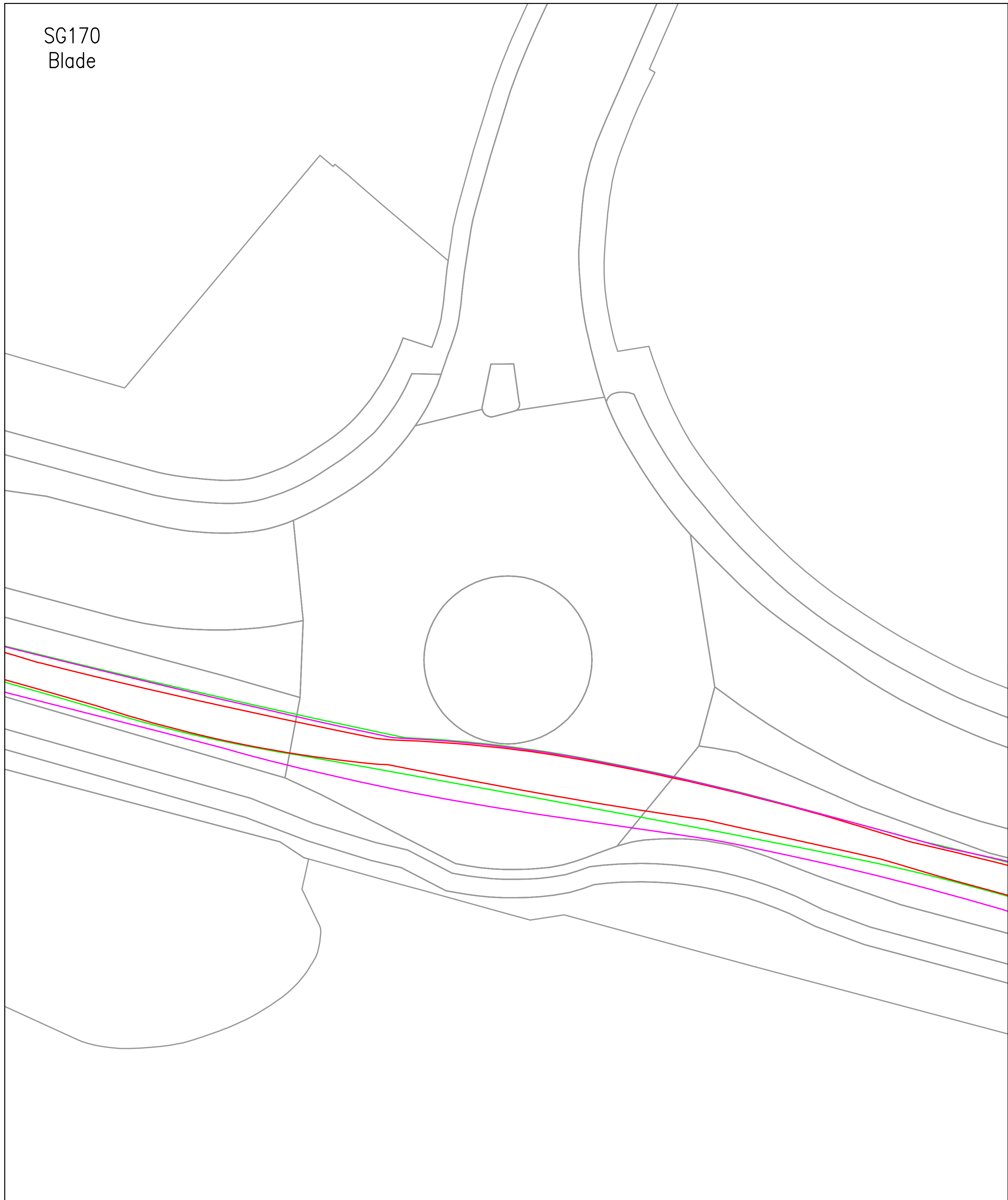
File No.: Quantans SPA (FINAL).dwg

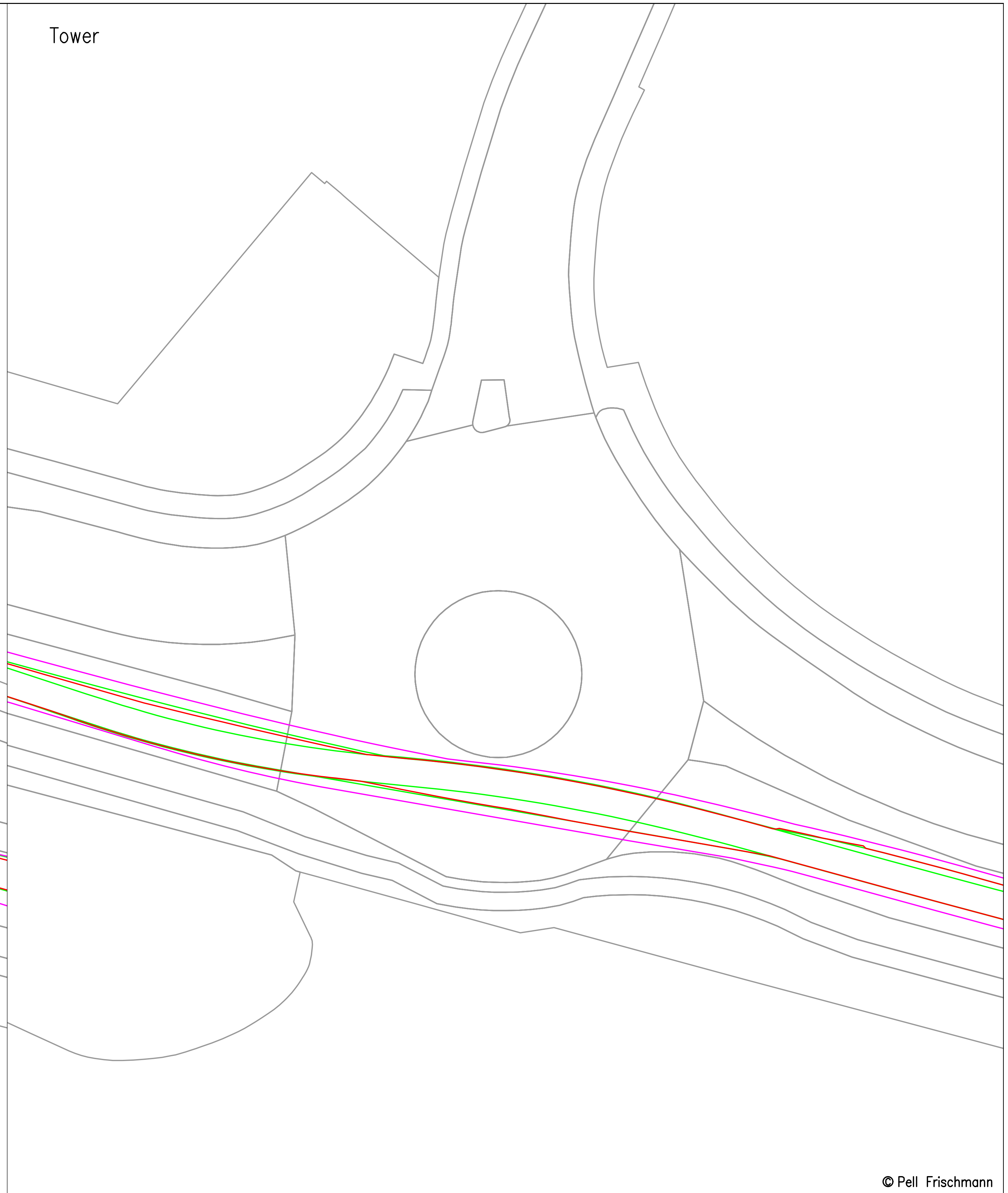
Drawing Status: Draft

Drawing No.: SK02A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: XXX





Pell Frischmann
93 GEORGE STREET, EDINBURGH. EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

NO MITIGATION

SPA Location: Kings Inch Drive Roundabout 3

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		3

Scale: 1:500 @ A3

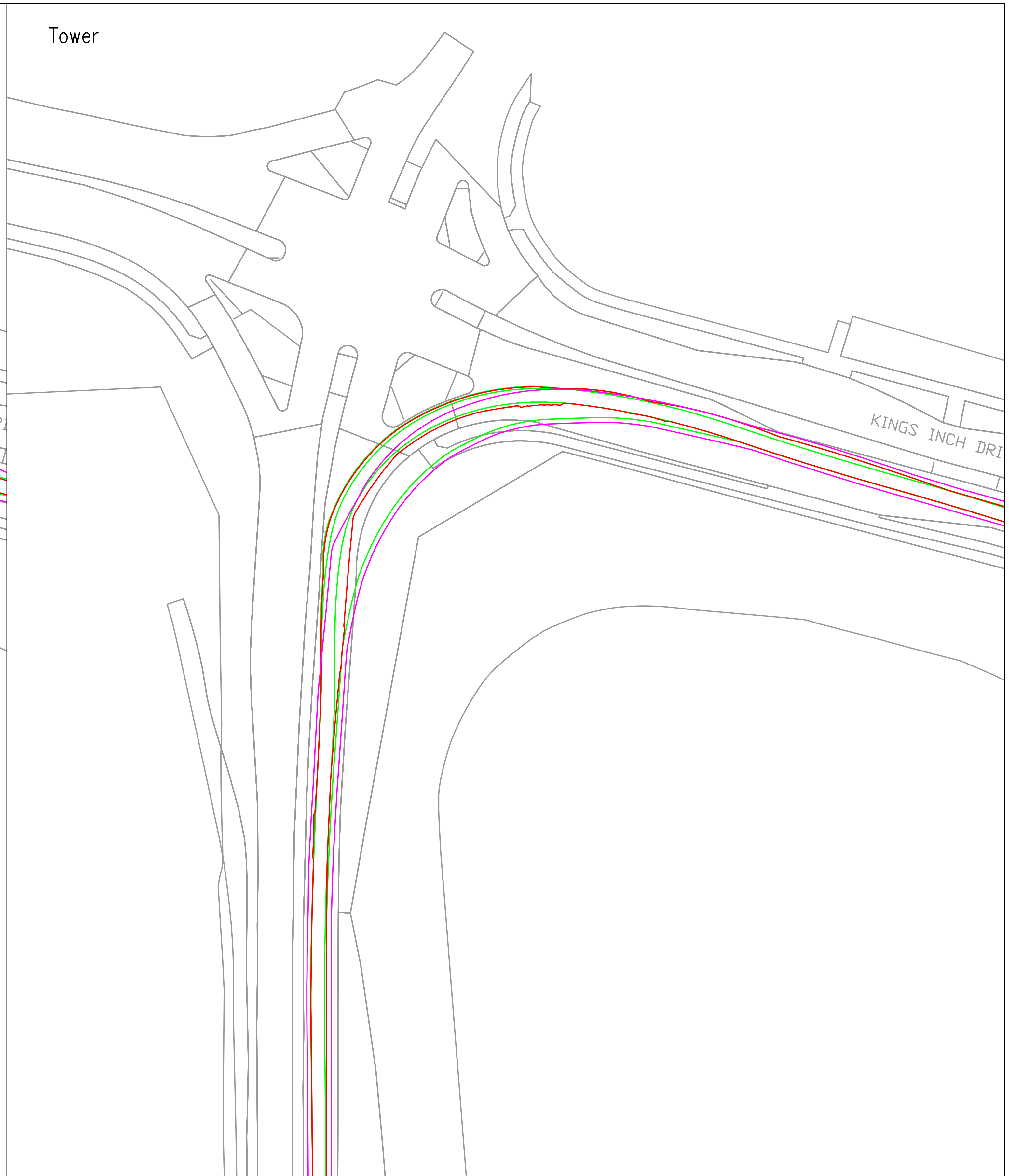
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK03

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: XXX



Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: Kings Inch Drive / Mayo Avenue Junction

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest	4	

Scale: 1:1000 @ A3

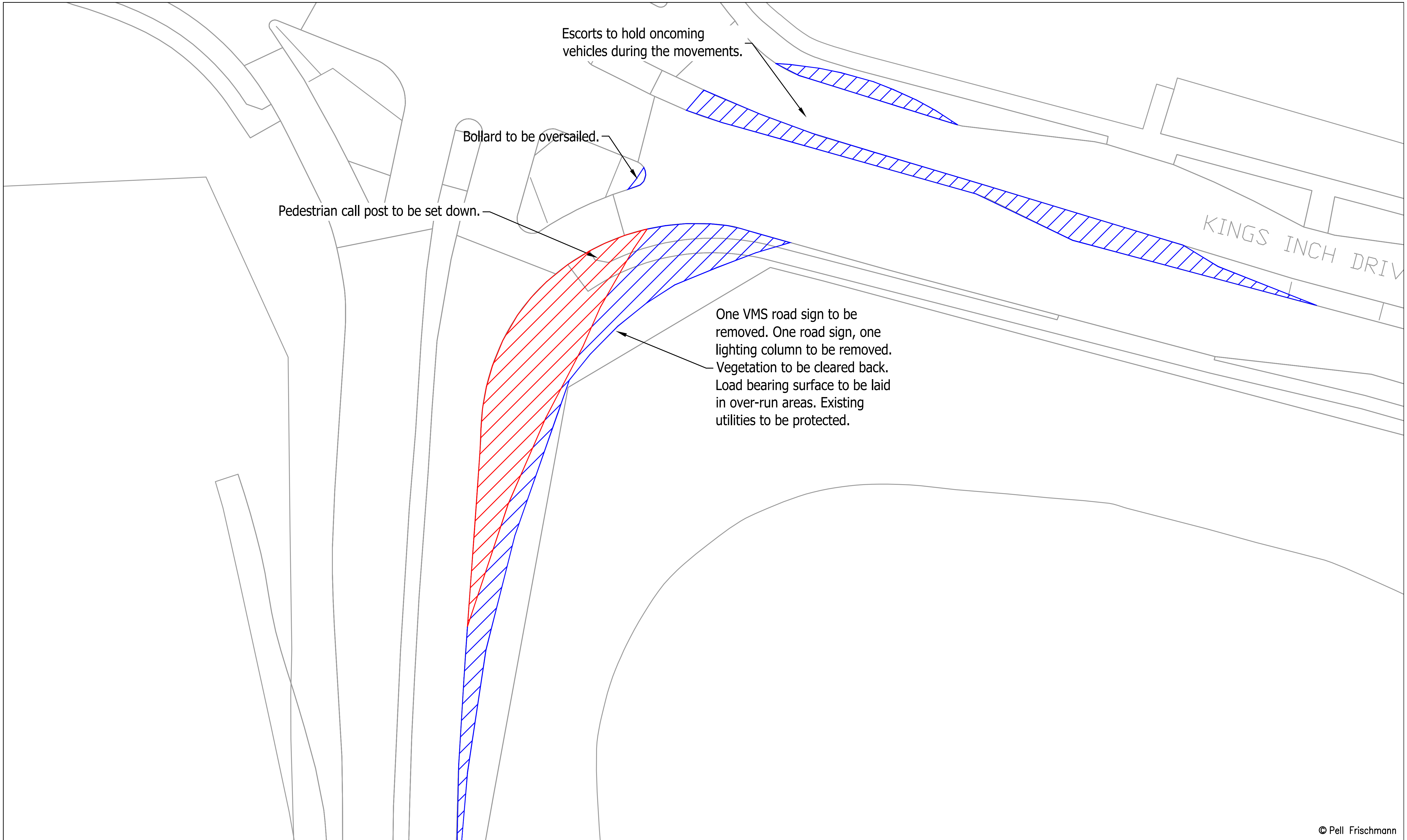
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK04

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: XXX



Pell Frischmann

93 GEORGE STREET, EDINBURGH, EH2 3ES

Tel: +44 (0)131 240 1270

Email: pfedinburgh@pellfrischmann.com

www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: Kings Inch Drive / Mayo Avenue Junction

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		4

Scale: 1:500 @ A3

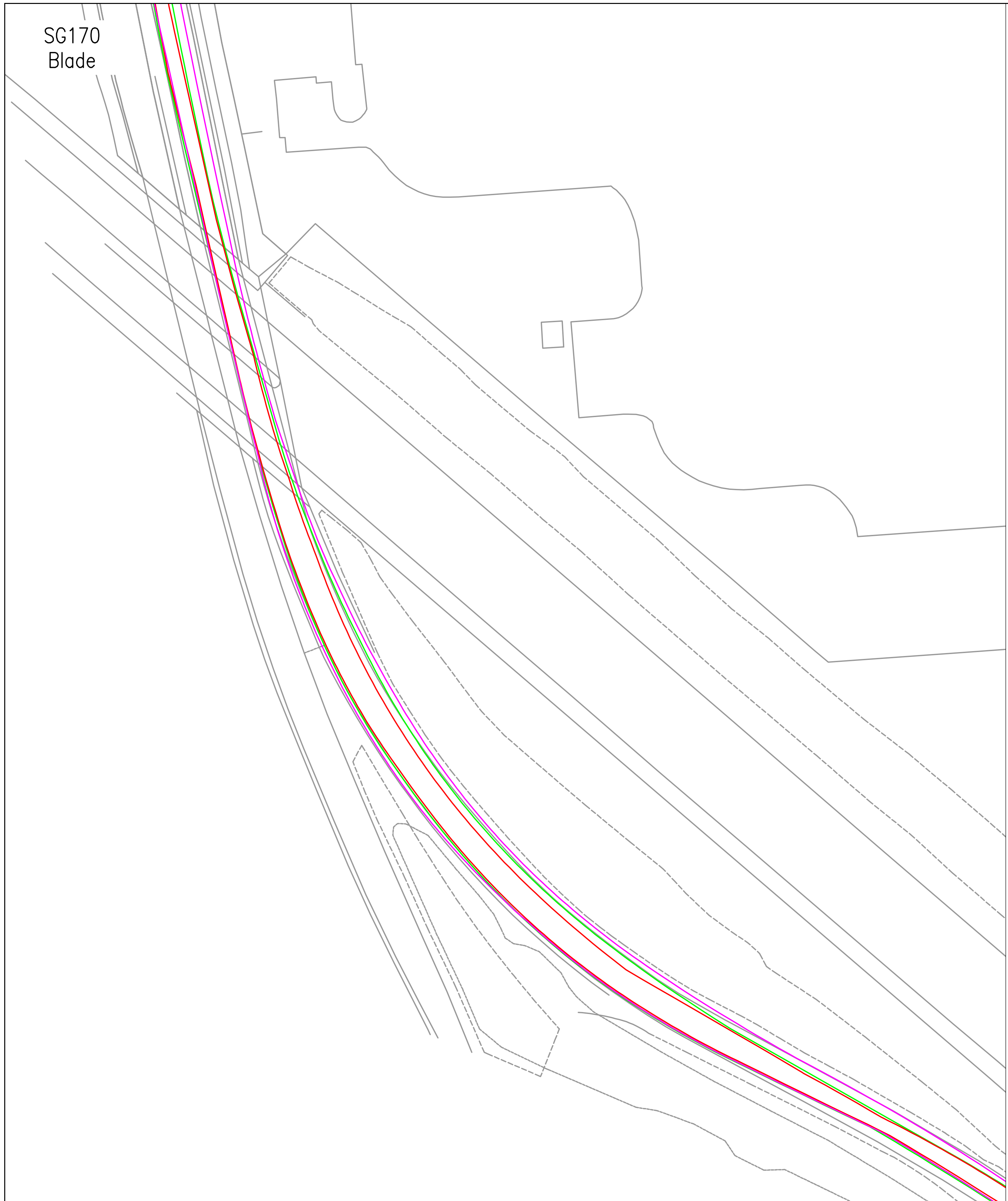
File No.: Quantans SPA (FINAL).dwg

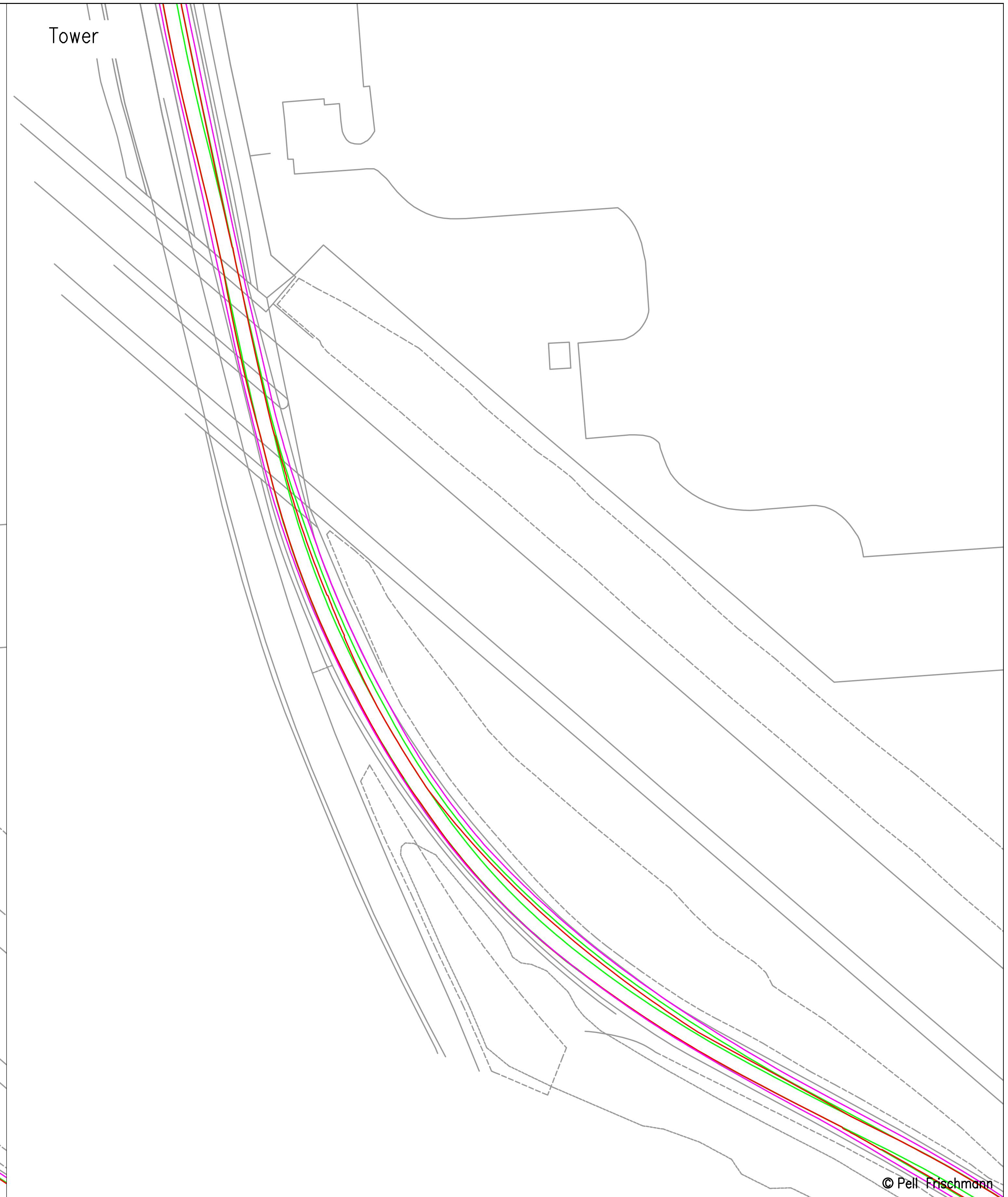
Drawing Status: Draft

Drawing No.: SK04A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: XXX





Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Project: Quantans Wind Farm

Client: Vattenfall

Drawing Title: SG170 Blade and Towers

SPA Location: M8 Junction 25a Slip Road

Key: Wheel SPA, Body SPA, Load SPA, Indicative, Over–run, Over–sail

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest	5	

Scale: 1:1000 @ A3

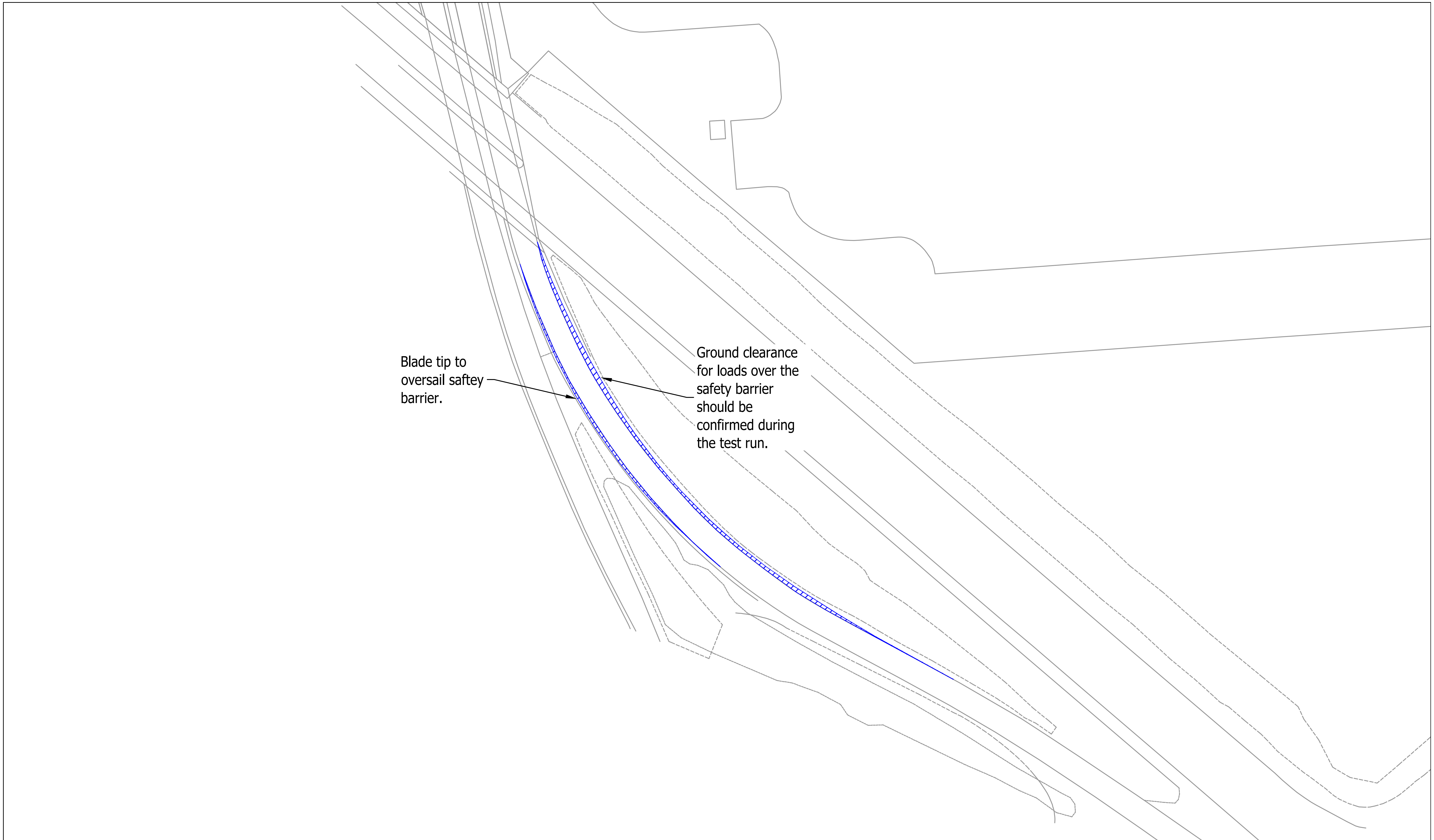
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK05

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: XXX



Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA · Body SPA · Load SPA · Indicative · Over–run · Over–sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: M8 Junction 25a Slip Road

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		5

Scale: 1:1000 @ A3

File No. Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No. SK05A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: XXX

Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Project	Quantans Wind Farm
Client	Vattenfall
Drawing Title	SG170 Blade and Towers
SPA Location	M73 / M74 Bend

NO MITIGATION REQUIRED

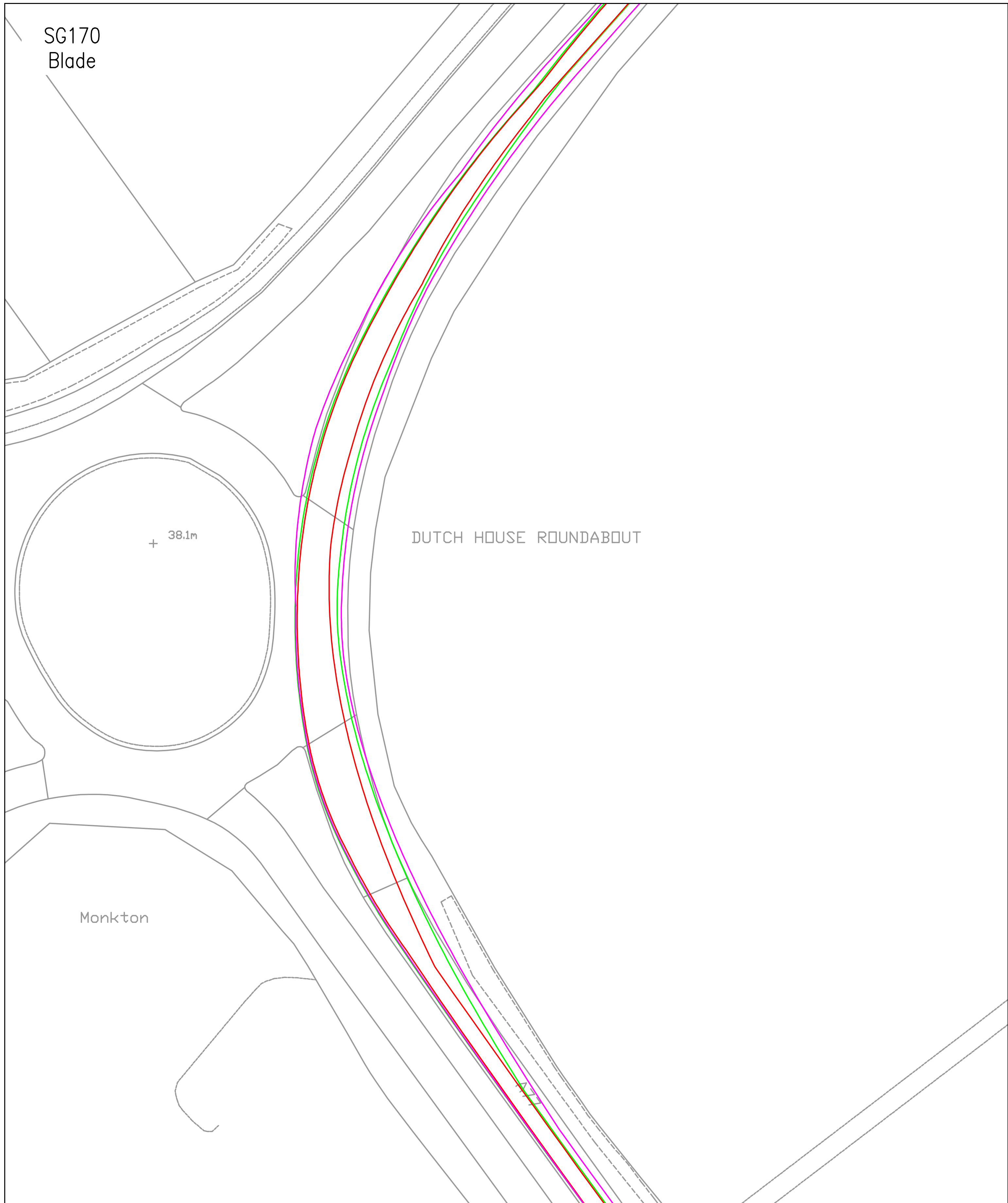
Key: Wheel SPA (red), Body SPA (green), Load SPA (magenta), Indicative (cyan), Over-run (red hatch), Over-sail (blue hatch)

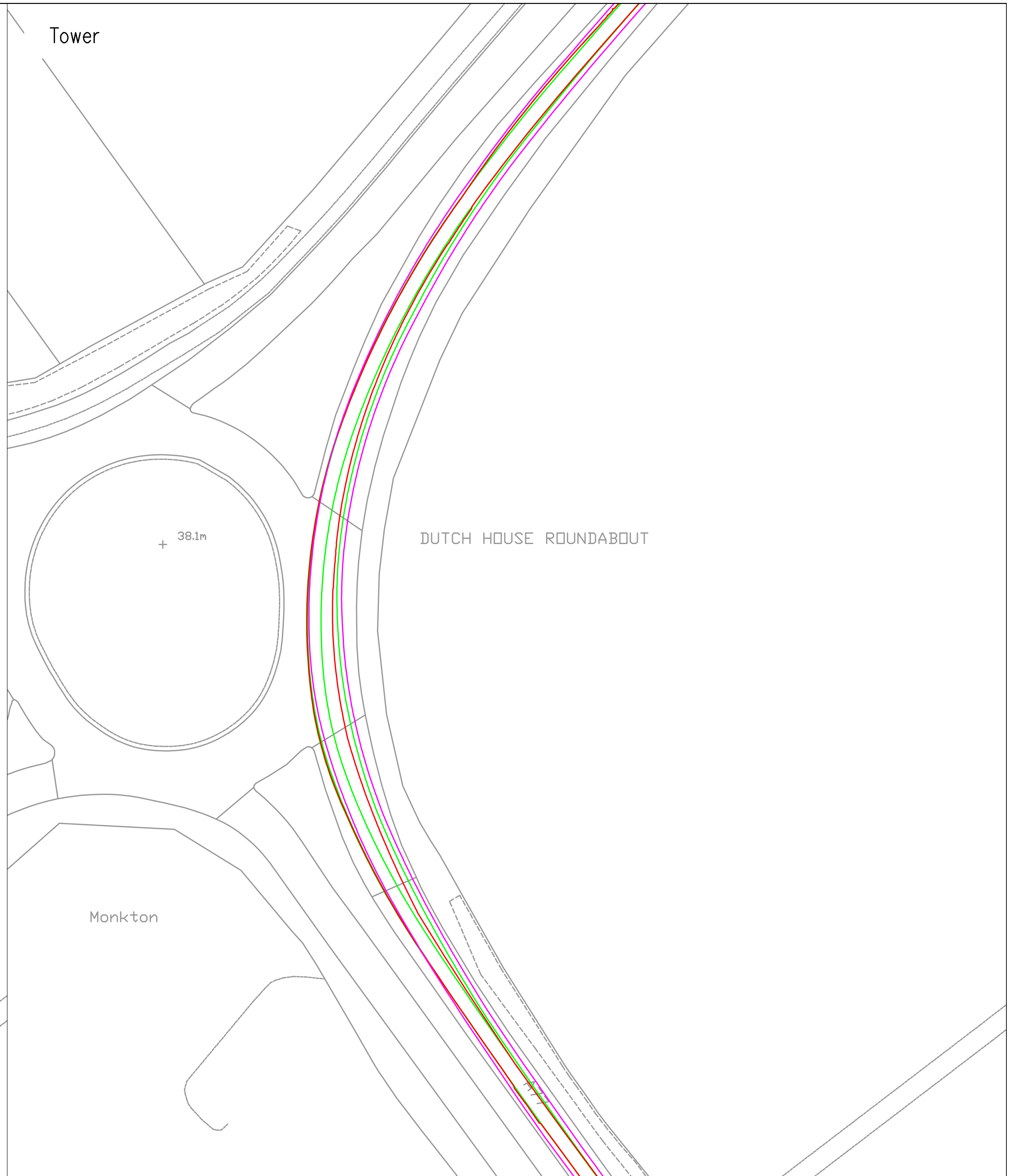
	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		7

Scale: 1:1000 @ A3
File No.: Quantans SPA (FINAL).dwg
Drawing Status: Draft
Drawing No.: SK06
Revision: XXX

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Pell Frischmann 93 GEORGE STREET, EDINBURGH, EH2 3ES Tel: +44 (0)131 240 1270 Email: pfedinburgh@pellfrischmann.com www.pellfrischmann.com	Project: Quantans Wind Farm		Name	Date	Scale: 1:1000 @ A3
		Drawn	JS	24/11/21	File No. Quantans SPA (FINAL).dwg
		Designed	GB	24/11/21	
		Checked	GB	24/11/21	Drawing Status: Draft
Client: Vattenfall	Drawing Title: SG170 Blade and Towers — NO MITIGATION REQUIRED	Point of Interest	7		
Key: Wheel SPA, Body SPA, Load SPA, Indicative, Over-run, Over-sail	SPA Location: M73 / M74 Bend	Drawing No. SK06A	Notes: 1. All mitigation is subject to confirmation through a test run. 2. This is not a construction drawing and is intended for illustration purposes only.		Revision: XXX





Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA, Body SPA, Load SPA, Indicative, Over-run, Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: Dutch House Roundabout

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest	9	

Scale: 1:1000 @ A3

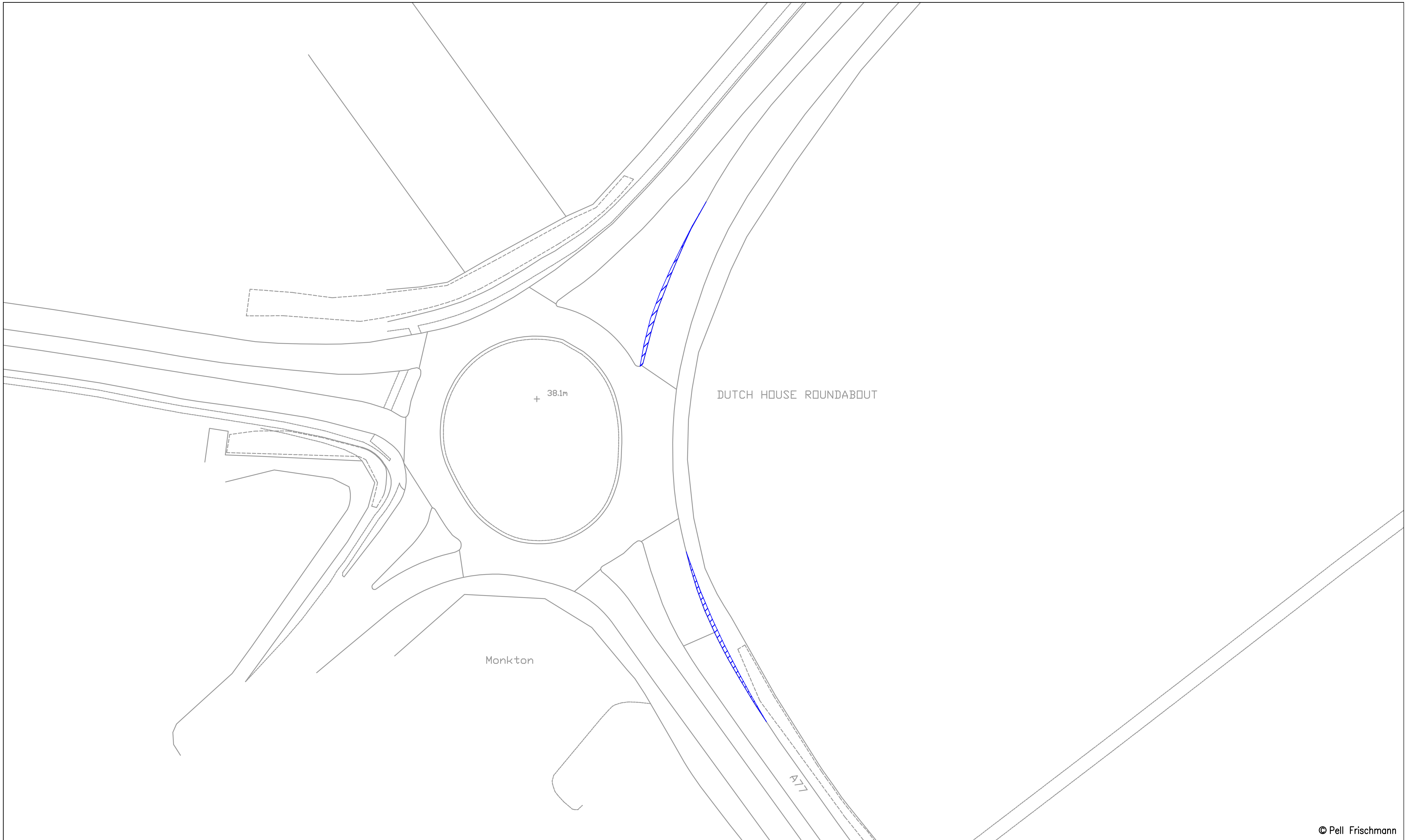
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK07

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: XXX



Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA, Body SPA, Load SPA, Indicative, Over–run, Over–sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: Dutch House Roundabout

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		9

Scale: 1:1000 @ A3

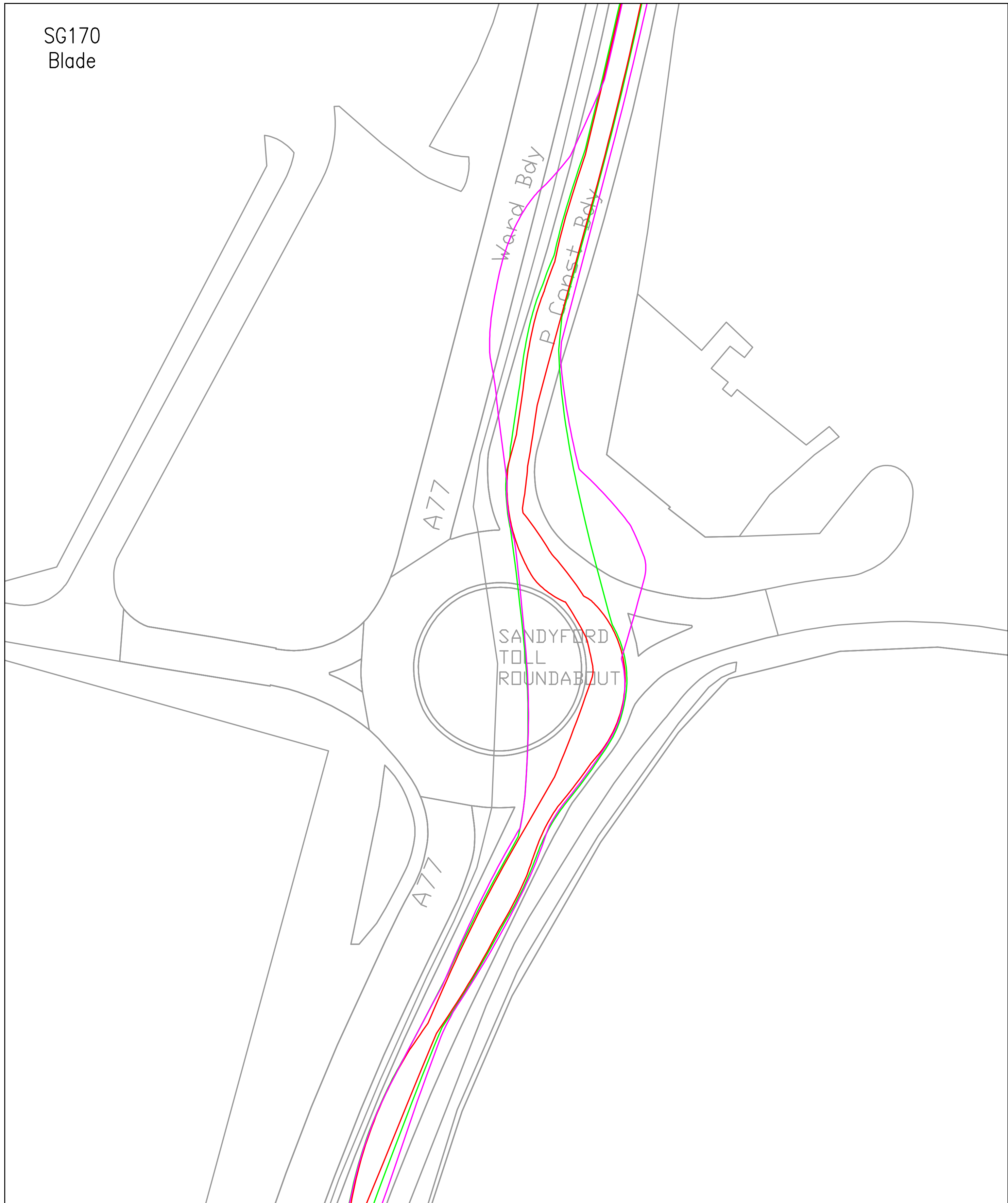
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK07A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: XXX



Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: Sandyford Toll Roundabout

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		10

Scale: 1:1000 @ A3

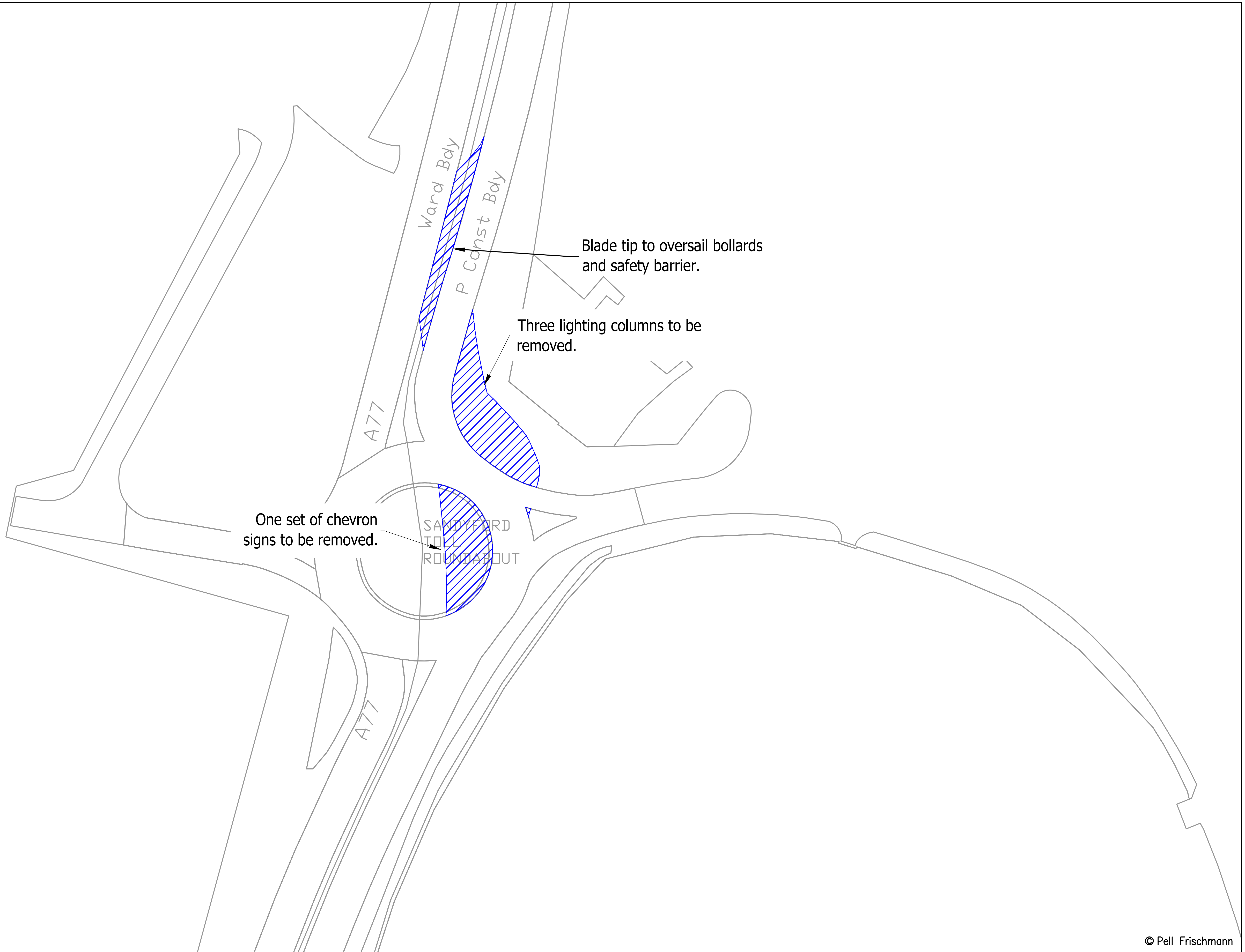
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK08

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: XXX

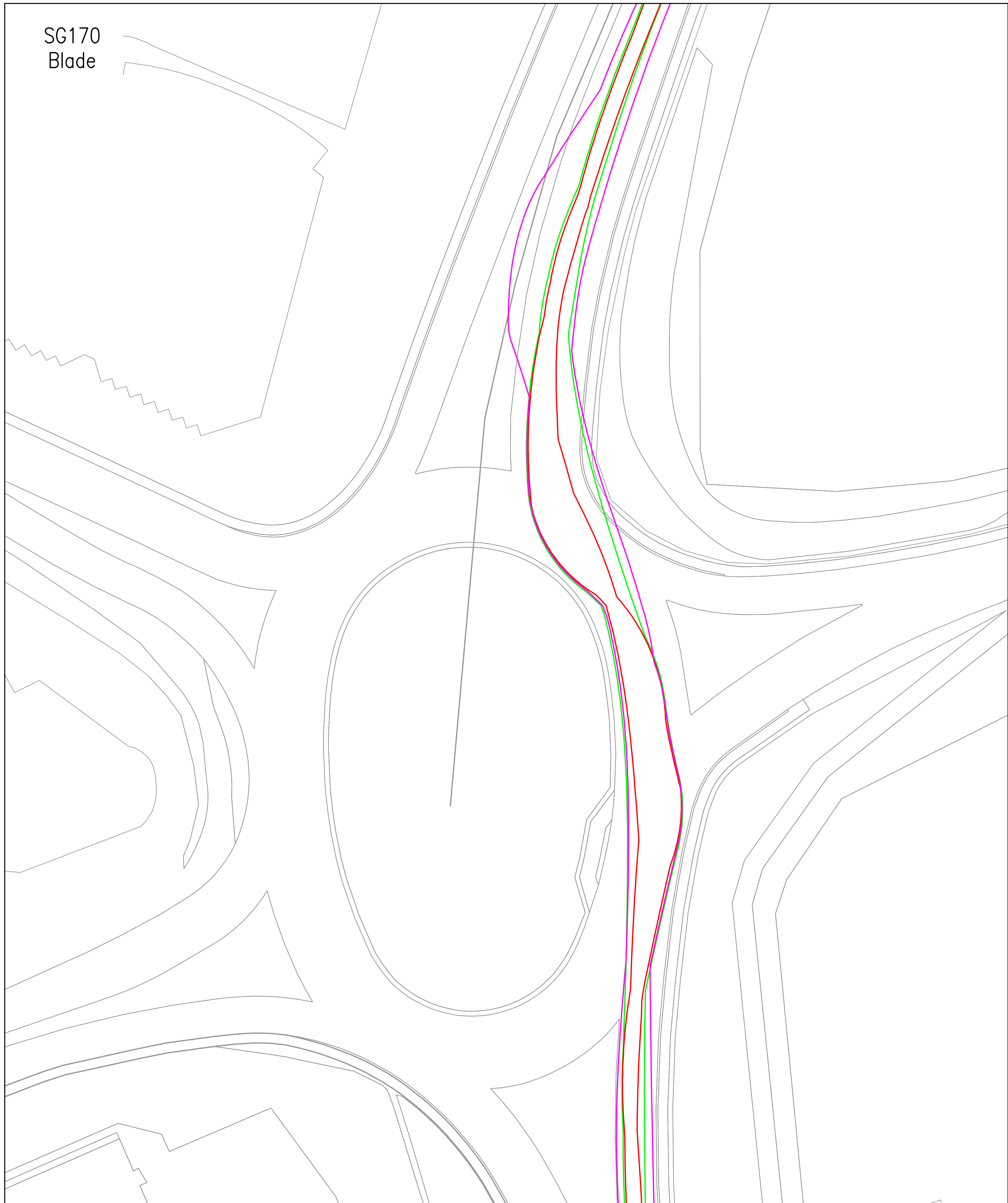


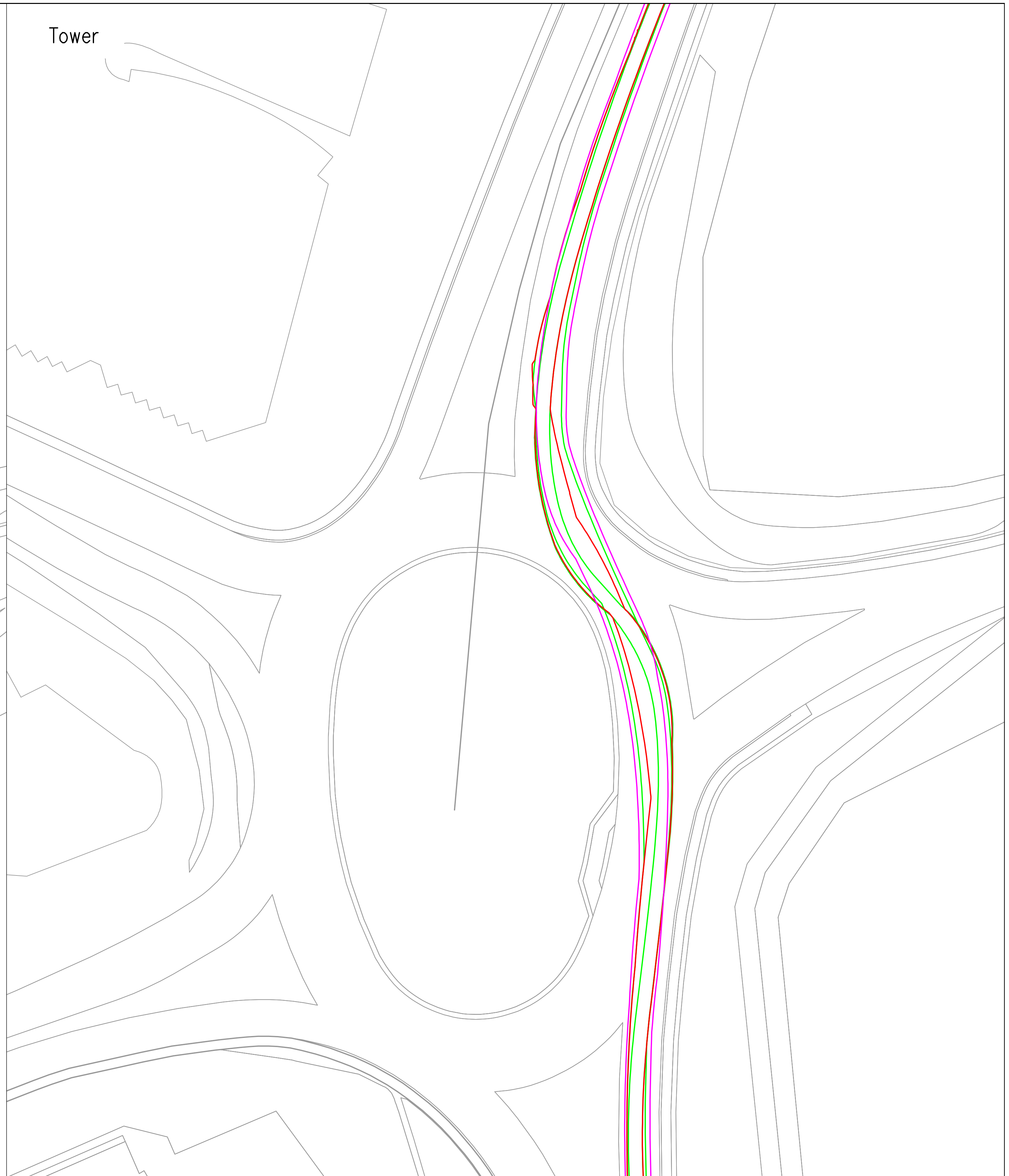
Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Project	Quantans Wind Farm		Name	Date	Scale: 1:1000 @ A3
		Drawn	JS	24/11/21	File No. Quantans SPA (FINAL).dwg
		Designed	GB	24/11/21	
		Checked	GB	24/11/21	Drawing Status: Draft
Client: Vattenfall	Drawing Title: SG170 Blade and Towers	Point of Interest		10	
	SPA Location: Sandyford Toll Roundabout	Drawing No. SK08A	Notes:		Revision: XXX

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Key: Wheel SPA, Body SPA, Load SPA, Indicative, Over-run, Over-sail





Pell Frischmann

93 GEORGE STREET, EDINBURGH, EH2 3ES

Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA, Body SPA, Load SPA, Indicative, Over–run, Over–sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: Whitletts Roundabout

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		11

Scale: 1:1000 @ A3

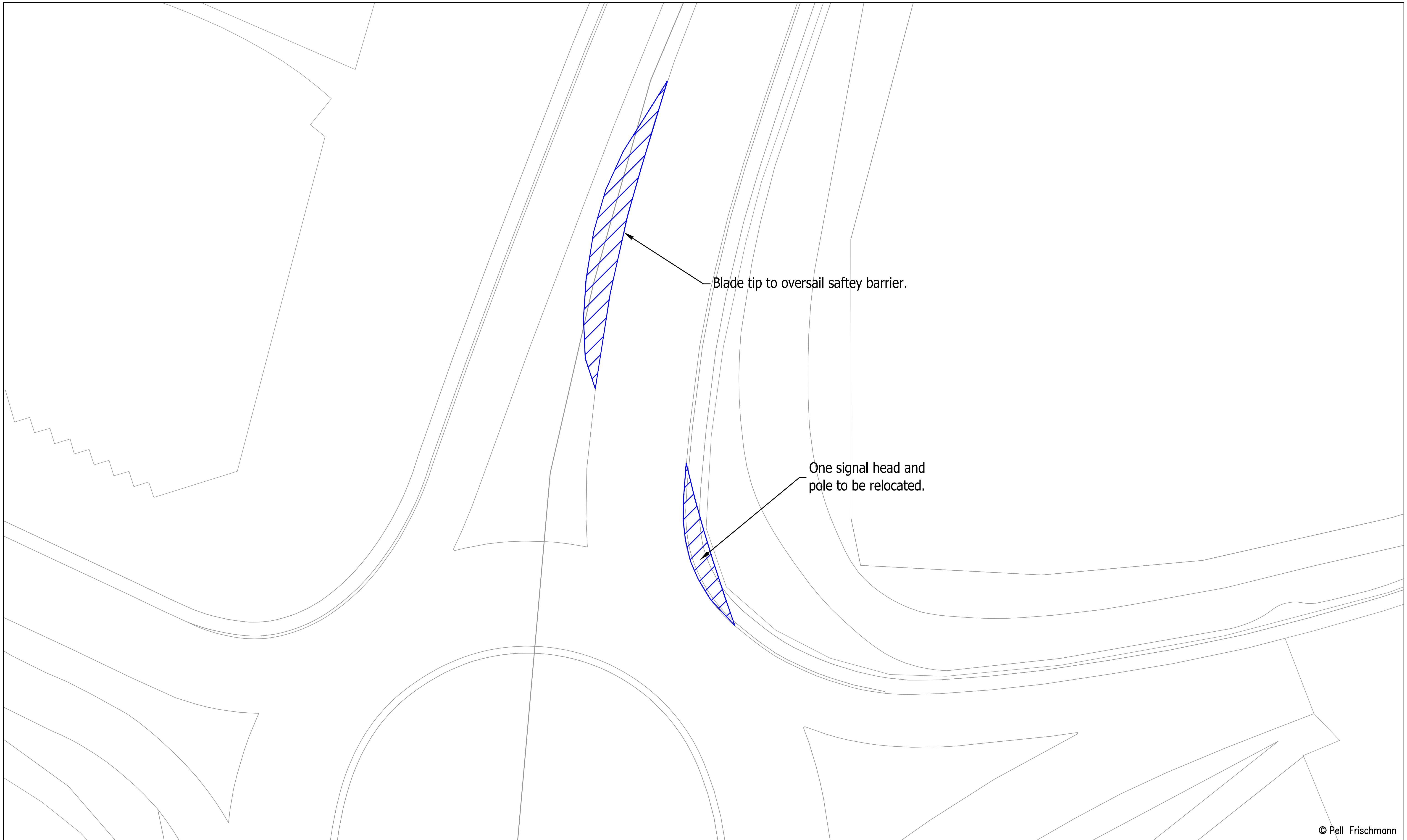
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK09

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: XXX



Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: Whitletts Roundabout

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		11

Scale: 1:500 @ A3

File No. Quantans SPA (FINAL).dwg

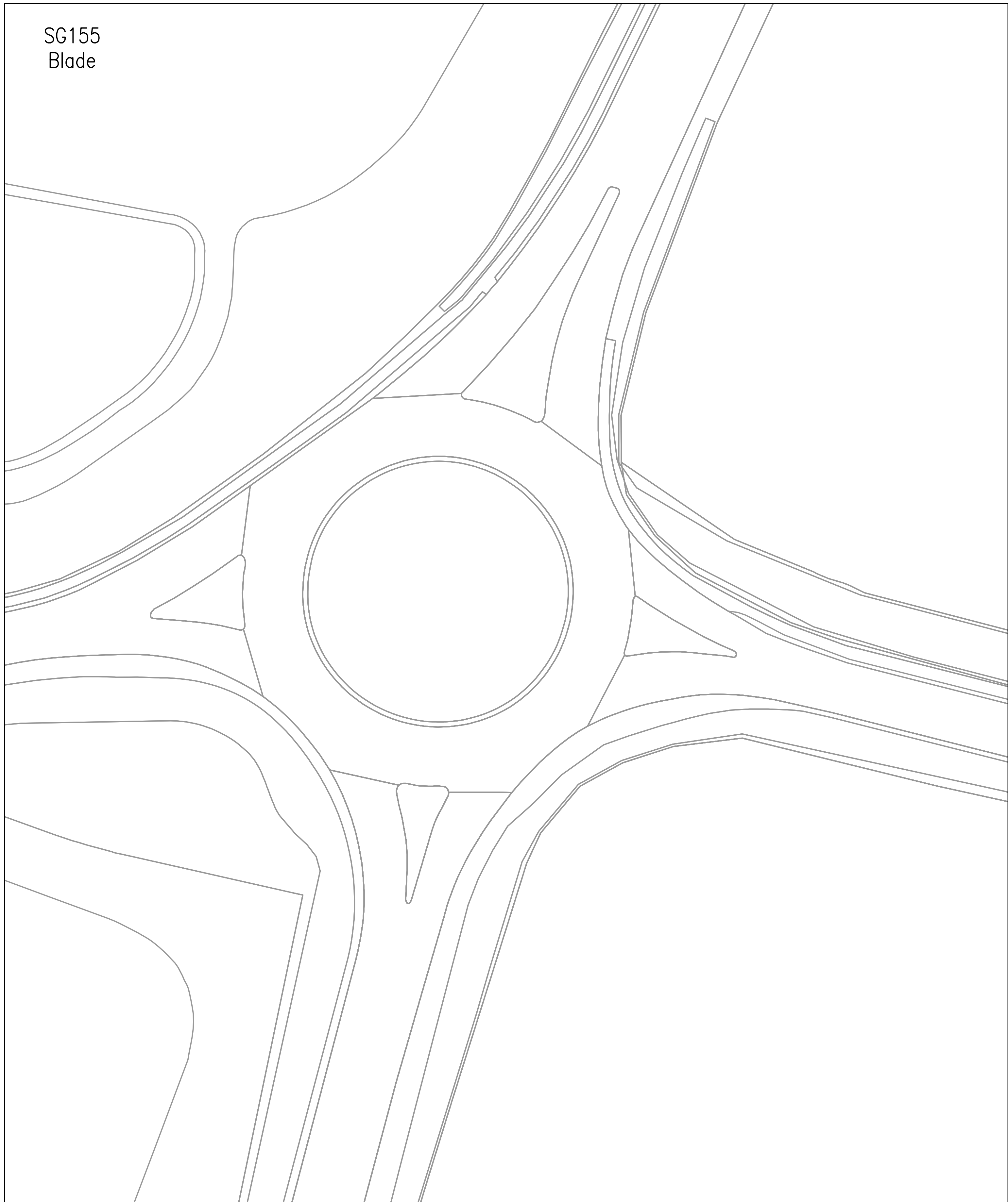
Drawing Status: Draft

Drawing No. SK09A

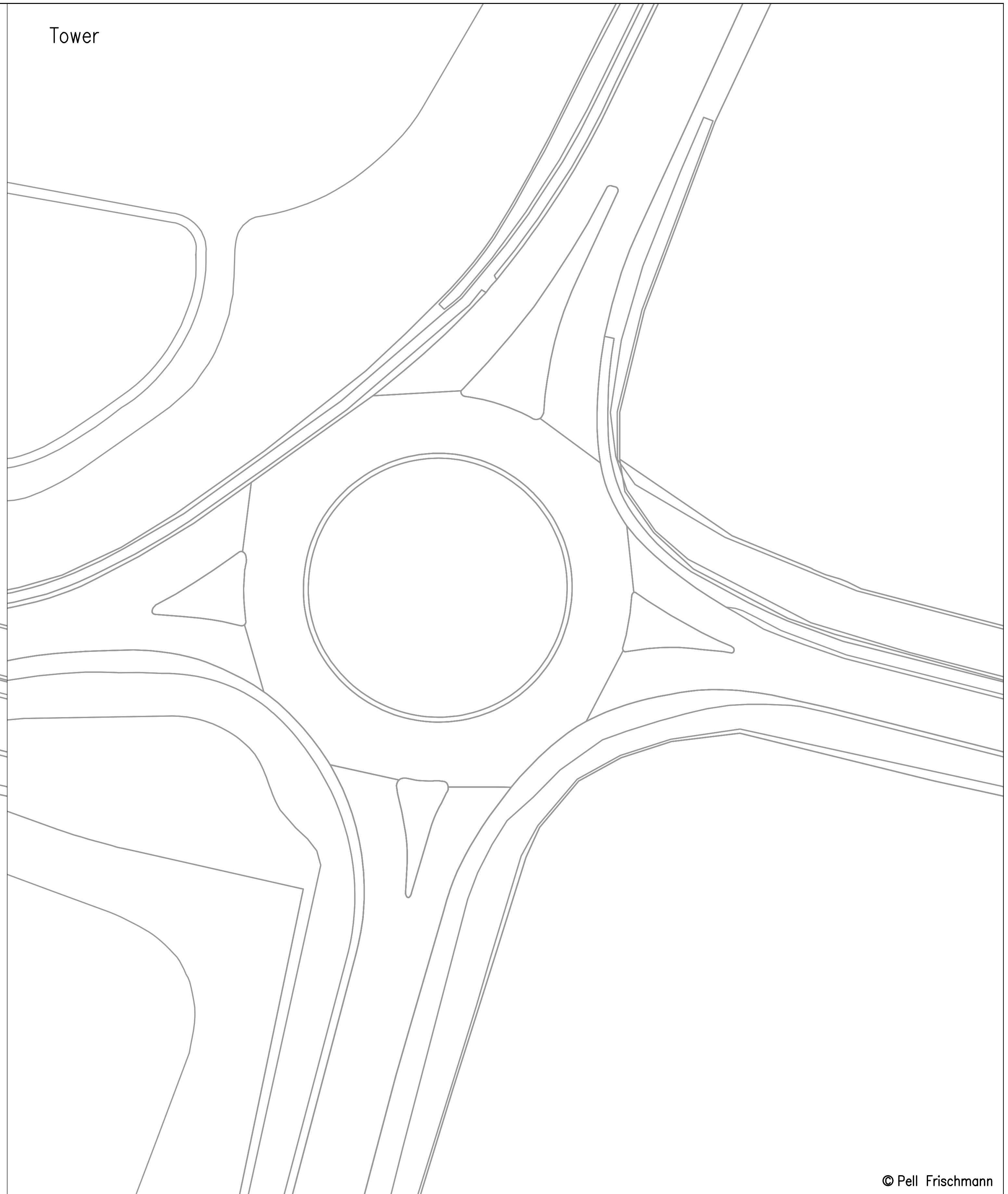
Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: XXX

SG155
Blade



Tower



Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A77 Holmeston Roundabout

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		16

Drawing No. SK13

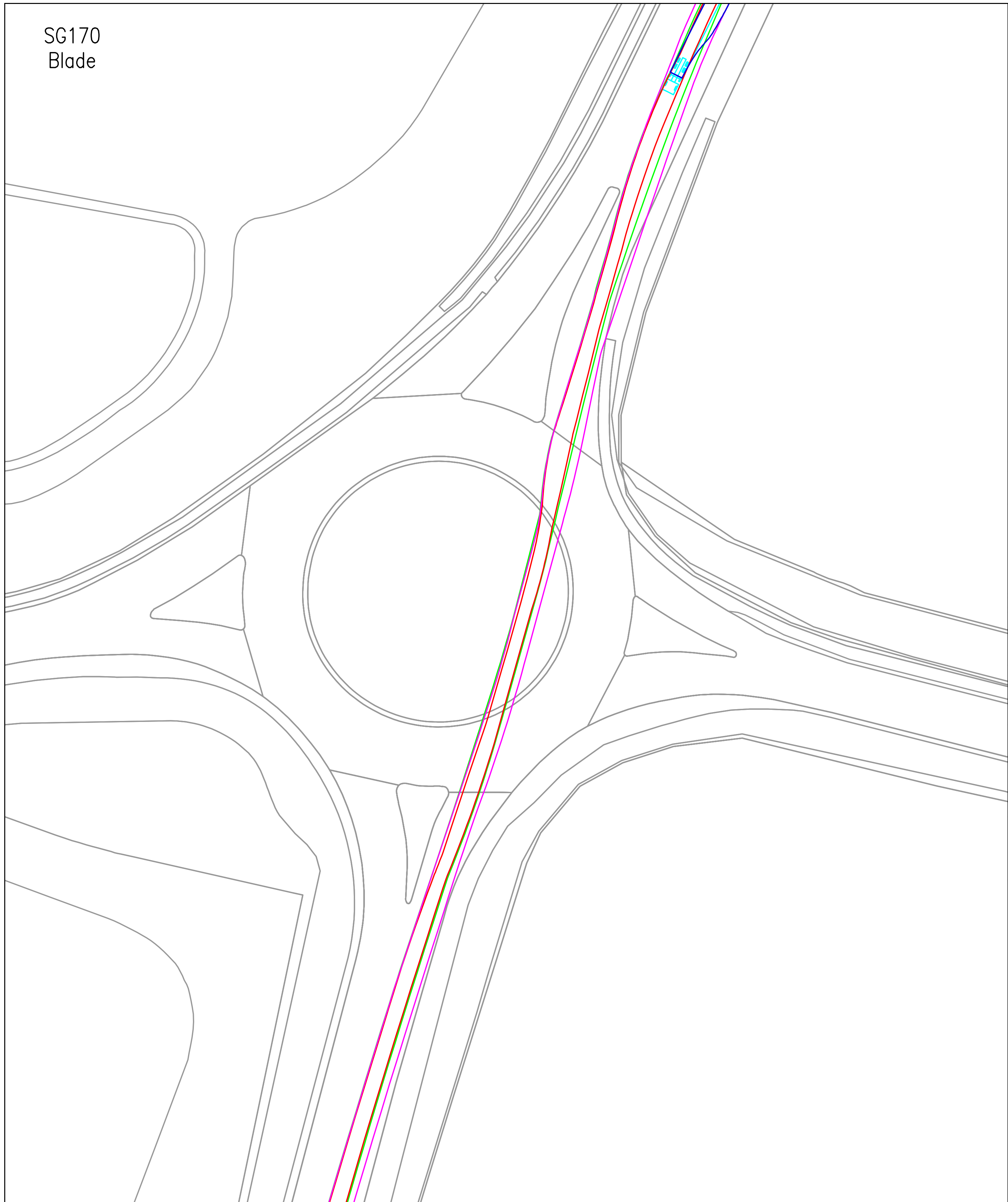
Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Scale: 1:1000 @ A3

File No. Quantans SPA (FINAL).dwg

Drawing Status: Draft

Revision: 1



Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA (red line) | Body SPA (green line) | Load SPA (magenta line) | Indicative (cyan line) | Over-run (red hatch) | Over-sail (blue hatch)

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A77 Holmeston Roundabout

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		16

Scale: 1:1000 @ A3

File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK13A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1

Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A77 Holmeston Roundabout

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		16

Scale: ##### @ A3

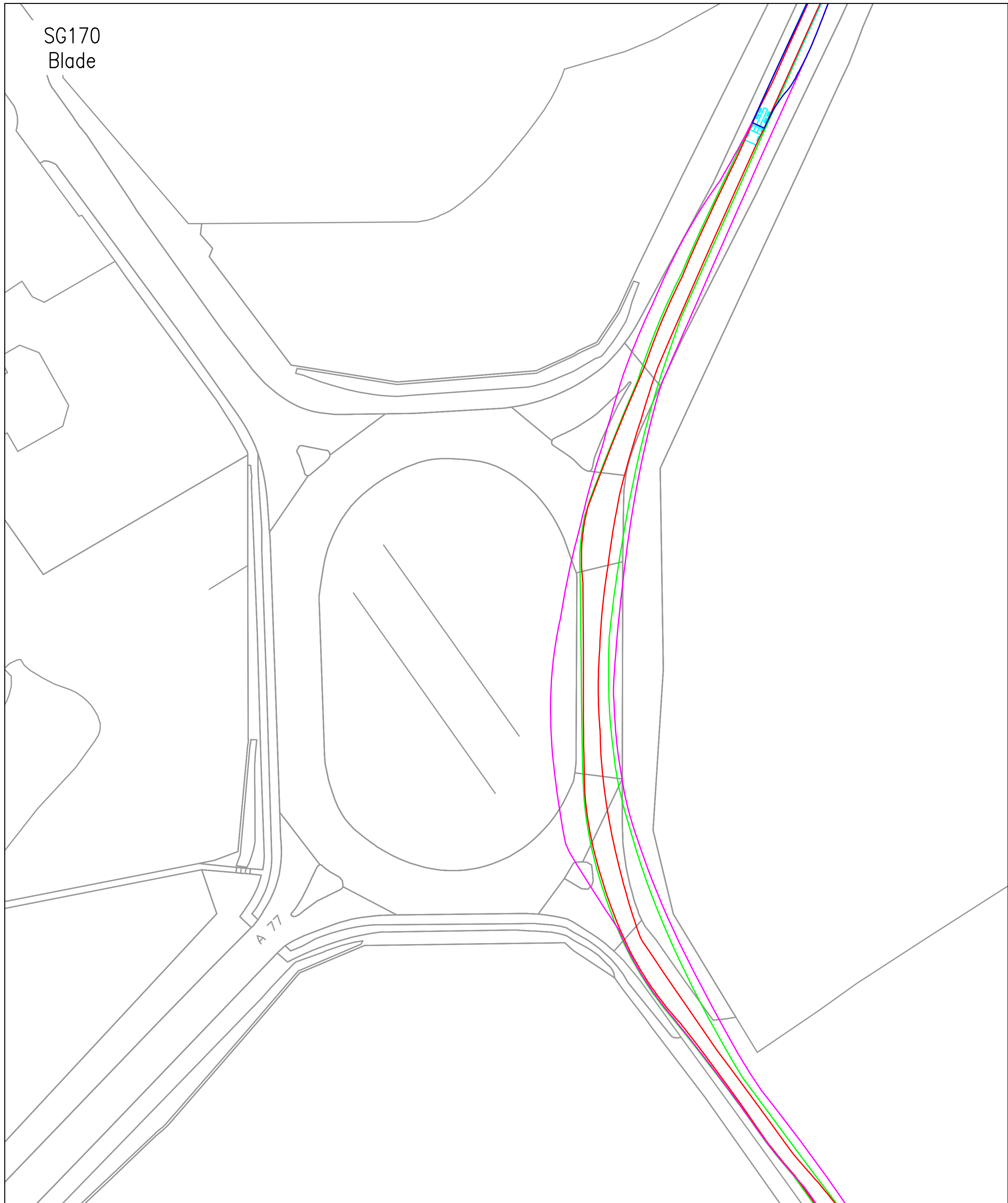
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK13B

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1



Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A77 Bankfield Roundabout

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		17

Scale: 1:1000 @ A3

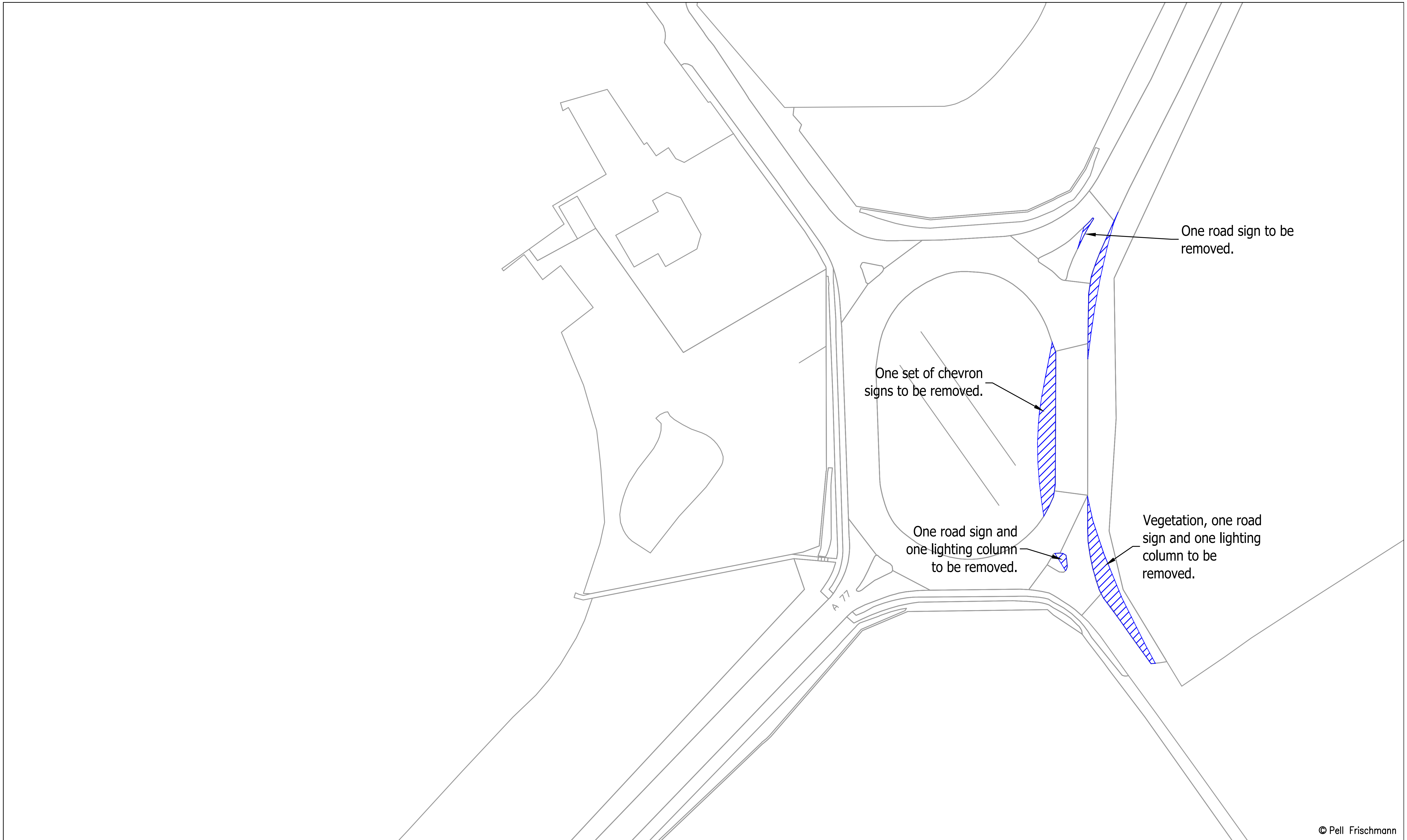
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK14A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1



Pell Frischmann

93 GEORGE STREET, EDINBURGH, EH2 3ES

Tel: +44 (0)131 240 1270

Email: pfedinburgh@pellfrischmann.com

www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA, Body SPA, Load SPA, Indicative, Over-run, Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A77 Bankfield Roundabout

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		17

Drawing No.: SK14B

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Scale: ###### @ A3

File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Revision: 1

Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA, Body SPA, Load SPA, Indicative, Over-run, Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Ailsa Hospital Junction

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		18

Scale: 1:1000 @ A3

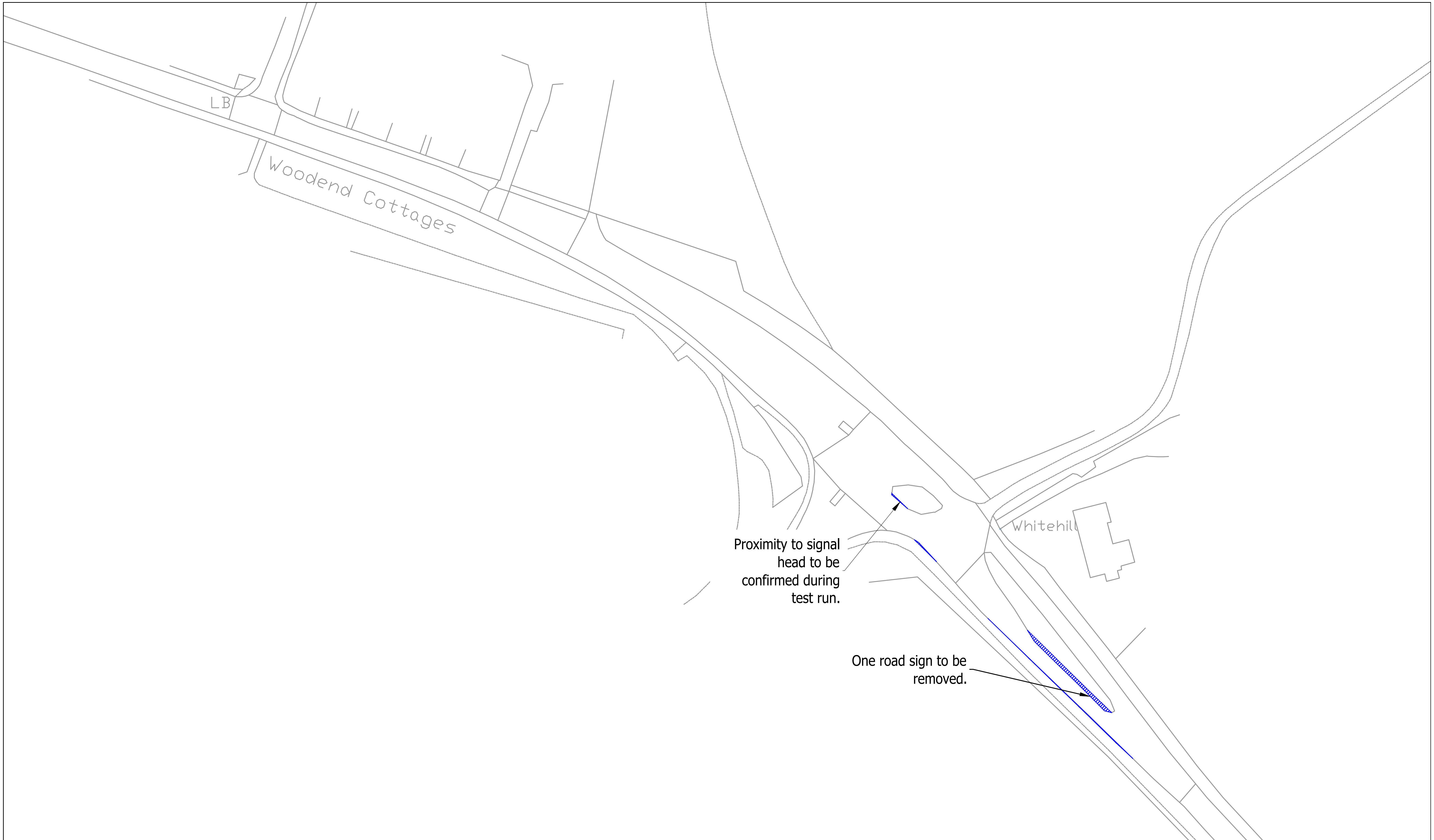
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK15A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1



Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

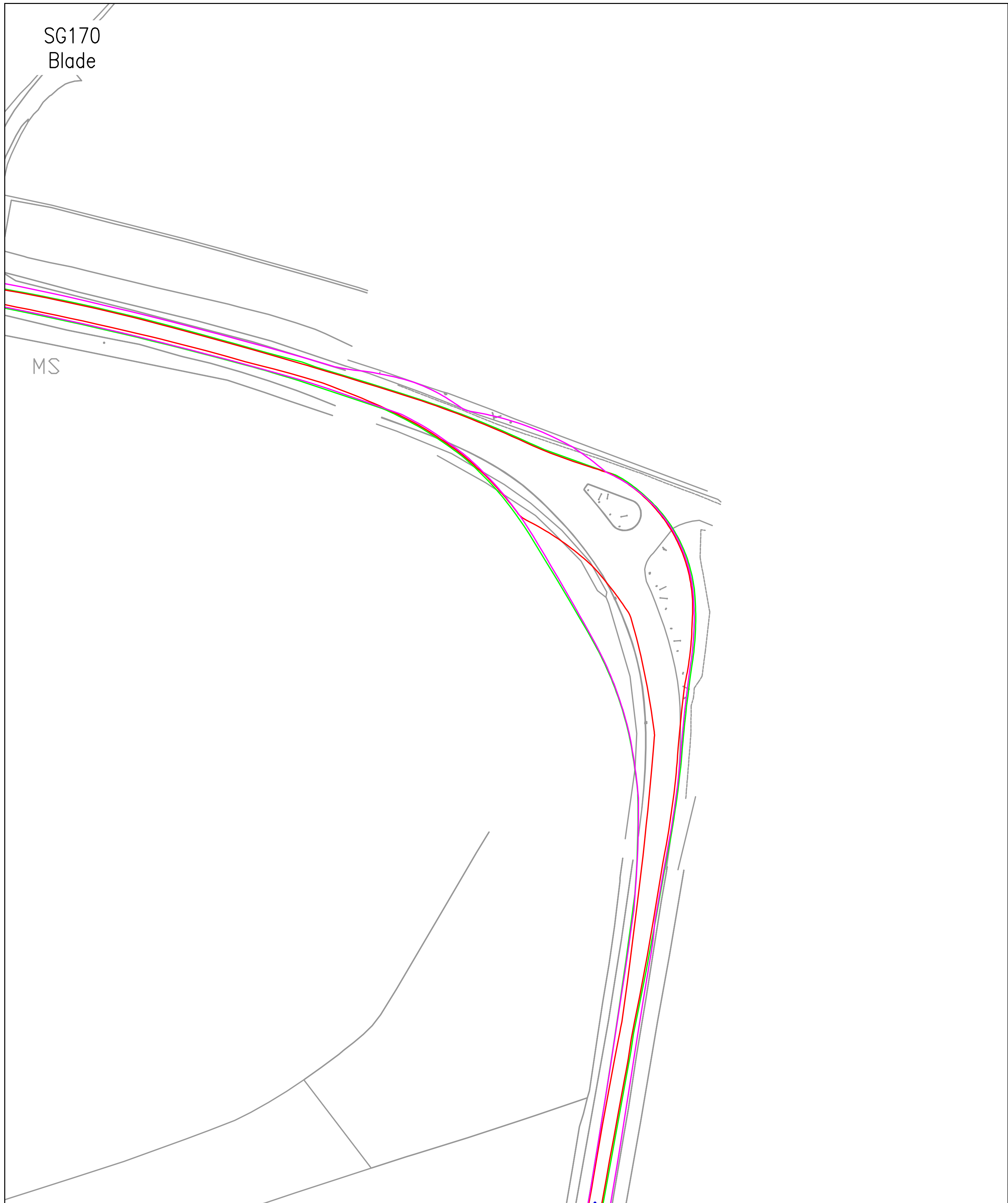
Client	Vattenfall
Project	Quantans Wind Farm
Drawing Title	SG170 Blade and Towers
SPA Location	A713 Ailsa Hospital Junction

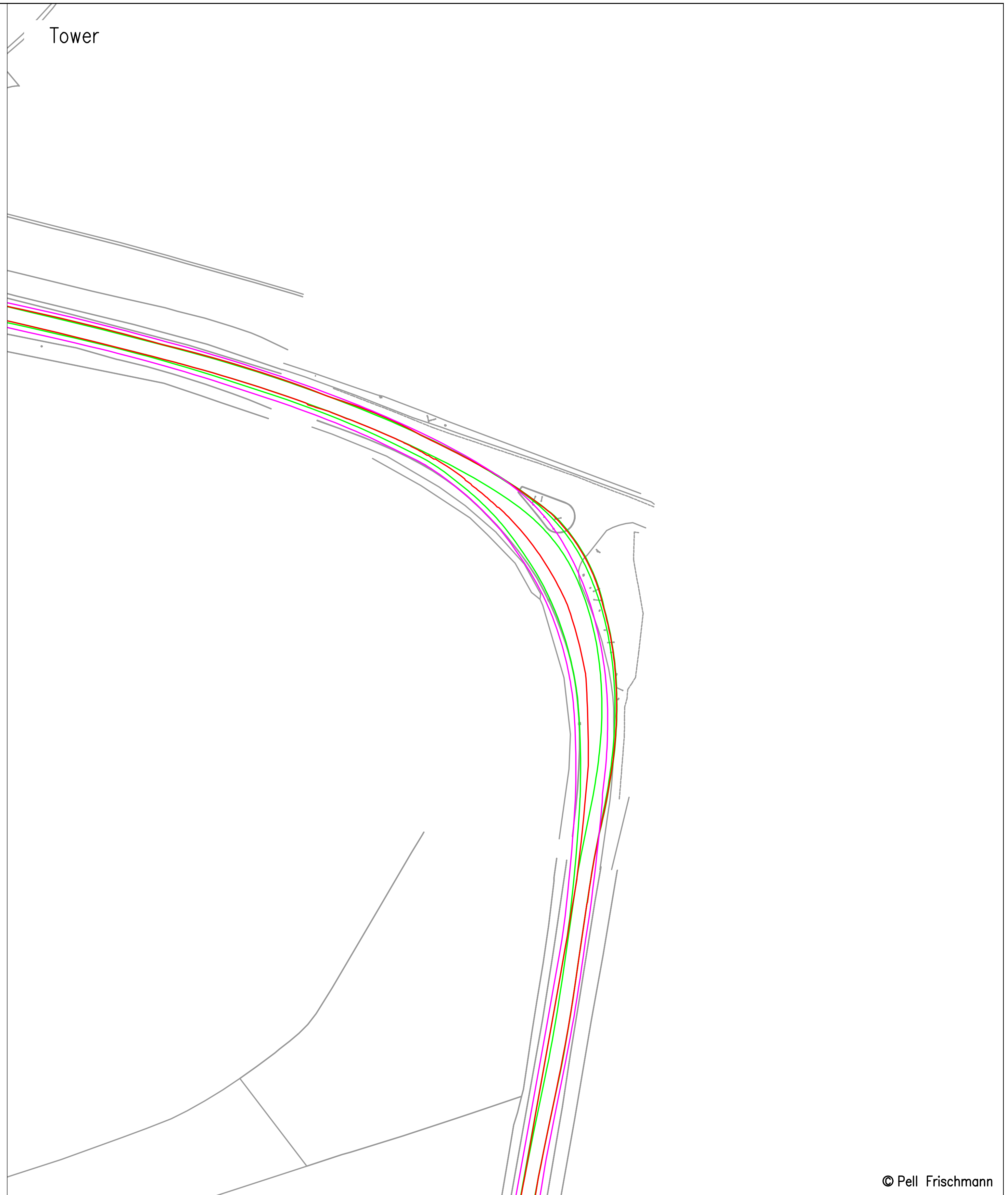
Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		18

Scale	##### @ A3
File No.	Quantans SPA (FINAL).dwg
Drawing Status	Draft
Drawing No.	SK15B
Revision	1

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.





Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over–run | Over–sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Craigs Road Bend

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		20

Scale: 1:1000 @ A3

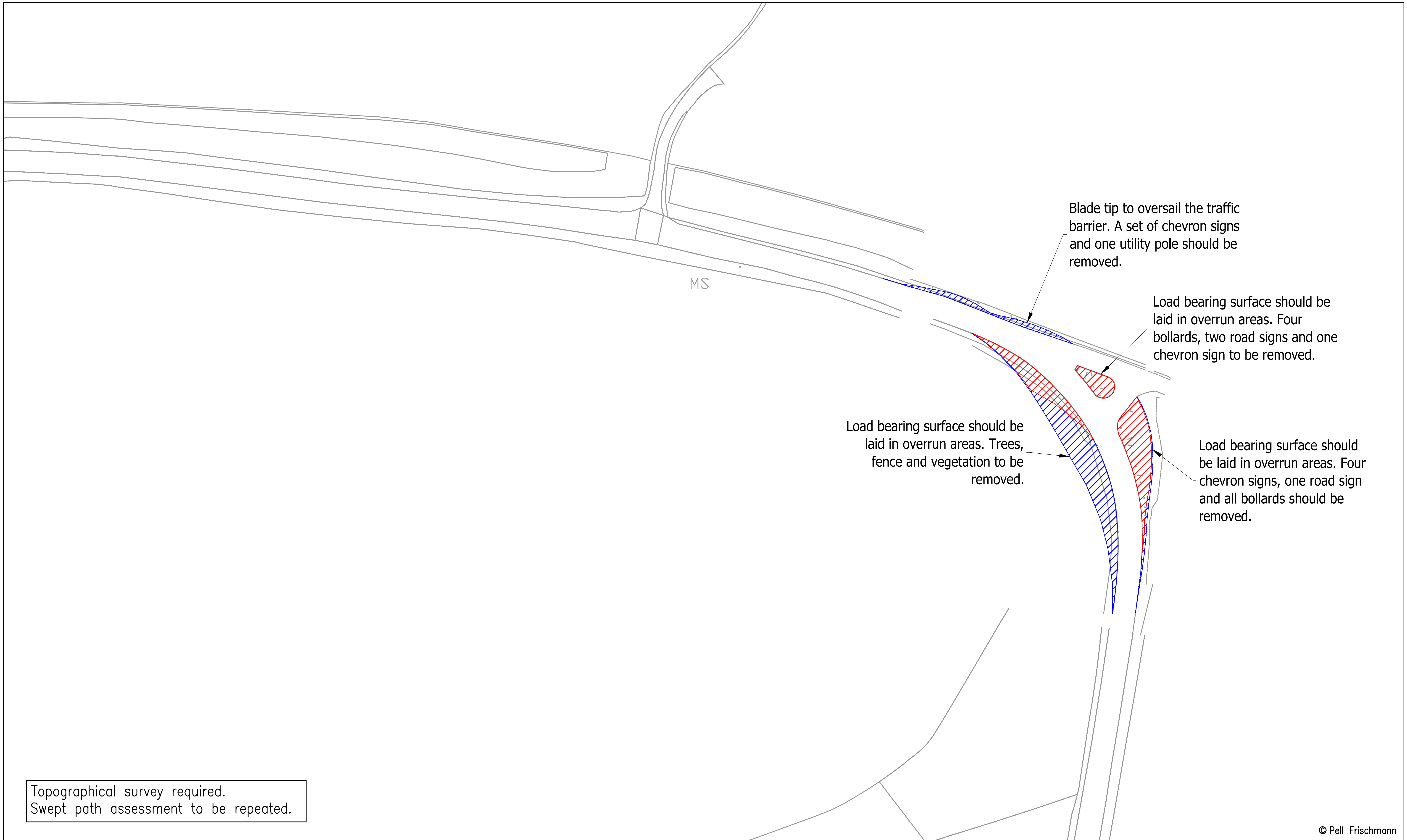
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK16A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1



Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA, Body SPA, Load SPA, Indicative, Over–run, Over–sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Craigs Road Bend

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		20

Scale: ###### @ A3

File No. Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No. SK16B

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1

Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA, Body SPA, Load SPA, Indicative, Over–run, Over–sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Right Bend North West of Holehouse Cottage

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		21

Scale: 1:1000 @ A3

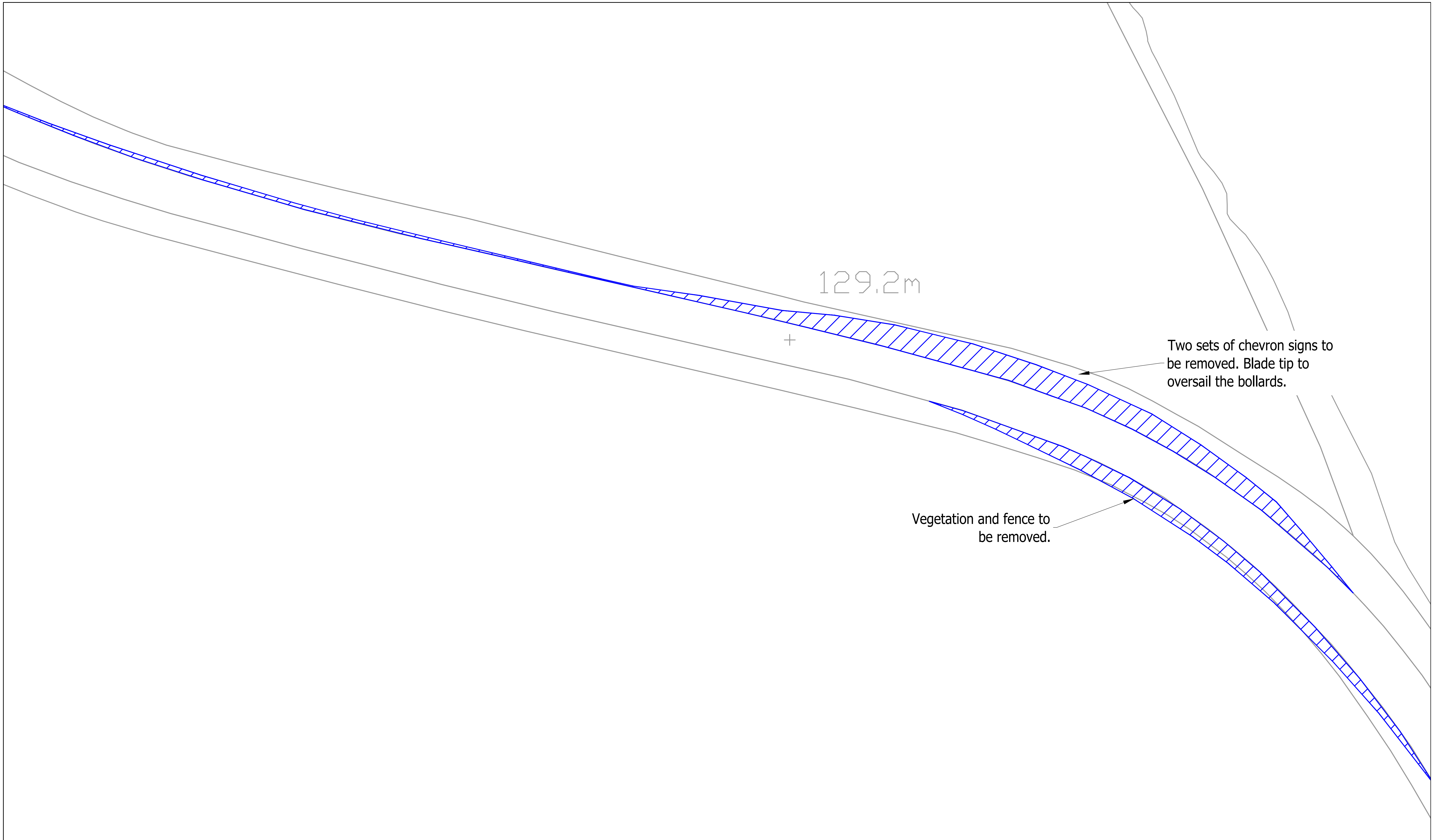
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK17A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1



Pell Frischmann
93 GEORGE STREET, EDINBURGH. EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Right Bend North West of Holehouse Cottage

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		21

Scale: ##### @ A3

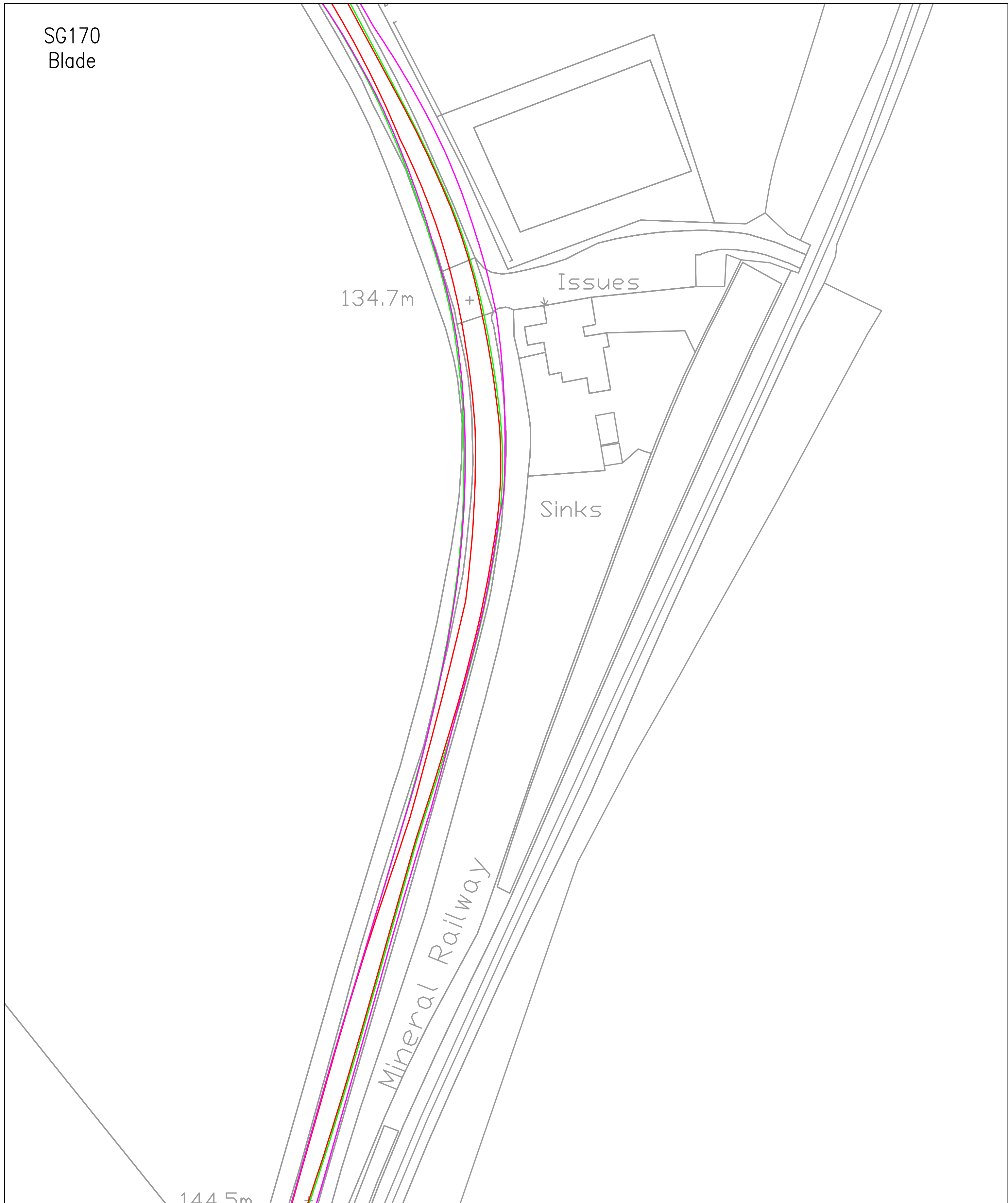
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK17B

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1



Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Right Bend at Holehouse Cottage

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		22

Scale: 1:1000 @ A3

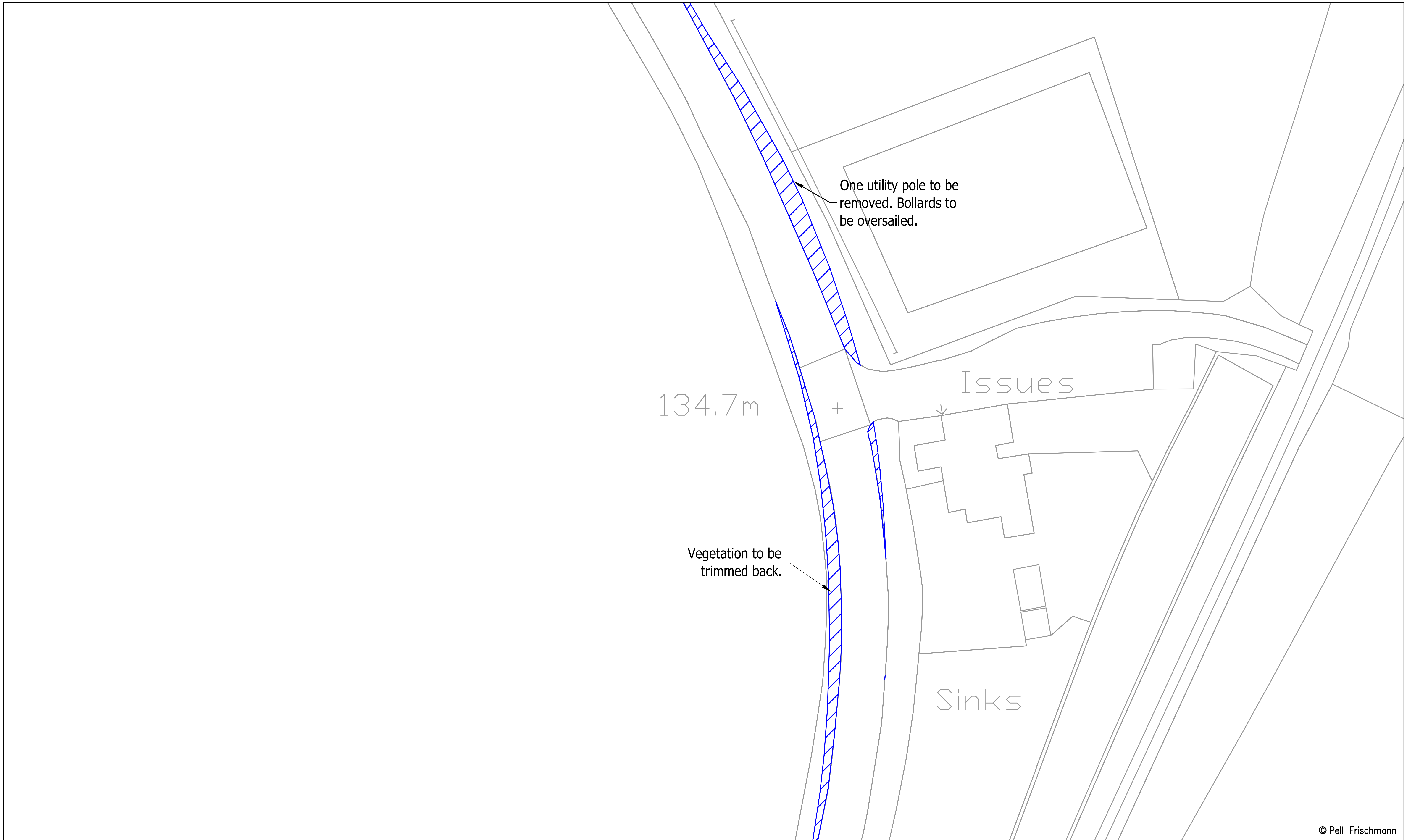
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK18A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1



Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Right Bend at Holehouse Cottage

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		22

Scale	##### @ A3
File No.	Quantans SPA (FINAL).dwg
Drawing Status	Draft
Drawing No.	SK18B
Revision	1

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA, Body SPA, Load SPA, Indicative, Over-run, Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Holehouse Junction

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		23

Scale: 1:1000 @ A3

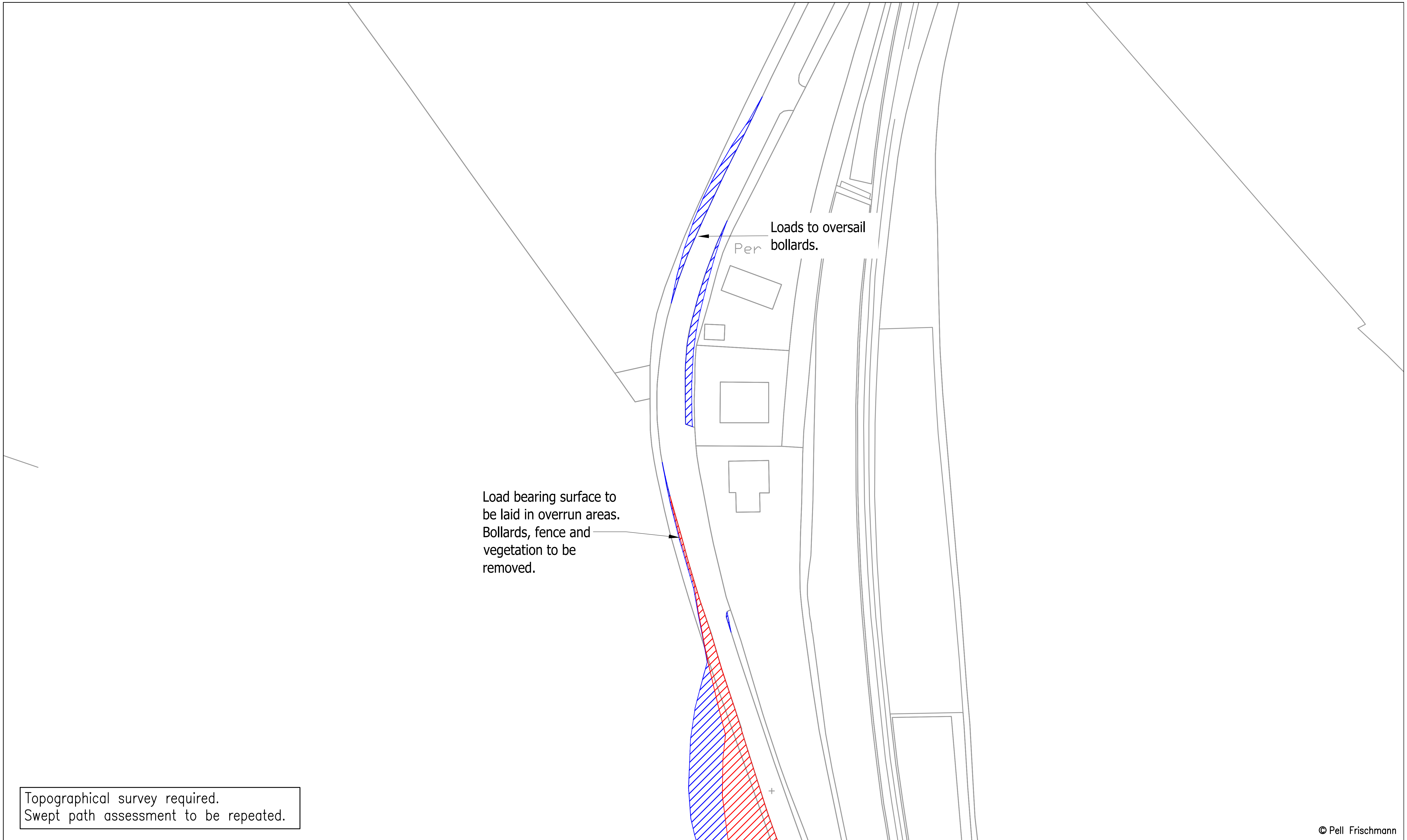
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK19A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1



Topographical survey required.
Swept path assessment to be repeated.

Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Project: Quantans Wind Farm

Client: Vattenfall

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Holehouse Junction

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		23

Scale: ##### @ A3

File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK19B

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1

Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Holehouse Railway Bridge

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		24,25

Scale: 1:1000 @ A3

File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK20B

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1

Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Holehouse Railway Bridge

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		24,25

Scale: 1:1000 @ A3

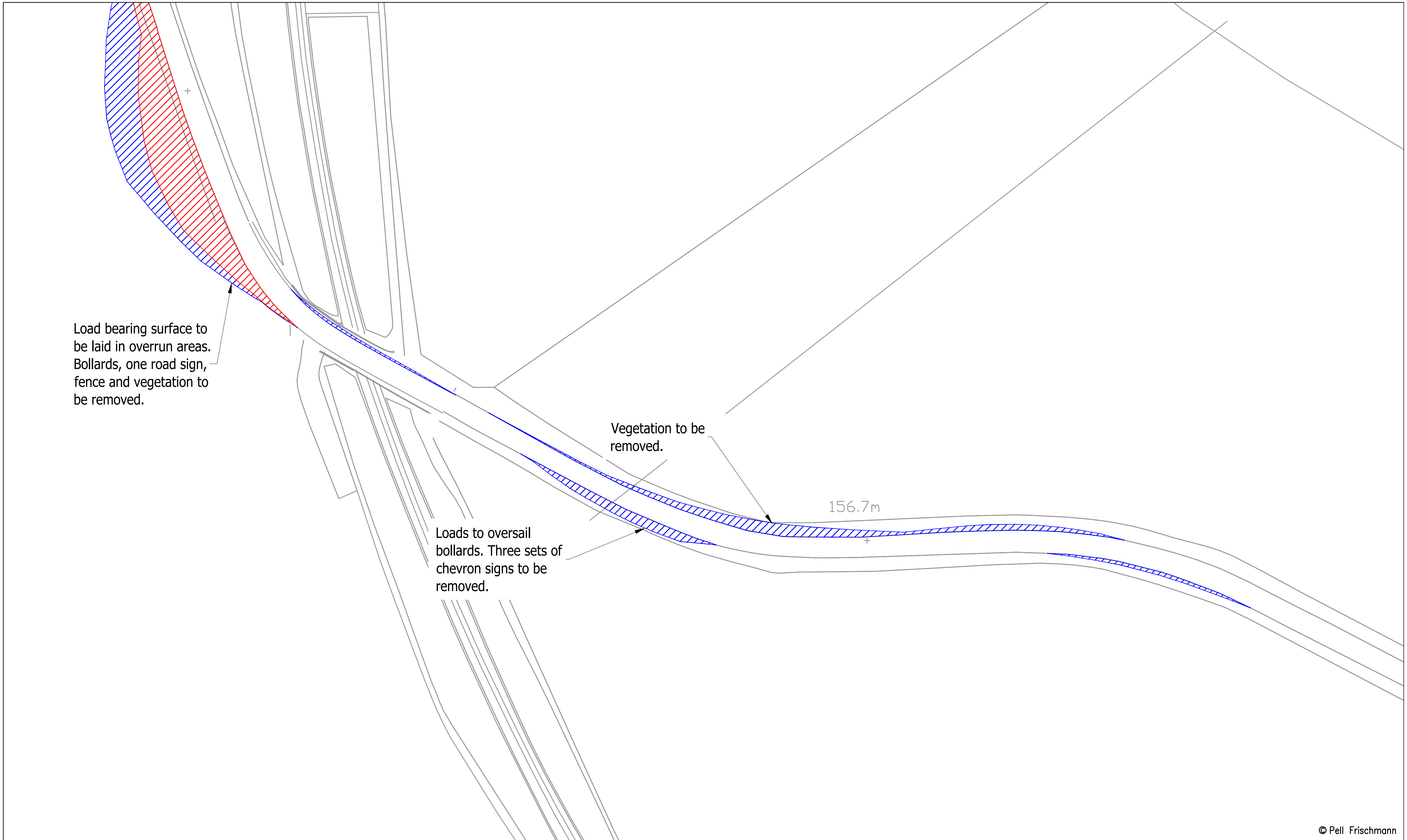
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK20C

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1



Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA, Body SPA, Load SPA, Indicative, Over-run, Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Holehouse Railway Bridge

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		24,25

Scale: 1:1000 @ A3

File No. Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No. SK20E

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1

Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA · Body SPA · Load SPA · Indicative · Over-run · Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Bends near Smithston

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		26

Scale: 1:1000 @ A3

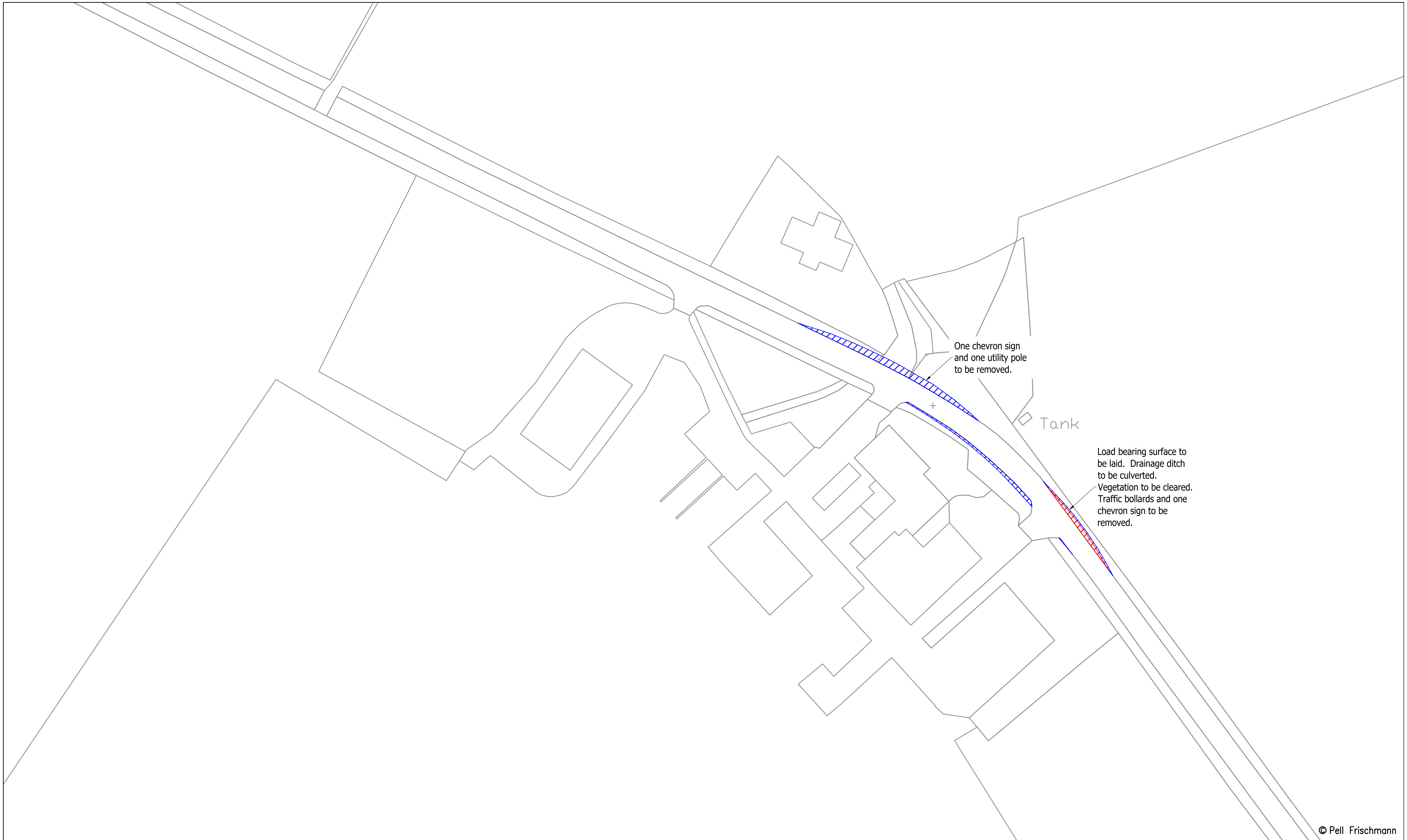
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK21A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1



Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Bends near Smithston

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		26

Scale: ##### @ A3

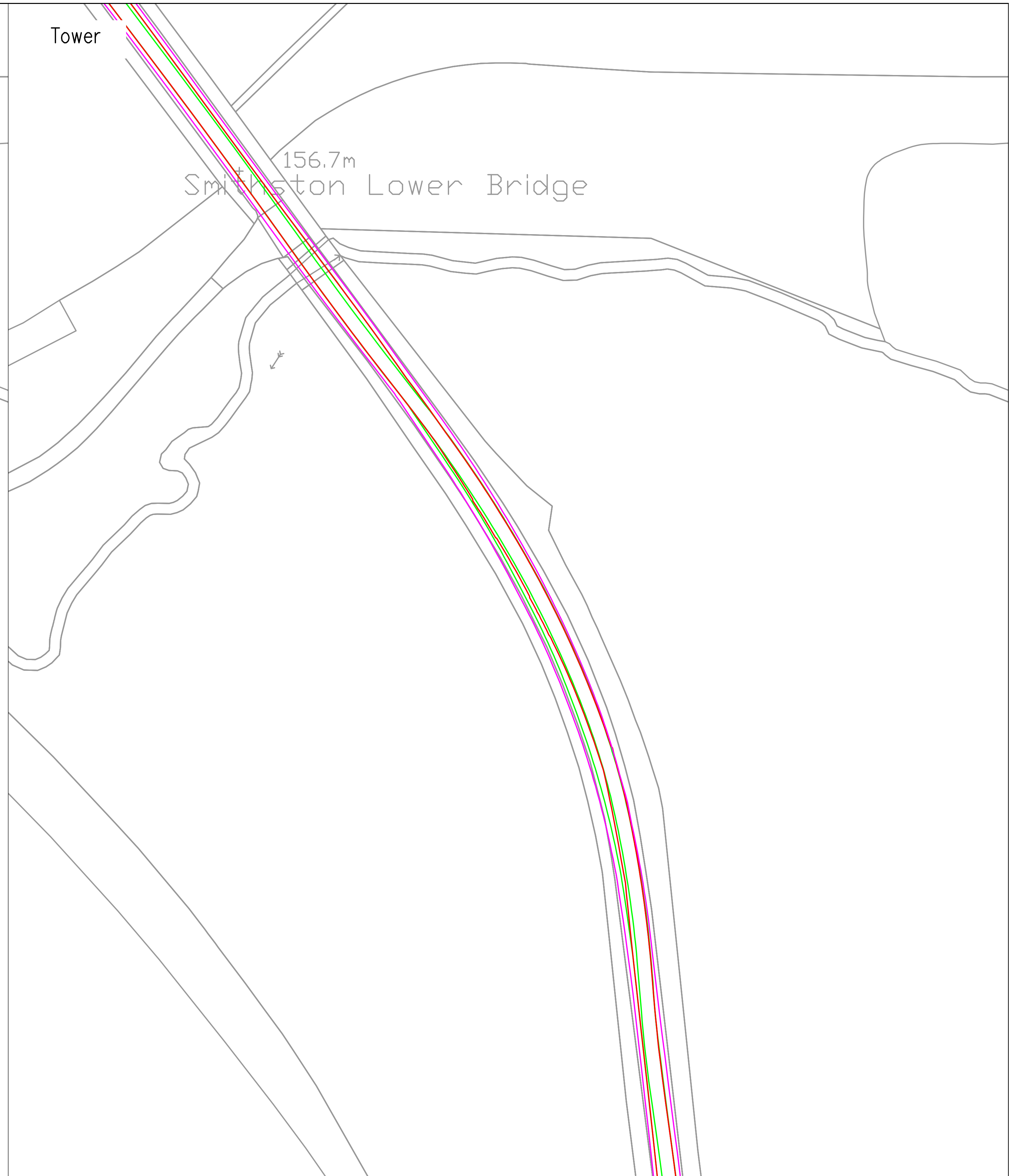
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK21B

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1



Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA, Body SPA, Load SPA, Indicative, Over-run, Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Old Smithston

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		27

Scale: 1:1000 @ A3

File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK22A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1

© Pell Frischmann

Pell Frischmann

93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over–run | Over–sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Old Smithston

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		27

Scale: ##### @ A3

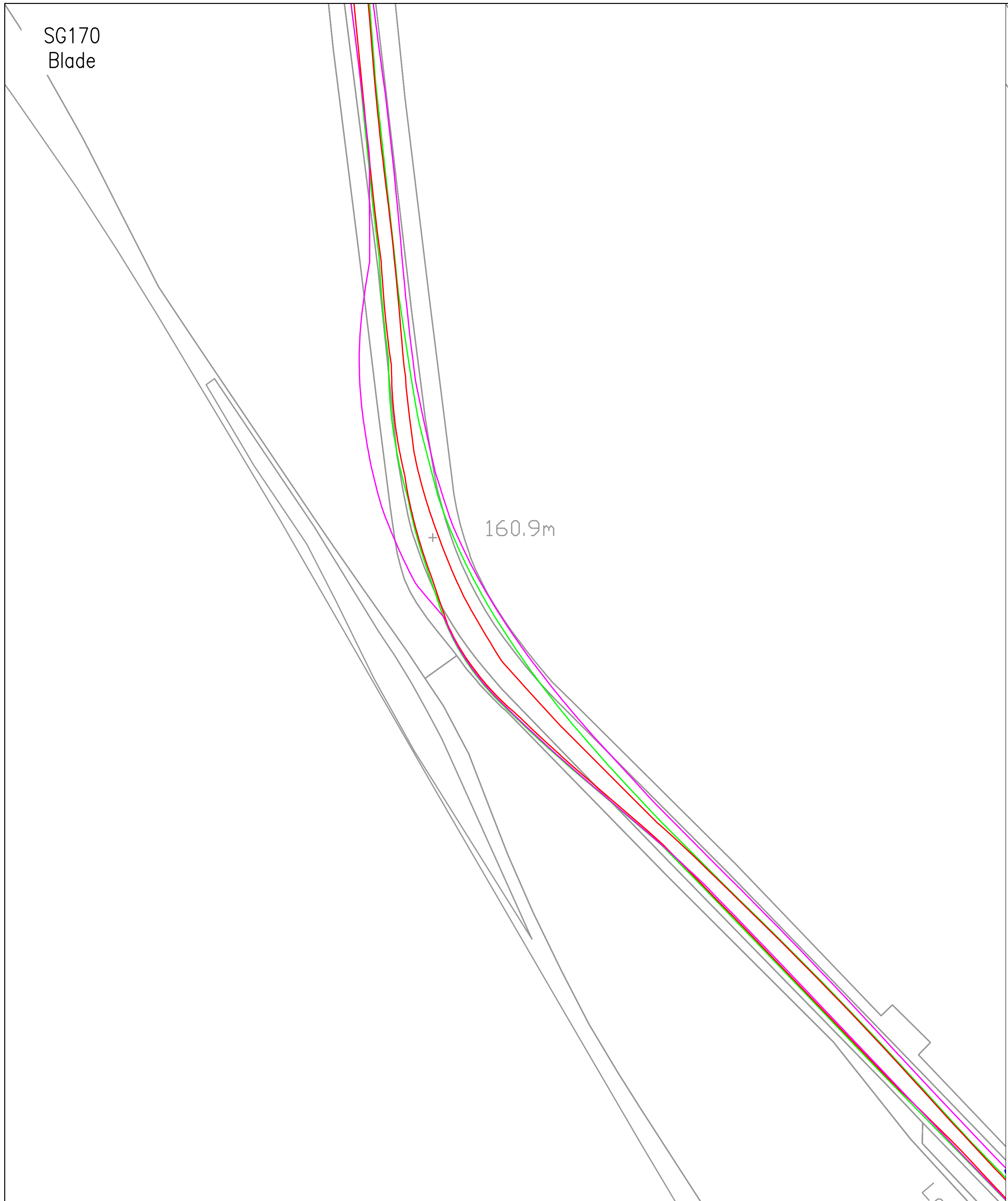
File No.: Quantans SPA (FINAL).dwg

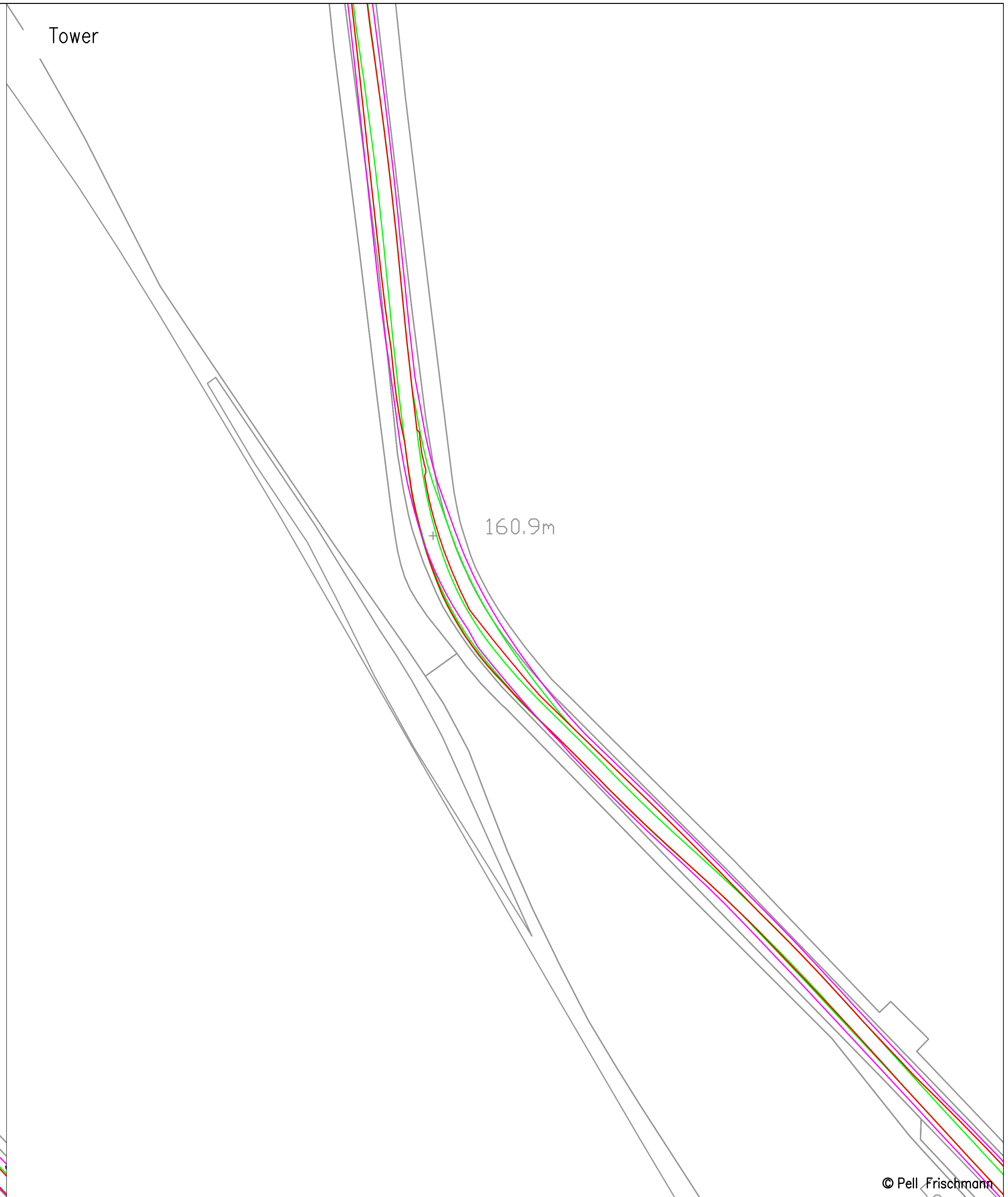
Drawing Status: Draft

Drawing No.: SK22B

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1





Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA, Body SPA, Load SPA, Indicative, Over-run, Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Carnochan

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		28

Scale: 1:1000 @ A3

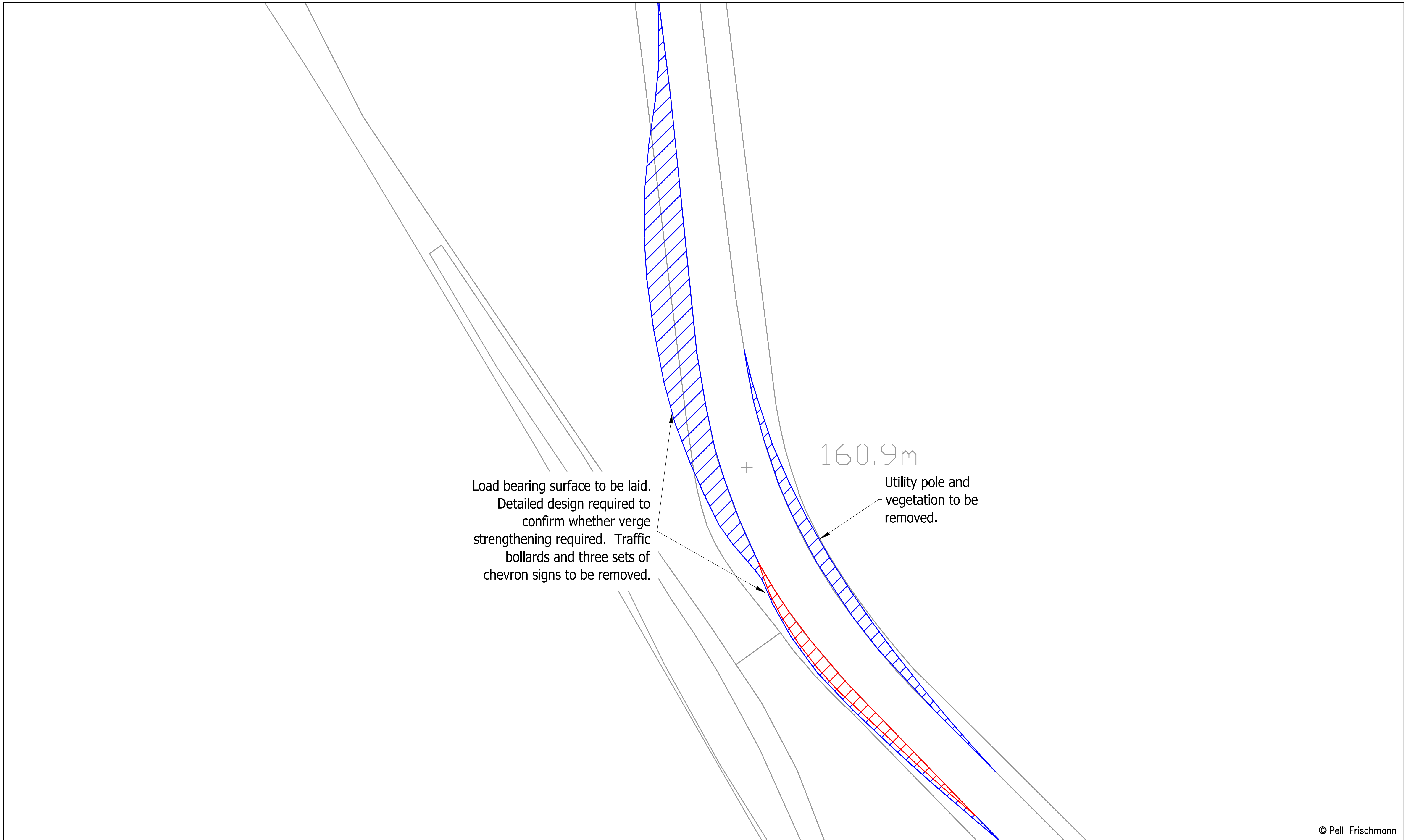
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK23A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1



Pell Frischmann
93 GEORGE STREET, EDINBURGH. EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA, Body SPA, Load SPA, Indicative, Over-run, Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Carnochan

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		28

Scale: ##### @ A3

File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK23B

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1

Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Polnessan

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		29

Scale: 1:1000 @ A3

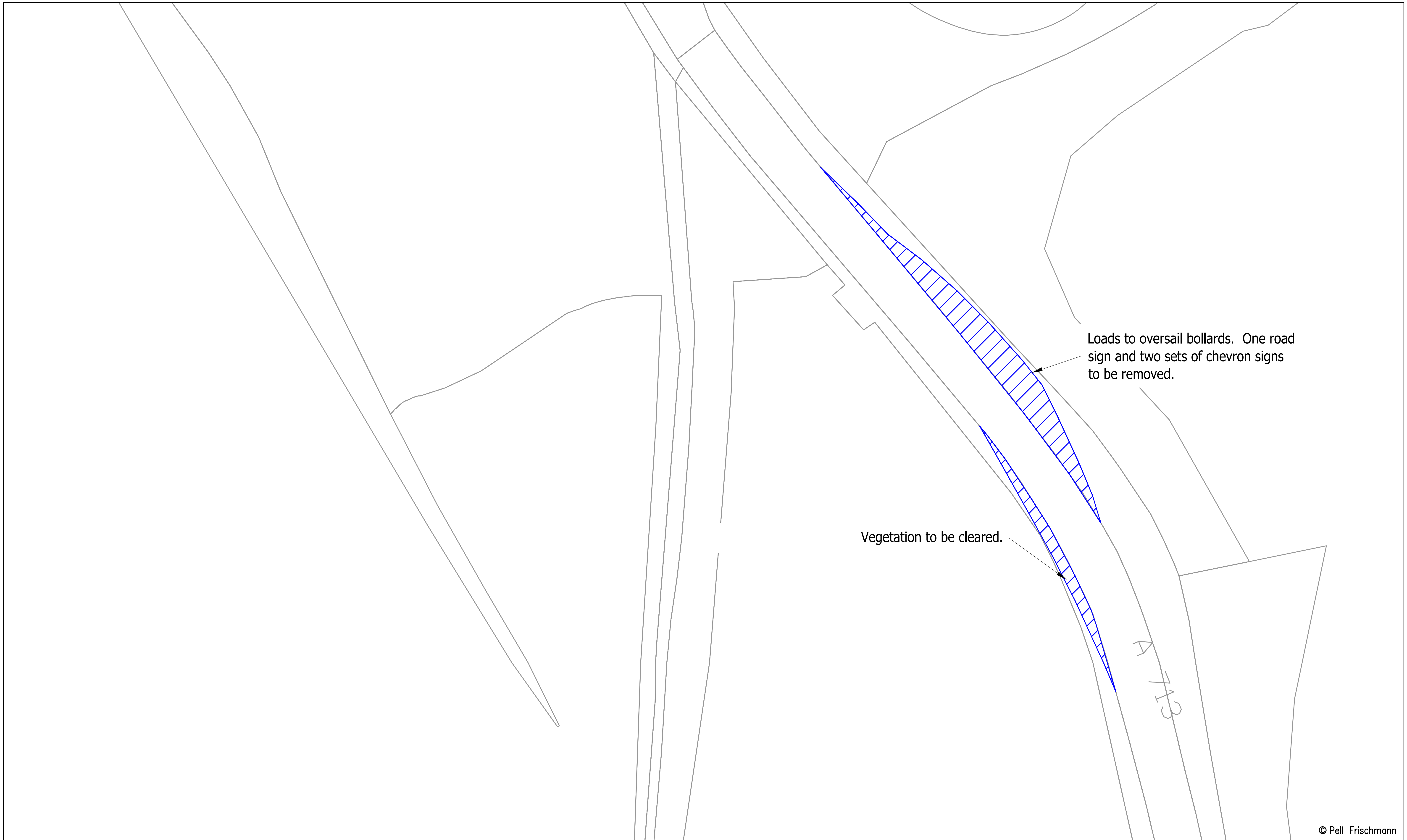
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK24A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1



Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Polnessan

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		29

Scale: ##### @ A3

File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK24B

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1

SG170
Blade

Tower

Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Project: Quantans Wind Farm

Client: Vattenfall

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Polnessan

Key: Wheel SPA — Body SPA — Load SPA — Indicative — Over-run — Over-sail

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		30

Scale: 1:1000 @ A3

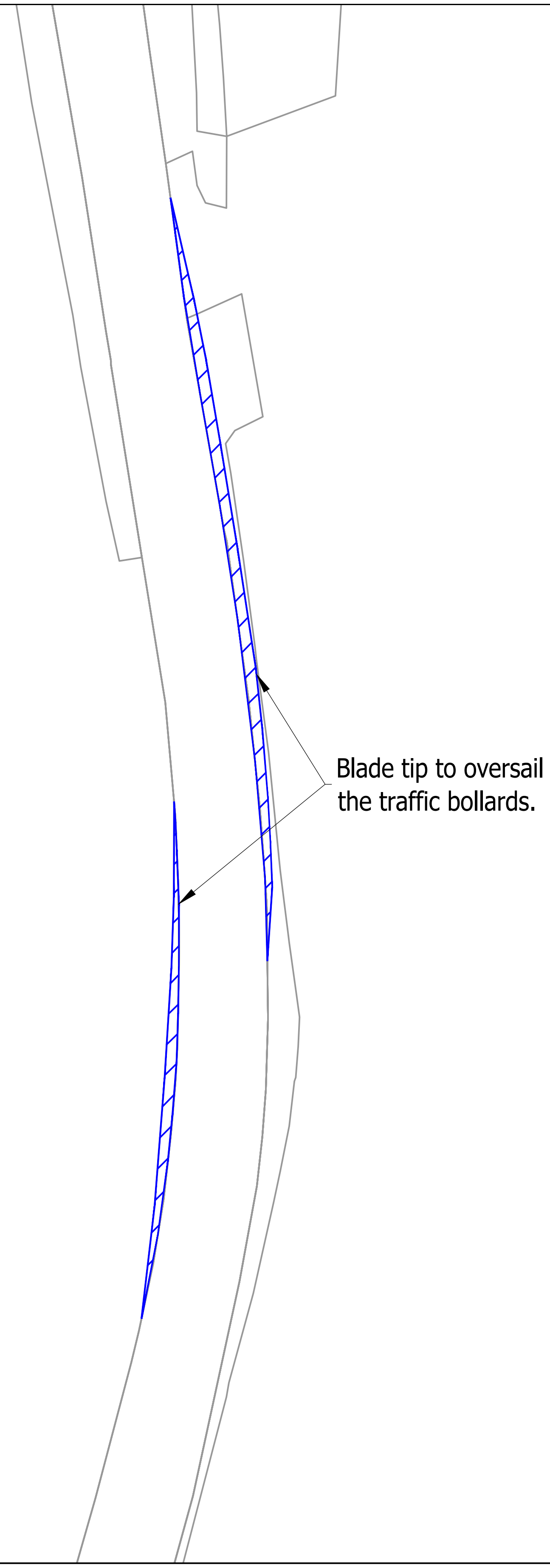
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK25A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1



Pell Frischmann
93 GEORGE STREET, EDINBURGH. EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over–run | Over–sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Polnessan

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		30

Scale: ##### @ A3

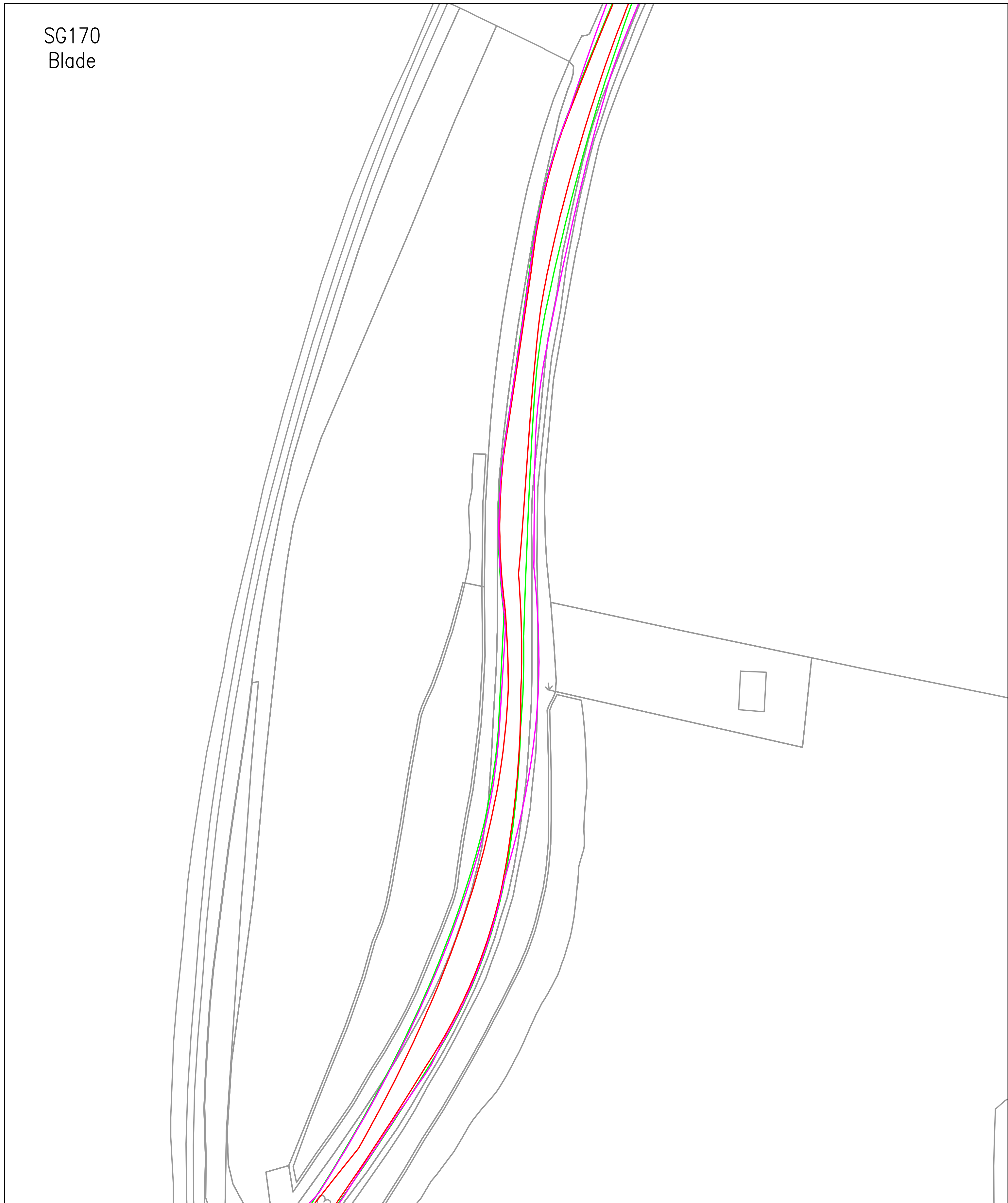
File No.: Quantans SPA (FINAL).dwg

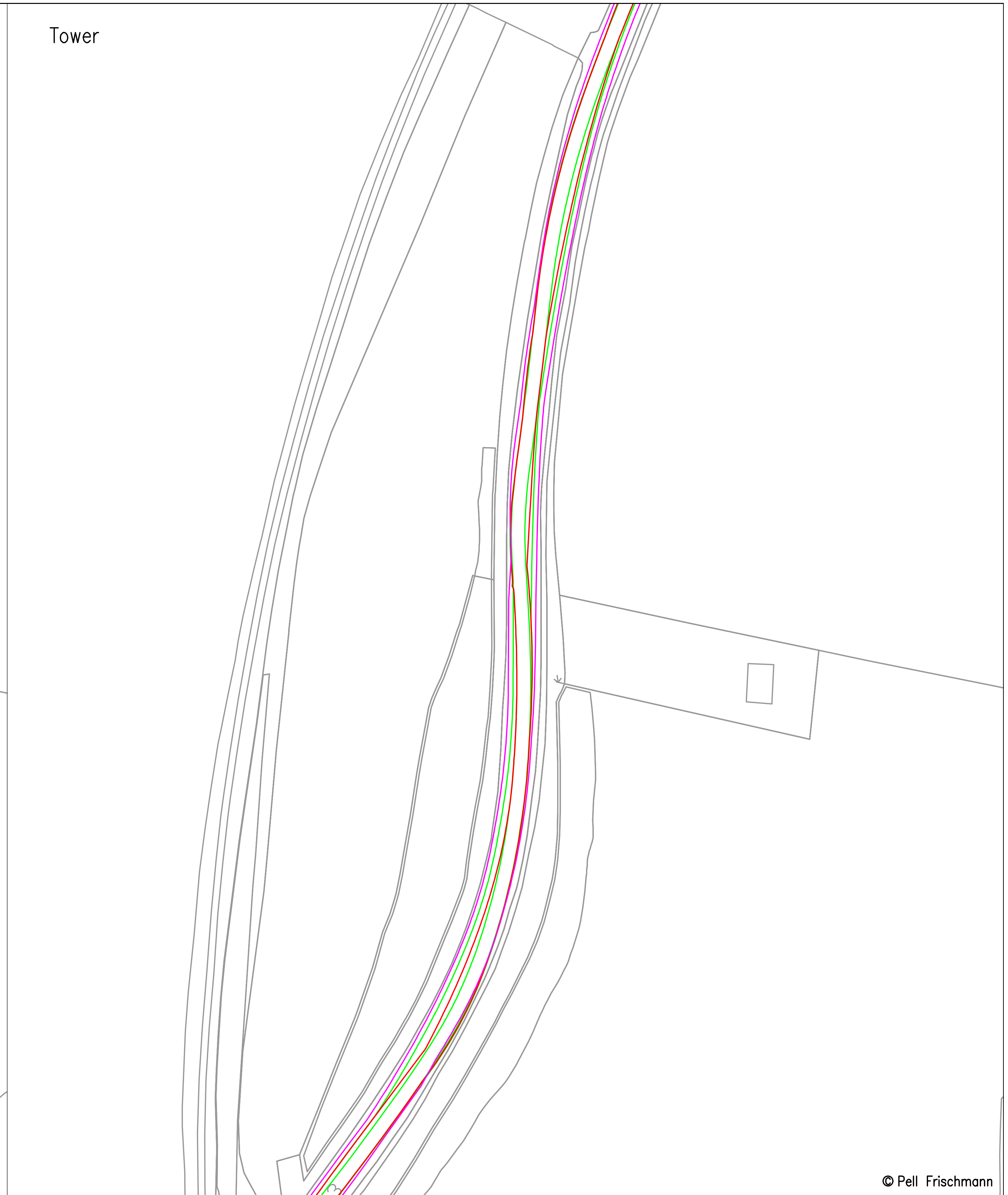
Drawing Status: Draft

Drawing No.: SK25B

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1





Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Bends South of Polnessan

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		31

Scale: 1:1000 @ A3

File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK26A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1

Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Bends South of Polnessan

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		31

Scale: ###### @ A3

File No.: Quantans SPA (FINAL).dwg

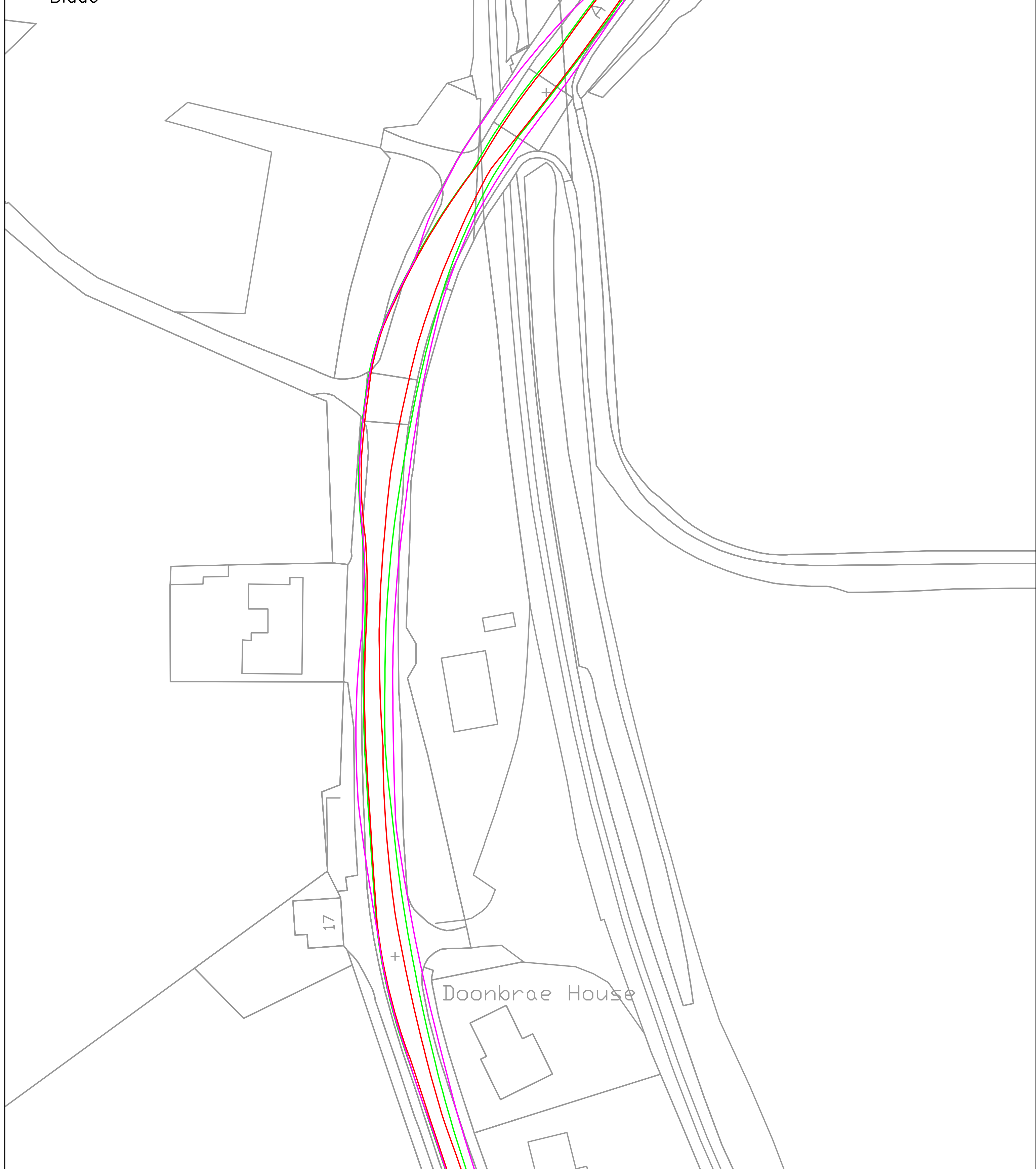
Drawing Status: Draft

Drawing No.: SK26B

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1

SG170
Blade



Tower

Pell Frischmann

93 GEORGE STREET, EDINBURGH, EH2 3ES

Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Project	Quantans Wind Farm
Client	Vattenfall
Drawing Title	SG170 Blade and Towers
SPA Location	A713 Bends South of Polnessan

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over–run | Over–sail

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		32

Scale: 1:1000 @ A3

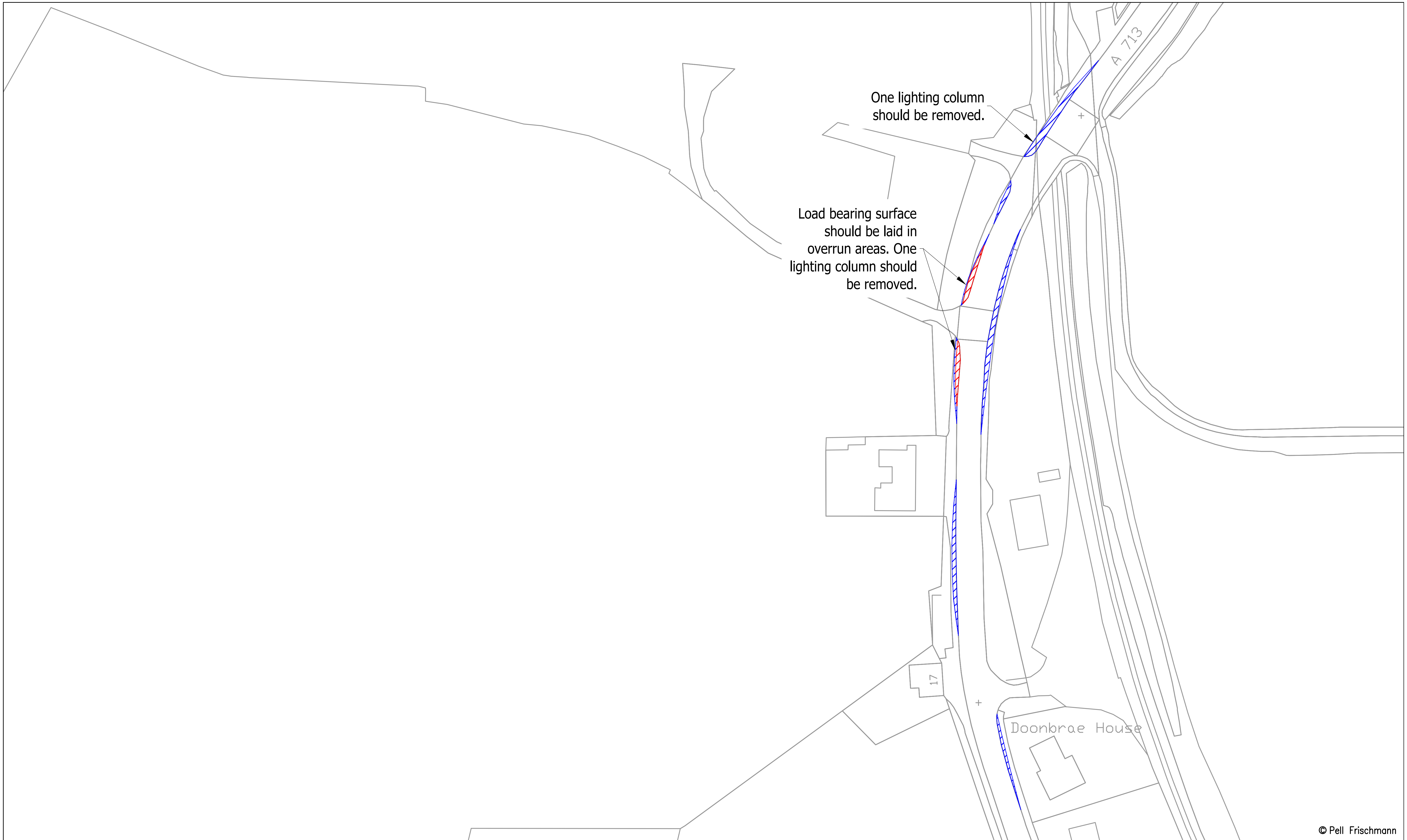
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK27A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1



Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA, Body SPA, Load SPA, Indicative, Over–run, Over–sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Bends South of Polnessan

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		32

Drawing No.: SK27B

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Scale: ##### @ A3

File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Revision: 1

Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Patna

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		33

Scale: 1:1000 @ A3

File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK28A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1

Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Patna

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest	33	

Scale: ##### @ A3

File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK28B

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1

Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Buchan's Bridge

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		38

Scale: 1:1000 @ A3

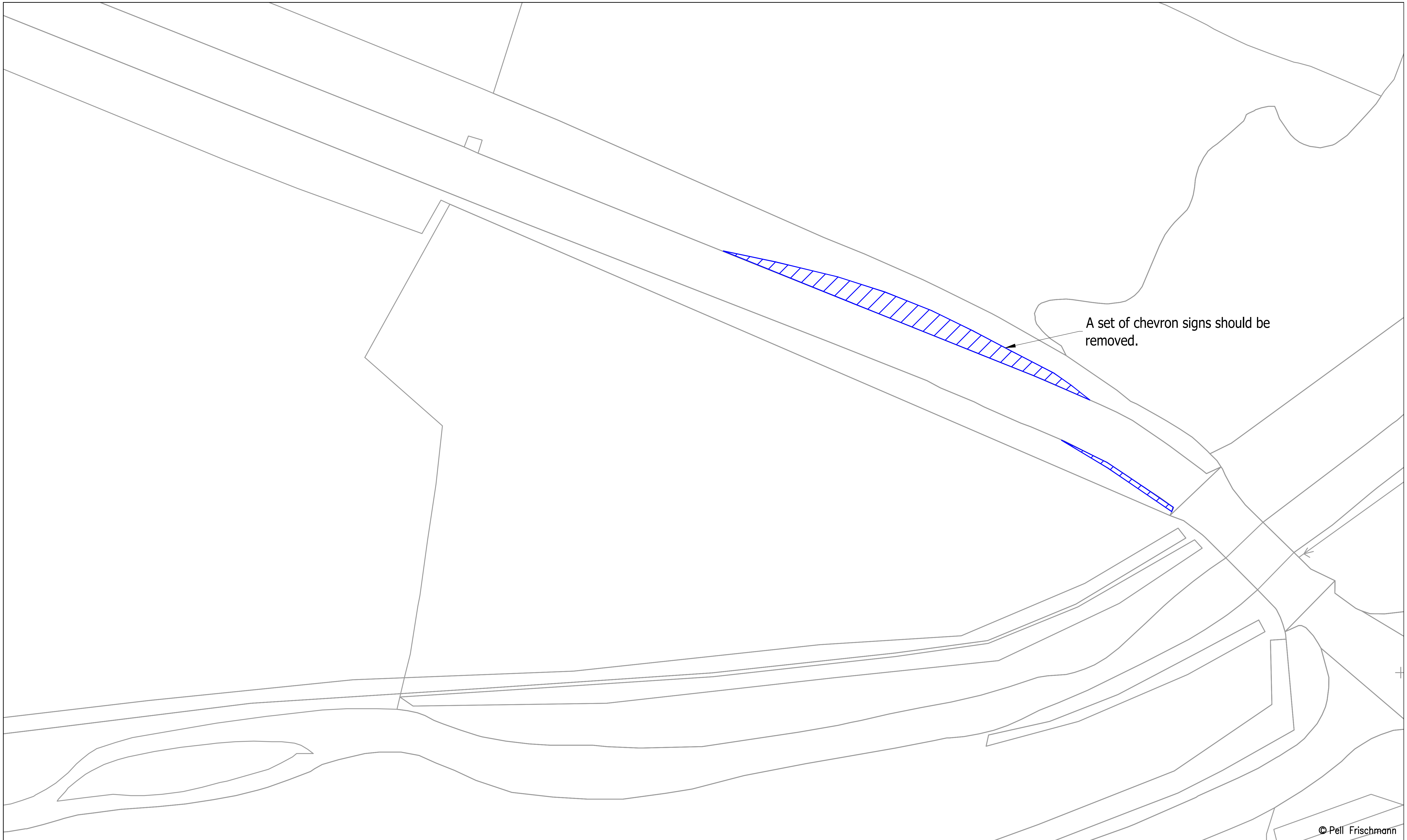
File No. Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No. SK29A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1



Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA, Body SPA, Load SPA, Indicative, Over–run, Over–sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Buchan's Bridge

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		38

Scale: ##### @ A3

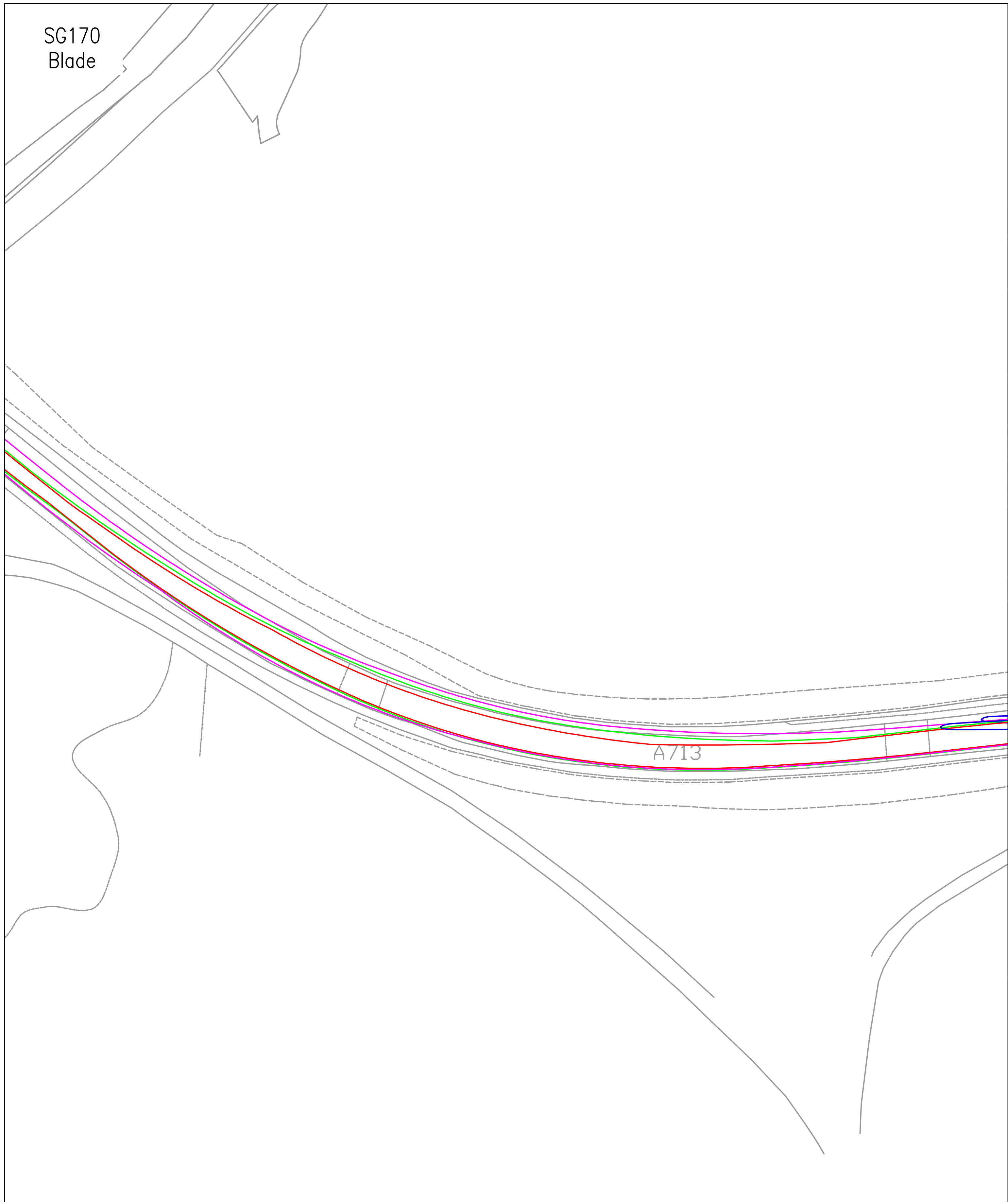
File No.: Quantans SPA (FINAL).dwg

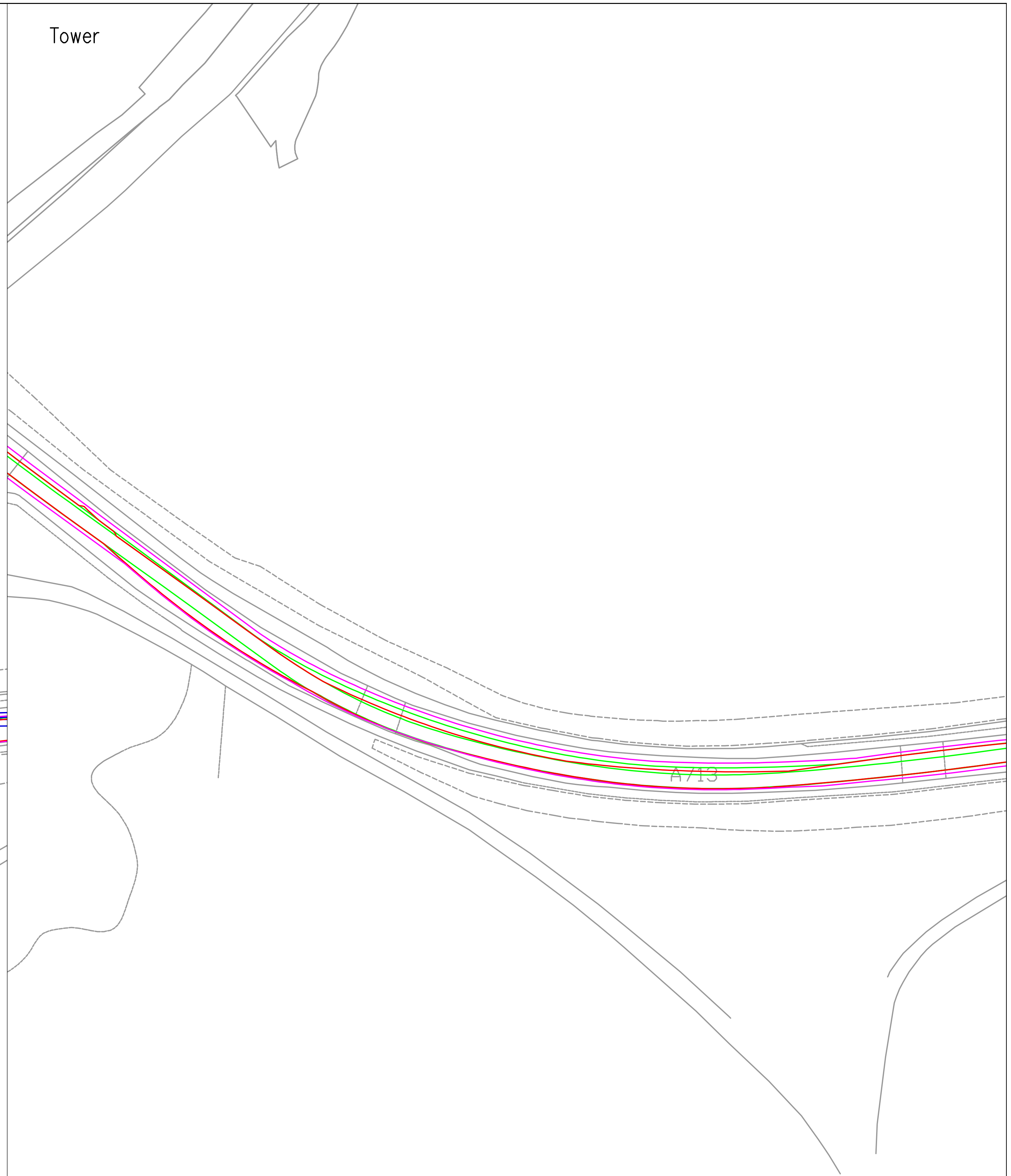
Drawing Status: Draft

Drawing No.: SK29B

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1





Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Left Bend, Dalmellington

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		40

Scale: 1:1000 @ A3

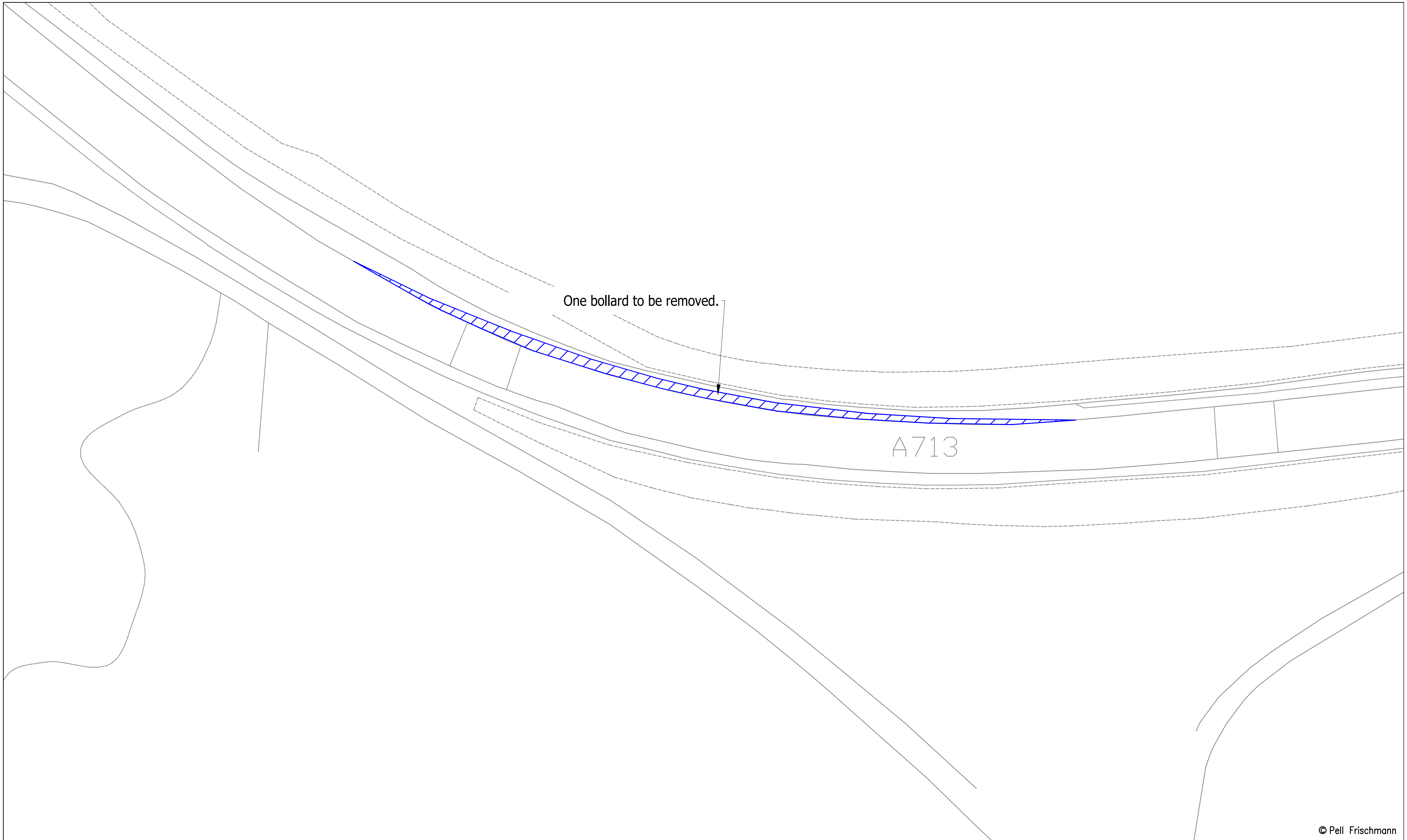
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK30A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1



Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Project: Quantans Wind Farm

Client: Vattenfall

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Left Bend, Dalmellington

Key: Wheel SPA, Body SPA, Load SPA, Indicative, Over-run, Over-sail

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		40

Scale: ##### @ A3

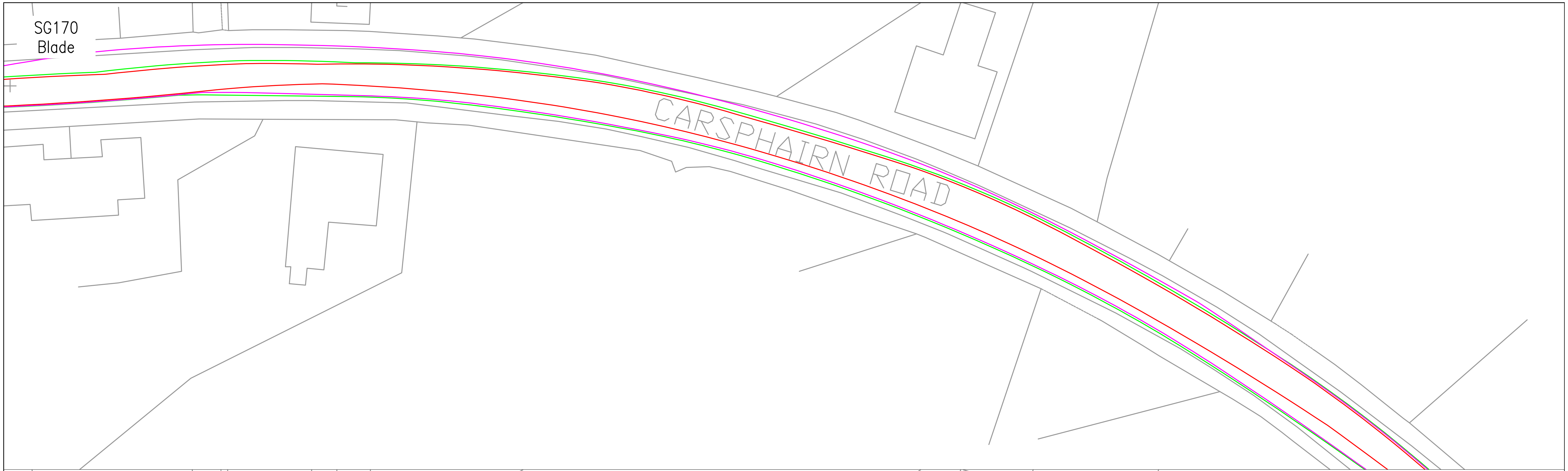
File No.: Quantans SPA (FINAL).dwg

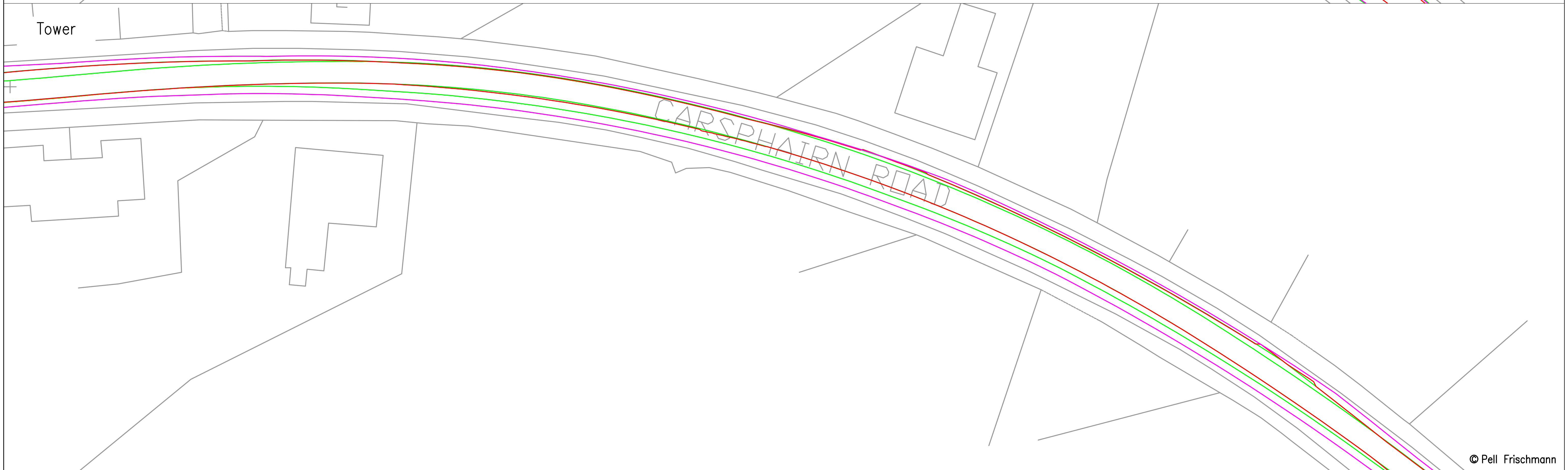
Drawing Status: Draft

Drawing No.: SK30B

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1





Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Dalmellington

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		41

Scale: 1:500 @ A3

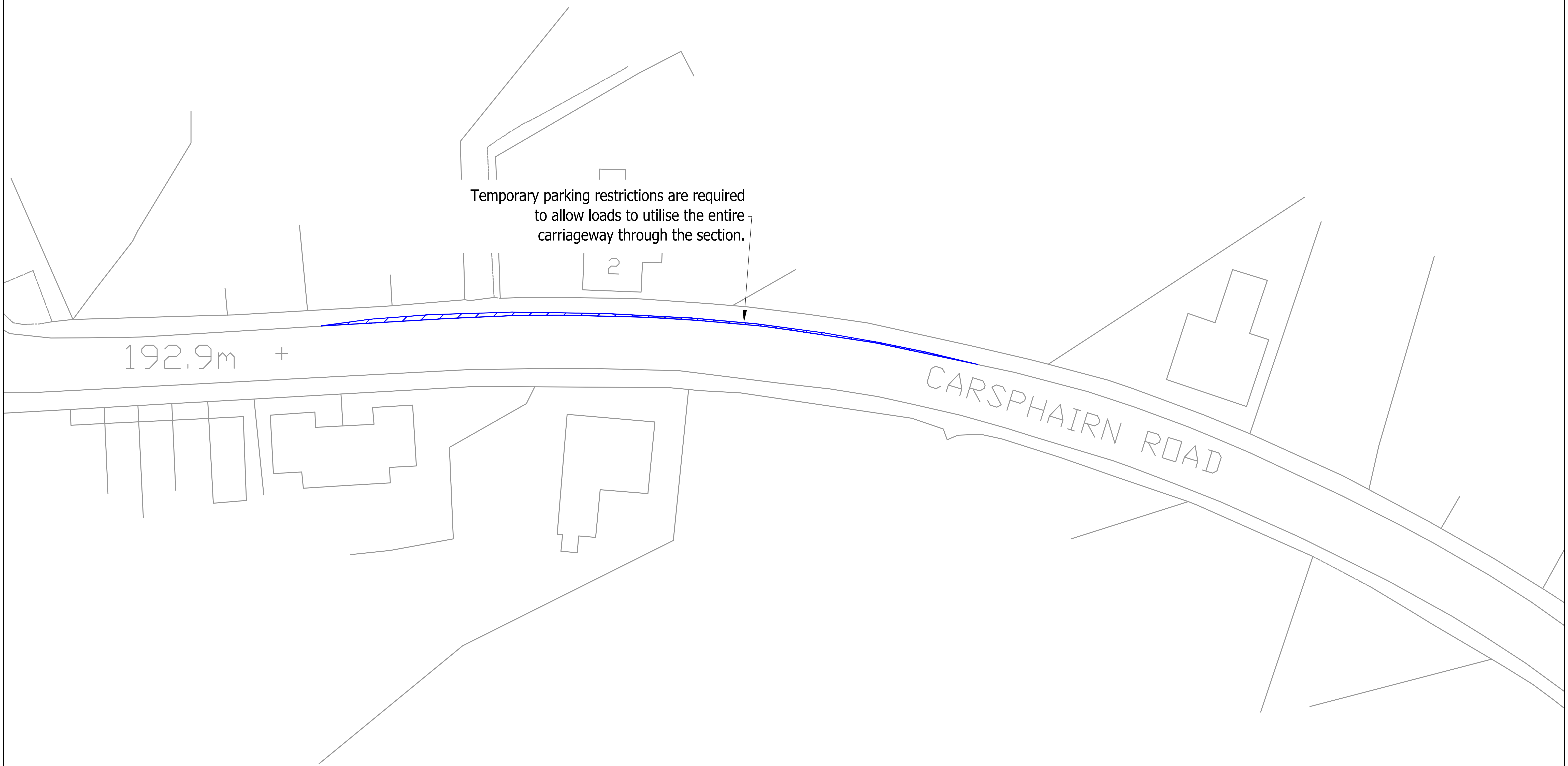
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK31A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1



Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA, Body SPA, Load SPA, Indicative, Over-run, Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Dalmellington

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		41

Scale: 1:500 @ A3

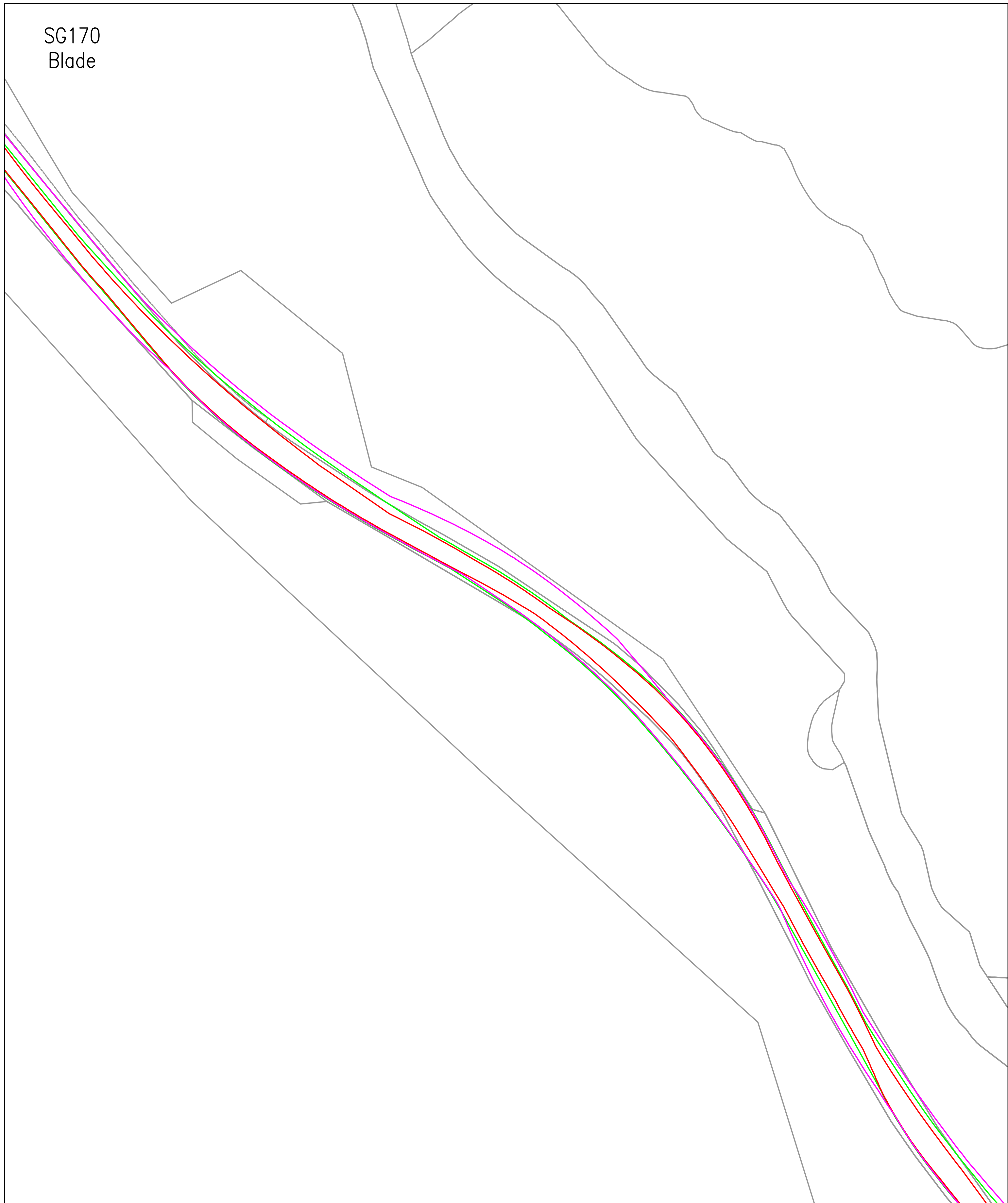
File No.: Quantans SPA (FINAL).dwg

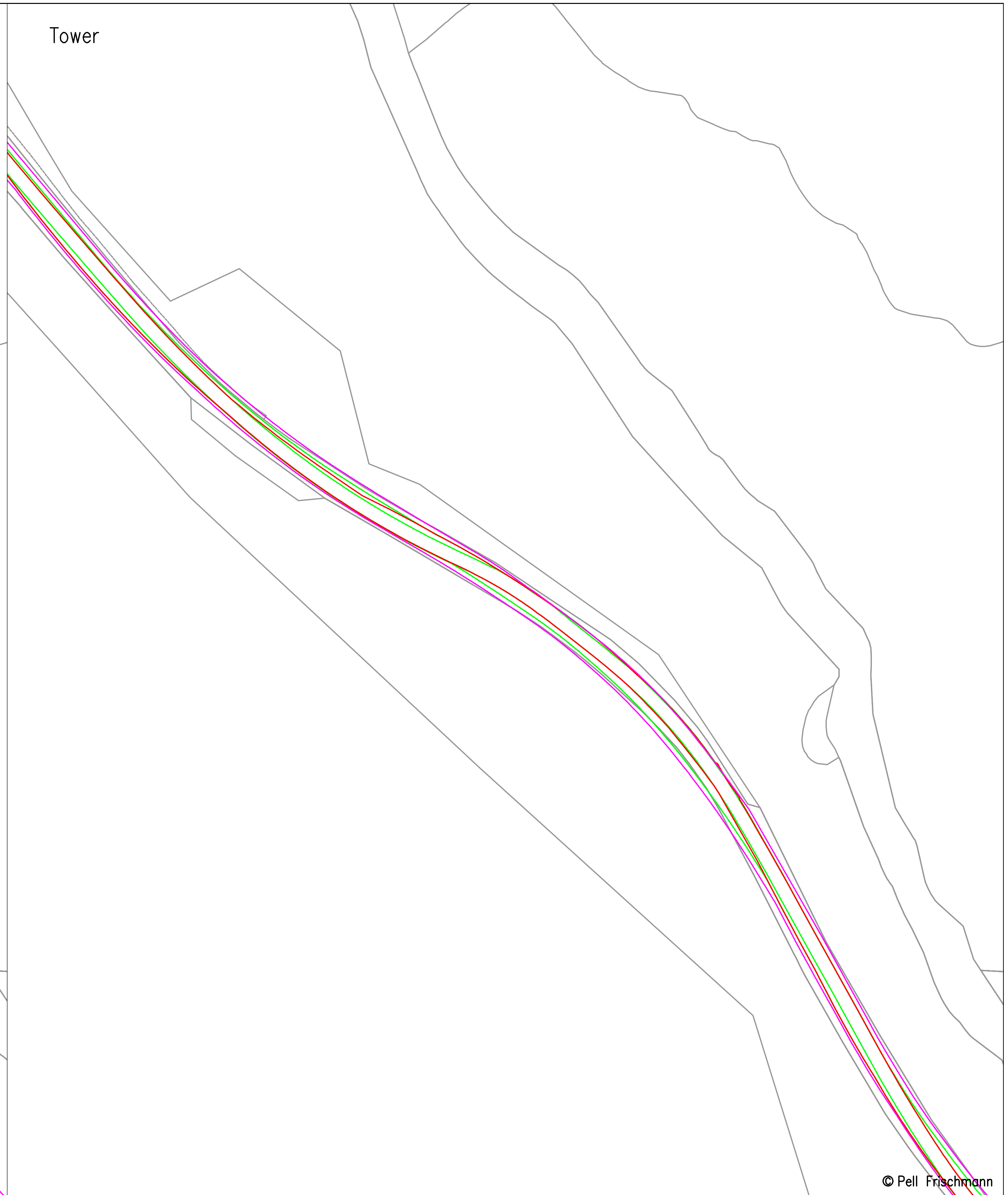
Drawing Status: Draft

Drawing No.: SK31B

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1





Pell Frischmann

93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA, Body SPA, Load SPA, Indicative, Over-run, Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 North of Kirn Bridge

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		42

Scale: 1:1000 @ A3

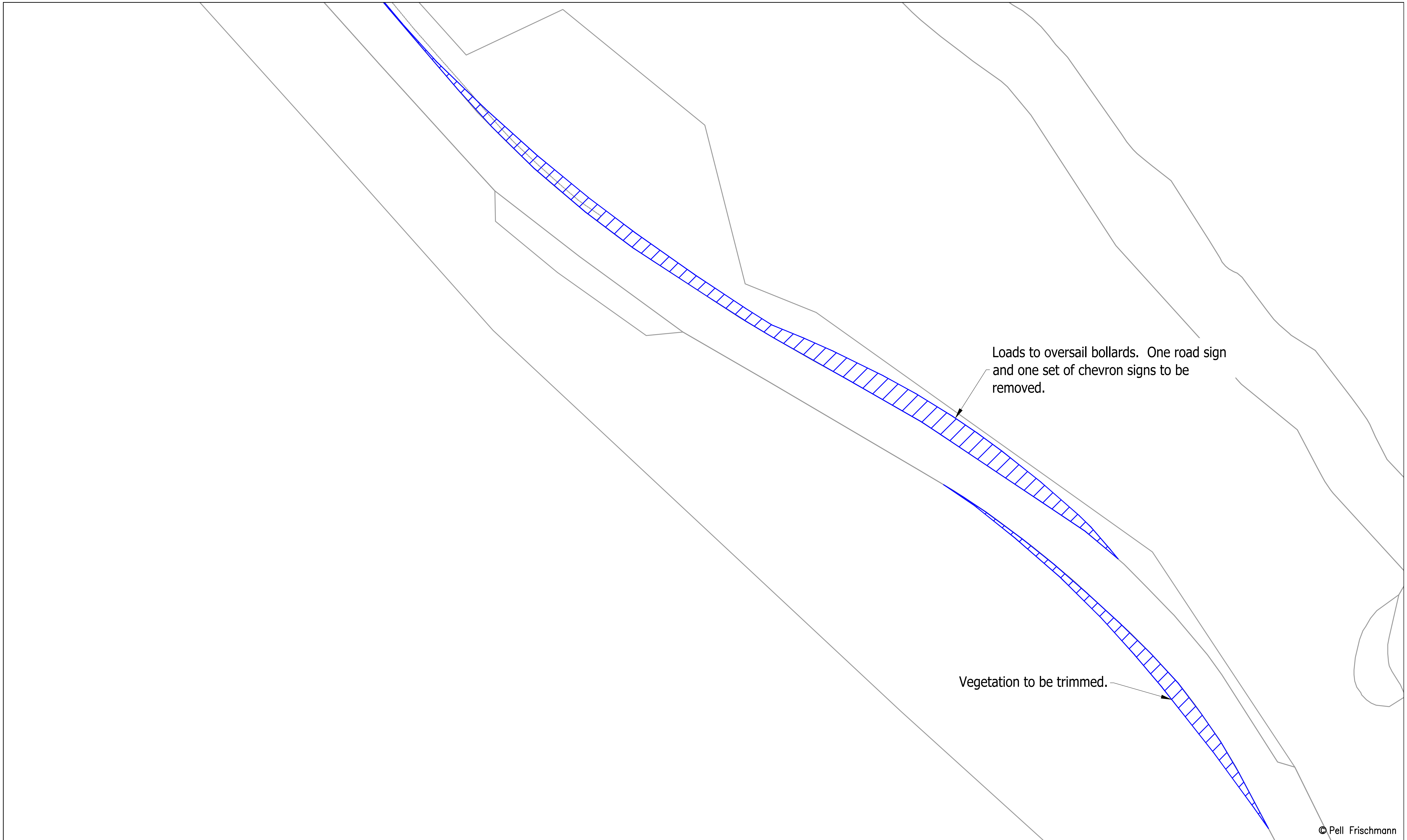
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK32A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1



Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over–run | Over–sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 North of Kirn Bridge

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		42

Scale: ##### @ A3

File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK32B

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1

Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Kirn Bridge

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		43

Scale: 1:1000 @ A3

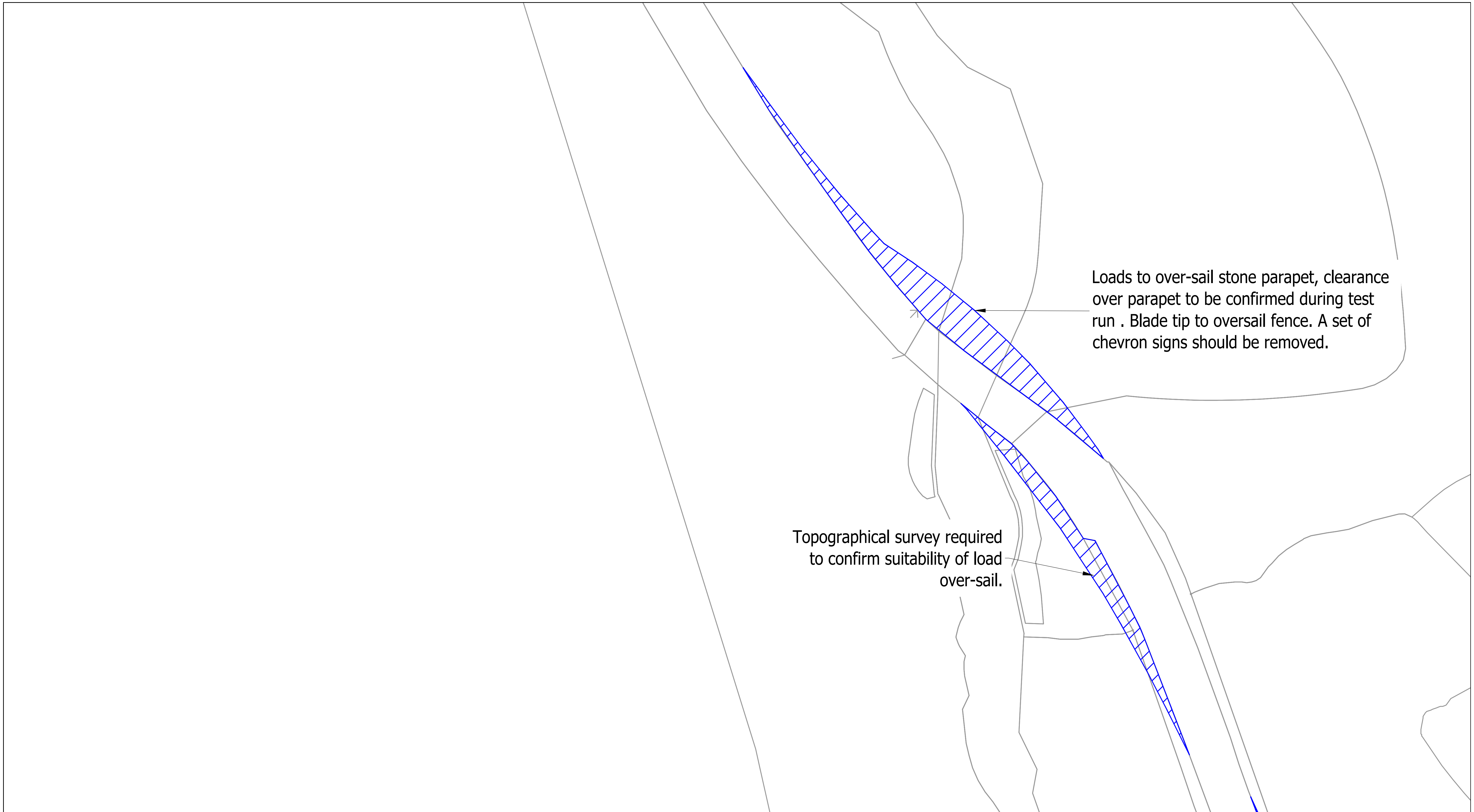
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK33A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1



Topographical survey required.
Swept path assessment to be repeated.

Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Kirn Bridge

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		43

Scale: ##### @ A3

File No. Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No. SK33B

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1

Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

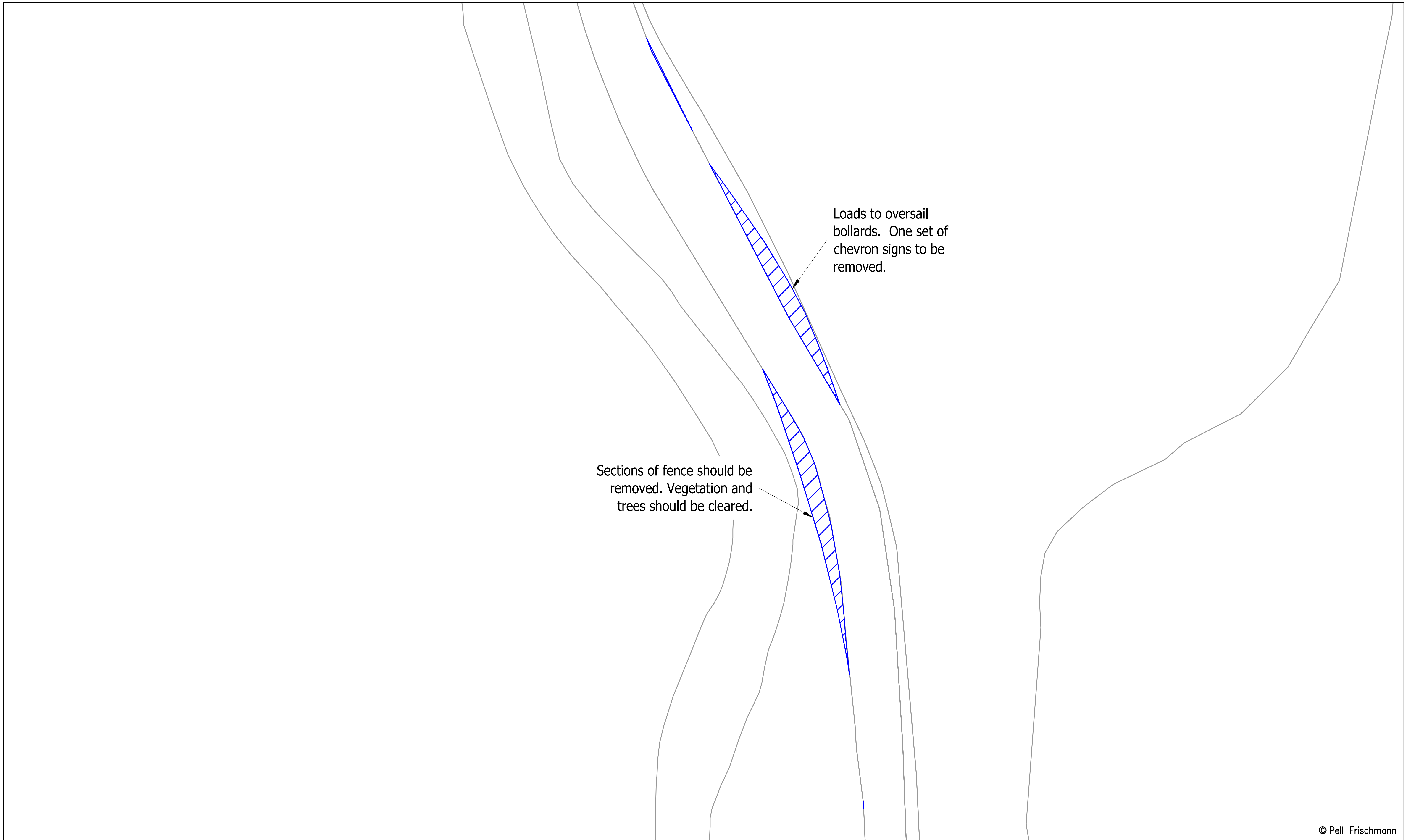
Client	Vattenfall
Project	Quantans Wind Farm
Drawing Title	SG170 Blade and Towers
SPA Location	A713 West of Snabb Cairn

Key: Wheel SPA, Body SPA, Load SPA, Indicative, Over-run, Over-sail

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		44

Scale	1:1000 @ A3
File No.	Quantans SPA (FINAL).dwg
Drawing Status	Draft
Drawing No.	SK34A
Revision	1

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.



Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 West of Snabb Cairn

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		44

Scale: ##### @ A3

File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK34B

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1

Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Project	Quantans Wind Farm
Client	Vattenfall
Drawing Title	SG170 Blade and Towers
SPA Location	A713 North of Mossdale

Key: Wheel SPA, Body SPA, Load SPA, Indicative, Over-run, Over-sail

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		45

Scale: 1:1000 @ A3

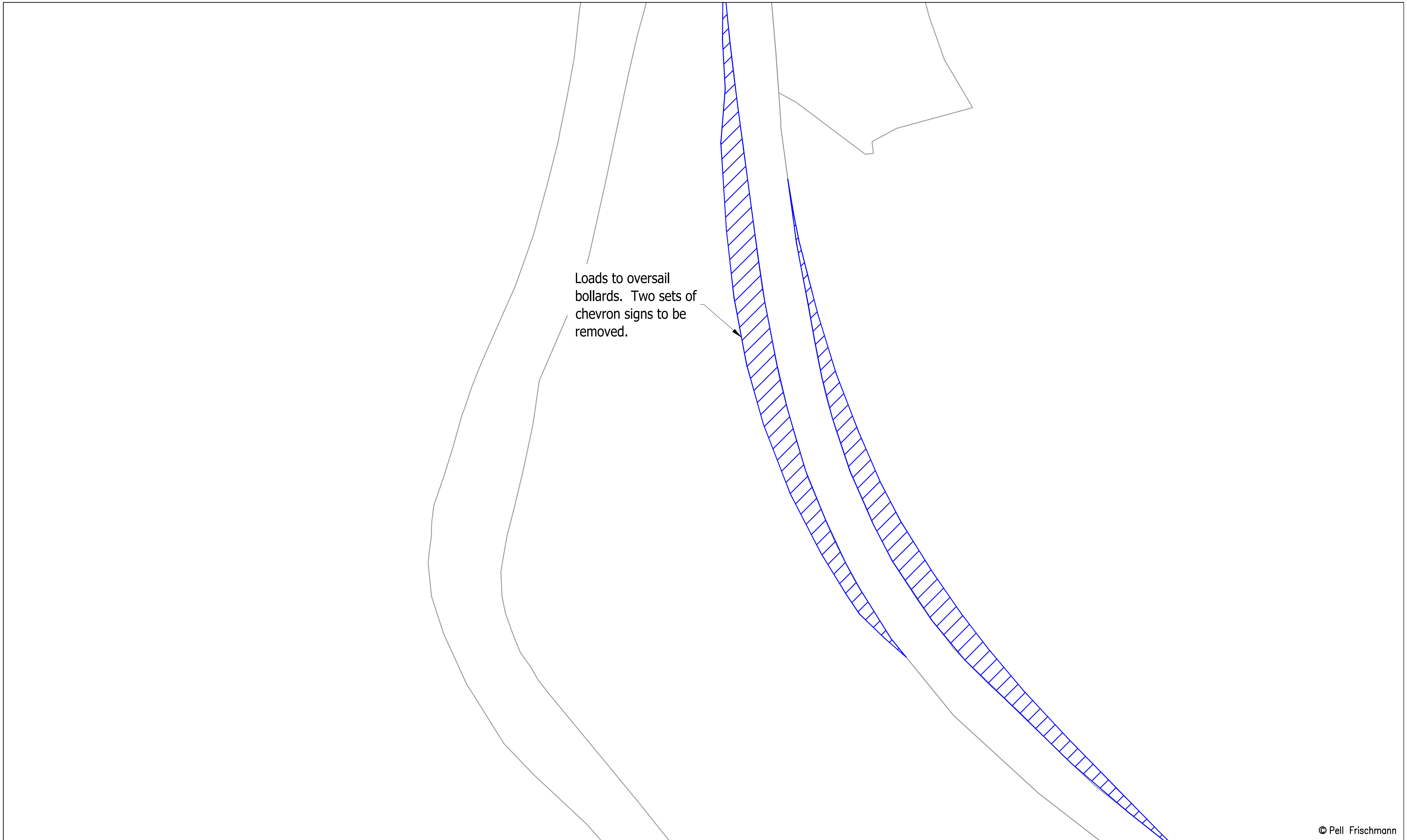
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK35A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1



Pell Frischmann
93 GEORGE STREET, EDINBURGH. EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over–run | Over–sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 North of Mossdale

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		45

Scale: ##### @ A3

File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK35B

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1

Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA, Body SPA, Load SPA, Indicative, Over-run, Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Mossdale

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		47

Scale: 1:1000 @ A3

File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK36A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1

Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Mossdale

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		47

Scale: ##### @ A3

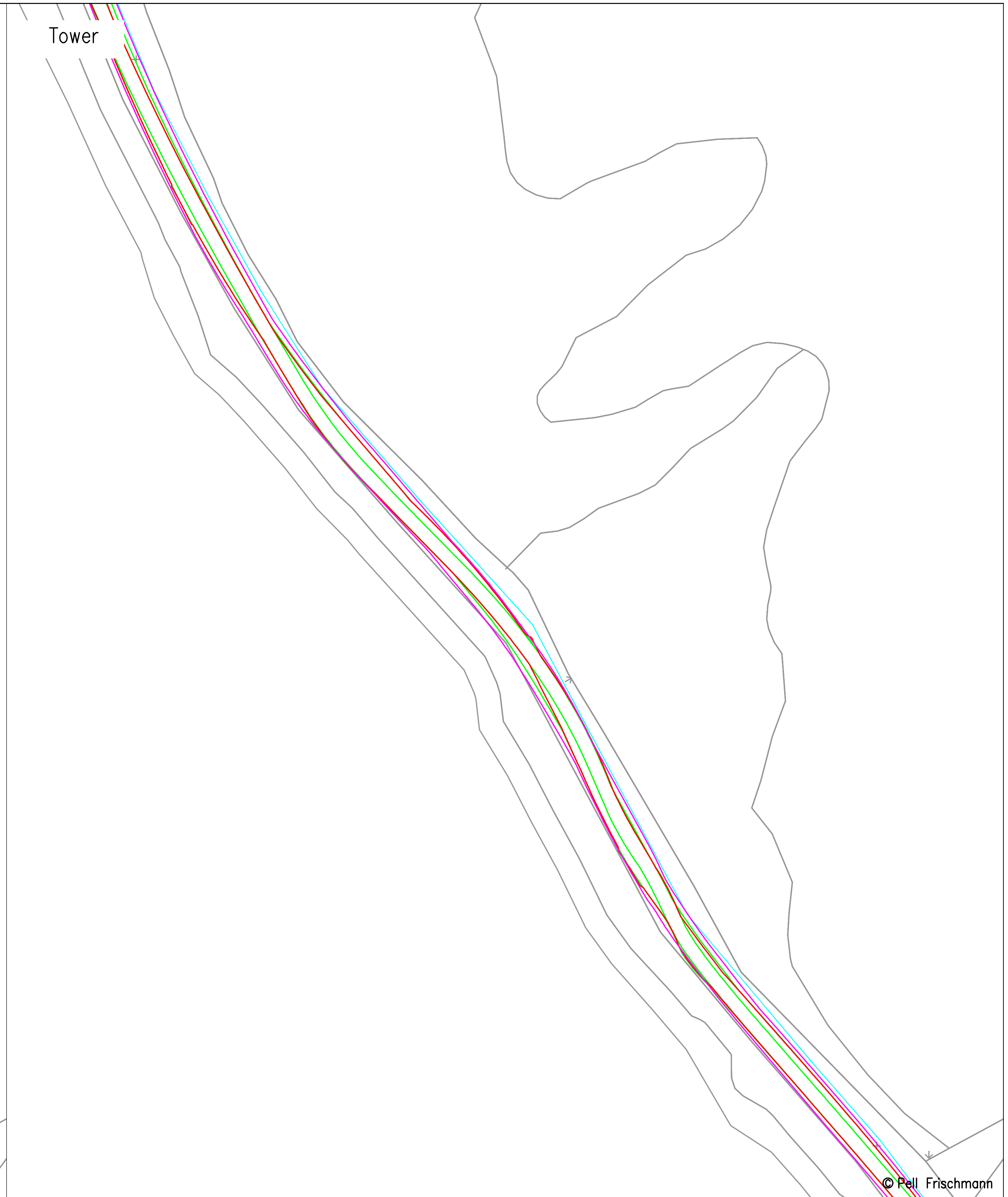
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK36B

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1



Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

NO MITIGATION REQUIRED

SPA Location: A713 South of Mossdale

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		48

Scale: 1:1000 @ A3

File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK37

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1

Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 South of Mossdale

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		48

Scale: 1:1000 @ A3

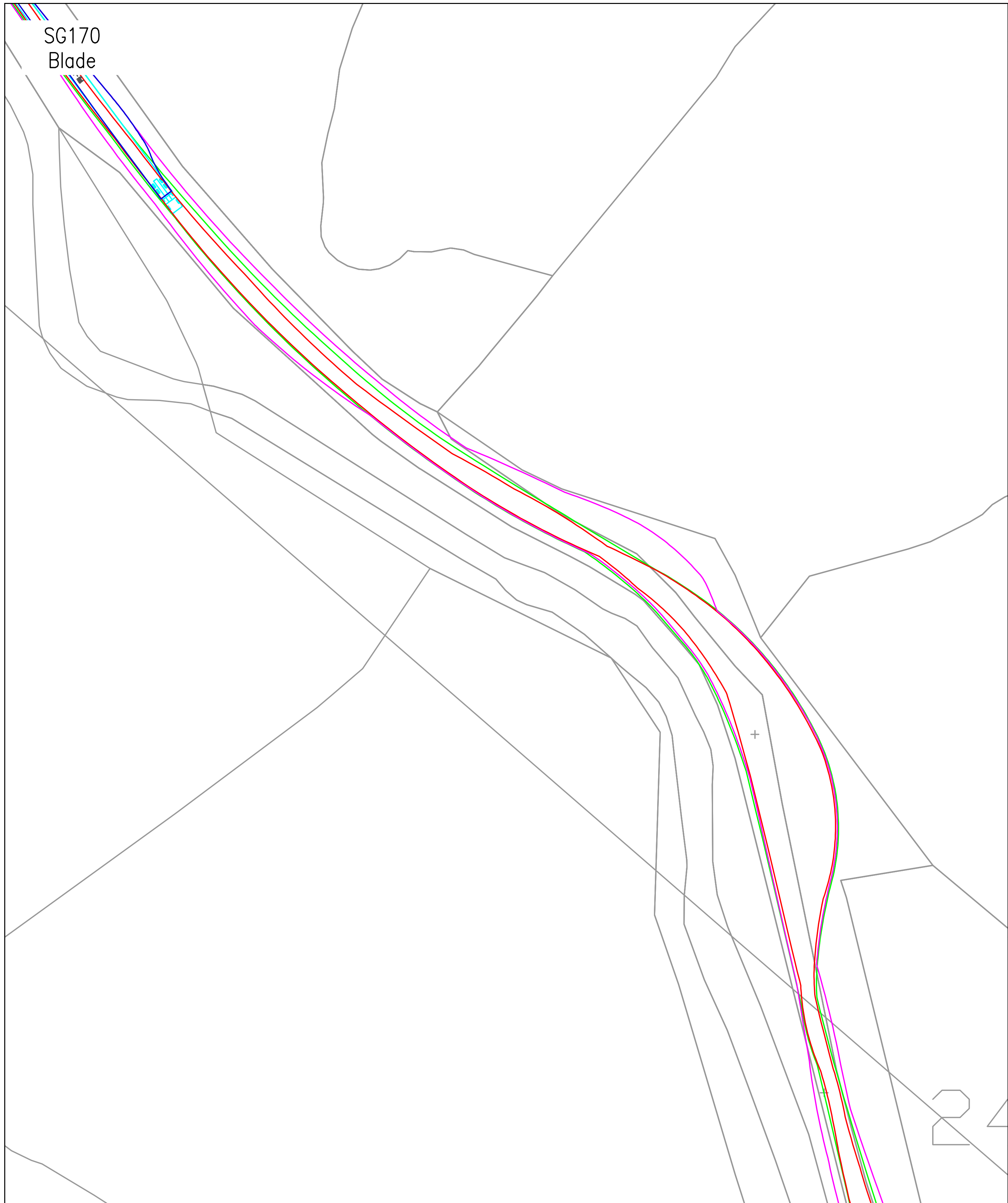
File No.: Quantans SPA (FINAL).dwg

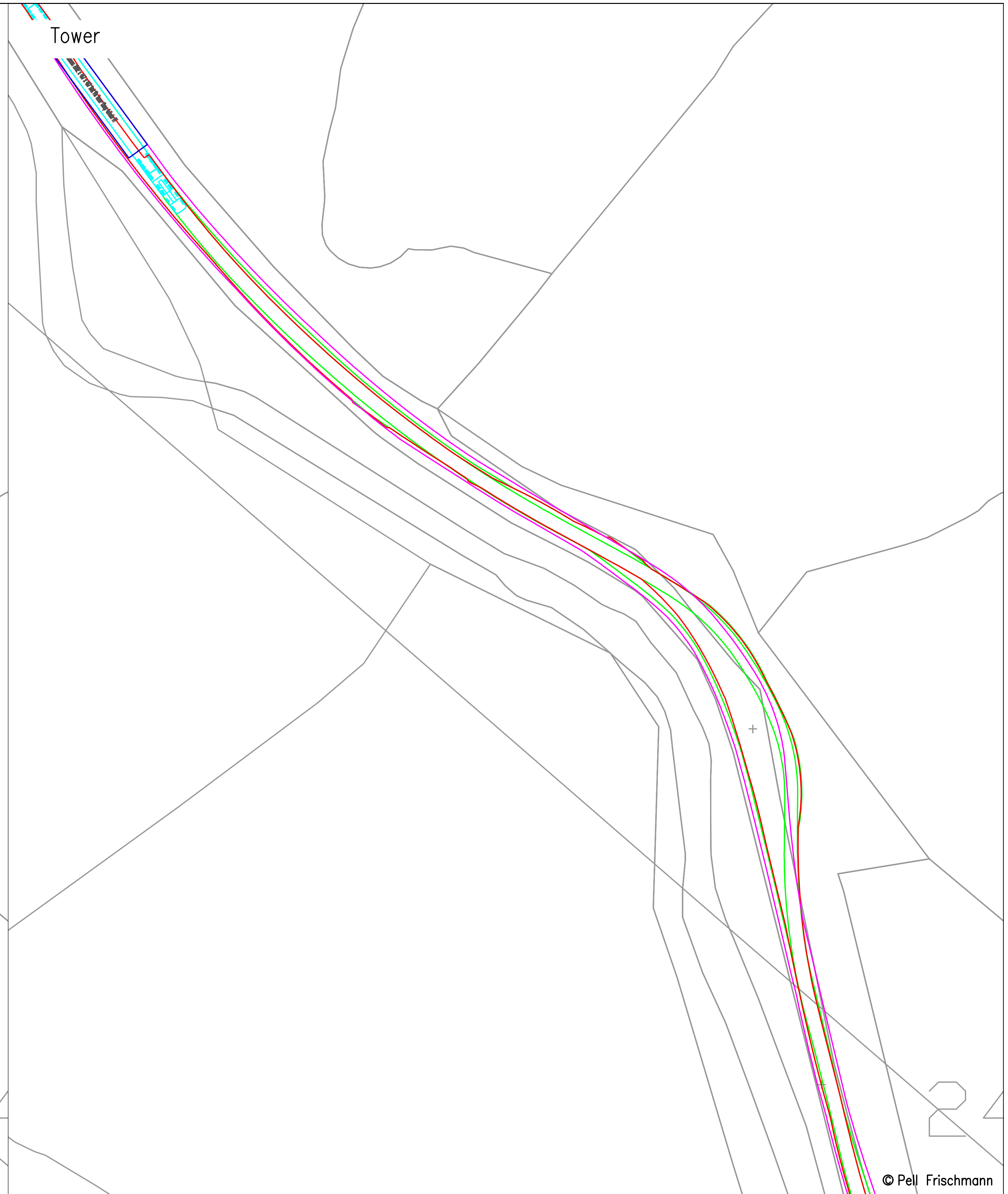
Drawing Status: Draft

Drawing No.: SK37A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1





Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA, Body SPA, Load SPA, Indicative, Over-run, Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 at Bryan's Heights

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		49

Scale: 1:1000 @ A3

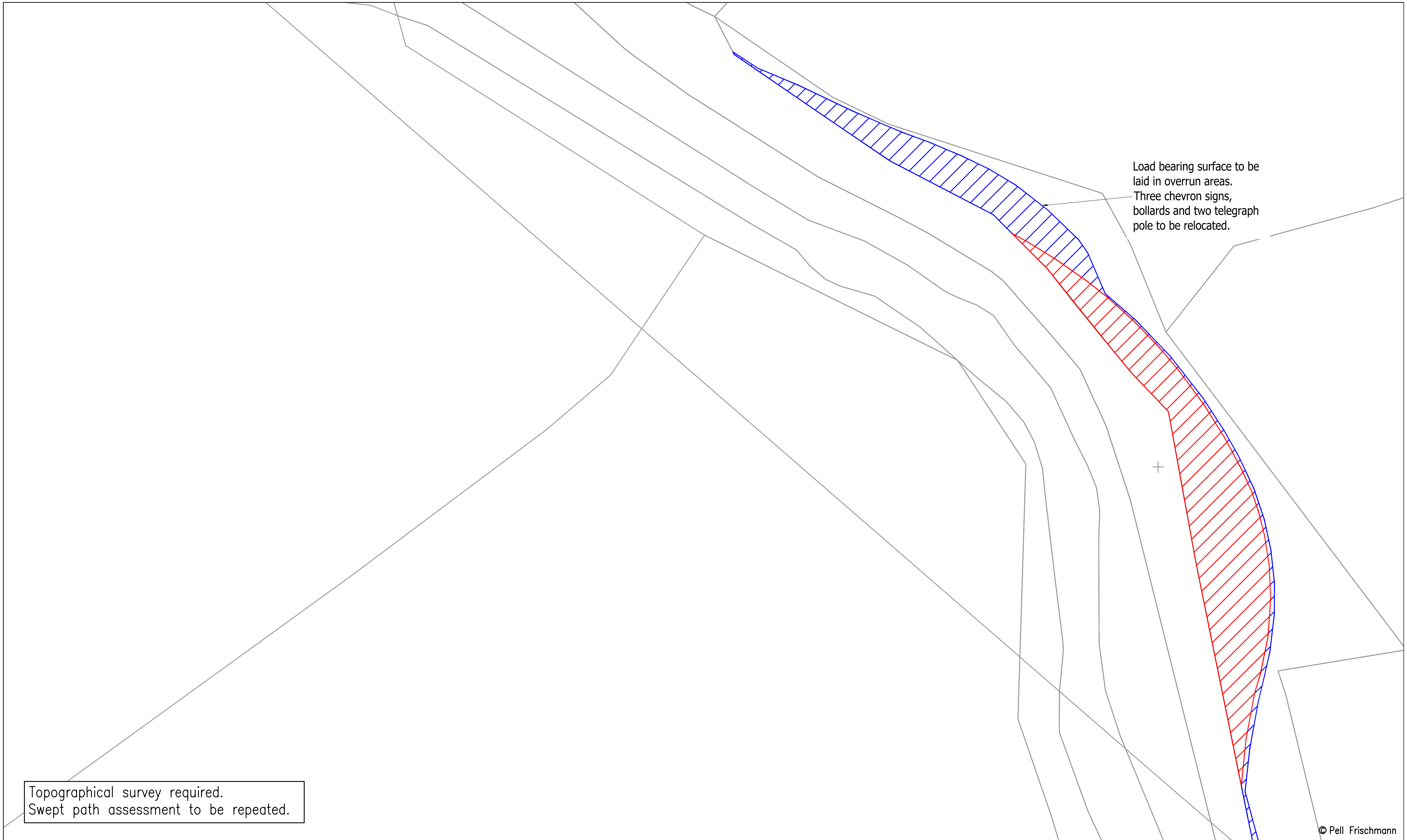
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK38A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1



Pell Frischmann
93 GEORGE STREET, EDINBURGH. EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA, Body SPA, Load SPA, Indicative, Over-run, Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 at Bryan's Heights

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		49

Scale: ##### @ A3

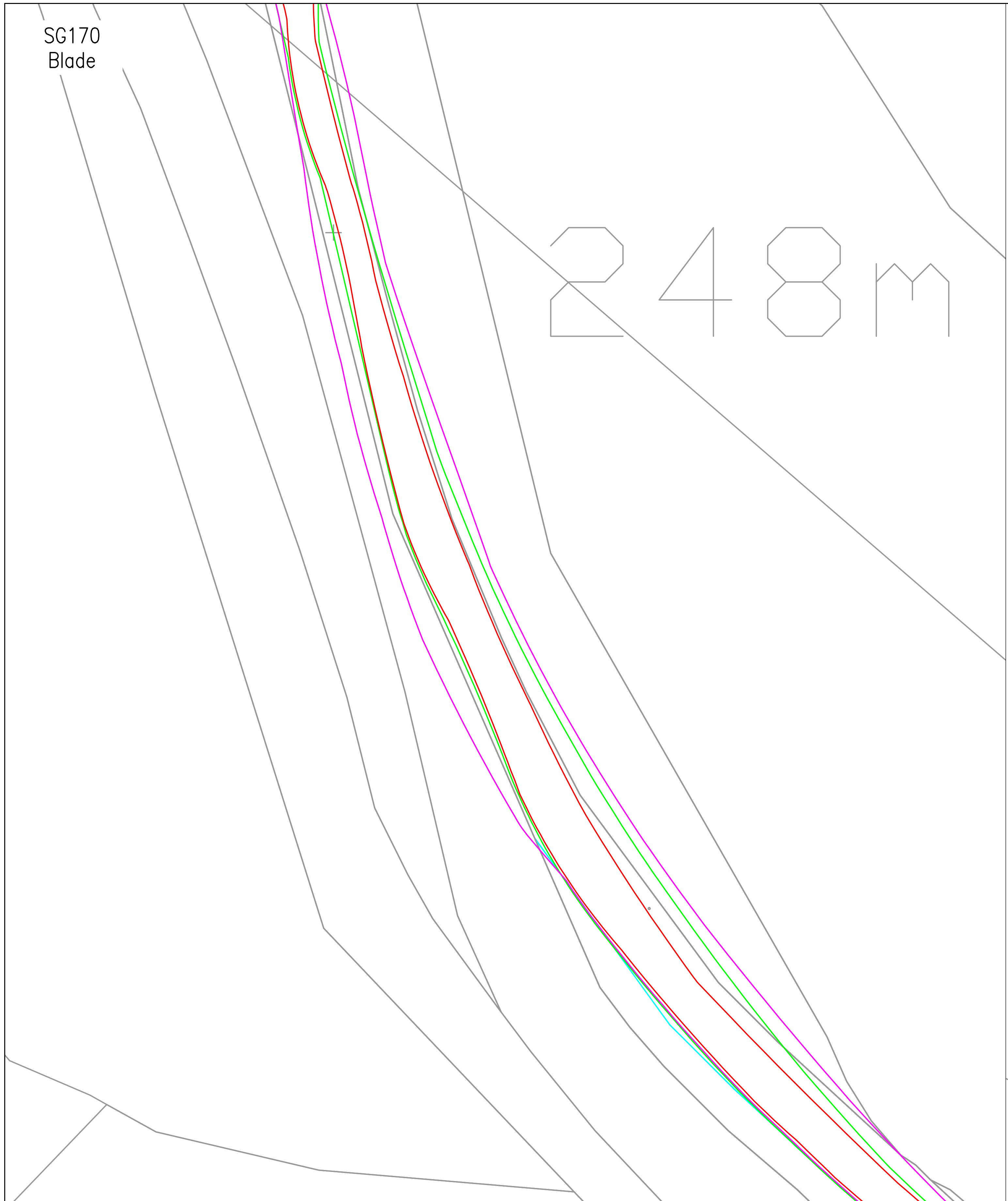
File No.: Quantans SPA (FINAL).dwg

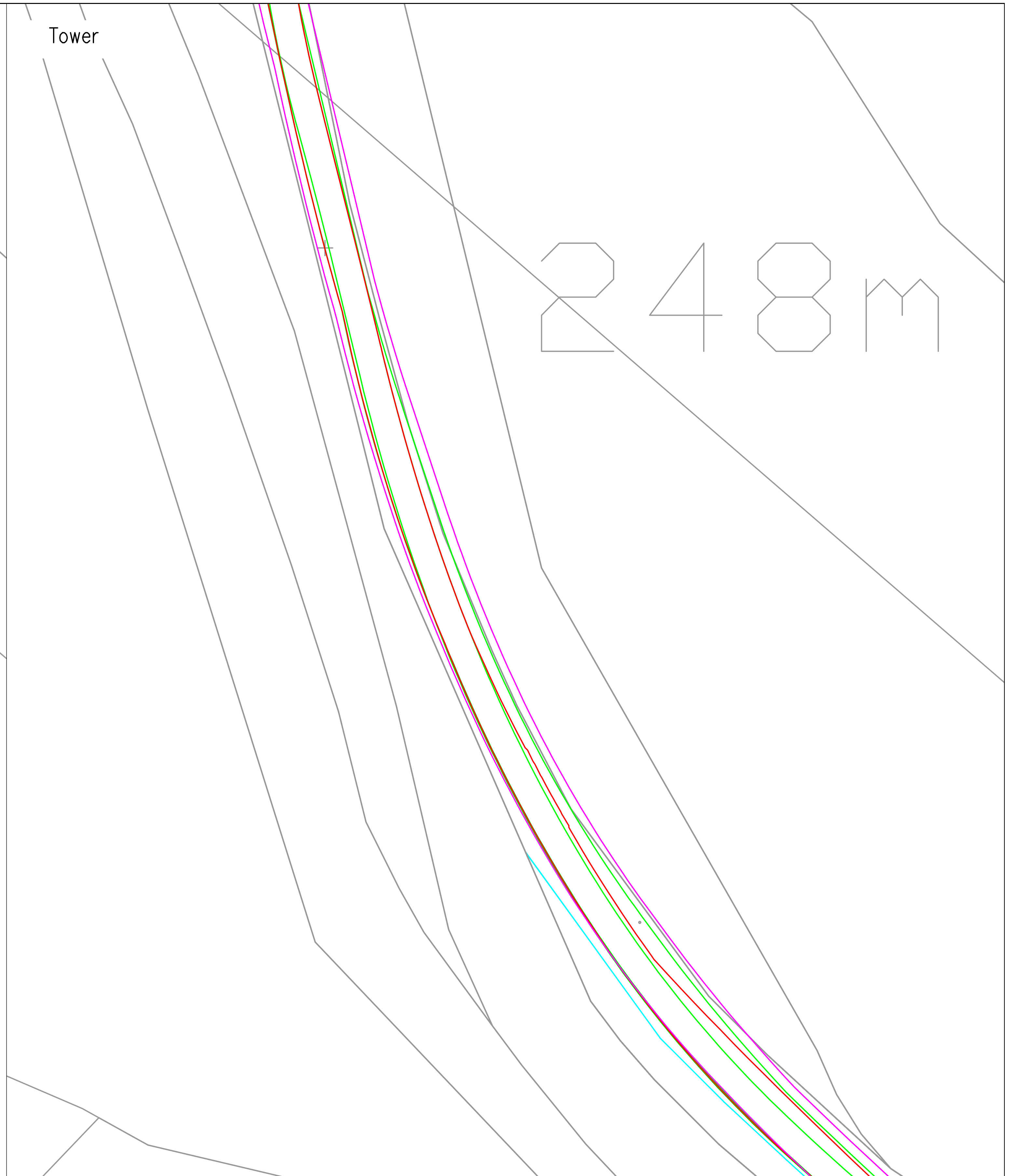
Drawing Status: Draft

Drawing No.: SK38B

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1





Pell Frischmann
93 GEORGE STREET, EDINBURGH. EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 at Bryan's Heights

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		50

Scale: 1:500 @ A3

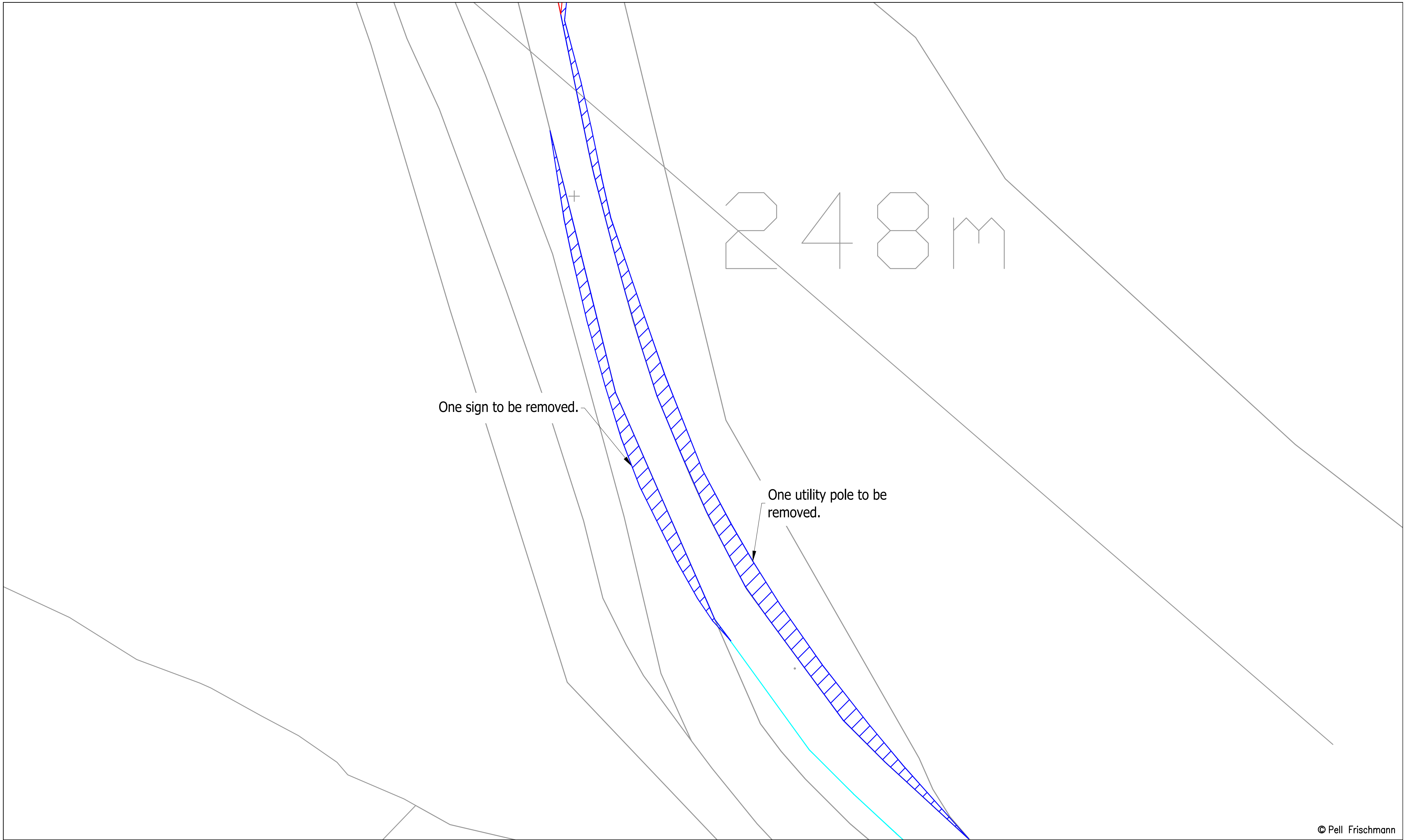
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK39A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1



Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 at Bryan's Heights

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest	50	

Scale: ##### @ A3

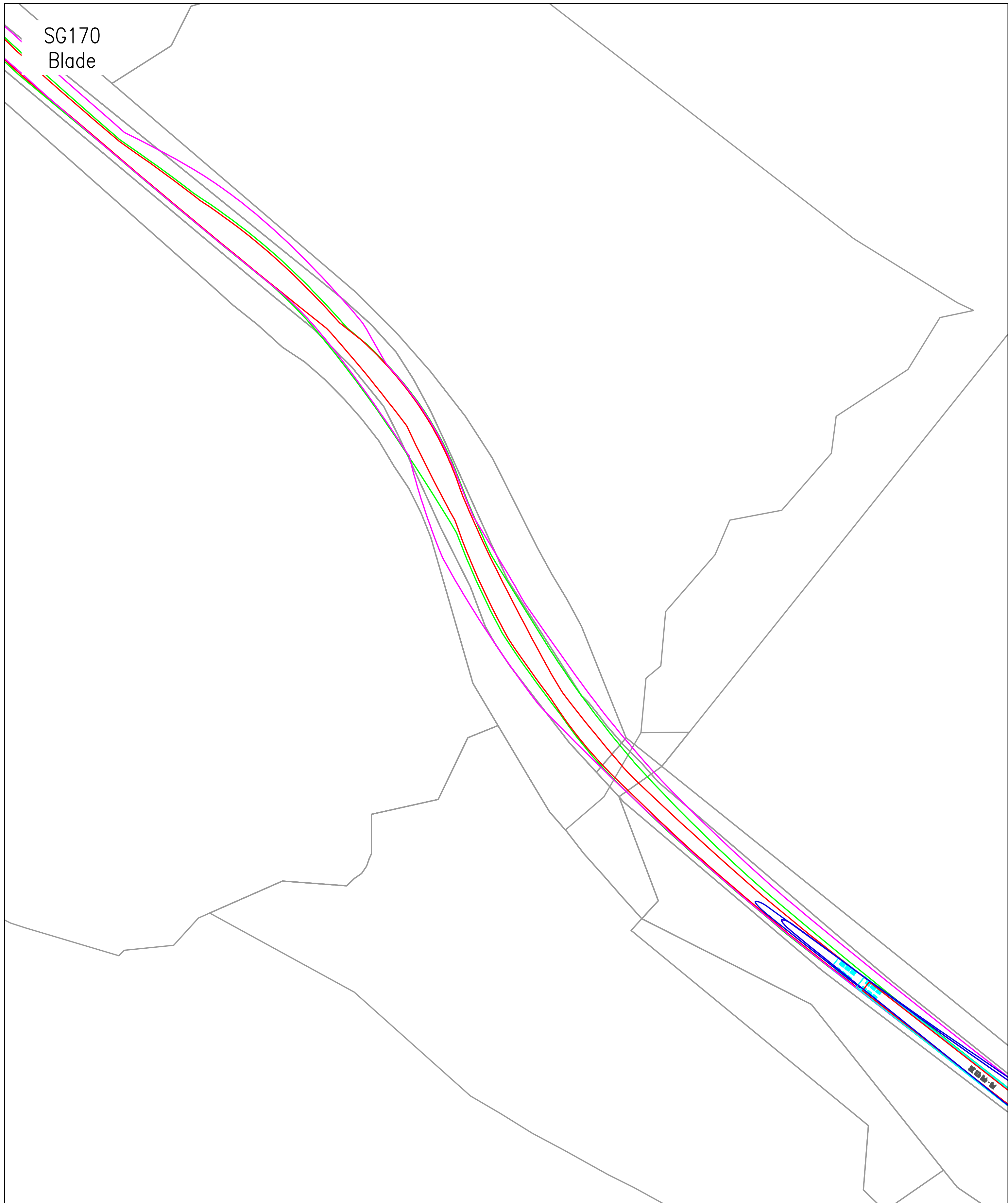
File No.: Quantans SPA (FINAL).dwg

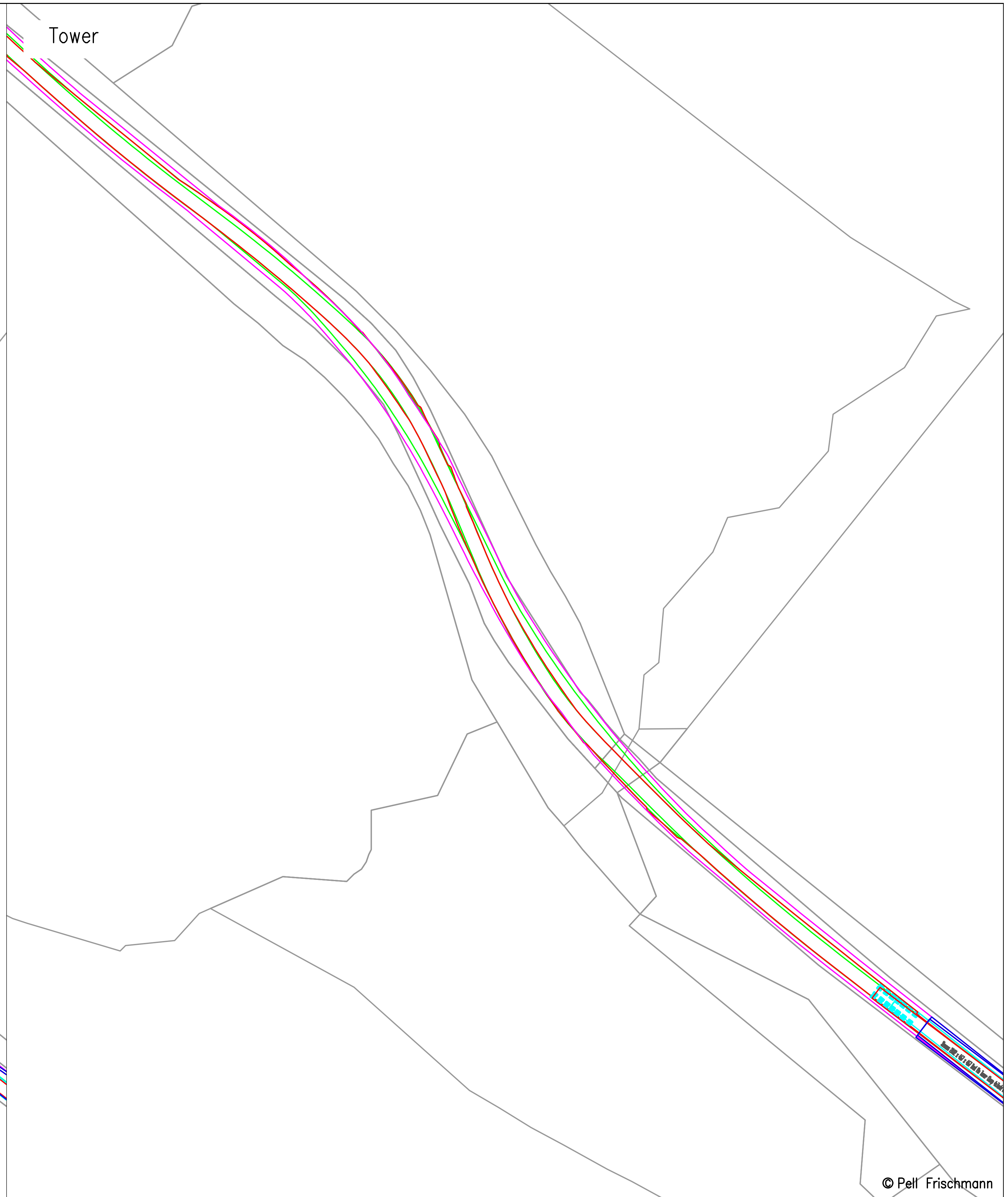
Drawing Status: Draft

Drawing No.: SK39B

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1





Pell Frischmann

93 GEORGE STREET, EDINBURGH, EH2 3ES

Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

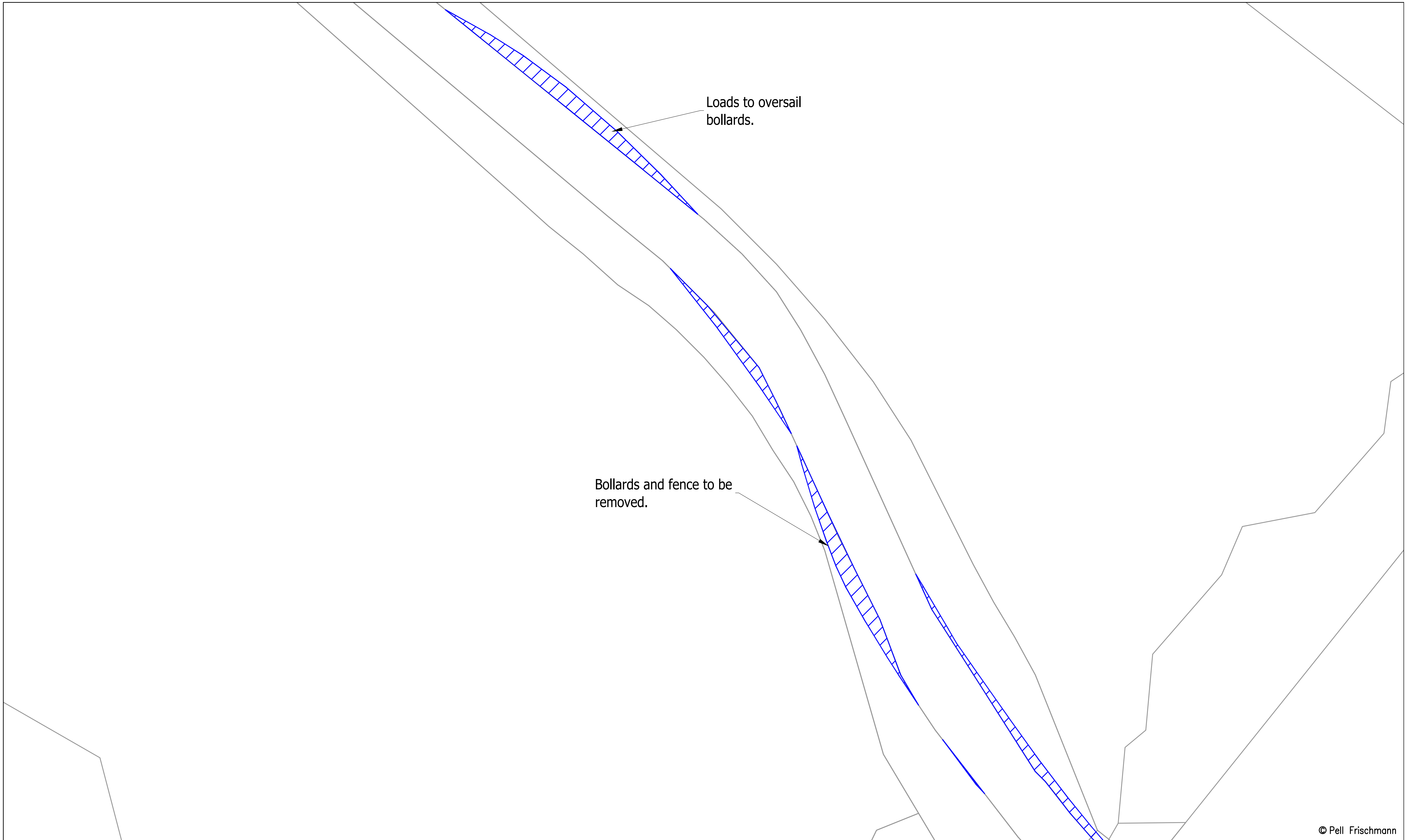
Project	Quantans Wind Farm
Client	Vattenfall
Drawing Title	SG170 Blade and Towers
SPA Location	A713 Craig Bridge

Key: Wheel SPA · Body SPA · Load SPA · Indicative · Over–run · Over–sail

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		51

Scale	1:1000 @ A3
File No.	Quantans SPA (FINAL).dwg
Drawing Status	Draft
Drawing No.	SK40A
Revision	1

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.



Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Craig Bridge

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		51

Scale: ##### @ A3

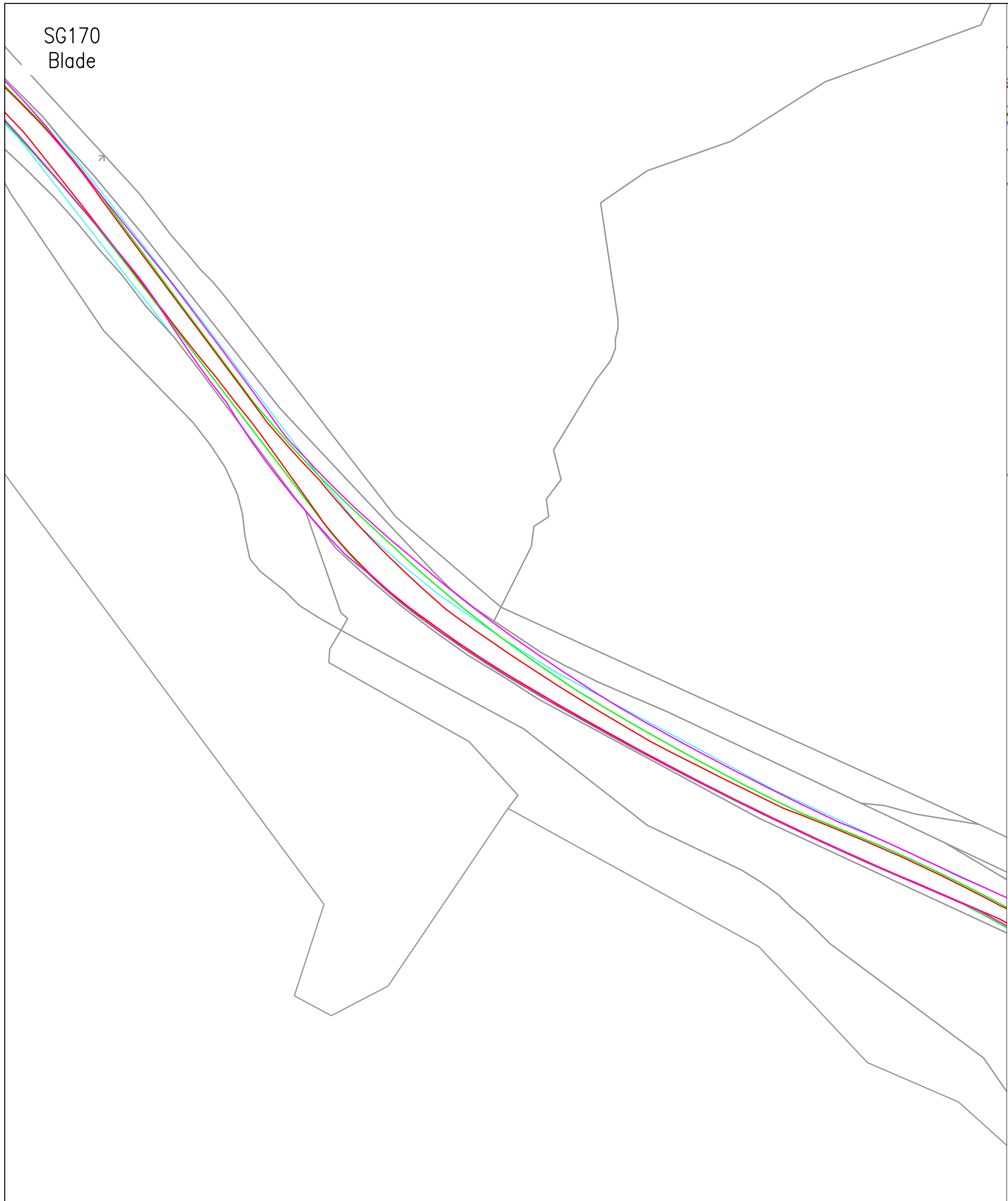
File No.: Quantans SPA (FINAL).dwg

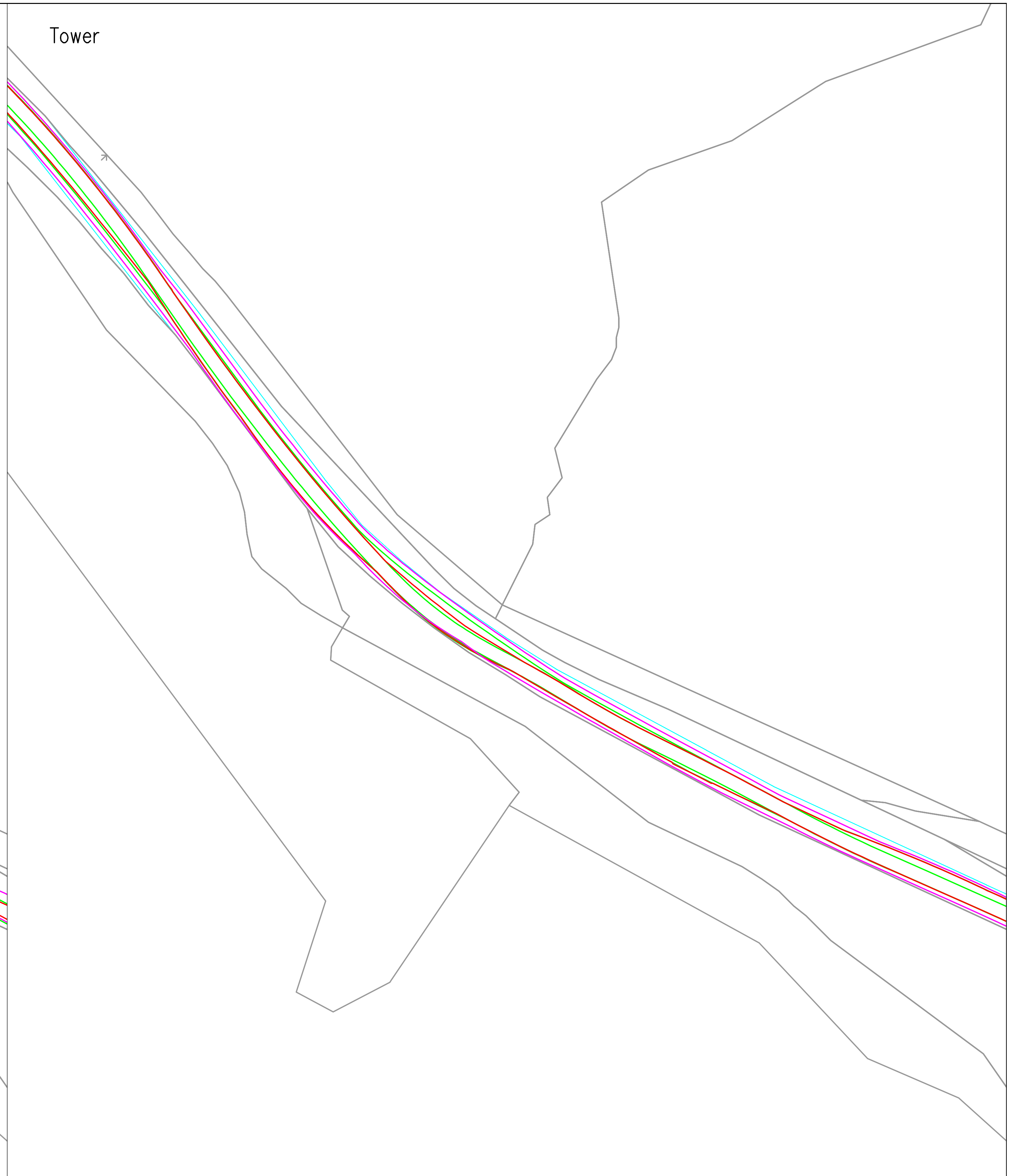
Drawing Status: Draft

Drawing No.: SK40B

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1





Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Glenmuck

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		52

Scale: 1:1000 @ A3

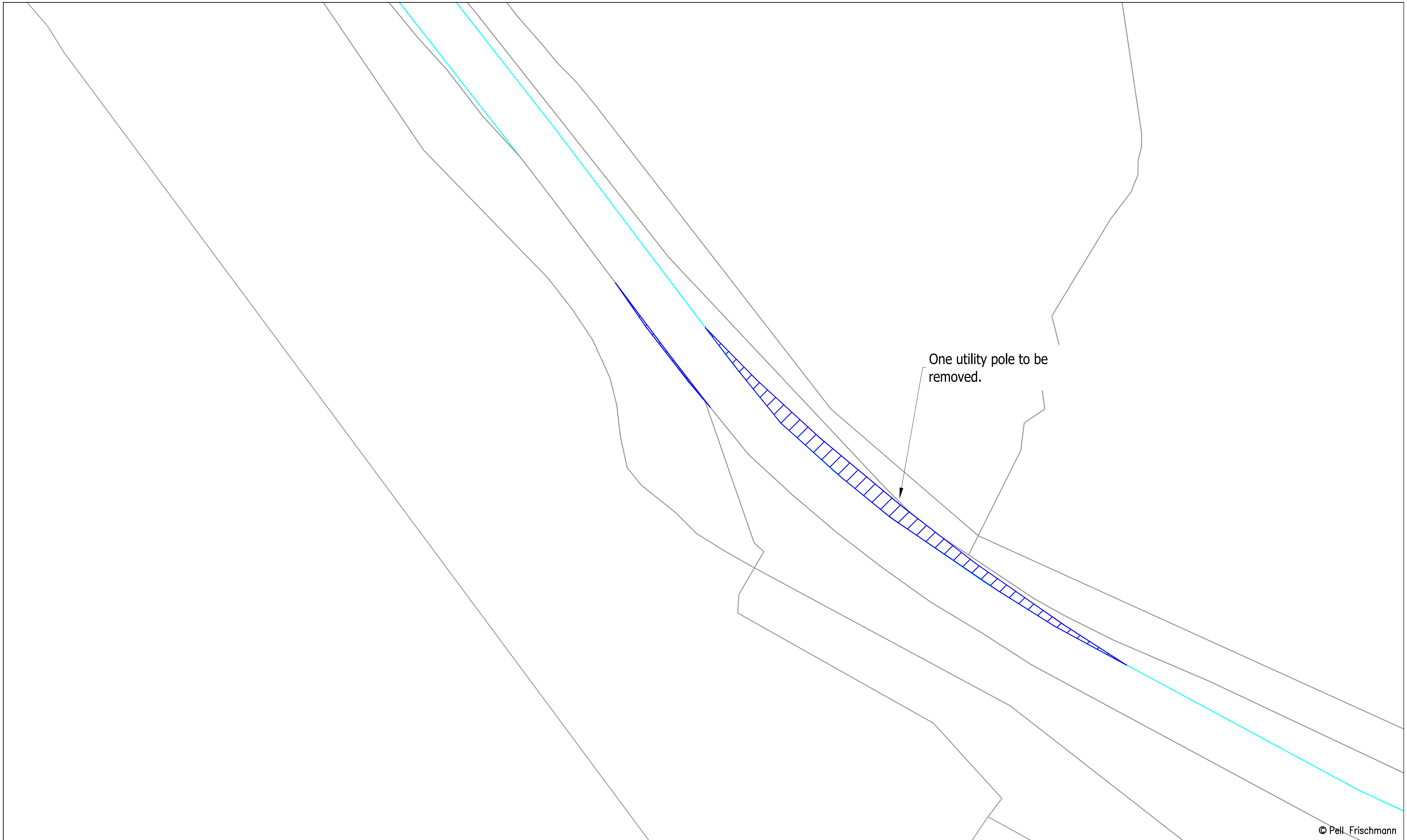
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK41A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1



Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Glenmuck

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		52

Scale: 1:500 @ A3

File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK41B

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1

Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Glenmuck

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		53

Drawing No.: SK42B

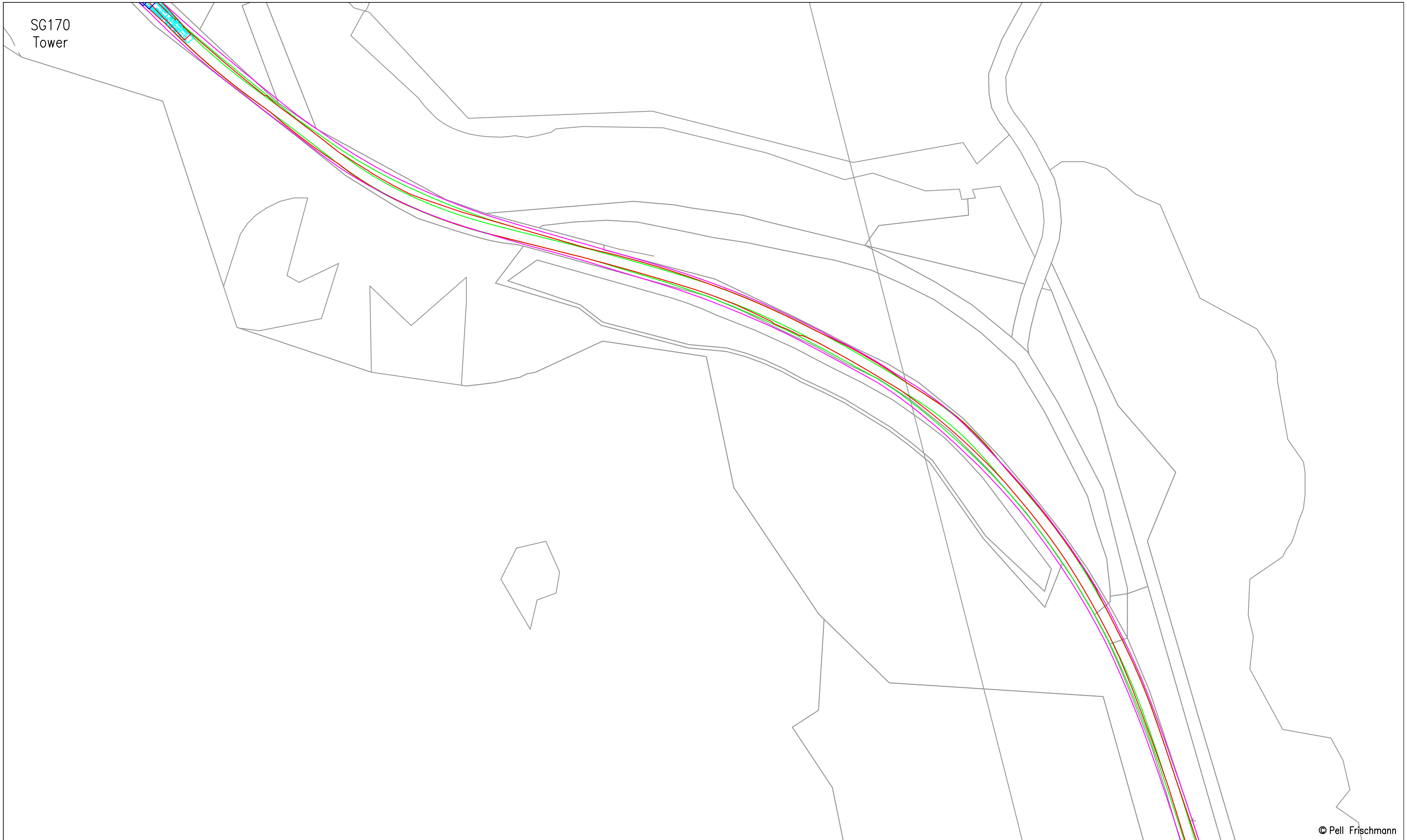
Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Scale: 1:1000 @ A3

File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Revision: 1



Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client	Vattenfall
Project	Quantans Wind Farm
Drawing Title	SG170 Blade and Towers
SPA Location	A713 Glenmuck

Key: Wheel SPA, Body SPA, Load SPA, Indicative, Over-run, Over-sail

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		53

Scale	1:1000 @ A3
File No.	Quantans SPA (FINAL).dwg
Drawing Status	Draft
Drawing No.	SK42C
Revision	1

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Pell Frischmann
93 GEORGE STREET, EDINBURGH. EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client	Vattenfall	Project	Quantans Wind Farm
Key	Wheel SPA, Body SPA, Load SPA, Indicative, Over-run, Over-sail	Drawing Title	SG170 Blade and Towers
		SPA Location	A713 Glenmuck

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		53

Scale	1:1000 @ A3
File No.	Quantans SPA (FINAL).dwg
Drawing Status	Draft
Drawing No.	SK42E
Revision	1

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Glenmuck

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		54

Scale: 1:1000 @ A3

File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK43A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1

Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Glenmuck

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		54

Scale: ##### @ A3

File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK43B

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1

Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA, Body SPA, Load SPA, Indicative, Over-run, Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Carsphairn

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		56, 57

Scale: 1:1000 @ A3

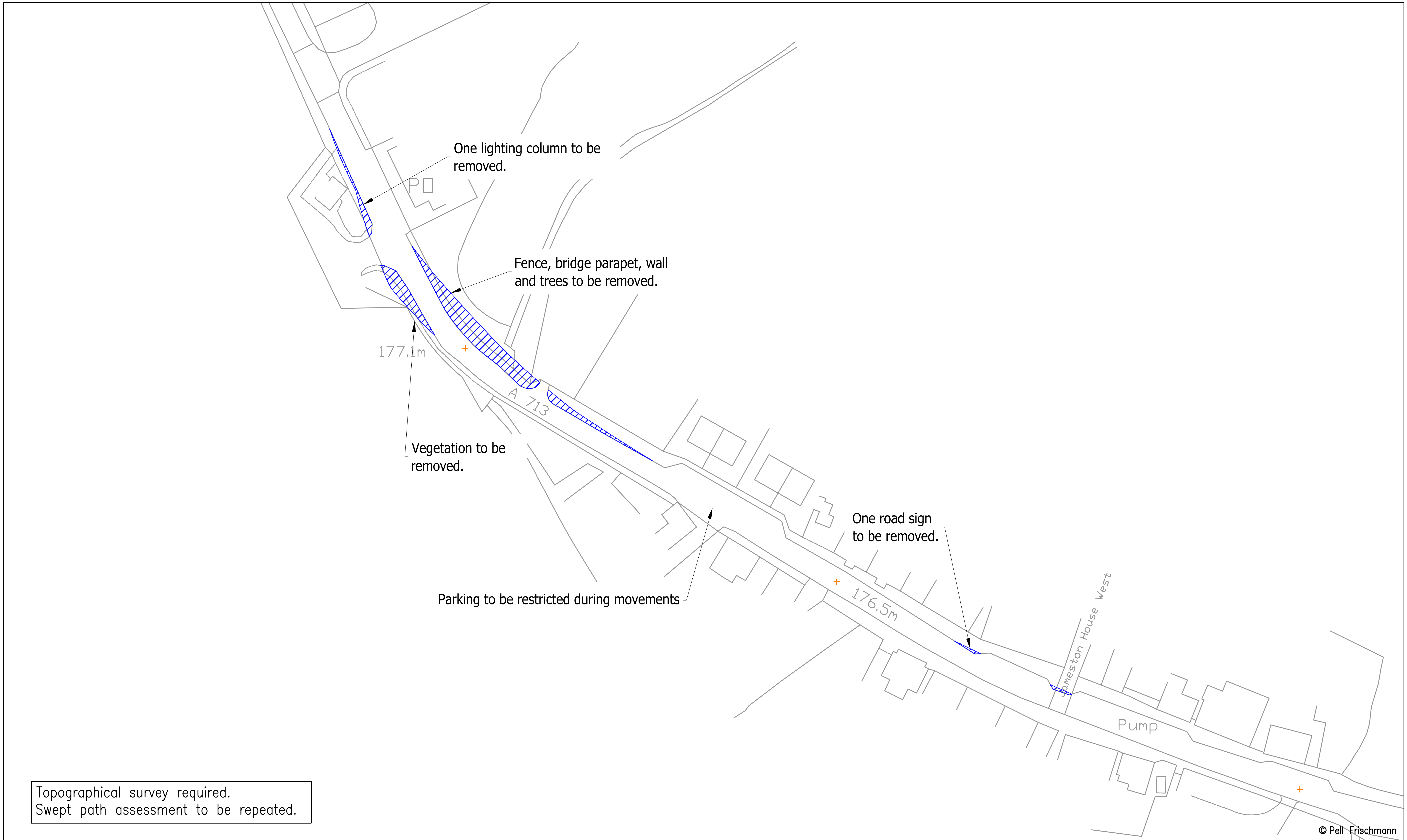
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK44A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1



Topographical survey required.
Swept path assessment to be repeated.

Pell Frischmann
93 GEORGE STREET, EDINBURGH. EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 Carsphairn

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		56, 57

Scale: ##### @ A3

File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK44B

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1

Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA | Body SPA | Load SPA | Indicative | Over-run | Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 / B729 Junctions

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		59, 60

Scale: 1:1000 @ A3

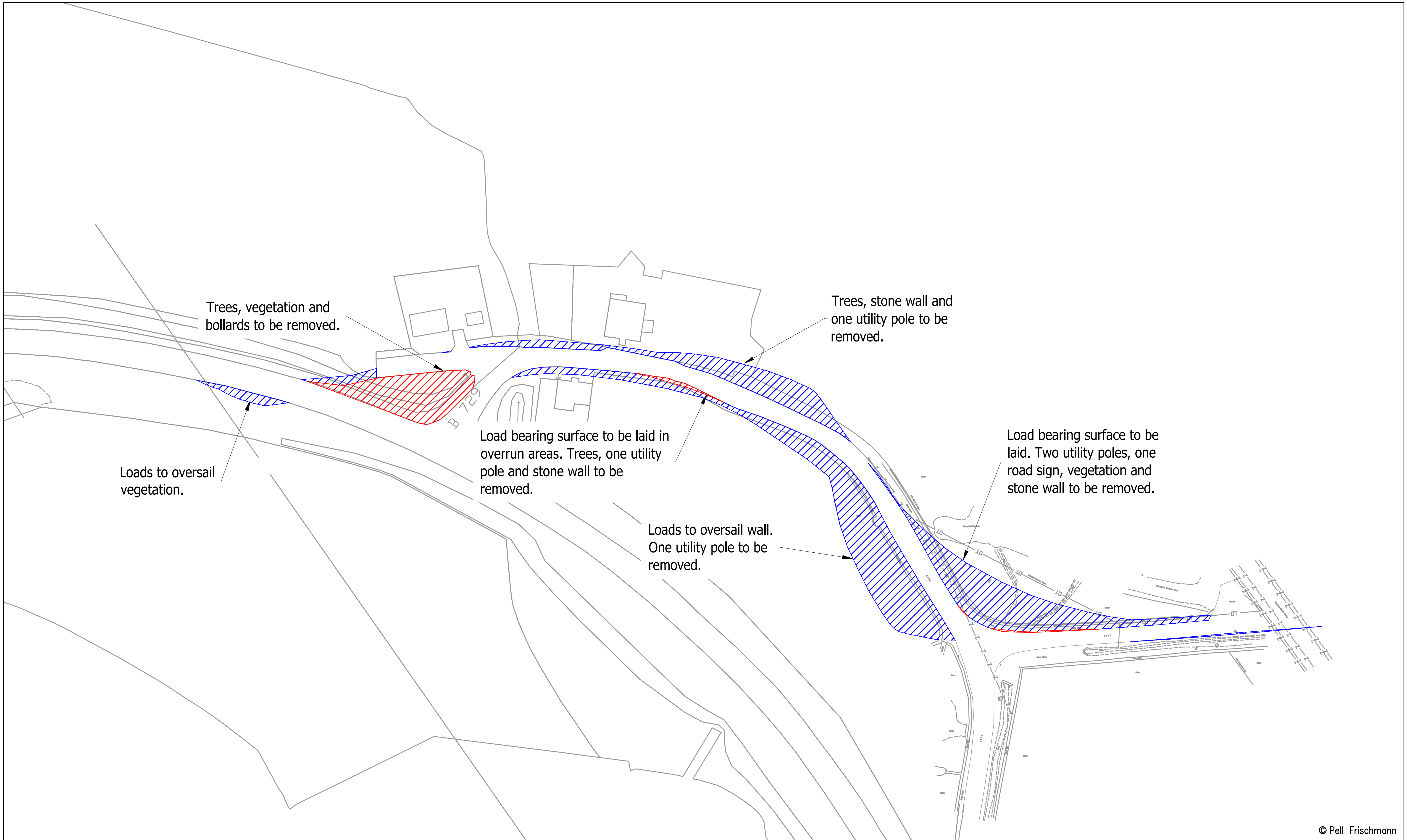
File No.: Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No.: SK45A

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1



Pell Frischmann
93 GEORGE STREET, EDINBURGH, EH2 3ES
Tel: +44 (0)131 240 1270
Email: pfedinburgh@pellfrischmann.com
www.pellfrischmann.com

Client: Vattenfall

Key: Wheel SPA, Body SPA, Load SPA, Indicative, Over-run, Over-sail

Project: Quantans Wind Farm

Drawing Title: SG170 Blade and Towers

SPA Location: A713 / B729 Junctions

	Name	Date
Drawn	JS	24/11/21
Designed	GB	24/11/21
Checked	GB	24/11/21
Point of Interest		59, 60

Scale: ##### @ A3

File No. Quantans SPA (FINAL).dwg

Drawing Status: Draft

Drawing No. SK45B

Notes:
1. All mitigation is subject to confirmation through a test run.
2. This is not a construction drawing and is intended for illustration purposes only.

Revision: 1

Appendix C
Weight Review Correspondence

From: Ierland, Alan
Sent: 03 August 2020 15:10
To: Jordan Stirrat
Cc: Nairn, Douglas Greig, Scott
Subject: RE: Quantans Wind Farm ESDAL [OFFICIAL] [PUBLIC]

CLASSIFICATION: **PUBLIC**

Jordan,

I refer to your email below and offer the following comments in respect of South Ayrshire Council and East Ayrshire Council.

The sections of the proposed route that fall within the jurisdiction of the two Councils are ;

- Port of Ayr out to the A77 Whitletts Roundabout
- A713 Bankfield Roundabout along the A713 to the site access south of Dalmellington

From the Port of Ayr out to Whitletts Roundabout there are two Council structures which should be OK in terms of the proposed 12 T axles. Network Rail should be consulted in respect of the rai bridge.

However, the developer will be required to undertake a topographical survey of the route to demonstrate via swept path analysis that the proposed abnormal loads can negotiate the route without the need for improvements to be undertaken. Any improvements will require to be approved by the Ayrshire Roads Alliance (ARA).

The section of the route from Bankfield Roundabout to the site access falls predominately within the East Ayrshire Council boundary and there are a substantial number of structures on the route and a number of locations where the geometry of the route may present problems for the abnormal load movements.

It is likely that all bridges and culverts on the A713 between the Bankfield Roundabout and the East Ayrshire/Dumfries and Galloway boundary should be satisfactory for the proposed 12T axle load with the exception of A713/30 Boneston Bridge at OS 238606, 616244 (Approximately 4.5km from the A713/A77 junction). A number of developers have been advised that the bridge is not currently suitable for wind farm abnormal load traffic.

The South Kyle Wind Farm (SKWF) developer is currently in the process of assessing various structures on the A713 to demonstrate their suitability to carry abnormal load vehicles specific to their development. They are also liaising with ARA in respect of proposals to strengthen Boneston Bridge.

Their route is from Ayr along the A713 to south of Dalmellington. All of their A713 route is part of your proposed A713 route. There is a further structure on the A713 at the East Ayrshire/Dumfries and Galloway boundary which would need to be included re the Quantans development. However, this structure is managed by Dumfries and Galloway Council and they should be contacted re its suitability.

From ARA's perspective it would seem to make sense for you to contact the SKWF developer and see if you can come to some arrangement with them. The consultant acting for them would I am sure be able to provide a report(s) on the suitability of the structures to carry the abnormal loads associated with the Quantans turbines and also ensure that the strengthening of Boneston Bridge meets the requirements of Quantans.

Several pinch points along the route are also being improved by the SKWF developer and it would make sense to ensure that the construction of these meets the future needs of the Quantans development.

Please note that the abnormal loads that make up the crane vehicles and ballast vehicles associated with a wind farm can often be more critical than the turbine component abnormal loads and these also need to be considered as part of the bridge assessment process.

Ultimately, ARA will require a report(s) from the Quantans developer demonstrating the adequacy of the structures on the route in respect of their proposed abnormal load configurations, including cranage and ballast vehicles.

I trust the above is of assistance.

Regards,

Alan Ierland, BSc Hons, CENG, MICE
Design & Environment Team Manager – Ayrshire Roads Alliance
Opera House, 8 John Finnie Street, Kilmarnock, East Ayrshire, KA1 1DD

From: SC Abnormal Loads
Sent: 30 July 2020 16:35
To: Jordan Stirrat
Subject: RE: Quantans Wind Farm ESDAL

No Scottish Canals Infrastructure Affected

SC Abnormal Loads

Email:

| | |

Scottish Canals

From: O'Connor, Brian (NS)
Sent: 31 July 2020 12:06
To: Jordan Stirrat
Cc: Dempsey, Henry (NS)
Subject: RE: Quantans Wind Farm ESDAL (OFFICIAL)

OFFICIAL

Hi Jordan,

As before, the proposed route out of KGV is acceptable to Glasgow City Council.
Perhaps with this proposal you might consider circumnavigating some of the shorter vehicles by utilising the Seward St junction, next to Jct 21 of the M8, it would save having to go all the way around the city. Just a thought.

Regards.

Brian O’Connor.

From: M8DBFO Abloads
Sent: 30 July 2020 18:33
To: Jordan Stirrat
Cc: M8DBFO Abloads
Subject: RE: Quantans Wind Farm ESDAL
Importance: High

No issues with this proposed route from a structural capacity point of view

Iain Franklin
Principal Project Manager | M8 DBFO | Transport Infrastructure
Amey | Bargeddie Office | Langmuir Road | Bargeddie | G69 7TU

From: Maniraj Sunil **On Behalf Of** Abnormal Loads Enquiries
Sent: 31 July 2020 11:10
To: Jordan Stirrat
Subject: RE: Q-835 Quantans Wind Farm ESDAL

OFFICIAL

Hi Jordan

The proposed route does cross one of our structures on Whitletts Road, Ayr. However in order for the complete the necessary assessment we require the full configuration including the actual axle weights and spacings.

Many Thanks

Sunil Maniraj
Abnormal Loads Clerk
Abnormal Loads Team – Part of the National Records Group

From: OSD Abnormal Loads Scotland
Sent: 31 July 2020 08:12
To: Jordan Stirrat
Subject: RE: Quantans Wind Farm ESDAL [OFFICIAL]

OFFICIAL

Morning

In response to your email enquiry, I can provide the following information on behalf of Police Scotland.

When a haulier has been selected for a particular project and they have been furnished with precise dimensions of the wind turbine components to be transported by road, thereafter as part of the planning process a detailed route survey is produced by the haulier identifying all potential issues often referred to as “pinch points” along the entire proposed route. The route is then examined and commented upon by Transport Scotland /Transerv and the relevant Local Council amongst other partners.

Police Scotland consider the proposed route primarily from a road safety perspective. If due to the abnormal dimensions it is apparent other road users will be required to be directed to stop along the route by police in order to safely facilitate the movement or encroachment into an opposing undivided carriageway will occur, then police officers will be deployed to warn other road users of the presence of the abnormal load. The timings of the movements are dependant on many factors dependant on the route and Transport Scotland may place restrictions on travel during peak times to ensure journey time reliability along their trunk road network.

The Abnormal Load Team who are involved with resourcing of current wind farm AILs and can be reached on the following email address abnormalloadsscotland@scotland.pnn.police.uk

Regards

Lorna Hazzard

Business Support Administrator
VRS & Abnormal Loads
Police Scotland
Fife Divisional HQ
Detroit Road,
Glenrothes
Fife
KY6 2 RJ

Email: OSDAbnormalLoadsScotland@scotland.pnn.police.uk

Website: www.scotland.police.uk
Twitter: @policescotland
Facebook: www.facebook.com/policescotland

From: rsgbrb
Sent: 31 July 2020 14:28
To: Jordan Stirrat
Subject: RE: Quantans Wind Farm ESDAL

Dear Jordan,

Thank you for your enquiry.

I have checked the proposed route, and as it will not impact any HRE structures, I have no comments or objections.

Regards
Tania

Tania Howell
Abnormal Loads Officer (on behalf of **Highways England Historical Railways Estate**)
Jacobs

From: Abnormal Load Routing
Sent: 31 July 2020 12:24
To: Jordan Stirrat
Subject: RE: Quantans Wind Farm ESDAL

Good afternoon Jordan,
In regard of the proposed route SWU has not a structures with particular restrictions.
Regards
Vassil Dimitrov

From: Paul.Winn
Sent: 03 August 2020 13:18
To: Jordan Stirrat
Subject: RE: Quantans Wind Farm ESDAL

Hi

We would prefer Ayr to be used as the port of entry. If this is not possible we would prefer the vehicles to use Seaward Street to get from the M8 to the M77 if possible rather than taking the M74 and M73.

Paul
Paul Winn
Network Administrator
Administration Team
Roads Directorate

transport.gov.scot

Appendix 11.2

Traffic Management Plan

Document history

Author Mhairi Bowley 18/08/2021

Client Details	
Contact	Matthew Bacon
Client Name	Vattenfall Wind Power Ltd

Issue	Date	Revision Details
A	06/10/2021	First issue
B	11/01/2022	Update from Client Comments
C	19/01/2022	Released

Quantans Hill Wind Farm

Preliminary Traffic Management Plan

18 August 2021

1259558

Vattenfall Wind Power Ltd.

Document history

Author	Mhairi Bowley	18/08/2021
Checked	Euan Reilly	29/09/2021
Approved	Craig Galloway	06/10/2021

Client Details	
Contact	Matthew Bacon
Client Name	Vattenfall Wind Power Ltd.
Address	St Andrews House, Haugh Lane, Hexham, NE46 3QQ

Issue	Date	Revision Details
A	06/10/2021	First Issue
B	11/01/2022	Update from Client comments
C	19/01/2022	Released

Local Office:

Ochil House
Springkerse Business Park
Stirling
FK7 7XE
SCOTLAND
UK
Tel: +44 (0) 1786 542

Registered Office:

The Natural Power Consultants Limited
The Green House
Forrest Estate, Dalry
Castle Douglas, Kirkcudbrightshire
DG7 3XS

Reg No: SC177881

VAT No: GB 243 6926 48

Contents

1. Introduction 1
   1.1. Policy and Legislation 1
2. Project Details 3
   2.1. Purpose 3
   2.2. Proposed Development 3
   2.3. Location 3
   2.4. Access 3
   2.5. Rights of Way 4
3. Construction Programme 4
4. Traffic Management 4
   4.1. General Information for Traffic Management 4
   4.2. Construction Vehicles 7
   4.3. Abnormal loads traffic to site 7
   4.4. Pre and Post Construction Road Condition Surveys 10
5. Works required to achieve vehicular access from the Port to site 10
6. Improvements to the public road/s to facilitate development 10
7. Trial Run 10
8. Summary 10

Appendices 12
A. Site access junction 12
B. Construction compound drawing 12

1. Introduction

This document has been prepared to establish the preliminary Traffic Management Plant (TMP) for the Proposed Development (Quantans Hill Wind Farm), establishing the route and methodology of transportation of the construction plant, equipment and materials during the construction phase of the wind farm. This preliminary TMP has been developed in conjunction with the Traffic and Transport chapter for the Environmental Impact Assessment Report (EIAR) as part of the planning application for the Proposed Development.

This preliminary TMP contains the principles that will form the basis for the appointed contractor (post consent) to develop their construction phase TMP which will be utilised to manage traffic during construction. It is expected that a planning condition will be included in any consent requiring the TMP to be submitted for approval by the planning authority prior to construction works commencing.

Traffic and Transport EIAR Chapter

The TMP includes a range of mitigation measures that were identified in the Traffic and Transport assessment of the EIAR to reduce the effect of the traffic associated with the Proposed Development and manage the construction traffic. The mitigation measures and recommendations from the Traffic and Transport assessment of the EIAR include:

- Proactive consultation with highways authorities and the local community and individuals effected by traffic routing to develop and agree mitigation measures as required. Suggested measures include:
  – Temporary railings along footpaths/edge of road to provide a physical demarcation to the highway;
  – Temporary speed restrictions; and/or
  – Stacking HGV deliveries up and running an escorted convey of HGVs.
- Public notifications and liaison during the construction phase of planned vehicle movements (e.g. turbine deliveries and timings, HGV numbers, timings, particular busy periods and durations).
- HGV deliveries, including abnormal loads, scheduled to avoid peak times
- To reduce risk to pedestrians and road users, abnormal loads should be adequately escorted and appropriate traffic management and signage used.
- It is important that the highway authorities are consulted on all transport issues and to make sure that deliveries do not conflict with other scheduled road works.

1.1. Policy and Legislation

1.1.1. Policy Context

1.1.1.1. *Scottish Government Web based advice for Onshore wind turbines (May 2014) –*

The section ‘Road Traffic Impacts’ touches the problem of Abnormal Indivisible Loads (AIL) deliveries, stating that

“*In siting wind turbines close to major roads, pre-application discussions are advisable with Transport Scotland’s Trunk Roads Network Management (TRNM). This is particularly important for the movement of large components (abnormal load routing) during the construction period, periodic maintenance and for decommissioning…”*

1.1.2. **Legislative Context**

1.1.2.2. **Abnormal Indivisible Loads**

All movements of abnormal loads shall be in accordance with the following legislation:

- Part II of the Road Traffic Act 1988
- Road Vehicle (Construction & Use) Regulations 1986
- Road Vehicle (Authorisation of Special Types) (General) Order 2003 (the latter commonly referred to as S.T.G.O.).

An "abnormal indivisible load" is defined in The Road Vehicles (Authorisation of Special Types) (General) Order 2003,:"*In this Order "abnormal indivisible load" means a load that cannot, without undue expense or risk of damage, be divided into two or more loads for the purpose of being carried on a road and that –*

(a) on account of its length or width, cannot be carried on a motor vehicle of category N3 or a trailer of category O4 (or by a combination of such vehicles) that complies in all respects with Part 2 of The Construction and Use Regulations; or(b) on account of its weight, cannot be carried on a motor vehicle of category N3 or a trailer of category O4 (or by a combination of such vehicles) that complies in all respects with –

(i) the Authorised Weight Regulations (or, if those Regulations do not apply, the equivalent provisions in Part 4 of the Construction and Use Regulations); and

(ii) Part 2 of the Construction and Use Regulations."

Notifications for abnormal indivisible loads are required where loads or vehicles exceed maximum gross vehicle weight or dimension limits in any of the following ways:

- a gross vehicle weight of more than 80,000kg
- a width exceeding 3m
- a length exceeding 18.75m

Each load requires at least two clear days' notice to the relevant police and highway authorities, as detailed in Table 2.1. The haulier must also indemnify each highway authority against any damage caused to any road, bridge or other structure.

Table 1.1: Weight Regulations

Weight	Action required
Gross weight or axle weights exceeding C&U or Authorised Weight limits up to 80,000kgs	Two clear days' notice with indemnity to Highway and Bridge Authorities
Gross weight (of vehicle carrying the load) exceeding 80,000kgs up to 150,000kgs	Two clear days' notice to Police and 5 clear days' notice with indemnity to Highway and Bridge Authorities.
Gross weight (of vehicle carrying the load) exceeding 150,000kgs	HA Special Order (BE16) (8-10 weeks) plus five clear days' notice to Police and five clear days' notice with indemnity to Highway and Bridge Authorities
Width	**Action required**
Width exceeding 2.9 metres (for C&U loads 3.0 metres) up to 5.0 metres for other loads	Two clear days' notice to the Police
Width exceeding 5.0 metres up to 6.1metres	HA form (VR1) (2 weeks) plus two clear days' notice to Police

Weight	Action required
Width exceeding 6.1 metres	HA Special Order (BE16) (8-10 weeks) plus five clear days' notice to Police and five clear days' notice with indemnity to Highway and Bridge Authorities
Length	**Action required**
Length exceeding 18.65 metres up to 30 metres rigid length (Vehicle or train of vehicles)	Two clear days' notice to the Police
Vehicle combination exceeding 25.9 metres	Two clear days' notice to the Police
When exceeding 30.0 metres rigid length	HA Special Order (BE16) (8-10 weeks) plus five clear days' notice to Police and five clear days' notice with indemnity to Highway and Bridge Authorities

2. Project Details

2.1. Purpose

The main purpose of the production of this TMP is to ensure the safety of the public and workforce and to manage traffic to/from the site efficiently to aid in minimising disruption to local residents and businesses

2.2. Proposed Development

The following key elements are currently being considered for the proposed development:

- Up to 14 wind turbines, with a maximum height of 200m to blade tip;
- Creation of a site access junction on the B729;
- Creation of 14.7km of new site tracks;
- Temporary borrow pits;
- Underground cables;
- Anemometry mast;
- Temporary construction and storage compounds;
- Substation, compound and control building and battery storage;
- Temporary batching plant(s);
- Improvements to the public roads to facilitate turbine deliveries.

2.3. Location

The Proposed Development is located on Quantans Hill, located in Dumfries and Galloway, northeast of the village of Carsphairn and east of the A713. The site total area is 1800ha.

The existing B729 road that leads to the site leaves the A713 approximately 0.5 km to the east of Carsphairn. These roads will be utilised and upgraded where necessary.

The site is not subject to any statutory environmental designation.

2.4. Access

The site will be accessed from a new dedicated access junction off the existing B729, with upgrades to the route as necessary. The site access junction will be suitable to take delivery of abnormal loads, see Appendix A for details.

2.5. Rights of Way

There is a Public Right of Way that traverses the site but does not appear to physically exist on site and an unmarked walking route to the summit of the Cairnsmore of Carsphairn in the north of the Proposed Development Area. At all times during construction signs shall be in place to warn users of local footpaths of the construction site and the hazards it would present. It may be necessary to erect a barrier to close off the public during the construction of the works. Consideration will be given to alternative accesses during this period.

3. Construction Programme

A construction programme, with key dates for construction works, has been included below, however it should be noted that this is a live document and subject to change without notice.

Table 3.1: Construction Programme

Indicative Date	Description
April 2025	Start of Forestry Works
August 2025	Start of Balance of Plant Construction Works
March 2026	Start of Wind Turbine component deliveries
May 2026	End of Abnormal Wind Turbine component deliveries
August 2027	End of Construction

Source: Vattenfall Project Key Dates

Upon appointment of the turbine supplier the delivery schedule of the wind turbine components will be incorporated into the construction programme.

4. Traffic Management

4.1. General Information for Traffic Management

4.1.1. Consultation

This preliminary TMP has been developed taking cognisance of the Traffic and Transport chapter of the EIAR. Key to the successful implementation of the TMP is proactive consultation with the local highway authorities and the local community and individuals effected by traffic routing to develop and agree appropriate traffic management measures.

The construction TMP shall be developed in consultation with the above parties with the traffic management measures agreed and implemented where necessary prior to construction commencing. A system of communication shall be agreed with the above parties for enabling proactive consultation to take place throughout the construction phase. This is expected to include signage on the road advising of dates for particular construction events affecting the road network (i.e. AIL deliveries, concrete pours, etc) well in advance of the scheduled dates, community meetings and direct notification (i.e. letter drops, face to face, SMS, etc) to affected parties.

Thereafter, the Principal Contractor shall appoint a nominated person to whom all traffic management and road safety issues shall be referred. The nominated contact will liaise with both the relevant stakeholders to review and updated the agreed construction TMP as required during the construction period.

4.1.2. Preliminary Traffic Management Measures

The Traffic and Transport chapter of the EIAR is based on a worst-case scenario of 100% import of materials, including aggregate for tracks and hardstands, and ready-mix concrete deliveries. In adopting this worst-case scenario, the Traffic and Transport chapter identified potential impacts and a number of potential traffic management measures that could be implemented to mitigate the impacts of the construction traffic on the local communities. The requirement to adopt these mitigation measures should be considered taking account of the actual material source and import (i.e. if aggregate for tracks and hardstands is won on site from borrow pits then the actual traffic impact will be less than that identified and mitigation measures may not be merited).

The range of mitigation measures identified in the Traffic and Transport chapter that would be considered include:

- Temporary pedestrian crossings for areas with limited footways and existing pedestrian crossings that will be particularly dissected by construction traffic.
- Temporary signage to inform both drivers and pedestrians of construction traffic, durations, routes, etc.
- Temporary railings along footpaths/edge of road in areas of limited or narrow footways, individual properties that front onto the highway and areas subject to pedestrian movement to provide a physical demarcation to the highway.
- Stacking HGV deliveries up and running an escorted convey of HGVs through particularly sensitive areas or at particularly sensitive times.
- Temporary localised speed restrictions (refer to Section 4.1.7).
- Scheduling of HGV deliveries (refer to Section 4.1.6).

As part of the construction TMP, the above measures, as well as any other measures identified during the development and consultation of the construction TMP, shall be fully developed and detailed including locations, extents and durations.

4.1.3. Signage

Any signage required on the public road will be erected and positioned in accordance with the requirements of Chapter 8 of the Traffic Signs Manual, and Safety at Street Works and Road Works – A Code of Practice, and in consultation with the relevant highway Authorities.

Any permanent signs and street furniture which require to be relocated to allow AIL loads to pass shall be identified in consultation with the local highway authorities and from the trial run. Where possible and agreed with the local highway authorities, signs requiring such relocation shall be permanently shifted onto new permanent mountings.

Where signs must be removed to facilitate the passing of the AIL, yet must remain at their existing location in the interim, they shall be updated as part of the advance works with temporary mountings designed to facilitate rapid removal. These signs shall be taken down immediately in advance of the passage of abnormal loads and re-erected immediately after the load has passed. This will be undertaken by operatives travelling in the load escort vehicles.

4.1.4. Routes and access

The route for general construction vehicle travel will be dependent upon the location of materials and supplies that are being delivered. Construction materials would be sourced as locally as possible (site won where possible). Materials that cannot be sourced on site will be sourced as locally as possible and delivered to site using the main road network.

Construction traffic will depart the A713 at the junction with the B729, and travel to site via a newly constructed access track.

It is envisaged that wind turbine components will be delivered as outlined in Section 4.3.2.

4.1.5. Emergency vehicle access

Details of the HGV site access and egress measures, including emergency procedures and an Emergency Response Plan, shall be included within the Principal Contractor's own site-specific Construction Phase Plan. A draft Construction Phase Plan will be provided as part of any Discharge Documentation. The Principal Contractor shall be responsible for communicating these details to all operatives, the emergency services and visitors to the site. For the avoidance of doubt, the access to the site shall remain free of obstruction at all times during the construction phase.

4.1.6. Timing of construction traffic

The hours of construction will be restricted to mitigate impact to neighbouring properties during anti-social hours.

In general, it is assumed that general construction activities will be permitted between the following times:

- Monday to Friday 07:00 – 19:00
- Saturday 07:00 – 16:00

It would be anticipated that traffic will travel at either side of these timings above.

Further, it is anticipated that certain activities such as concrete pours and turbine deliveries will be permitted outside the general working hours.

4.1.7. Driving and speed restrictions

All vehicles (cars, LGVs, HGVs and AILS) shall be driven in a manner which is safe and defensive at all times. A zero tolerance policy shall be adopted by all contractors, such that any infringement results in that person not returning to site.

All cars and drivers of site operatives vehicles used for commuting to site must be roadworthy and fully and legally compliant.

All commercial vehicles and drivers must be road worthy and fully and legally compliant.

An advisory speed limit of <20mph onsite will be maintained and all site drivers will be made aware of this.

4.1.8. Operation and maintenance of onsite tracks

The following measures shall be adopted during the construction phase of the project and implemented by the Principal Contractor as and when appropriate:

- The onsite tracks will be in sufficient condition prior to commencement of construction and improvements will be ongoing to keep the tracks in a suitable state for deliveries.
- All road cross drains shall be kept clear of blockages, and longitudinal drains maintained as necessary.
- The onsite tracks will be inspected frequently by the Site Manager and any deficiencies shall be made good.
- Any aspects resulting in immediate safety concerns shall be subject to immediate temporary rectification.
- The access roads shall be kept clear and swept on an as-needs basis.

4.1.9. Travel plan to minimise private car travel

The traffic impacts associated with commuting to and from the site are not expected to be significant.

To minimise private car travel, construction personnel will be sourced locally to site where possible and travel to site in shared vehicles as far as reasonably practicable in line with prevailing Covid procedures, if still applicable at the point of construction.

The use of crew buses will minimise the number of individual trips made to and within the Quantans Hill Wind Farm construction site.

Car parking will be provided entirely within the confines of the site boundary and will not be permitted on the adjacent road network so that sight lines are maintained at the site access junction and to minimise the impact on existing road users.

Car parking will be segregated into clean areas for non-construction use vehicles and “dirty” areas for site-based traffic. Facilities for cleaning vehicles will be provided.

Any off-site temporary park and ride facility location would be planned, agreed and coordinated with the local authority.

A Project ‘Winterisation Plan’ will be developed which will detail measures to be taken to assess travel to the wind farm and on the wind farm during periods of inclement winter weather to ensure the safety of workers and the general public. The plan will detail communications and plans to ensure safety should the site need to be closed during periods of severe weather conditions. The plan will include emergency preparedness procedures.

Given the remoteness of Quantans Hill Wind Farm and the physical nature of the construction works, other initiatives for minimising private car travel, such as promoting public transport or providing opportunities to work from home, may prove to be impractical for introduction on this project.

4.2. Construction Vehicles

4.2.1. Wheel Cleaning

The Principal Contractor shall ensure the public roads are kept clear of deposits from the construction site which may constitute a road safety hazard for users.

Wheel cleaning facilities shall be established and maintained immediately before any vehicles coming from site upon reaching the public road at both identified access/egress points. All vehicles from site carrying mud on their tyres shall be required to use the wheel cleaning facilities.

4.2.2. Construction Vehicle Parking

A temporary parking area for cars and LGV’s will be established near to the compound area/s. The surface will be hard-core for use by all construction vehicles as well as visitors. An indicative Construction Compound drawing is contained within Appendix B.

Upon completion of the construction of the wind farm, the car park area will be landscaped, and the temporary fencing removed. The hard core will be covered with topsoil and turves stripped from the road widening works which will help to maintain a local seed base and the local geological/hydrological characteristics. If there is not sufficient turf to completely cover the area, then turf will be spread in smaller sections to offer some protection and spread the seed bank rather than leave larger exposed areas. If natural re-vegetation from the existing seed bank is not successful and has not occurred within an agreed period of time (e.g. two growing seasons) then reseeding using a native species mix may be considered.

4.3. Abnormal loads traffic to site

An abnormal load is a vehicle which exceeds certain weight, length or width limits set out in the Road Vehicle (Construction and Use) Regulation 1986.

Generally, these limits are:

Not exceeding 2.9m (9’6”) overall width.

Not exceeding 18.3m (60’0”) overall length.

Not exceeding 44,000kgs (44t) gross weight.

4.3.1. Permits

The hauliers will be contractually responsible for applying for the necessary abnormal load BE16 permits and ensuring that such deliveries are undertaken in accordance with the statutory requirements. These permits will apply to the entire abnormal load delivery route to the point of entry to site. The hauliers will ensure that no abnormal loads are allowed to be transported unless the required permits are in place.

4.3.2. AIL delivery route

Due to the size of some of the candidate turbine components, some elements will be moved as abnormal loads from King George V Dock in Glasgow, and some may be moved from Port of Ayr, to the proposed site entrance. The abnormal load route which is identified as the most appropriate route for delivery of the wind turbine components is set out in “Abnormal Indivisible Load Route Survey” prepared by Pell Frischmann July 2020, see EIAR Appendix 11.1. The “Abnormal Indivisible Load Route Survey” desk-top assessment of the route has identified a total of 60 points of interest along both public and private land. The findings of these will be confirmed through further assessments, including a trial run, once the turbine supplier has been appointed

4.3.3. Escorts

Where necessary under statutory regulations, abnormal deliveries shall be escorted by service vehicles provided by the transport haulier. Utilising the services of an escort aids in advance warning to other road users of the approaching load and allows traffic to be temporarily held at passing places to allow the AIL convoy to pass. Where escorts are required, there are typically two services vehicles per convoy. If required by the local police the convoys will also have a police escort.

4.3.4. Advance Arrangements

Each transport haulier will be responsible for agreeing a final delivery schedule with the relevant authorities with regards to the number of deliveries per convoy and the number of those convoys travelling to site per day. It is envisaged that an optimum number of abnormal loads per convoy will be implemented such that it will reduce the overall number of convoys without significantly impacting on local traffic flows.

Once the trailer has delivered its load to site, its length can then be reduced to a standard HGV size. When compressed, these HGV vehicles shall be able to utilise the local trunk network without the assistance of escort vehicles.

4.3.5. Number of Loads

The turbine components will be transported to site using a number of different large vehicles specially designed to carry the wide, heavy and/or long loads.

The following is a general assessment of the standard number of loads required based on standard turbine components for one turbine comprising: three tower sections, one nacelle, three blades, one hub and three fixtures and fittings.

It is estimated that the deliveries would equate to approximately 11 deliveries per turbine. A total of 154 turbine component deliveries would be required for the complete development. This will be reviewed once the final turbine is selected post-consent.

4.3.6. Maximum Loading

The maximum vehicle and axle loadings will be confirmed by the nominated haulier prior to planning for the AIL deliveries. All weight restrictions on the delivery route will be complied with.

4.3.7. Timing of AIL Deliveries

The movement of abnormal loads will be timed to avoid periods of heavy traffic flow to minimise disruption to the public. In additional to normal daily rush hour periods, festivals, and major public events will be avoided. The programme for deliveries will be arranged with the police and local authorities prior to taking place.

Consideration shall be given to night-time deliveries to avoid impacts of driver delay on other road users. No movements of major turbines components, cranes or deliveries of materials will take place at peak school times (08.30 to 09.30 and 15.00 to 16.30) unless prior agreement has confirmed that there is no school transport using the proposed delivery route.

Notification will be given to all the relevant highway authorities of all deliveries which qualify as abnormal loads.

4.3.8. Contingency planning

The hauliers shall be responsible for preparing their own contingency plan for use in the event that unforeseen circumstances arise during the course of the abnormal load deliveries. Their contingency plans will further elaborate on issues such as road blockages and breakdowns.

The contingency plan will take account the results from any trial runs conducted.

Vattenfall will be responsible for any costs associated with repairing or replacing street furniture, street lighting, verges, carriageway surfaces/reflectors/markings, ditches, drainage, ironwork, cattle grids or structures damaged during deliveries to the site. The Highway Authorities reserve the right to recover any such costs under Section 96 of the Roads (Scotland) Act 1984, unless a Section 96 agreement is in place.

4.3.9. Emergency procedure

The hauliers shall be responsible for developing their own breakdown/emergency procedures that will be implemented ahead of their normal deliveries. It is anticipated that the procedure will follow a similar structure to that outlined below:

- The situation shall be assessed to ascertain the risks involved and to establish the necessary action required to resolve the situation.
- Where possible the vehicle shall be moved off the road or cleared to the nearest suitable location to allow any emergency vehicles to pass
- The vehicle’s emergency flashing lights will be activated, and a reflective emergency triangle placed behind the vehicle to warn other drivers of the potential hazards associated with the breakdown/emergency situation.
- The vehicle will remain immobile until the incident has cleared, and the driver has been given the go ahead to continue from either the police or the haulier Site Manager.

4.3.10. Reporting of incidents

The hauliers will have an incident reporting hierarchy in place which everyone involved in the transportation will be aware of. The reporting of incidents will be escalated externally to the relevant parties, such as the police, if deemed necessary by the hauliers.

The reporting arrangements will require to be linked with the turbine supplier’s own health and safety arrangements.

4.4. Pre and Post Construction Road Condition Surveys

Pre and post condition route surveys will be completed in line with planning conditions. A map of the full AIL route is contained in the appendix section of the EIAR.

5. Works required to achieve vehicular access from the Port to site

The proposed site junction is located within Dumfries and Galloway Council area. Works would be undertaken in agreement with Dumfries and Galloway Council and subject to appropriate consents. Dumfries and Galloway Council have already confirmed they have no objections in principle to the current junction proposal.

Visibility sightline splay areas will be formed and maintained at the access points, and no obstruction greater in height than 1m within the splay areas formed. The windfarm will be in full control of the area the splay areas pass over.

Refer to the Appendix A for drawings showing the required works to create the site access junctions suitable for vehicular access including AILs.

6. Improvements to the public road/s to facilitate development

Upgrade works would be required at various locations along the route to accommodate the abnormal loads. The locations are identified within "Abnormal Indivisible Load Route Survey" prepared by Pell Frischmann July 2020, see EIAR Appendix 11.1, and will be confirmed as the scheme progresses. The proposed works to the pinch points along the public highway would be carried out in agreement with the Local Authority with the relevant consent.

7. Trial Run

A trial run would be organised with the haulage contractor appointed by the developer using a vehicle appropriate to simulate carriage of the proposed turbine components. The whole route would be driven between the King George V Dock in Glasgow and the site entrance, along with the whole route from Port of Ayr to a common point to ensure all options have been driven.

8. Summary

This preliminary TMP has been specifically prepared for planning submission to address the transportation needs of the Quantans Hill Wind Farm Development and has done so through the following process:

- Desktop assessment of potential access route(s).
- Consultation with the Quantans Hill Wind Farm developer;
- Consultation with Transport Scotland.

Once a final turbine has been selected, a trial run will help to supplement the development of this document with information on specific sections along the complete proposed route that may require further investigation to determine modifications to road infrastructure. These investigations will be undertaken as part of the construction phase works and will involve a full assessment and detailed design of upgrades required and will be carried out by a competent civil engineering contractor.

Management measures have been identified for both the delivery of abnormal loads, HGV vehicles and general construction traffic, which when implemented, will help to ensure that the route to site remains a safe environment and disruption to local traffic flows are kept to a minimum. No long-term road closures are envisaged for the identified route.

Signage will be deployed along the route to warn other road users of potential hazards.

Prior to the transportation of any abnormal loads, the turbine supplier will ensure that all necessary permits are in place and that the accommodations works have been carried out to a satisfactory standard.

Appendices

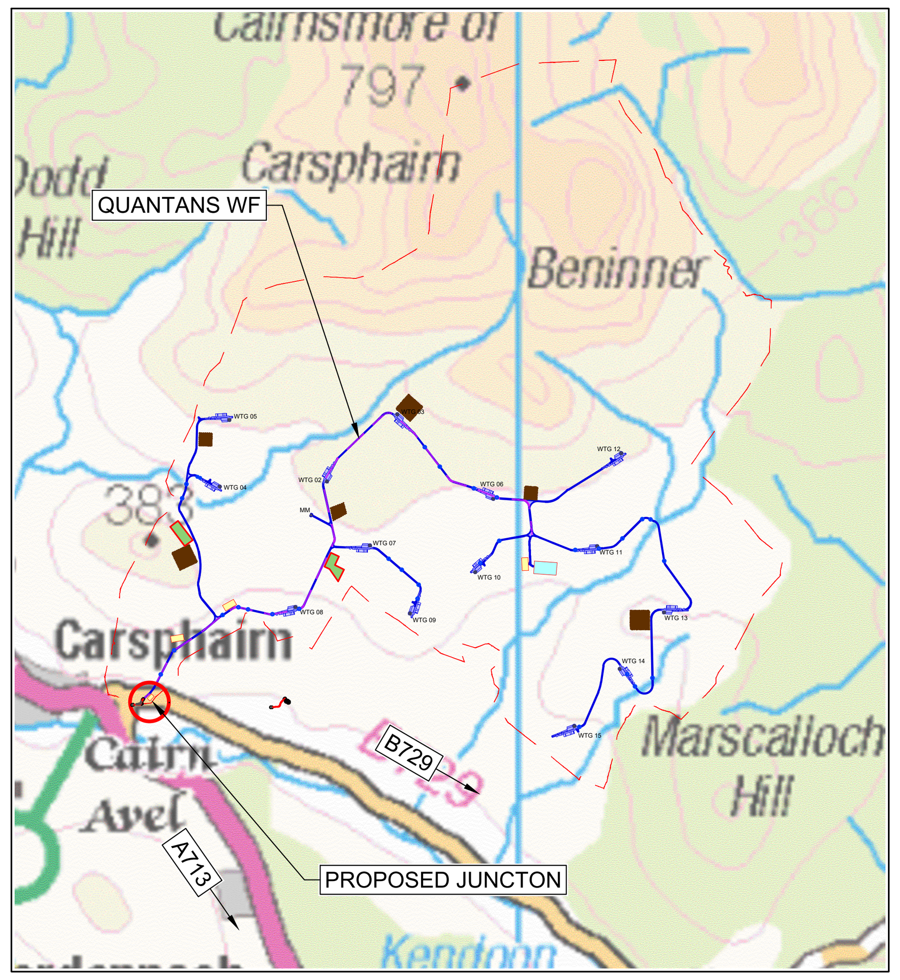
A. **Site access junction**

B. **Construction compound drawing**

Creating a better environment

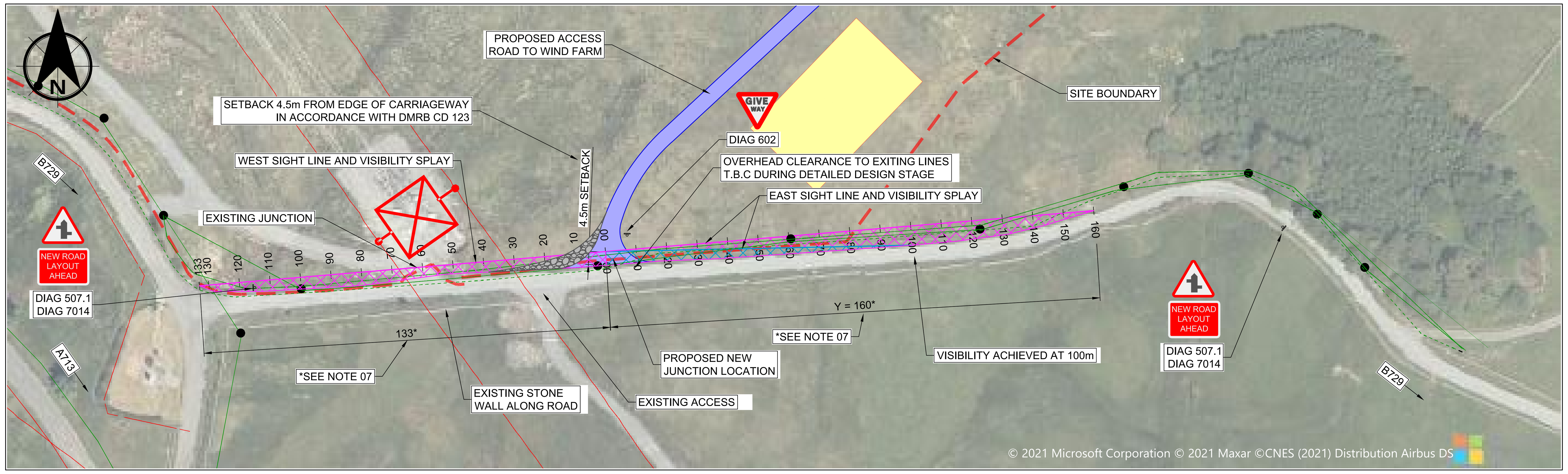
naturalpower.com
sayhello@naturalpower.com

For full details on our ISO and other certifications, please visit our website.



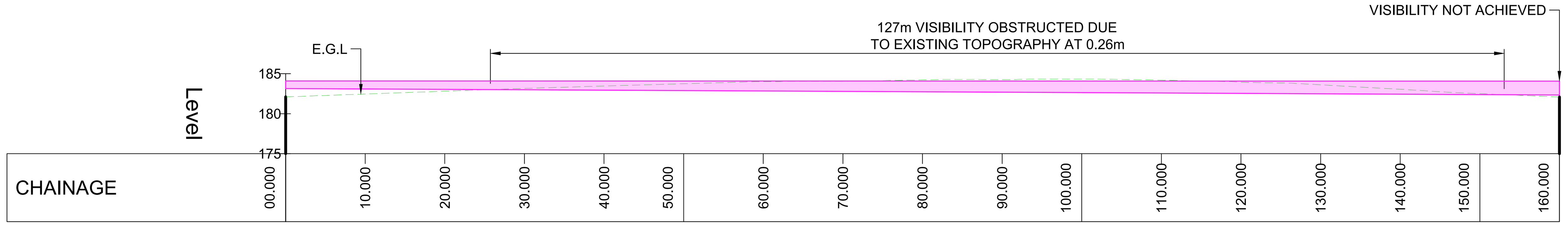
LOCATION PLAN

SCALE 1:50,000

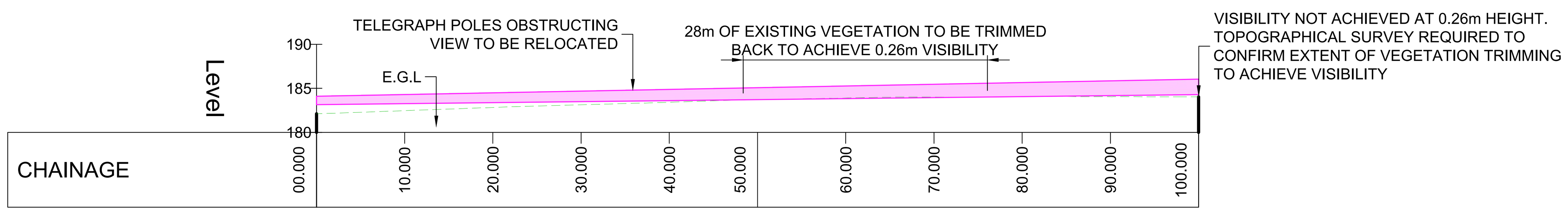


VISIBILITY SPLAY

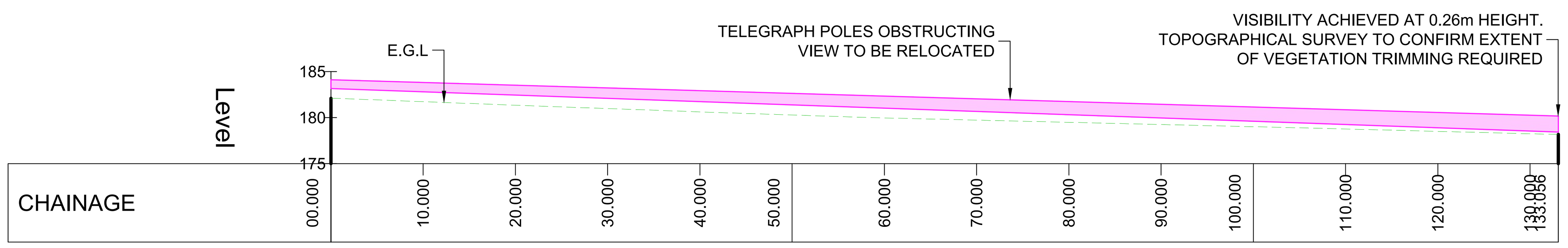
SCALE 1:1000



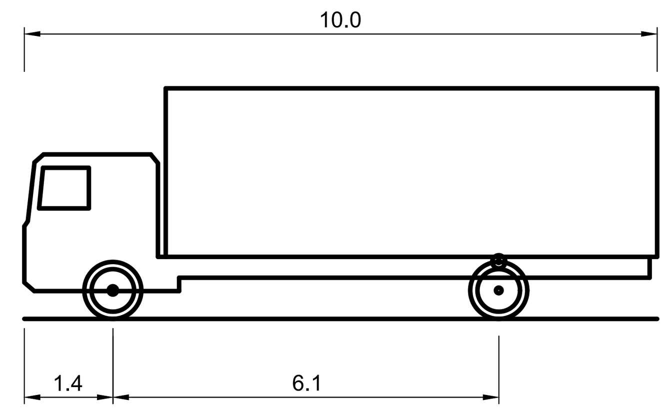
VISIBILITY SPLAY - EAST SIDE
SCALE: H 1:500,V 1:500. DATUM: 175.000



VISIBILITY SPLAY - EASTSIDE 100M
SCALE: H 1:500,V 1:500. DATUM: 180.000

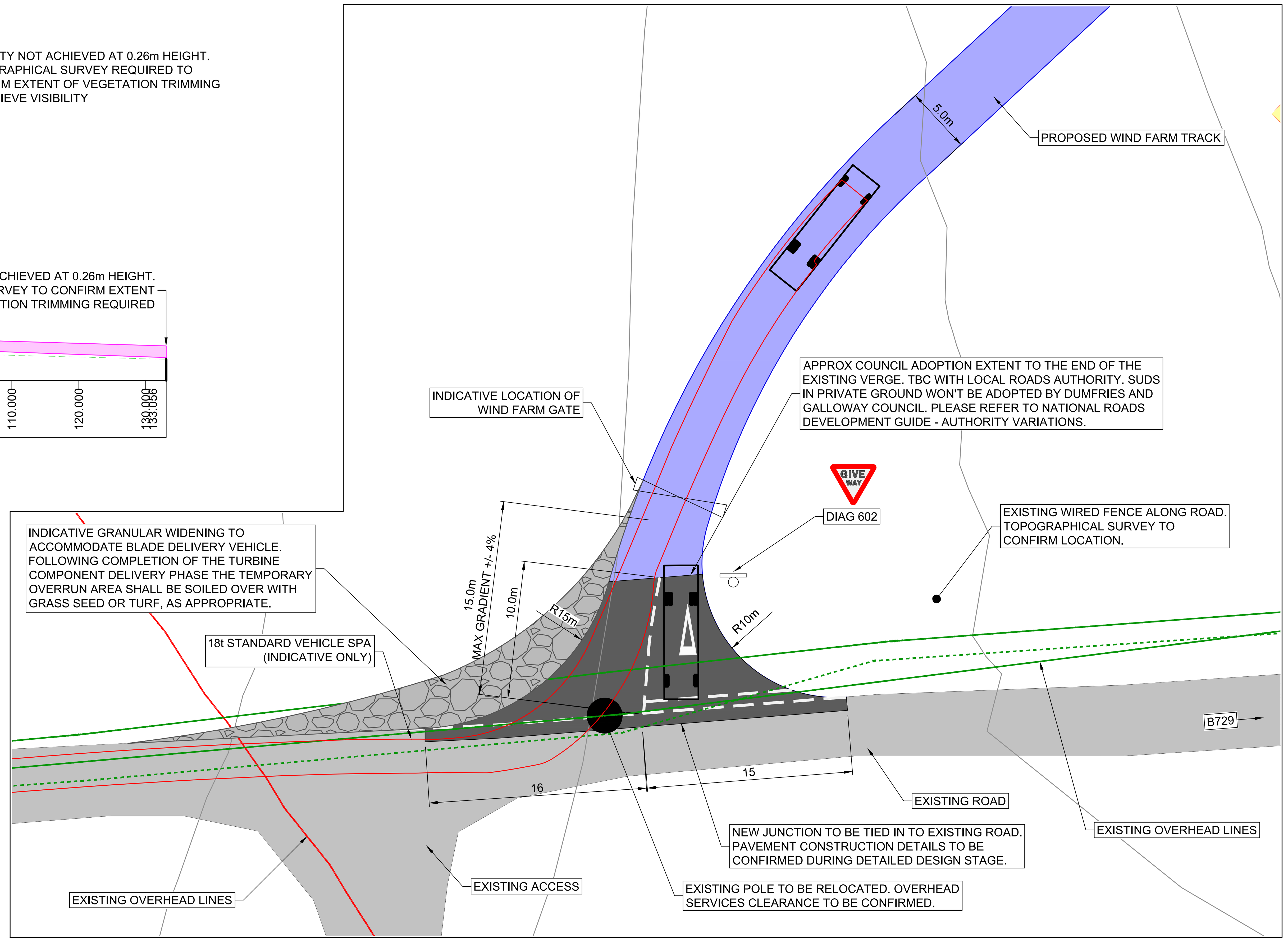


VISIBILITY SPLAY - WEST SIDE
SCALE: H 1:500,V 1:500. DATUM: 175.000



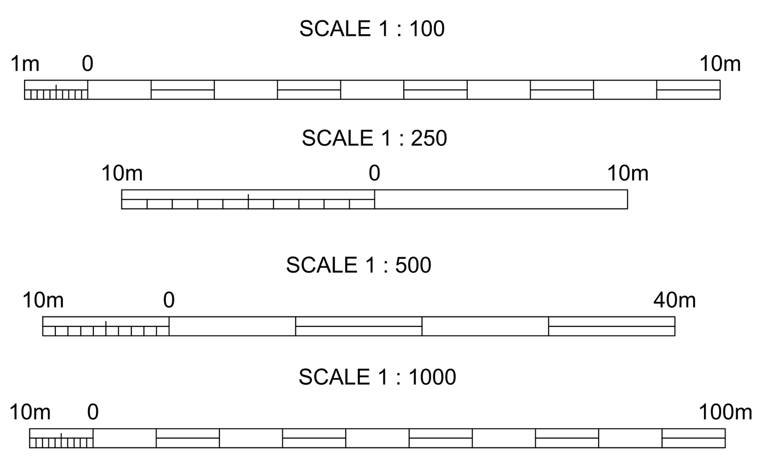
INDICATIVE 18t RIGID DELIVERY VEHICLE

SCALE 1:100



PROPOSED JUNCTION

SCALE 1:250



IMPORTANT

HEALTH, SAFETY & ENVIRONMENTAL INFORMATION

IN ADDITION TO THE HAZARDS AND RISKS NORMALLY ASSOCIATED WITH THE TYPE OF WORK DETAILED ON THIS DRAWING, PLEASE NOTE THE FOLLOWING ADDITIONAL RISKS TO HEALTH AND SAFETY:-

DESIGNER'S RISK ASSESSMENT REFERENCE GIVING FULL DETAILS:-

IP09-F01 DESIGN RISK ASSESSMENT

CONSTRUCTION PHASE:-
1. EXISTING SERVICES IDENTIFIED IN VICINITY OF PROPOSED WORKS
2. ENVIRONMENTAL CONSTRAINTS NOT INDICATED
3. RISK OF GENERATING CONTAMINATED/SILT LADEN RUNOFF TO SENSITIVE ENVIRONMENTAL AREAS. CONTRACTOR TO PROPOSED ADDITIONAL TEMPORARY CONSTRUCTION STAGE DRAINAGE AS NECESSARY.
4. POTENTIAL HAZARDOUS DROPS ALONG ACCESS ROUTE.

IT IS ASSUMED THAT ALL WORKS WILL BE CARRIED OUT BY A COMPETENT CONTRACTOR WORKING, WHERE APPROPRIATE, TO AN APPROVED METHOD STATEMENT.

NOTES

1. ALL DIMENSIONS IN METRES AND ALL LEVELS IN METRES AOD UNLESS SHOWN OTHERWISE.
2. CONTAINS ORDNANCE SURVEY DATA © CROWN COPYRIGHT AND DATABASE RIGHT 2021. MAP ACCURACY NOT GUARANTEED DUE TO REPRODUCTION METHODS. LICENCE NUMBER: 100031961.
3. CONTAINS AERIAL MAP DATA "© 2021 MICROSOFT CORPORATION © 2021 MAXAR ©CNES (2021) DISTRIBUTION AIRBUS DS".
4. ACCURACY OF MAP NOT GUARANTEED DUE TO REPRODUCTION METHODS.
5. THE JUNCTION DESIGN HAS BEEN BASED UPON LIDAR SURVEY INFORMATION. TOPOGRAPHICAL SURVEY REQUIRED TO CONFIRM EXTENT OF WORKS.
6. WHERE THE WORKS CROSS EXISTING LAND DRAINS THESE SHALL BE MAINTAINED, AS FAR AS PRACTICAL, WITH THEIR ORIGINAL INTENT.
7. STOPPING SIGHT DISTANCES FOR VISIBILITY SPLAYS BASED UPON INFORMATION IN "DESIGN MANUAL FOR ROADS AND BRIDGES, "CD 123" AND "CD 109".
8. ALTHOUGH THE B729 IS A NATIONAL SPEED LIMIT ROUTE, BASED ON A DMRB DESIGN SPEED CALCULATION AN 85B RATING WAS OBTAINED. AS PER "DMRB, CD109, SECTION 2", STOPPING SITE DISTANCE REQUIRED FOR NEW JUNCTIONS AT A DESIGN SPEED OF 85 IS 160m. APPROVAL FROM THE DUMFRIES AND GALLOWAY COUNCIL IS REQUIRED FOR THE RELAXATION BELOW MINIMUM STANDARD AT THE PROPOSED JUNCTION LOCATION.

LEGEND:
- SITE BOUNDARY
- PROPOSED TRACK
- EXISTING ROAD
- PROPOSED LOCAL ROAD AUTHORITY FULL DEPTH PAVEMENT
- GRANULAR WIDENING
- VISIBILITY SPLAY
- VISIBILITY SPLAY

EXISTING UTILITIES NOTES

1. EXISTING SERVICES SHOWN. THE PRESENCE OF ADDITIONAL SERVICES SHOULD BE ANTICIPATED AND APPROPRIATE PRECAUTIONS TAKEN.
2. THE CONTRACTOR SHALL TAKE APPROPRIATE STEPS TO ENSURE THEY HAVE ACCURATE AND UP-TO-DATE INFORMATION PRIOR TO COMMENCING ANY SITE WORKS.
3. IF THE CONTRACTOR IS IN ANY DOUBT AS TO THE LOCATION OR IDENTIFICATION OF ANY SERVICES, THEY SHALL CONTACT THE APPROPRIATE PLANT PROTECTION OFFICER.

SERVICES LEGEND:
- HV_LV ELECTRIC
- HV_LV ELECTRIC
- OPENREACH
- OPENREACH
- EXISTING POLE

Rev.	Date	Amendment Details	Drawn	Chk'd	App'd
0A	31.08.21	REVISED SITE LAYOUT	BR	JHD	MT
0	10.08.21	FOR COMMENT	JM	BR	MT

Sweco
2nd Floor, Quay 2
139 Fountainbridge
Edinburgh
EH3 9QG
Tel: +44 (0)131 550 6300
Web: www.sweco.co.uk

SWECO

Client
VATTENFALL
RJ McLEOD

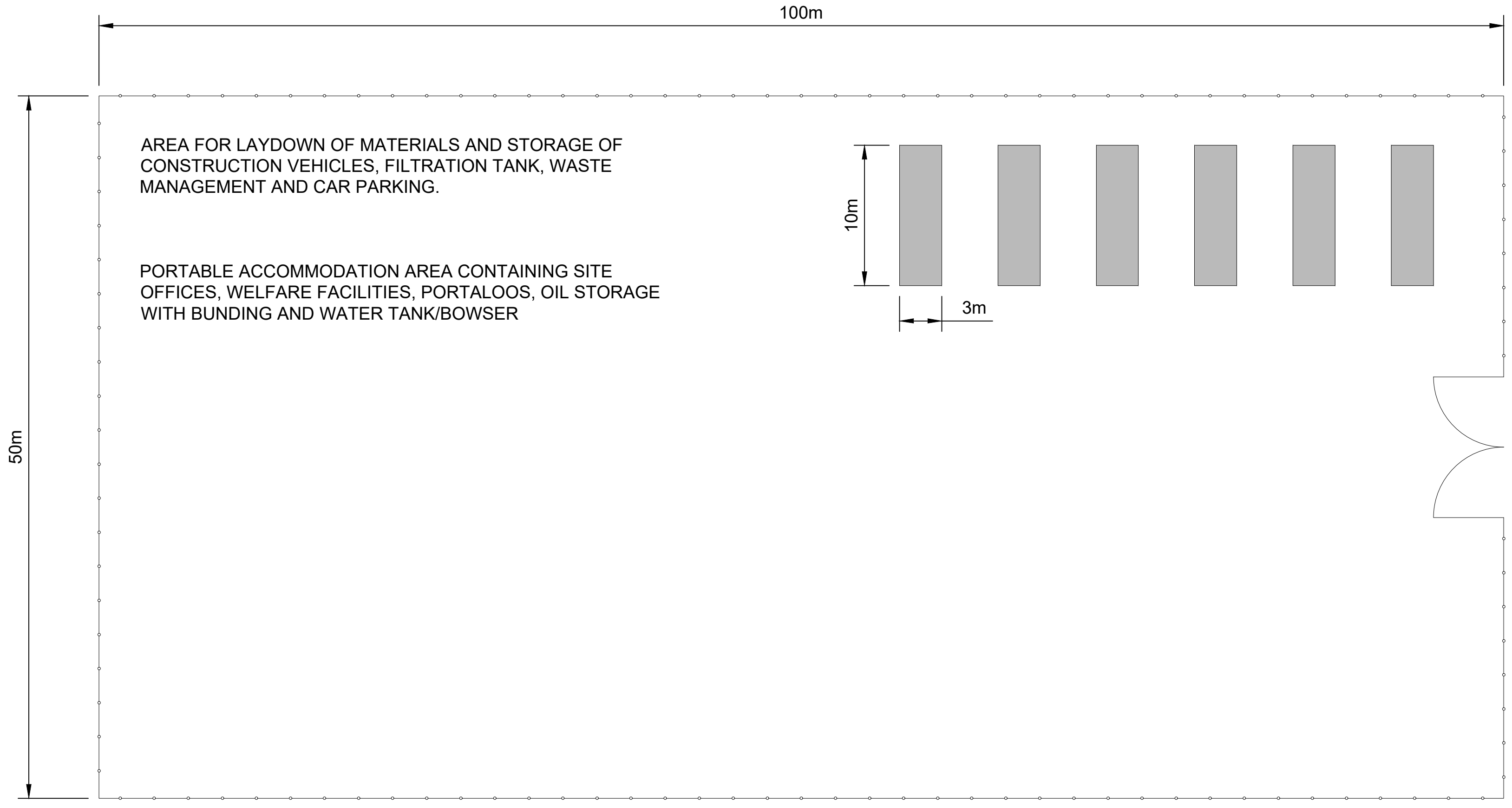
Drawing Status
FOR COMMENT

Project Title
QUANTANS WF

Drawing Title
SITE ACCESS
B729 JUNCTION

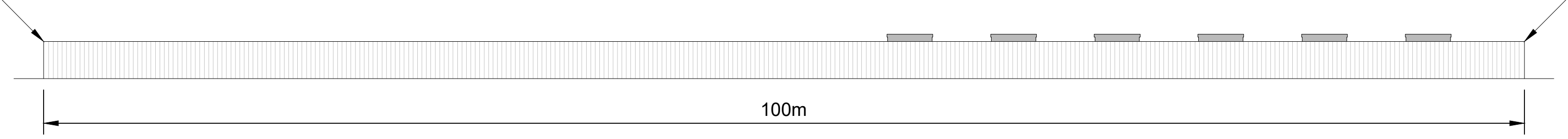
Scale	Designed	Drawn	Checked	Approved
AS SHOWN	JM	JM	BR	MT
Original Size	Date	Date	Date	Date
A1	09.03.21	09.03.21	29.06.21	30.06.21

Drawing Number	Revision
65201985-100-104	0A



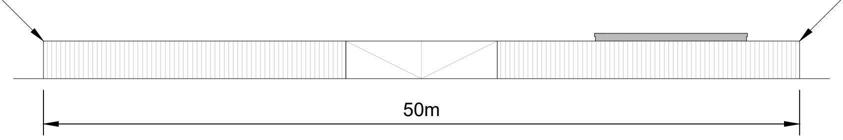
COMPOUND LAYOUT

SCALE 1:500



FRONT ELEVATION

SCALE 1:500



SIDE ELEVATION

SCALE 1:500

SCALE AT 1:500

0mm 10000 20000 30000 40000mm

LEGAL: NATURAL POWER CONSULTANTS LTD TAKE NO RESPONSIBILITY FOR THE ACCURACY OF DATA PROVIDED BY THIRD PARTIES.

NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE STATED.
2. THIS IS A TYPICAL ARRANGEMENT ONLY AND NOT FOR CONSTRUCTION.

REV	DESCRIPTION	BY	CH	APP	DATE
B	PLATFORM AREA UPDATED	JB	MB	CG	15/12/21
A	INITIAL DRAWING ISSUE	MY	MB	CG	24/09/21

CLIENT: VATTENFALL

NATURAL POWER CONSULTANTS LTD.
THE GREENHOUSE
FORREST ESTATE DALRY
CASTLE DOUGLAS
DG7 3XS
SCOTLAND, UK
TEL: +44 (0) 1644 430 008
WWW.NATURALPOWER.COM

natural power

IFS DOC NO.: 1261015	IFS ACTIVITY: 2035
SCALE: 1:500 @ A3	SHEET NO.: 1 OF 1

STATUS: **FOR INFORMATION**

PROJECT: QUANTANS HILL WIND FARM

DRAWING TITLE: FIGURE 3.9
TYPICAL TEMPORARY CONSTRUCTION COMPOUND

DRAWING NO.: 13736_DET_3008

REVISION **B**

Appendix 11.3

Offsite Accommodation Works Impact Assessment

Document history

Author	Emma Thackeray	06/12/2021
Checked	Lesley Cartwright	06/12/2021
Approved	Emily Galloway	06/12/2021

Client Details	
Contact	Matthew Bacon
Client Name	Vattenfall Wind Power Ltd

Issue	Date	Revision Details
A	06/12/2021	Draft for client review
B	09/12/2021	Issued for review
C	10/12/2021	Update
D	10/12/2021	Released

11.1. Introduction

A11.1.1. This Offsite Accommodation Works Impact Assessment is intended to assist the decision maker in a judgement as to the overall environmental effect of the works required to the public road network to facilitate transportation of abnormal loads from port of entry to the site entrance.

A11.1.2. The assessment has been undertaken on the basis of a 'worst case scenario' swept path analysis which considered the largest size of blades which might be transported to the Proposed Development. Given the large number of points, the assessment was largely desk-based on the basis of a screening exercise with a roadside visit to particular points of interest undertaken as part of an ecological assessment, which has focused on the potential for protected species[1] to be impacted by the proposed works. Consideration has also been given to the potential for the offsite accommodation works, individually and collectively, to affect any statutory designated sites (e.g., Special Areas of Conservation, Special Protection Areas and Sites of Special Scientific Interest) and their associated qualifying features.

A11.1.3. Review of the assessment would be undertaken after consent was granted and prior to construction to consider updated swept path analysis taking into account the blades selected as a result of a procurement exercise (which may be equal in size or smaller than the blades used for the swept path assessment but no larger), changes to the baseline conditions of the road network in the intervening years, and with the benefit of detailed topographical survey of individual points of interest.

A11.1.1. The approach to this assessment was discussed and agreed in principle with the Scottish Government's Energy Consents Unit, Transport Scotland, the Ayrshire Road Alliance, and Dumfries and Galloway Council ahead of submission. This assessment is supported by:

- Chapter 11: Traffic and Transport;
- Technical Appendix 11.1: Abnormal Indivisible Road Route Survey; and
- Technical Appendix 11.2: Traffic Management Plan.

A11.1.2. Table A.11.1 below summarise each Point of Interest and the likely required accommodation works, as described in Technical Appendix 11.1, with reference to the environmental matters considered. Please refer to Technical Appendix 11.1 for plans of each point of interest described.

[1] That is, species which receive special legal protection in Scotland under the Wildlife & Countryside Act (1981), Protection of Badgers Act (1992) and the Conservation (Natural Habitats, &c.) Regulations (1994), as amended.

Table A.11.1: Offsite Accommodation Works Impact Assessment

Point of Interest (POI)	The required works	Comments on Potential Ecological Impacts	Comments on Potential Hydrological Constraints (desk based)	Comments on potential LVIA Constraints (desk based)
1	Two road signs on the exit splitter island would need to be removed to enable over-sail.	No ecological constraints, no impacts anticipated.	None anticipated	None anticipated
2	One lighting column should be removed	No ecological constraints, assuming no trees/vegetation affected, no impacts anticipated.	None anticipated.	None anticipated
3	No physical mitigation works are required however, loads will require access to all lanes	n/a	None anticipated.	None anticipated
4	Loads will overrun and oversail the eastern verge where a load bearing surface should be laid in overrun areas and existing utilities protected. One VMS road sign, few road signs, two lighting columns and one pedestrian call post should be removed. Vegetation should be cleared back.	Area potentially affected appears to be mostly located in road verge and likely to be subject to annual cutting and disturbance from road traffic. Any tree/scrub clearance that may be required could result in impacts on nesting birds (depending on time of year) and potentially on bat roosts, however, bat roost potential appears to be low at this location. Survey for protected species should be completed prior to any vegetation clearance.	None anticipated.	None anticipated
5	Loads will oversail the western verge, but no works are required. Loads will oversail the eastern verge where the ground clearance for loads over the safety barrier should be confirmed during the test run.	If road widening is necessary and vegetation on the cutting slope would be affected, then a Phase I habitat survey of the works area +50m buffer should be completed. Any tree/scrub clearance that may be required could result in impacts on nesting birds (depending on time of year) and potentially on bat roosts, however, bat roost potential appears to be low at this location. Survey for protected species should be completed prior to any vegetation clearance.	None anticipated.	None anticipated
6	Loads will take the slip road and join the M73 at this location.	n/a	None anticipated.	None anticipated
7	M73 / M74 Bend	n/a	None anticipated.	None anticipated
8	M77 Slip Road	n/a	None anticipated.	None anticipated
9	Dutch House Roundabout Loads will oversail the western verge of the entry arm on the central reserve and the eastern verge on the exit arm, but no works are required.	n/a	None anticipated.	None anticipated
10	**Sandyford Toll Roundabout:** Loads will oversail the central reserve on the entry arm where the blade tip will oversail the bollards and safety barrier. Loads will oversail the eastern verge where one lighting column is to be removed. Loads will cross the central island. Load bearing surface to be laid. Two sets of lit chevron signs to be removed. Trees to be cleared. One road sign to be removed. Load proximity to one lighting column to be confirmed during test run.	Area potentially affected appears to be mostly located in road verge and likely to be subject to annual cutting and disturbance from road traffic. Any tree/scrub clearance that may be required could result in impacts on nesting birds (depending on time of year) and potentially on bat roosts, however, bat roost potential appears to be low at this location. Survey for protected species should be completed prior to any vegetation clearance.	None anticipated.	None anticipated

	The required works	Comments on Potential Ecological Impacts	Comments on Potential Hydrological Constraints (desk based)	Comments on potential LVIA Constraints (desk based)

Point of Interest (POI)				
11	**A77 Whitletts Roundabout:** Loads will oversail the entry arm central reserve where the blade tip will oversail the safety barrier. Loads will oversail the eastern verge where one signal head and pole should be relocated.	No ecological constraints, assuming no trees/vegetation affected, no impacts anticipated	None anticipated.	None anticipated
16	**A77 Holmeston Roundabout** Loads will overrun and oversail the central island where one set of chevron signs should be removed, and a load bearing surface laid in overrun areas.	Area potentially affected appears to be mostly located in road verge and likely to be subject to annual cutting and disturbance from road traffic. Any tree/scrub clearance that may be required could result in impacts on nesting birds (depending on time of year) and potentially on bat roosts, however, bat roost potential appears to be low at this location. Survey for protected species should be completed prior to any vegetation clearance.	None anticipated.	None anticipated
17	**A77 Bankfield Roundabout** Loads will oversail the entry arm splitter island where one road sign may be removed. Loads will oversail the eastern verge on the entry arm, one lighting column to be removed. Loads will oversail the eastern side of the central island where one set of chevron signs should be removed. Trees to be trimmed Loads will oversail the exit arm splitter island where one road sign and one lighting column should be removed. Loads will oversail the eastern verge of the exit arm where one road sign, one lighting column and vegetation should be removed.	Area potentially affected appears to be mostly located in road verge and likely to be subject to annual cutting and disturbance from road traffic. Any tree/scrub clearance that may be required could result in impacts on nesting birds (depending on time of year) and potentially on bat roosts, however, bat roost potential appears to be low at this location. Survey for protected species should be completed prior to any vegetation clearance.	None anticipated.	None anticipated
18	**A713 Ailsa Hospital Junction** In order to minimise mitigation works it is proposed that loads should contraflow through the junction. Loads will oversail two out of the three central traffic islands. It may be necessary to move one traffic signal. The lit traffic sign may be removed from the final traffic island. Loads will oversail the south western verge, but no works are required	No ecological constraints, assuming no trees/vegetation affected, no impacts anticipated.	None anticipated.	None anticipated
19	**A713 Boneston Bridge** Loads will traverse over Boneston Bridge on approach the bend. This has historically had a weight restriction, however, a design solution has been undertaken by Vattenfall as part of the South Kyle development.	n/a	Works over watercourse. Appropriate silt mitigation / protective measures should be used as required.	None anticipated

Point of Interest (POI)	The required works	Comments on Potential Ecological Impacts	Comments on Potential Hydrological Constraints (desk based)	Comments on potential LVIA Constraints (desk based)
20	**A713 Craigs Road Bend** The blade tip will over-sail the safety barrier, two chevron signs, and one bollard on the northern verge prior to the bend. Trees and vegetation should be trimmed. Loads will over-run the splitter island where a load bearing surface should be laid, and one road sign, two chevron signs, and four bollards should be removed. Loads will over-sail the inside of the bend where trees and vegetation should be trimmed. Loads will over-run and over-sail the outside of the bend where a load bearing surface should be laid, and four chevron signs, several bollards, one road sign, a section of fence, a section of hedge, and one tree should be removed. Vegetation should be cleared.	Area potentially affected appears to extend beyond the road verge. Any tree/scrub clearance that may be required could result in impacts on nesting birds (depending on time of year) and potentially on bat roosts, however, bat roost potential appears to be low at this location. Survey for protected species should be completed prior to any vegetation clearance.	None anticipated.	None anticipated
21	**A713 Right Bend North West of Holehouse Cottage:** Loads will over-run and over-sail the outside of the bend where a load-bearing surface should be laid, and a series of bollards and six chevron signs should be removed. The blade tip will over-sail the fence and hedge, and vegetation should be cleared. Loads will over-sail the inside of the bend where vegetation should be trimmed.	Area potentially affected appears to be mostly located in road verge and likely to be subject to annual cutting and disturbance from road traffic. Any tree/scrub clearance that may be required could result in impacts on nesting birds (depending on time of year) and potentially on bat roosts, however, bat roost potential appears to be negligible at this location. Survey for protected species should be completed prior to any vegetation clearance.	None anticipated.	None anticipated
22	**A713 Right Bend at Holehouse Cottage:** Loads will over-run and over-sail the outside of the bend where a load bearing surface should be laid, and two lighting columns, a series of bollards, and three chevron signs should be removed. The blade tip will over-sail a series of bollards and one chevron sign. Vegetation should be cleared. Loads will over-sail the inside of the bend where vegetation should be trimmed.	Area potentially affected appears to be mostly located in road verge and likely to be subject to annual cutting and disturbance from road traffic. Any tree/scrub clearance that may be required could result in impacts on nesting birds (depending on time of year) and potentially on bat roosts, however, bat roost potential appears to be negligible at this location. Survey for protected species should be completed prior to any vegetation clearance.	None anticipated.	None anticipated
23	**A713 Holehouse Junction** The blade tip will over-sail a series of bollards on the outside of the bend. Loads will over-run and over-sail the inside of the bend where a load bearing surface should be laid, and vegetation should be trimmed. The proximity of loads to one utility pole should be confirmed during the test run.	Area potentially affected appears to be mostly located in road verge and likely to be subject to annual cutting and disturbance from road traffic. Any tree/scrub clearance that may be required could result in impacts on nesting birds (depending on time of year) and potentially on bat roosts, however, bat roost potential appears to be negligible at this location. Survey for protected species should be completed prior to any vegetation clearance.	None anticipated.	None anticipated

Point of Interest (POI)	The required works	Comments on Potential Ecological Impacts	Comments on Potential Hydrological Constraints (desk based)	Comments on potential LVIA Constraints (desk based)
24 & 25	**A713 Holehouse Railway Bridge**: Loads will over-run and over-sail the outside of the first left-hand bend where a load-bearing surface should be laid, and a section of fence, two chevron signs, a series of bollards, and one road sign should be removed. Loads will over-sail the inside of the bend where vegetation should be trimmed. The blade tip will over-sail a series of bollards, one road sign, and three chevron signs on the outside of the second left-hand bend. Vegetation should be trimmed. Loads will over-sail the inside of the bend where vegetation should be trimmed. The blade tip will over-sail a series of bollards and three chevron signs on the outside of the right-hand bend where vegetation should be trimmed. Loads will over-sail the inside of the bend where vegetation should be trimmed.	Area potentially affected appears to be mostly located in road verge and likely to be subject to annual cutting and disturbance from road traffic. Any tree/scrub clearance that may be required could result in impacts on nesting birds (depending on time of year) and potentially on bat roosts, however, bat roost potential appears to be negligible at this location. Survey for protected species should be completed prior to any vegetation clearance.	None anticipated.	None anticipated
26	**A713 Bends near Smithston**: The blade tip will over-sail a series of bollards on the outside of the bend, where one utility pole should be removed, and vegetation should be trimmed. Following the junction, loads will over-run and over-sail the outside of the bend, where a load bearing surface should be laid, and a series of bollards and one chevron sign should be removed. Trees should be trimmed, and vegetation should be cleared. Loads will over-sail the inside of the bend where one utility pole should be removed.	Area potentially affected appears to be mostly located in road verge and likely to be subject to annual cutting and disturbance from road traffic. Any tree/scrub clearance that may be required could result in impacts on nesting birds (depending on time of year) and potentially on bat roosts, however, bat roost potential appears to be low at this location.	None anticipated.	None anticipated
27	**A713 Old Smithston:** The blade tip will over-sail a series of bollards on the outside of the bend. The proximity of the blade tip to one utility pole should be confirmed during the test run. Loads will over-sail the inside of the bend where vegetation should be cleared.	Area potentially affected appears to be mostly located in road verge and likely to be subject to annual cutting and disturbance from road traffic. Any tree/scrub clearance that may be required could result in impacts on nesting birds (depending on time of year) and potentially on bat roosts, however, bat roost potential appears to be negligible at this location. Survey for protected species should be completed prior to any vegetation clearance.	None anticipated.	None anticipated
28	**A713 Carnochan:** The blade tip will over-sail the fence, a series of bollards, and one chevron sign on the outside of the bend. Vegetation should be trimmed. Loads will also over-run and over-sail the outside following the bend where a load bearing surface should be laid, and three chevron signs and a series of bollards should be removed. Loads will over-sail the inside of the bend where vegetation should be cleared. The proximity of loads to one utility pole anchor cable should be confirmed during the test run. Detailed design is required to confirm whether the verge on the outside of the bend will require strengthening.	Area potentially affected appears to be mostly located in road verge and likely to be subject to annual cutting and disturbance from road traffic. Any tree/scrub clearance that may be required could result in impacts on nesting birds (depending on time of year) and potentially on bat roosts, however, bat roost potential appears to be low at this location. Survey for protected species should be completed prior to any vegetation clearance.	None anticipated.	None anticipated

Point of Interest (POI)	The required works	Comments on Potential Ecological Impacts	Comments on Potential Hydrological Constraints (desk based)	Comments on potential LVIA Constraints (desk based)
29	**A713 Polnessan:** The blade tip will over-sail a series of bollards, one road sign, and two chevron signs on the outside of the bend. Loads will then over-run and over-sail the outside verge following the bend where a load bearing surface should be laid, and one utility pole, two chevron signs, and a series of bollards should be removed. Trees should be trimmed, and vegetation cleared. Loads will over-sail the inside of the bend where vegetation should be cleared.	Area potentially affected appears to be mostly located in road verge and likely to be subject to annual cutting and disturbance from road traffic. Any tree/scrub clearance that may be required could result in impacts on nesting birds (depending on time of year) and potentially on bat roosts, however, bat roost potential appears to be negligible at this location. Survey for protected species should be completed prior to any vegetation clearance.	Works near watercourse (culvert). Appropriate silt mitigation / protective measures should be used as required.	None anticipated
30	**A713 Polnessan:** The blade tip will over-sail a series of bollards on the outside of the bend. Loads will over-run and over-sail the verge where a load bearing surface should be laid, and a series of bollards should be removed. Loads will over-sail the inside of the bend where a series of bollards should be removed, and vegetation should be cleared.	Area potentially affected appears to be mostly located in road verge and likely to be subject to annual cutting and disturbance from road traffic. Any tree/scrub clearance that may be required could result in impacts on nesting birds (depending on time of year) and potentially on bat roosts, however, bat roost potential appears to be low at this location. Survey for protected species should be completed prior to any vegetation clearance.	Works near watercourse (culvert). Appropriate silt mitigation / protective measures should be used as required.	None anticipated
31	**A713 Bends South of Polnessan:** Loads will over-sail the inside of the left-hand bend, though no physical mitigation measures are required. The blade tip will over-sail a series of bollards on the outside of the right-hand bend. Loads will over-sail the inside of the bend, though no physical mitigation measures are required.	n/a	None anticipated	None anticipated

Point of Interest (POI)	The required works	Comments on Potential Ecological Impacts	Comments on Potential Hydrological Constraints (desk based)	Comments on potential LVIA Constraints (desk based)
32	**A713 Bends South of Polnessan:** The blade tip will over-sail the outside of the first left-hand bend where one lighting column should be removed. Loads will over-sail the inside of the bend, though no physical mitigation measures are required. Loads will over-run and over-sail the western verge following the first bend where a load bearing surface should be laid, and one lighting column should be removed.	No ecological constraints, assuming no trees/vegetation affected, no impacts anticipated.	None anticipated	None anticipated
33	**A713 Patna:** The blade tip will over-sail the outside of the bend, though no physical mitigation measures are required. Loads will overrun and over-sail the verge where load bearing surfaces should be laid, and one lighting column should be removed. Loads will over-run and over-sail the inside of the bend where a load bearing surface should be laid, and one lighting column should be removed. Vegetation should be cleared. Traffic cushions are located in the road surface. Loads to transit the section with care. Parking should be suspended during load movements through this bend and the following bend.	Area potentially affected appears to be mostly located in road verge and likely to be subject to annual cutting and disturbance from road traffic. Any tree/scrub clearance that may be required could result in impacts on nesting birds (depending on time of year) and potentially on bat roosts, however, bat roost potential appears to be negligible at this location. Survey for protected species should be completed prior to any vegetation clearance.	Works near watercourse. Appropriate silt mitigation / protective measures should be used as required.	None anticipated
34	**A713 Waterside Bends:** Loads are likely to over-sail the northern verge through the first bend, though no physical mitigation measures are required.	n/a	None anticipated	None anticipated
35	**A713 South of Waterside:** The vertical profile of the road at this location is pronounced and should be reviewed during the test run stage to ascertain if tar wedges will be required to prevent grounding.	n/a	None anticipated	None anticipated
36	**A713 Cutler:** The vertical profile of the road at this location is pronounced and should be reviewed during the test run stage to ascertain if tar wedges will be required to prevent grounding.	n/a	None anticipated	None anticipated
37	**A713 Left Bend West of Burnton:** Loads are likely to over-sail the northern verge through this bend, though no physical mitigation measures are required.	n/a	None anticipated	None anticipated

Point of Interest (POI)	The required works	Comments on Potential Ecological Impacts	Comments on Potential Hydrological Constraints (desk based)	Comments on potential LVIA Constraints (desk based)
38	**A713 Buchan's Bridge:** Blade tip will over-sail a series of bollards and two chevron signs on the outside of the bend. Loads will over-sail the inside of the bend where the bridge railing should be removed.	Pollution risk to watercourse from railing removal/replacement, works method statement, following best practice pollution prevention measures, should be sufficient to address this.	Works over watercourse. Appropriate silt mitigation / protective measures should be used as required.	None anticipated
39	**A713 Dalmellington:** Traffic cushions have been placed on the road surface. Loads to transit the section with care.	n/a	None anticipated	None anticipated
40	**A713 Left Bend, Dalmellington:** The blade tip will over-sail the outside of the left-hand bend, though no physical mitigation measures are required. Loads will over-sail the inside of the bend where one bollard should be removed. Traffic cushions have been placed on the road surface. Loads to transit the section with care.	No ecological constraints, assuming no trees/vegetation affected, no impacts anticipated	None anticipated	None anticipated
41	**A713 Dalmellington:** Loads will over-sail both verges through the section, though no physical mitigation measures are required. Temporary parking restrictions are required to allow loads to utilise the entire carriageway through the section.	n/a	None anticipated	None anticipated
42	**A713 North of Kirn Bridge:** The blade tip will over-sail one road sign on the outside of the first left-hand bend. Loads will over-sail the inside of the bend, though no physical mitigation measures are required. The blade tip will over-sail a series of bollards, four chevron signs, and one road sign on the outside of the right-hand bend. Loads will also over-sail the verge where one road sign should be removed, and vegetation and trees should be trimmed. Loads will over-sail the inside of the bend where vegetation should be trimmed. The blade tip will over-sail a series of bollards on the outside of the second left-hand bend.	Area potentially affected appears to be mostly located in road verge and likely to be subject to annual cutting and disturbance from road traffic. Any tree/scrub clearance that may be required could result in impacts on nesting birds (depending on time of year) and potentially on bat roosts, however, bat roost potential appears to be negligible at this location. Survey for protected species should be completed prior to any vegetation clearance.	Works adjacent to watercourse (within 50 m). Appropriate silt mitigation / protective measures should be used as required.	None anticipated

Point of Interest (POI)	The required works	Comments on Potential Ecological Impacts	Comments on Potential Hydrological Constraints (desk based)	Comments on potential LVIA Constraints (desk based)
43	**A713 Kirn Bridge:** Loads will over-sail the stone parapet on the inside of the first left-hand bend. Vertical clearance of loads to the parapet should be confirmed during the test run or on a topographical base survey. The blade tip will over-sail the fence and two chevron signs should be removed. Loads will over-sail the inside of the following right-hand bend. A topographical survey is required to confirm the parapet wall height and suitability for load over-sail. The blade tip will over-sail a series of bollards on the outside of the second right-hand bend. Loads will over-sail the inside of the bend, though no physical mitigation measures are required.	Pollution risk to watercourse from sign removal and replacement, works method statement, following best practice pollution prevention measures, should be sufficient to address this.	Works adjacent to watercourse (within 50 m). Appropriate silt mitigation / protective measures should be used as required.	None anticipated
44	**A713 West of Snabb Cairn:** Blade tip will over-sail a series of bollards and two chevron signs on the outside of the right-hand bend. Loads will over-run and over-sail the inside of the bend where a load bearing surface should be laid, and a section of fence should be removed. Vegetation should be cleared.	Area potentially affected appears to be mostly located in road verge and likely to be subject to annual cutting and disturbance from road traffic. Any tree/scrub clearance that may be required could result in impacts on nesting birds (depending on time of year) and potentially on bat roosts, however, bat roost potential appears to be low at this location. Survey for protected species should be completed prior to any vegetation clearance.	Works adjacent to watercourse (within 50 m). Appropriate silt mitigation / protective measures should be used as required.	None anticipated
45	**A713 North of Mossdale:** Blade tip will over-sail the fence, a series of bollards, and four chevron signs on the outside of the left-hand bend. Loads will over-sail the inside of the bend. Blade tip will over-sail the outside of the following righthand bend. Loads will over-sail the inside of the bend, though no physical mitigation measures are required. The vertical profile of the road at this location is pronounced and should be reviewed during the test run stage to ascertain if tar wedges will be required to prevent grounding.	n/a.	Works adjacent to watercourse (within 50 m). Appropriate silt mitigation / protective measures should be used as required.	None anticipated
46	**A713 Mossdale:** It is recommended that the vertical clearance through this section is assessed during the test run to ensure adequate ground clearance is available.	n/a	Works adjacent to watercourse (within 50 m). Appropriate silt mitigation / protective measures should be used as required.	None anticipated

Point of Interest (POI)	The required works	Comments on Potential Ecological Impacts	Comments on Potential Hydrological Constraints (desk based)	Comments on potential LVIA Constraints (desk based)
47	**A713 Mossdale:** Loads will over-sail both verges through the section. Vegetation should be cleared from the western verge. The blade tip will over-sail bollards one both verges, and one road sign on the western verge.	Area potentially affected appears to be mostly located in road verge and likely to be subject to annual cutting and disturbance from road traffic. Any tree/scrub clearance that may be required could result in impacts on nesting birds (depending on time of year) and potentially on bat roosts, however, bat roost potential appears to be negligible at this location. Survey for protected species should be completed prior to any vegetation clearance.	Works adjacent to watercourse (within 50 m). Appropriate silt mitigation / protective measures should be used as required.	None anticipated
48	**A713 South of Mossdale:** Loads will over-sail both verges through the section, though no physical mitigation measures are required. Oncoming traffic should be held in advance of this section to improve manoeuvrability.	n/a	Works adjacent to watercourse (within 50 m). Appropriate silt mitigation / protective measures should be used as required.	None anticipated
49	**A713 at Bryan's Heights:** Blade tip will over-sail several bollards and two chevron signs on the outside of the left-hand bend. Loads will over-run and over-sail the outside of the right-hand bend where a load bearing surface should be laid, and two utility poles, five chevron signs, and a series of bollards should be removed. Trees and vegetation should be cleared. Loads will over-run and over-sail the inside of the bend where a load bearing surface should be laid. The clearances to overhead power lines throughout the route should be reviewed with the utility provider prior to loads moving to ensure that there is sufficient head height and flashover protection for all temperature ranges.	Phase I habitat survey of the works area +50m buffer should be completed. Any tree/scrub clearance that may be required could result in impacts on nesting birds (depending on time of year) and potentially on bat roosts, however, bat roost potential appears to be low at this location. Survey for protected species should be completed prior to any vegetation clearance. .	Works adjacent to watercourse (within 50 m). Appropriate silt mitigation / protective measures should be used as required.	None anticipated
50	Blade tip will over-sail several bollards and three chevron signs on the outside of the first left-hand bend. Vegetation should be trimmed. Loads will over-sail the inside of the bend where one utility pole should be removed.	Area potentially affected appears to be mostly located in road verge and likely to be subject to annual cutting and disturbance from road traffic. Any tree/scrub clearance that may be required could result in impacts on nesting birds (depending on time of year) and potentially on bat roosts, however, bat roost potential appears to be negligible at this location. Survey for protected species should be completed prior to any vegetation clearance.	Works adjacent to watercourse (within 50 m). Appropriate silt mitigation / protective measures should be used as required.	None anticipated
51	Blade tip will over-sail several bollards on the outside of the first right-hand bend. Loads will over-sail the inside of the bend where the proximity of loads to the fence should be confirmed during the test run. The blade tip will over-sail several bollards on the outside of the second right-hand bend. Loads will over-sail the inside of the bend where several bollards and a section of fence should be removed.	n/a	Works adjacent to watercourse (within 50 m). Appropriate silt mitigation / protective measures should be used as required.	None anticipated

Point of Interest (POI)	The required works	Comments on Potential Ecological Impacts	Comments on Potential Hydrological Constraints (desk based)	Comments on potential LVIA Constraints (desk based)
52	Loads will over-sail both verges through the first right-hand bend, though no physical mitigation measures are required. The blade tip will over-sail the fence on the outside of the following left-hand bend. Loads will over-sail the inside of the bend where one utility pole should be removed. The blade tip will over-sail a series of bollards on the outside of the final right-hand bend. Loads will over-sail the inside of the bend where their proximity to the safety barrier should be confirmed during the test run.	n/a.	Works adjacent to watercourse (within 50 m). Appropriate silt mitigation / protective measures should be used as required.	None anticipated
53	Blade tip will over-sail several bollards on the outside of the first left-hand bend. Trees should be trimmed. Loads will over-sail the inside of the bend where their proximity to the safety barrier and utility stay wire should be confirmed on a topographical survey. The blade tip will over-sail several bollards on the outside of the following right-hand bend. Loads will over-sail the inside of the bend where vegetation should be cleared.	Area potentially affected appears to be mostly located in road verge and likely to be subject to annual cutting and disturbance from road traffic. Any tree/scrub clearance that may be required could result in impacts on nesting birds (depending on time of year) and potentially on bat roosts, however, bat roost potential appears to be negligible at this location. Survey for protected species should be completed prior to any vegetation clearance.	None anticipated.	None anticipated
54	**A713 Glenmuck:** Loads will over-sail both verges on approach to the junction. Vegetation should be cleared on the western verge.	Area potentially affected appears to be mostly located in road verge and likely to be subject to annual cutting and disturbance from road traffic. Any tree/scrub clearance that may be required could result in impacts on nesting birds (depending on time of year) and potentially on bat roosts, however, bat roost potential appears to be negligible at this location. Survey for protected species should be completed prior to any vegetation clearance.	None anticipated.	None anticipated
55	**A713 Carsphairn Splitter Island:** One island to be flattened. Two bollards should be removed to allow loads to pass.	No ecological constraints, assuming no trees/vegetation affected, no impacts anticipated.	Flood barrier is in place on west side of road. Permissions will be required to modify.	None anticipated
56 & 57	Loads will over-run and over-sail the outside of the left-hand bend where a load bearing surface should be laid, one lighting column and one road sign should be removed, and trees and vegetation should be trimmed. The blade tip will over-sail the stone parapet. The proximity of the blade tip to the building should be confirmed during the test run or on a topographical base survey. Loads will over-run and over-sail the inside of the bend where a load bearing surface should be laid, and the bridge railing and stone parapet should be removed. Trees should be cleared. Loads will over-sail the left-hand verge following the bend, where one road sign should be removed. Parking to be restricted during movements.	Area potentially affected appears to be mostly located in road verge and likely to be subject to annual cutting and disturbance from road traffic. Any tree/scrub clearance that may be required could result in impacts on nesting birds (depending on time of year) and potentially on bat roosts, however, bat roost potential appears to be low at this location. Survey for protected species should be completed prior to any vegetation clearance.	Minor watercourse likely to be culverted under road.	None anticipated
58	Two islands to be flattened. Three bollards and one lighting column should be removed to allow loads to pass.	No ecological constraints, assuming no trees/vegetation affected, no impacts anticipated.	None anticipated.	None anticipated

Point of Interest (POI)	The required works	Comments on Potential Ecological Impacts	Comments on Potential Hydrological Constraints (desk based)	Comments on potential LVIA Constraints (desk based)
59	Two islands to be flattened. Three bollards and one lighting column should be removed to allow loads to pass.	No ecological constraints, assuming no trees/vegetation affected, no impacts anticipated.	None anticipated.	None anticipated
59 & 60	Blade tip will over-sail the southern verge of the A713. Loads will over-run and over-sail the inside of the turn where a load bearing surface should be laid, several bollards should be removed, and vegetation and trees should be cleared. The blade tip will over-sail the fence. The blade tip will over-sail the northern verge of the B729, where its proximity to two utility poles and one building should be confirmed during the test run or on a topographical base survey. The blade tip will also over-sail a stone wall and outbuilding, where three utility poles should be removed, trees should be cleared, and vegetation trimmed. Loads will also over-run the verge, where a load bearing surface should be laid, three utility poles should be removed, and vegetation should be cleared. Loads will over-run and over-sail the southern verge of the B729, where load-bearing surfaces should be laid, and the stone wall, one utility pole, one metal gate, and one outbuilding should be removed. Trees should be cleared. The proximity of loads to the building should be confirmed during the test run or on a topographical base survey. On navigating the second junction the blade tip will over-sail the stone wall on the outside of the turn where one utility pole should be removed. Loads will over-run and over-sail the inside of the turn, where a load-bearing surface should be laid, and a section of stone wall, one utility pole, and one road sign should be removed. Vegetation should be cleared. Loads will over-run and over-sail the southern verge of the B729 following the junction, where a load bearing surface should be laid, and one utility pole should be removed. The ditch should be culverted.	Area potentially affected appears to extend beyond the road verge. A Phase 1 habitat survey of the ground works area +50m is recommended. Any tree/scrub clearance that may be required could result in impacts on nesting birds (depending on time of year) and potentially on bat roosts, however, bat roost potential appears to be low at this location. Survey for protected species should be completed prior to any vegetation clearance.	Scottish Water Main Supply Descending from hill to the north with WTW adjacent to road. Mapping indicates minor watercourses.	None anticipated

Source: Natural Power

Appendix 12.1

Total permanent woodland removal area in hectares by forest

Document history

Author	Neil McKay	26/10/2021

Client Details	
Contact	Matthew Bacon
Client Name	Vattenfall Wind Power Ltd

Issue	Date	Revision Details
A	26/10/2021	draft for client review
B	28/10/2021	Issued for review
C	15/12/2021	Released

Technical Appendix 12.1: Total permanent woodland removal area in hectares by forest.

Woodland	**Conifer**	**Broadleaf**	**Total (ha)**
Marbrack	4.44	0.34	4.78
Furmiston	7.99	0.29	8.28
Shelterbelt	0.75		0.75
Totals (Ha)	13.18	0.63	13.81

Appendix 12.2

Planting year and species in hectares by forest. Comparison with and without wind farm.

Document history

Author	Neil McKay	26/10/2021

Client Details	
Contact	Matthew Bacon
Client Name	Vattenfall Wind Power Ltd

Issue	Date	Revision Details
A	26/10/2021	draft for client review
B	28/10/2021	Issued for review
C	15/12/2021	Released

Technical Appendix 12.2: Planting year and species in hectares by forest. Comparison with and without wind farm.

Marbrack Planting year 2022		**With wind farm**	**Change (reduction)**
Species	**Area (ha)**	**Area (ha)**	**Area (ha)**
SS	34.82	30.80	4.02
PF	4.48	4.06	0.42
SP	1.44	1.44	0.00
NBL	4.36	4.02	0.34
OG	8.29	8.29	0.00
OL peat	2.28	2.28	0.00
OL woodland	0.88	0.88	0.00
OL	1.22	1.22	0.00

Furmiston planting year 2022		**With wind farm**	**Change (reduction)**
Species	**Area (ha)**	**Area (ha)**	**Area (ha)**
SS	159.13	152.09	7.04
DF	10.95	10.95	0.00
LP	6.18	5.23	0.95
MB	5.41	5.41	0.00
NBL	9.41	9.12	0.29
DOG/MB	2.47	2.47	0.00
DOG/NBL	6.86	6.86	0.00
DOG	36.93	35.95	0.98
OL	68.24	68.24	0.00

Shelterbelts Est Planting year 1980		**With wind farm**	**Change (reduction)**
Species	**Area (ha)**	**Area (ha)**	**Area (ha)**
SS	0.88	0.88	0.00
SS	0.18	0.18	0.00
SS	0.12	0.12	0.00
SS	0.7	0.7	0.00
SS	0.61	0.61	0.00
SS	0.75	0	0.75
SS	0.7	0.7	0.00
SS	0.89	0.89	0.00

Document history

Author	Lucy Freeman	11/11/2021
Checked	Ffion Edwards	11/11/2021
Approved	Lesley Cartwright	12/11/2021

Client Details	
Contact	Matthew Bacon
Client Name	Vattenfall Wind Power Ltd

Issue	Date	Revision Details
A	12/11/2021	draft for client review
B	07/12/2021	Released

Appendix 13.1

Carbon Balance Assessment

Contents

A13.1.1. INTRODUCTION 3
A13.1.2. SCOPE 3
A13.1.3. WIND FARM CO2 EMISSION SAVINGS 6
A13.1.4. EMISSIONS DUE TO TURBINE LIFE 6
A13.1.5. CAPACITY REQUIRED DUE TO BACK UP 6
A13.1.6. LOSS OF CARBON FIXING POTENTIAL 7
A13.1.7. LOSS OF CARBON DIOXIDE FROM REMOVED PEAT (DIRECT LOSS) 7
A13.1.8. LOSS OF CARBON DIOXIDE FROM DRAINED AREAS LEFT IN SITU (INDIRECT LOSS) 9
A13.1.9. LOSS OF CARBON DIOXIDE FROM DOC AND POC LOSS 9
A13.1.10. TOTAL LOSS OF CARBON DIOXIDE FROM IMPACT ON PEAT 9
A13.1.11. LOSS OF CARBON FIXING DUE TO FOREST FELLING 9
A13.1.12. CARBON GAIN DUE TO SITE IMPROVEMENT AND RESTORATION 9
A13.1.13. CARBON BALANCE SUMMARY 10
A13.1.14. CARBON CALCULATOR INPUT DATA 12
A13.1.15. LABORATORY RESULTS – CARBON CONTENT 13
A13.1.16. LABORATORY RESULTS – DRY SOIL BULK DENSITY 14

List of Abbreviations

Abbreviation	Description
CO_2	Carbon Dioxide
DETS	Derwentside Environmental Testing Services Limited
DOC	Dissolved Organic Carbon
EIAR	Environmental Impact Assessment Report
GHG	Green House Gas
ha	Hectares
HMP	Habitat Management Plan
IUCN	International Union for Conservation of Nature
m	Metre
MW	Megawatt
PMP	Peat Management Plan
POC	Particulate Organic Carbon
SEPA	Scottish Environment Protection Agency

A13.1.1. INTRODUCTION

1.1.1 This report has been prepared by Natural Power Consultants and describes the carbon balance assessment undertaken for the Quantans Hill Wind Farm (hereafter known as the Proposed Development) which consists of 14 turbines and ancillary infrastructure[1]. This report presents the carbon balance findings for the Proposed Development and has been produced to assist consultees with their review of the Proposed Development's impact on peat and to assess the impact in terms of carbon dioxide (CO_2) emissions against the total potential carbon savings attributed to the Proposed Development.

1.1.2 This report should be read in conjunction with the Geology, Hydrology and Hydrogeology (Chapter 8), Ecology (Chapter 6), and Project Description (Chapter 3) chapters and relevant appendices of the EIAR which describe the Proposed Development in more detail and provided important information on the peat resource within the area.

A13.1.2. SCOPE

1.2.1 In the UK, Scotland is at the forefront in terms of providing a guidance framework through which the impact of development upon peatlands can be minimised. The carbon balance assessments make use of the carbon calculator tool[2] which is currently the best method to date to undertake this kind of assessment and is endorsed by the Scottish Environment Protection Agency (SEPA) and the Scottish Government.

1.2.2 The carbon balance assessment has been undertaken in accordance with guidance [3] Calculating Carbon Losses & Savings from Wind Farms on Scottish Peatlands – Technical Note 2.10.0'. As well as Technical Note 2.10.0[4] , this report has been produced giving consideration to the following guidance documents:

- D.R.Nayak et al. Calculating Carbon Budgets of Wind Farms in Scottish Peatlands (May 2010).
- Calculating carbon savings from wind farms on Scottish peat lands - A New Approach by Nayak et al., 2010
- Smith et al. Carbon Implications Of Windfarms Located On Peatlands – Update Of The Scottish Government Carbon Calculator Tool (2011).
- Scottish Natural Heritage: Carbon rich soil, deep peat and priority peatland habitats map (2016)
- CCW Guidance Note: Assessing the impact of windfarm developments on peatlands in Wales (Jan 2010).
- Natural England Commissioned Report: Investigating the impacts of windfarm development on peatlands in England (Jan 2010).
- Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and the Minimisation of Waste. Scottish Renewables (2014).
- Lindsay, R. Peatlands and Carbon: a critical synthesis to inform policy development in peatland conservation and restoration in the context of climate change (2010).
- Scottish Government, SNH and SEPA - Peatland Survey - Guidance on Developments on Peatland – 2017.

1.2.3 In addition, advice from the authors of the carbon calculator tool sought for previous assessments has been used again here and the completion of the carbon balance assessments for the Proposed Development required input from hydrology, peat, ecology and site investigation specialists.

1.2.4 Version v1.6.1 of the carbon calculator is currently the latest version of the online tool available (as of 11.11.2021).[5] The inputs from the online carbon calculator tool run are presented under sub-heading A13.1.14 of this report (Reference: 06H7-PTSF-6OZ8v0). As the online tool does not allow any amendments to functionality and cannot be changed, the carbon balance assessment was undertaken subject to the specifications that the tool dictates. The tool does not currently allow users to describe the sources of the input data or the detailed information that is inserted to conduct the analysis. Therefore, Table A13.1 presents this source information for the assessment. The data and infrastructure dimensions used have been based on the best data available at the time and, in cases where infrastructure design or construction methods were not yet clear, the worst case values were used to ensure that the assessment presented a worst case scenario in any areas of uncertainty. This carbon balance assessment is based on the data and infrastructure dimensions that reflect the final design of the Proposed Development, as far as is possible, as provided by RJ McLeod (the lead design consultant) and Vattenfall Wind Power Ltd. (the Applicant).

1.2.5 It is important to highlight that the assessment used a robust and comprehensive peat depth dataset that was collected during the earlier stages of the design and which provide a fair representation of peat depths across the Proposed Development Area. Working areas and drainage/cable trench areas have also been included within the infrastructure dimensions to attempt to account for any damage/disturbance to peat over and above peat removal within these additional areas.

Table A13.1: Record of Source of Data

Input	Source of Information
Turbine capacity and lifespan	Vattenfall. Up to 14 turbines, each with a rated output of up to 6.6 MW. Fixed life-span of the turbines is expected to be up to 30 years (expected scenario), and 25 (minimum scenario) and 35 (maximum scenario).
Capacity factor	Vattenfall. The capacity factor for the Proposed Development Area has been provided by Vattenfall based on wind flow model and turbine power curve data.
Fraction of output to backup	The extra capacity that would be needed for back-up power generation is currently estimated at 5% of the rated capacity of wind plant as UK wind power regularly contributes more than 20% to the National grid.
Type of peatland	MBEC and Hydrology Department, Natural Power Consultants Ltd. In the tool, the choice of peatland habitats is limited to acid bog or fen. In this case, acid bog was selected as the ecological surveys identify the Proposed Development would be located in an area comprised of a mosaic of blanket mire, wet heath, marshy grassland and semi-improved grasslands. The generalised soil type according to the National Soil Map of Scotland[6] within the Proposed Development includes peaty gleys, peaty podzols, peat, montane soils and mineral gleys as presented in Figure 8.5 (Scotland's Environment, 2020). The central, eastern and southern areas of the Proposed Development Area are dominated by podzols, with blanket peats also being mapped on the higher plateaux areas around Quantans Hill and Furmiston Craig. These soils are likely to be poorly drained and in areas of level ground will be waterlogged. The soils in the north of the Proposed Development Area are comprised of more poorly developed rankers and mineral gleys, which are likely to be thin and more freely draining. Natural exposures encountered during hydrology surveys often identified relatively thin

[1] To note, the proposed battery storage facility isn't included in the assessment as its location will be within the proposed compound and therefore has already been considered in the overall carbon balance assessment.

[3] Available online from: http://www.gov.scot/Topics/Business-Industry/Energy/Energy-sources/19185/17852-1/CSavings/CCguidance2-10-0 (last accessed on 21/09/2021)

[5] Available online from: https://informatics.sepa.org.uk/CarbonCalculator/index.jsp (last accessed 21/09/2021)

[6] National Soil Map of Scotland, http://map.environment.gov.scot/Soil_maps/?layer=1 accessed 21/09/2021

Input	Source of Information
	organic horizons overlying more granular matrix supported glacial deposits, with both layers appearing to be poorly drained.
Average air temp. at Proposed Development Area	Proposed Development Area specific temperature based on 29 years (1981-2010) data collected from the closest Met office weather station to the Proposed Development. The Glenlee Climate Station is positioned approximately 14.5 km from the Proposed Development and remains at a comparable altitude giving a good idea of temperature and rainfall totals expected at the Proposed Development Area. The expected value is the average annual temperature over the years. The minimum value is the minimum average annual temperature and maximum value is the maximum average annual temperature. https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/gcv12y3xn (last accessed 11/11/2021)
Average depth of peat on Proposed Development Area	Hydrology Department, Natural Power Consultants Ltd. Informed by peat probe data collection. The average of all the peat probe data collected across the Proposed Development Area during the 100 m grid sampling. It was considered that the 100 m grid data was more appropriately used for this parameter as it covered the whole of the Proposed Development area whereas the more detailed grid data focussed on infrastructure areas only. As advised by the authors of the original Excel tool, the arithmetic mean was calculated from this data to represent the 'expected' value, and the minimum and maximum values provided represent the lower and upper bound values of the 95% confidence intervals of the sample data collected.
Carbon content of dry peat	Derwentside Environmental Testing Services Limited (DETS) results August 2021 – see A13.14. Eight peat cores were collected from the Proposed Development Area where the deepest peat depths were found during surveys. As advised by the authors of the original Excel tool, the arithmetic mean was calculated from this data to represent the 'expected' value, and the minimum and maximum values provided represent the lower and upper bound values of the 95% confidence intervals of the sample data collected.
Extent of drainage	Hydrology Department, Natural Power Consultants Ltd. Based on Proposed Development Area observation, literature review and previous experience on similar, unforested sites.
Average water table depth	Hydrology Department, Natural Power Consultants Ltd. These values are based on water table depth observations across the Proposed Development Area during site visits, results of dip well monitoring reported by Holden et al. 2011[7], and previous experience on similar, unforested sites.
Dry soil bulk density	MAT test Limited results July 2020 – see A13.15. Site survey guidance provides details on how dry bulk density is measured and where possible, site-specific dry bulk density values should be used. Density was determined using the eight samples analysed at the laboratory which provided on value for dry soil bulk density. -/+ 10% of the amalgamated value has been used as

[7] Holden, J., Wallage, Z.E., Lane, S. N. and McDonald, A. T. (2011). Water table dynamics in undisturbed, drained and restored blanket peat. *Journal of Hydrology* **402**, 103-114.

Input	Source of Information
	the tool does not allow the same value to be inserted into all three scenarios. Confirmed as acceptable by Energy Consents Unit (ECU).
Time for regeneration of bog plants	MBEC. The period for successful re-vegetation in areas of disturbed peat will be dependent on a wide range of variables. Most importantly protection and stabilisation of bare peat, peat depth, condition and wetness, seed source, slope, altitude, and the degree of grazing and trampling pressure. Vegetation recovery on disturbed peat can be encouraged by protection with suitable vegetated turves and the application of an appropriate nurse seed mix and heather brash / seed as soon as possible following construction. Around infrastructure the local hydrology is usually altered due to the deep excavations. Therefore, unless peat of over 1 m depth is consolidated and high water level maintained, then the result is likely to be a form of wet heath, or potentially a drier heath, rather than bog vegetation. The extent of dwarf-shrub cover will also be heavily influenced by grazing pressure. In this case, the period for appreciable cover of bog plants, assuming suitable conditions are maintained in the peat body, has been estimated to be 10 years (5 years minimum and 20 years maximum). Achieving some cover of wet heath/bog plants within 5 years and complete cover of wet heath/bog vegetation within 20 years. Depending on the condition of the peat (and the other variables mentioned above) the vegetation is likely to trend towards a wet heath assemblage rather than a more natural blanket bog community. The timescales provided are based on the professional experience of the project ecologists.
Carbon accumulation due to Carbon fixation by bog plants	Values have been inserted from the online tool notes that quote published primary literature and Scottish Natural Heritage/NatureScot guidance values.
Area of forestry plantation to be felled	McKay Forestry Only shelter belt trees being felled around one turbine, and compensatory planting will be undertaken. Therefore it is assumed there will be no net loss of forestry, and authors of the tool have previously advised therefore not to include it in the assessment.
Coal-fired emission factor	Fixed value of the carbon calculator tool.
Grid mix emission factor	Fixed value of the carbon calculator tool.
Fossil fuel mix emission factor	Fixed value of the carbon calculator tool.
No. of borrow pits and dimensions	RJ McLeod Six borrow pits within Proposed Development. Total area for all borrow pits is estimated to be 97,500 m^2, therefore area divided by 6 to give average area per borrow pit of 16,250 m^2 with working area also included. Min and max values +/- 10%
Average depth of peat removed from turbine	Informed by 100 m grid and detailed peat probe data (i.e. Phase 1 and 2 peat surveys). A total of 6246 probes were collected within the Proposed Development

Input	Source of Information
foundations, hard standing and borrow pits	area. These values are derived from interrogation of the peat depth data collected underlying each type of infrastructure As advised by the authors of the original Excel tool, the arithmetic mean was calculated from this data to represent the 'expected' value, and the minimum and maximum values provided represent the lower and upper bound values of the 95% confidence intervals of the sample data collected.
No. of foundations/ hardstandings and dimensions	RJ McLeod The foundations will be made from reinforced concrete, delivered to the Proposed Development Area. Assume a circular shape with 26 m diameter which is considered representative of a turbine of this size however this is indicative only. The value inputs into tool allow for excavation areas, working areas (4 m) and 10% tolerance for min and max. Dimensions for hardstanding considers the permanent crane hardstanding area, 50 m x 20 m including 5 m working area on all sides apart from side adjoining access track (to avoid double counting) +/-10% for min and max values.
Volume of concrete	RJ McLeod Based on 14 turbine foundations (14,000 m^3), 1 met mast (125 m^3), 1 control building(500 m^3), 2 x bridges, (40 ^{m3}), 14 x external transformers (28m^3) (although considered worst case as it is assumed that internal transformers will be deployed) . + or - 10% for min and max values.
Total length of track	RJ McLeod 14,155 m of excavated road and 202 m floating road. The minimum and maximum scenarios are -/+ 10% of the expected value as the tool does not allow the same value to be inserted into all three scenarios.
Length of floating roads	RJ McLeod 202 m floating road. The minimum and maximum scenarios are -/+ 10% of the expected value as the tool does not allow the same value to be inserted into all three scenarios.
Excavated road length	RJ McLeod This value covers 14,155 m of excavated roads. The minimum and maximum scenarios are -/+ 10% of the expected value as the tool does not allow the same value to be inserted into all three scenarios.
Excavated road width	RJ McLeod The expected scenario value of 18.5 m is based on 8 m running width, 2.5 m drainage/cable trench on one side (1 m drainage + 1.5 m cable trench) and then 2 m working area either side + 2 m batters either side. Running widths, batters etc could vary therefore a range is presented for min and max.
Length of rock filled roads	RJ McLeod There will be no rock filled roads.
Length of cable trenches	RJ McLeod It is assumed that all cables will follow tracks and an allowance for cable trenches has been made when calculating excavated road widths.

Input	Source of Information
Additional peat excavated	RJ McLeod 38,280.56 m^3 of additional peat will be excavated. This input accounts for the substation and construction compound areas. External transformers are not included as they would be covered by turbine/crane hardstanding excavations. Calculations are shown in Table A13.3 of this chapter.
Area of degraded bog to be improved	MBEC. The development's Environmental Impact Assessment Report (EIAR) predicts a loss or affect to approximately 16.5 ha of peatland habitat. To compensate for these effects from construction and operation of the development an area of at least 85.37 ha will be targeted for restoration (value used in min scenario). The size and extent of the area will be determined through detailed ground investigation and will be detailed in the development's Habitat Management Plan (HMP). Max scenario is all areas proposed for peatland restoration.
Water table depth in degraded bog before and after improvement	Hydrology Department, Natural Power Consultants Ltd. The water table depths are based on field observations and an expectation that drained peat will have a lower water table around ditches as a result of de-watering. Values for after improvement are based on an assumption that rewetting measures (e.g. blocking drainage ditches) would increase water table depth. Consistent with findings of Holden et al. 2011.
Time required for hydrology and habitat of bog to return to its previous state on improvement	Hydrology Department, Natural Power Consultants Ltd. & MBEC The timescales provided are broad as effects of construction of the development have the potential to alter hydrological flows within peatland habitats from hydrological severance which cannot be restored post-construction. Consequently, areas of bog may be permanently affected by the development and will not return to their previous state. These losses have been considered in the development's EIAR and will be compensated in the development's HMP. Where hydrological severance does not occur then timescales are dependent on the restoration methods implemented at the time of construction, the vegetation available for restoration purposes and the level of previous destruction disturbance. Based on figures in IUCN Peatland Restoration review[8] blocking techniques can achieve water table and biodiversity gains after the first year; minimum figure of 5 years therefore adopted as bog will not be significantly degraded by the end of construction. Most known gains accrue by around 5 years, but some gains are thought to accrue as late as c. 20 years after enhancement. 10 years taken as a cautious midpoint given that gains may well be front-loaded. Blocking techniques can achieve water table and biodiversity gains after the first year however, The figures provided are based on the professional opinion of the project's ecologist and hydrologist.
Period of time when effectiveness of the improvement can be guaranteed (years)	Any improvement measures proposed can be guaranteed to occur within the lifetime of the wind farm. Values inserted into the tool include: expected, 30 years, minimum 25 years and maximum 35 years. After this time period the developer has no control.
Area of borrow pits to be restored	RJ McLeod Same values used as area of borrow pits excavated.

[8] https://www.iucn-uk-peatlandprogramme.org/resources/commission-inquiry/work-commission-2011/peatland-restoration [Accessed 08/11/2021]

Input	Source of Information
Water table depth in borrow pits before and after improvement	Hydrology Department. Natural Power Consultants Ltd. The water table depths are based on field observations and an expectation that drained peat will have a lower water table around ditches as a result of de-watering. The values represent the target for water table depths at the restored surface in borrow pits to be restored to similar water table depths of the Proposed Development Area prior to commencement of groundwork.
Time required for hydrology and habitat of borrow pits to return to its previous state on restoration (years)	MBEC & Hydrology Department. Natural Power Consultants Ltd. Values of 10, 5 and 20 years used. Borrow pit locations have been selected to avoid areas of peatland habitat which would be dependent on hydrological processes. As such, the predicted timeframe for recolonisation of these areas to their former habitats are shorter than for bog habitats as a stable hydrological regime is not required prior to species recolonisation. Where heath habitats were previously present, these will initially start to form in 5 years, however due to the slow growth rates of key species such as ling heather, the timescale for these to their former abundance may be significantly longer, up to 20 years.
Period of time when effectiveness of the improvement can be guaranteed (years)	Any improvement measures proposed can be guaranteed to occur within the lifetime of the wind farm. Values inserted into the tool include: expected, 30 years, minimum 25 years and maximum 35 years. After this time period the developer has no control.
Water table depth around foundations and hardstandings before and after restoration	Hydrology Department. Natural Power Consultants Ltd. The 'before restoration' water table depth is based on the scenario whereby drainage is not removed but left in situ. It assumes that, the drainage left in place would cause some draw down on the existing water table. The 'after restoration' water depths are based on backfilling of the drainage which would bring the water table depth up to, and likely higher, than previous levels before construction.
Time to completion of backfilling, removal of any surface drains, and full restoration of the hydrology (years)	Hydrology Department. Natural Power Consultants Ltd. Values of 3, 2 and 5 years used. Based on professional judgement.
Will the hydrology of the Proposed Development Area be restored on decommissioning	Yes. During the construction and commissioning of the wind farm, drainage ditches will be blocked and therefore the water table will increase. Upon the decommissioning of the wind farm, best practice principles will be adopted.
Will the habitat of the Proposed Development Area be restored on decommissioning?	MBEC No. At the moment it is assumed that upon decommissioning, restoration of habitats will not be undertaken. There are no plans to reintroduce species using nurse crops or fertilisation, therefore a worst case scenario of "no restoration" has been inputted into the carbon calculator tool.

Source: Multiple Sources highlighted at the top of each 'Source Information' cell.

1.2.6 The following paragraphs and tables report on the results of the carbon calculator calculations that are present within the online tool. For further clarification of the calculations, the reader will need to view the online submission (Reference: 06H7-PTSF-6OZ8v0).

A13.1.3. WIND FARM CO2 EMISSION SAVINGS

1.3.1 The amount of CO_2 emissions produced during energy production varies with the type of fuel used; therefore, the potential CO_2 savings from the proposed development depends on the type of fuel it replaces. The wind farm CO_2 emission savings over other types of generation (i.e. coal-fired, grid-mix, fossil fuel-mix) is calculated by multiplying the energy output of the wind farm development by the emissions factor of the other type of generation.

1.3.2 Based on an average 6.6 MW turbine model scenario, the expected potential annual energy output of the proposed development is 311,628.2 MWh yr^{-1} (9,348,847 MWh over 30 years), with minimum and maximum potential outputs at 250,161.08 MWh yr^{-1} and 365,270.09 MWh yr^{-1}.

1.3.3 Based on the expected annual energy output of the proposed development (311,628.2 MWh yr-1), the potential expected emissions saved over coal-fired electricity generation is 286,698 tonnes of CO_2 per year (tCO_2 yr^{-1}); and over grid-mix generation is 79,023 tCO_2 yr^{-1} and over fossil-fuel mix generation is 140,233 tCO_2 yr^{-1}.

A13.1.4. EMISSIONS DUE TO TURBINE LIFE

1.4.1 Energy is consumed and associated carbon dioxide (CO_2) emissions are released during manufacture of the turbine components, construction of the site (including site tracks and turbine foundations etc.), and during the decommissioning of the development.

1.4.2 The carbon calculator includes a module for assessing the carbon emissions due to turbine life. Nayak et al. (2010) explain that the turbine life calculation within the carbon calculator is based on generic data as it does not accommodate a site-specific full life-cycle analysis. Therefore, the turbine life emissions for the proposed development are estimated utilising an equation for ≥1 MW turbines that has been derived from data from numerous European sites, and which shows a significant relationship across the European sites examined.

1.4.3 The carbon calculator reveals an expected emissions figure of 84,431 tonnes of CO_2 (tCO_2) equivalent (equiv.) emitted due to the manufacture, construction and decommissioning of the turbines. Based on the calculated emissions savings for fossil fuel-mix generation, the payback time for turbine life is expected to take approximately 7 months.

A13.1.5. CAPACITY REQUIRED DUE TO BACK UP

1.5.1 In order to maintain security of energy supply, a second-by-second balance between generation and demand must be maintained by the grid operators. It has been noted that the inherent variable nature of wind energy may affect this balance and therefore, a certain proportion of power is required to stabilise the supply to the customer. The electricity system however, is designed and operated in such a way as to cope with large and small fluctuations in supply and demand. No power station is totally reliable, and demand, although predictable to a degree, is also uncertain. Therefore, the system operator establishes reserves that provide a capability to achieve balance, given the statistics of variations expected over different timescales. The variability of wind generation is but one component of the generation and demand variations that are considered when setting reserve levels.

1.5.2 It should also be noted that an individual wind turbine will generally generate electricity for 70-85% of the time, and its electricity output can vary between zero and full output in accordance with the wind speed. However, the combined output of the UK's entire wind power portfolio shows less variability, given the differences in wind speeds over the country as a whole. Whilst the amount of UK wind generation varies, it rarely, if ever, goes completely to zero, nor to full output at the same time throughout the UK.

1.5.3 The extra capacity that would be needed for back-up power generation is currently estimated to be approximately 5% of the rated capacity of the wind plant as UK wind power contributes more than 20% to the National Grid.

1.5.4 The carbon calculator assumes that backup is provided by a fossil fuel mix of energy generation and reveals an expected emissions figure of 54,636 tCO_2 equiv. due to the back-up. Based on the calculated emissions savings for fossil fuel-mix generation, the payback time for back-up is expected to take approximately 5 months.

A13.1.6. LOSS OF CARBON FIXING POTENTIAL

1.6.1 Construction of the Proposed Development will involve the installation of infrastructure such as turbine foundations, access tracks and hardstandings etc. Where vegetation and/or peat is removed or covered, the vegetation will no longer be able to photosynthesise and therefore, its ability to fix carbon will be lost. In addition, changes to drainage can have an effect on the vegetation of peatlands. Accordingly, the carbon calculator assumes that the carbon-fixing potential is lost from both the area occupied by infrastructure as well as working areas used to install the infrastructure and areas affected by drainage. In order to demonstrate a worst-case scenario of the Proposed Development's impact on carbon fixing potential through drainage, the extent of drainage around infrastructure is given as 10 m expected and 5 m and 15 m as minimum and maximum values respectively.

1.6.2 The carbon calculator also assumes that the footprint of the wind farm has 100% coverage of bog plants that are still accumulating carbon for those areas where vegetation is either removed during construction or compromised due to disturbance or drainage. This assumption is considered to be very much a worst-case scenario as 100% bog habitat cover is not an accurate representation of the Proposed Development Area's total habitat characteristics.

1.6.3 Habitat loss calculations for the development have been recalculated based on the revised infrastructure and are discussed in Chapter 6 of the EIAR. The table below provides a summary of total effects to habitats as a result of the Proposed Development which shows that not all of the habitats effected are peatland habitats.

Table A13.2: Summary of total effects to habitats

Phase 1 Habitat type	Area within 250 m of the Proposed Development (ha)	Area lost to Proposed Development (ha)*	Peatland Habitat Y/N
Broad-leaved plantation woodland	0.69	0.00	N
Coniferous plantation woodland	3.88	0.23	N
Mixed plantation woodland	1.75	0.00	N
Semi-improved acid grassland	114.36	11.35	N
Semi-improved neutral grassland	19.79	0.89	N
Marsh/marshy grassland	286.03	30.26	N
Continuous bracken	19.53	0.85	N
Scattered bracken	1.11	0.07	N
Acid dry dwarf shrub heath	0.37	0.00	N
Wet dwarf shrub heath	43.04	3.06	N
Wet heath/acid grassland mosaic	3.19	0.00	N
Blanket bog	23.92	0.51	Y
Wet modified bog	188.32	17.55	Y
Acid/neutral flush	4.03	0.17	N
Basic flush	0.04	0.00	N
Running water	0.11	0.00	N
Rocks	0.03	0.00	N
Other	0.08	0.00	N
Grand Total	**710.27**	**64.93**	

*Development footprint + 5m disturbance buffer (+ additional 5 m buffer for hydrologically sensitive habitats)

Phase 1 habitats considered as potentially hydrologically sensitively habitats: B5, D2, D6, E161, E17, E21, E22

Development footprint includes: Turbine bases and hardstanding, proposed tracks, substation, batching plant, compounds, borrow pit areas.

Source: MBEC

1.6.4 It is therefore considered that the carbon calculator's assumption that 100% of the land lost through construction or drainage of the Proposed Development is covered in bog plants or peatland vegetation is considered to be highly precautionary in this instance as other types of habitats do exist on site and will also be lost. Furthermore, another input required for the assessment is the time required for regeneration of bog plants. This has been estimated to be 10 years (5 years minimum and 20 years maximum) as described in Table A13.1. This, in part, is based on the observation of the quality of the bog vegetation on Proposed Development Area. In addition, any indirect damage which may result from the construction would be dealt with sensitively using best practice techniques to support rapid regeneration of vegetation.

1.6.5 The carbon calculator reveals that the expected total emissions attributable to the loss of carbon accumulation by bog plants is equivalent to 3,210 tCO_2 equiv. over the operational period of the wind farm. Based on the calculated emissions savings for fossil fuel-mix generation, the payback time for loss of carbon fixing potential is expected to be less than 3 months. However, as previously described above, it is important to recognise that 100% bog/mire habitat cover is not an accurate description of the Proposed Development Area's characteristics.

A13.1.7. LOSS OF CARBON DIOXIDE FROM REMOVED PEAT (DIRECT LOSS)

1.7.1 The 2017 Peatland Survey Guidance[9] states that peat is defined as the partially decomposed remains of plants and soil organisms which have accumulated at the surface of the soil profile. Peat accumulates where the rate of input of organic material from the surface exceeds the rate of decomposition and 'turn-over' of this new material. A peat layer does not include a mineral fraction (hence being differentiated from topsoil). Peat deposits are made up of organic soil which contains more than 60% of organic matter and exceeds 50 cm in thickness. Peat depths

[9] Available online from: https://www.gov.scot/Resource/0051/00517174.pdf (last accessed 09/09/2021

of less than 0.5 m are categorised as peat soils with peat deposits being >0.5 m in depth (JNCC, 2011[10]; Scottish Government *et al.,* 2017[11]).

1.7.2 The peat depth data at the Proposed Development are taken from the peat study using a 100 m grid sample and the more detailed peat depth probing undertaken on the site. Overall, 6,246 peat depth measurements were taken across the Proposed Development to inform peat depths across the Proposed Development Area. As advised by the authors of the tool, the arithmetic mean was calculated from this data to represent the 'expected' value, and the minimum and maximum values provided represent the lower and upper bound values of the 95% confidence intervals of the sample data collected.

1.7.3 Peat survey methodology was conducted in accordance with the guidance documentation 'Guidance on Developments on Peatland – Peatland Surveys 2017'. The results from the detailed peat probe surveys are shown in Table A8.4.1 of Technical Appendix 8.3 Peat Management Plan. An interpolation of the results shows that the highest proportion (60%) of recorded peat depths fell within the <0.5 m range, with the next highest proportion (21%) within the ≥0.5 – <1.0 m range. The areas of deep peat (greater than 0.5 m) are constrained to a few discrete locations within the Proposed Development Area, namely on the interfluve between the Knockgray Burn and Benloch Burn, just east of Craig of Knockgray hill as well as the summit of Quantans Hill and in the far east of the Proposed Development area, north-east of Furmiston Craig. In all cases, these locations also correspond with the identification of Class 1 peat (SNH, 2016). To obtain site-specific information relating to the characteristics of the peat/soil, peat core samples were also collected using a Russian peat core and were retained for laboratory and geochemical analysis.

1.7.4 Carbon content of dry peat (% by weight) and dry soil bulk density (g cm^{-3}) were analysed in a laboratory (see A13.14 for results) and the expected, minimum and maximum values have been inserted in the carbon calculator. A single amalgamated dry soil bulk density was analysed and gave a result of 0.14 g cm^{-3} and as advised by the authors of the tool, it was acceptable to input minimum and maximum values of +/- 10-% into the tool.

1.7.5 The excavated peat volumes calculated and reported within the assessment accommodate realistic working areas with the assumption built into the model that all peat in working areas is excavated and lost. Within this assessment, in order to represent a worst case scenario the following working areas and assumptions have been incorporated into the analysis:

- The expected values for excavated new roads width discussed above include the running width proposed access tracks have been assumed to accommodate a 8 m running width, and additional width to account for drainage/cable trench (2.5 m) on one side (1 m drainage + 1.5 m cable trench), and a working area/batters of 2 m either side, giving a total running width of 18.5 m. In some areas, batters would not be needed smaller than noted in expected scenario above (minimum scenario) or cable trench/working areas and batters may be wider (maximum scenario), therefore minimum and maximum values of 17.5 m and 23.5 m have been provided respectively.
- Working areas, excavation areas and batters have been included around turbine foundations and the average length and width included for the range of turbines sizes considered (indicative dimensions of 26 m x 26 m, with an additional excavation area of 4 m). Minimum and maximum values allow +/- 10% tolerance to account for changes in these areas that may be required. In most cases, the turbine foundation footprint and working areas will overlap with the hardstandings/working areas/laydown areas. As such, the minimum dimensions included within this assessment for turbine foundations should be considered very worst case as there is an element of double counting.
- Working areas have also been included in the calculations around the hardstandings (1 side assumed to be next to a road with no additional working area, therefore an indicative dimension of 60 m x 25 m for hardstandings is used.
- The expected length of floating road is 202 m which has been entered into the Carbon Balance Assessment tool with minimum and maximum values 10% less and more so that the assessment.

1.7.6 Some of these assumptions above will differ from those used to calculate peat extraction volumes within the Peat Management Plan (PMP). The working areas presented within this carbon balance assessment represent those areas where peat and/or peat vegetation may be removed or damaged/disturbed whereas the PMP investigates only those areas where peat is extracted and stored, then available for re-use. As such, the peat volumes reported in the carbon balance assessment are considered to be precautionary and considered to be highly worst case. In fact, latest guidance states that peat depth measurements of less than 0.5 m are not categorised as peat (rather peat soils), and deep peat deposits are considered being >0.5 m in depth. Accordingly, in line with this guidance, the PMP excludes measurements of less than 0.5 m from the peat extraction volume calculations. However, this assessment uses these data as a worst case.

1.7.7 The carbon calculator also requires information relating to other ancillary infrastructure not explicitly accounted for above, namely the substation, construction compound, anemometer mast etc. The following table utilises the expected dimensions of the additional infrastructure and peat depths used to calculate the total area and total volume of excavations.

Table A13.3: Additional peat excavated calculations

Additional Peat Excavated			
	Expected	**Minimum**	**Maximum**
Substation (m^2)	20,900	16,929	25,289
Substations Average Peat Depth (m)	0.41	0.22	0.60
Met Mast Area (m^2)	324	262.44	392.04
Met Mast Average Peat Depth (m)	0.64	0.29	0.99
Borrow Pits (m^2)	18,425	14,625	17,875
Borrow Pits Average Peat Depth (m)	0.17	0.15	0.20
Laydown Areas (m^2)	43,233	35,020	52,310
Laydown Areas Average Peat Depth (m)	0.61	0.56	0.67
Total Area of Peat Removed (m^2)	82,882	66,836	95,866
Total Volume of Peat Removed (m^3)	**38,280.56**	**25,605.33**	**54,184.19**

Source: Natural Power

1.7.8 Sheet 5, Table 5a of the carbon calculator calculates the total expected area of land lost due to the wind farm construction as 49.243 ha (does not include drained peat areas) and expected volume of peat removed over the footprint of the wind farm is expected to be 203,723.24 m³. Total volumes and areas have been stated within the results of the tool, these values are not rounded which conveys a false accuracy and it should be borne in mind that these values are only highly indicative as not all of the volume and areas reported as removed will be peat habitat.

[10] JNCC Report 445 (2011), Towards an assessment of the state of UK Peatlands. Towards an assessment of the state of UK peatlands | JNCC Resource Hub (last accessed 12/11/2021)

[11] Scottish Government, NatureScot, SEPA (2017) Guidance on Developments on Peatland – Peatland Survey.

1.7.9 The CO_2 release associated with the volume of peat excavated assumes a worst-case scenario that 100% of the peat is lost. However, this is not the case as the peat will be reused as part of peat reinstatement and restoration. The total expected amount of CO_2 loss, attributable to peat removal only, (i.e. CO_2 emissions from peat that is excavated for the wind farm only, no impacts from drainage of peat) that is reported within the online submission is calculated to be 29,846 tCO_2 equiv.

A13.1.8. LOSS OF CARBON DIOXIDE FROM DRAINED AREAS LEFT IN SITU (INDIRECT LOSS)

1.8.1 Carbon is also lost from peat habitats through drainage that occurs in the peat around the Proposed Development's infrastructure. The carbon calculator and associated guidance refers to this CO_2 loss as an "indirect loss". The extent of the Proposed Development Area affected by drainage assumes an expected, minimum and maximum extent of drainage around each drainage feature e.g. turbine foundation, tracks etc. It is important to bear in mind that the extent of drainage is dependent on existing drainage conditions on Proposed Development Area and also topography. The carbon calculator, however, assumes no existing drainage on Proposed Development Area and flat terrain which is not representative of the actual Proposed Development Area characteristics. Therefore, results using this parameter should only be considered as indicative at best.

1.8.2 Hydrological and site investigation specialists visually noted and recorded water table depths during surveys which informed the Proposed Development Area design evolution. Extent of drainage is a reasonable estimation based on knowledge of the Proposed Development Area (topography etc.), experience at similar sites and expert judgement. As such, a recommended average extent around the drainage feature of 10 m was considered as an appropriate expected average for the calculation. Values of 5 m and 15 m were inserted as inputs to represent best and worst case scenarios respectively.

1.8.3 Page 5, Table 5 of the carbon calculator calculates the total expected CO_2 loss from removed peat and from drained peat reported within the online tool submission is 29,846 tCO_2 equiv. This is the same carbon gain value as for CO_2 loss from peat removal only, as in Table 5d of the tool assumes that the emissions from drained and undrained peat have the same proportion over the emissions period and therefore the net emissions due to drainage is 0 tCO_2 equiv.

A13.1.9. LOSS OF CARBON DIOXIDE FROM DOC AND POC LOSS

1.9.1 Additional CO_2 emissions from organic matter can occur as carbon dioxide and methane, which can leach out of peat that is restored to conditions where the water table depth is higher after restoration than before restoration, and is a further consideration of the carbon calculator. Dissolved Organic Carbon (DOC) is defined as the organic matter that is able to pass through a filter (range in size generally between 0.7 and 0.22 µm). Conversely, Particulate Organic Carbon (POC) is the fraction of soil carbon that is larger in particle size. The assessment tool assumes that 100% of the losses due to leaching DOC and POC from restored drained and improved land are eventually lost as gaseous CO_2.

1.9.2 Only restored drained and improved land has been included in the calculations within the carbon calculator for DOC and POC, because if the land is not restored or improved, then the carbon loss has already been accounted for in the calculations for excavated and drained peat (i.e. the carbon assessment assumes that if land is not restored then 100% of the carbon will be lost from the removed or drained volume of soil).

1.9.3 The carbon calculator calculates that there will be an expected 0.34 tCO_2 equiv. lost due to DOC and POC leaching over the operational life of the wind farm.

A13.1.10. TOTAL LOSS OF CARBON DIOXIDE FROM IMPACT ON PEAT

1.10.1 The following calculations on total loss of CO_2 from the impact on peat have been based on a number of key assumptions (some of which are built into the tool itself), specifically in relation to peat, in order to demonstrate a worst-case (unrealistic) scenario using on-site data with input from ecology and hydrology specialists. In summary, these assumptions are:

- 100% of the area potentially affected by the wind farm is covered in peat forming mire habitat;
- The terrain is relatively flat with no existing drainage;
- Infrastructure dimensions for foundations, tracks and hardstandings include working/laydown areas;
- 100% of the carbon stored in the excavated peat will be lost as carbon dioxide and not reinstated on site;
- 10 m metre expected average extent of drainage to demonstrate a conservative expected scenario and 15 m worst case scenario;
- The average extent of drainage assumes that the depth of peat affected by drainage is equal to the depth of peat removed;
- The peat depth data used to inform the volumes of peat removed assume that all recorded depths are in peat; and
- The model assumes no micrositing to further reduce impacts on peat.

1.10.2 The combined expected impact of the development on peat and vegetation over the operational lifetime of the development for the proposed layout is calculated as:

Table A13.4: Total loss of CO_2 from impact on peat

	CO_2 loss from plants +	CO_2 loss from removed peat+ CO_2 loss from drained peat (i.e. soil organic matter loss)	+CO_2 DOC & POC loss
	3,210	29,845.71	0.34
Total loss CO_2 equivalent	33,056.05		

Source: Online Tool Reference 06H7-PTSF-6OZ8v0

1.10.3 Based on the calculated emissions savings for fossil fuel-mix generation, the payback time for loss of soil organic carbon and loss of CO_2 fixing potential is expected to be less than 3 months.

A13.1.11. LOSS OF CARBON FIXING DUE TO FOREST FELLING

1.11.1 The Proposed Development Area is currently unforested however new plantations have been consented which are due to be planted before construction would commence. Therefore 'new forestry' would need to be felled to accommodate the windfarm. Following construction compensatory planting would be completed and therefore there will be no loss of carbon fixing associated with forest felling on the site.

A13.1.12. CARBON GAIN DUE TO SITE IMPROVEMENT AND RESTORATION

1.12.1 Restoration of areas within a proposed site can reverse emissions and act as carbon storage, reducing the total CO_2 emissions as a result of the Proposed Development. The carbon calculator takes into account reductions for emissions resulting from the improvement of degraded bog, as well as the restoration of borrow pits and early removal of drainage from turbine foundations.

1.12.2 The drainage associated with the hardstandings and foundations will have an expected draw down on the water table during the construction period until such a time when they are removed/backfilled. This restoration work will where possible, intend to raise the water table depth above that which is already present before construction. All construction ditches and drainage on site will be blocked to minimise indirect habitat damage and loss through drainage. In cases where peat is excavated during the construction, it will be translocated or appropriately stored and used for reinstatement to best practice techniques.

1.12.3 The EIAR predicted a loss or effect to approximately 16.5 ha of peatland habitat. To compensate for these effects from construction and operation of the development area an area of at least 16.5 ha will be targeted for restoration. The specific measures to be undertaken are identified in the Outline Habitat Management Plan presented in Appendix 6.6 of the EIAR.

1.12.4 This assessment accommodates for expected improvements to degraded bog, of which an expected value of 107 ha is proposed for bog restoration for the Proposed Development (see Table A13.1).

1.12.5 The results report -16,752 tCO_2 equiv. in carbon gains from the restoration measures in the expected scenario and -42,549 tCO_2 equiv. in carbon gains from restoration in the maximum (best case) scenario. It is important to note that the minimum scenario does not show any carbon gains accrued from improvements of the site as the tool has assumed that no improvement has occurred which is considered to be an unrealistic scenario.

A13.1.13. CARBON BALANCE SUMMARY

1.13.1 Table A13.5 below reveals the carbon losses and carbon gains for each of the above parameters for the Proposed Development.

Table A13.5 Expected CO_2 losses and gains

Carbon Balance Input Parameter	Expected Results
1. Windfarm CO_2 emission saving over …	
Coal fired electricity generation (tCO_2yr^{-1})	286,698
Grid mix of electricity generation (tCO_2yr^{-1})	79,023
Fossil fuel mix of electricity generation (tCO_2yr^{-1})	140,233
Energy output from windfarm over lifetime (MWh)	9,348,847
Total CO_2 losses due to wind farm (tCO_2 eq.)	
2. Losses due to turbine life (e.g. manufacture, construction, decommissioning)	84,431
3. Losses due to backup	54,636
4. Losses due to reduced carbon fixing potential	3,210
5. Losses from soil organic matter	29,846
6. Losses due to DOC & POC leaching	1
7. Losses due to felling forestry	0
Total losses (tCO_2 eq.)	172,125
Total CO2 gains due to improvement of site (tCO_2 eq.)	
8a. Gains due to improvement of degraded bogs	-15,558
8b. Gains due to improvement of felled forestry	0
8c. Gains due to restoration of peat from borrow pits	-64
8d. Gains due to removal of drainage from foundations and hardstandings	-1,130
Total gains (tCO_2 eq.)	*-16,752*
Net CO_2 emissions (tCO_2 eq.)	155,373

Source: Online Tool Reference Online Tool Reference 06H7-PTSF-6OZ8v0: Payback Time and CO_2 emissions page.

1.13.2 The net emissions of CO_2 of the Proposed Development is calculated by deducting the total CO_2 gains produced by improvement and restoration of the site from the total CO_2 emissions from manufacture of, construction of, and impacts on peat from, the individual elements of the alternative Proposed Development (described in the preceding paragraphs). Table A13.5 reveals the net CO_2 emissions.

1.13.3 The wind farm CO_2 emissions savings of the Proposed Development over other types of generation (i.e. coal-fired, grid-mix, fossil fuel-mix) is calculated by multiplying the energy output of the Proposed Development by the emissions factor of the other type of generation. However, this parameter only takes into consideration the energy output of the Proposed Development and does not take into account any of the carbon losses or gains that are produced from manufacture of, construction of, and impacts on peat from, the individual elements of the Proposed Development. The parameter that takes all of this into account is the carbon payback time and it is this value that evidences the carbon balance of the Proposed Development.

1.13.4 The carbon payback time for the wind farm is calculated by comparing the net loss of CO_2 from the site due to wind farm development with the carbon savings achieved by the wind farm while displacing electricity generated from coal-fired generation, grid-mix generation or fossil-fuel mix electricity generation.

1.13.5 Figures 1 and 2 below illustrate the payback times for the alternative Proposed Development in years and months (respectively).

Source: Carbon Calculator – online submission Reference: 06H7-PTSF-6OZ8v0

RESULTS	Exp.	Min.	Max.
Net emissions of carbon dioxide (t CO2 eq.)	155,373	87,898	234,178
Carbon Payback Time			
...coal-fired electricity generation (years)	0.5	0.3	1.0
...grid-mix of electricity generation (years)	2.0	0.9	3.7
...fossil fuel-mix of electricity generation (years)	1.1	0.5	2.1

Figure 1: Carbon payback time for the Proposed Development

Source: Carbon Calculator – online submission Reference: 06H7-PTSF-6OZ8v0

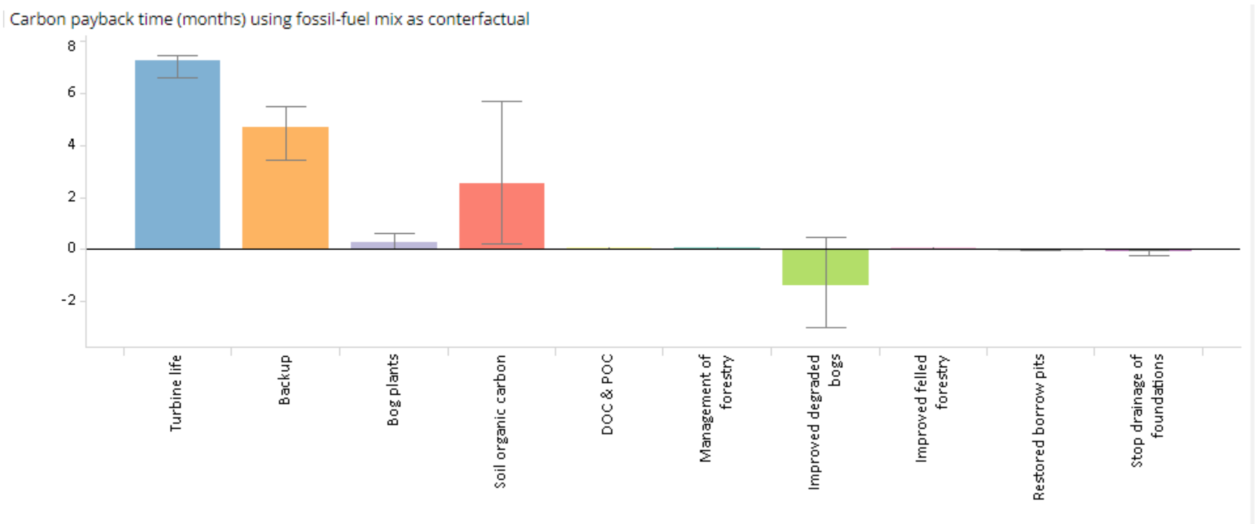


Figure 2: Carbon payback time (months) using fossil-fuel mix as a counterfactual

1.13.6 The results from the carbon calculator reveal that the Proposed Development would have effectively paid back its expected carbon debt from manufacture, construction, impact on habitat and decommissioning 1.1 years, if it replaced with the fossil fuel electricity generation method. Based on the minimum and maximum scenarios however, the analysis shows that the payback time for fossil fuel-mix generation ranges between 0.5 to 2.1 years respectively.

1.13.7 The Institute of Environmental Management and Assessment (IEMA) has identified the online carbon calculator tool for wind farm carbon assessments. This tool provides a consistent and the most comprehensive method for carbon assessment for wind farm developments on peat lands to date. However, the online tool does not define what level of impact on peat is considered to be a 'significant effect' as the existing carbon balance literature using this carbon assessment tool does not state this requirement.

1.13.8 In this regard, IEMA conclude that:

"…*when evaluating significance, all new Green House Gas (GHG) emissions contribute to a significant negative environmental effect; however; some projects will replace existing development that have higher GHG profiles. The significance of a project's emissions should therefore be based on its net impact, which may be positive or negative*".

1.13.9 In this context, the results of this assessment reveal that the net impact of the Proposed Development at Quantans Hill will be positive overall, as over the 30-year lifespan (in the expected scenario, however consent is being sought for 35 years which would be considered best case) of the Proposed Development, it is expected to generate over 28 years' worth of clean energy if it replaced fossil fuel electricity generation. In addition, over the expected 28 years that the wind farm is likely to be generating carbon-free electricity, this could result in expected CO_2 emission savings of over 3,926,524 tonnes[12] of CO_2 when replacing fossil fuel electricity generation. This illustrates a positive net impact through contributing significantly towards the reduction of greenhouse gas emissions from energy production.

[12] Calculation is 28 years x 140,233 tCO_2 (as shown in Table 5 and online submission).

A13.1.14. CARBON CALCULATOR INPUT DATA

Carbon Calculator v1.6.1
Quantans Hill Location: 55.224494 -4.219845
Natural Power

Core input data

Input data	Expected value	Minimum value	Maximum value	Source of data
Windfarm characteristics				
Dimensions				
No. of turbines	14	14	14	TA13.1
Duration of consent (years)	30	25	35	TA13.1
Performance				
Power rating of 1 turbine (MW)	6.6	6.2	6.8	TA13.1
Capacity factor	38.5	32.9	43.8	TA13.1
Backup				
Fraction of output to backup (%)	5	5	5	TA13.1
Additional emissions due to reduced thermal efficiency of the reserve generation (%)	10	10	10	Fixed
Total CO2 emission from turbine life ($tCO2\ MW^{-1}$) (eg. manufacture, construction, decommissioning)	Calculate wrt installed capacity	Calculate wrt installed capacity	Calculate wrt installed capacity	
Characteristics of peatland before windfarm development				
Type of peatland	Acid bog	Acid bog	Acid bog	TA13.1
Average annual air temperature at site (°C)	8.59	4.49	12.69	TA13.1
Average depth of peat at site (m)	0.39	0.36	0.42	TA13.1
C Content of dry peat (% by weight)	50	45	55	TA13.1
Average extent of drainage around drainage features at site (m)	10	5	15	TA13.1
Average water table depth at site (m)	0.3	0.1	0.5	TA13.1
Dry soil bulk density ($g\ cm^{-3}$)	0.14	0.11	0.17	TA13.1
Characteristics of bog plants				
Time required for regeneration of bog plants after restoration (years)	10	5	20	TA13.1
Carbon accumulation due to C fixation by bog plants in undrained peats ($tC\ ha^{-1}\ yr^{-1}$)	0.25	0.12	0.31	TA13.1
Forestry Plantation Characteristics				
Area of forestry plantation to be felled (ha)	0	0	0	TA13.1
Average rate of carbon sequestration in timber ($tC\ ha^{-1}\ yr^{-1}$)	3.6	3.5	3.7	TA13.1
Counterfactual emission factors				
Coal-fired plant emission factor ($t\ CO2\ MWh^{-1}$)	0.92	0.92	0.92	
Grid-mix emission factor ($t\ CO2\ MWh^{-1}$)	0.25358	0.25358	0.25358	
Fossil fuel-mix emission factor ($t\ CO2\ MWh^{-1}$)	0.45	0.45	0.45	
Borrow pits				
Number of borrow pits	6	6	6	TA13.1
Average length of pits (m)	167.5	151.5	183.5	TA13.1
Average width of pits (m)	110	110	110	TA13.1
Average depth of peat removed from pit (m)	0.17	0.15	0.2	TA13.1
Foundations and hard-standing area associated with each turbine				
Average length of turbine foundations (m)	30	27	33	TA13.1
Average width of turbine foundations (m)	30	27	33	TA13.1
Average depth of peat removed from turbine foundations(m)	0.61	0.56	0.67	TA13.1
Average length of hard-standing (m)	60	54	66	TA13.1
Average width of hard-standing (m)	25	22.5	27.5	TA13.1
Average depth of peat removed from hard-standing (m)	0.61	0.56	0.67	TA13.1
Volume of concrete used in construction of the ENTIRE windfarm				

Input data	Expected value	Minimum value	Maximum value	Source of data
Volume of concrete (m^3)	14693	13223.7	16162.3	TA13.1
Access tracks				
Total length of access track (m)	14357	12921.3	15792.7	TA13.1
Existing track length (m)	0	0	0	TA13.1
<u>Length of access track that is floating road (m)</u>	202	181.8	222.2	TA13.1
Floating road width (m)	17.5	16.5	22.5	TA13.1
Floating road depth (m)	0.87	0.59	1.15	TA13.1
Length of floating road that is drained (m)	202	181.8	222.2	TA13.1
Average depth of drains associated with floating roads (m)	1.5	1.35	1.65	TA13.1
<u>Length of access track that is excavated road (m)</u>	14155	12739.5	15570.5	TA13.1
Excavated road width (m)	18.5	17.5	23.5	TA13.1
Average depth of peat excavated for road (m)	0.47	0.46	0.49	TA13.1
<u>Length of access track that is rock filled road (m)</u>	0	0	0	
Rock filled road width (m)	0	0	0	
Rock filled road depth (m)	0	0	0	
Length of rock filled road that is drained (m)	0	0	0	
Average depth of drains associated with rock filled roads (m)	0	0	0	
Cable trenches				
Length of any cable trench on peat that does not follow access tracks and is lined with a permeable medium (eg. sand) (m)	0	0	0	
Average depth of peat cut for cable trenches (m)	0	0	0	
Additional peat excavated (not already accounted for above)				
Volume of additional peat excavated (m^3)	38280.56	25605.33	54184.19	TA13.1
Area of additional peat excavated (m^2)	82882	66836	95866	TA13.1
Peat Landslide Hazard				
Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments	negligible	negligible	negligible	Fixed
Improvement of C sequestration at site by blocking drains, restoration of habitat etc				
<u>Improvement of degraded bog</u>				
Area of degraded bog to be improved (ha)	106.63	85.37	127.89	TA13.1
Water table depth in degraded bog before improvement (m)	0.5	0.4	1	TA13.1
Water table depth in degraded bog after improvement (m)	0.4	0.3	0.7	TA13.1
Time required for hydrology and habitat of bog to return to its previous state on improvement (years)	10	5	20	TA13.1
Period of time when effectiveness of the improvement in degraded bog can be guaranteed (years)	30	25	35	TA13.1
<u>Improvement of felled plantation land</u>				
Area of felled plantation to be improved (ha)	0	0	0	TA13.1
Water table depth in felled area before improvement (m)	0	0	0	
Water table depth in felled area after improvement (m)	0	0	0	
Time required for hydrology and habitat of felled plantation to return to its previous state on improvement (years)	0	0	0	
Period of time when effectiveness of the improvement in felled plantation can be guaranteed (years)	0	0	0	
<u>Restoration of peat removed from borrow pits</u>				
Area of borrow pits to be restored (ha)	1.84	1.82	1.86	TA13.1
Depth of water table in borrow pit before restoration with respect to the restored surface (m)	0.4	0.2	0.5	TA13.1
Depth of water table in borrow pit after restoration with respect to the restored surface (m)	0.3	0.1	0.4	TA13.1
Time required for hydrology and habitat of borrow pit to return to its previous state on restoration (years)	10	5	20	TA13.1
Period of time when effectiveness of the restoration of peat removed from borrow pits can be guaranteed (years)	30	25	35	TA13.1

Input data	Expected value	Minimum value	Maximum value	Source of data
Early removal of drainage from foundations and hardstanding				
Water table depth around foundations and hardstanding before restoration (m)	0.4	0.2	0.5	TA13.1
Water table depth around foundations and hardstanding after restoration (m)	0.3	0.1	0.4	TA13.1
Time to completion of backfilling, removal of any surface drains, and full restoration of the hydrology (years)	3	2	5	TA13.1
Restoration of site after decomissioning				
Will the hydrology of the site be restored on decommissioning?	Yes	Yes	Yes	
Will you attempt to block any gullies that have formed due to the windfarm?	Yes	Yes	Yes	TA13.1
Will you attempt to block all artificial ditches and facilitate rewetting?	Yes	Yes	Yes	TA13.1
Will the habitat of the site be restored on decommissioning?	No	No	No	
Will you control grazing on degraded areas?	No	No	No	TA13.1
Will you manage areas to favour reintroduction of species	No	No	No	TA13.1
Methodology				
Choice of methodology for calculating emission factors	Site specific (required for planning applications)			

Forestry input data

N/A

Construction input data

N/A

A13.1.15. LABORATORY RESULTS – CARBON CONTENT

Certificate of Analysis

Certificate Number	21-17228
Issued:	23-Aug-21
Client	MATTest Ltd. 10 Queenslie Point 120 Stepps Road Glasgow G33 3NQ
Our Reference	21-17228
Client Reference	21/880
Order No	MATSC3664
Contract Title	Quantans Hill
Description	8 Soil samples.
Date Received	16-Aug-21
Date Started	16-Aug-21
Date Completed	23-Aug-21
Test Procedures	Identified by prefix DETSn (details on request).
Notes	Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Kirk Bridgewood
General Manager

UKAS TESTING
2139

Summary of Chemical Analysis
Soil Samples

Our Ref 21-17228
Client Ref 21/880
Contract Title Quantans Hill

			Lab No	1890551	1890552	1890553	1890554	1890555	1890556	1890557	1890558
			.Sample ID	Core 1	Core 2	Core 3	Core 5	Core 6	Core 7	Core 2B	Core 3b
			Depth	0.00-0.90	0.00-1.60	0.00-2.00	0.00-2.90	0.00-1.40	0.00-1.70	0.00-0.90	0.00-2.00
			Other ID								
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sampling Date	29/07/2021	29/07/2021	29/07/2021	29/07/2021	29/07/2021	29/07/2021	29/07/2021	29/07/2021
			Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**								
Inorganics											
Carbon, Total	DETSC 2002*	0.1	%	36	48	54	53	55	50	49	55
Total Organic Carbon	DETSC 2084#	0.5	%	36	49	55	58	57	51	49	55

Key: * -not accredited. # -MCERTS (accreditation only applies if report carries the MCERTS logo). n/s -not supplied.

Information in Support of the Analytical Results

Our Ref 21-17228
Client Ref 21/880
Contract Quantans Hill

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
1890551	Core 1 0.00-0.90 SOIL	29/07/21	PT 1L	Carbon, Total (14 days)	
1890552	Core 2 0.00-1.60 SOIL	29/07/21	PT 1L	Carbon, Total (14 days)	
1890553	Core 3 0.00-2.00 SOIL	29/07/21	PT 1L	Carbon, Total (14 days)	
1890554	Core 5 0.00-2.90 SOIL	29/07/21	PT 1L	Carbon, Total (14 days)	
1890555	Core 6 0.00-1.40 SOIL	29/07/21	PT 1L	Carbon, Total (14 days)	
1890556	Core 7 0.00-1.70 SOIL	29/07/21	PT 1L	Carbon, Total (14 days)	
1890557	Core 2B 0.00-0.90 SOIL	29/07/21	PT 1L	Carbon, Total (14 days)	
1890558	Core 3b 0.00-2.00 SOIL	29/07/21	PT 1L	Carbon, Total (14 days)	

Key: P-Plastic T-Tub

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.
Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.
The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-
Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

End of Report

A13.1.16. LABORATORY RESULTS – DRY SOIL BULK DENSITY

MATtest Limited
materials testing & consultancy

10 Queenslie Point
Queenslie Industrial Estate
120 Stepps Road
Glasgow
G33 3NQ

Tel: 0141 774 4032

email: info@mattest.org
Website: www.mattest.org

LABORATORY TEST CERTIFICATE

Certificate No :	**21/880 - 01**
To :	**Chris McCulla**
Client :	**The Natural Power Consultants** The Green House Forrest Estate Dalry Castle Douglas **DG7 3XS**

LABORATORY TESTING OF SOIL

Introduction

We refer to samples taken from Quantans Hill and delivered to our laboratory on 29th July 2021.

Material & Source

Sample Reference	:	See Report Plates
Sampled By	:	Client
Sampling Certificate	:	Not Supplied
Location	:	See Report Plates
Description	:	See Page 2
Date Sampled	:	Not Supplied
Date Tested	:	29th July 2021 Onwards
Source	:	13736UKC - Quantans Hill

Test Results

As Detailed On Page 2 to Page 3 inclusive

Comments

The results contained in this report relate to the sample(s) as received
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
All remaining samples for this project will be disposed of 28 days after issue of this test certificate

Remarks

Approved for Issue

[redacted]

T McLelland (Director)

Date 25/08/2021

UKAS TESTING 2643

BOREHOLE	SAMPLE	DEPTH (m)	SAMPLE DESCRIPTION
Core 1	C	0.00-0.90	PEAT (Von Post Classification - H7)
Core 2	C	0.00-1.60	PEAT (Von Post Classification - H7)
Core 2B	C	0.00-0.90	PEAT (Von Post Classification - H6)
Core 3	C	0.00-2.00	PEAT (Von Post Classification - H3)
Core 3B	C	0.00-2.00	PEAT (Von Post Classification - H9)
Core 5	C	0.00-2.90	PEAT (Von Post Classification - H9)
Core 6	C	0.00-1.40	PEAT (Von Post Classification - H7)
Core 7	C	0.00-1.70	PEAT (Von Post Classification - H3)

SUMMARY OF SAMPLE DESCRIPTIONS

MATtest Limited
materials testing & consultancy

BOREHOLE	SAMPLE	DEPTH (m)	MOISTURE CONTENT (%)	BULK DENSITY (Mg/m^3)	DRY DENSITY (Mg/m^3)
Core 1	C	0.00-0.90	665	1.10	0.14
Core 2	C	0.00-1.60	434	1.16	0.22
Core 2B	C	0.00-0.90	654	1.10	0.15
Core 3	C	0.00-2.00	771	1.08	0.12
Core 3B	C	0.00-2.00	807	1.10	0.12
Core 5	C	0.00-2.90	832	1.10	0.12
Core 6	C	0.00-1.40	724	1.11	0.13
Core 7	C	0.00-1.70	700	1.08	0.14

Tested in accordance with BS1377 Part 2 : 1990
Bulk Density : Linear Measurement

SUMMARY OF MOISTURE CONTENT AND DENSITY TEST RESULTS

Appendix 13.2

Proximity-Activated Lighting System Report

Document history

Author	Malcolm Spaven	10/11/2021

Client Details	
Contact	Matthew Bacon
Client Name	Vattenfall Wind Power Ltd

Issue	Date	Revision Details
A	10/11/2021	draft for client review
B	10/01/2022	Issued for review
C	27/01/2022	Released

QUANTANS HILL WIND FARM, DUMFRIES & GALLOWAY:
ESTIMATED SWITCH-ON TIMES FOR PROXIMITY-ACTIVATED LIGHTING SYSTEM

January 2022

Report No.21/959/VAT/3

Reservoir House
Gladhouse, Midlothian EH23 4TA
Tel: 0771 044 7378
E-mail: info@aviatica.co.uk

1. Introduction

1.1 This document assesses the probable amount of time that visible lighting on the Quantans Hill wind farm would be switched on by passing aircraft if a proximity-activated lighting system was fitted to the wind farm.

1.2 Proximity-activated lighting systems consist of:

- a sensor or sensors to detect aircraft in the vicinity;
- a control system to determine whether detected aircraft meet the criteria for the lights to be switched on; and
- a lighting control network to pass switch on/off commands from the sensors and control system to the lights.

1.3 There are two principal forms of proximity-activated lighting system: those based on primary surveillance radar sensors, and those based on passive sensors that detect transponder or other electronic conspicuity transmissions from aircraft. This document does not differentiate between these types of proximity-activated lighting system.

1.4 The document assumes that the activation criteria will be as stated by the CAA in their preliminary views on proximity-activated lighting systems, i.e. an aircraft entering a 4km radius bubble around the outer perimeter of the wind farm at an altitude less than 300m (1000ft) above the blade tips of the highest turbine and higher than 150m (500ft) above the ground level at the lowest turbine. In the case of Quantans Hill these altitude criteria translate to a bubble between 391m (1282ft) and 851m (2791ft) Above Ordnance Datum (AOD). The lighting activation zone around the Quantans Hill wind farm is illustrated in Figure 1.

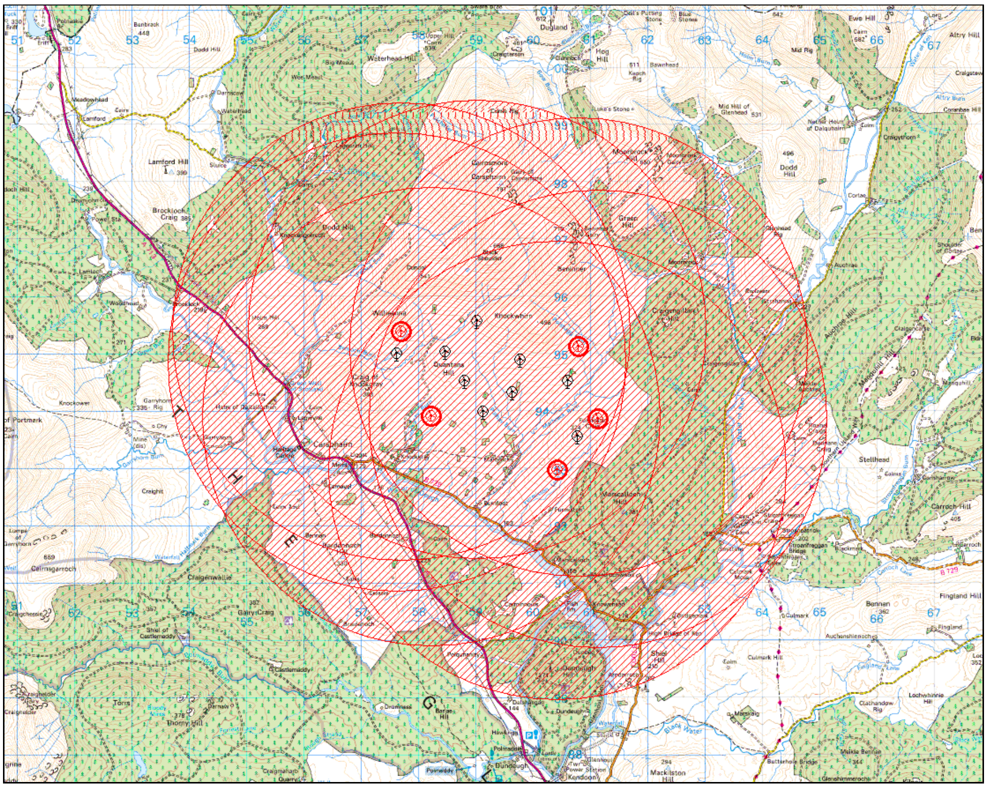


Figure 1: Quantans Hill wind farm lighting activation zone

2. Air traffic estimates

2.1 There are no specific data available for the volume of air traffic at low level passing a particular location. However some generic data on activity levels by particular forms of air traffic are available and have been used as a basis for the estimates generated in this document.

Military low flying

2.2 Quantans Hill is located in Allocated Region 2 (AR2) in the military Night Low Flying System, one of five such Regions across the UK where fixed and rotary wing night low flying may take place (see Figure 2). AR2 covers the whole of Central and Southern Scotland. Quantans Hill is in the western part of AR2, designated AR2B. There are no military airfields within AR2B but some night low flying in the area is generated by aircraft temporarily deployed to Prestwick Airport for training and by periodic military exercises centred on the former West Freugh airfield near Stranraer.

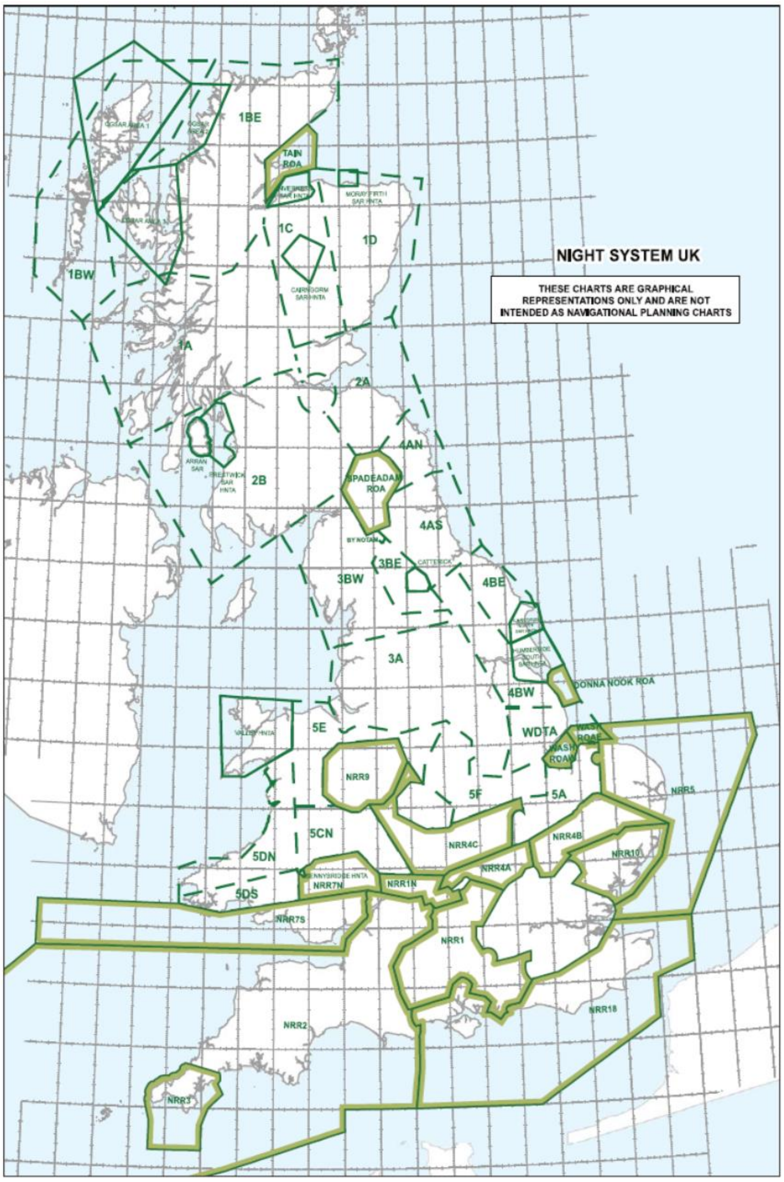


Figure 2: Structure of the UK Night Low Flying System

2.3 Data published by the Ministry of Defence (MoD) show that, in the latest year for which data is available, AR2 as a whole was the least busy of the five Allocated Regions (see Table 1).

Table 1: Military night low flying hours per region, year to 31 March 2020[1]		
Allocated Region	*No. of flying hours*	*% of UK night flying hours*
1	170	1.9%
2	80	0.9%
3	841	9.5%
4	229	2.6%
5	272	3.1%

2.4 AR2B, in which Quantans Hill is located, was used for 34.5 hours of military night low flying in 2019-20. However, the probability of a military aircraft on a night low level training flight passing over any given location depends not only on the number of hours flown in the relevant Allocated Region, but also on the area covered by that AR. Table 2 shows the 'density' of military night low level flying in each of the five ARs, including a breakdown between AR2A and AR2B, for the period 2016-2020. It can be seen that AR2B had a lower density of traffic than the adjoining AR2A (covering the eastern Borders and Fife) and AR3, 4 and 5 covering England and Wales. Only AR1 (covering Scotland north of the central belt) had a lower density of military night low level traffic (see Table 2).[2]

Table 2: Military night low level traffic density			
Night low flying area	*Area (sq km)*	*Night low flying hours 1 April 2016-31 March 2020*	*Mean traffic density (minutes per sq km per annum)*
Allocated Region 1	88301	424.25	0.072
Allocated Region 2A	9319	253.95	0.409
Allocated Region 2B	25025	246.17	0.148
Allocated Region 3	8370	2263.88	4.057
Allocated Region 4	20067	653.30	0.488
Allocated Region 5	32074	1320.40	0.618

2.5 The 34.5 night low flying hours in AR2B in the year to 31 March 2020 consisted of 12.4 hours by fixed wing aircraft and 22.1 hours by helicopters. Since the retiral of the Tornado from RAF service in March 2019, the fixed wing hours are likely to consist almost exclusively of flights by transport aircraft. Assuming each fixed wing flight in AR2B lasts 45 minutes, the figures for fixed wing flying in AR2B in 2019-20 would suggest a frequency of approximately one flight every three weeks. In 45 minutes a transport aircraft is likely to travel approximately 150 nautical miles (278km). Since light activation will occur when an aircraft is within 4km of the wind farm, the 'light activation swathe' for an aircraft on a 45 minute transit through AR2B is 2224km². The area of AR2 is some 25,000 km². If each aircraft flew a separate,

[1] Source: MoD, *The Pattern of Military Low Flying Across the UK* 2019-20, Table 2. The bulk of night low flying across the UK – over 80% of the total - takes place in fifteen additional areas known as Night Rotary Regions (NRRs), where precedence is given to rotary wing (helicopter) low flying. All NRRs are located in the southern half of England and Wales.

[2] Ministry of Defence, The Pattern of Military Low Flying Across the UK 2019-202, Table 2; UK Military Aeronautical Information Publication, ENR 5.2.7; Ministry of Defence, FOI response 2021/12724, 1 November 2021.

non-overlapping route to every other flight through AR2B over the course of a year, the probability of overflight within 4km of any given location would be approximately once a year. If on the other hand every aircraft flew the same route through AR2B, the probability of overflight for locations that happened to be under that route would be once every three weeks. The actual frequency of overflights within 4km of any given location will be somewhere between these two highly improbable extremes.

2.6 For a military transport aircraft flying at a typical speed of 210 knots, transit of the 4km radius lighting activation ‘bubble’ around the Quantans Hill wind farm would take between one and three minutes, depending on the direction of travel. On this basis, fixed wing military activations of the lights on the Quantans Hill wind farm may occur for between one and 52 minutes per annum.

2.7 For military helicopters, which fly at slower speeds than fixed wing aircraft, typical time spent for each flight through AR2B can be assumed to be one hour. Thus the 22.1 helicopter hours per annum in AR2B translate to one flight every 2.35 weeks. At an assumed groundspeed of 120 knots, each helicopter flight through AR2B would cover a lighting activation swathe of 1778km^2. If each flight followed a separate, non-overlapping route to all others over the course of a year, the probability of overflight within 4km of any given location would be once a year. If on the other hand every helicopter flew the same route through AR2B, the probability of overflight for locations that happened to be under that route would be once every 2.35 weeks. The actual frequency of overflights within 4km of any given location will be somewhere between these two highly improbable extremes.

2.8 For a helicopter flying at a typical speed of 120 knots, transit of the 4km radius lighting activation ‘bubble’ around the Quantans Hill wind farm would take between one and four and a half minutes, depending on the direction of travel. On this basis, military helicopter activations of the lights on the Quantans Hill wind farm may occur within a range of between one and 100 minutes per annum.

2.9 It should be noted that no account has been taken, in preparing these estimates of the frequency of activation of the lights by military aircraft, of aircraft flying below the lighting activation trigger ‘bubble’, i.e., in the case of Quantans Hill, at less than 1282 ft above sea level (approximately 700 feet above ground level in the centre of the Glenkens valley at Carsphairn). In practice a proportion of flights will be operating below these levels and will not, therefore, activate the lights.

Search and rescue (SAR) helicopters

2.10 In the year to 31st March 2021 the Prestwick-based SAR helicopter unit completed 350 taskings.[3] Of these, 57 were to incidents to the south east of Prestwick and could therefore have involved search or transit flying in the vicinity of Quantans Hill. Of the 57 taskings, 16 occurred between the hours of 6pm and 6am, approximating to the hours of darkness.

2.11 Since the Quantans Hill site lies only 18km from the edge of the Prestwick Control Zone and in one of two prominent valleys linking East Ayrshire with Dumfries

[3] Search and rescue helicopter statistics: year ending March 2021 - GOV.UK (www.gov.uk)

& Galloway, it can be expected that SAR helicopter flights between Prestwick and the south east pass within 4km of the site relatively frequently.
If it is conservatively assumed that:

- 2020-21 Prestwick-based SAR helicopter activity is representative of future activity levels;
- 50% of the night flights involve flying within 4km of Quantans Hill;
- all such flights are operating at less than 1000ft above the highest blade tips; and
- each tasking that takes the helicopter within 4km of Quantans Hill involves two activations of the lights – one on the outbound flight, another on return;

that would result in the Prestwick SAR helicopter activating the lights at Quantans Hill approximately sixteen times a year. At a typical AW189 cruise speed of 140kts, each transit of the light activation bubble would take between one and three and a half minutes. Assuming all SAR helicopter activations are by transiting aircraft, this would mean that light activations would be between 16 and 56 minutes per annum.

Air ambulance helicopters

2.12 Scotland's Charitable Air Ambulance at Perth flew 460 missions in 2020.[4] The SCAA hours of operation are 0700 to 1900 daily. On an annual basis, approximately 9% of those hours of operation are during official night. If it is assumed that 9% of missions are flown at night, that would equate to 41 missions a year. The Quantans Hill site is 78nm from the SCAA base at Perth Airport and approaching the southern edge of SCAA's operational area. In addition, SCAA's night time missions are restricted to patient transfers only. It is therefore unlikely that more than two of those 41 night flights per annum would be in the vicinity of Quantans Hill. Transit time of the light activation bubble would be between one and four and a half minutes. It is assumed for the purposes of this assessment that the helicopter flies the same route back to base as on the outbound transit and therefore activates the lights twice. Thus the annual light activation time by the SCAA helicopter is estimated to be between four and 18 minutes.

2.13 The Scottish Ambulance Service (SAS) helicopter operation at Glasgow City Heliport covers the Dumfries & Galloway region. It has full 24-hour capability. Data on the number of call-outs of the Glasgow air ambulance helicopter are not available. In 2019-20, the whole of the Scottish Ambulance Service air ambulance operation – which consists of helicopters based at Glasgow and Inverness and fixed wing aircraft based at Glasgow and Aberdeen – flew 3732 missions.[5] If it is assumed that each unit flew an equal share of those missions that would equate to 943 flights a year by the Glasgow-based helicopters. The Glasgow unit's operational area extends from the English border to the Western Isles. If it is assumed that one flight a day (39% of all call-outs) is carried out at night, and 1% of those flights pass within 4km of Quantans Hill, that would equate to approximately four flights a year. As with the SCAA helicopters, transit time of the light activation bubble would be between one and four and a half minutes and it is assumed that the return route is the same as the outbound route, causing two periods of light activation, giving a total estimated lighting activation time by the SAS helicopters of eight to 36 minutes a year.

4 https://www.scaa.org.uk/saving-time-saving-lives/call-out-statistics
5 Scottish Ambulance Service - Annual Report and Accounts for year ended 31 March 2020, para 1.5.

Police helicopters

2.14 Figures are not available for the operations of the Police Scotland Air Support Unit helicopter at Glasgow Heliport. For the purposes of this analysis it is assumed that the probability of it flying at night in the vicinity of Quantans Hill is similar to that of the SAS Glasgow helicopters – approximately 8-36 minutes a year.

Other night low level traffic

2.15 Other categories of night low level airspace user – private and commercial VFR helicopter flights, Private Pilot's Licence Night Rating training flights and night transits by private light aircraft – are estimated to be rare in the Quantans Hill area. While some such flights may follow the Glenkens valley in order to take advantage of greater separation between the terrain and the cloudbase, the relative absence of lit features along the valley and the existence of terrain in excess of 2600ft on either side of the valley make it highly unlikely that any aircraft not equipped with night vision equipment would pass within 4km of the Quantans Hill wind farm at an altitude lower than 300m above the highest blade tips (i.e. at less than 2791 ft above sea level). For the purposes of this analysis it is assumed that one such flight occurs per annum. Transit speed is assumed to be 90 knots, giving a transit time of one to six minutes depending on route and direction of travel.

3. Overall estimates

3.1 The estimates of activation times for each category of air traffic, and for all air traffic, are shown in Table 3. It can be seen that, even if the maximum amounts of activity in each category are assumed, the lights would be switched on for less than 0.13% of the periods of official night (Sunset +30 minutes until Sunrise -30 minutes). For those maximum periods to occur, every military night low level flight through west central and south west Scotland would have to fly within 4km of Quantans Hill – a highly improbable scenario. In practice, the periods of activation of the lights on the Quantans Hill wind farm can be expected to be comfortably under 0.1% of official night time.

Table 3: Quantans Hill lighting activation time estimates

	Estimated activation time (minutes/year)			*Percentage of official night hours*[6]		
Category of air traffic	*Min*	*Max*	*Mean*	*Min*	*Max*	*Mean*
Military fixed wing	1	52	27	0.0004%	0.0222%	0.0115%
Military helicopter	1	100	51	0.0004%	0.0427%	0.0218%
SAR helicopters	16	56	36	0.0068%	0.0239%	0.0154%
SCAA helicopter	4	18	11	0.0017%	0.0077%	0.0047%
SAS helicopter	8	36	44	0.0034%	0.0154%	0.0188%
Police helicopter	8	36	44	0.0034%	0.0154%	0.0188%
Other users	1	6	5	0.0004%	0.0026%	0.0021%
Totals	39	304	172	0.0167%	0.1299%	0.0735%

[6] Data from HM Nautical Almanac Office Websurf 2.0 shows the total period of Official Night at Quantans Hill to be 3901 hours per annum.

4. Comparison with operational proximity-activated lighting systems in Germany and Austria

4.1 To provide context for the estimates of lighting activation times set out above, Table 4 below shows the percentage activation times for 11 operational wind farms in Germany and Austria where Lanthan Safe Sky proximity-activated lighting systems are deployed.

4.2 The German-Austrian data show generally higher activation times than those estimated for Quantans Hill. However five of the wind farms had activation times within a similar range to Quantans Hill (between zero and 0.1% of night time). It is understood that some of the German wind farms are located close to airfields and low flying routes that are routinely used at night. Wiemersdorf, for example, is only 1.8km from a large Federal Police helicopter base, and has the controlled airspace of Hamburg Airport at 4500ft above the wind farm, and 1000ft above ground level 1.5nm to the south of the wind farm, forcing many aircraft to fly at lower levels.

Table 4: Lighting activation times at eleven wind farms in Germany/Austria

Wind farm name	*Lighting switch-on times*	
	% of night time	*Minutes per week*
Wiemersdorf	1.96	88.2
Bremen 24	2.80	126
Bremen 26	0.00	0
Bremen 27	6.50	292.5
Bremen 28	1.80	81
Bremen 29	0.00	0
Bremen 30	0.00	0
Bremen 31	7.30	328.5
Mistelbach	0.10	4.5
Eisenstadt	4.80	216
Rendlbahn	0.10	4.5
Average	2.31	103.95

Appendix 13.3

Civil Aviation Authority Approval Letter

Document history

Author	Civil Aviation Authority	17/02/2022

Client Details	
Contact	Matthew Bacon
Client Name	Vattenfall Wind Power Ltd

Issue	Date	Revision Details
A	18/02/2022	Released

Safety and Airspace Regulation Group
Safety and Business Delivery

Civil Aviation Authority

Malcolm Spaven
Director, Aviatica Ltd.
Reservoir House
Gladhouse
Midlothian
EH23 4TA

17 February 2022
Ref Windfarms/Quantans Hill

Dear Malcolm,

Proposed Obstacle Lighting Scheme for Quantans Hill Wind Farm, Dunfries and Galloway

Reference: Aviatica Report No. 20/853/VAT/2, e-mailed 23 December 2021

1. Thank you for the e-mail at reference. The attached report discusses the proposed obstacle lighting plan for the Quantans Hill wind farm.

2. The proposed Quantans Hill wind farm consists of 14 turbines, with tip heights up to between 200m. This brings the wind farm within scope of the Air Navigation Order (ANO) Article 222.

3. We have considered the report carefully and take note of the intent to address concerns relating to the night-time visual impact of such aviation lighting while ensuring that the lighting installed on the turbines meets air safety requirements.

4. You have conducted an aviation study that considers the type of aviation operations who might be expected to fly in this area and set out the rationale for a reduced lighting scheme.

5. We note the local terrain aspects and additional mitigation provided by the provision of infra-red lighting for those operators who carry Night Vision Device capability.

6. As a result, the CAA agrees a variation to the lighting requirements specified in the ANO Article for the Quantans Hill wind farm, under provisions given in the Air Navigation Order (ANO) Article 222 section 6, as per the following:

• medium intensity steady red (2000 candela) lights on the nacelles of turbines T01, T03, T10, T12 and T14;

Civil Aviation Authority
2W Aviation House City Place Gatwick Airport South West Sussex RH6 0YR www.caa.co.uk
Telephone 0330 138 3166 andy.wells@caa.co.uk

• a second 2000 candela light on the nacelles of the above turbines to act as alternates in the event of a failure of the main light;

• the lights on these turbines to be capable of being dimmed to 10% of peak intensity when the lowest visibility as measured at suitable points around the wind farm by visibility measuring devices exceeds 5km;

• infra-red lights to MoD specification installed on the nacelles of turbines T01, T02, T03, T04, T09, T10, T11, T12, T13 and T14.

7. Intermediate level 32 candela lights are not required to be fitted on the turbine towers.

8. The proposed intent to install an aircraft detection lighting system (ADLS) to the Quantans Hill wind farm in the future is noted.

9. Please let me know if you have any further queries.

Yours sincerely,

[redacted]

Andy Wells
Manager Rulemaking and Safety Publications

natural power

The Greenhouse
Forrest Estate, Dalry
Castle Douglas
DG7 3XS
Scotland

www.naturalpower.com