ScottishPower Renewables

Harestanes West Windfarm

Environmental Impact Assessment Report

Volume 2

Chapter 10: Hydrology, Hydrogeology, Geology and Soils

December 2024

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Abbreviations

Above Ordnance Datum	AOD
Borrow Pit Assessment	BPA
British Geological Survey	BGS
Construction Environmental Management Plan	CEMP
Digital Terrain Models	DTM
Drinking Water Protected Areas	DWPA
Environmental Clerk of Works	ECoW
Environmental Impact Assessment Report	EIA Report
Forestry and Land Scotland	FLS
Groundwater dependent terrestrial ecosystem	GWDTE
National Nature Reserve	NNR
Ordnance Survey	OS
Outline Peat Management Plan	PMP
Peat Slide Risk Assessment	PSRA
Private Water Supply	PWS
Scottish Environment Protection Agency	SEPA
Sites of Special Scientific Interest	SSSI
Special Areas of Conservation	SAC
UK Meteorological Office	Met Office

10. Hydrology, Hydrogeology, Geology and Soils

10.1. Executive Summary

1. Harestanes West Windfarm (hereafter 'the proposed Development') has been assessed in relation to the potential impacts on hydrology, hydrogeology, geology and soils during the construction and operational phases. Information on the study area was compiled using data gathered within a desk study and verified by an extensive fieldwork programme.

2. The assessment considered the sensitivity of the receptors, their proximity to the Application Boundary and any primary mitigation measures which have been incorporated into the proposed Development design. Where particularly sensitive receptors were identified, additional mitigation procedures were outlined. Private water supplies (PWS) and potentially groundwater-dependent terrestrial ecosystems which are within, near or have a hydraulic linkage to the application site have been assessed individually and appropriate mitigation measures have been set out where linkages have been identified.

3. A detailed programme of peat depth and condition surveying has been completed, and the results have been used to inform the design. An Outline Peat Management Plan has been produced for the proposed Development, which illustrates how peat resources have been safeguarded by avoiding excursion into areas of deep peat. Additionally, the Outline Peat Management Plan demonstrates that any excavated peat would be reused on-site or nearby for peatland restoration.

4. A Drainage Impact Assessment has been produced for the proposed Development which includes an Outline Drainage Strategy for the application site. Sustainable drainage systems have been proposed to ensure that the rate of runoff from the proposed Development post-development is no greater than that prior to development. The proposed sustainable drainage systems allow water quality to be managed at source, prior to any discharge, thereby helping to prevent any reduction in water quality in watercourses downstream of the Application Boundary.

10.2. Introduction

5. This Chapter of the Environmental Impact Assessment Report (EIA Report) describes the existing geological, hydrogeological and hydrological conditions within the Site (the area within the Application Boundary) and identifies and assesses the potential impacts that may be caused by the Harestanes West Windfarm Development, hereafter the 'proposed Development'. This includes site preparation, construction works, restoration of construction works, site operation and decommissioning. Mitigation measures that may be employed to relieve any adverse effects are also set out.

6. Within this Chapter, the study area is considered to include the Application Boundary (the 'Site') and an area up to 2 km from this boundary. For hydrological concerns, areas

downstream of the planning Application Boundary are considered at a distance of up to 5 km as it is possible for effects to be transmitted downstream for greater distances.

7. This Chapter is supported by several Figures and Technical Appendices which provide additional in-depth information on relevant aspects of the development.

8. The chapter figures are found in Volume 3a of the EIA and include:

- **Figure 10.1a**: Geology mapping;
- **Figure 10.1b**: Superficial geology;
- **Figure 10.2a**: Soils mapping;
- **Figure 10.2b**: Peat and carbon mapping;
- **Figure 10.3a**: Peat Depth – North;
- **Figure 10.3b**: Peat Depth – South;
- **Figure 10.3c**: Peat depth – North Access Track;
- **Figure 10.3d**: Peat depth - South Access Track;
- **Figure 10.4**: Hydrological catchments;
- **Figure 10.5**: Private water supplies; and
- **Figure 10.6**: Water quality monitoring locations.

9. The Technical Appendices are found in Volume 4 of the EIA:

- **Technical Appendix 10.1**: Peat Slide Risk Assessment (PSRA);
- **Technical Appendix 10.2**: Peat Management Plan (PMP);
- **Technical Appendix 10.3**: Borrow Pit Assessment (BPA);
- **Technical Appendix 10.4**: Groundwater-Dependent Terrestrial Ecosystems Assessment (GWDTE); and
- **Technical Appendix 10.5**: Drainage Impact and Watercourse Crossing Assessment (DIWCA).

10. The Technical Appendices are accompanied by a number of figures which are found in Volume 4 of the EIA. Key findings of the above Technical Appendices are summarised within this Chapter.

10.3. Consultation

10.3.1. Consultation Undertaken

11. Consultation in relation to issues concerning hydrology, hydrogeology, geology and soils has been undertaken with several statutory and non-statutory consultees and interested parties, including the Scottish Government, Dumfries and Galloway Council, the Scottish Environment Protection Agency (SEPA), Scottish Water and local stakeholder including landowners, community councils and members of the public. Responses were received

to the EIA Scoping Report in November 2023. Those with relevance to hydrology, hydrogeology, geology and soils are provided in **Table 10.1**.

Table 10.1 Consultee Responses Relevant to Hydrology, Hydrogeology, Geology and Soils

Name of Stakeholder/ Consultee	Key Concerns	Response
Energy Consents Unit response dated 03.11.23	This applicant should investigate the presence of any private water supplies which may be impacts by the development. Details of supplies identified should be included in the EIAR and an assessment of potential impacts, risks, and mitigation.	PWS are identified in **Section 5.6.3** Water Resources. Impacts, risk and mitigation are considered and assessed in **Sections 6.2 and 6.3**.
	Peat landslide hazard and risk assessment to be undertaken as part of EIA process. The Peat Landslide Hazard and Risk Assessments: Best Practice Guidance for Proposed Electricity Generation Developments (Second Edition) should be followed and clear justification provided if a PLHRA is not required.	Effects on peat and risk of peat landslide are identified and addressed in **Technical Appendices 10.1** and **10.2**.
	When considering proposed borrow pits as a source of on-site aggregate, it is essential to include them in the Environmental Impact Assessment Report (EIA Report). The EIA Report should provide detailed information on: Location, Size, and Nature: Exact location, dimensions, and characteristics of the borrow pits. Depth of Excavation: Comparison between the proposed depth and the actual topography and water table. Drainage and Settlement Traps: Planned drainage systems and settlement traps to manage water flow and sediment. Turf and Overburden Management: Methods for removing and storing turf and overburden for future site reinstatement. Restoration Profile: Detailed plans for restoring the site after excavation is complete. Additionally, the EIAR must assess the impact of these borrow pits on: Dust Emission Blasting Activities Water Quality and Hydrology The assessment should adhere to the guidelines in 'Pan 50: Controlling the Environmental Effects of Surface Mineral Workings'.	The proposed Development will not involve the creation of new borrow pits; instead, it is proposed that suitable aggregate is won from existing borrow pits on the Site currently operated by Forestry and Land Scotland (FLS). These are considered in **Technical Appendix 10.3**.

Name of Stakeholder/ Consultee	Key Concerns	Response
SEPA response dated 24/04/23	Engineering activities which may have effects on the water environment	Effects on the water environment are identified in **Sections 10.10** and **5.11** of this Chapter and in **Technical Appendices 10.4** and **10.5**.
	Disturbance and re-use of excavated peat and other rich soils	Impacts upon peat are considered in **Section 10.8** of this Chapter and in **Technical Appendix 10.2**.
	Disruption to Groundwater Dependent Terrestrial Ecosystems	Impacts upon GWDTE are considered in **Technical Appendix 10.4** and in **Section 10.10** of this Chapter.
	Existing groundwater abstractions	Groundwater is considered further in **Section 10.10**.
	Borrow Pits	The proposed Development will not involve the creation of new borrow pits; instead, it is proposed that suitable aggregate is won from existing borrow pits on the Site currently operated by Forestry and Land Scotland (FLS). These are considered in **Technical Appendix 10.3**.
	Pollution prevention and environmental management	This Chapter has identified all proposed activities that would be subject to environmental legislation in relation to hydrology, hydrogeology, geology and soils. The Applicant and principal contractor would ensure that all environmental obligations during the construction, operation and decommissioning, as detailed in **Chapter 3: Proposed Development**, and relevant environmental legislation would be implemented in the discharge of their duties.
Dumfries and Galloway Council response dated 03.05.24	Developer needs to manage surface runoff from the site during and after construction. Runoff should mimic that of existing conditions and not be increased. Developer should consider the rate of runoff into the watercourses which are located within the site. Any significant increase may increase the flood risk downstream, All culverts that form part of the development should be hydrologically assessed to ensure there will be no capacity issues during peak flow e.g. 1 in 200 year + CC storm events, Developer is advised to have measures in place regarding future maintenance of drains and culverts,	Flood risk is assessed in **Section 10.11.4** of this Chapter. Impacts upon drainage and watercourse crossings at the proposed Development are considered in **Technical Appendix 10.5**.

Name of Stakeholder/ Consultee	Key Concerns	Response
	New access tracks should in no way act as a flow route for surface water flows.	

10.3.2. Statutory and Planning Context

12. 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 Environmental Protection Act 1990 (as amended);
- 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;
- 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.
- Scottish Government's Guidance on Developments on Peatland: Peatland Survey (2017)
- Scottish Environment Protection Agency'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.

10.4. Scope and Methodology

10.4.1. Study Area

13. For most constraints and sensitivities, the study area is considered to be up to 2 km from the Application Boundary. This is shown in **Figure 2.1**.

14. 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.

15. 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.

10.4.2. Assessment Method

16. The assessment was undertaken through a desk study and site inspection of existing geological, hydrogeological and hydrological features on and surrounding the Site. The existing conditions were described and potential risks that may be associated with the proposed Development were identified and assessed. The following effects were assessed:

- Physical changes to overland drainage and surface water flows;
- Particulates and suspended solids;
- Water contamination from fuels, soils, concrete batching or foul drainage;
- Changes in or contamination of water supply to vulnerable receptors;
- Increased flood risk;
- Watercourse crossings;
- Modification to groundwater flow paths;
- Groundwater-dependent terrestrial ecosystems;
- Soil erosion and compaction; and
- Peat instability.

17. Effects scoped out of further assessment include mining impacts, including coal mining.

18. The above effects are deemed to have no relevant impacts relating to the proposed Development and have not been considered any further in this assessment.

19. The initial desk studies were undertaken to determine and verify the baseline conditions through review and collation of available and relevant information relating to hydrology, hydrogeology, geology and soils. This included a review of published mapping, including OS topographical mapping at 1:25,000 and 1:50,000 scales, British Geological Survey (BGS) geological mapping, Scotland's Soils soil and peatland mapping, aerial and satellite imagery and site-specific data such as site investigation data, geological and hydrogeological reports, digital terrain models (DTM, to provide slope data) and geological literature.

20. Private water supply (PWS) data were requested from Dumfries and Galloway Council's Environmental Health Officer with additional data provided by local landowners.

21. A site visit and walkover 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;
- visit any identified potentially groundwater-dependent terrestrial ecosystems (GWDTE) (in consultation with the project ecology team);
- prepare a schedule of potential watercourse crossings and existing crossings that would require upgrading;
- inspect rock exposures and establish by probing an estimate of overburden thickness and confirmation of likely substrate;
- allow appreciation of the site including awareness of gradients, possible borrow pit sites, access route options and 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, e.g. in watercourse channels and alongside existing track cuttings.

22. The reconnaissance survey was undertaken on 29th February and 1st March 2024. The weather was mainly dry and breezy with some showers.

23. In parallel with the reconnaissance survey, a peat probing exercise was undertaken. This involved undertaking a peat depth survey with a hand-held probe on a 100 m grid across the proposed Site, to identify areas of deeper peat and natural variation in the peat substrate across the area. These surveys were undertaken in May and June 2023.

24. Following finalisation of the infrastructure design, a second phase of peat survey work was scheduled. 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;
- 50 m intervals along each side of access tracks to be upgraded; and

- 10-20 m resolution grid sampling at turbine locations, and at all other infrastructure locations.

25. The Site is heavily forested and includes areas of active, recently active and older clear-fell as well as areas that have experienced significant windblow and related damage. These factors create significant challenges for safe access in parts of the Site, which has led to restrictions on data availability for some areas. Where possible, survey points were taken as close as possible to the original location. Efforts were made during return visits to the Site to gather data for all the survey points as areas of windblown trees were cleared.

26. Data from these surveys were used to ensure that there was sufficient peat depth information to support the infrastructure design process and related studies on peat instability and peat excavation and reuse. These surveys were undertaken in February and March 2024 for areas of proposed infrastructure and access tracks, with additional surveys conducted in June and July 2024 following design revisions.

27. Following the field surveys, a geomorphological mapping exercise was undertaken to link the topographic features with the underlying geology, and to identify areas of the site that may be potentially at risk from peat landslide. This made use of collected field data, DTM, topographical mapping and aerial photography.

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

29. A peat slide risk assessment (PSRA) was undertaken in accordance with the Scottish Government's Peat Landslide Hazard & Risk Assessments: Best Practice Guide for Proposed Electricity Developments (The Scottish Government, 2017). The PSRA was informed by the peat depth model, site reconnaissance and peat depth surveys, detailed geomorphological mapping and terrain classification. 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 likelihoods were compared with identified receptors to identify risks and determine appropriate mitigation measures. The assessment is provided in **Technical Appendix 10.1**.

30. A peat management plan (PMP) was prepared in accordance with the Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and the Minimisation of Waste (Scottish Renewables & SEPA, 2012). The PMP was informed by the collated peat depth probing described above, combined with a full site appraisal of potential reuse opportunities e.g. reinstatement and landscaping requirements associated with infrastructure, mapping of drainage ditches, peat hagging and areas of forestry on deep peat. Where opportunities were identified to integrate the PMP with wider environmental enhancement measures, such as peatland restoration, the PMP identifies the volume and type of peat to be used for this activity. The outline peat management plan is provided in **Technical Appendix 10.2**.

31. An assessment of bedrock suitability for track and hardstanding construction was undertaken, together with a mapping exercise to identify potentially suitable locations for

use as borrow pits for the proposed Development. The assessment is provided in **Technical Appendix 10.3**.

32. 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 are 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 10.4**.

33. An assessment of drainage requirements to manage surface runoff and potential downstream flood risk was undertaken for the proposed Development. The assessment also incudes an inventory of all proposed watercourse crossings, both for new structures and for existing crossings that may require upgrading. The assessment is provided in **Technical Appendix 10.5**.

34. A number of data sources were considered in writing this Chapter; the main sources are detailed below:

- Ordnance Survey (OS) topographical mapping, current and historical, at 1:25,000 and 1:50,000 scale and equivalent;
- BGS geological mapping, superficial and bedrock;
- BGS online borehole database;
- Scotland's Soils mapping; and
- Scottish Environment Protection Agency's (SEPA) *A functional wetland typology for Scotland*.

10.5. Effects Evaluation

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

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

36. This approach is based on guidance contained within the joint NatureScot/Historic Environment Scotland publication Environmental Impact Assessment Handbook v5.

10.5.1. Receptor Sensitivity

37. The sensitivity of a receptor represents its ability to absorb the anticipated effect without resulting in perceptible change. Four levels of sensitivity have been used, as defined in **Table 10.2**.

Table 10.2 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 (NNR), 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 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.

10.5.2. Effect Magnitude

38. The magnitude of effects includes the timing, scale, size and duration of the potential effect. Four levels of magnitude have been used, as defined in **Table 10.3**.

Table 10.3 Magnitude Ratings

Magnitude	Definition
Substantial	Substantial changes, over a significant area, to key characteristics or to the geological /hydrogeological/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/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/no change	Any change would be negligible, unnoticeable or there are no predicted changes.

10.5.3. Likelihood of Effect

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

10.5.4. Effects Significance

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 embedded and additional mitigation measures. The assessment concludes with a review of various effects to determine if they would be

'Significant'. 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 10.4**.

Table 10.4 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	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
		Highly Unlikely	Minor
	Negligible	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	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	Likely	Negligible
		Unlikely	Negligible
		Highly Unlikely	Negligible

40. In addition to the sensitivity, magnitude and likelihood of an effect, effects can be direct, indirect, secondary, cumulative, transboundary, short-term, medium-term and long-term, permanent and temporary, positive and negative. Definitions of these terms are provided in NatureScot and Historic Environment Scotland's Environmental Impact Assessment Handbook V5 (NatureScot, 2018).

10.6. Baseline Conditions

10.6.1. Meteorology and Climate

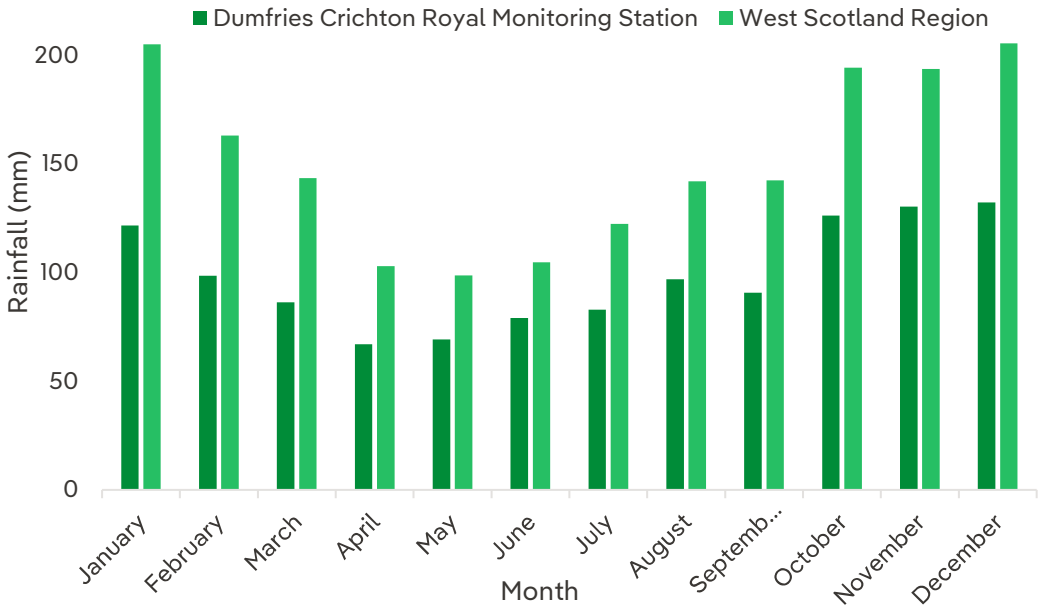
41. The proposed Development is in Dumfries and Galloway, located in the UK Meteorological (Met) Office's 'Western Scotland climatic area'. Western Scotland experiences a temperate maritime climate, characterised by substantial rainfall and strong westerly winds (Met Office, 2016).

42. The Site is situated 1.20 km north west of the village of Ae, and is characterised by undulating high ground and peaks, with elevations ranging from 100 m to 380 m above Ordnance Datum (AOD). A series of watercourses intersect the Site, including the Water of Ae in the north east and Goukstane Burn in the south west. Detailed topographical information is provided in section **10.9 Topography** of this Chapter.

10.6.2. Rainfall

43. Western Scotland is one of the wettest regions in the UK, with annual rainfall typically exceeding 1,500 mm. This is largely due to prevailing westerly winds from the Atlantic, resulting in frequent and substantial rainfall throughout the year (Met Office, 2023). Dumfries Crichton Royal No 2 (henceforth referred to as Dumfries Crichton Royal) climate monitoring station is approximately 13 km south of the proposed Development (Met Office, 2023). Rainfall data from this station is likely to provide a good representation of the Site and surrounding area.

44. **Graph 10.1** shows the average monthly rainfall distribution for the Dumfries Crichton Royal monitoring station and the Western Scotland climatic region for comparison.



Graph 10.1 Monthly rainfall averages at Dumfries Crichton Royal monitoring station and for West Scotland climate region. Averages cover the period 1991-2020 (Met Office, 2023).

45. The majority of rain falls in the winter months (October to January), with December having the highest recorded monthly rainfalls – approximately 130 mm. From January to April rainfall declines, with April having the lowest monthly rainfall at approximately 60 mm. From May rainfall slowly increases towards the end of the year. Rainfall for the Crichton Royal monitoring station is significantly lower than the Western Scotland climatic region (1,181 mm annual rainfall compared with 1,818 mm, respectively) but the general pattern of distribution is similar.

10.7. Geology

46. Geological information is derived from the British Geological Survey (BGS) GeoIndex online geological mapping at a 1:50,000 scale and the BGS Lexicon of Named Rock Units (BGS, 2024a, b).

10.7.1. Bedrock Geology

47. The bedrock within the Site is predominantly greywacke sandstone, ranging from fine to very coarse grained and locally pebbly, with some bands of mudstone, siltstone and conglomerate in places. A minor area of breccia, a small intersection of mudstone, chert and smectite-claystone, and sandstone are present at the southern end of the Site access. Bedrock geology is shown on **Figure 10.1a**.

10.7.2. Mineral Extraction

48. The proposed Development is located in an area of commercial forestry, parts of which have previously undergone rock extraction.

49. Fourteen quarries are identifiable from OS 1:25,0000 scale mapping, five of which lie within the Site and nine within 2 km of the Application Boundary.

50. Of the five quarries within the Site, two are located within the turbine area, Drumfadkens Quarry (known as Mitchelslacks by FLS) towards the north west and Glencorse Hill Quarry (known as Quarriebraes by FLS) in the centre. The three remaining quarries are located along the access track to the turbine area, Killyminshaw Hill Quarry to the north west, Holehouse Hill Quarry in the south and Bog Shaw Quarry to the east. All quarries are identifiable on OS 1:25,000 scale mapping and are listed as ceased (BGS, 2024a).

51. One additional quarry is known to be present within the Site, but is not indicated on either the OS mapping or the BGS Geoindex. This quarry is called Branrigg by FLS.

52. There are six ceased and inactive borrow pits, sand pits and gravel pits within the northern region of the Site (BGS, 2024a). However, these quarries are not identifiable on OS 1:25,000 scale mapping and, as they are ceased, are not considered to be of significance.

53. There are a number of ceased and inactive quarries, borrow pits, sand pits and gravel pits located in the study area to the south, east, and north west. Of these, nine are visible on OS 1:25,000 scale mapping and details of these are provided in **Table 10.5**. The remaining quarries are not identified on 1:25,000 scale mapping and, as they are ceased, are not considered to be of significance.

Table 10.5 Former quarries near the proposed Development (OS 1:25,000 maps, BGS GeoIndex, 2024)

No.	Name	Grid Reference	Commodity	Status	Distance & Direction from proposed Development
1	Holehouse Hill	301381 595441	Unknown	Ceased	Within Site
2	Bog Shaw (north)	302154 594537	Unknown	Ceased	Within Site
3	Killyminshaw Hill	299128 596103	Unknown	Ceased	Within Site
4	Drumfadkens (Mitchelslacks)	295141 593910	Unknown	Active	Within Site
5	Glencorse Hill (west) (Quarriebraes)	295839 591369	Unknown	Active	Within Site
6	Branrigg (not shown on OS mapping)	298439, 595524	Unknown	Active	Within Site
7	Bog Shaw (south)	302439 593827	Unknown	Ceased	225 m west
8	Craigshiels	298402 593028	Unknown	Ceased	1 km north

No.	Name	Grid Reference	Commodity	Status	Distance & Direction from proposed Development
9	Dan's Pool	298527 593352	Unknown	Ceased	675 m north
10	Fellard	293411 593232	Unknown	Ceased	1.56 km east
11	Glencorse Hill (east)	296781 591419	Unknown	Ceased	343 m south west
12	Green Hill	297735 592071	Unknown	Ceased	1.50 km south west
13	Gubhill	297399 592535	Unknown	Ceased	1.25 km north west
14	White Hill	294212 593463	Unknown	Ceased	910 m east
15	Whitefauld Hill	302188 592973	Unknown	Ceased	95 m north east

10.7.3. Superficial Geology

54. Superficial geology mostly consists of diamicton till (BGS GeoIndex, 2024), although much of the Site is without any mapped superficial geology. In the turbine area to the west of the Site, diamicton till is the most prominent, along with a few peat deposits. The largest of these peat deposits is located approximately 1 km north east of Auchengeith Hill, the second between the peaks of Auchengeith Hill and Big Craig, and the last is approximately 300 m north west of Auchengeith Hill.

55. To the east of the Site, along the access track to the turbine area, the area is underlain by diamicton till, peat and alluvium (comprising silt, sand and gravel). A single peat deposit is found where the access track intersects the Deer Burn. Superficial Geology is shown on **Figure 10.1b**.

10.8. Soils and Peat

56. The Soil Survey of Scotland (1981) digital soils mapping indicates that the soil coverage within the Application Boundary is predominantly peaty gleys, peat podzols and noncalcareous gleys (brown forest soils). Peaty gleys are described as poorly drained acidic soils which support wet heathland and rough grassland communities. An area to the south of the turbine area has been identified as predominantly peaty podzols, which often have a thin iron-pan restricting the flow of water deeper into the soil.

57. A small section of the access track to the turbine area, at Deer Burn, has been identified as peat. Further details on soils within the Site are provided in **Table 10.6**.

Table 10.6 Soil types within the Application Boundary

Soil Association	Parent Material	Component Soils	Landforms	Vegetation	Area %
Organic Soils (4)	Organic deposits	Blanket peat	Uplands and northern lowlands with gentle and strong slopes	Blanket and flying bent bog; Upland and mountain blanket bog	1.30%
Ettrick (209)	Drifts derived from Lower Paleozoic greywackes and shales	Brown forest soils with gleying; some noncalcareous gleys	Foothills and undulating lowlands with gentle and strong slopes	Arable and permanent pastures; Sharp-flowered rush pastures	0.50%
Ettrick (216)	Drifts derived from Lower Paleozoic greywackes and shales	Peaty podzols, peaty gleys, peat, some brown forest soils and rankers	Undulating uplands with complex and short, gentle and strong slopes	Moist Atlantic heather moor; Heath-rush - fescue grassland; Blanket and flying bent bog	6.60%
Ettrick (218)	Drifts derived from Lower Paleozoic greywackes	Peaty podzols, peaty gleys, peat	Hills with gentle and strong slopes	Moist Atlantic heather moor; Heath-rush - fescue grassland; Blanket and flying bent bog	39.02%
Ettrick (220)	Drifts derived from Lower Paleozoic greywackes	Peaty gleys, peat; some peaty podzols	Foothills and undulating uplands with gentle slopes	Moist Atlantic heather moor; Heath-rush - fescue grassland; Blanket and flying bent bog	33.95%
Ettrick (230)	Drifts derived from Lower Paleozoic greywackes and shales	Peaty podzols, peaty gleys; some peat and rankers	Hills with complex strong and steep slopes: non-rocky	Moist Atlantic heather moor Heath-rush-fescue grassland; Blanket and flying bent bog	0.01%
Ettrick (232)	Drifts derived from Lower Paleozoic greywackes	Non-calcareous gleys, brown forest soils	Hills and valley sides with generally concave, strong and steep slopes	Sharp-flowered rush pasture; Tussock-grass pasture; Acid bent-fescue grassland	17.80%
Holywood (303)	Drifts derived from sandstones and conglomerates of Permian age	Brown forest soils with gleying, brown forest soils	Undulating lowlands with gentle and strong slopes	Arable and permanent pastures	0.83%

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

59. Within the Site, soils are predominantly Class 4 (unlikely to include carbon-rich soils). There are some areas of Class 5 (peat depth greater than 50 cm but currently lacking peatland vegetation), distributed throughout the Site. Two small areas are identified as Class 3 (peaty soils that support some or mostly peat-forming vegetation) in the north western and south eastern corners of the Site. The remainder of the Site is Class 0 (mineral soils).

60. Details of each peatland class and the associated areas are provided in **Table 10.7**. Soils mapping and peatland class mapping are shown on **Figure 10.2a** and **Figure 10.2b**, respectively.

Table 10.7 Carbon and Peatland classes present within the Application Boundary (NatureScot, 2016)

Peatland Class	Description	Area %
Class 0	Mineral soil - Peatland habitats are not typically found on such soils.	18.49%
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.	0.57%
Class 4	Area unlikely to be associated with peatland habitats or wet and acidic type. Area unlikely to include carbon-rich soils.	49.83%
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.	31.10%

61. Phase 1 peat depth surveys of the Site were undertaken in May and June 2023. A Phase 2 peat depth and condition survey was undertaken in February-March 2024 for areas of proposed infrastructure and access tracks, with additional surveys in June and July 2024 following design revisions. Peat survey data from the Harestanes South Windfarm Extension development have also been incorporated.

62. The combined peat depth surveys include a total of 5,700 individual peat depth records, of which 4,070 are within the Application Boundary. Peat depth data distribution within the Site is provided on **Figure 10.3a**, **Figure 10.3b, Figure 10.3c** and **Figure 10.3d.** Peat depth surveys indicate that peat depth is variable across the Site. Excluding the access track to the turbine area, four main areas of peat have been identified. These areas are typically associated with the headwaters of the main watercourses. Additionally, there are numerous isolated and usually small pockets of peat scattered throughout the Site.

63. The first main area is located in the south east of the turbine area, on a gentle slope in a young forestry plantation, where peat depth reaches up to 5.80 m. The second area is approximately 1 km north west at Peat Moss, between Big Craig and Auchengeith Hill, in

an open wet meadow. Here, peat depth varies from 2 m to 6 m. The third area is approximately 2 km north, between Glencorse Hill and Windyhill Rig, with peat depths of up to 3 m. The fourth area is to the north of the turbine area, approximately 500 m east of Tod Slack, where there are peat depths of up to 6.80 m.

64. A few patches of peat have been identified along the access track to the turbine area. Two areas are noteworthy. The first is located 500 m north of Whitefauld Hill, in a recently felled forestry area, where peat depths range from 1 m to 3.50 m[1]. The second area is along the western bank of the Water of Ae, within a semi-mature forestry plantation, where peat depths range from 1 m to 2 m.

65. Further details of peat depth and peat depth variation are provided in **Technical Appendix 10.2**.

10.9. Topography

66. Topography within the Application Boundary is variable, with elevations ranging from 108 m to 380 m AOD. The highest point on Site is towards the north east of Holehouse Hill, situated within the eastern portion of the access track, lying at 380 m AOD. Topography undulates across the Site with scattered peaks including: Auchengeith (299 m) in the south west, Shiel Cleuch (300 m AOD) to the east and Hound Knowe (340 m AOD) to the north.

67. The lowest point within the Site is to the south east of the access track where it meets the A701, lying at 108 m AOD. Valleys caused by the incision of river systems account for several other areas of low elevation on Site, at roughly 200 m AOD.

68. Threap Moor is found to the north outwith the Application Boundary, with a series of peaks including Queensberry (697 m AOD), Wee Queensberry (512 m AOD) and Earncraig (611 m AOD). The operational Harestanes Windfarm is found to the east, along with several hills and fells including Green Hill (314 m AOD), Knockespen (344 m AOD) and Brownmoor Hill (347 m AOD). The south is bounded by the village of Ae, Cocklet Hill (269 m AOD), and the operational Dalswinton Windfarm. Three hills, Dins Rig (324 m AOD), Great Hill (353 m AOD) and White Hill (302 m AOD), as well as Loch Ettrick, are found to the west.

10.10. Hydrogeology

69. The bedrock within the Application Boundary is classified as a low-productivity aquifer of the Gala Group, comprising highly indurated greywackes with limited groundwater in the near-surface weathered zone and accompanied by secondary fractures (BGS, 2024a). Groundwater flow is predominantly through fractures and other discontinuities.

70. Three groundwater bodies are associated with the Application Boundary (SEPA, 2015b). The East Dumfrieshire groundwater body lies beneath most of the Site. The Dalveen Pass groundwater body lies beneath the western part of the Site. The Lochmaben groundwater

[1] *Large scale soil disturbance was noted during the peat survey in this location. As such, peat depths may be overestimated due to the accumulation of soil beside vehicle tracks or uprooted trees. Samples are taken from the visibly least disturbed area to be as representative as possible.*

body lies beneath a southern part of the access track. All groundwater bodies are in good condition.

10.10.1. Groundwater Vulnerability

71. 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).

72. Groundwater vulnerability mapping (Dochartaigh *et al.*, 2011) has identified that groundwater within the Application Boundary has vulnerability classes of 4a, 4b or 5.

73. Class 4 is considered vulnerable to pollutants not readily absorbed or transformed; class 4a is more likely to contain low permeability soil with less clay in superficial deposits compared with class 4b, which has a greater likelihood to contain clay in superficial deposits. Class 5 is considered the most vulnerable and will display a rapid sensitivity to pollutants.

10.10.2. Groundwater-dependent Terrestrial Ecosystems

74. A habitat mapping exercise was completed as part of the ecology baseline assessment, which was used to identify potential groundwater-dependent terrestrial ecosystems (GWDTE) within the Site. The results of the habitat mapping exercise are discussed in **Chapter 8: Ecology and Biodiversity, of the EIA Report**.

75. GWDTE are defined by UKTAG as: "*A terrestrial ecosystem of importance at Member State level that is directly dependent on the water level in 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 of substances (and potentially pollutants) within that groundwater body, but there must be a direct hydraulic connection with the groundwater body*" (UKTAG, 2004).

76. The bedrock at the Site is classified as a low productivity aquifer, indicating that the presence of GWDTE is unlikely; however, in line with guidance provided by UKTAG (2004), a dual approach to identifying GWDTE has been used. This involves detailed study of vegetation communities in order to determine the potential level of groundwater dependency, combined with detailed hydrogeological study in order to identify locations where groundwater reaches the surface and is therefore able to provide a source of water to associated habitats. Some potentially suitable habitats were identified as part of UK habitat classification and NVC surveys.

77. NVC communities identified by the SEPA as potentially, highly or moderately groundwater-dependent, depending on the hydrogeological setting, are listed in SEPA's publication "*Planning guidance on on-shore windfarm Proposed Developments*" (SEPA, 2017).

78. Potential groundwater-dependent NVC communities identified within the Site are:

- M6 Carex echinata – Sphagnum recurvum mire;
- M23 Juncus effusus/acutiflorus – Galium palustre rush-pasture;
- M15 Scirpus cespitosus – Erica tetralix wet heath;

- M27 Filipendula ulmaria – Angelica sylvestris mire; and
- M25 Molinia caerulea – Potentilla erecta mire.

79. The list of NVC communities provided by SEPA in Land Use Planning Systems SEPA Guidance Note 4 (SEPA, 2017) indicates that M6 and M23 are likely to have high groundwater dependency, while M15, M27 and M25 are likely to have moderate/low groundwater dependency in Scottish situations, dependent on the hydrogeological setting.

80. GWDTE have been assessed separately; details are provided in **Technical Appendix 10.4**.

10.11. Hydrology

81. Catchment data have been derived from the Flood Estimation Handbook Web Service (UKCEH, 2024). The Application Boundary is situated across five catchment areas: Water of Ae (u/s Goukstane Burn), Goukstane Burn, Pennyland Burn, Glenkiln Burn and Garrel Water. The catchment areas are shown on **Figure 10.4**. The Water of Ae, Goukstane Burn, Glenkiln Burn and Garrel Water are all tributaries to the River Annan. The Pennyland Burn is a tributary to the River Nith.

82. The majority of the land within the Application Boundary lies within the Water of Ae (u/s Goukstane Burn) catchment, including the northern half of the turbine area and a large part of the access track to the turbine area. The southern half of the turbine area primarily lies within the Goukstane Burn catchment, while a small area to the south west of the turbine area is drained by the Pennyland Burn catchment. The eastern part of the access track to the turbine area is drained by the Glenkiln Burn and Garrel Water catchments.

83. The catchment wetness index for the catchment areas is between 0.60-0.64, indicating the Site is wet 60-64% of the time (**Table 10.8**). The area has a base flow index (BFI HOST19) of between 0.32 and 0.55 indicating a moderate to low input of groundwater baseflow to surface watercourses. The standard percentage runoff (SPR HOST) is 35-48%, which indicates that this percentage of rainfall on Site is converted into surface runoff from rainfall events. This represents a high runoff rate where soils have limited capacity to store rainfall and/or a slow infiltration rate and would quickly saturate, leading to rapid runoff.

Table 10.8 Catchment statistics for the proposed Development

Catchment Name	Catchment Wetness Index (PROPWET)	Base Flow index (BFI HOST19)	Standard Percentage Runoff (SPR Host)	Area %*
Water of Ae (u/s Goukstane Burn)	**0.63**	**0.32**	**48.12**	**52.00**
Goukstane Burn	**0.64**	**0.38**	**43.87**	**29.24**
Pennyland Burn	**0.64**	**0.55**	**35.34**	**6.03**
Garrel Water	**0.60**	**0.48**	**40.76**	**9.59**
Glenkiln Burn	**0.60**	**0.36**	**46.67**	**3.13**

*The % area does not total 100% due to rounding.

10.11.1. Watercourses

84. Watercourses within the Application Boundary appear to be modified, with a few larger watercourses in near-natural condition. The modification is likely to be a result of diverting watercourses for the surrounding commercial forestry.

Water of Ae (u/s Goukstane Burn)1

85. The Water of Ae (u/s Goukstane Burn) catchment has a total area of 72.68 ha and drains 52.00% of the land within the Application Boundary.

86. The Water of Ae is the largest fluvial system intersecting the Site and is in a near-natural condition. Many minor headwater tributaries contribute to the drainage of this catchment, including the Capel Water, Bran Burn, Clerk Grain, Deer Burn and Windyhill Burn. These tributaries have been artificially modified in places to accommodate the surrounding commercial forestry and associated infrastructure.

87. This catchment predominantly comprises commercial forestry, with upland areas towards the source. There are also small areas of grazing, as well as a small residential area in the Ae Valley.

Goukstane Burn

88. The Goukstane Burn catchment has a total area of 11.43 ha and drains 29.24% of the land within the Application Boundary.

89. The Goukstane Burn is the second largest fluvial system on-site and ultimately drains into the Water of Ae. The Goukstane Burn is mostly in a near-natural condition due to its size; however, it has been artificially modified upstream to accommodate track infrastructure. Several unnamed minor tributaries drain into the Goukstane Burn. The majority of these have been artificially modified.

90. This catchment is predominantly characterised by commercial forestry, with small areas of grazing.

Garrel Water

91. The Garrel Water catchment has a total area of 25.15 ha and drains 9.59% of the land within the Application Boundary.

92. The Garrel Water catchment drains into the Water of Ae a few kilometres downstream of the Site. Several minor watercourses drain into the Garrel Water, including the Mill Burn. These are likely to have been artificially modified.

93. This catchment is characterised by a mixture of arable and livestock farming, and commercial forestry.

Pennyland Burn

94. The Pennyland Burn catchment has a total area of 29.60 ha and drains 6.03% of the land within the Application Boundary.

95. The site drains into Duncow Burn (off-site to the West), a minor tributary of the Pennyland Burn. The Duncow Burn and Pennyland Burn have both probably been artificially

modified, due to their small size and proximity to commercial forestry. There are no other watercourses within the Application Boundary associated with this catchment.

96. This catchment is characterised by a mixture of arable and livestock farming, and commercial forestry.

Glenkiln Burn

97. The Glenkiln Burn catchment has a total area of 15.12 ha and drains 3.13% of the land within the Application Boundary.

98. The Glenkiln Burn is a fluvial system similar in size and character to the Goukstane Burn and drains into the Water of Ae just upstream of the Goukstane Burn. It is likely that parts of the Glenkiln Burn have been artificially modified in the headwaters but it is in a near-natural condition downstream. Several minor watercourses drain into the Glenkiln Burn, including the Lambfoot Linn. These are likely also to have been artificially modified.

99. This catchment is predominantly characterised by commercial forestry, with smaller areas of moorland and deciduous forestry.

10.11.2. Water quality

Surface waterbodies

100. SEPA's Water Classification and Water Environment Hubs have been consulted to determine the existing baseline quality for the main watercourses and waterbodies within the application site (SEPA, 2015a; SEPA, 2015b). The details are summarised in **Table 10.9**.

Table 10.9 Baseline surface water quality status - summary

Waterbody Name and ID	Status		Pressures
Goukstane Burn (ID 10664)	Condition in 2014	Overall: Poor Biology (Fish): Poor Hydromorphology: Good Water Quality: Good	None
	Condition in 2022	Overall: Good Biology (Fish): High Hydromorphology: Good Water Quality: Good	
Capel Water / Garroch Water (ID 10663)	Condition in 2014	Overall: Poor Biology (Fish): Poor Hydromorphology: Good Water Quality: Good	None
	Condition in 2022	Overall: Good Biology (Fish): High Hydromorphology: Good Water Quality: Good	
Water of Ae (u/s Goukstane Burn; ID 10661)	Condition in 2014	Overall: Poor Biology (Fish): Poor Hydromorphology: Good Water Quality: High	None
	Condition in 2022	Overall: Good Biology (Fish): High Hydromorphology: Good Water Quality: High	

Waterbody Name and ID	Status		Pressures
Glenkiln Burn (ID 10662)	Condition in 2014	Overall: Poor Biology (Fish): Poor Hydromorphology: Good Water Quality: Good	None
	Condition in 2022	Overall: Good Biology (Fish): High Hydromorphology: Good Water Quality: Good	
Garrel Water (u/s Kirland Burn; ID 10659)	Condition in 2014	Overall: Poor Biology (Fish): Poor Hydromorphology: Moderate Water Quality: Data Unavailable (2015: Good)	The watercourse has been designated as heavily modified because of physical alteration that cannot be addressed without a significant impact on the drainage of surrounding agricultural land.
	Condition in 2022	Overall: Good ecological potential Biology (Fish): High Hydromorphology: Poor Water Quality: Good	

Groundwater

101. SEPA's Water Classification and Water Environment Hubs have also been consulted for groundwater quality information (SEPA, 2015b). The East Dumfriesshire groundwater body (ID 15690) is classified as having a 'Good' overall status.

Receiving Waterbodies

102. SEPA's Water Classification and Water Environment Hubs have also been consulted to determine the existing baseline water quality for receiving waterbodies (SEPA, 2015a; SEPA, 2015b). The majority of the watercourses on Site drain into the Water of Ae (d/s Goukstane Burn), with one watercourse draining in the Pennyland Burn. The details are summarised in **Table 10.10.**

Table 10.10 Receiving waterbody quality status – summary.

Waterbody Name and ID	Status		Pressures
Water of Ae (d/s Goukstane Burn; ID 10657)	Condition in 2014	Overall: Bad Biology (Fish): Poor Hydromorphology: Bad Water Quality: Good	The watercourse has been designated as heavily modified because of physical alteration that cannot be addressed without a significant impact on the drainage of surrounding agricultural land.
	Condition in 2022	Overall: Moderate ecological potential. Biology (Fish): High Hydromorphology: Bad Water Quality: Good	
Pennyland Burn (ID 10634)	Condition in 2014	Overall: Poor Biology (Fish): Poor Hydromorphology: Good Water Quality: Good	The watercourse has been designated as heavily modified because of physical alteration that cannot be addressed without

	Condition in 2022	Overall: Poor ecological potential Biology (Fish): Poor Hydromorphology: Poor Water Quality: Good	a significant impact on the drainage of surrounding agricultural land.

10.11.3. Water Resources

103. No wells, springs or boreholes are identified on OS 1:25,000 scale mapping within the Application Boundary. In the wider study area, within 2 km of the Application Boundary, two wells and five springs are identified.

104. Data obtained from Dumfries and Galloway Council regarding private water supplies (PWS) indicate that no PWS are present within the Application Boundary. There are no PWS identified within 2 km of the Application Boundary with a linkage to proposed works. Details of PWS identified are provided in **Table 10.11** and shown on **Figure 10.5**.

Table 10.11 Private water supplies within or near the Application Boundary

Properties Served	Source Location (BNG)	Distance to Application Boundary (km)	Linkage
Knockenshang	296826 593472	0.15	No linkage, upstream of infrastructure
Burrance of Courance	304460 590313	0.18	No linkage, supply source in separate sub-catchment
Burrancehill Cottage	304237 591240	0.48	No linkage, upstream of infrastructure
Burrancebrae Courance	304650 590688	0.54	No linkage, upstream of infrastructure
Tigh Na Coille Na Coille	304687 590671	0.56	No linkage, upstream of infrastructure
Sunnybrae Courance	304715 590665	0.58	No linkage, upstream of infrastructure
Shielburn Cottage	304727 590679	0.60	No linkage, upstream of infrastructure
Courancehill	304659 591330	0.80	No linkage, upstream of infrastructure
Kirkland Farmhouse	303426 589569	0.81	No linkage, removed from immediate catchment.
Craigshiels (PWS) (north)	298368 593098	0.95	No linkage, supply source in separate sub-catchment
Mitchellslacks Cottage	296593 596187	1.29	No linkage, upstream of infrastructure

Properties Served	Source Location (BNG)	Distance to Application Boundary (km)	Linkage
Mitchellslacks	296511 596271	1.40	No linkage, upstream of infrastructure
Mitchellslacks Townhead	296507 596281	1.41	No linkage, upstream of infrastructure
Craigshiels (PWS) (south)	298644 592585	1.43	No linkage, supply source in separate sub-catchment
Shaws Auldgirth	294904 587802	1.48	No linkage, supply in separate sub-catchment
Glenkiln Parkgate	301244 591227	1.60	No linkage, supply in separate sub-catchment
Gilchristland	293260 593808	1.81	No linkage, separate catchment.

105. In addition to the PWS, there are two locations immediately downstream of the proposed Development where SEPA has granted CAR licences with relevance to this assessment. These locations are discussed in Table 10.12 below.

Table 10.12 CAR licences granted by SEPA with linkages downstream of the Application Boundary

Authorisation No	Site	Location (BNG)	Authorisation Activity	Distance to Application Boundary (m)	Linkage
CAR/L/ 1003543	Ae Valley Fish Farm, Parkgate, Dumfries	299758 588533	Abstraction Fish Production; Abstraction Return; Fish Farm Freshwater Tank or Hatchery	2,900	Linked along the Water of Ae
CAR/L/ 1011303	Carse of Ae Trout Farm, Dumfries	302293 586308	Abstraction Fish Production; Abstraction Return	4,170	Linked along the Water of Ae

106. The Ae Valley Fish Farm is located approximately 6.60 km downstream of the nearest proposed works area within the watercourse catchment. The Carse of Ae Trout Farm is located approximately 10.80 km downstream of the nearest proposed works area within the watercourse catchment. These are assessed in the impact assessment below.

107. A review of The Scottish Government (2014) online maps shows there are no surface, river, or loch Drinking Water Protected Areas (DWPA) with hydrological connectivity to the Site.

108. The Site lies within the East Dumfriesshire groundwater DWPA in the north, and a small section within the Dalveen Pass groundwater DWPA (The Scottish Government, 2014) to the south. Downstream, to the south of the Application Boundary, the Water of Ae and Goukstane Burn catchments lie within the Annan Valley groundwater DWPA. The Tinwald groundwater DWPA – within 2 km of the Application Boundary – is not hydrologically connected.

10.11.4. Flood Risk

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

110. On Site there are several fluvial systems with a high likelihood of flooding, namely the Goukstane Burn, Capel Water, Bran Burn, Water of Ae, Glenkiln Burn and Garrel Water. Within the Application Boundary, the areas at risk of flooding are largely confined to the main river channels. Downstream, the Water of Ae has substantial areas indicated to have high and medium likelihood of flood risk, often adjacent to urban settlements.

111. On the Site there are several areas with a high, medium and low likelihood of pluvial flood risk. These areas are often small, isolated, and pose less risk than fluvial flooding. These areas are often shallow dips within the topography, with poor drainage, and often correlate with mapped peat. There are no major areas of pluvial flood risk downstream of the Site.

10.12. Designated Sites

112. NatureScot's SiteLink (2024) map indicates that there are no designated sites within the study area. One site, designated as a Site of Special Scientific Interest (SSSI), is located 2.50 km from the Application Boundary, downstream and along the Glenkiln Burn.

113. This site, Black Loch SSSI, is an example of a basin fen plant community undergoing a successional transition from a central fen to a drier moorland plant community. Positioned along the Glenkiln Burn and likely to be influenced by its hydrological regime, any upstream activities affecting the Glenkiln Burn's water flow could impact the SSSI by altering the successional change from a wetland to a terrestrial community. The SSSI is directly downstream and within 5 km of the Application Boundary and is therefore considered to have a linkage to the Site.

10.13. Identification and Evaluation of Impacts

10.13.1. Influence on Design

114. The importance of hydrology, hydrogeology, geology and soils 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;

- designated sites;
- private water supplies; and
- existing borrow pits.

10.14. Mitigation

115. While outlined and accounted for within the assessment below, this section provides a detailed summary of the mitigation that would be adopted for the proposed Development.

10.14.1. Mitigation by Design

116. 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 in order to minimise disruption to peatland ecosystems and hydrology, and to avoid the risk of induced peat instability.

117. Areas of new access track are anticipated to be constructed using established cut-and-fill methods. Any peat present along the route would be excavated and stored for use in reinstatement of elements of project infrastructure where appropriate.

10.14.2. Mitigation Commitments

Soil and Peat

118. Soil stripping would be undertaken by the Principal Contractor with care and 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 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 bunds for separate soil types in order to preserve the soil quality.

119. For work within areas of peat, acrotelmic peat (the uppermost 0.50 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.

120. 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.

121. Catotelmic peat would be extracted as close to intact as is feasible within the constraints of the area. Remoulding of the peat by the excavator would be kept to a minimum.

122. 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.

123. Excavated soil and peat would be used in 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.

124. 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.

125. Construction work would make use of the current best practice guidance relating to developments in peatland areas. A risk management system, such as a geotechnical risk register, would be compiled and maintained at all stages of the proposed Development and developed as part of the post-consent detailed design works, and would be updated as new information becomes available.

126. Micrositing would be used to avoid possible problem areas identified during ground investigation or other detailed design works. This would be assisted by additional verification of peat depths, to full depth, in any highlighted areas were construction work is required, particularly for areas where depth information is not currently available as a result of safety restrictions. Track drainage would be installed in accordance with published good practice documentation and would be minimised in terms of length and depth in order to minimise concentration of flows.

127. 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. Careful track design would ensure that the volume and storage timescale for excavated materials would be minimised as far as practicable during construction works.

128. Vegetation cover would be re-established as quickly as possible on track and infrastructure verges and cut slopes, by re-laying of excavated peat acrotelm and 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.

129. During construction, members of the construction staff would undertake advance inspections and carry out regular monitoring for signs of peat landslide indicators. A geotechnical specialist would be on call to provide advice should any peat landslide indicators be identified.

130. Construction staff would be made aware of peat slide indicators and emergency procedures. Emergency procedures would include measures to be taken in the event that an incipient peat slide is detected.

Surface Watercourses and Groundwater

131. Silt fencing or appropriate alternative sediment control protection would be installed on the downhill side of excavations to prevent inadvertent discharge of silty water into, or towards, any watercourse within the Application Boundary.

132. All engineering works adjacent to watercourses, including access tracks and watercourse crossing structures, would have appropriate sediment control measures established prior to any groundworks.

133. Vegetation would be retained along watercourse banks to act as additional protection to the watercourses.

134. Water quality monitoring would begin prior to any construction works, to allow pre-construction baseline quality to be determined. Details would be agreed with SEPA, but are anticipated to include at least the following:

- visual checks for entrained sediment; and
- in-situ measurements of pH, temperature and specific conductivity.

135. In situ measurement of turbidity and dissolved oxygen may be recommended by SEPA or the Environmental Clerk of Works (ECoW) for locations with particular sensitivity, such as upstream of PWS intakes, if relevant.

136. Pre-construction monitoring would be undertaken by the Principal Contractor on a monthly basis for a minimum period of three months prior to any work taking place.

137. During construction, the monitoring would be undertaken by the ECoW or suitably experienced alternative individual nominated by the ECoW. Any change from baseline conditions of pH and/or specific conductivity would potentially indicate an incident and additional investigation would be required in order to identify the origin of the change. Control Locations are intended to help differentiate between incidents arising from, and those unrelated to, the proposed Development.

138. Frequency of monitoring for the different locations are provided in **Table 10.13**. Proposed monitoring locations are shown in **Figure 10.6**.

139. No new borrow pits are planned for the proposed Development. Only existing FLS borrow pits would be used, specifically, Branrigg Quarry, Mitchelslacks and Quarriebraes. These are shown in **Figure 10.1a** and discussed in more detail in **Technical Appendix 10.3**. As these are already extant, there would be no requirement for groundwater monitoring at the locations as there are no plans to lower the borrow pit floors beyond their current level. Any water collecting within a borrow pit area would be managed in line with best practice, with discharge via a settlement pond to allow any entrained sediment to be removed prior to discharge. Any required discharge licence would be obtained prior to excavation commencing.

140. All works through and adjacent to wetland areas would be supervised by the ECoW.

141. Targeted monitoring would be put in place to provide a check on the identified wetland areas and to ensure that mitigation and protection measures are in place and effective.

142. All areas of sensitive habitat would be visited and assessed by the ECoW prior to any construction work. Assessment would include collection of representative photographs of the areas which are most likely to be affected by the works. Regular assessment visits would be undertaken throughout the construction period and for a minimum of 12 months after reinstatement to ensure that habitat protection is effective, and any restoration and recovery works become established.

143. Proposed habitat monitoring would begin at least 6 months prior to construction work, would continue throughout the construction period and for at least 12 months following reinstatement.

Table 10.13 Proposed Water Quality Monitoring Locations and Recommended Monitoring Frequency by Phase of Development (Figure 10.6)

ID	Location	Grid Reference	Monitoring Schedule
WQM 1	Garrel Water – east of Site entrance.	304336 590103	**Baseline**: Monthly min. 3 months. **Construction**: Twice daily during construction work on access tracks.
WQM 2	Dupple Burn – north of access track	300359 598156	**Baseline**: Monthly min. 3 months **Construction**: Twice daily during construction work on access tracks.
WQM 3	Dupple Burn south of access track	300305 598016	**Baseline**: Monthly min. 3 months **Construction**: Twice daily during construction work on access tracks.
WQM 4	Bran Burn – North of access track	298020 595724	**Baseline**: Monthly min. 3 months **Construction**: Twice daily during construction work on access tracks.
WQM 5	Bran Burn – south of access track	298084 595581	**Baseline**: Monthly min. 3 months **Construction**: Twice daily during construction work on access tracks.
WQM 6	Capel Water – north of access track	297015 595084	**Baseline**: Monthly min. 3 months **Construction**: Twice daily during construction work on access tracks.
WQM 7	Capel Water/Water of Ae	298758 593776	**Baseline**: Monthly min. 3 months **Construction**: Twice daily during construction work on access tracks.
WQM 8	Windyhill Burn – south and south east of infrastructure.	296362 592762	**Baseline**: Monthly min. 3 months **Construction**: Twice daily during construction works at Turbines 7, 9 and 10, construction compound and associated access tracks; otherwise monthly.
WQM 9	Goukstane burn – north of T13	295354 590961	**Baseline**: Monthly min. 3 months **Construction**: Twice daily during construction works at Turbines 2, 3, 6, 11, 12 and 13 and associated access tracks; otherwise monthly
WQM10	Goukstane Burn – south east of infrastructure.	297363 589700	**Baseline**: Monthly min. 3 months **Construction**: Twice daily during construction works at Turbines 2, 3, 6, 11, 12 and 13 and associated access tracks; otherwise monthly

Drainage Infrastructure

144. Trackside drainage would be no longer or deeper than necessary to provide the required track drainage.

145. The surface of access tracks would have a cross-fall in order to encourage runoff to drain into trackside ditches along the side of the track where necessary, and lateral and cross-drains would also be installed where required. Drainage outlets would be carefully located with erosion protection if required.

146. For tracks parallel or sub-parallel to contours, best practice recommendations are for a ditch along the uphill side only, with cross-drains installed at regular intervals below the track to minimise flow concentration.

147. Cross-drains under tracks would be installed at an appropriate frequency to mimic natural drainage patterns and to minimise concentration of flows.

148. Cross-drains would discharge onto vegetated ground where possible, to encourage spread of surface flow rather than focused flow and the consequent development of new drainage channels.

149. Tracks crossing contours may require ditches or swales on both sides.

150. All drainage infrastructure would be designed with a capacity suitable for a rainfall intensity of a 1-in-200 year storm event plus allowance for climate change.

151. Where track sections cross wetland or bog areas, cross-drainage would be provided within the track construction to ensure continuity of flow. This may take the form of a drainage layer within the track, suitably closely-spaced drainage pipes, or both as appropriate. These would be determined on a case-by-case basis to suit each individual area.

152. All required licences for watercourse crossings and construction works would be in place prior to construction commencing.

153. 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, hardstanding areas and borrow pits. Where possible, trackside drainage would be laid up to 100 m ahead of construction works for new track on a running basis.

154. Temporary water control measures would be implemented as necessary adjacent to larger areas of excavation. These would include borrow pit sites and may also include turbine base excavations and hardstanding areas. These measures would take the form of temporary settlement ponds and filter drains, and may include proprietary treatment measures such as Siltbusters if required by Site conditions. Details would be provided within the Pollution Prevention Plan(s) prepared for the Construction Runoff Permit. The local experience gained in constructing the existing Harestanes Windfarm will be drawn upon in developing the details of the plan.

155. All earthmoving activity would be restricted during periods of wet weather, particularly for work occurring within 20 m of a watercourse, to minimise mobilisation of sediment in heavy rainfall. The 'stop' conditions provided in **Table 10.14** are recommended to guide all earthmoving activity at all stages of the proposed Development.

156. Long-term drainage infrastructure would have a monitoring and maintenance programme established, to include regular visual inspection of drainage infrastructure to check for blockages, debris or damage that may impede flow. Remediation would be undertaken immediately by the Principal Contractor. Routine maintenance would be scheduled where possible for dry weather.

Excavations

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

158. Cables would be laid in disturbed trackside material. 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.

159. Vegetation cover would be re-established as quickly as possible on all areas of stripped ground, once activity involving these areas is complete. This would include track verges, screening bunds, cut slopes and much of the site and site access during reinstatement and restoration works. Where possible this would be achieved using excavated peat acrotelm and topsoil turf. Additional measures including hydroseeding and/or use of a biodegradable geotextile would be considered if insufficient peat and topsoil turf is available and for areas of particular sensitivity that require immediate protection.

160. Rock testing would be undertaken by the Principal Contractor on appropriate samples from the borrow pit areas to determine its suitability for unbound track and hardstanding construction. This would include testing to determine likely degradation patterns during the lifespan of the proposed Development. Should the tests identify problems with parts of the rock within the borrow pit footprints, care would be taken to ensure that unsuitable material is not used for construction, but would be retained for use in borrow pit restoration.

161. Any unused or remaining unsuitable aggregate material, plus any spare rock material arising from hardstanding or track reinstatement, may be used to reinstate borrow pits to a suitable profile, and capped with soil or turf to promote re-establishment of natural vegetation cover.

162. Only tracked or low ground pressure vehicles would be permitted access to unstripped ground.

Proposed Development Traffic

163. Tracks and hardstanding areas would be monitored on a regular basis by the Principal Contractor, or by the Site Operator during the operation of the proposed Development, particularly following periods of heavy or prolonged rainfall or after snow clearance. Any sections of track or hardstanding showing signs of excessive wear would be repaired as necessary with suitable rock from borrow pits or external sources.

164. The bridge structure at watercourse crossings would have appropriate splash control measures as part of their design, to prevent silty water splashing into the watercourses from vehicle movements. The splash controls would be monitored regularly by the Principal Contractor and Site Operator to ensure they remain effective and have not become damaged in any way.

165. Routine monitoring checks of project infrastructure, including track hardstanding surfaces and all drainage infrastructure, would be undertaken by the Principal Contract or Site Operator on a quarterly basis throughout project construction and operation. Monitoring

would involve visiting the infrastructure and undertaking a visual inspection to identify the following:

- areas where track surfaces or hardstanding areas were showing evidence of erosion or surface damage;
- any areas where surface water was ponding or collecting on tracks or hardstanding areas; and
- any areas where drainage infrastructure was damaged, blocked or inadequate.

166. Any areas of track or hardstanding surface showing signs of damage, erosion or excessive wear would be repaired as necessary. Drainage features would be repaired, reinstated or replaced as necessary to ensure continued efficient operation.

167. Site-specific mitigation, including track drainage segregation to avoid 'flushing' from excavated works, and micrositing to avoid areas of high sensitivity, would be identified and established where appropriate.

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

Pollution Prevention

169. Oil and fuel storage and handling on-site would be undertaken by the Principal Contractor in compliance with the Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended).

170. Risk assessments would be undertaken by the Principal Contractor and all Hazardous Substances and Non-Hazardous Pollutants that would be used and/or stored within the proposed Development would be identified. Hazardous substances likely to be within used on Site include oils, fuels, hydraulic fluids and anti-freeze. No non-hazardous pollutants have been identified as likely to be used.

171. All deliveries of oils and fuels would be supervised by the Principal Contractor.

172. All storage tanks would be located within impermeable, bunded containers where the bund is sufficient to contain 110% of the tank's capacity. For areas containing more than one tank, the bund would be sufficient to contain 110% of the largest tank's capacity or 25% of the total capacity, whichever is the greater.

173. Any valve, filter, sight gauge, vent pipe or other ancillary equipment would be located within the containment area.

174. Waste oil would not be stored within the Application Boundary, but would be removed to dedicated storage or disposal facilities.

175. Management procedures and physical measures would be put in place to deal with spillages, such as spill kits and booms.

176. Maintenance procedures and checks would ensure the minimisation of leakage of fuels or oils from plant.

177. Refuelling and servicing would be undertaken by the Principal Contractor in a designated area or location with adequate precautions in place, such as a dedicated impermeable surface with lipped edges to contain any contaminants.

178. Where vehicle maintenance is necessary in the field, owing to breakdown, additional precautions would be taken to contain contaminants, such as spill trays or absorbent mattresses.

179. The access track would be designed and constructed to promote good visibility where possible and two-way access where visibility is restricted, to minimise risk of vehicle collisions.

180. It is anticipated that the construction phase welfare facilities would use a suitably sized holding tank with wastewater removed from the proposed Development by tanker for disposal at a licensed disposal facility. Operational phase welfare facilities may use a similar procedure or would install a waste treatment package plant with associated discharge. All relevant water environment authorisations would be put in place should there be any requirement for these.

181. The Site Spillage and Emergency Procedures would be prominently displayed at the Site office and staff would be trained in their application. The Procedures document would incorporate guidance from the relevant SEPA Guidance Notes.

182. In the event of any spillage or discharge that has the potential to be harmful to or to 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 within the Site to mop up spillages. These would be in the form of oil booms and pads and, for smaller spillages, quantities of proprietary absorbent materials;
- Sand bags 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 Site.

183. SEPA would be informed of any discharge or spillage that may be harmful or polluting to the water environment. Written details of the incident and its resolution would be forwarded to SEPA no later than 14 days after the incident.

184. All works through and adjacent to wetland areas would be supervised by the ECoW.

10.15. Predicted Impacts

10.15.1. Proposed Development Characteristics

185. The construction phase would involve a number of different elements. **Chapter 3: Proposed Development** describes these elements in detail. The elements with particular reference to hydrology, hydrogeology, geology and soils are as follow:

- 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.

186. 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;
- long-term drainage around permanent infrastructure; and
- additional extraction and processing of rock for necessary maintenance.

10.15.2. Predicted Impacts During Construction

Physical Changes to Overland Drainage and Surface Water Flows

187. 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.

188. Sections of new track would require installation of trackside drainage and cross-drains to protect the tracks from water damage. Modifications to the existing track would require relocation of some trackside drainage, where track widening is required, and additional cross-drains may be necessary. 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.

189. 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, hardstanding areas and borrow pits. Where possible, trackside

drainage would be laid up to 100 m ahead of construction works for new track on a running basis.

190. Several watercourses would be crossed by the access track. Eighteen crossings of regulated watercourses have been identified and details are provided in **Technical Appendix 10.5.** Fifteen of these crossings would require upgrading of an existing structure, while three crossings would be new structures.

191. 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.

192. All necessary permissions for watercourse crossing works would be obtained prior to commencement of associated works.

193. The receptor, surface watercourses within the Application Boundary, 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'**.

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

Water Contamination from Particulates and Suspended Solids

195. 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, all hardstanding areas (including crane pads, substation, construction compounds and laydown areas) and borrow pits 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.

196. During excavation works for turbine foundations, cut sections of track, cut areas for hardstandings and borrow pits, 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 Application Boundary. Pre-construction installation of long-term drainage would provide an additional level of sediment control.

197. 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.

198. For areas of larger excavation, such as turbine bases and crane pads or borrow pit excavations, 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.

199. 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 (**Table 10.14**).

Table 10.14 Recommended 'Stop' Conditions for Earth Moving Activities (CH2M & Fairhurst, 2018)

'Stop' Rule	Location
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

200. 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 Dumfries Crichton Royal, to allow identification of these conditions being exceeded to allow appropriate action to be taken.

201. 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.

202. 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.

203. All necessary permissions relating to construction works, plus accompanying pollution prevention plans, would be obtained prior to any construction work commencing within the Application Boundary. 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.

204. A water quality monitoring 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 10.13.

205. The receptor, surface watercourses within the Application Boundary, 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'**.

206. 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

207. 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.

208. 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) and the Water Environment (Miscellaneous) (Scotland) Regulations 2017. The details would be contained in the CEMP and are summarised as follows:

- risk assessments would be undertaken by the Principal Contractor and all hazardous substances and non-hazardous pollutants that would be used and/or stored within the Site would be identified. Hazardous substances likely to be within the Site include oils, fuels, hydraulic fluids and anti-freeze. No non-hazardous pollutants have been identified as likely to be used within the Site. Herbicides would not be used;
- all deliveries of oils and fuels would be supervised by the site manager or nominated deputy;
- all storage tanks would be located within impermeable, bunded containers where the bund is sufficient to contain 110% of the tank's capacity. For areas containing more than one tank, the bund would be sufficient to contain 110% of the largest tank's capacity or 25% of the total capacity, whichever is the greater;
- any valve, filter, sight gauge, vent pipe or other ancillary equipment would be located within the containment area;
- waste oil would not be stored within the Site, but would be removed to dedicated storage or disposal facilities;
- management procedures and physical measures would be put in place to deal with spillages, such as spill kits and booms;
- maintenance procedures and checks would ensure the minimisation of leakage of fuels or oils from plant;
- refuelling and servicing would be undertaken by the Principal Contractor in a designated area or location with adequate precautions in place, such as a dedicated impermeable surface with lipped edges to contain any contaminants. This area would have a self-contained drainage system fully separated from the main drainage system within the compound;
- where vehicle maintenance is necessary in the field, owing to breakdown, additional precautions would be taken to contain contaminants, such as spill trays or absorbent mattresses; and

- the access track would be designed and constructed to promote good visibility where possible and two-way access where visibility is restricted, to minimise risk of vehicle collisions.

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

210. 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.

211. 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.

212. 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 on-site 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.

213. 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.

214. A water quality monitoring 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 10.13**.

215. The receptor, surface watercourses within the Application Boundary, 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'**.

216. 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

217. Vulnerable receptors that have the potential to be affected by the proposed Development works have been identified. These include potential GWDTE and PWS sources (**Table 10.11; Figure 10.5)**. None of the designated or protected sites have a linkage to the proposed Development so further assessment is not required. Each of these vulnerable receptors is considered in more detail below.

GWDTE

218. The potential GWDTE habitats are sparsely distributed around the proposed Development. Some areas of the identified habitat types are located within 100 m of excavations less than 1 m in depth and/or within 250 m of excavations deeper than 1 m.

219. The potential groundwater-dependent habitats have been assessed specifically within the context of the proposed Development, taking into account the local bedrock, superficial geology, hydrogeology, peat depth and distribution and on-Site observations. No groundwater discharges were identified at any location within the Application Boundary. Peat deposits would act to insulate the groundwater in the bedrock from the ground surface in areas where they are present, leading to reliance on rainwater and surface water flow. Although till and alluvium may contain groundwater in some quantities, their extent at the Site is relatively limited and till deposits are noted to include a high proportion of clay material which would prevent groundwater flow. The bedrock is a low productivity aquifer with very limited groundwater potential.

220. The potential GWDTE habitats identified were mostly associated with surface watercourse channels and pockets of deep peat. It is determined, as a result, that none of the five potential GWDTE habitats identified within the Application Boundary are truly groundwater dependent, but rely on a combination of surface water, shallow throughflow in surface vegetation and rainwater.

221. Details of the GWDTE assessment are provided in **Technical Appendix 10.4**.

222. The potential GWDTE within the proposed Development are considered to be of **High** sensitivity as a result of the high conservation importance of the habitats. 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**.

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

PWS and Water Abstractions

224. Seventeen PWS have been identified within 2 km of the of the Application Boundary. These are detailed in **Table 10.11**.

225. None of the PWS identified are at risk as there are no potential linkages between the water supply source locations and proposed works.

226. Two licensed abstractions are located downstream of the proposed Development. These are located at approximately 6.60 km and 10.80 km downstream of the nearest works within the watercourse catchment area. The distance between the proposed works and

the potential receptors means that there would be significant attenuation of any contaminating materials, such as sediment, that may enter the water. The sediment management, pollution prevention, spillage and emergency procedures set out above would help to control potential for contamination of water supplies for these abstractions.

227. Abstractions for fisheries are considered to be of '**Very High**' sensitivity. The magnitude of effect is considered to be '**Negligible**'. The likelihood of effect is considered to be '**Highly Unlikely**'.

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

Increased Flood Risk

229. The proposed Development is at risk from fluvial and pluvial flooding. On Site there are several fluvial systems with a high likelihood of flooding which converge into the Water of Ae. The Water of Ae includes various areas indicated to be at high and medium risk of flooding.

230. On Site there are several small areas with a high, medium and low risk of pluvial flooding. These areas are often shallow dips within the topography, with poor drainage, and often correlate with mapped peat. There are no major areas of pluvial flood risk downstream of the Site.

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

- use of bunds and 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 the natural terrain, making use of low points where runoff would naturally be focused;
- 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 have to 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.

232. With the appropriate mitigation measures in place, as described above, runoff during construction of the proposed Development would not be greater than natural pre-development runoff. Details are provided in **Technical Appendix 10.5**.

233. 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 any increased flood risk is considered to be '**Slight**'. The likelihood of effect is considered to be '**Highly Unlikely**'.

234. The effect of increase in flood risk resulting from the construction works is assessed as '**Minor**', temporary, adverse and '**Not Significant**'.

Modification to Groundwater Flow Paths

235. 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.

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

237. The bedrock within the Application Boundary 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 predominantly diamicton till where there is likely to be some presence of groundwater. Smaller areas of peat are present which would store some groundwater but would contribute very little to groundwater flow.

238. There are no proposals to excavate new borrow pits, but the proposed Development would make use of the following existing FLS borrow pits: Branrigg Quarry, Mitchelslacks and Quarriebraes (**Figure 10.1a**). None of these pits currently show any indications of groundwater seepage or inflow. Additional excavation would take the form of moving the faces further into the hill slopes, and there are no plans to lower the borrow pit floor levels as part of the works. Interactions with groundwater are therefore considered to be extremely unlikely. Further detail on borrow pits is provided in **Technical Appendix 10.3**.

239. 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 0.50 m change in elevation along the length of the trench to minimise in-trench groundwater flow.

240. 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 '**Unlikely**'.

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

Soil Erosion and Compaction

242. Proposed construction activity, particularly plant and vehicle movements, soil stripping and stockpiling, would affect the nature of the soils within the Application Boundary. 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.

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

244. 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.

245. Soil stripping would be undertaken by the Principal Contractor with care and 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 unstriped 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.

246. For work within areas of peat, acrotelmic peat (the uppermost 0.50 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.

247. 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 and use of floating road construction on areas of deeper peat.

248. 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.

249. 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.

250. 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.

251. The receptor, soils and peat within the Application Boundary, 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'**.

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

Peat Instability

253. Construction activity on peatland 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 to 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.

254. A detailed Peat Slide Risk Assessment (PSRA) has been undertaken for the proposed Development and is provided in **Technical Appendix 10.1**. The key effects assessment findings are provided below.

255. The PSRA found that the majority of the Site has a negligible or low risk of natural or induced peat landslide. Seventeen areas within the Application Boundary, and six areas within the wider study area, were identified as potentially having a moderate or high risk of peat instability. The areas were appraised in greater detail, taking into account location-specific details including information gathered from the reconnaissance survey. Mitigation measures have been recommended to control the peat landslide hazard. For these areas, the peat landslide hazard can be controlled by use of good construction practice and micrositing.

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

257. The 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.

258. With appropriate design constraints and mitigation measures in place, as described in **Technical Appendix 10.1**, the magnitude of effect is considered to be '**Slight'**. The likelihood of effect is considered to be '**Highly Unlikely'**.

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

10.15.3. Predicted Impacts During Operation

Physical Changes to Overland Drainage and Surface Water Flows

260. 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.

261. The receptor, surface watercourses within the Application Boundary, 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**'.

262. 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

263. 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 rock from either the borrow pits or external sources.

264. 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.

265. 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.

266. The receptor, surface watercourses within the Application Boundary, 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**'.

267. 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

268. 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 Application Boundary. The majority of potential pollutants would no longer be present within the proposed Development. 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.

269. 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.

270. It is anticipated that welfare facilities at the substation control building would use one of the following:

- A suitably sized holding tank with wastewater removed from the proposed Development 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; and
- Waterless composting toilet facilities with bottled water provided for washing and drinking.

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

272. The receptor, surface watercourses within the Application Boundary, 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**'.

273. 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

274. Only minor works would take place within the Application Boundary during the operational phase, to allow necessary maintenance activities to be undertaken.

275. Additional works with potential to affect water abstractions via linkages to the proposed Development would be of very minor scale. Should concerns arise during the construction phase, additional monitoring during any required operational phase maintenance works would be put in place to provide a safety check for the PWS intakes.

276. Additional works affecting GWDTE would be negligible.

277. The potential GWDTE identified are 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**'.

278. The water abstraction sources are considered to be of '**Very High**' sensitivity. The magnitude of effect is considered to be '**Negligible**'. The likelihood of effect is considered to be '**Highly Unlikely**'.

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

Increased Flood Risk

280. 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.

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

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

Modification to Groundwater Flow Paths

283. There is a minor ongoing requirement for additional rock extraction at the borrow pit sites during operation, for track and hardstanding maintenance. These operations would be limited in nature.

284. 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 assessed as '**Highly Unlikely**'.

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

Soil Erosion and Compaction

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

287. 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.

288. The receptor, soils and peat within the Application Boundary, 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 '**Unlikely**'.

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

Peat Instability

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

10.16. Summary of Effects

291. This assessment is based on a site-specific risk assessment method following recommended environmental impact assessment techniques. Potential effects, both positive and negative, long-term or temporary, adverse or beneficial, to the hydrological, hydrogeological, geological and soils regime have been considered.

292. **Table 10.15** summarises the assessment of effects during the construction and operational phases, taking account of the embedded and additional mitigation proposed.

Table 10.15 Summary of Residual Effects During Construction and Operation

Effect	Phase	Receptor	Receptor Sensitivity	Magnitude of Effect	Likelihood of Effect	Assessment Consequence	Effect Significance
Physical changes to overland drainage and surface water flows	Construction	Surface watercourses within the Application Boundary	High	Slight	Likely	Minor, long-term and adverse	Not Significant
	Operation			Negligible	Highly Unlikely	Negligible	Not Significant
Water contamination from particulates and suspended solids	Construction	Surface watercourses within the Application Boundary	High	Slight	Likely	Minor, temporary and adverse	Not Significant
	Operation			Slight	Unlikely	Minor, temporary and adverse	Not Significant
Water contamination from fuels, oils and foul drainage	Construction	Surface watercourses within the Application Boundary	High	Moderate	Highly Unlikely	Minor, temporary and adverse	Not Significant
	Operation			Negligible	Highly Unlikely	Negligible	Not Significant
Changes in or contamination of water supply to vulnerable receptors	Construction	GWDTE	High	Slight	Likely	Minor, temporary and adverse	Not Significant
	Construction	Water abstractions	Very High	Negligible	Highly Unlikely	Negligible	Not Significant
	Operation	GWDTE	High	Negligible	Highly Unlikely	Negligible	Not Significant
	Operation	Water abstractions	Very High	Negligible	Highly Unlikely	Negligible	Not Significant
Increased flood risk	Construction	Infrastructure downstream of the	Very High	Slight	Highly Unlikely	Minor, temporary and adverse	Not Significant

Effect	Phase	Receptor	Receptor Sensitivity	Magnitude of Effect	Likelihood of Effect	Assessment Consequence	Effect Significance
	Operation	proposed Development		Negligible	Highly Unlikely	Negligible	Not Significant
Modification to groundwater flow paths	Construction	Groundwater	Moderate	Negligible	Unlikely	Negligible	Not Significant
	Operation			Negligible	Highly Unlikely	Negligible	Not Significant
Soil erosion and compaction	Construction	Soils and peat within the Application Boundary	High	Slight	Likely	Minor, temporary and adverse	Not Significant
	Operation			Slight	Unlikely	Minor, temporary and adverse	Not Significant
Peat Instability	Construction	Peatland habitat, water environment and proposed Development infrastructure	High	Slight	Highly Unlikely	Minor, long-term and adverse	Not Significant
		Construction Personnel	Very High	Slight	Highly Unlikely	Minor, long-term and adverse	Not Significant
	Operation	Peatland habitat, water environment and proposed Development infrastructure	No change				Not Significant
		Construction Personnel	No change				Not Significant

10.17. Decommissioning

293. Potential effects of decommissioning the proposed Development are anticipated to be similar to those encountered in the construction phase, although generally with lower magnitude, as the level of activity with the Application Boundary would be lower. Therefore, it is considered that the construction effects assessed above represent a worst-case scenario.

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

10.18. Indirect and Secondary

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

10.19. Cumulative Effects

296. The potential for the proposed Development to contribute to cumulative effects in relation to other developments within 5 km has been assessed. Three developments have been identified including the operational: Dalswinton Wind Farm, Minnygap Wind Farm and Harestanes Windfarm. Furthermore, Harestanes South Windfarm Extension is currently in the planning stage.

Hydrogeology

297. Effects on hydrogeology are confined to shallow groundwater found within the same hydrological catchments as the proposed Development.

298. The proposed Development is located within the same hydrological catchments as the operational Harestanes, Minnygap and Dalswinton windfarms. Cumulative effects from operational windfarms are unlikely to affect the hydrogeological regime as these are more likely to occur during the construction phase of development.

299. As the bedrock is described as a low productivity aquifer, and interactions with groundwater during aggregate extraction as part of FLS' site activities have not been identified, there are not anticipated to be any cumulative effects on hydrogeology.

Hydrology and Designated Areas

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

301. The operational Harestanes Windfarm and Minnygap Wind Farm are located within the Water of Ae catchment and the operational Dalswinton Wind Farm is located within the Pennyland Burn Catchment. Cumulative effects from operational Windfarms are unlikely to affect the hydrological regime as these mainly occur during the construction phase of development when activity on Site is highest. Water quality monitoring at the proposed Development and at the operational Windfarms will aid in determining sources of pollution.

302. There are no designated areas which could conceivably be connected to the proposed Development and to the other Windfarms in the area, therefore no cumulative effects are predicted.

Geology and Soils

303. Effects relating to geology and soils are very localised. Effects do not transmit over any noticeable distance. Although there are operational Wind Farms within 1 km of the Site, cumulative effects on geology and soils are unlikely.

Summary

304. Although there are potential linkages between operational Windfarms in the area and the proposed Development, cumulative effects on Hydrology, Hydrogeology, Geology and Soils are highly unlikely. Potential effects from Windfarms in the operational phase are minimal compared to those in construction phase. Water quality monitoring at the proposed Development will determine any pollution sources arising during the construction phase.

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