Wind Power North Two Limited

Balblair Wind Farm

Environmental Impact Assessment Report (Volume 2)

Chapter 9 - Geology, Hydrogeology, Hydrology and Peat

663896

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9 GEOLOGY, HYDROGEOLOGY, HYDROLOGY AND PEAT

9.1 Introduction

9.1.1 This chapter of the Environmental Impact Assessment (EIA) Report describes the existing geological, hydrogeological, hydrological and peat conditions within the Site, and identifies and assesses the potential impacts that may be caused by Balblair Wind Farm (hereafter the proposed Development). The potential impacts include preparation, construction works, restoration of construction works, Site operation and decommissioning. Mitigation measures that may be employed to ameliorate any adverse effects are also set out in this section.

9.1.2 This chapter uses terminology to refer to different aspects of the proposed Development including:

- the 'application boundary', which refers to the red line boundary of the proposed Development;
- the 'Site', which refers to the area of land within the application boundary; and
- The 'study area', which is defined as the Site plus any additional area over which desk based or field assessments cover.

9.1.3 This chapter is supported by various Technical Appendices and figures which provide additional in-depth information on relevant aspects of the proposed Development and are referenced throughout the text.

9.1.4 The Technical Appendices referred to in the chapter are as follows:

- **Technical Appendix 9.1: Peat Slide Risk Assessment**
- **Technical Appendix 9.2: Peat Management Plan**
- **Technical Appendix 9.3: Groundwater-Dependent Terrestrial Ecosystems Assessment**
- **Technical Appendix 9.4: Drainage Impact and Watercourse Crossing Assessment**

9.1.5 Key findings are summarised within this chapter.

9.1.6 Figures referenced in this chapter include:

- **Figure 9.1:** Study Area
- **Figure 9.2:** Bedrock Geology
- **Figure 9.3:** Superficial Geology
- **Figure 9.4:** Soils, Peat and Carbon
- **Figure 9.5:** Peat Depth
- **Figure 9.6:** Hydrological Catchments and Watercourses
- **Figure 9.7:** PWS
- **Figure 9.8**: WQM Locations

9.2 Relevant legislation, policy and guidance

9.2.1 In preparing this section of the EIA Report, consideration has been given to relevant statutory requirements and planning policy/guidance at all levels. This includes, but is not limited to, the following:

- The European Water Framework Directive (2006/60/EC) and associated daughter Directives including the Groundwater Daughter Directive (Protection of Groundwater Against Pollution, 2006/118/EC);
- The European Mining Waste Directive (2007/60/EC);
- The European Floods Directive (2007/60/EC);
- The Environmental Protection Act 1990 (as amended);
- The Environmental Impact Assessment (Scotland) Regulations 1999;
- The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017;
- The Water Environment and Water Services (Scotland) Act 2003;
- The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended);
- The Pollution Prevention and Control (Scotland) Regulations 2012;
- Scottish Government's National Planning Framework 4 (NPF4) 2023;
- Scottish Government's Planning Advice Note 51: planning, environmental protection and regulation;
- The Scottish Environment Protection Agency's (SEPA's) Position Statement WAT-PS-10-01: Assigning Groundwater Assessment Criteria for Pollutant Inputs;
- Scottish Government's Planning Advice Notes (PAN):
    - PAN 51: planning, environmental protection and regulation, 2006;
    - PAN 61: sustainable urban drainage systems, 2001;
    - Flood risk, planning advice 2015 (formerly PAN 69); and
    - PAN 79: water and drainage, 2006.
- SEPA's Guidance for Pollution Prevention (GPP and PPG):
    - GPP 1: Understanding your environmental responsibilities – good environmental practices, 2021;
    - GPP 2: Above ground oil storage tanks, 2021;
    - GPP 3; Use and design of oil separators in surface water drainage systems, 2022;
    - GPP 4: Treatment and disposal of wastewater where there is no connection to the public foul sewer, 2021;
    - GPP 5: Works and maintenance in or near water, 2018;
    - GPP 13: Vehicle washing and cleaning, 2021;
    - PPG 18: Managing fire water and major spillages, 2000;
    - GPP 21: Pollution incident response planning, 2021;
    - GPP 22: Dealing with spills, 2018; and
    - Code of Practice for Using Plant Protection Products in Scotland.

9.3 Consultation undertaken

9.3.1 Consultation in relation to issues concerning geology, hydrogeology, hydrology and peat has been undertaken with several statutory and non-statutory consultees and interested parties, including the Energy Consents Unit (ECU), The Highland Council (THC), SEPA,

NatureScot, Scottish Water and the Royal Society for the Protection of Birds (RSPB). Responses with relevance to geology, hydrogeology, hydrology and peat are provided in **Table 9.1**.

Table 9.1: Summary of consultee responses relevant to geology, hydrogeology, hydrology and peat

Name of stakeholder/ consultee	Key concerns	Response
Statutory consultees		
ECU	**Geology, hydrogeology, hydrology and peat** A full assessment on the impact on peat should be included in the EIA Report. A PMP should also be prepared.	Peat depth survey details and results are provided within this chapter as well as **Technical Appendices 9.1: Peat Slide Risk Assessment** and **9.2: Outline Peat Management Plan**.
	Peat landslide hazard and risk assessment (PLHRA) Where there is a demonstrable requirement for PLHRA, the assessment should be undertaken as part of the EIA process.	A full Peat Slide Risk Assessment is provided in **Technical Appendix 9.1**.
	Private Water Supplies The EIA Report should include details of any supplies identified by this investigation, and if any supplies are identified, an assessment of the potential impacts, risks, and provision of mitigation measures.	PWS are identified in **Section 9.5** – Water resources. Impacts, risk and mitigation are considered in **Sections 9.6** and **9.7**.
THC	**Geology, hydrogeology and hydrology** A full assessment of the development's impact on peat should be undertaken.	Peat depth survey details and results are provided in **Technical Appendices 9.1** and **9.2**. Potential impacts on peat are assessed in this chapter.
	The EIA Report should assess borrow pits, earthworks, Site restoration and the soil generally including direct effects and any indirect.	Three borrow pit search areas have been identified for Balblair Wind Farm. Refer to EIA Report **Chapter 2: The Proposed Development.** Earthworks and Site restoration are discussed in **Sections 9.6** and **Technical Appendix 9.2**.

Name of stakeholder/ consultee	Key concerns	Response
	The Site's hydrology and potential impacts on water need to be assessed, including water quality, quantity, and impact on aquatic flora and fauna.	Water quality and quantity are assessed in **Sections 9.6** and **9.7**. Potential impacts on aquatic flora and fauna are discussed further in the **Chapter 8: Ecology** and corresponding Technical Appendices.
	Projects should minimize the impact on watercourses and bridges should be used when crossing is necessary. The EIA Report should include detailed justifications and photographs of affected watercourses.	A full watercourse crossing assessment is provided in **Technical Appendix 9.4: Drainage Impact & Watercourse Crossing Assessment**.
	The Council's Flood Risk Management Team had no comments to make at this stage. The Applicant must investigate and report on any private water supplies that may be affected by the development. The report should also include measures to prevent contamination and disruption, along with details of monitoring and contingency measures.	PWS are identified in **Section 9.5** and discussed further in **Sections 9.6** and **9.7**.
SEPA	**Site specific comments**: Application should be supported by comprehensive Site specific PMP and national vegetation classification (NVC) survey. Watercourse crossings should be designed to accommodate the 1 in 200 year event plus climate change, and other infrastructure should be located well away from watercourses.	A comprehensive PMP is provided in **Technical Appendix 9.2.** NVC survey was undertaken by the Ecology team. A watercourse crossing assessment is provided in **Technical Appendix 9.4**.
	Water Environment The proposals should demonstrate how impacts on local hydrology have been minimised and the Site layout designed to minimise watercourse crossings and avoid other direct impacts on water features.	Design evolution is provided in **Chapter 3: Site Selection and Alternatives Considered** Within this chapter, sensitive receptors are assessed up to 5 km downstream of any development. Measures to mitigate and protect sensitive receptors are discussed in **Sections 9.6** and **9.7**.

Name of stakeholder/ consultee	Key concerns	Response
	Flood risk Crossings must be designed to accommodate the 0.5% annual exceedance probability flows (with an appropriate allowance for climate change), or information provided to justify smaller structures.	Flood risk is discussed within **Section 9.5** and further in **Technical Appendix 9.4**.
	Peat and peatland It should be clearly demonstrated that the assessment has informed careful project design and ensured that adverse impacts are first avoided and then minimised through best practice. Submission should include layout drawings overlaying the following: • peat depth survey showing peat probe locations, colour coded using distinct colours for each depth category. • interpolated peat depths. • peatland condition Drawings should demonstrate the development avoids natural peatland and any excavation is on peat less than 1m deep. **The Outline PMP must include:** A table clearly setting out the volumes of acrotelmic, catotelmic and amorphous excavated peat: • used in making good Site-specific areas disturbed by development, including borrow pits • used in onsite and offsite peatland restoration, and • disposed of, and the proposed means of disposal Details of proposals for temporary storage and handling of peat.	Peat depth survey details and results are provided in **Technical Appendices 9.1** and **9.2**. A full PMP is provided in **Technical Appendix 9.2**. A full set of figures will be provided for the EIA Report and Technical Appendices.
	GWDTE and existing groundwater abstractions A NVC survey should be submitted including: Drawings demonstrating all GWDTE and existing groundwater abstractions are outwith a 100m radius of all excavations shallower than 1m and outwith 250m of all excavations deeper than 1m.	GWDTE are assessed in **Technical Appendix 9.3: Groundwater – Dependent Terrestrial Ecosystems** using NVC data provided by the ecology team.
	Pollution prevention and environmental management	Mitigation measures, with reference to pollution prevention and

Name of stakeholder/ consultee	Key concerns	Response
	Schedule of mitigation, which includes reference to best practice pollution prevention and construction techniques and regulatory requirements.	construction techniques, are discussed in **Section 9.6** and specifically to peat within **Technical Appendix 9.2**.
NatureScot	**Peatland** Peatland guidance has been updated to reflect NPF4 (November 2023). Any area of peatland restoration should be at least 10x the scale of that impacted by the development.	NPF4 guidance was referred to whilst carrying out surveys and assessments. Peatland restoration is discussed in **Technical Appendix 9.2** and in **Chapter 8.**
	Hydrology Designated sites should be considered in context to potential hydrological effects from construction and decommissioning. Best Practice measures and Pollution Prevention Guidelines should be the focus for ensuring impacts are avoided or kept to very low levels	Designated sites are identified and discussed further in **Section 9.5**. Effects during construction, operation and decommissioning are discussed in **Section 9.7**. Mitigation measures using best practice and pollution prevention guidelines are provided in **Section 9.6**.
Non-Statutory Consultees		
RSPB	**Peatland Assessment** Peat depth should inform location of turbines by avoiding areas of deep peat over 50 cm.	Phase 2 peat surveys were used to inform the layout and design – avoiding deep peat where practicable. Design iterations which reflect this are provided in **Chapter 3**.

9.4 Approach to assessment

Study area

9.4.1 For most constraints and sensitivities, the study area is considered to be up to 2 km from the application boundary.

9.4.2 Geological sensitivities do not transmit over any significant distance, except potential considerations relating to mining activity. For mining, activities up to 5 km from the application boundary have been considered. For other geological considerations, the study area is 1 km from the application boundary.

9.4.3 For hydrological aspects, as effects can be transmitted downstream, a distance up to 5 km downstream of the application boundary has been used for the study area.

9.4.4 The study areas are shown in **Figure 9.1**.

Assessment method

9.4.5 The assessment is undertaken through a desk study and Site inspection of existing geological, hydrogeological, hydrological and peat-related features within and surrounding the Site. The existing conditions are described and potential risks that may be associated with the proposed Development are identified and assessed. This includes:

- physical changes to overland drainage and surface water flow paths;
- particulates and suspended solids;
- water contamination from concrete, fuels, oils or foul drainage;
- changes in or contamination of water supply to vulnerable receptors (including water supply, GWDTE and designated sites);
- modification to groundwater flow paths;
- soil erosion and compaction; and
- peat instability.

9.4.6 Effects scoped out of further assessment include:

- mining impacts, including coal mining and quarrying; and
- flood risk.

9.4.7 Mining impacts are deemed to have no relevant impacts relating to the proposed Development and are not considered further in this assessment.

9.4.8 Flood risk within the Site is indicated to be low and therefore a full flood risk assessment is deemed unnecessary. Flood risk to areas downstream is discussed further within **Section 9.7** of this chapter and in **Technical Appendix 9.4**.

9.4.9 Initial desk-based studies were undertaken to determine and verify the baseline conditions within the Site through review and collation of available and relevant information relating to geology, hydrogeology, hydrology and peat. This includes a review of published mapping, including Ordnance Survey (OS) topographical mapping at 1:25,000 and 1:50,000 scales, British Geological Survey (BGS) geological mapping, Scotland's Soils and peat/carbon mapping, aerial and satellite imagery and site-specific data such as any available site investigation data, geological and hydrogeological reports, digital terrain models (DTM, to provide slope data) and geological literature.

9.4.10 PWS data was obtained from THC.

9.4.11 A Site visit and reconnaissance survey were undertaken to:

- verify the information collected during the baseline desk study;
- undertake a visual assessment of the main surface waters and verify any PWS, including intakes, that could be affected by the proposed Development;
- identify drainage patterns, areas vulnerable to erosion or sediment deposition, and any pollution risks;
- allow appreciation of the Site, including awareness of gradients, access route options (including potential watercourse crossings), prevailing ground conditions, and to assess the relative location of all the components of the proposed Development; and
- collection of peat and substrate information where exposures are present, for example in watercourse channels and alongside infrastructure.

9.4.12 RSK undertook a reconnaissance survey between 2-6 September 2024. The weather was a variable mixture of rain and sunshine over the course of the week. Ground conditions were boggy as a result of the wet weather.

9.4.13 A Site wide Phase 1 peat survey on a 100 m grid was undertaken to identify areas of peat and natural variation in the peat substrate across the area. The Phase 1 survey was undertaken by WSP in November 2022, the results of which were provided to RSK by the Applicant. The initial infrastructure design made use of the Phase 1 survey results in order to avoid identified areas of peat.

9.4.14 Following the infrastructure design process, a Phase 2 peat probing exercise in parallel with the reconnaissance survey was carried out by WRc in September 2024. This included peat probing at:

- 50 m intervals along the centreline of proposed new access tracks, and at 10 m perpendicular offsets from the centreline; and
- 10-20 m resolution grid sampling at turbine locations, and at all other infrastructure locations.

9.4.15 RSK's Phase 2 survey did not include the Garvary wind farm access track and borrow pit as these areas had already been surveyed by SLR Consulting in December 2019. The data for these parts of the Site was provided to RSK by the Applicant.

9.4.16 Following the field surveys, a geomorphological mapping exercise was undertaken to link the topographic features with the underlying geology and to identify areas within the Site that may potentially be at risk from peat landslide. This used the collected field data, DTM, topographical mapping and aerial imagery.

9.4.17 The information obtained from the review of existing data, Site surveys and guidance documentation formed the basis of the assessment of the potential effects associated with the proposed Development. Where potential likely significant effects were identified, mitigation measures have been proposed.

9.4.18 A PSRA was undertaken in accordance with the Scottish Government's Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Developments. The PSRA was informed by the peat depth model, reconnaissance survey, peat depth surveys, geomorphological mapping and terrain classification produced from a DTM. The assessment used a combined qualitative (contributory factor) and quantitative (factor of safety) approach to determine the likelihood of peat landslides. Areas with the highest likelihood were compared with identified receptors to identify and determine appropriate mitigation measures. The assessment is provided in **Technical Appendix 9.1**.

9.4.19 An Outline PMP was prepared to investigate anticipated volumes of peat required to be removed for construction of the proposed Development and appropriate reuse of the excavated material. The PMP was informed by the collated peat depth probing described above, combined with a full appraisal of potential reuse opportunities, for example reinstatement and landscaping associated with the infrastructure and mapping of drainage ditches and degraded peat. Where opportunities were identified to integrate the PMP with wider environmental enhancement measures, such as peatland restoration and biodiversity enhancement, the PMP identifies the volume and type of peat to be used for this activity. The assessment is provided in **Technical Appendix 9.2**.

9.4.20 An assessment of GWDTE was undertaken based on the NVC mapping undertaken by the ecology team. Where areas of potentially moderate or high GWDTE were identified in proximity to proposed infrastructure, additional investigation was undertaken to: identify if the wetland areas were truly groundwater-dependent; refine their mapped extent;

conceptualise the hydrogeology; and assess any potential effects on these areas. The assessment is provided in **Technical Appendix 9.3**.

9.4.21 An assessment of drainage requirements to manage surface runoff and potential downstream flood risk was undertaken for the proposed Development. The assessment also included an inventory of all proposed watercourse crossings, both for new structures and for existing crossings that may require upgrading. This assessment is provided in **Technical Appendix 9.4**.

Effects evaluation

9.4.22 The significance of potential effects has been classified taking into account three principal factors:

- The **sensitivity** of the receiving environment;
- The potential **magnitude** of the effect; and
- The **likelihood** of that effect occurring.

9.4.23 This approach is based on guidance contained within the joint NatureScot/Historic Environment Scotland publication Environmental Impact Assessment Handbook v5 (SNH/HES, 2018).

Receptor sensitivity

9.4.24 The sensitivity of a receptor represents its ability to absorb the anticipated effect without resulting perceptible change. Four levels of sensitivity have been used, as defined in **Table 9.2**.

Table 9.2: Sensitivity ratings

Sensitivity	Definition
Very High	The receptor has very limited ability to absorb change without fundamentally altering its present character, is of very high environmental value and/or is of international importance e.g. Special Areas of Conservation (SAC), RAMSAR sites.
High	The receptor has limited ability to absorb change without significantly altering its present character, is of high environmental value and/or is of national importance e.g. National Nature Reserves, Sites of Special Scientific Interest (SSSI).
Moderate	The receptor has moderate capacity to absorb change without significantly altering its present character, has moderate environmental value and/or is of regional importance e.g. Geological Conservation Review (GCR) sites.
Low	The receptor is tolerant of change without detriment to its present character, is of low environmental value and/or of local importance e.g. Local Nature Reserves, Local Geodiversity Sites.

Effect magnitude

9.4.25 The magnitude of effects includes the timing, scale and size and duration of the potential effect. Four levels of magnitude have been used, as defined in **Table 9.3**.

Table 9.3: Magnitude ratings

Magnitude	Definition
Substantial	Substantial changes, over a significant area, to key characteristics or to the geological/hydrogeological/hydrological/peatland classification or status for more than 2 years.
Moderate	Noticeable but not substantial changes for more than 2 years or substantial changes for more than 6 months but less than 2 years, over a substantial area, to key characteristics or to the geological/ hydrogeological/hydrological/peatland classification or status.
Slight	Noticeable changes for less than 2 years, substantial changes for less than 6 months, or barely discernible changes for any length of time.
Negligible or No Change	Any change would be negligible, unnoticeable or there are no predicted changes.

Likelihood of effect

9.4.26 The likelihood of an effect occurring is evaluated to three levels: **Highly Unlikely, Unlikely** or **Likely**.

Effects significance

9.4.27 The findings in relation to the three criteria discussed above have been brought together to provide an assessment of significance for each potential effect. Potential effects are concluded to be of **major**, **moderate**, **minor** or **negligible** significance. Potential effects are assessed taking into account the proposed mitigation measures. The assessment concludes with a review of various effects to determine if they would be significant in terms of the *Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017.* Effects assessed as **major** or **moderate** are deemed to be significant; those assessed as **minor** or **negligible** are deemed to be not significant, as defined in **Table 9.4**.

Table 9.4: Effects significance matrix

Sensitivity	Magnitude	Likelihood	Significance
Very High	Substantial	Likely	**Major**
		Unlikely	**Major**
		Highly Unlikely	**Moderate**
	Moderate	Likely	**Major**
		Unlikely	**Moderate**
		Highly Unlikely	**Moderate**
	Slight	Likely	**Moderate**
		Unlikely	Minor
		Highly Unlikely	Minor
	Negligible/No Change	Likely	Minor
		Unlikely	Negligible
		Highly Unlikely	Negligible
High	Substantial	Likely	**Major**
		Unlikely	**Major**
		Highly Unlikely	**Moderate**
	Moderate	Likely	**Moderate**
		Unlikely	**Moderate**
		Highly Unlikely	Minor
	Slight	Likely	Minor
		Unlikely	Minor

Sensitivity	Magnitude	Likelihood	Significance
		Highly Unlikely	Minor
	Negligible/No Change	Likely	Minor
		Unlikely	Negligible
		Highly Unlikely	Negligible
Moderate	Substantial	Likely	**Major**
		Unlikely	**Moderate**
		Highly Unlikely	Minor
	Moderate	Likely	**Moderate**
		Unlikely	Minor
		Highly Unlikely	Minor
	Slight	Likely	Minor
		Unlikely	Minor
		Highly Unlikely	Negligible
	Negligible/No Change	Likely	Negligible
		Unlikely	Negligible
		Highly Unlikely	Negligible
Low	Substantial	Likely	**Moderate**
		Unlikely	Minor
		Highly Unlikely	Negligible
	Moderate	Likely	Minor
		Unlikely	Minor
		Highly Unlikely	Minor
	Slight	Likely	Minor
		Unlikely	Negligible
		Highly Unlikely	Negligible
	Negligible/No Change	Likely	Negligible
		Unlikely	Negligible
		Highly Unlikely	Negligible

9.4.28 In addition to the **sensitivity**, **magnitude** and **likelihood** of an effect, effects can be **direct** or **indirect**, **primary** or **secondary**, **transboundary**, **short-term**, **medium-term** and **long-term**, **permanent** and **temporary**, **positive** and **negative**.

Difficulties and uncertainties

9.4.29 The reconnaissance survey involved walking through and around the Site to gather visual information concerning elements such as slope, rock outcrop, ground conditions, types of watercourses, drainage pathways and the presence or absence of springs or groundwater seepages. No ground investigation was undertaken as part of the visit. As a result, information is limited to detail that can be gathered from a visual survey of this kind. Uncertainties may arise as a result of preceding weather, e.g. very wet conditions, may cause under- or over-estimation of the watercourse nature or ground conditions that would be considered 'normal' for this area.

9.4.30 The information gathered has been combined with information derived from surveys to map peat depths, as well as details from other disciplines such as vegetation and archaeological surveys, and photography to give as full a picture of conditions within the Site as possible. All reasonable attempts were made to ensure that good coverage of the Site and wider area was included. However, it is possible from the type of surveys undertaken that some information was not collected.

9.4.31 The professional experience of the staff who carried out the Site surveys ensures that difficulties and uncertainties are unlikely to have had any effect on the assessment or its conclusions.

9.5 Existing environment

Meteorology and climate

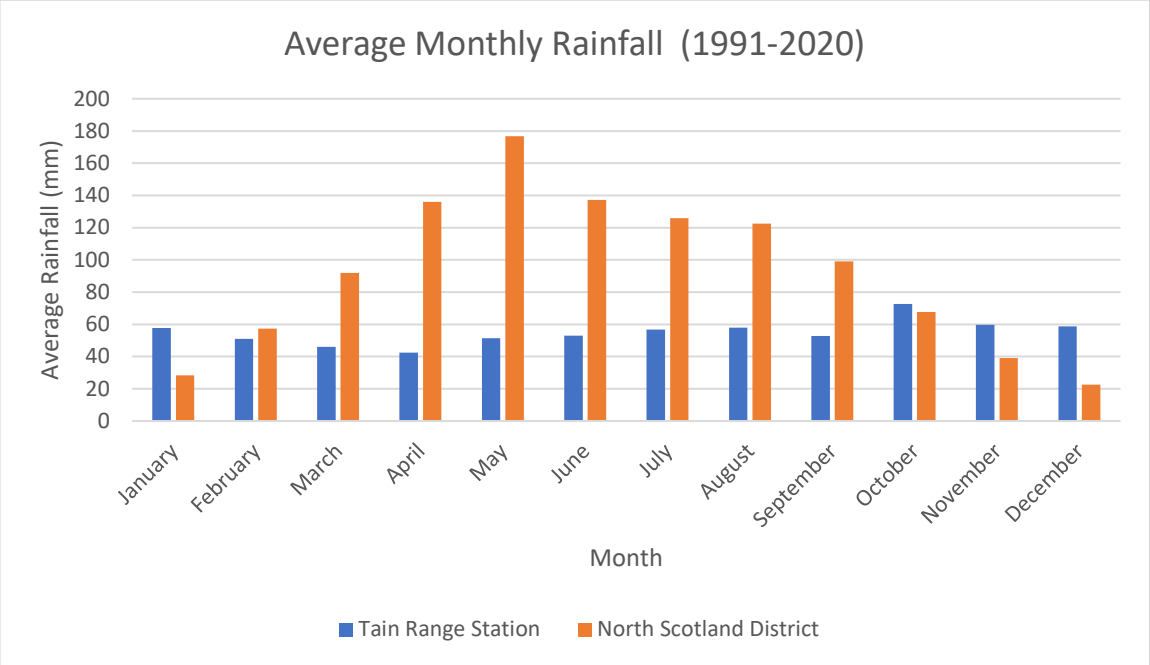
9.5.1 The proposed Development is situated within the UK Meteorological (Met) Office's Northern Scotland Climate District. Much of northern Scotland is exposed to rain-bearing westerly winds, particularly along the west coast. The wettest part of the district is immediately north west of Fort William on the west coast, which receives over approximately 4,000 mm per year. Lower-lying areas towards the east are drier, where rainfall averages are around 700 mm per year. Due to the proposed Development's low-lying easterly location within the climate district, it is afforded some protection against the Atlantic weather fronts that affect the west (Met Office, 2016).

9.5.2 Northern Scotland is characterised by steep mountains, glens and sea-lochs which contribute to the changeable weather patterns and temperatures within the region. Temperatures are highly variable depending on the combination of topography and distance from the coast. On average, annual temperatures for the region are around 9°C in areas of lower altitude and 1°C in areas of higher ground (Met Office, 2016).

Rainfall

9.5.3 The proposed Development is located approximately 20 km north west of the Tain Range climate monitoring station (Met Office, 2024). Rainfall patterns at the proposed Development are expected to be similar to those observed at the Tain Range monitoring station.

9.5.4 Average annual rainfall for the Tain Range monitoring station between 1991-2020 was 660 mm, in comparison to 1,702 mm for the Northern Scotland Climate District. The altitude at the Tain Range monitoring station is 4 m above Ordnance Datum (AOD). **Graph 9.1** compares the average monthly rainfall for the Tain Range climate monitoring station and the Northern Scotland climate district between 1991-2020.



Graph 9.1: Monthly rainfall averages for Tain Range Monitoring Station and North Scotland Climate District from 1991-2020

Geology

9.5.5 Geological information is sourced from the BGS GeoIndex online geological mapping at a 1:50,000 scale and the BGS Lexicon of Named Rock Units (BGS, 2024a; BGS, 2024b). Geological mapping is shown in **Figures 9.2** and **9.3**.

Bedrock geology

9.5.6 The Site is situated on bedrock of the Altnaharra Psammite Formation of the Morar Group, comprising metasedimentary psammites from the Neoproterozoic period.

9.5.7 A monzogranite pluton is present in the south eastern region of the Site, which forms the higher ground of Creag a'Ghobhair and adjacent hills. This forms part of the Argyll and Northern Highlands Granitic Suite. A small group of east to west or south east to north west trending magmatic dykes are present within the south and south western regions of the Site.

9.5.8 There are no mapped faults within the Site. Three minor faults are apparent within the wider study area, all to the west of the application boundary. Two are oriented north west to south east, and one is north east to south west. No earthquakes or earth tremors have been recorded within 10 km of the application boundary.

Mineral extraction

9.5.9 The Coal Authority Interactive Map (Coal Authority, 2024) and BGS GeoIndex (2024a) show no records of active or historic mining within the Site.

9.5.10 There are no mapped mineral occurrences or mineral abstraction sites within the Site.

9.5.11 There are several inactive gravel pits and quarries mapped within 1 km of the application boundary, details of which are provided in **Table 9.5: Quarries within 1 km of the application boundary (OS** 1:25,000 maps)

Table 9.5: Quarries within 1 km of the application boundary (OS 1:25,000 maps)

No	Name	Source location	Commodity	Status	Distance & direction from the application boundary
1	Lydsurach Track Pits	26145 89481	Unknown	Ceased	0.15 km south east
2	Maikle Wood	26100 89363	Unknown	Ceased	0.2 km south
3	Ausdale Pits	26250 89595	Unknown	Ceased	0.25 km east
4	Culrain Pits	25781 89496	Gravel	Ceased	0.4 km south west
5	Invershin Quarry	25830 89432	Sand and Gravel	Ceased	0.8 km south west
6	Clais na Faire Pits	26278 89832	Gravel	Ceased	1 km north

Superficial geology

9.5.12 BGS GeoIndex (2024a) indicates that superficial deposits are variable, with an even distribution of till and morainic deposits and peat. Large sections of the southern area of the Site are without mapped superficial deposits.

9.5.13 Till and morainic deposits are described as undifferentiated, poorly sorted diamicton, sand and gravel of highly variable glacial sediment, ranging in size from clay to boulders.

9.5.14 Peat is present in pockets of variable size and depth, distributed around the Site. Peat is described as the accumulation of organic material that can form beds and lenses within lagoons, bogs and swamps. The largest areas of peat are found along the north western and eastern boundaries. Patchier areas of peat are dispersed through the north and central areas of the Site.

9.5.15 Two small pockets of alluvium are present within the Site which are associated with tributaries to Migdale Burn and Henman's Burn in the south west and east respectively.

9.5.16 No artificial ground was identified within the Site.

Soils and peat

9.5.17 The National Soil Map of Scotland (Scotland's Soils, 2024; Soil Survey of Scotland, 1982) indicate that the Site is underlain by soils of the Arkaig Association. These soils consist mainly of peaty gleys, peaty podzols, peaty gleyed podzols, with some humus-iron podzols. Areas of dystrophic blanket peat have also been identified within the Site. .

9.5.18 Further details of soils within the Site are provided in **Table 9.6**.

Table 9.6: Soil types within the Site

Soil assoc.	Parent material	Component soils	Landforms	Vegetation	Area %
Arkaig	Drifts derived from schists, gneisses, granulites and quartzites principally of the Moine Series	Peat, peaty gleys and peaty podzols	Undulating lowlands and uplands with gentle and strong slopes; non-rocky	Bog and northern bog heather moor Blanket and northern blanket bog Moist Atlantic heather moor	60.2%
		Peaty gleys, peat; some peaty podzols and peaty rankers	Undulating hills with gentle and strong slopes; moderately rocky	Bog and northern bog heather moor Moist Atlantic heather moor Blanket and northern blanket bog	24.7%
		Peaty podzols, peat, peaty gleys	Hummocky valley and slope moraines: often bouldery	Bog and northern bog heather moor Blanket and northern blanket bog Moist Atlantic heather moor	11%
		Humus-iron podzols, some brown forest soils, non-	Undulating lowlands and valley sides with gentle and	Arable and permanent pastures Rush pastures and sedge mires	4.1%

Soil assoc.	Parent material	Component soils	Landforms	Vegetation	Area %
		calcareous gleys and peaty gleys	strong slopes; non-rocky	Dry Atlantic heather moor.	

9.5.19 NatureScot's Carbon and Peatland Map (NatureScot, 2016) classifies soils into five carbon classes, as well as three classes for mineral soils, non-soil or unknown. The map was consulted to understand where carbon-rich soils, deep peat and priority peatland habitat are located within the Site. Classes 1 and 2 are considered to be nationally important carbon-rich soils, deep peat and priority peatland habitat.

9.5.20 The map indicates that much of the Site is underlain by Class 2 soils and peatland. Small areas of Class 1 are mapped in the eastern part of the Site. Areas of Class 5 peatland, described as carbon-rich soils and deep peat, are present in the south west, north and eastern parts of the Site and underly the western half of the access route. Small pockets of Classes 3 and 0 are also present.

9.5.21 Details of each peatland class and the associated areas within the Site are provided in **Table 9.7**. Soils and peat coverage is shown in **Figure 9.4**.

Table 9.7: Carbon and peatland classes present within the Site

Peatland class	Description	Area %
Class 1	Nationally important carbon-rich soils, deep peat and priority peatland habitat. Areas likely to be of high conservation value	5.8%
Class 2	Nationally important carbon-rich soils, deep peat and priority peatland habitat. Areas of potentially high conservation value and restoration potential	74.7%
Class 3	Dominant vegetation cover is not priority peatland habitat but is associated with wet and acidic type. Occasional peatland habitats can be found. Most soils are carbon-rich soils, with some areas of deep peat	2.1%
Class 5	Soil information takes precedence over vegetation data. No peatland habitat recorded. May also include areas of bare soil. Soils are carbon-rich and deep peat.	13.3%
Class 0/Mineral Soil	Peatland habitats are not typically found on such soils	4.1%

9.5.22 Phase 1 peat survey data was completed by WSP in November 2022 and provided to WRc by the Applicant in September 2023. A Phase 2 peat survey was undertaken by WRc in September 2024. The Phase 2 survey excluded the Garvary access track and borrow pit as these had already been surveyed by SLR Consulting in December 2019. The data for these areas was also provided to WRc by the Applicant. The combined survey results were used to inform the infrastructure design to minimise incursion into areas of deep peat and priority peatland habitat.

9.5.23 A total of 2,702 individual peat depths were taken. The surveys indicate that peat depths vary widely across the Site, ranging from 0.01 - 6.42 m depth. Contained pockets of deep peat (>1.0 m) are widely distributed throughout the Site. The deepest areas of peat recorded were found in the eastern part of the Site, which correlates with the carbon and peatland mapping.

9.5.24 Further details of peat depth and peat depth variation are provided in **Technical Appendices 9.1** and **9.2**. An overview map of the peat depth distribution within the Site is provided in **Figure 9.5**.

Topography

9.5.25 The Site is characterised by upland moorland on undulating ground with a mixture of gentle and steep slopes. Elevations within the Site range from approximately 20 m to 298 m AOD.

9.5.26 The highest points within the Site are Cnoc Blàr na Curaich at 293 m AOD and Cnoc a' Choire Bhuidhe at 298 m AOD, both of which form part of the upland plateau in the central part of the Site. The lowest elevation within the Site is located along the south west boundary near Invershin, where the ground falls to around 20 m AOD.

9.5.27 There are ranges of prominent hills to the north and east of the Site. To the north is Meall Eachainn at 343 m AOD. To the east lies Creag a' Ghobhair at 346 m AOD and Cnoc Dubh Mòr at 340 m AOD. Slopes in the southern part of the Site fall to the Kyle of Sutherland, an estuary connected to the Dornoch Firth.

Hydrogeology

9.5.28 The bedrock unit is classed as a low productivity aquifer of the Morar Group, comprising metasedimentary psammites where small amounts of groundwater exist in the near-surface weathered zone and within secondary fractures. Groundwater flow is virtually all through fractures and other discontinuities.

9.5.29 Superficial deposits consist of till and morainic sand and gravel and peat. Till and moraine exhibit varying levels of permeability as a result of their highly variable composition. Peat holds some groundwater; although flow within peat is extremely slow, it can contribute to some limited baseflow in local watercourses.

9.5.30 There is one groundwater body within the Site - the Northern Highlands groundwater body (SEPA, 2022) which is in good overall condition. Regional groundwater flow will tend to mimic the natural topography, where the central plateau will influence direction and flow patterns.

9.5.31 No springs or wells are mapped within the Site; however, a number of springs and wells are mapped within a 2 km study area.

Groundwater vulnerability

9.5.32 Groundwater vulnerability is *"the tendency and likelihood for general contaminants to move vertically through the unsaturated zone and reach the water table after introduction at the ground surface"* (Dochartaigh *et al*., 2011). Groundwater vulnerability classes range from 1 (*"only vulnerable to conservative pollutants in the long term when continuously and widely discharged/leached"*) to 5 (*"vulnerable to most pollutants, with rapid impact in many scenarios"*).

9.5.33 Groundwater vulnerability mapping has identified groundwater within the Site to have vulnerability classes of 4a, 4b and 5. Both classes 4a and 4b are considered vulnerable to pollutants not already absorbed or transformed. Class 4b is more likely to have clay present within superficial deposits. Class 4a may have low permeability soils and is less likely to have clay present within superficial deposits. Class 5 is vulnerable to most pollutants, with rapid impacts predicted in many scenarios.

GWDTE

9.5.34 GWDTE are defined by UKTAG (2004) as:

A terrestrial ecosystem of importance at Member State level that is directly dependent on the water level or flow of water from a groundwater body (that is, in or from the saturated zone). Such an ecosystem may also be dependent on the concentrations or substances (and potentially pollutants) within that groundwater body, but there must be a direct hydraulic connection with the groundwater body.

9.5.35 In line with the guidance provided by UKTAG (2004), a dual approach to identifying GWDTE has been used. This involves the detailed study of vegetation communities for determining the potential level of groundwater dependency, and a detailed hydrogeological study that can identify locations where groundwater reaches the surface and is thus able to provide a source of water to associated habitats.

9.5.36 A habitat mapping exercise was completed as part of the ecology baseline assessment, which was used to identify potential GWDTE within the Site. The results of the habitat mapping exercise are discussed in **Chapter 8**.

9.5.37 GWDTE have been assessed separately. Details are provided in **Technical Appendix 9.3**.

9.5.38 Within the Site, the potentially groundwater-dependent NVC communities identified are:

- M6 *Carex echinata – Sphagnum recurvum/auriculatum* mire
- M15 *Scirpus cespitosus – Erica tetralix* wet heath
- M25 *Molinia caerulea – Potentilla erecta* mire

9.5.39 NVC Communities identified by SEPA as being potentially highly or moderately groundwater-dependent, depending on the hydrogeological setting, are listed in SEPA's publication 'Planning guidance on onshore windfarm developments' (SEPA, 2017). M6 has potentially high groundwater dependency in a Scottish setting. M15 has potentially moderate groundwater dependency in a Scottish setting. M25 has potentially moderate/low groundwater dependency in Scottish situations, dependent on the hydrogeological setting.

Hydrology

9.5.40 The Site is situated across six catchments areas: River Shin, An Uidh, Migdale Burn, Allt na Claise Mòire, Allt Port na Lice and Henman's Burn.

9.5.41 The An Uidh catchment drains the largest area within the Site and includes most of the proposed Development. It stretches north of the application boundary to include Loch Laro and its tributaries.

9.5.42 There are a number of watercourses and unnamed tributaries within the Site and surrounding area. Catchment areas are shown in **Figure 9.6**.

9.5.43 The catchment wetness index (PROPWET) indicates the proportion of time that soils are defined as wet, with the Flood Estimation Handbook (FEH) defining 'wet' as being when soil moisture deficits are less than 6 mm. PROPWET values for the identified catchments are mid to high and range from 57-81% (CEH, 2024).

9.5.44 Baseflow index (BFI HOST19) is a measure of catchment responsiveness to rainfall. Each soil type has been assigned one of 29 specific HOST (hydrology of soil types)

classifications. The HOST value in turn determines the baseflow index (BFI) for a catchment and can range from 0.17 to 1.0. BFI measures the input derived from stored sources, with more permeable rocks, superficial deposits and soils in a catchment leading to a higher BFI. The identified catchments have a BFI HOST19 ranging from 0.29 to 0.58%, which is a mid to low BFI value, indicating relatively impermeable geology and a low-level input of groundwater to surface watercourses within the Site.

9.5.45 SPRHOST is a measure of catchment responsiveness to rainfall and represents the average value where the standard percentage of rainfall (SPR) is expected to exceed the infiltration capacity of the soil type (HOST) leading to surface runoff. SPR values range from 34.09-52.53%. These mid to high values indicate that soils within the catchments have a limited capacity for storage/infiltration and represent a high risk of surface run-off. Watercourses in the catchments are thus likely to be dominated by input from surface waters and are expected to have a flashy nature with a quick response to rainfall.

9.5.46 Catchment statistics and descriptions of the main catchments within the Site, derived from the FEH Web Service (CEH, 2024), are provided in **Table 9.8**.

Table 9.8: Catchment statistics for the proposed Development

Catchment name	PROPWET	BFIHOST19	SPRHOST	Area %
An Uidh	0.58	0.29	52.53%	50.4
Henman's Burn	0.66	0.34	47.63%	22.0
Migdale Burn	0.57	0.58	35.37%	13.2
River Shin	0.76	0.41	52.02%	6.1
Allt Port Na Lice	0.81	0.58	34.09%	5.5
Allt Na Claise Mòire	0.77	0.51	40.42%	2.8

Watercourses

9.5.47 Watercourses within the Site appear to be in natural or near-natural condition, with relatively high levels of sinuosity, defined as having lots of meanders. Watercourses in the southern region of the development, where the Site meets an area of commercial forestry, appear to have been modified in places for drainage purposes.

9.5.48 Key watercourses are shown in **Figure 9.6**.

An Uidh

9.5.49 The An Uidh catchment has a total area of 14.68 km^2 and drains approximately 50.4% of the land within the Site.

9.5.50 The catchment covers the northern half of the Site and incorporates most of the proposed Development including all turbines, construction compounds, substation and the battery energy storage system (BESS), the majority of the internal access track network and the northern section of the shared access track.

9.5.51 Several watercourses located in the northern and central areas of the catchment combine to form An Uidh which flows south east from the Site, then east towards Loch an Lagain.

Two waterbodies, Loch Laro and Loch Leisgein, are present within the catchment although both lie outwith the application boundary.

9.5.52 The catchment is characterised by undulating upland moorland, watercourses, waterbodies and small areas of commercial forestry.

Henman's Burn

9.5.53 The Henman's Burn catchment has a total area of 4.06 km^2 and drains approximately 22% of the land within the Site.

9.5.54 The Henman's Burn catchment drains an area in the west of the Site. Two watercourses, namely Henman's Burn and an unnamed tributary to Henman's Burn, drain this area, generally flowing west before joining the Kyle of Sutherland. The watercourse appears to be highly modified for agricultural purposes in its lower reaches.

9.5.55 The catchment includes a small area of access track between turbines T04 and T07.

9.5.56 The catchment is characterised by commercial forestry, agricultural land and upland moorland.

Migdale Burn

9.5.57 The Migdale Burn catchment has a total area of 4.04 km^2 and drains approximately 13.2% of the land within the Site.

9.5.58 The Migdale Burn catchment covers the south eastern area of the Site. The catchment is drained by several unnamed tributaries which merge to form the Migdale Burn approximately 1.1 km south east of the application boundary. The tributaries generally flow south east towards Loch Migdale. Watercourses within the southern part of the catchment are highly modified for agricultural purposes.

9.5.59 The catchment is characterised by several settlements, commercial forestry, agricultural land, crofts and upland moorland.

River Shin

9.5.60 The River Shin catchment has a total area of 583.11 km^2 and drains approximately 6.1% of the land within the Site.

9.5.61 The River Shin catchment drains a section to the west of turbine T07 and a significant section of the access track from the A836. Drainage is provided by two watercourses, the Allt na Ciste Duibhe and Allt an Rèidhe Dhorcha, which both flow west to join the River Shin. The catchment also includes a small section of the access track between turbines T04 and T07. The watercourses, particularly the Allt na Ciste Duibhe, have been modified for commercial forestry. The River Shin has been modified for hydro-electric power production at locations outwith the study area.

9.5.62 This catchment is characterised by forestry and agricultural land, with some moorland.

Allt Port na Lice

9.5.63 The Allt Port na Lice catchment has a total area of 0.79 km^2 and drains approximately 5.5% of the Site.

9.5.64 The Allt Port na Lice catchment drains an area in the south west of the Site. This catchment is drained by the Allt Port na Lice which flows west then south west to join the

Kyle of Sutherland. The watercourse has been modified in some areas for commercial forestry.

9.5.65 The catchment is predominantly characterised by commercial forestry.

Allt na Claise Mòire

9.5.66 The Allt na Claise Mòire catchment has a total area of 0.73 km^2 and drains approximately 2.8% of the land within the Site.

9.5.67 The Allt na Claise Mòire catchment drains a small section of the south of the Site. The Allt na Claise Mòire forms the main watercourse for this catchment, flowing generally southwards into the Kyle of Sutherland. The watercourse has been modified in some areas for commercial forestry.

9.5.68 The catchment is predominantly characterised by commercial forestry.

Water quality

Surface waterbodies

9.5.69 SEPA's Water Classification and Water Environment Hubs have been consulted to determine the existing baseline water quality for the main watercourses and waterbodies within the Site (SEPA, 2022; SEPA, 2021). Details were not available for Henman's Burn. The details are summarised in **Table 9.9**.

Table 9.9: Summary of surface water quality status

Waterbody name and ID	Status		Pressures
Migdale Burn (20082)	**Condition in 2020**	Overall: Good Water flows & levels: High Physical condition: Good Water quality: High	None
	Classification in 2022	Overall: Good Biology (fish): High Hydromorphology: Good	
River Evelix *Including An Uidh* (20079)	**Condition in 2020**	Overall: Good Water flows & levels: Good Physical condition: Good Water quality: High	None
	Classification in 2022	Overall: Good Biology (fish): High Hydromorphology: Good	
River Shin *Including Allt na Ciste Duibhe and*	**Condition in 2020**	Overall: Moderate Water flows & levels: Good Physical condition: Good Water quality: Good	Water flows and levels from water abstraction and water

Waterbody name and ID	Status		Pressures
Allt an Rèidhe Dhorcha (20093)	**Classification in 2022**	Overall: Good Biology (fish): High Hydromorphology: Moderate	storage for hydroelectricity generation

Groundwater

9.5.70 SEPA's Water Environment Hub was consulted to determine the existing baseline water quality for the groundwater body associated with the Site (SEPA, 2021). Overall status, chemical status and water quality of the Northern Highlands water body (ID: 150701) are classified as 'Good' in the latest available records from 2020.

Receiving waterbodies

9.5.71 SEPA's Water Classification and Water Environment hubs have also been consulted to determine the existing baseline water quality for Site's receiving waterbodies. The details are summarised in **Table 9.10**.

9.5.72 The Migdale Burn drains into Loch Migdale. Henman's Burn, River Shin and River Evelix (via Loch an Lagain) drain into the Dornoch Firth (via the Kyle of Sutherland).

Table 9.10: Summary of receiving waterbody quality status

Waterbody name and ID	Status		Pressures
Loch Migdale (100100)	**Condition in 2020**	Overall: Good Water flows & levels: High Physical condition: Good Water quality: Good	None.
	Classification in 2022	Overall: Good Biology (fish): No data Hydromorphology: Good	
Dornoch Firth (200165)	**Condition in 2020**	Overall: Good Water flows & levels: High Physical condition: Good Water quality: Good	None.
	Classification in 2022	Overall: Good Biology (fish): Good Hydromorphology: High	

Water resources

9.5.73 No wells or springs are identified on OS mapping within the Site; eight wells and three springs have been identified within 2 km of the Site. There are no borehole records within the Site.

9.5.74 Data obtained from THC regarding PWS indicate that one PWS is present within the Site. A further twelve PWS have been identified within 2 km of the Site. Details of PWS

identified are provided below with an initial risk screening in **Table 9.11** and shown in **Figure 9.7**.

Table 9.11: PWS within or near the Site

Supply name	Source location	Source type	Properties served	Distance to Site	Linkage to proposed Development
Aultnagar	25848, 89916	Spring	1	Within Site	Potential linkage – adjacent to proposed access track for Garvary.
Coirshellach	261483, 895243	Borehole	1	0.03 km	No linkage- located in separate sub-catchment
Auchinduich Farm	25827, 89986	Stream	1	0.2 km	No linkage – located in separate sub-catchment.
Auchinduich Lodge	25803, 89993	Borehole	1	0.3 km	No linkage – located in separate sub-catchment.
Craigton Farm	26269, 89611	Borehole	1	0.3 km	No linkage – located in separate sub-catchment.
1 Airdens	26138, 89427	Groundwater Spring	1	0.35 km	No linkage – no development in catchment
Reidbreac Croft	26357, 89642	Groundwater Spring	1	0.8 km	No linkage – uphill of proposed Development
Inver House	25677, 89634	Not disclosed	1	1.6 km	No linkage – located in different catchment
Sleasdaraidh	26447, 89661	Spring	1	1.6 km	No linkage – uphill of proposed Development
Achue Croft	26304, 89434	Well	1	1.7 km	No linkage – located in different catchment
Culrain Mains	25725, 89373	Not disclosed	1	1.7 km	No linkage – located in different catchment

Supply name	Source location	Source type	Properties served	Distance to Site	Linkage to proposed Development
Rowan House	25665, 89652	Borehole	1	1.8 km	No linkage – located in different catchment.
Helendale	25669, 89673	Groundwater Borehole	1	1.9 km	No linkage – located in different catchment

Flood risk

9.5.75 SEPA's Indicative Flood Map (2024) was consulted to gain an overview of the likelihood of flooding within, and downstream of, the proposed Development. The indicative flood risk assessment comprises river (fluvial) flooding and surface water (pluvial) flooding, categorised by high, medium and low likelihood.

9.5.76 Flood risk from surface water is shown to be minimal within the Site.

9.5.77 There is a high likelihood (10% chance each year) of fluvial flooding in the wider area; however, these risk areas are generally confined to nearby watercourse channels.

9.5.78 There is a high likelihood (10% chance each year) of coastal flooding along the Kyle of Sutherland and Dornoch Firth, downstream of the proposed Development, although these areas are mainly confined to saltmarsh and low-lying ground immediately adjacent to the coast.

9.5.79 Future flooding events are unlikely to disrupt the proposed Development directly; however, it is anticipated they would affect river and coastal systems in the surrounding area.

Designated sites

9.5.80 Designated sites of relevance to geology, hydrogeology and hydrology that are located within 5 km of the application boundary are identified in **Table 9.12**. Data was collated using NatureScot's SiteLink map (NatureScot, 2024).

9.5.81 Sites reviewed include SSSIs, SACs and Ramsar sites (internationally recognised wetlands). GCR sites were also reviewed; these do not have statutory designation but identify sites of national importance for their geological features.

Table 9.12: Designated sites relevant to geology, hydrogeology, hydrology

Site name	Qualifying features	Distance from application boundary	Linkage to the proposed Development
Strath Carnaig and Strath Fleet Moors SSSI	Habitats including upland heather moorland and blanket bog	1 km east	Potential linkage – downstream of Site
River Oykel SAC (including the Kyle of Sutherland)	Freshwater pearl mussel and Atlantic salmon	0.1 km west	Potential linkage – downstream of Site and infrastructure

Site name	Qualifying features	Distance from application boundary	Linkage to the proposed Development
Dornoch Firth and Morrich More SAC	Complex estuary, extensive mudflats and sandflats, saltmarshes and saltmeadows, dune complexes, otters and seals	0.2 km south	Potential linkage – downstream of Site
Kyle of Sutherland Marshes SSSI	Floodplain and rare plant communities	0.1 km west	Potential linkage – downstream of Site and infrastructure
Migdale Rock SSSI	Valley fen including open water pools, reed swamps, wet and dry heath, scarce plants	3.7 km south west	No linkage – upstream of Site and in a different catchment

9.6 Mitigation

Embedded mitigation

9.6.1 The importance of geology, hydrogeology, hydrology and peat has been recognised throughout the proposed Development design process. Key features that have had a considerable influence on design are:

- peatland and peat depths;
- watercourses and waterbodies;
- potential GWDTE;
- private water supplies; and
- designated sites.

9.6.2 This section provides a detailed summary of the mitigation that would be adopted for the proposed Development.

Mitigation by design

9.6.3 All excavation works requiring removal of bedrock or superficial deposits have been kept to a practical minimum by good Site design.

9.6.4 Careful and informed infrastructure design forms a key measure for prevention of induced instability in peat. The collated peat depth information has been used to inform the proposed infrastructure layout throughout the design process. Incursion into areas of deeper peat has been kept to a practical minimum by careful design and would be further reduced by local micrositing, in order to minimise disruption to peatland ecosystems and hydrology, and to avoid the risk of induced peat instability.

9.6.5 Access tracks are anticipated to be constructed using established cut-and-fill construction methods. Any peat present along the route would be excavated and stored for use in reinstatement of elements of project infrastructure or for restoration purposes where appropriate.

Mitigation commitments

9.6.6 The Outline CEMP (**Technical Appendix 2.1**) contains the mitigation commitments prescribed in respect of Geology, Hydrogeology, Hydrology and Peat. These relate to soil and peat, surface watercourses and groundwater, constructed drainage, excavations, site traffic and movement, and pollution prevention.

9.7 Predicted effects

Development characteristics

9.7.1 The construction phase would involve a number of different elements. **Chapter 2** describes these elements in detail. The elements with particular reference to geology, hydrogeology, hydrology and peat are as follows:

- physical changes to overland drainage and surface water flows;
- water contamination from particulates and suspended solids;
- water contamination from fuels, oils or foul drainage;
- changes in or contamination of water supply to vulnerable receptors;
- increased flood risk;
- modification to groundwater flow paths;
- soil erosion and compaction; and
- peat instability.

9.7.2 During operation, activities with particular reference to geology, hydrogeology, hydrology and peat are as follows:

- surface water drainage, including treatment and discharge of surface drainage;
- maintenance of tracks and trackside drainage; and
- long-term drainage around permanent infrastructure.

Effects during construction

Physical changes to overland drainage and surface water flows

9.7.3 Changes to overland drainage patterns would arise principally from upgrading and construction of the track network with subsidiary effects from construction of the turbine foundations, crane hardstandings and ancillary infrastructure.

9.7.4 Sections of new track would require installation of trackside drainage and cross-drains to protect the tracks from water damage. Constructed drains would be no longer and deeper than necessary to provide the required track drainage. Cross-drains would be installed at an appropriate frequency to minimise concentration of flows from above the catchment areas, to minimise changes to the hydrological regime. All drainage infrastructure would be designed with suitable capacity for a rainfall intensity of a 1-in-200 year storm event, plus allowance for climate change, as per SEPA guidance.

9.7.5 All long-term and temporary drainage infrastructure would be established on a running basis ahead of excavation works. This includes temporary bunding and cut-off drains around turbine bases and hardstanding areas. Where possible, trackside drainage would be laid up to 100 m ahead of construction works for new track on a running basis.

9.7.6 Two watercourses would be crossed by the access track. One crossing is a regulated watercourse and both crossings would require new structures. Further details are provided in **Technical Appendix 9.4**. A watercourse crossing is required on the proposed Garvary access track, approximately 1.8 km east of the A836. The final proposals for this crossing would be identified as part of the detailed design of the proposed Development prior to construction and in line with current best practice guidance.

9.7.7 All crossings would be designed with sufficient capacity for a rainfall intensity of a 1-in-200 year storm event, plus allowance for climate change. All necessary permissions for watercourse crossing works would be obtained prior to commencement of associated works.

9.7.8 The receptor, surface watercourses within the Site, is considered to be of **'High'** sensitivity. With appropriate mitigation measures in place, as described above, the magnitude of effect is considered to be **'Slight'**. The likelihood of effect is considered to be **'Likely'**.

9.7.9 The effect of physical changes to overland drainage from construction works is assessed as **'Minor'**, long-term, adverse and **'Not Significant'.**

Particulates and suspended solids

9.7.10 All development work involving earthmoving operations would generate loose sediment, which could potentially gain access to surface watercourses and waterbodies through entrainment in surface runoff. This could potentially have an adverse effect on the downstream watercourses through damage to fish spawning habitat and changes to dissolved oxygen and nutrient levels in watercourses and waterbodies. Surface water from the areas surrounding the turbine bases and all hardstanding areas (including crane pads, substation, construction compounds and laydown areas) would be prevented from entering the working areas by appropriate use of peripheral bunding and cut-off drains. These would help to divert clean water around and away from the working areas.

9.7.11 During excavation works for turbine foundations, cut sections of track and cut areas for hardstandings, silt fencing or appropriate alternative sediment control measures would be installed on the downhill side of the excavation to prevent inadvertent discharge of silty water into any watercourse within the Site. Pre-construction installation of long-term drainage would provide an additional level of sediment control.

9.7.12 All engineering work adjacent to watercourses, including track construction and installation of watercourse crossings, would have appropriate sediment control measures established prior to any ground works. Vegetation would be retained along watercourse banks to act as additional protection.

9.7.13 For areas of larger excavation, such as turbine bases and crane pads, additional temporary water control measures may be used. These may include use of temporary settlement ponds, cut-off drains, diversion bunds or the use of proprietary treatment systems such as Siltbusters, as appropriate.

9.7.14 Construction activities would be restricted during periods of wet weather, particularly for any work occurring within 20 m of a watercourse or within areas of identified deeper peat, to minimise mobilisation of sediment in heavy rainfall. The following 'stop' conditions are recommended to guide construction activity (CH2M & Fairhurst, 2018).

Table 9.13: Recommended 'stop' conditions for earth moving activities

'Stop' rule	Requirements
High intensity rainfall	Rainfall during construction greater than 10 mm per hour
Long duration rainfall	Rainfall in the preceding 24 hours greater than 25 mm
7-day cumulative rainfall (1)	Preceding 7 days of rainfall greater than 50% of the monthly average
7-day cumulative rainfall (2)	Preceding 7 days of rainfall greater than 50 mm

9.7.15 Monitoring of rainfall for 'stop' conditions would require access to a suitable local source of data, such as the Met Office's monitoring station at Tain Range, to allow identification of these conditions being exceeded to allow appropriate action to be taken.

9.7.16 Any water collecting within excavations would be pumped out prior to further work in the excavation. This water is likely to require treatment to remove suspended solids prior to discharge to ground.

9.7.17 Vegetation cover would be re-established as quickly as possible on track verges and cut slopes, by re-laying of excavated peat acrotelm (the vegetated upper layer of peat) and/or topsoil turf, to improve slope stability and provide erosion protection. Additional methods, including hydroseeding and/or use of a biodegradable geotextile, would be considered, if necessary, in specific areas and areas of sensitivity.

9.7.18 All necessary permissions relating to construction works, plus accompanying pollution prevention plans, would be obtained prior to any construction work commencing within the Site. All the management and control measures, including emergency response procedures, would be set out in a Construction Environmental Management Plan (CEMP), produced by the appointed Contractor prior to any works commencing. This would be a live document and would be updated as required throughout construction.

9.7.19 A WQM programme would be established at key locations around the proposed Development. Monitoring would begin prior to any construction works, to allow pre-construction baseline quality to be determined. Details are provided in **Table 3.1 of Technical Appendix 2.1: Outline Construction Management Plan** and **Figure 9.8**.

9.7.20 The receptor, surface watercourses within the Site, is considered to be of **'High'** sensitivity. With appropriate mitigation measures in place, as described above, the magnitude of effect is considered to be **'Slight'**. The likelihood of the effect is considered to be **'Likely'**.

9.7.21 The effect of particulates and suspended solids from construction works is assessed as **'Minor'**, temporary, adverse and **'Not Significant'**

Water contamination from fuels, oils or foul drainage

9.7.22 Spillage of fuels, oils, wet concrete or concrete washout water could have an adverse effect on surface water quality, and major spillages could have a potential influence on watercourses and catchments.

9.7.23 Oil and fuel storage and handling would be undertaken by the Principal Contractor following published guidance, in particular *Guidance on Pollution Prevention 2 – Above ground oil storage tanks (2021)* and in compliance with the *Water Environment (Controlled Activities) (Scotland) Regulations 2011* (as amended). Refer to outline CEMP provided in **Technical Appendix 2.1**.

9.7.24 There are no plans to provide a foul drainage network.

9.7.25 It is anticipated that Site welfare facilities would include a suitably-sized holding tank, which would be emptied by tanker and removed from the Site on an appropriate timescale for disposal at a suitably licensed facility.

9.7.26 Spillage and emergency procedures would form part of the CEMP and would be prominently displayed at the Site and staff would be trained in their application. The Procedures document would incorporate guidance from the relevant SEPA Guidance Notes.

9.7.27 In the event of any spillage or discharge that has the potential to be harmful to or pollute the water environment, all necessary measures would be taken to remedy the situation. These measures would include:

- identifying and stopping the source of the spillage;
- containing the spillage to prevent it spreading or entering watercourses, by means of suitable material and equipment;
- absorbent materials, including materials capable of absorbing oils, would be available onsite to mop up spillages. These would be in the form of oil booms and pads and, for smaller spillages, quantities of proprietary absorbent materials. Sandbags would also be readily available for use to prevent spread of spillages and create dams if appropriate;
- where an oil/fuel spillage may have soaked into the ground, the contaminated ground would be excavated and removed from the Site by a licensed waste carrier to a suitable landfill facility;
- the emergency contact telephone number of a specialist oil pollution control company would be displayed within the Site; and
- sub-contractors would be made aware of the guidelines for handling of oils and fuels and of the spillage procedures at the proposed Development.

9.7.28 SEPA would be informed of any discharge or spillage that may be harmful or polluting to the water environment. Written details of the incident would be forwarded to SEPA no later than 14 days after the incident, in line with SEPA's requirements.

9.7.29 A WQM programme would be established at key locations around the proposed Development. Monitoring would begin prior to any construction works, to allow pre-construction baseline quality to be determined. Details are provided in **Table 3.1 of Technical Appendix 2.1** and **Figure 9.8**.

9.7.30 The receptor, surface watercourses within the Site, is considered to be of '**High'** sensitivity. With appropriate mitigation measures in place, as described above, the magnitude of effect is considered to be '**Moderate'**. The likelihood of effect is considered to be **'Highly Unlikely'**.

9.7.31 The effect of water contamination from fuels, oils or foul drainage from construction works is assessed as **'Minor'**, temporary, adverse and **'Not Significant'**

Changes in or contamination of water supply to vulnerable receptors

9.7.32 Vulnerable receptors that have the potential to be affected by the proposed Development works have been identified. These include PWS, potential GWDTE and designated sites (**Figure 9.7; Figure 9.3.1; Table 9.11; Table 9.12**). Each vulnerable receptor is considered in more detail below.

GWDTE

9.7.33 A detailed assessment of the interactions between the proposed Development and potential GWDTE has been undertaken. Three potential groundwater- dependent NVC habitats have been identified within the Site: M6 mire has potentially high groundwater dependency within a Scottish setting. M15 wet heath has moderate groundwater dependency in a Scottish setting. M25 mire has potentially moderate groundwater dependency in a Scottish setting, dependent on the hydrological setting.

9.7.34 The potentially groundwater-dependent habitats are widely distributed around the Site making it impossible to avoid them in places. Some areas of identified habitat types are located within 100m of excavations less than 1m in depth and/or within 250m of excavations deeper than 1m.

9.7.35 The potentially groundwater-dependent habitats have been assessed specifically within the context of the Proposed Development, considering the local bedrock and superficial geology, peat distribution and local observations. No groundwater discharges were identified at any location within the Site. Large parts of the Site are underlain by peat deposits which would act to insulate the groundwater in the bedrock from the ground surface, effectively preventing groundwater discharge at surface. The bedrock is noted to have very limited groundwater potential and no indications of groundwater at surface were apparent during any of the Site surveys.

9.7.36 It is determined, as a result of the above, that none of the three potentially groundwater-dependent communities identified within the Site are actually groundwater-dependent, but are likely to rely on a mix of surface water, shallow throughflow in surface vegetation and rainwater.

9.7.37 Details of the full GWDTE assessment are provided in **Technical Appendix 9.3**.

9.7.38 The potential GWDTE within the Site are considered to be of '**High**' sensitivity as a result of the conservation importance of the habitats. With appropriate mitigation measures in place, as described above and in **Section 9.6**, the magnitude of effect is considered to be '**Slight**'. The likelihood of effect is considered to be '**Likely**'.

9.7.39 The effect of changes in or contamination to water supply to GWDTE from construction works is assessed as '**Minor**', temporary, adverse and '**Not significant**'.

Private water supplies

9.7.40 Thirteen PWS have been identified within 2 km of the application boundary. These are detailed in **Table 9.11**. One of the PWS identified (at Aultnagar) is within the Site and appears to be at direct risk from development of the Garvary access track. A further three PWS are in close proximity to the proposed Development but are located in separate sub-catchments so are not anticipated to be at risk. The remaining eight PWS are upstream of and/or in different hydrological catchments from the proposed Development, therefore no potential linkage was determined.

9.7.41 Recommended protection measures for the Aultnagar PWS would include regular monitoring of the PWS sources for the duration of construction and installation of additional sediment management protections such as cut-off ditches, diversion bunds and/or extra lines of silt fencing to trap or divert water with entrained sediment.

9.7.42 PWS are considered to be of '**Very High**' sensitivity. The magnitude of effect is considered to be '**Slight**'. The likelihood of effect is considered to be '**Unlikely**'.

9.7.43 The effect of changes in or contamination of water supply to PWS from construction works is assessed as 'M**inor**', temporary, adverse and '**Not Significant**'.

Designated sites

9.7.44 Five designated sites have been identified within 5 km of the application boundary. Four of these designated sites are identified as having potential linkage to the proposed Development: Strath Carnaig and Strath Fleet Moors SSSI, River Oykel SAC, Dornoch Firth and Morrich More SAC and Kyle of Sutherland Marshes SSSI.

9.7.45 Precautions would be taken during construction to ensure that any potential contaminating materials would not be permitted to enter any of the watercourses within the Site. Particular care would be afforded to the watercourses that run through or drain directly into the identified designated sites. All works that have the potential to affect the designated sites would be supervised by the ECoW and additional levels of protection would be established if advised during Site works.

9.7.46 Dust suppression sprays would be used as required in dry weather. Water monitoring locations at key points downstream of proposed works would be included in the project WQM programme.

9.7.47 Designated sites with hydrological linkage are considered to be of '**Very High**' sensitivity. With appropriate mitigation measures in place, as described, the magnitude of the works is considered to be '**Negligible**'. The likelihood of effect is considered to be '**Unlikely**'.

9.7.48 The effect of changes in or contamination of water supply to designated sites from construction works is assessed as '**Negligible**' and '**Not significant**'.

Increased flood risk

9.7.49 The proposed Development infrastructure is not at risk of flooding from any source. However, there is a requirement to prevent exacerbation of flood risk to any areas downstream of the Site.

9.7.50 The drainage installed around long-term infrastructure would be designed to minimise concentration of flows. This would be achieved by the implementation of embedded mitigation measures in line with best practice, including:

- use of cut-off drains to divert runoff around necessary 'hard' infrastructure such as turbine bases and hardstanding areas;
- use of regular cross-drains underneath access tracks. These would be installed in line with natural terrain, making use of low points where runoff would naturally be focused. Cross-drains under existing tracks would be maintained;
- use of a slight gradient on installed 'hard' infrastructure to encourage drainage into a filter drain or swale, for infiltration into vegetated areas and as shallow through-flow;
- long-term drainage would be installed ahead of related construction works or excavations taking place, to ensure that drainage can be controlled appropriately. For tracks, the required trackside drainage would be put in place ahead of access track construction, on a rolling basis as the track development progresses; and
- any areas which must be left unvegetated during the construction phase, such as turbine foundations, hardstanding areas and borrow pits, would have settlement ponds put in place to attenuate flow until vegetation can be re-established at the end of the construction period.

9.7.51 With the appropriate mitigation measures in place, runoff during construction of the proposed Development would not be greater than natural pre-development runoff. Further details are provided in **Technical Appendix 9.4**.

9.7.52 The receptors, infrastructure and property downstream of the proposed Development, are considered to be of '**Very High**' sensitivity. With appropriate mitigation measures in place, as described above and in **Section 9.6**, the magnitude of any increased flood risk is considered to be '**Negligible**'. The likelihood of effect is considered to be '**Highly Unlikely**'.

9.7.53 The effect of increase in flood risk resulting from the construction works is assessed as '**Negligible**' and '**Not significant**'.

Modification to groundwater flow paths

9.7.54 Physical changes to the shallow subsurface as a result of all excavation works have potential to interrupt shallow groundwater flow paths. This would include proposed cut-and-fill track sections, turbine foundations, hardstanding areas, substation, laydown areas, construction compounds and cable trenches.

9.7.55 Physical changes to the deeper subsurface (>5 m below ground surface) have potential to interrupt deeper groundwater flow paths. This would potentially include some excavations for turbine and crane hardstandings.

9.7.56 The bedrock within the Site is classified as a low-productivity aquifer with limited groundwater flow in the near-surface weathered zone and through fracture networks within the bedrock. Superficial deposits are mainly till and glacial deposits where there is likely to be some limited presence of groundwater. Smaller areas of peat are present which would store some groundwater but would contribute very little to groundwater flow.

9.7.57 There are proposals to win material for Balblair Wind Farm at the Garvary Indicative Borrow Pit (shown in **Figure 2.1: Proposed Development Layout**), and from excavations to create the foundations and bases for Turbines T2 and T3. Interactions with groundwater are considered to be likely.

9.7.58 Excavation of cable trenches could lead to groundwater flow between catchments if the trenches act as preferential flow paths. This can be avoided by laying cables in disturbed ground adjacent to access tracks. In areas where cable routes cross up or down slopes, clay bunds or alternative impermeable barriers would be placed for every 0.5 m change in elevation along the length of the trench to minimise in-trench groundwater flow.

9.7.59 The groundwater receptor is considered to be of '**Moderate**' sensitivity. With appropriate mitigation measures in place, as described above, the magnitude of effect is considered to be '**Negligible**. The likelihood of effect is considered to be '**Highly Unlikely**'.

9.7.60 The effect of modification to groundwater flow paths from construction works is assessed as '**Negligible'** and '**Not Significant**'.

Soil erosion and compaction

9.7.61 Proposed construction activity, particularly plant and vehicle movements, soil stripping and stockpiling, would affect the nature of the soils within the Site. Plant movements would act to compact soils through movements over unstripped ground. All activity requiring removal, transport and stockpiling of soils would have potential to lead to soil erosion and loss of structure, resulting in overall soil degradation.

9.7.62 All proposed traffic routes would be clearly demarcated and vehicles would not be permitted access outwith these areas.

9.7.63 Only tracked or low ground pressure vehicles would be permitted access to unstripped ground. Existing tracks have been incorporated into the proposed Development as far as possible and use of these would help to keep additional soil disturbance to a minimum.

9.7.64 Soil stripping would be undertaken by the Principal Contractor with care and stripping would be restricted to as small a working area as practicable. Topsoil would be removed and laid in a storage bund, up to 2 m in height, on unstripped ground adjacent to the specific working area. It would be attempted to retain the turf layer vegetation-side-up where possible, although ground conditions may make this challenging. Subsoils and superficial geological deposits would be removed subsequently and laid in storage bunds, also up to 2 m in height, clearly separated from the topsoil bund. Care would be taken to maintain separate stockpiles for separate soil types in order to preserve the soil quality.

9.7.65 For work within areas of peat, acrotelmic peat (the uppermost 0.5 m) would be removed as for the topsoil. It would be attempted to retain the acrotelm vegetation-side-up where possible, although ground conditions may make this challenging.

9.7.66 The underlying catotelmic peat would be stored in bunds up to 1 m in height. Catotelmic peat is sensitive to handling, and loses its internal structure easily, so would be transported as short a distance as possible to its storage location. Excavation of catotelmic peat has been limited by careful infrastructure design.

9.7.67 Limited smoothing or 'blading' of stockpiled soils and catotelmic peat would be undertaken by the Principal Contractor to help shed rainwater and prevent ponding of water on the stockpile. Bunds on notably sloping ground would have sediment control measures installed near the base, on the downslope side, to collect and retain any sediment mobilised by rainfall. Stockpiles would be located on flat or nearly flat ground where possible.

9.7.68 Excavated soil and peat would be used for restoration and rehabilitation at the end of the construction period, in order to promote fast re-establishment of vegetation cover on worked areas and areas of bare soil or peat that are not required for the operational phase. Soils and peat would be stored for as short a time as practicable, in order to minimise degradation through erosion and desiccation.

9.7.69 Should prolonged periods of dry weather occur, a damping spray would be employed to maintain surface moisture on the soil and peat bunds. This would help to maintain vegetation growth in the turves and to retain the soil structure.

9.7.70 The receptor, soils and peat within the Site, is considered to be of '**High'** sensitivity. With appropriate mitigation measures in place, as described above, the magnitude of the effect is considered to be '**Slight'**. The likelihood of effect is considered to be '**Likely'**.

9.7.71 The effect of soil erosion and compaction from the construction works is considered to be '**Minor'**, temporary, adverse and '**Not Significant'**

Peat instability

9.7.72 Construction activity on peat can affect the natural stability of the peat deposits in areas near to or associated with construction works. Particular risk areas are associated with works at or near breaks-in-slope, areas where natural peat instability has been recorded

and locations where peat has degraded through, for example, erosion processes, drying out, afforestation or overgrazing.

9.7.73 A detailed PSRA has been undertaken for the proposed Development and is provided in **Technical Appendix 9.1**. The key effects assessment findings are provided below.

9.7.74 The PSRA found that the majority of the Site has a negligible or low risk of natural or induced peat landslide. Six areas were identified as potentially having a moderate risk of peat instability. These areas were appraised in greater detail, taking into account location-specific details including information gathered from Site surveys. Mitigation measures have been recommended to control peat landslide hazard. For these areas, peat landslide hazard can be controlled by use of good construction practices and micrositing.

9.7.75 The receptors for peat landslide hazard are the peat soil, peatland habitat, the water environment including surface water and groundwater, proposed Development infrastructure and construction personnel.

9.7.76 The peat soil, peatland habitat, water environment and proposed Development infrastructure receptors are considered to be of '**High**' sensitivity. Construction personnel are considered to be a '**Very High**' sensitivity receptor.

9.7.77 With appropriate design constraints and mitigation measures in place, as described in **Technical Appendix 9.1**, the magnitude of effect is considered to be '**Slight'**. The likelihood of effect is considered to be '**Highly Unlikely'**.

9.7.78 For all receptors, the effect of peat instability is assessed as '**Minor'**, long-term, adverse and '**Not Significant'**.

Effects during operation

Physical changes to overland drainage and surface water flows

9.7.79 No additional changes to overland drainage and surface water flows are anticipated during the operational phase of the proposed Development. Trackside and infrastructure drainage would remain in place during operation. A monitoring and maintenance programme would be put in place for the drainage infrastructure, to include regular visual inspection of drainage ditches, crossing structures and cross-drains to check for blockages, debris or damage that might impede water flow. Any identified blockage, including build-up of sediment that may lead to future blockage, or damage to structures would be remediated immediately. Where practicable, routine maintenance would be undertaken by the Operator during dry weather; where this is not practicable, additional sediment control measures may need to be established to manage silty water arising from the work.

9.7.80 The receptor, surface watercourses within the Site, is considered to be of '**High**' sensitivity. With appropriate mitigation measures in place, as described above, the magnitude of effect is considered to be '**Negligible**'. The likelihood of effect is considered to be '**Unlikely**'.

9.7.81 The effect of physical changes to overland drainage from operational works is assessed as '**Negligible**' and '**Not Significant**'.

Water contamination from particulates and suspended solids

9.7.82 The main operational phase work of the proposed Development would involve track and hardstanding maintenance and repair. Regular monitoring of the track and hardstanding condition would be undertaken by the Operator, particularly following periods of heavy or prolonged rainfall and after snowfall and clearance, if relevant. Any sections of the track showing signs of excessive wear would be repaired as necessary with suitable material.

9.7.83 The drainage network would also be subject to regular monitoring to ensure that it remains fully operational, as water build-up can cause considerable damage to unbound track construction.

9.7.84 All bridge structures would have appropriate splash control measures as part of their design, to prevent silty water splashing into the watercourse from vehicle movements. These splash controls would be monitored regularly by the Operator to ensure they remain effective and have not become damaged in any way.

9.7.85 The receptor, surface watercourses within the Site, is considered to be of '**High**' sensitivity. With appropriate mitigation measures in place, as described above, the magnitude of effect is considered to be '**Slight**'. The likelihood of effect is considered to be '**Unlikely**'.

9.7.86 The effect of particulates or suspended solids from operational works is assessed as '**Minor**', temporary, adverse and '**Not Significant**'.

Water contamination from fuels, oils or foul drainage

9.7.87 The risk of water contamination from fuel or oils is considerably lower during operation of the proposed Development than during construction, as there are significantly decreased levels of activity within the Site. The majority of potential pollutants would no longer be present within the Site. Lubricants for turbine gearboxes, transformer oils and maintenance vehicle fuels would remain present in small quantities. There are no plans for herbicide use during operation; physical cutting of vegetation would be the preferred form of management, where required.

9.7.88 The pollution prevention plan and spillage and emergency procedures, as set out above, would remain in force throughout the operational phase of the proposed Development.

9.7.89 It is anticipated that operational phase welfare facilities would use one of the following:

- A suitably sized holding tank with wastewater removed from the Site by tanker for disposal at a licensed disposal facility, in line with construction phase proposals;
- A waste treatment package plant with associated discharge would be installed as a longer-term alternative;
- Waterless composting toilet facilities with bottled water provided for washing and drinking.

9.7.90 All relevant water environment authorisations would be put in place should there be any requirement for these.

9.7.91 The receptor, surface watercourses within the Site, is considered to be of '**High**' sensitivity. With appropriate mitigation measures in place, as described above, the magnitude of effect is considered to be '**Negligible**'. The likelihood of effect is considered to be '**Highly Unlikely**'.

9.7.92 The effect of water contamination from fuels, oils or foul drainage from operational works is assessed as '**Negligible**' and '**Not Significant**'.

Changes in or contamination of water supply to vulnerable receptors

9.7.93 Only minor works would take place within the Site during the operational phase, to allow necessary maintenance activities to be undertaken. Additional works affecting PWS, GWDTE and designated sites would be of very minor scale.

9.7.94 PWS and designated sites are considered to be of '**Very High**' sensitivity.

9.7.95 The potential GWDTE identified are considered to be of '**High**' sensitivity.

9.7.96 With appropriate mitigation measures in place, as described, the magnitude of effect is considered to be '**Negligible**'. The likelihood of effect is considered to be '**Highly Unlikely**'.

9.7.97 The effect of changes in or contamination of water supply to vulnerable receptors is assessed as '**Negligible**' and '**Not Significant**'.

Increased flood risk

9.7.98 Infrastructure drainage would remain in place during the operational phase. A regular monitoring and maintenance programme for the drainage infrastructure would be implemented by the Operator to ensure that it remains fully operational and in good condition. Where practicable, routine maintenance would be undertaken by the Operator during dry weather, to help ensure that drainage operation during wet weather is fully functional.

9.7.99 The water management infrastructure would be designed such that there is no change from natural pre-development runoff in the post-development setting.

9.7.100 The receptors, infrastructure and property downstream of the proposed Development, are considered to be of '**Very High**' sensitivity. With appropriate mitigation measures in place, as described above, the magnitude of effect is considered to be '**Negligible**'. The likelihood of effect is considered to be '**Unlikely**'.

9.7.101 The effect of increase in flood risk resulting from the operational works is assessed as '**Negligible**' and '**Not Significant**'.

Modification to groundwater flow paths

9.7.102 There may be minor ongoing requirement for excavation of materials at the proposed Development during operation for track and hardstanding maintenance. These would be limited in nature.

9.7.103 The groundwater receptor is considered to be of '**Moderate**' sensitivity. The magnitude of effect is considered to be '**Negligible**', the likelihood of effect is assessed as '**Unlikely**'.

9.7.104 The effect of modification to groundwater flow paths from operational works is assessed as '**Negligible**' and '**Not significant**'.

Soil erosion and compaction

9.7.105 There are no soil stripping or stockpiling activities planned for the operational phase of the proposed Development.

9.7.106 Ongoing monitoring and maintenance work would require vehicle activity onsite. This would be much reduced from the construction phase and would mostly involve significantly lighter vehicles than heavy construction plant. The ongoing vehicle activity would have some effect on soil and peat compaction below access tracks, although at a significantly lower level than during construction.

9.7.107 The receptor, soils and peat within the Site, is considered to be of '**High**' sensitivity. With appropriate mitigation measures in place, as described above, the magnitude of the effect is considered to be '**Slight**'. The likelihood of effect is considered to be '**Highly Unlikely**'.

9.7.108 The effect of soil erosion and compaction from operational works is considered to be '**Minor**', temporary, adverse and '**Not Significant**'.

Peat instability

9.7.109 No changes to the proposed infrastructure are anticipated during the operational phase of works.

9.7.110 The peat soil, peatland habitat, water environment and proposed Development infrastructure receptors are considered to be of '**High**' sensitivity. Construction personnel are considered to be a '**Very High**' sensitivity receptor.

9.7.111 With appropriate design constraints and mitigation measures in place, as described in **Technical Appendix 9.1**, the magnitude of effect is considered to be '**No Change**'. The likelihood of effect is considered to be '**Highly Unlikely**'.

9.7.112 For all receptors, the effect of peat instability is assessed as '**No Change**' and '**Not Significant**'.

Effects during decommissioning

9.7.113 Potential effects of decommissioning the proposed Development would be similar to those encountered in the construction phase, although generally with lower magnitude as the level of activity at the proposed Development would be reduced.

9.7.114 Discussions would be held between the Applicant and the appropriate regulatory authorities prior to decommissioning to agree an appropriate decommissioning strategy.

Indirect and secondary effects

9.7.115 No indirect or secondary effects relating to geology, hydrogeology, hydrology and peat have been identified for any phase of the proposed Development.

Cumulative effects

9.7.116 The potential for the proposed Development to contribute to cumulative effects in relation to other developments within 5 km has been assessed. One development, Garvary wind farm, is identified within this study area. Garvary is approximately 0.5 km north of the proposed Development with the access track for Garvary anticipated to be shared with the proposed Development. An application for Garavry has been submitted and is awaiting a decision.

Geology and soils

9.7.117 Effects relating to geology and soils are very localised. As a result, there are no cumulative effects relating to geology and soils from this development as effects do not transmit over any noticeable distance.

Hydrogeology

9.7.118 Effects on hydrogeology are confined to shallow groundwater found within the same hydrological catchments as the proposed Development. There will be some cumulative effects arising from works within the An Uidh and River Shin catchments, but effects on groundwater are expected to be minor as long as good construction practice is followed for both developments. Use of a shared access would help to minimise cumulative effects.

9.7.119 The receptor, groundwater within the study area, is considered to be of '**Moderate**' sensitivity. With appropriate mitigation measures in place, as described above, the magnitude of the effect is considered to be '**Sligh**t'. The likelihood of effect is considered to be '**Likely**'.

9.7.120 The cumulative impact on groundwater is considered to be '**Minor**', temporary, adverse and '**Not Significant**'.

Hydrology and designated sites

9.7.121 Effects on hydrology are generally confined to developments located within the same hydrological catchment as the proposed Development, or that drain into the same receiving waterbodies.

9.7.122 Garvary is located within the River Shin and An Uidh catchments. The An Uidh catchment contains most of the infrastructure for the proposed Development and a significant portion of the Garvary infrastructure. It is therefore possible that cumulative effects could occur.

9.7.123 It is assumed that construction of Garvary would be completed before construction commenced at the proposed Development. Cumulative effects are most likely to affect the hydrological regime and hydraulically connected designated sites during the construction phase of development when activity on Site is highest, therefore cumulative effects would be reduced. It is assumed that both developments would make use of established best practice construction methods including for management of runoff, sediment and potentially polluting materials.

9.7.124 The receptor, surface watercourses, is considered to have '**High**' sensitivity. With appropriate mitigation measures in place, as described above, the magnitude of the effect is considered to be '**Slight**'. The likelihood of effect is considered to be '**Unlikely**'.

9.7.125 The receptor, designated sites, is considered to have '**Very High**' sensitivity. With appropriate mitigation measures in place, as described above, the magnitude of the effect is considered to be '**Slight**'. The likelihood of effect is considered to be '**Highly Unlikely'**.

9.7.126 The cumulative impacts on surface watercourses and designated sites are considered to be '**Minor**', temporary, adverse and '**Not Significant**'.

9.8 Summary of residual effects

9.8.1 This assessment is based on a site-specific risk assessment method following recommended EIA techniques. Potential effects, including positive and negative, long-term or temporary, adverse or beneficial, to the geological, hydrogeological, hydrological and peat regime have been considered. These effects are summarised in **Table 9.14**.

Table 9.14: Summary of residual effects

Effect	Phase	Assessment consequence	Effect significance
Physical changes to overland drainage and surface water flows	Construction	Minor, long-term and adverse	Not Significant
	Operation	Negligible	Not Significant
Particulates and suspended solids	Construction	Minor, temporary and adverse	Not Significant
	Operation	Minor, temporary and adverse	Not Significant
Water contamination from fuels, oils, concrete batching or foul drainage	Construction	Minor, temporary and adverse	Not Significant
	Operation	Negligible	Not Significant
Changes in or contamination of water supply to GWDTE	Construction	Minor, temporary and adverse	Not Significant
	Operation	Negligible	Not Significant
Changes in or contamination of water supply to PWS	Construction	Minor, temporary and adverse	Not Significant
	Operation	Negligible	Not Significant
Changes in or contamination of water supply to designated sites	Construction	Negligible	Not Significant
	Operation	Negligible	Not Significant
Increased flood risk	Construction	Negligible	Not Significant
	Operation	Negligible	Not Significant
Modification to groundwater flow paths	Construction	Negligible	Not Significant
	Operation	Negligible	Not Significant
Soil erosion and compaction	Construction	Minor, temporary and adverse	Not Significant
	Operation	Minor, temporary and adverse	Not Significant
Peat instability	Construction	Minor, long-term and adverse	Not Significant
	Operation	No Change	
Cumulative effects			
Geology and soils	Construction	Negligible	Not Significant
	Operation	No Change	

Effect	Phase	Assessment consequence	Effect significance
Hydrogeology	Construction	Minor, temporary and adverse	Not Significant
	Operation	Negligible	Not Significant
Hydrology	Construction	Minor, temporary and adverse	Not Significant
	Operation	Negligible	Not Significant

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