Chapter 10

Hydrology, Hydrogeology, Geology and Soils

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10.1 Executive summary

1. The proposed Development has been assessed in relation to the potential impact on hydrology, hydrogeology, geology and soils during the construction and operational phases.

2. Information on the study area was compiled using baseline information from a desk study and verified by an extensive programme of field work. The assessment was undertaken considering the sensitivity of receptors identified during the baseline study and considering any mitigation measures incorporated as part of the Site design.

3. A detailed programme of peat depth probing has been completed and the results have been used to inform the Site design. A Peat Landslide and Hazard Risk Assessment (PLHRA) and Peat Management Plan (PMP) has been prepared which show that areas of deep peat can be avoided, and peat resources safeguarded.

4. The Site lies outside of any floodplains and no drinking water protected areas have been identified within 1 km of the Site. No designated sites, that are dependent on water have been recorded within 1 km of or in hydraulic continuity with the Site. Site investigation has been undertaken to confirm the location of private water supply sources within 1 km of the Site and an assessment of the potential for the proposed Development to impair these has been completed. An assessment of the potential effects on Groundwater Dependent Terrestrial Ecosystems has also been completed. A schedule of proposed watercourse crossings is given.

5. Mitigation measures have been identified, either through the Site design or in accordance with good practice guidance.

6. Sustainable Drainage Systems (SuDS) have been proposed to ensure that the rate of runoff from the Site during construction and post development is no greater than that prior to development so as not to increase flood risk. The proposed SuDS measures allow the quality of water to be managed at source prior to any discharge being made. Further, the proposed habitat management proposals set out measures that include disruption to drainage pathways which would reduce both the rate and volume of peak water flows, providing a flood risk benefit when compared to existing conditions.

7. It has been shown, as a consequence of the Site design and embedded mitigation, that the proposed Development would not result in any significant impacts on hydrology, hydrogeology, geology and soils, including private water supplies and GWDTE habitat. To confirm this, a programme of baseline and construction water monitoring has been proposed.

10.2 Introduction

8. This Chapter assesses the impacts of the proposed Development on soils, geology and the water environment (hydrology and hydrogeology). The assessment of impacts has been made on the basis of the proposed turbine and infrastructure layout as fully described in **Chapter 3: Description of the proposed Development.**

9. The Chapter details the assessment undertaken to determine the potential effects of construction and operation of the proposed Development on the current baseline environment of soils, geology and hydrological and hydrogeological regimes (forming the water environment). It outlines the embedded good practice methods which have been incorporated into the design and would be used during the construction and operation of the proposed Development to prevent or reduce identified effects and risks.

10. Further mitigation methods to address any potential effects are proposed, where appropriate, and residual effects assessed.

11. In addition, the assessment uses information and findings presented in **Chapter 8: Ecology** to inform the assessment of potential effects on possible areas of Groundwater Dependent Terrestrial Ecosystems (GWDTE) which is presented in **Technical Appendix 10.3: GWDTE**.

12. This Chapter presents summary information from the following Technical Appendices:

- Technical Appendix 10.1: Peat Landslide Hazard and Risk Assessment (PLHRA);
- Technical Appendix 10.2: Peat Management Plan (PMP);
- Technical Appendix 10.3: Groundwater Dependent Terrestrial Ecosystems (GWDTE) Assessment;
- Technical Appendix 10.4: Private Water Supply Risk Assessment;
- Technical Appendix 10.5: Schedule of Watercourse Crossings; and
- Technical Appendix 10.6: Borrow Pit Assessment.

13. This Chapter has been prepared by SLR Consulting Ltd, who has also undertaken the assessment.

10.3 Approach to assessment and methods

14. The potential effects from the proposed Development on soils, geology and the water environment have been assessed by completing an initial desk study and a detailed programme of site investigation followed by an impact assessment.

10.3.1 Study area

15. The study area includes all of the proposed Site infrastructure. In addition, details of local water use and quality within a buffer of at least 1 km from the proposed new and upgraded infrastructure have been considered. The study area encompasses the Site as well as bodies of water and their catchments which could potentially be affected by the construction and operation of the proposed Development.

16. The study area for potential cumulative effects uses the catchments within the study area, with a maximum downstream distance of 5 km from the Site.

10.3.2 Legislation, policy and guidance

17. The assessment has been undertaken with regard to environmental legislation, planning policy and general guidance. Planning policies of relevance to this assessment are outlined in **Chapter 4: Climate Change, Renewable Energy and Planning Policy.**

10.3.3 Temporal scope

18. Due to the consent in perpetuity, which is proposed, the temporal scope requires consideration of the potential for climate change to impact on future baseline conditions. Climate change studies predict a decrease in summer precipitation and an increase in winter precipitation alongside slightly higher average temperatures. This suggests that there may be greater pressures on water supplies and water levels in summer months in the future. In addition, summer storms are predicted to be of greater intensity. Therefore, peak fluvial flows associated with extreme storm events may also increase in volume and velocity.

10.3.4 Effects assessed in full

19. The following potential impacts have been assessed in full in relation to the proposed Development:

- pollution risk, including potential impact on surface water and groundwater quality and public and private water supplies during forest felling, and construction and operation;
- erosion and sedimentation which could give rise to potential impact on surface water and groundwater quality, and private water supplies during forest felling, construction and operation;
- fluvial flood risk resulting from changes to runoff volumes and rates and modifications to natural and man-made drainage patterns during operation;

- potential impact upon the linkage between groundwater and surface water during construction and operation;
- potential impact on areas of peat during construction and operation;
- potential impact on areas of GWDTE during construction and operation; and
- potential cumulative impact during construction and operation.

10.3.5 Effects scoped out

20. On the basis of the desk based and survey work undertaken, policy, guidance and standards, the professional judgement of the EIA team, feedback from consultees and experience from other relevant projects, the following topic areas have been 'scoped out':

- potential effects on geology, including sites designated for their geological interest within 1 km of the Site, during both construction and operation as there are no protected geological features within the Site. Furthermore, the nature of the activities during construction and operation of the proposed Development would be unlikely to alter the geology of the Site. Potential cumulative effects on geology have also been scoped out on this basis. For context, information on the geology of the Site is presented in the 'Baseline conditions' and **Technical Appendix: 10.1 Peat Landslide Hazard and Risk Assessment (PLHRA**) and **Technical Appendix: 10.2 Peat Management Plan (PMP);**
- increased flood risk caused by blockages to flow in watercourses during operation and maintenance of the proposed Development. These crossings would be subject to maintenance requirements under the Controlled Activities Regulations (CAR), flood risk onsite is negligible and the Development design ensures no critical infrastructure is located near watercourses;
- changes to public/private water supply yield as a consequence of changes to runoff rates and volumes during operation and maintenance of the proposed Development as no significant alterations to runoff rates/infiltration or drawdown of the water table are anticipated during or as a consequence of construction;
- potential cumulative effects in relation to public/private water supply yields during the operational phase as water requirements are low during operation and any change would not be discernible at the catchment level; and
- potential effects associated with forest felling on surface water quality and runoff as all forest felling would be undertaken in accordance with good practice guidelines published by Scottish Forestry (formerly Forestry Commission Scotland). Details of forestry felling for the construction of the proposed Development are given in **Technical Appendix 3.2: Forestry**. The turbines located in areas which will require felling would be 'key holed' into the existing forest crop where possible. Only trees required for the infrastructure and an immediate buffer would be felled and cleared ahead of the current forest plan. The Forestry Commission (Forestry Commission, 2014) report that research shows that the effects on harvesting on surface water acidity are difficult to discern when 20% or less of a catchment is felled within any three year and ten year period. Consequently, where the rate of felling exceeds this figure it may be necessary to carry out a site impact assessment to determine if the watercourse is at risk; this includes felling for habitat restoration or windfarm development. The proportion of proposed felling is much less than 20% and thus it can be expected that acidification of the watercourses would not occur as a consequence of felling to establish the wind farm. All the felling required to establish the wind farm would occur in Phase 2 of the proposed felling plan and it is confirmed the felling would account for the following areas and percentages in the surface water catchments that drain the site:

Table 10.1: Water catchment felling

Water Catchment	Water Catchment Area (km^2)	Area of Felling (Phase 2) (km^2)	Percentage of Water Catchment Area (%)
Euchan Water	36.8	1.820	4.95
Kellow Water	31.1	0.035	0.11
Scaur Water	84.4	1.104	1.31
Shinnel Water	56.8	1.159	2.04
Water of Ken	88.2	1.989	2.25

10.3.6 Baseline determination

Data Sources

21. An initial desk study has been undertaken to determine and confirm the baseline characteristics by reviewing available information on soils, geology, hydrology and hydrogeology such as: groundwater resources, licensed and unlicensed groundwater and surface water abstractions, public and private water supplies, surface water flows, flooding, rainfall data,

water quality and soil data. This has also included a review of published soils, peatland and geological maps, OS maps, aerial photographs and Site-specific data such as site investigation data, geological and hydrogeological reports, digital terrain models (slope plans) and geological literature.

22. The following sources of information, including good practice guidance and legislation have been consulted in order to characterise and assess the soils, geology, hydrogeology and hydrology of the area within and surrounding the Site:

- Ordnance Survey (OS) 1:50,000 and 1:10,000 scale mapping data;
- Flood Estimation Handbook (FEH) web service (available online at https://fehweb.ceh.ac.uk/);
- British Geological Survey (BGS) 1:50,000 scale data - superficial deposits, bedrock, linear features, mass movement and artificial ground (available online at http://mapapps2.bgs.ac.uk/geoindex/home.html);
- BGS Hydrogeological Map of UK, 2019;
- James Hutton Institute The National soil map of Scotland (1:250,000) (available online at http://soils.environment.gov.scot/maps/);
- BGS Hydrogeological Maps of Scotland (groundwater vulnerability and aquifer productivity) 1:100,000 scale;
- The Scottish Environment Protection Agency (SEPA) flood maps (available online at https://www.sepa.org.uk/environment/water/flooding/flood-maps/ and http://map.sepa.org.uk/reservoirsfloodmap/Map.htm);
- SEPA Water Environment Hub for water body classifications (available online at https://www.sepa.org.uk/data-visualisation/water-classification-hub/);
- Scottish Natural Heritage (SNH) Sitelink Online Information Service (available online at https://gateway.snh.gov.uk/sitelink/searchmap.jsp);
- Natural England Magic Map (available online at http://magic.defra.gov.uk/MagicMap.aspx);
- data requests with SEPA regarding details of registered/licensed abstractions and discharges (November 2019); and
- data requests with Dumfries and Galloway Council (DGC) and East Ayrshire Council (EAC) environmental health departments regarding details of historic flooding records and private water abstractions (November 2019).

Field survey

23. The project hydrologists, geologists and ecologists have worked closely on this assessment to ensure that appropriate information is gathered to allow a comprehensive impact assessment to be completed.

24. Detailed site visits and walkover surveys have been undertaken by SLR Consulting Ltd on the following dates:

- March 2013 Phase I peat depth probing and peat characterisation;
- February 2020 Phase I peat depth probing and peat characterisation;
- March 2020 Phase II peat depth probing and peat characterisation;
- May 2020 Phase II peat depth probing and peat characterisation, private water supply and watercourse crossing surveys;
- June 2020 borrow pit assessment and Phase II peat depth probing and characterisation;
- July 2020 borrow pit assessment;
- October 2020 additional watercourse crossing and NVC surveys.

25. The scope of the private water supply survey was also informed by data received from DGC and EAC and a review of the EIAs of neighbouring developments along with OS mapping and aerial photography as detailed within **Technical Appendix 10.4: Private Water Supply Risk Assessment**. To complete the Private Water Supply Risk Assessment properties which may have or have a recorded private water supply downstream of the site were visited and where possible the source of the water supply was verified and confirmed. Where this was not possible a questionnaire was left with the occupiers of the property and they were asked to provide details of their water supply, or details of private water supply sources were obtained from Forestry and Land Scotland (FLS). Their responses have been incorporated in the assessment. This has ensured a thorough assessment of Private Water Supplies has been completed.

26. The field work has been undertaken in order to:

- verify the information collected during the desk and baseline study;
- undertake a visual assessment of the main surface waters and identify and verify private water supplies;
- identify drainage patterns, areas vulnerable to erosion or sediment deposition, and any pollution risks;

- visit any identified potential GWTDE (in consultation with the project ecologist);
- visit any potential watercourse crossings and prepare a schedule of potential watercourse crossings;
- inspect rock exposures and establish by probing, an estimate of overburden thicknesses, peat depth and stability;
- confirm underlying substrate, based on the type of refusal of a peat probe and by coring; and
- allow appreciation of the Site, determine gradients, potential borrow pit locations, access routes, ground conditions, etc., and to assess the relative location of all the components of the proposed Development.

27. The desk study and field surveys have been used to identify potential development constraints and have been used as part of the iterative design process. The peat probing completed as part of the initial field surveys has been developed further as part of the assessment of effects. This assessment is reported in **Technical Appendix: 10.1: PLHRA** with a summary provided in this Chapter. In conjunction with the project ecologists and hydrologists, an assessment of the condition of the peat has been undertaken. This has included details related to the characteristics of the soils, classification of vegetation cover, assessment of current land use impacts, assessment of drainage paths and channels, evidence of peat erosion and coring to further characterise the peat. This is reported in **Technical Appendix: 10.2: PMP**.

28. The data obtained as part of the desk study and collected as part of the field work has been processed and interpreted to complete the impact assessment and recommend mitigation measures where appropriate.

10.3.7 Consultation

29. The scope of the study has been determined through a combination of professional judgement, reference to relevant guidance documents and consultation with stakeholders.

30. Consultation for the proposed Development was undertaken with statutory and non-statutory bodies during 2019 and 2020 as set out in **Chapter 6: Scoping and Consultation**. The outcome of the relevant consultations with regard to soils, geology and the water environment is summarised in **Table 10.2.**

Table 10.2: Consultation responses

Consultee	Summary of Consultation	Comment/Action
SEPA	Letter dated 31 March 2020 The following information must be submitted in support of the application: • Map and assessment of all engineering activities in or impacting on the water environment including proposed buffers, details of any flood risk assessment and details of any related CAR applications. • Map and assessment of impacts upon Groundwater Dependent Terrestrial Ecosystems (GWDTEs) and buffers. • Map and assessment of impacts upon groundwater abstractions and buffers. • Peat depth survey and table detailing re-use proposals. • Map and table detailing forest removal. • Map and site layout of borrow pits. • Schedule of mitigation including pollution prevention measures. • Borrow Pit Site Management Plan of pollution prevention measures. • Decommissioning statement	 See Section 10.4 Baseline Assessment and **Technical Appendix (TA) 10.5**. See **TA10.3**. See **Figure 10.1** and **TA 10.4**. See **TA10.1** and **TA10.2**. See **TA3.2:** Forestry See **TA10.6.** See Section 10.5, Assessment of Effects. See **TA10.6**. See **Chapter 3: Description of the proposed Development.**
SEPA	Letter dated 7 September 2020 Confirmed the information detailed in their letter dated 31 March 2020 should be submitted in support of the application. In addition, the following informative were given: • Confirmed that if watercourse crossings were designed to accommodate the 1 in 200 year event and other	

Consultee	Summary of Consultation	Comment/Action
	infrastructure is located away from watercourses a detailed flood risk assessment is not required. • GWDTE and sensitive habitats should be avoided. The need for the track south of T5 and watercourse crossing 17 should be assessed. • The proximity of borrow pits 1, 3 and 5 to watercourses and required mitigation measures should be detailed. • A buffer should be maintained around any proposed borrow pits. • Watercourse crossings may require CAR authorisation and the site will require a Construction Site Licence and Associated Pollution Prevention Plan.	1 in 200 year design standard proposed, wee Section 10.5, Assessment of Effects. See **TA10.3** and **Chapter 3: Description of the proposed Development.** A buffer of at least 50 m to watercourses has been incorporated in the wind farm design. Noted.
Galloway Fisheries Trust (on behalf of Dee District Salmon Fishery Board)	<u>Letter dated 5 March 2020</u> The following issues should be addressed in the EIA: • the number and location of new and upgraded watercourse crossings; • peat depth information in relation to water quality, peat slides or ground slips; • borrow pit locations; • changes to instream hydrological conditions and flush zones and any adverse changes to instream morphology; • exacerbated erosion and/or elevated levels of suspended silt to watercourses during construction activities; • water quality monitoring information; • pollution to watercourses in the form of both silt and chemical pollution; and • mitigation measures to protect watercourses, fish and their habitats.	See **TA10.5**. See **TA10.1** and **TA10.2**. See **Figure 10.1** and **TA10.6**. See Section 10.5, Assessment of Effects. See Section 10.5, Assessment of Effects. See Section 10.4 Baseline Assessment. See Section 10.5, Assessment of Effects. See Section 10.5, Assessment of Effects and **Chapter 8: Ecology.**
Tynron Community	The following issues should be addressed within the EIA: • the cumulative effects of drainage and soil erosion in the area, particularly with respect to water quality and flood risks; and • details on how the impacts of peat destruction will be assessed, mitigated, avoided and quantified.	See Section 10.5, Assessment of Effects See **TA10.1** and **TA10.2**.
Marine Scotland	<u>Email dated 5 March 2020</u> Recommended that their generic scoping guidelines were reviewed (www2.gov.scot/Topics/marine/Salmon-Trout-Coarse/Freshwater/Research/onshoreren), which confirms that the information to be included in the ES is as follows: 1. A description of which fish species are present and their abundance in the waterbodies and watercourses which could be impacted by the development, and whether they are important for conservation or supporting fisheries 2. A description of the water quality of waterbodies which could be impacted and how the development may impact on these pre-construction conditions 3. A description of what activities during construction, post-construction and decommissioning have the potential to impact	**See Chapter 8: Ecology**. See Section 10.4 Baseline Assessment. See Section 10.5 Assessment of Effects.

Consultee	Summary of Consultation	Comment/Action
	on fish or associated fisheries and what mitigation measures will be put in place to avoid and/or reduce this impact 4. Consideration of potential cumulative effects with adjacent and other developments 5. Proposals for monitoring during construction, post-construction and decommissioning	See Section 10.5 Assessment of Effects. See Section 10.5 Assessment of Effects.
Nith District Salmon Fishery Board	Email dated 18 February 2020 Confirmed they are comfortable with the approach taken in environmental terms at the stage that this project is currently at. As and when the project progresses through planning and evolves further, it will be appropriate to enter into further discussions and conduct more in depth surveys to verify the initial findings of the walkover surveys. Email dated 17 July 2020 Confirmed existing watercourse crossings at Site which pose potential barriers to fish migration.	**See Chapter 8: Ecology**. **See Chapter 8: Ecology**.

10.3.8 Good practice measures and mitigation

31. Any potential effects of the proposed Development on soils, geology and the water environment identified by the assessment have been addressed and mitigated by the conceptual Site design and the application of good practice guidance implemented as standard during construction and operation to prevent, reduce or offset effects where possible. As such a number of measures would form an integral part of the design/construction process (embedded mitigation) and these have been taken into account prior to assessing the likely effects of the proposed Development. Where appropriate, furthermore tailored mitigation measures have been identified prior to determining the likely significance of residual effects.

32. Good practice measures would be applied in relation to pollution risk, sediment management, peat management and management of surface runoff rates and volumes. This would form part of the Construction Environment Management Plan (CEMP) to be implemented for the proposed Development and would be prepared prior to construction, an outline of which is provided in **Technical Appendix 3.1: Outline Construction Environmental Management Plan**.

33. As the CEMP develops it would include details and responsibilities for environmental management onsite for Site environmental aspects and would outline the necessary surface water management, oil and chemical delivery and storage requirements, waste management, traffic and transport management and would specify monitoring requirements for waste water, water supply including an Environmental Incident Response Plan (EIRP) and all appropriate method statements and risk assessments for the construction of the proposed Development.

10.3.9 Approach to assessment of effects

Significance of effect

34. The significance of potential effects of the proposed Development has been assessed by considering two factors: the sensitivity of the receiving environment and the potential magnitude of impact, should that effect occur. The assessment methodology has also been informed by the assessor's experience of carrying out such assessments for renewable energy developments, knowledge of soils, geology and the water environment characteristics in Scotland and cognisance of good practice.

35. This approach provides a mechanism for identifying the areas where mitigation measures are required and for identifying mitigation measures appropriate to the significance of potential effects presented by the proposed Development.

36. Criteria for determining the significance of effects are provided in **Table 10.3**, **Table 10.4** and **Table 10.5**.

Sensitivity

37. The sensitivity of the receiving environment (i.e. the baseline quality of the receiving environment) is defined as its ability to absorb an effect without a detectable change and can be considered through a combination of professional judgement and a

set of pre-defined criteria which is set out in **Table 10.3.** Receptors in the receiving environment only need to meet one of the defined criteria to be categorised at the associated level of sensitivity.

Table 10.3: Criteria of assessing sensitivity of receptor

Sensitivity	Definition
High	• SEPA Water Framework Directive Water Body Classification: High-Good or is close to the boundary of a classification: Moderate to Good or Good to High; • receptor is of high ecological importance or National or International value (e.g. Site of Special Scientific Interest (SSSI), Special Area of Conservation (SAC), habitat for protected species) which may be dependent upon the hydrology of the Development Area; • receptor is at high risk from flooding above 0.5% Annual Exceedance Probability (AEP) and/or water body acts as an active floodplain or flood defence; • receptor is used for public and/or private water supply (including Drinking Water Protected Areas; • groundwater vulnerability is classified as High; • if a Groundwater Dependent Terrestrial Ecosystem is present and identified as being of high sensitivity; and • soil type and associated land use is highly sensitive (e.g. unmodified blanket bog peatland).
Moderate	• SEPA Water Framework Directive Water Body Classification: Moderate or is close to the boundary of a classification: Low to Moderate; • receptor is at moderate risk from flooding (0.1% AEP to 0.5% AEP) but does not act as an active floodplain or flood defence; • moderate classification of groundwater aquifer vulnerability; and • soil type and associated land use moderately sensitive (e.g. arable, commercial forestry).
Low	• SEPA Water Framework Directive Water Body Classification: Poor or Bad; • receptor is at low risk from flooding (less than 0.1% AEP); • receptor not used for water supplies (public or private); and • soil type and associated land use not sensitive to change in hydrological regime and associated land use (e.g. intensive grazing of sheep and cattle)
Not Sensitive	• receptor would not be affected by the proposed development e.g. lies within a different and unconnected hydrological / hydrogeological catchments.

Magnitude

38. The potential magnitude of impact would depend upon whether the potential effect would cause a fundamental, material or detectable change. In addition, the timing, scale, size and duration of the potential effect resulting from the proposed Development are also determining factors. The criteria that have been used to assess the magnitude of impact are defined in **Table 10.4.**

Table 10.4: Criteria of assessing magnitude of impact

Magnitude	Criteria	Definition
Major	Result in loss of attribute	Fundamental (long term or permanent) changes to the baseline soils, geology, hydrology, hydrogeology and water quality such as: • permanent degradation and total loss of the soils habitat; • loss of important geological structure/features; • wholesale changes to watercourse channel, route, hydrology or hydrodynamics; • changes to the site resulting in an increase in runoff with flood potential and also significant changes to erosion and sedimentation patterns; • major changes to the water chemistry and • major changes to groundwater levels, flow regime and risk of groundwater flooding.

Magnitude	Criteria	Definition
Medium	Results in impact on integrity of attribute or loss of part of attribute	Material but non-fundamental and short to medium term changes to baseline soils, geology, hydrology, hydrogeology and water quality, such as: • loss of extensive areas of soils habitat, damage to important geological structures/features; • some fundamental changes to watercourses, hydrology or hydrodynamics; • changes to site resulting in an increase in runoff within system capacity; • moderate changes to erosion and sedimentation patterns; • moderate changes to the water chemistry of surface runoff and groundwater; and • moderate changes to groundwater levels, flow regime and risk of groundwater flooding.
Low	Results in minor impact on attribute	Detectable but non-material and transitory changes to the baseline soils, geology, hydrology, hydrogeology and water quality, such as: • minor or slight loss of soils or slight damage to geological structures / feature; • minor or slight changes to the watercourse, hydrology or hydrodynamics; • changes to site resulting in slight increase in runoff well within the drainage system capacity; • minor changes to erosion and sedimentation patterns; • minor changes to the water chemistry of surface runoff and groundwater; and • minor changes to groundwater levels, flow regime and risk of groundwater flooding.
Negligible	Results in an impact on attribute but of insufficient magnitude to affect the use/integrity	No perceptible changes to the baseline soils, geology, hydrology, hydrogeology and water quality such as: • no impact or alteration to existing important geological environs; • no alteration or very minor changes with no impact to watercourses, hydrology, hydrodynamics, erosion and sedimentation patterns; • no pollution or change in water chemistry to either groundwater or surface water; and • no alteration to groundwater recharge or flow mechanisms.

Significance of effect

39. The sensitivity of the receiving environment together with the magnitude of the impact determines the significance of the effect, which can be categorised into level of significance as identified in **Table 10.5**. This also takes into account good practice measures implemented and embedded as part of the design and construction of the proposed Development and use of professional judgement where appropriate.

40. The table provides a guide to assist in decision making. However, it should not be considered as a substitute for professional judgment and interpretation. In some cases, the potential sensitivity of the receiving environment or the magnitude of potential impact cannot be quantified with certainty and, therefore, professional judgement remains the most robust method for identifying the predicted significance of a potential effect.

Table 10.5: Significance of effect

Magnitude of impact	Sensitivity			
	High	Moderate	Low	Not Sensitive
Major	**Major**	**Major**	**Moderate**	Negligible
Medium	**Moderate**	**Moderate**	Minor	Negligible
Low	**Moderate**	Minor	Minor	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible

41. A statement of residual effects, following consideration of any further specific mitigation measures where identified, is then given.

Cumulative effects

42. A cumulative effect is considered to be the effect on a receptor arising from the proposed Development in combination with other developments which are likely to affect soils, geology, hydrology and hydrogeology.

43. Existing and proposed developments within the same catchments as the Site and within a distance of 5 km from the proposed Development have been considered.

44. Cumulative effects are considered using the same methodology as for effects of the proposed Development in isolation.

Statement of significance

45. The soils, geology and water environment assessment concludes with a statement of significance associated with the proposed Development. Effects of 'major' and 'moderate' significance are considered to be 'significant' in terms of the EIA Regulations.

Limitations to the assessment

46. The assessment uses site investigation and survey data and publicly available data sources, including but not limited to SEPA, Met Office, DGC and EAC and commercial data supply companies, as well as additional information supplied from stakeholders during the scoping and consultation stages.

47. It is considered that the data and information used to complete this assessment is robust and that there are no significant data gaps or limitations.

10.4 Baseline conditions

48. This section presents information gathered regarding the existing soils, geological, hydrogeological and hydrological conditions at the Site and its immediate surrounding.

10.4.1 Site setting

49. The proposed Development is located approximately 9.8 km south west of Sanquhar, Dumfries and Galloway, as measured to the nearest turbine location. It is proposed to access the Site from the A76, north of the development area, via the existing Hare Hill Windfarm (Access Route A), or via Blackaddie Road and the Whiteside Hill Windfarm bypass road to the east (Access Route B). The proposed Development including the proposed access routes occupies a total area of 2,389 ha although only a small proportion of this would be occupied by the new infrastructure of the proposed Development.

50. An extract of Ordnance Survey (OS) mapping showing the proposed Development is presented in **Figure 10.1.**

51. Ground elevations within the proposed Development range between 250 m Above Ordnance Datum (AOD) in the southeast of the Site and approximately 230 m AOD at the access point off the A76 to 643 m AOD at the summit of Meikledodd Hill. There are many hills above 500 m AOD located across the Site.

52. The standard average annual rainfall (SAAR) for the largest surface water catchments that serve the Site, based on data obtained from the Flood Estimation Handbook (FEH) Web Service (CEH, 2019) confirms a wet climate:

- 1,480 mm for the River Nith catchments; and
- 1,754 mm for the Water of Ken catchment.

53. Existing land use across the proposed turbine area comprises commercial coniferous plantation forestry. The proposed access track (Access Route A) utilises existing tracks constructed to establish Hare Hill and extension Windfarms and crosses open moorland to the proposed turbines.

10.4.2 Statutory designated sites

54. A review of the Scottish Natural Heritage (SNH) Sitelink (SNH, 2020) and Magic Map (DEFRA, 2020) webpage highlights that the there are no statutory designated sites within the Site.

55. The locations of statutory designated sites within 1 km of the Site are shown on **Figure 10.1** and are summarised as follows:

- Fountainhead Site of Special Scientific Interest (SSSI), which extends to 5.68 ha, is located approximately 230 m north west of the proposed access route (Access Route A), at its closest extent. The SSSI is designated for geological outcrops which show important mineralogy. The SSSI would not be intercepted or impacted by the proposed Development and therefore is not considered further in this Chapter; and
- Polhote and Polneul Burns SSSI, which extends to 32.11 ha, is located approximately 850 m north east of the proposed access route (Access Route A) at its closest extent. The SSSI is designated for Upper Carboniferous geological outcrops. Again, the SSSI would not be intercepted or impacted by the proposed Development and therefore is not considered further in this Chapter.

56. Further from Site, and between 1 km and 5 km of the Site, are the following designated sites:

- Muirkirk and North Lowther Uplands Special Protection Area (SPA) and SSSI, which extends to 26,823 ha, is located approximately 2 km north of the proposed access point (Access Route A) of the A76. The SPA and SSSI are designated for Silurian to Devonian Chordata outcrops, upland habitats including blanket bogs and an assemblage of breeding birds (including golden plover, hen harrier, merlin, peregrine and short-eared owl). The SSSI is located within catchments which are not connected to the proposed Development and it is therefore not considered further in this Chapter; and
- Lagrae Burn SSSI, which extends to 9.71 ha, is located approximately 3.8 km north east of the proposed access route (Access Route A). The SSSI is designated for Upper Carboniferous geological outcrops. The SSSI would not be intercepted or impacted by the proposed Development and therefore is not considered further in this Chapter.

10.4.3 Geology

Soils and superficial deposits

57. An extract of the 1:250,000 National Soil Survey of Scotland (James Hutton Institute, 2020) mapping is presented as **Figure 10.2.**

58. The principal soil types underlying the Site are dystrophic blanket peat, peaty gleys and peaty podzols. Areas of noncalcareous gleys with brown forest soils and areas of humus-iron podzols with rankers are located in the east and southeast of the Site and near the proposed site access point off the A76 (Access Route A).

59. An extract of the 1:50,000 BGS superficial deposits data is presented as **Figure 10.3**. A review of this and of the BGS Onshore Geoindex 1:50,000 data (BGS, 2020) shows peat is present on areas where surface relief is shallow, Glacial Till is present on the valley sides and alluvial deposits adjacent to larger watercourses. In some of the wider, flatter valleys there are hummocky glacial deposits present. Peat and superficial deposits are shown as absent on the hill tops locally and in the headwaters of the steeper water channels.

60. An extract of Peatland Classification mapping published by SNH is shown as **Figure 10.4**, review of which shows that much of the Site may be underlain by Class 4 and Class 5 peatland. Small areas of Class 1, 2 and 3 peatland are located along the proposed access track and within the proposed turbine area.

61. As part of the baseline assessment a comprehensive peat probing and characterisation exercise has been conducted and informs the Peat Landslide Hazard Risk Assessment (**Technical Appendix 10.1: PLHRA**). In summary:

- the presence and depth of peat was assessed at more than 3,600 locations;
- much of the peat was confirmed to have been disturbed by the commercial forestry;
- the areas of thickest peat are generally located in areas with the flatter gradients;
- the higher ground, where the majority of the turbines are located have significantly less peat and in general comprise mainly peaty soils (<0.5 m depth); and
- a hazard impact assessment has been completed, which has concluded that subject to the employment of appropriate mitigation measures, the presence of peat and potential peat slide instability are not development constraints.

Bedrock geology and linear features

62. An extract of the 1:50,000 BGS bedrock and linear features data is presented as **Figure 10.5.** The site is predominantly underlain by sedimentary lithologies with localised igneous intrusions. The majority of the site is underlain by the Kirkcolm Formation, a wacke unit made of sandstone and siltstone turbidite sequences. There is one localised outcrop of the Galdenoch Formation, also a wacke unit, within the Kirkcolm Formation. This sequence rests on the Moffat Shale Group, a mudstone unit present to the south of the Kirkcolm Formation. There are numerous faults present on the site, one of these is present between the Moffat Shale Group and the Portpatrick Formation. The Portpatrick Formation is present to the south of the Moffat Shale group and consists of wacke and siltstone turbidite succession.

63. Following review of publicly available records, there is evidence of historic mining on site noted as a disused pit marked on the OS map in the south of the Site. However, review of historical maps presents no evidence of active mining. There are four large borrow pits present on the Site which have been utilised for building forestry access tracks. All four are marked as quarries on OS maps.

10.4.4 Hydrogeology

Aquifer characteristics and groundwater vulnerability

64. BGS mapping of the Regional Hydrogeology of Scotland (**Figure 10.6**) shows that the bedrock deposits beneath the Site are considered low productivity aquifers, all of which are defined as rocks with limited groundwater in near surface weathered zone and secondary fractures.

65. A description and hydrogeological classification of the geological units at the Site is presented in **Table 10.6**. This is based on BGS aquifer productivity and groundwater vulnerability maps (BGS, 2019).

Table 10.6: Hydrogeological characteristics of geological units at the Site

Period	Geological Unit	Hydrogeological Characteristics	Hydrogeological Classification and Groundwater Vulnerability
Pleistocene to Recent	Peat	Where not degraded or eroded, characteristically wet underfoot and dominated by Sphagnum. Typically peat consists of two layers: the upper very thin (up to 30 cm) acrotelm layer contains upright stems of Sphagnum mosses and allows relatively free water movement and the lower catotelm layer comprising the thicker bulk of peat where individual plant stems have collapsed. Water movement in the catotelm layer is very slow and normally the water table in a peat never drops below the acrotelm layer.	Not a groundwater unit.
	Alluvium	The deposits are predominantly silt and clays with some pebbles and rocks. Groundwater storage and movement typically limited by small regional extent of this unit. Regionally, groundwater flow will be limited by the variability of these deposits and consequently any groundwater yields are normally low. Local differences in thickness, material type and its sorting can realise a considerable range in hydraulic conductivity. Commonly in hydraulic continuity with nearby watercourses and can support locally important potable water supplies.	Intergranular flow. Potentially High productivity. Considered to be highly vulnerable due to potential rapid groundwater movement and shallow depth to groundwater.
	Glacial Till	Sand and gravel horizons within this unit are capable of storing groundwater, although their lateral and vertical extent realises a variable and	Not classified.

Period	Geological Unit	Hydrogeological Characteristics	Hydrogeological Classification and Groundwater Vulnerability
		often small groundwater yield. Intergranular flow mechanisms dominate. Clay within this unit acts as an aquitard to the more permeable sand and gravel lenses and will hinder/prevent large scale groundwater movement. Regionally, groundwater flow will be limited by the variability of these deposits and consequently any groundwater yields are normally low.	Not considered to be vulnerable to pollution as a consequence of predominance of clay in the Till.
Ordovician	Kirkcolm Formation and Portpatrick Formation	Generally classified as low productivity aquifers with limited groundwater flow. Weathering of the upper surface of the rock may enhance intergranular permeability but in general groundwater flow and storage is entirely within fractures which are more common at depth.	Intergranular and fracture flow. Low productivity. Where not overlain by superficial deposits vulnerable to pollution due to potential rapid groundwater movement and shallow depth to groundwater. Afforded protection when overlain by Glacial Till.

66. The BGS groundwater vulnerability data (**Figure 10.7**) classifies the underlying aquifer (superficial and bedrock) according to the predominant groundwater flow mechanism (fracture or intergranular) and the estimated groundwater productivity. Groundwater vulnerability is divided into five classes (1 to 5) with 1 being least vulnerable and 5 being most vulnerable. The vulnerability map shows that the groundwater underlying the Site is classified by high vulnerability (Class 5, and 4), due to the potential shallow depth to groundwater and generally thin or absent superficial cover. Groundwater is of slightly lower vulnerability (Class 4b) where there are overlying superficial deposits.

Groundwater levels and quality

67. Baseline factors that inhibit groundwater recharge at Site include the following:

- steeper topographic gradients present across the site would encourage the formation of surface water runoff;
- the underlying Glacial Till deposits would inhibit infiltration owing to its characteristic low bulk permeability; and
- the underlying bedrock (where it is not weathered or fractured) generally displays a low permeability that would limit groundwater recharge.

68. SEPA have confirmed they have no information regarding groundwater levels and quality within 1 km of the Site.

69. In the absence of published information or data held by SEPA, it is inferred that groundwater will be present as perched groundwater within more permeable horizons (sand and gravels) of the Glacial Till deposits, and within weathered zones, fractures within the bedrock deposits. Limited groundwater may also be present in deposits of Alluvium that bound larger watercourses.

70. All of Scotland's groundwater bodies have been designated as Drinking Water Protected Areas under the Water Environment (Drinking Water Protected Area) (Scotland) Order 2013 and require protection for their current use or future potential as drinking water resources.

71. The current status of groundwater bodies in Scotland has been classified by SEPA (SEPA, 2018) in accordance with the requirements of the Water Framework Directive (WFD). SEPA identify three groundwater bodies that underlie the Site:

- Upper Nithsdale (SEPA ID: 150663) classified in 2018 with an overall classification of Poor;
- Moniaive (SEPA ID: 150644) classified in 2018 with an overall classification of Good with no pressures identified; and
- Galloway (SEPA ID: 150694) classified in 2018 with an overall classification of Good with no pressures identified.

72. The Poor overall classification of the Upper Nithsdale groundwater body is due to Poor chemical status, in particular due to poor levels of cadmium, lead and zinc caused by pollution from legacy mining or quarrying sites. It is noted that this is likely to reflect the influence of historic coal mining to the north of the Site.

Groundwater dependant terrestrial ecosystems

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

74. An assessment of the GWDTE, and in particular whether the habitats are sustained by ground or surface water, is included in **Technical Appendix 10.3: GWDTE** and summarised as follows:

- areas that have not been subject to commercial forest planting are shown to have habitats which might be moderately or highly groundwater dependent;
- areas of potentially highly dependent GWDTE are typically associated with watercourse corridors;
- areas of potentially moderately dependent GWDTE are located either along the watercourse corridors or on open ground;
- much of the Site has been proven to be underlain by peat and/or Glacial Till, both of which are characterised by low bulk permeability which hinders the movement of groundwater;
- the underlying bedrock has low bulk permeability and contains little groundwater;
- the Site receives a high annual rainfall; and
- surface gradients are typically steep and given the low permeability soils and geology rainfall will preferentially form surface water runoff.

75. With reference to **Technical Appendix 10.3: GWDTE** it has been shown that the areas of potential moderate GWDTE are typically associated with modified ground, as a result of forestry, drainage or farming activity. The distribution of the moderate GWDTE is not typical of that sustained by emerging groundwater, such as a groundwater spring, but rather is influenced by land use. It is, therefore, considered that the potential moderate GWDTE are sustained by the high average annual rainfall, surface water runoff and localised surface water ponding rather than by groundwater. Buffers specified in SEPA guidance to this habitat therefore need not apply, but safeguards will be required during construction to maintain existing surface water flow paths to these habitats.

76. Again, with reference to **Technical Appendix 10.3: GWDTE** it has been shown that with the exception of a number of groundwater springs recorded near proposed Borrow Pit BP07, the distribution of potential high GWDTE is not characteristic of habitat that is sustained by groundwater. The areas of potential high GWDTE are typically not associated with linear spring lines or areas of groundwater emergence but rather are sustained by saturated soils which result from waterlogging due to surface water runoff and ponding, within a part of Scotland which receives relatively frequent and high rainfall. It is concluded, therefore, in this instance buffers specified in SEPA guidance to this habitat need not apply. With the exception of watercourse crossings (the number of which has been minimised) the proposed 50 m standoff either side of watercourses will ensure direct impacts on these habitats is minimised or avoided.

77. Without appropriate design however, there is potential that construction of Borrow Pit 07 could intercept groundwater and reduce the flow of the water emerging east of the borrow pot. To mitigate this, and as part of the detailed site design, measures will be required to ensure shallow groundwater flow paths to the springs are maintained. For example, a shallow cut-off drain could be installed on the western boundary of the borrow pit to route shallow groundwater around the borrow pit to the habitat located east of the borrow pit and proposed access track. A diffuse discharge from the drain would need to be maintained to ensure that all the habitat to the east of the borrow pit is sustained. The drainage measures would need to be routinely inspected by the site ECoW.

10.4.5 Hydrology

Local hydrology

78. The Site is drained by five sub catchments of the River Nith (River Nith – Sanquhar to New Cumnock, Kello Water, Euchan Water, Shinnel Water and Scaur Water) which drain the proposed access route, the northern section of the Site and the east and southern extent of the Site. The western extent of the Site is drained by the Water of Ken surface water catchment which is a tributary of the River Dee. Details of each are given below.

River Nith (Sanquhar to New Cumnock) and Kello Water

79. The River Nith (Sanquhar to New Cumnock) has an overall catchment size of 234 km^2 of which 31.1 km^2 is drained by the Kello Water. The Kello Water flows generally north eastward before discharging into the River Nith some 5 km northeast of the Site. The majority of the proposed access route to the Site is drained by the Kello Water surface water catchment whilst the northernmost section is drained by the River Nith – Sanquhar to New Cumnock surface water catchment.

Euchan Water

80. The Euchan Water has an overall catchment size of 36.8 km^2 (of which 6.7 km^2 lies within the Site) and discharges into the River Nith approximately 5.7 km north east of the Site. The catchment drains the northern section of the Site, including turbines T1 to T5 and borrow pit BP1. Within the northern section of the Site, the Euchan Water has many named tributaries including the Rye Grain, Mid Grain, Graystone Burn, Magheuchan Burn, Dalmet Burn, Slot Burn and Poltallan Burn.

Shinnel Water

81. The Shinnel Water has an overall catchment size of 56.8 km^2 (of which 5.8 km^2 lies within the Site) and discharges into the Scaur Water approximately 12.3 km south east of the Site. The catchment drains the southern area of the Site, including turbines T15 to T21 and borrow pits BP4 and BP5. Within the southern section of the Site, the Shinnel Water has many tributaries including the Horse Grain, Fingland Burn, Lockerty Burn, Over Grain, Nether Grain, Grain Burn and White Burn.

Scaur Water

82. The Scaur Water has an overall catchment size of 84.4 km^2 (of which 3.6 km^2 lies within the Site) and discharges into the River Nith approximately 14 km south east of the Site. The catchment drains the eastern extent of the Site which includes turbine T6, T8 and T13, as well as the proposed met mast and borrow pit BP2. Within the Site, the Scaur Water is drained by the following named watercourses, Polskeoch Burn, Rashy Grain and Black Burn.

Water of Ken

83. The Water of Ken (upstream of High Bridge of Ken) is part of the larger River Dee catchment and has an overall catchment size of 88.2 km^2 (of which 4.7 km^2 lies within the Site). The watercourse generally flows south westwards and discharges into the Kendoon Loch approximately 13 km south west of the Site. The catchment drains the western margins of the Site including turbines T7, T9 to T12 and T14. Within the Site, the Water of Ken is drained by the following named watercourses, Polvaddoch Burn, Pot Burn, Pullosh Sikes and Fortpenny Burn.

Surface water flow

84. **Table 10.7** presents catchment areas and the key catchment descriptors from the FEH Web Service (CEH, 2020) for the River Nith and Water of Ken catchments, which can be used to describe the catchments' anticipated response to rainfall.

Table 10.7: Surface water catchment descriptors

Watercourse	Downstream Point (NGR)	Area (km^2)	SAAR (mm)	ALTBAR (mASL)	DPSBAR (m/km)	LDP (km)	BFIHOST (dim)
River Nith	NX 87550 92450	741.55	1,480	307	161.20	68.55	0.378
Water of Ken	NX 61500 90000	88.16	1,754	350	156.10	21.52	0.336
Notes :Grid reference of downstream maximum extent of catchment as denoted by ether the proposed Development Site boundary or confluence with another watercourse; SAAR – surface average annual rainfall between 1961 and 1990; ALTBAR – mean catchment altitude (metres above sea level); DPSBAR – index of catchment steepness; and LDP – longest drainage path; BFIHOST - base flow index is a measure of catchment responsiveness to precipitation.							

85. SEPA provided precipitation data for the two nearest rain gauges to the proposed Development (Craigdarroch at NGR NX 73942 90947 and Eliock at NGR NS 79666 07398. In 2018 a total of 1,647 and 1,323 mm were recorded at Craigdarroch and Eliock rain gauges respectively, slightly lower than the SAAR data provided by the FEH web service.

Surface water quality

86. Water quality in the Euchan Water, Shinnel Water, Scaur Water and Water of Ken is monitored by SEPA and classified annually in accordance with the requirements of the Water Framework Directive (WFD). **Table 10.8** provides summary details of the SEPA classifications reported in 2018 (SEPA, 2018). Smaller watercourses within the proposed Development are not monitored nor classified by SEPA.

Table 10.8: SEPA waterbody classification (2018)

Watercourse (SEPA ID)	Overall Status	Overall Ecology	Physico-Chemical Status	Hydromorphology
River Nith – Sanquhar to New Cumnock (10611)	Poor	Poor	High	Poor
Kello Water (10616)	Good	Good	Good	High
Euchan Water (10617)	Good	Good	Good	Good
Shinnel Water (10628)	Good	Good	Good	Good
Scaur Water – u/s Shinnel Water (10625)	Good	Good	Good	Good
Water of Ken – u/s High Bridge of Ken (10559)	Poor	Poor	High	Good

87. The Poor classification for the River Nith catchment, shown in **Table 10.8**, is caused by modifications to bed, banks and shores of the watercourse.

88. The Poor classification for the Water of Ken catchment is caused by the presence of a barrier to fish migration on the watercourse (SEPA ID: 20674).

10.4.6 Fisheries

89. Fisheries within the River Nith and its subcatchments are managed by the Nith Catchment Fishery Trust in partnership with the Nith District Salmon Fishery Board (NDSFB). Fisheries within the River Dee catchments (including the Water of Ken) are managed by the Galloway Fisheries Trust (GFT) in partnership with the Dee District Salmon Fishery Board (DDSFB), who undertake the fieldwork on behalf of GFT. Fishery interests are discussed in detail and assessed within **Chapter 8: Ecology.**

10.4.7 Flood risk

90. SEPA has developed national flood maps (SEPA, 2018a) that present modelled flood extents for river, coastal, surface water and groundwater flooding. The river, coastal, surface water and groundwater maps were developed using a consistent methodology to produce outputs for the whole of Scotland, supplemented with more detailed, local assessments where available and suitable for use. Flood extents are presented in three likelihoods:

- high likelihood: A flood event is likely to occur in the defined area on average more than once in every ten years (1:10). Or a 10% chance of happening in any one year;
- medium likelihood: A flood event is likely to occur in the defined area on average more than once in every two hundred years (1:200). Or a 0.5% chance of happening in any one year; and
- low likelihood: A flood event is likely to occur in the defined area on average more than once in every thousand years (1:1000). Or a 0.1% chance of happening in any one year.

91. The flood risk from each of these potential sources is discussed in the following sections. Consultation with DGC, EAC, and SEPA has been conducted and used to inform this assessment. DGC and EAC report no flooding events within 5 km of the main turbine area and SEPA confirmed details presented within their online Flood Maps service provide information regarding potential flood extents.

Flooding from the sea or tidal flooding

92. The SEPA coastal flood maps confirm that the Site is distant from coastal flooding extents. The lowest elevations within the proposed Development are approximately 250 m AOD. Sea or tidal flooding, therefore, is not considered further.

Flooding from rivers or fluvial flooding

93. SEPA mapping has identified that the floodplain extents associated with watercourses that drain the site are local and do not extend far from the watercourses or waterbodies. Areas of High Risk of flooding are located along the main watercourses which drain the Site, including the Kello Water, Polstacher Burn (a tributary of the Kello Water), Euchan Water, Scaur Water, Shinnel Water and Water of Ken. These high risk areas also include watercourse crossing WX07 and WX20, associated with flooding of the Euchan Water and Water of Ken respectively. Flooding from this source is considered further in Section 10.5.

Flooding from surface water

94. SEPA has modelled many small surface water flood extents within the Site, largely coinciding with existing forestry tracks and along watercourse channels. It is noted, however, that the flood extents are minor and localised, never forming large linked areas or flow paths; they are not, therefore, considered a development constraint.

Flooding from groundwater

95. The SEPA groundwater flood map illustrates that the Site is not considered at risk from potential groundwater flooding. This concurs with the desk-based assessment which has shown that there is little potential for significant groundwater at the Site.

Flooding from infrastructure failure

96. SEPA has produced reservoir inundation maps (SEPA, 2018b) for those sites currently regulated under the Reservoirs Act 1975. Review of the SEPA Inundation Mapping highlights that there is no risk of reservoir inundation within the Site. One breach scenario has been recorded within the River Nith catchment. This represents a breach from Afton reservoir (reference number; RES/R/1127948) which has been designated as high risk. The modelled flood extent does not encroach on to the Site.

10.4.8 Private Water Supplies and licensed sites

97. Private water supplies (PWS) are regulated by The Water Intended for Human Consumption (Private Supplies) (Scotland) Regulations 2017. The regulatory objective is to ensure the provision of clean and wholesome drinking water and the delivery of significant health benefits to those using such supplies.

98. As part of this assessment, a data request was made to DGC and EAC who provided details of PWS sources near to the Site. These data were then augmented with information from Ordnance Survey mapping and aerial photography, review of the EIAs of neighbouring developments, and data held by FLS. A programme of site specific field investigation that involved visiting properties, enquiring about their water use and source, and mapping water abstraction locations, was also undertaken.

99. A total of five PWS sources were identified within 1 km of the Site.

100. A Private Water Supply Risk Assessment has been completed (**Technical Appendix 10.4: PWSRA**) and it has been shown that with the exception of a stream abstraction used for animal watering at Euchanbank (PWS01) none of the other water sources are considered at risk from the proposed Development. Monitoring of the stream abstraction at Euchanbank has been proposed, to confirm the proposed Development does not impair the water source.

101. SEPA provided details of CAR registrations/licences within 1 km of the of the Site; these are shown on **Figure 10.1** and summarised as follows:

- 21 discharges for engineering activities to watercourses (bridges, bridging culverts and green bank reinforcement);
- 11 discharges of sewage (private) primary (6 of which are to groundwater and 5 are to watercourses);
- 2 discharges of sewage (private) secondary to groundwater;
- 1 discharge of other effluent mine water to watercourses;
- 1 discharge for sheep dip onto land to groundwater; and
- 2 water abstractions (1 from surface water and 1 from groundwater).

102. SEPA hold two records of registered or licensed abstractions within 1 km of the Site, which are both located within the Euchan Water surface water catchment. One is a groundwater abstraction, located approximately 560 m north of borrow pit BP1, and serves the Sanquhar Community Windfarm (CAR/R/1150311) whilst the other is a surface water abstraction for the Whiteside Hill Windfarm (CAR/R/1146949), located approximately 2 km east of the proposed security compound near Glenglass. Both abstractions are remote to the proposed Development and therefore are not considered further in this Chapter.

103. A further surface water abstraction licence is recorded by SEPA downstream of the site within the Shinnel Water surface water catchment. The abstraction is associated with the High Appin property for hydropower generation and is located approximately 4 km southeast of turbine T21.

10.4.9 Summary of sensitive water environment receptors

104. **Table 10.9** outlines the receptors identified as part of the baseline study, and their sensitivity based upon the criteria contained in **Table 10.3.** These receptors form the basis of the assessment and, as per the previously introduced methodology, are used in conjunction with an estimate of the magnitude of an effect to determine significance.

105. While a catchment carries a high sensitivity if private water supplies are present, the risk to private water supplies is assessed at an individual source level. This allows for a more detailed risk assessment of individual sources based upon the proposed design layout. All private water supplies carry a 'high' sensitivity designation. See Private Water Supply Risk Assessment (**Technical Appendix: 10.4: PWSRA**).

106. **Table 10.9** outlines the receptors identified as part of the baseline study, together with a description of their sensitivity to potential impacts associated with windfarm development.

Table 10.9: Sensitivity of receptors

Receptor	Sensitivity	Reason for Sensitivity
Statutory Designated Sites	Not Sensitive	No designated sites within 5 km of the Site have been identified that are in hydraulic connectivity with the Site. Sites afforded protection for their geological exposures have been avoided.
Geology	High	Although the bedrock deposits have no rarity value, sensitive peat soils (including Peatland Classes 1 and 2) have been recorded within and adjacent to the proposed Development.
Groundwater	High	Groundwater quality has been classed by SEPA as Good beneath much of the Site and vulnerability is classified as High.
Surface water	High	The majority of the surface water watercourses have been classified by SEPA as Good and no pressures have been identified in the surface water catchments draining the Site.
Flooding	Moderate	Minor floodplains have been identified adjacent to larger watercourses within the Site boundary. Forest felling will be undertaken in accordance with best practice and felling areas phased so as not to increase flood risk.
Private Water Supplies	High	Private water supplies have been identified within 1 km of the Site and 5 km downstream of the site.
Licensed sites	High	A licensed water abstraction has been recorded 4 km downstream of the Site within the Shinnel Water sub catchment.

10.5 Assessment of effects

10.5.1 Potential effects

Embedded measures

107. The assessment of effects is based on the proposed Development description outlined in **Chapter 3: Description of the proposed Development** and is structured as follows:

- construction effects of the proposed Development;
- operational effects of the proposed Development; and
- cumulative effects of the proposed Development combined with other proposed windfarms in the study area (no other types of development were identified as relevant to the assessment when screening for cumulative effects).

108. The proposed Development has undergone design iterations and evolution in response to the constraints identified as part of the baseline studies and field studies so as to avoid and/or minimise potential effects on receptors where possible. This has

included soils, geological, hydrological and hydrogeological constraints which include areas of peatland, slope stability, watercourse locations, areas of potential flooding, and GWDTE.

Buffer to watercourses

109. In accordance with SEPA's PPG5, a buffer distance between watercourses and any proposed construction activities or infrastructure was applied to those watercourses within the Site. A 50 m buffer has been applied for the wind turbine infrastructure which is in excess of the PPG guidance.

110. Whilst all key infrastructure and hardstanding areas have been designed to be located out with these areas, the access track has had to impinge on the buffer where it crosses watercourses (as presented in **Technical Appendix 10.5: Schedule of Watercourse Crossings**). The layout of the access tracks was designed to utilise existing tracks where possible and minimise the number of new watercourse crossings across the Site. The location of the existing watercourse crossings and the proposed new crossings is shown in **Figure 10.1.**

Peat

111. The potential presence of peat within the Site formed a key consideration in the design of the proposed Development. Informed by the extensive programme of peat probing undertaken across the Site, the design has avoided areas of deeper peat, where possible.

Groundwater dependent habitats

112. SEPA's windfarm planning guidance (SEPA, 2017) states a National Vegetation Classification (NVC) survey should be undertaken to identify wetland areas that might be dependent on groundwater. If potential GWDTE are identified within (a) 100 m of roads, tracks and trenches, or (b) within 250 m of borrow pits and foundations, then it is necessary to assess how the potential GWDTE may be affected by the proposed Development.

113. This guidance has been used to inform the Site design which has been located so as to minimise potential effects on areas of possible GWDTE. A summary of the habitat surveys completed at Site is provided in **Chapter 8: Ecology** along with a detailed NVC habitat plan. An assessment of GWDTE is presented in **Technical Appendix 10.3: GWDTE** and **Figure 10.3.1** therein shows areas of potential GWDTE and the proposed Development.

114. As discussed in **Technical Appendix 10.3: GWDTE**, and following field investigation, it is concluded that areas of potential moderately and areas of highly GWDTE habitat are likely to be sustained by incident rainfall and local surface water runoff rather than by groundwater.

115. Measures have been proposed to safeguard existing water flow paths and maintain existing water quality. It is considered, therefore, that the water dependent habitats identified by the NVC mapping can be sustained. This would be confirmed, in accordance with good practice, by the Ecological Clerk of Works (ECoW) at the time of the construction of the proposed Development.

Good practice measures

116. Measures would be adhered to during the construction and operation of the proposed Development. Good practice measures would be applied in relation to pollution risk, sediment management and management of surface runoff rates and volumes. This would form part of the CEMP (**Technical Appendix 3.1: Outline CEMP**) to be implemented for the proposed Development.

117. SPR is committed to implementing good practice measures as a matter of course during the construction of the proposed Development and these are not considered to be mitigation measures but form an integral part of the design/construction process. Key good practice measures are stated below and the assessment incorporates these measures as part of the proposed Development. Any further specific mitigation which may be required to reduce the significance of a potential effect is identified in the assessment of likely effects during the construction and operation phases.

General measures

118. As a principle, preventing the release of any pollution/sediment is preferable to dealing with the consequences of any release. There are several general measures which cover all effects assessed within this Chapter, details are given below.

- prior to construction, section specific drainage plans would be produced. These would take into account any existing local drainage which may not be mapped and incorporate any section specific mitigation measures identified during the assessment;
- measures would be included in the final CEMP for dealing with pollution/sedimentation/flood risk incidents and would be developed prior to construction. This would be adhered to should any incident occur, reducing the effect as far as practicable;
- the final CEMP would contain details on the location of spill kits, would identify 'hotspots' where pollution may be more likely to originate from, provide details to Site personnel on how to identify the source of any spill and state procedures to be adopted in the case of a spill event. As identified in the outline CEMP, a specialist spill response contractor would be identified to deal with any major environment incidents;
- a wet weather protocol would be developed. This would detail the procedures to be adopted by all staff during periods of heavy rainfall. Toolbox talks would be given to engineering / construction / supervising personnel. Roles would be assigned, and the inspection and maintenance regimes of sediment and runoff control measures would be adopted during these periods; and
- in extreme cases, the above protocol would dictate that work onsite may have to be temporarily suspended until weather/ground conditions allow.

Water quality monitoring

119. The sub catchments of the River Nith and the Water of Ken catchment have been highlighted as being at risk of potential construction effects due to the nature of the works within the catchments as well as their high sensitivity. Water quality monitoring before and during the construction phase would be undertaken, to ensure that the tributaries of the main channels identified at risk from the proposed Development have no significant impacts to water quality and/or quantity. Monitoring would be carried out at a specified frequency (depending upon the construction phase) on these catchments.

120. This monitoring would continue throughout the construction phase and immediately post construction. Monitoring would be used to allow a rapid response to any pollution incident as well as assess the impact of good practice or remedial measures. Monitoring frequency would increase during the construction phase if remedial measures to improve water quality were implemented. Water quality monitoring plans would be developed during detailed design (SEPA, DGC, NDSFB and GFT/DDSFB would be consulted on the plan) and would be contained within the Construction Management Plan.

121. The performance of the good practice measures would be kept under constant review by the water monitoring schedule, based on a comparison of data taken during construction with a baseline data set, sampled prior to the construction period.

Pollution risk

122. Good practice measures in relation to pollution prevention would include the following:

- refuelling would take place at least 50 m from watercourses and where possible it would not occur when there is risk that oil from a spill could directly enter the water environment. For example, periods of heavy rainfall or when standing water is present would be avoided;
- foul water generated onsite would be managed in accordance with PPG4;
- a vehicle management plan and speed limit would be strictly enforced onsite to minimise the potential for accidents to occur;
- drip trays would be placed under stationary vehicles which could potentially leak fuel/oils;
- areas would be designated for washout of vehicles which are a minimum distance of 50 m from a watercourse;
- washout water would also be stored in the washout area before being treated and disposed of;
- if any water is contaminated with silt or chemicals, runoff would not enter a watercourse directly or indirectly prior to treatment;
- water would be prevented as far as possible, from entering excavations such as borrow pits;
- areas of battery storage will be bunded and positively drained so that the quality of runoff can be monitored and contained if required;
- procedures would be adhered to for storage of fuels and other potentially contaminative materials in line with the Controlled Activity Regulations, to minimise the potential for accidental spillage (e.g. stored in 110% bunded storage facilities); and
- a plan for dealing with spillage incidents would be designed prior to construction, and this would be adhered to should any incident occur, reducing the effect as far as practicable. This would be included in the final CEMP for the proposed Development.

Erosion and sedimentation

123. Good practice measures for the management or erosion and sedimentation would include the following:

- all stockpiled materials would be located out with a 50 m buffer from watercourses;
- where possible, stockpiled material would either be seeded or appropriately covered;
- water would be prevented as far as possible, from entering excavations such borrow pits through the use of appropriate cut-off drainage;
- where the above is not possible, water that enters a borrow pit would pass through a number of settlement lagoons and silt/sediment traps to remove silt prior to discharge into the surrounding drainage system. Detailed assessment of ground conditions would be required to identify locations where settlement lagoons would be feasible;
- clean and dirty water onsite would be separated, and dirty water would be filtered before entering the water environment;
- if the material is stockpiled on a slope, silt fences would be located at the toe of the slope to reduce sediment transport;
- the amount of ground exposed, and time period during which it is exposed, would be kept to a minimum and appropriate drainage would be in place to prevent surface water entering deep excavations, specifically borrow pit excavations;
- a design of drainage systems and associated measures to minimise sedimentation into natural watercourses would be developed - this may include silt traps, check dams and/ or diffuse drainage;
- silt/sediment traps, single size aggregate, geotextiles or straw bales would be used to filter any coarse material and prevent increased levels of sediment. Further to this, activities involving the movement or use of fine sediment would avoid periods of heavy rainfall where possible; and
- SPR construction personnel and the Principal Contractor would carry out regular visual inspections of watercourses to check for suspended solids in watercourses downstream of work areas.

Fluvial flood risk

124. It is proposed to adopt Sustainable Drainage Systems (SuDS) as part of the proposed Development. SuDS techniques aim to mimic pre-development runoff conditions and balance or throttle flows to the rate of runoff that might have been experienced at Site prior to development. Good practice in relation to the management of surface water runoff rates and volumes and potential for localised fluvial flood risk would include the following:

- drainage systems would be designed to ensure that any sediment, pollutants or foreign materials which may cause blockages are removed before water is discharged into a watercourse;
- onsite drainage would be subject to routine checks to ensure that there is no build-up of sediment or foreign materials which may reduce the efficiency of the original drainage design causing localised flooding.
- appropriate drainage would attenuate runoff rates and reduce runoff volumes to ensure minimal effect upon flood risk;
- where necessary, check dams would be used within cable trenches in order to prevent trenches developing into preferential flow pathways; and
- as per good practice for pollution and sediment management, prior to construction, section specific drainage plans would be developed and construction personnel made familiar with the implementation of these.

125. Further information on ground conditions and drainage designs would be provided in the final CEMP.

Water abstractions

126. Abstraction of water for construction activities may be required from a suitable source yet to be identified. An application for a CAR Licence would be made to SEPA and managed through the regulation of the CAR Licence. Should a suitable source not be identified, a water bowser would be used.

127. Good practice that would be followed in addition to the CAR Licence regulations includes:

- water use would be planned so as to minimise abstraction volumes;
- water would be re-used where possible;
- abstraction volumes would be recorded; and
- abstraction rates would be controlled to prevent significant water depletion in a source.

Watercourse crossings

128. 18 new and 25 upgraded water crossings are required during the construction phase and would remain in place during the operational phase of the proposed Development.

129. The upgraded crossings will have the same design as the existing crossing and at least the same hydraulic conveyance capacity of the existing crossing.

130. As discussed in **Chapter 8: Ecology**, there are a number of inappropriately seated culverts on Site that currently act as barriers to fish migration. Some but not all of these are at proposed water crossing locations. It is proposed that these would all be upgraded during construction to facilitate fish migration. In addition, SPR is working with local fishery boards on other watercourse crossings located outwith the proposed Development boundary that may also be upgraded, subject to landowner approval.

131. Good practice in relation to new water crossings involves the following aspects:

- the design of the watercourse crossings would be agreed with SEPA prior to construction and be regulated in accordance with CAR;
- the appropriate crossing type would be identified from SEPA's good practice guidance and would take into account any ecological and hydrological constraints; and
- the crossing would be sized and designed so as to minimise effect upon flood risk (sized to accommodate at least the 200 year flow plus an allowance for climate change).

Peat management

132. A detailed review of the distribution and depth of peat at the Site is contained in **Technical Appendix 10.1: PLHRA**.

133. As shown in **Technical Appendix 10.2: PMP**, the Site design has avoided areas of deep peat and only very limited amounts of peat would be encountered by the proposed Development which can be readily managed and accommodated within the Site layout without significant environmental impact. No surplus peat would be generated, and the limited volumes of peat generated from the proposed excavations can be used to reinstate track verges, turbine bases, cane hardstandings and restoration of on-site borrow pits.

Peat landslide hazard

134. A Design and Geotechnical Risk Register would be compiled to include risks relating to peat instability, as this would be beneficial to both SPR and the Contractor in identifying potential risks that may be involved during construction.

135. Good construction practice and methodologies to prevent peat instability within areas that contain peat deposits are identified in the PLHRA. These include:

- measures to ensure a well-maintained drainage system, to include the identification and demarcation of zones of sensitive drainage or hydrology in areas of construction;
- minimisation of 'undercutting' of peat slopes, but where this is necessary, a more detailed assessment of the area of concern would be required;
- careful micro-siting of turbine bases, crane hardstandings and access track alignments to minimise effects on the prevailing surface and sub-surface hydrology;
- raising peat stability awareness for construction staff by incorporating the issue into the Site Induction (e.g. peat instability indicators and good practice);
- introducing a 'Peat Hazard Emergency Plan' to provide instructions for Site staff in the event of a peat slide or discovery of peat instability indicators;
- developing methodologies to ensure that degradation and erosion of exposed peat deposits does not occur as the break-up of the peat top mat has significant implications for the morphology, and thus hydrology, of the peat (e.g. minimisation of off-track plant movements within areas of peat);
- developing robust drainage systems that would require minimal maintenance; and
- developing drainage systems that would not create areas of concentrated flow or cause over-, or under-saturation of peat habitats.

136. Notwithstanding any of the above good construction practices and methodologies, detailed design and construction practices would need to take into account the particular ground conditions and the specific works at each location throughout the construction period. An experienced and qualified engineering geologist / geotechnical engineer would be appointed as a supervisor, to provide advice during the setting out, micro-siting and construction phases of the proposed Development.

10.5.2 Potential construction effects

Pollution risk

137. During the construction phase, there is the potential for a pollution event to affect surface water and local groundwater bodies impacting on their water quality. This would have a negative effect on the receptor and the resulting degradation of the water quality would impact on any aquatic life and private water supplies abstracting from the watercourse/aquifer.

138. Pollution may occur from excavated and stockpiled materials during Site preparation and excavation of borrow pits. Contamination of surface water runoff from machinery, leakage and spills of chemicals from vehicle use and the construction of hardstanding also have the potential to affect surface water bodies. Potential pollutants include sediment, oil, fuels and cement.

139. The risk of a pollution incident occurring would be managed using good practice measures as detailed above. Many of these practices are concerned with undertaking construction activities away from watercourses and identifying safe areas for stockpiling or storage of potential pollutants that could otherwise lead to the pollution of watercourses.

140. The baseline assessment has shown that the proposed Development would be located in the five sub catchments of the River Nith (River Nith – Sanquhar to New Cumnock, Kello Water, Euchan Water, Shinnel Water and Scaur Water) and the Water of Ken catchment (which is a sub catchment of the River Dee). Private water supplies from surface and groundwater have been shown to be located within 1 km of the Site. Therefore, the watercourses onsite, and immediately downstream, and local groundwater have amenity interests.

141. With adoption of the good practice measures the magnitude of a pollution event impairing private water supplies and licensed water abstractions is considered Negligible. Private water supplies and licensed water abstractions have a High sensitivity and the resultant significance of effect is Negligible. No further mitigation measures are required.

142. After consideration of good practice measures the magnitude of a pollution event within the sub catchments of the River Nith and the Water of Ken catchment is considered Negligible following adherence to good practice and Site-specific mitigation measures. The potential effect of a Negligible magnitude event on these hydrological receptors of High sensitivity would be of Negligible significance. No further mitigation measures are required.

143. The groundwater bodies extending beyond the study area are very large when compared to the area of proposed Development. Any effects are judged not to be detectable beyond the study area. Potential pollution events occurring during the construction of the turbines or any hardstanding would be Negligible magnitude as they would be controlled by good practice measures and would be subject to some attenuation in the soils before reaching groundwater. Should pollutants reach the groundwater the scale of the effect would be low in relation to the overall groundwater body. The effect to groundwater, which has been assigned a High sensitivity is, therefore, assessed as having Negligible significance. No further mitigation measures are required.

Erosion and sedimentation

144. Site traffic during the construction phase has the potential to cause erosion and increase in sedimentation loading during earthworks, and due to increased areas of hard-standing and such features as stockpiles, tracks and borrow pits, which could be washed by rainfall into surface water features. This has the potential to reduce the surface water quality, increase turbidity levels, reduce light and oxygen levels and effect ecology, including fish populations.

145. Excavation of borrow pits, construction of hardstanding, diversion of drainage channels and construction of watercourse crossings associated with the proposed Development are the key sources of sediment generation. Adherence to good practice measures would ensure that any material generated is not transported into nearby watercourses.

146. Location specific good practice measures would be in place for sediment control for each of the borrow pits to control the amount of fine sediment that could potentially enter a watercourse if not managed appropriately. These measures would be dependent upon the final borrow pit designs and stone quality, but would potentially include cut-off drainage, sediment traps, sediment lagoons and flocculation stations.

147. Similar good practice measures to those applied at the borrow pit locations would be required around the track construction activities.

148. After consideration of good practice measures, the magnitude of impact to the receptors is assessed as Negligible and, therefore, with the High sensitivity receptors described previously, the significance of effect without mitigation is assessed as Negligible and no further mitigation measures are required.

Fluvial flood risk

149. Construction of hardstanding including the construction compound and turbine bases would create impermeable surface areas. This would lead to a relatively small increase in the total impermeable surface area of the Site causing Negligible increases in runoff rates and volumes within the surface water catchments.

150. The permanent effect of the increase in impermeable surface area is assessed during the operational phase to avoid any double counting of effects. The construction phase includes the effects of temporary increases in impermeable area and temporary drainage diversions during the construction phase.

151. The proposed access track crosses tributaries of the River Nith, Kello Water, Euchan Water, Shinnel Water, Scaur Water and Water of Ken. Details of the proposed watercourse crossing are shown in **Technical Appendix 10.5**: **Schedule of Watercourse Crossings**. The greatest risk of localised flooding would be at these locations where any blockage would reduce the ability of the channel to convey water leading to short duration, localised flooding.

152. The drainage design would ensure management of any increase in runoff volumes for a 1 in 200 year return period (plus an allowance for climate change) at the detailed design stage. During the construction phase, the good practice measures would be in place to prevent materials entering watercourses and to ensure that man-made drains and blockages do not lead to bank erosion and localised flooding.

153. Adherence with good practice measures including appropriate drainage design and compliance with the final CEMP would limit potential effects to being local and short duration and so of Negligible magnitude.

154. The proposed advanced forest felling to establish the wind farm has been shown to only result in a very small percentage increase in felling in the surface water catchments that drain from the Site and as a result no significant increase in rate or volume of surface water runoff in response to rainfall is anticipated. No additional mitigation is therefore required.

155. Rainwater and limited groundwater ingress that collects in the turbine excavations during construction would be stored and attenuated prior to controlled discharge to ground adjacent to the excavation. Attenuation of runoff generated within the proposed turbine excavations would allow settlement of suspended solids within the runoff prior to discharge in accordance with ‘Site control’ component of the SuDS ‘management train.’

156. Where possible, it is proposed to develop the borrow pits with a fall on the floor of the pits which falls away from the edge of the pit. This would ensure that all surface water runoff generated on the floor of the pit during construction would be contained within the pit prior to controlled disposal by pump or gravity (in a cut trench with granular fill) under supervision of the ECoW.

157. If necessary, a shallow open drain would be developed around the pit rim to prevent surface water inflow to the borrow pits. This drain would route the drainage around the pit and thus maintain the pre-development drainage paths.

158. Water in the borrow pits would be managed in accordance with SuDS techniques. Attenuating runoff within the borrow pits would provide an opportunity for any suspended solids within the runoff to settle within the pit prior to controlled and pumped discharge from the pit.

159. The potential effect of a short-term increase in runoff on the hydrological receptors is, therefore, assessed of Negligible significance. No further mitigation is therefore required.

160. The magnitude of the increase in impermeable area is not sufficient to have a measurable effect on groundwater levels, therefore, groundwater flood risk is not considered in this assessment.

Infrastructure and man-made drainage

161. During the construction period, drainage would be required to ensure construction areas are workable and not saturated. In particular, drainage, some of which would be temporary, would be required around turbine working areas, the construction

compound and borrow pits to manage surface flows. Excavation of turbine foundations may require temporary de-watering for the period of the foundation build. These drainage activities may lead to temporary changes in the water table surrounding these construction activities (where de-watering is required below the level of the natural water table).

162. As construction of proposed infrastructure is required through the buffers associated with GWDTE, there is potential to disrupt water contributions to these habitats. It has been shown that areas of potential GWDTE are sustained by surface water rather than groundwater and that the construction of the proposed Development would have no long-term effect on any potential GWDTE habitat.

163. Excavations associated with constructions works (e.g. cut tracks, turbine bases foundations, cable trenches, borrow pits) can result in local lowering of the water table. This is important in areas of peat deposits, where the water table is characteristically near the ground surface (e.g. where the excavations are likely to intercept the groundwater table) and/or areas where there are groundwater dependent water supplies.

164. Dewatering associated with construction of wind turbine foundations is commonly temporary and dewatering following construction would not be required. Cable laying, without appropriate mitigation measures, can also lower high groundwater levels and provide a preferential drainage route for groundwater movement that can lead to local and permanent drying of soils/superficial deposits and / or water supplies.

165. The design of the proposed Development has avoided areas of ecological or habitat interest wherever possible. Furthermore, the bedrock has little groundwater and, therefore, limited or little dewatering is likely to be required. There remains potential, however, for local dewatering of soils near cable trenches, turbine bases and borrow pits, without incorporation of mitigation measures.

166. The sensitivity of the receptor (groundwater and habitat that may be dependent on groundwater) has been assessed as being High. Without mitigation the magnitude of impact is assessed as Negligible and, therefore, the potential significance of effect of changing groundwater levels and flow due to dewatering is considered Negligible significance and requires no further mitigation.

167. The potential effect of the proposed Development on groundwater and areas of GWDTE is not considered to change during the operation of the proposed Development and, therefore, has not been considered under operational effects.

Water abstraction

168. During the construction of the proposed Development, water may be required for uses such as dust suppression and vehicle washing. The volume of water and mitigation required would be regulated through the CAR and, therefore, the magnitude of an effect on groundwater-surface water interactions is considered Negligible. The significance of effect is, therefore, Negligible.

Peat landslide hazard

169. A detailed review of potential peat slide risk and appropriate mitigation is presented in **Technical Appendices 10.1: PLHRA** and **10.2: PMP**.

170. During the construction phase there is potential from the siting of turbines and other Site infrastructure for the instability, removal or loss of soils. The magnitude of impact is Negligible due to the careful micro-siting that has occurred during the Site design and, therefore, the significance of effect to potential soils, geology, groundwater and surface water receptors is assessed as Negligible and requires no further mitigation.

Proposed mitigation

171. As there are no predicated significant construction effects under the terms of the EIA Regulations, other than the good practice measures that SPR implement as standard (and as described above), no specific mitigation, during construction, is required.

Residual effects

172. No significant residual effects on soils (inc. peat), geology, surface water or groundwater receptors are predicted during the construction period of the proposed Development.

10.5.3 Potential operational effects

173. During the operational phase of the proposed Development, it is anticipated that routine maintenance of infrastructure and tracks would be required across the Site. This may include work such as maintaining access tracks and drainage and carrying out wind turbine maintenance.

174. Should any maintenance be required onsite which would involve construction type activities; mitigation measures would be adhered to along with the measures in the CEMP to avoid potential effects.

Pollution risk

175. The possibility of a pollution event occurring during operation is very unlikely. There would be a limited number of vehicles required onsite for routine maintenance and SPR's operational presence. Storage of fuels/oils onsite would be limited to the hydraulic oil required in turbine gearboxes and this is bunded to (110% bund capacity) to prevent fluid escaping.

176. As noted above batteries in the energy storage compound would be bunded and would benefit from a positive drainage system that would allow runoff from this area to be collected and monitored, and if required contained, prior to discharge. In the unlikely event of a pollution event occurring this would ensure no uncontrolled discharge is made to the water environment.

177. Based upon this, the potential risk associated with frequency, duration and likelihood of a pollution event is low. It is, therefore, anticipated that the magnitude of a pollution event during the operational phase of the proposed Development would be Negligible, as no detectable change would likely occur. Therefore, the significance of effect for a pollution event during the operational phase of the proposed Development is predicted to be Negligible for all receptors. No mitigation is, therefore, required.

Erosion and sedimentation

178. During the operation of the proposed Development, it is not anticipated that there would be any excavation or stockpiled material, reducing the potential for erosion and sedimentation effects. Should any excavation be required, this is likely to be limited and required for maintenance of tracks etc. Any excavation, handling and placement of material from borrow pits would be subject to the same safeguards that would be used during the construction phase of the project.

179. Immediately post-construction, newly excavated drains and track dressings may be prone to erosion as any vegetation would not have matured. Appropriate design of the drainage system, incorporating sediment traps, would reduce the potential for the increased delivery of sediment to natural watercourses. Potential effects from sedimentation or erosion during the operational phase are considered to come from linear features on steeper slopes, where velocities in drainage channels are higher. Immediately post-construction, flow attenuation measures would remain and be maintained to slow runoff velocities and prevent erosion until vegetation becomes established.

180. The likelihood, magnitude and duration of a potential erosion and sedimentation event occurring within the surface water catchments would be Negligible following adherence to good practice measures. Therefore, the potential significance of effect on high sensitivity receptors is of Negligible significance. No mitigation is, therefore, required.

181. Should any non-routine maintenance be required at the sections of track crossing wet areas (defined visually onsite by a contractor or operational personnel) there would be potential for erosion and sedimentation effects to occur due to the existence of disturbed material. Should this type of activity be required, then the good practice measures as detailed for the construction phase would be required on a case by case basis. Extensive work at watercourse crossings/adjacent to the water environment may require approval from SEPA under the CAR (depending upon the nature of the activity).

Infrastructure and man-made drainage

182. Operation of the proposed Development requires limited activities relative to the construction phase. The presence of access tracks and hardstanding, as opposed to their construction, may affect the potential infiltration and groundwater conditions as well as the sub-surface flow paths around the infrastructure. In addition, cabling and crane hardstanding would also remain in situ to serve the proposed Development.

183. Drainage would be required to service new sections of access track. This could also potentially alter groundwater levels and recharge. The dispersed nature of new drainage, coupled with good practice, means that the magnitude of the predicted effect of an alteration to drainage on groundwater levels and recharge of the groundwater body is considered Negligible. This

magnitude level has been determined principally through the fact that any change is unlikely to be detectable through monitoring and the associated track drainage remaining during operation is likely to be less than 1 m deep.

184. The magnitude of a potential effect on groundwater and sub-surface flows as a result of permanent hardstanding and associated drainage would be Negligible on the overall groundwater body due to the dispersed nature of the proposed hardstanding. The significance of effect is Negligible. No further mitigation is required.

Proposed mitigation

185. As there are no predicated significant operational effects under the terms of the EIA Regulations, other than the good practice measures that SPR implement as standard, no specific mitigation, during operation, is required.

Residual effects

186. No significant residual effects on soils (inc. peat), geology, surface water or groundwater receptors are predicted during the operational period of the proposed Development.

10.5.4 Cumulative effects assessment

187. This section considers the potential cumulative hydrological effect of the proposed Development taking into consideration other windfarm developments within the same hydrological catchments as the proposed Development and within 5 km of any proposed infrastructure. Any developments which are out with the study area are not considered.

188. Windfarms within the sub catchments of the River Nith and the Water of Ken and within 5 km of the application boundary include:

- **River Nith (Sanquhar to New Cumnock):**
  - Sandy Knowe (consented);
- **Euchan Water:**
  - Whiteside Hill Windfarm (operational);
  - Sanquhar II Windfarm (in planning); and
  - Sanquhar Six Windfarm (consented);
- **Scaur Water**
  - Sanquhar II Windfarm (in planning);
- **Kello Water:**
  - Hare Hill Windfarm (operational);
  - Hare Hill Extension Windfarm (operational);
  - Sanquhar II Windfarm (in planning);
  - Sanquhar Six Windfarm (consented); and
  - Sanquhar Wind farm (operational);
- **Water of Ken**
  - Lorg (consented subject to variation application)

189. The surface water catchments are considered to be of High sensitivity. The magnitude of a potential pollution event at each of the developments is assessed as Negligible following good practice measures as discussed in this assessment. This would result in a cumulative effect which is Negligible and, therefore, not significant. The probability of a pollution event occurring at more than one development at one time is judged to be low.

190. The magnitude of a potential sedimentation and erosion event at each development is also Negligible following good practice measures as discussed previously. As with a pollution event, the probability of a sedimentation event occurring at more than one development at one time is judged to be low. This would result in a cumulative effect which is Negligible and, therefore, not significant.

191. The potential increase in peak runoff from each development should be mitigated through the detailed design of the drainage systems at each development. The developments should be managed to ensure there is no increased downstream fluvial flood risk. This would result in a cumulative effect which is Negligible and, therefore, not significant.

192. The developments should not have a significant effect on the wider groundwater bodies but if a localised area of GWDTE is thought to be at risk of alteration, it should be mitigated on a case by case basis dependant on the sensitivity of the receiving GWDTE. Assuming such mitigation is applied, the cumulative effect is Negligible and, therefore, not significant.

193. It is concluded that there would be a Negligible cumulative effect on hydrological receptors from both the construction and operating phases of the proposed Development.

10.5.5 Further survey requirements and monitoring

194. This Chapter has demonstrated that the effects of the proposed Development that have been assessed are not likely to have significant effects on the study areas soils, geology or hydrological receptors. The lack of significant effects relates primarily to the proposed 'Good Practice Measures', proposed water quality monitoring and the iterative design process **(Chapter 2: Site Description and Design Evolution),** which effectively act as 'embedded' mitigation.

195. No other further surveys or monitoring is considered necessary to complete this assessment.

196. It has been recognised in this assessment that a programme of water monitoring would be required prior to any construction activity and during construction of the proposed Development. The monitoring programme would be agreed with SEPA, DGC, NDSFB and DDSFB, and it is expected to include monitoring watercourses identified as being potentially at risk without incorporation of best practice construction and mitigation techniques.

10.5.6 Summary of effects

197. A summary of proposed mitigation measures required to reduce the potential effects to acceptable levels are identified in **Table 10.10.**

Table 10.10: Proposed mitigation measures

Potential effect	Significance of effect before mitigation	Proposed mitigation / enhancements	Significance of residual effect
Construction			
Pollution, Erosion and Sedimentation Flood Risk Peat Instability	Negligible	• good practice techniques • confirmatory water quality monitoring of principal watercourses and Euchanhead stream abstraction (used for animal watering)	Negligible
Operation			
No additional mitigation measures required.			
Cumulative			
There are no predicted cumulative effects of the proposed Development within the hydrological study area.			

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