Chapter 10

Hydrology, hydrogeology, geology and soils

SCOTTISHPOWER RENEWABLES

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Hydrology, hydrogeology, geology and soils

10.1 Executive summary

1. The proposed Development has been assessed in relation to the potential impact on geology, hydrogeology and hydrology 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 private water supplies or drinking water protected areas have been identified near the Site. No designated sites, that are dependent on water have been recorded near or in hydraulic continuity with the Site.

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 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 include a programme of ditch blocking in the headwaters of the Clachan Burn which would reduce both the rate and volume of peak water flows in the burn, 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 soils, geology, hydrogeology and hydrology.

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, solar and infrastructure layout as fully described in **Chapter 3 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 are presented in this Chapter.

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 Private Water Supply Risk Assessment;
- Technical Appendix 10.4 Schedule of Watercourse Crossings; and
- Technical Appendix 10.5 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 Site is drained by four main surface water catchments; the Clachan Burn, Claonaig Water, Whitehouse Burn and Alltan Fhearachair. The Clachan Burn drains the majority of the Site whilst the proposed infrastructure within the eastern and northern extent of the Site is drained by Claonaig Water, and, Whitehouse Burn and Alltan Fhearachair, respectively. Full details of the study area hydrology are provided in Section 10.3.5.

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

10.3.2 Legislation, policy and guidance

18. 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 Renewable Energy and Planning Policy**.

Temporal scope

19. 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.

10.3.3 Effects assessed in full

20. 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.

10.3.4 Effects scoped out

21. 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 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**. It is proposed that only four wind turbines for the proposed Development would require some form of felling on the site within the timescales of the construction period. These turbines would be 'key holed' into the existing forest crop. Only trees required for the infrastructure and an immediate buffer would be felled and cleared ahead of the current forest plan. Other areas of the site would be felled ahead of the proposed Development construction. 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 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 windfarm.

10.3.5 Baseline determination

Data Sources

22. 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 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.

23. 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 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 (May 2019); and
- Data requests with A&BC environmental health department regarding details of historic flooding records and private water abstractions (May 2019).

Field Survey

24. 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.

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

- 13 to 17 May 2019, initial Site reconnaissance, peat depth probing and peat characterisation;
- 10 to 11 June 2019, borrow pit assessment and track layout planning;
- 3 and 4 July 2019, private water supply survey, GWDTE assessment and watercourse crossing survey;
- 8 to 12 July 2019, peat probing and characterisation;
- 5 and 6 September 2019, peat depth probing and characterisation; and
- 5 September 2019, further private water supply and watercourse crossing survey.

26. The scope of the private water supply survey was also informed by data received from A&BC and a review of the EIAs of neighbouring developments along with OS mapping and aerial photography as detailed within **Technical Appendix 10.3 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. Their responses have been incorporated in the assessment. This has ensured a thorough assessment of Private Water Supplies has been completed.

27. 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.

28. 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**.

29. 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.

10.3.6 Consultation

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

31. Consultation for the proposed Development was undertaken with statutory and non-statutory bodies during 2018 and 2019 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 10.1**.

Consultee	Summary of Consultation	Comment / Action
Scottish Environment Protection Agency (SEPA)	Letter dated 29th April 2019: To avoid delay and potential objection, the information outlined below and in the attached appendix must be submitted in support of the application: a) 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. b) Map and assessment of impacts upon Groundwater Dependent Terrestrial Ecosystems and buffers. c) Map and assessment of impacts upon groundwater abstractions and buffers. d) Peat depth survey and table detailing re-use proposals. e) Map and table detailing forest removal. f) Map and site layout of borrow pits. g) Schedule of mitigation including pollution prevention measures. h) Borrow Pit Site Management Plan of pollution prevention measures. i) Map of proposed waste water drainage layout. j) Map of proposed surface water drainage layout. k) Map of proposed water abstractions including details of the proposed operating regime. l) Decommissioning statement.	See **Figure 10.1**. See **Figure 10.8**. See **Figure 10.1** and **Technical Appendix 10.3**. See **Technical Appendices 10.1 and 10.2**. See **Figure 3.2.6** See **Figure 3.1**. See **Section 10.4.1**. See **Section 10.4.1** and **Technical Appendix 10.5 Borrow Pit Assessment**. See **Section 10.4.1** for principles that will be adopted at detailed design. See **Section 10.4.1** for principles that will be adopted at detailed design. See **Section 10.5.1 Sub Section Good practice measures** for principles that will be adopted at detailed design. Decommissioning is not proposed.
Argyll and Bute Council (A&BC)	Letter dated 21st June 2019: The proposed development will be assessed against the following criteria: • impacts on communities and individual dwellings (with reference to this Chapter this includes private water supplies); • impacts on carbon rich soils, using the carbon calculator; • effects on hydrology, the water environment and flood risk. Email dated 30th August 2019 • Highlights that flooding might be an issue at the site.	See **Technical Appendix 10.3.** See Chapter **15 Other Issues**. See **Section 10.3.7 and Section 10.5.2 Sub Section Fluvial flood risk** See **Section 10.3.7 and Section 10.5.2 Sub Section Fluvial flood risk**
Scottish Natural Heritage (SNH)	Letter dated 1st May 2019: Consider that the one of the key considerations associated with this proposal to be impacts on nationally important carbon-rich soils, deep peat and priority peatland habitat.	See **Technical Appendices 10.1 and 10.2 and Chapter 8 Ecology**.
Scottish Water	Letter dated 15th April 2019: Scottish Water has no objection. A review of their records indicates that there are no Scottish Water drinking water catchments or water abstraction sources, which are designated as Drinking Water Protected Areas under the Water Framework Directive, in the area that may be affected by the proposed activity.	Noted.
Fisheries Management Scotland (FMS)	Email dated 25th April 2019 (15:10): The proposed development falls within the district of the Argyll District Salmon Fishery Board, and the catchments relating to the Argyll Fisheries Trust. It is important that the proposals are conducted in full consultation with these organisations.	See **Chapter 8 Ecology**.
Argyll District Salmon Fishery Board (ADSFB)	Letter dated 30th April 2019: ADSFB note that the proposed development has some potential to affect watercourses with trout and salmon populations and should therefore undertake fish population, fish habitat and water	See **Chapter 8 Ecology**.

Consultee	Summary of Consultation	Comment / Action
	quality surveys in pre and post construction phases to demonstrate that there has been no deterioration of the fisheries resource as a result of the development.	
Argyll Fisheries Trusts	No response	N/A
Marine Scotland Science	Letter dated 30th April 2019: Salmon and trout are likely to be present within and/or downstream of the watercourses draining the proposed development area and advises the following is completed: • site characterisation surveys of watercourses within and downstream of the proposed development area to assess the potential impact of the proposed development on fish populations; • appropriate site specific mitigation measures are identified including measures to mitigate for the potential impacts associated with felling on water quality and fish populations; • establishes a robust integrated water quality and fish population monitoring programme and includes the potential cumulative impact of adjacent developments on fish populations, particularly in the selection of control sites; and • contact ADSFB is contacted for information on local fish populations and fisheries.	See **Chapter 8 Ecology**. See **Chapter 3 Proposed Development** and **Section 10.2.4**. See **Section 10.4.4**. See **Chapter 8 Ecology**.
The Coal Authority	Letter dated 17th April 2019: Confirm that the proposed development site is located outside of the defined coalfield and the Coal Authority has no comments or observations to make on this proposal.	Noted
RSPB	Letter dated 16th May 2019: **Peatland Impacts**. It will be important to avoid deep peat especially in the Class 1 area and a detailed peat mapping exercise is required. The design process should ensure peat impacts are avoided and should consider opportunities for restoration and positive management. Carbon calculations for the proposal should be based on the latest version of the Scottish Government's carbon calculator and should clearly show the carbon payback period for the proposed scheme.	See **Technical Appendices 10.1 and 10.2**. Also see Habitat
	Habitat Management. The restoration of suitable areas to bog/peat and increased planting of native tree species in suitable areas within and surrounding the site for biodiversity gain is encouraged.	Management Plan (**Chapter 8 Ecology**). See Chapter **15 Other Issues**. See Habitat Management Plan (**Chapter 8 Ecology**).

Table10.1: Consultation responses

10.3.7 Good practice measures and mitigation

32. 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.

33. 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**.

34. 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.

10.3.8 Approach to assessment of effects

Significance of effect

35. 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.

36. 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.

37. Criteria for determining the significance of effect are provided in **Table 10.2**, **Table 10.3** and **Table 10.4**.

Sensitivity

38. 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 10.2**. Receptors in the receiving environment only need to meet one of the defined criteria to be categorised at the associated level of sensitivity.

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.

Table 10.2: Criteria of assessing sensitivity of receptor

Magnitude

39. 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 10.3**.

Magnitude	Criteria	Definition
Major	Results in loss of attribute	Fundamental (long term or permanent) changes to the baseline 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.
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 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 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.

Table 10.3: Criteria for assessing magnitude of impact

Significance of effect

40. 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 10.4**. 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.

41. 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.

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

Table 10.4: Significance of effect

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

Cumulative effects

43. A cumulative effect is considered to be the effect on a hydrological or hydrogeological receptor arising from the proposed Development in combination with other proposed developments which are likely to affect surface water and groundwater.

44. Proposed developments within the same catchment as the Site and within a distance of 5 km from the proposed Development have been considered.

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

Statement of significance

46. 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

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

48. 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

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

10.4.1 Site setting

50. The proposed Development is located approximately 2 km east of Clachan, Kintyre and is centred at National Grid Reference (NGR) 181302, 657098. The proposed Development occupies an area of 1,248 ha although only a small proportion of this would be occupied by the new infrastructure of the proposed Development.

51. An extract of Ordnance Survey (OS) mapping for the Site is presented in **Figure 10.1**.

52. Ground elevations within the proposed Development range between 130 m Above Ordnance Datum (AOD) in the north of the Site at the A83, and 270 m AOD at the summit of Cruach nam Fiadh in the east of the Site.

53. 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:

- 1,626 mm for the Clachan Burn catchment; and
- 1,754 mm for the Claonaig Water catchment.

54. The existing land use across the proposed Development comprises open upland moorland with commercial coniferous plantation forestry.

55. The proposed Development has been designed to use existing access tracks onsite, wherever possible. The existing access track includes four existing watercourse crossing scheduled for upgrade (**Figure 10.1**). An audit of the existing watercourse crossings and details of watercourses at locations of proposed new watercourse crossings is presented in **Technical Appendix 10.4 Schedule of Watercourse Crossings**.

10.4.2 Statutory designated sites

56. A review of the Scottish Natural Heritage (SNH) Sitelink (SNH, 2019) and Magic Map (DEFRA, 2019) webpage highlights that the there are no statutory designated sites within the Site nor within 1 km of the Site.

57. The locations of nearby statutory designated sites are shown on **Figure 10.1** and are summarised as follows:

- Inner Hebrides and the Minches Special Area of Conservation (SAC), which extends to 1,381,391 ha is downstream of the proposed Development, approximately 4 km west of the site at its closest extent. The SAC is a marine designation located near to where the Clachan Burn discharges into Dunskeig Bay. The designation is for Harbour porpoise (*Phocoena phocoena*). At its closest extent it bounds the entrance to West Loch Tarbert. The qualifying interests are not considered at risk from the proposed Development, as a consequence of its distance from site and the presence of West Loch Tarbert, and thus are not considered further in this Chapter.

- Claonaig Wood Site of Special Scientific Interest (SSSI), a 55 ha site, is located approximately 2 km south east of the Site. The qualifying features include upland oak woodland which was classified as unfavourable declining in 1999. The declining condition is caused by agricultural operations, invasive species and over grazing. The SSSI is located within catchments which are not connected with the application boundary. Therefore, it is not considered to be in hydrological connectivity with the proposed Development and is not considered further in this Chapter.

- Tarbert Woods SAC, a 1576 ha site, is located 1.9 km north west of the Site. Qualifying features include the western acidic oak woodland which was classified as unfavourable recovering in November 2008. The SAC is located on the opposite side of the West Loch Tarbert and is not in hydrological connectivity with the proposed Development and is not considered further in this Chapter.

- Ardpatrick and Dunmore Wood SSSI, a 758 ha site, is located 1.9 km north west of the Site at its closest extent. Qualifying features include quaternary geological deposits (classified as favourably maintained in March 2010) and upland oak woodland (classified as unfavourable recovering in June 2008 with pressures from invasive species including Rhododendrons). The SSSI is located on the opposite side of the West Loch Tarbert and is not considered to be in hydrological connectivity with the proposed Development and is not considered further in this Chapter.

10.4.3 Geology

Soils and superficial deposits

58. An extract of the 1:250,000 National Soil Survey of Scotland (James Hutton Institute, 2019) mapping is presented as **Figure 10.2**.

59. The principal soil type underlying the Site is peaty gleys with either dystrophic semi-confined peats or with dystrophic blanket peat. Areas of noncalcareous gleys with humic gleys are located west of the Site towards Clachan and beneath the proposed solar area SA2.

60. An extract of the 1:50,000 BGS superficial deposits data is presented as **Figure 10.3**, review of this and of the BGS Onshore Geoindex 1:50,000 data (BGS, 2019) shows that majority of the Site is absent of any superficial deposits, however, small areas of Glacial Till (diamicton) are present across the south western and northern extents of the Site, at lower elevations. The BGS do not map the presence of peat at Site.

61. 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 1 and Class 2 peatland.

62. 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)**. In summary:

- the presence and depth of peat was assessed at more than 2,280 locations;
- the areas of thickest peat are generally located in areas with the flatter gradients;
- the steeper slopes, 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

63. An extract of the 1:50,000 BGS bedrock and linear features data is presented as **Figure 10.4**. Bedrock within the application boundary includes several units of low-grade metamorphic units trending in north east to south west orientation and minor igneous intrusions.

64. No faults are recorded to pass beneath the Site.

10.4.4 Hydrogeology

Aquifer characteristics and groundwater vulnerability

65. BGS mapping of Scotland (**Figure 10.5**) 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.

66. A description and hydrogeological classification of the geological units at the Site is presented in **Table 10.5**. This is based on BGS aquifer productivity and groundwater vulnerability maps (BGS, 2019).

Period	Geological Unit	Hydrogeological Characteristics	Hydrogeological Classification and Groundwater Vulnerability
Pleistocene to Recent	Glacial Till	Sand and gravel horizons within this unit are capable of storing groundwater, although their lateral and vertical extent realises a variable and 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 classified. Not considered to be vulnerable to pollution as a consequence of predominance of clay in the Till.
Precambrian	Beinn Bheula Schist and Green Beds Formation	Generally classified as low to very 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.	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.

Table 10.5: Hydrogeological characteristics of geological units at the Site

67. The BGS groundwater vulnerability data (**Figure 10.6**) 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 4a), due to the potential shallow depth to groundwater and generally thin or absent superficial cover. Groundwater in the north and east of the Site is of a slightly lower vulnerability (Class 4c and 4d) due to the presence of overlying superficial deposits.

Groundwater levels and quantity

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

- steeper topographic gradients present in parts of 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.

69. SEPA has confirmed they have no information regarding groundwater levels and quality within the Site.

70. 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.

71. 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.

72. The current status of groundwater bodies in Scotland has been classified by SEPA (SEPA, 2017) in accordance with the requirements of the Water Framework Directive (WFD). SEPA identify one groundwater body that underlies the Site:

- Oban and Kintyre (SEPA ID 150698), classified in 2017 with an Overall Status of Good and no pressures are identified.

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)** and areas of potential GWDTE are shown on **Figure 10.7**.

74. An assessment of the GWDTE, and in particular whether the habitats are sustained by ground or surface water, is summarised in the following points:

- areas that have not been subject to forest planting are shown to have habitat which might be moderately or highly groundwater dependent;
- areas of potentially highly dependent GWDTE are located within the north, north western and eastern extent of the Site and are often associated along forest rides and watercourse corridors;
- the vegetation over the remainder of the Site is potentially moderately dependent on groundwater;
- the Site has been proven to be underlain by peat and Glacial Till, both of which are characterised by low bulk permeability which hinders the movement of groundwater;
- the underlying bedrock has a very low bulk permeability and contains little groundwater;
- the Site receives a high annual rainfall;
- often the areas of potential GWDTE were recorded at the time of the Site survey to be dry underfoot; and
- surface gradients are typically shallow and given the low permeability soils and geology rainfall will preferentially pond on the ground surface and form surface water runoff.

75. Following review of the Site setting and the findings of field investigations, it is concluded that the areas mapped as potential GWDTE are not sustained by groundwater but rather are sustained by incident rainfall and surface water runoff.

10.4.5 Hydrology

Local hydrology

76. The Site is drained by four main surface water catchments; the Clachan Burn, Claonaig Water, Whitehouse Burn and Alltan Fhearachair. The Clachan Burn drains the majority of the Site whilst the proposed infrastructure within the eastern and

northern extent of the Site is drained by Claonaig Water, Whitehouse Burn and Alltan Fhearachair. The catchment areas are shown in **Figure 10.1** and the surface water catchments are described below.

77. Flooding and flood risk is considered later in this Chapter.

Clachan Burn

78. The Clachan Burn has an overall catchment size of 28.8 km^2 (of which 6.6 km^2 lies within the application boundary) and discharges at Dunskeig Bay, 3.5 km west of the Site. The catchment is drained by two main watercourses, the Clachan Burn and a tributary, the Allt Mòr.

79. Within the study area, the Clachan Burn has many unnamed watercourses, as well as, a watercourse named Allt a'Chreagain and waterbodies named Lochan a'Chreimh, Lochan Fraoich, Loch Chorra-riabhaich and Loch nan Gad. The catchment is composed of approximately 50% commercial conifer forestry, with an extensive drainage network, and 50% open moorland (Photograph 10.3-1).

Photograph 10.3-1: Clachan Burn catchment downstream of turbine 5.

80. The Clachan Burn drains much of the existing access track, the proposed solar areas (SA1 and SA2), three borrow pits (BP03, BP04 and BP05) and the western turbines (T3, 4, 5, 8, 10, 11, 12 and 13 and watercourse crossings WX03 and 04).

81. The forestry areas within the catchment are composed of both mature and young conifers. Part of the forestry, especially near to turbine 3 and the proposed solar areas, have been recently clear felled (Photograph 10.3-2).

Photograph 10.3-2: Area of mature conifer forestry and recent felling near turbine 3.

Claonaig Water

82. Claonaig Water has an overall catchment size of 29.4 km^2 (3.6 km^2 exists within the application boundary) and discharges at Claonaig Bay, 3.3 km east of the Site. Within the application boundary, the catchment is drained by several unnamed watercourses, a watercourse named the Larachmor Burn and waterbodies named Loch Lurach and Loch Cruinn.

83. Surface water within the site drains either north east towards Loch Cruinn or south eastward to Larachmor Burn;

- the surface water catchment to Loch Cruinn includes turbines T9, 14 and 15 as well as watercourse crossing WX02 and comprises open ground (Photograph 10.3-3); and
- the surface water catchment to the Larachmor Burn includes turbines T16, 17, 18, and 19, as well as watercourse crossing WX05 and also comprises open ground (Photograph 10.3-4).

Photograph **10.3**-3: View of Loch Cruinn from near turbine 14.

Photograph 10.3-4: Larachmor Burn catchment downstream of turbine 18 and 19.

Whitehouse Burn

84. The Whitehouse Burn has an overall catchment size of 9.7 km^2 and discharges at Kilchamaig Bay, approximately 3 km north of the Site. Land use within the catchment is principally extensive commercial forestry containing both mature and young conifers, with an extensive drainage network, as well as areas of open ground (Photograph 10.3-5).

Photograph 10.3-5: View of Whitehouse Burn catchment looking north east towards turbine 1.

85. The Whitehouse Burn catchment include the proposed construction compound, substation and turbines T1, 2, 6 and 7, and, watercourse crossing WX01.

Alltan Fhearachair

86. The Alltan Fhearachair has an overall catchment size of 2 km^2 and discharges into the West Loch of Tarbert, approximately 1 km north of the Site. The entire catchment comprises commercial forestry with areas that have been recently felled and re-forested (Photograph 10.3-6).

Photograph 10.3-6: Alltan Fhearachair catchment near borrow pit BP01.

87. Alltan Fhearachair and its tributaries drain the most northern extent of the Site, which includes a portion of the existing access track, borrow pits BP01 and the western extent of borrow pit BP02.

Unnamed catchment

88. A small unnamed catchment, which includes 0.1 km^2 of the application boundary, serves part of access track between borrow pit BP02 and the proposed construction compound and the eastern extent of borrow pit BP02.

Surface water flow

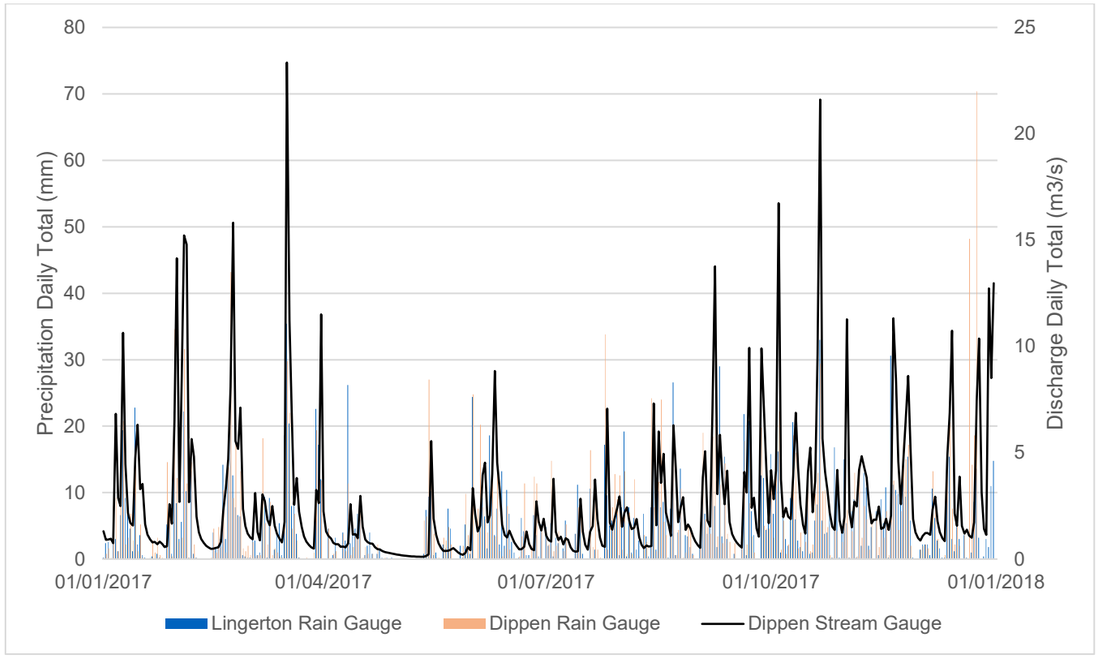
89. **Table 10.6** presents catchment areas and the key catchment descriptors from the FEH Web Service (CEH, 2019) for the Clachan Burn and Claonaig Water catchments, which can be used to describe the catchments' anticipated response to rainfall.

Watercourse	Downstream Point (NGR)	Area (km^2)	SAAR (mm)	ALTBAR (mASL)	DPSBAR (m/km)	LDP (km)	BFIHOST (dim)
Clachan Burn	NR 76300 56100	27.48	1,626	147	88.30	7.99	0.2670
Claonaig Water	NR 85400 58250	16.65	1,754	154	87.30	6.96	0.2570

Table 10.6: Surface water catchment descriptors

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.

90. SEPA provided precipitation data for the two nearest rain gauges to the proposed Development (Dippen at NGR NR 797 376 and Lingerton at NGR NR 867 852) and the closest stream gauge on the River Carradale at Dippen (NGR NR 797 376). Daily precipitation totals for the two gauges and mean daily discharge for 2017 are presented in **Chart 10.1**.



91. Chart 10.1: SEPA precipitation and stream flow data for River

92. In 2017 a total of 1,857 and 2,081 mm were recorded at Lingerton and Dippen rain gauges respectively, notably higher than the SAAR data provided by the FEH web service, while the mean daily discharge recorded at Dippen was 2.7 m^3/s. Review of **Chart 10.1** highlights that autumn to spring records are generally higher with more variation in precipitation and flows.

Surface water quality

93. Water quality of the Clachan Burn, Allt Moor, Claonaig Water and Loch Ciaran is monitored by SEPA and classified annually in accordance with the requirements of the Water Framework Directive (WFD). **Table 10.7** provides summary details of the SEPA classifications reported in 2017 (SEPA, 2017). It should be noted that smaller watercourses within the proposed Development are not monitored nor classified by SEPA.

Watercourse (SEPA ID)	Overall Status	Overall Ecology	Physico-Chemical Status	Hydromorphology
Clachan Burn (10246)	Poor	Poor	Good	Good
Allt Moor (d/s Loch Ciaran) (10247)	Poor	Poor	-	Good
Loch Ciaran (100301)	High	High	High	High
Allt Moor (u/s Loch Ciaran) (10248)	High	High	High	High
Claonaig Water	Good	Good	Good	Good

Table 10.7: SEPA waterbody classification (2017)

94. No pressures are identified by SEPA for any of the monitored waterbodies or watercourses.

10.4.6 Fisheries

95. Fisheries locally are managed by the Argyll Fisheries Trust (AFT) in partnership with the ADSFB. Fishery interests are discussed in detail and assessed within **Chapter 8 Ecology**.

10.4.7 Flood risk

96. 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.
- 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.

97. The flood risk from each of these potential sources is discussed in the following sections. Consultation with A&BC and SEPA has been conducted and used to inform this assessment. A&BC report several flooding events within 5 km of the main turbine area and SEPA confirmed details presented within their online Flood Maps service.

Flooding from the sea or tidal flooding

98. The SEPA coastal flood maps confirm that the Site is distant from coastal flooding extents. The lowest elevations within the proposed Development are approximately 50 m AOD.

Flooding from rivers or fluvial flooding

99. SEPA mapping has identified that the main floodplain extents within the four catchments are local, never extending far from the watercourses or waterbodies.

100. High risk areas associated with flooding are located along Allt Mòr, Clachan Burn and Larachmor Burn watercourses and the main waterbodies across the Site (Lochan Fraoich and Loch Chorra-riabhaich in the Clachan Burn surface water catchment and Loch Lurach in the Claonaig Water surface water catchment). These high risk areas also includes watercourse crossing WX04, associated with flooding of the Clachan Burn.

Flooding from surface water

101. SEPA has modelled many small surface water flood extents within the Site, largely coinciding with existing forestry tracks and along watercourse channels (i.e. Clachan Burn and Larachmor Burn) and waterbodies (i.e. Loch Chorra-riabhaich and Loch Lurach). It is noted, however, that the flood extents are minor and localised, never forming large linked areas or flow paths.

Flooding from groundwater

102. The SEPA groundwater flood map illustrates that the Site is not at risk from predicted 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

103. 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 proposed Development Site.

104. One breach scenario has been recorded within the Clachan Burn catchment. This represents a breach from Loch Ciaran reservoir (reference number; RES/R/1128354) which has been designated as high risk. The modelled flood extent does not encroach on to the Site.

Historical flooding records

Consultation with A&BC highlighted that there have been five historical flooding events within catchments connected to the proposed Development, illustrated in **Figure 10.1**. All of these are associated with the Clachan Burn, in and around Clachan, and it is understood relate to highway flooding which might result from overtopping of the Clachan Burn culvert as it passes beneath the A83. Following discussion with A&BC it is understood that they have commissioned a study to assess the source of these flood events and to assess potential measures that could be adopted to alleviate the instances of flooding.

10.4.8 Private Water Supplies and licenced sites

105. 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.

106. As part of this assessment, a data request was made to A&BC who provided details of 14 properties and PWS sources within 10 km of the main turbine area. This data was then augmented with information from Ordnance Survey mapping and aerial photography. Additional properties, and potential water users, were also identified following an extensive programme of site specific field investigation that involved visiting properties, enquiring about their water use and source, and mapping water abstraction locations. A total of 14 PWS sources were identified within 1 km of the application boundary and/or potentially down gradient of the surface water and groundwater catchments that drain from the Site.

107. A Private Water Supply Risk Assessment has been completed (**Technical Appendix 10.3**) and it has been shown that none of the identified water sources are considered at risk from the proposed Development.

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

- 13 discharges of sewage (private) primary (8 of which are to groundwater and 5 are to watercourses);
- 1 discharge of sewage (private) secondary to groundwater;
- 1 discharge of other effluent to watercourse attributed to a fishery hatcher; and
- 2 discharges for engineering activities (bridging culvert and bridge activities) to watercourses.

109. A further 9 CAR licences exists further downstream of the Site within the Clachan Burn catchment and summarised as follows:

- 3 discharges of sewage (private) primary (2 of which to groundwater and 1 to watercourses);
- 1 discharge of sewage (private) secondary to watercourse;
- 1 discharge of sewage (public) secondary to watercourse;
- 1 discharge of fish farm freshwater tank or hatchery to watercourse;
- 1 discharge for engineering activities (dredging) to watercourse; and
- 1 discharge for sheep dip onto land to groundwater.

110. SEPA hold no records of registered or licenced abstractions within 1 km of the centre of the main turbine area. One surface water abstraction licence exists within the Clachan Burn surface water catchment, approximately 1.2 km west of the Site. The abstraction is associated with Allt Mor Hatchery owned by J S Salmon Ltd. J S Salmon Ltd have provided further details of licenced abstraction which it is understood is associated with a hydroelectric scheme on the Allt Mòr. As it is not hydraulically linked to the proposed Development, this abstraction is not considered further.

111. During the site visit conducted on 5th September 2019, a discussion with the landowner regarding their Scotmill property confirmed that an in-situ septic tank remains in place immediately to the south of the property. However, currently this is not in use.

10.4.9 Summary of sensitive water environment receptors

112. **Table 10.8** outlines the receptors identified as part of the baseline study, and their sensitivity based upon the criteria contained in **Table 10.2**. 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.

113. 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 10.3**).

114. **Table 10.8** outlines the receptors identified as part of the baseline study, together with a description of their sensitivity to potential impacts associated with windfarm development.

Receptor	Sensitivity	Reason for Sensitivity
Statutory Designated Sites	Not Sensitive	The Inner Hebrides and the Minches SAC is located downstream of the Site but the qualifying interests would not be impaired as West Loch Tarbert is located between the Site and SAC.
Geology	High	Sensitive peat soils have been recorded within the proposed Development.
Groundwater	High	Groundwater has been classed by SEPA as Good and vulnerability is classified as High.
Surface water	High	Surface water watercourses have been classified by SEPA as either Good and no pressures identified for the catchments serving the main turbine area.
Flooding	Moderate	Minor floodplains have been identified adjacent to larger watercourses within the Site boundary.
Private Water Supplies	High	Properties have been identified to be served by a PWS that are downgradient of the proposed Development.
Licenced sites	Negligible	No licenced abstractions or sensitive discharges are recorded within 1 km of the application boundary.

Table 10.8: Sensitivity of receptors

10.5 Assessment of effects

10.5.1 Potential effects

Embedded measures

115. The assessment of effects is based on the proposed Development description outlined in **Chapter 3 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).

116. 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 geological, hydrological and hydrogeological constraints which include slope stability, watercourse locations, areas of potential flooding, and groundwater dependent terrestrial ecosystems.

Buffer to watercourses

117. 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 and a 20 m buffer for elements of the proposed solar arrays; both buffers are in excess of the PPG guidance.

118. 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 10.4 Schedule of Watercourse Crossings**). The layout of the access tracks was designed to minimise the number of watercourse crossings across the Site. The location of the existing watercourse crossings and the proposed new crossings is shown in **Figure 10.1**.

Peat

119. 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

120. 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.

121. This guidance has been used to inform the Site design and the proposed renewable energy technologies and associated infrastructure 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 Section 10.4.4 Sub Section Groundwater Dependant Terrestrial Ecosystems

122. **Figure 10.7** shows area of potential GWDTE and the proposed Development.

123. As discussed in Section 10.4.4 Sub Section Groundwater Dependant Terrestrial Ecosystems, further field investigation onsite, has concluded that areas of potential moderately or highly GWDTE habitat are likely to be sustained by incident rainfall and local surface water runoff rather than by groundwater.

124. 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

125. 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.

126. 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

127. 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.

128. 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.

129. 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.

130. 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.

131. A wet weather protocol would be developed. This would detail the procedures to be adopted by all staff during periods of heavy rainfall. Tool box 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.

132. 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

133. The catchments of the Clachan Burn, Claonaig Water, Whitehouse Burn, Alltan Fhearachair and a small unnamed catchment have been highlighted as being at risk of potential construction effects due to the nature of works within the catchments as well as the high sensitivity receptors within the catchments. 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.

134. 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, A&BC and ADSFB would be consulted on the plan) and would be contained within the Construction Management Plan.

135. 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

136. 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 (15 mph) 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 (refer to **Technical Appendix 10.5 Borrow Pit Assessment**);
- 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

137. 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 (refer to **Technical Appendix 10.5 Borrow Pit Assessment**);
- 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

138. 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.

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

140. A HMP is proposed for a large area of the site and includes provision for ditch blocking. There are approximately 38 km of drains across the HMP area which would benefit from being dammed. SPR has developed a technique to successfully restore drained blanket bog, termed “wave damming” which has proven successful on a number of similar sites in Scotland. The method rapidly creates dams within existing drains to prevent water flow, which helps stabilise the hydrology and support bog forming species such as *Sphagnum* mosses. See **Chapter 8 Ecology** for further details.

141. The proposed HMP area lies in the headwater of the Clachan Burn and the proposed ditch blocking will slow the rate of rainfall runoff in this part of the Clachan Burn catchment and downstream of the HMP area.

142. The proposed HMP and SuDS measures would control and limit the rate of rainfall shed from site and reduce current runoff rates. The proposed drainage measures would help to reduce flows in the Clachan Burn, which has been identified as being at risk of flooding.

Water abstractions

143. 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.

144. 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

145. Seven new and four upgraded water crossings are required during the construction phase and would remain in place during the operational phase.

146. The upgraded crossings will have the same design as the existing crossing and at least the same hydraulic conveyance capacity of the existing crossing which would follow relevant good practice guidance.

147. 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).

Peat management

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

149. 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

150. 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.

151. 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.

152. 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

153. 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.

154. Potential effects on the identified private water supplies in **Figure 10.1** are assessed at an individual source level in **Technical Appendix 10.3 Private Water Supply Risk Assessment**. No PWS sources have been identified as being at risk from the proposed Development.

155. 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.

156. 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.

157. The baseline assessment has shown that the majority of the proposed Development would be located in the catchments of the Clachan Burn and Claonaig Water. 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.

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

159. After consideration of good practice measures the magnitude of a pollution event within the Clachan Burn and Claonaig catchments is considered Negligible following adherence to good practice and Site specific mitigation measures. The magnitude of a pollution even caused by the proposed Development within the Whitehouse Burn, Alltan Fhearachair and the small unnamed catchment is also 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.

160. 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 ground mounted solar arrays, 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

161. 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.

162. 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.

163. 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 (refer to **Technical Appendix 10.5 Borrow Pit Assessment**).

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

165. To establish the solar panels little ground disturbance is required. The panels are installed on frames and the panels are located above ground levels. Subject to adherence to good practice with respect to vehicle movements and material handling there is little potential for construction of the solar panels to increase erosion and sedimentation.

166. 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

167. 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.

168. 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.

169. The proposed access track crosses tributaries of the Clachan Burn, Whitehouse Burn, Larachmor Burn and Claonaig Water. Details of the proposed watercourse crossing are shown in **Technical Appendix 10.4 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.

170. The drainage design would ensure management of any increase in runoff volumes for a 1 in 200 year return period 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.

171. 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.

172. The Forestry Commission (Forestry Commission, 2011) report forest establishment and growth appear to have a small effect (decrease) on peak flows, with the impact of clear felling (increase) often being difficult to detect. Overall, research suggests that the contrasting effects of the different stages of the forest cycle (cultivation, drainage, road construction, forest growth and harvesting) would even out at the catchment scale, especially as forest areas become more diverse in age. As a result, upland forests are unlikely to adversely affect downstream flood risk. Therefore, this has not been assessed for the proposed Development.

173. 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.’

174. 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.

175. 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.

176. 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.

177. The proposed solar arrays would not result in an increase in the volume of rainfall – runoff shed from these parts of the Site and thus they would not increase flood risk either on or downstream of Site.

178. 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.

179. 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

180. 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).

181. No groundwater dewatering would be required to establish or maintain the solar arrays during the operational phase. It is not considered further.

182. 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.

183. 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.

184. 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.

185. 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.

186. 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.

187. 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

188. 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

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

190. During the construction phase there is potential from the siting of turbines, solar arrays 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.

10.5.3 Proposed mitigation - Construction

191. As there are no predicated significant 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.

10.5.4 Residual effects - Construction

192. No significant residual effects on surface water or groundwater receptors are predicted during the construction period of the proposed Development.

10.5.5 Potential operational effects

193. 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 and solar panel maintenance.

194. 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

195. 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.

196. 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

197. 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.

198. 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.

199. 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 these high sensitivity receptors is of **Negligible** significance. No mitigation is, therefore, required.

200. 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

201. 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.

202. 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.

203. 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.

10.5.6 Proposed mitigation - Operation

204. As there are no predicated significant 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.

10.5.7 Residual effects - Operation

205. No significant residual effects on surface water or groundwater receptors are predicted during the operational period of the proposed Development.

10.5.8 Cumulative effects assessment

206. 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 up/downstream of any proposed infrastructure. Any developments which are out with the study area are not considered.

207. Windfarms within the catchments of the Clachan Burn, Claonaig Water and Whitehouse Burn within 5 km of the application boundary include:

- Clachan Burn
  - Stewartfield Wind Farm (scoping);
- Claonaig Water and Whitehouse Burn;
  - Freasdail Wind Farm (consented);

208. 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.

209. 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.

210. 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.

211. The developments should not have a significant effect on the wider groundwater bodies but if a localised area of groundwater 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.

212. 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.

10.5.9 Further survey requirements and monitoring

213. 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 area's 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.

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

215. 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 and A&BC, and it is expected to include monitoring watercourses identified as being potentially at risk without incorporation of best practice construction and mitigation techniques.

10.5.10 Summary of effects

216. A summary of proposed mitigation measures required to reduce the potential effects to acceptable levels are identified in **Table 10.9**.

Potential effect	Significance of effect before mitigation	Proposed mitigation / enhancements	Significance of residual effect
Construction			
• Pollution, Erosion and Sedimentation • Flood Risk • Peat Instabilty	Negligible	• good practice techniques • confirmatory water quality monitoring	Negligible
Operation			
No additional mitigation measures required.			
Cumulative			
There are no predicted cumulative effects of the proposed Development within the hydrological study area.			

Table 10.9: Proposed mitigation measures

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ScottishPower Renewables
320 St Vincent Street
Glasgow
G2 5AD

T +44 (0)141 614 0451

sheirdrimrenewables@scottishpower.com

www.scottishpowerrenewables.com

SCOTTISHPOWER
RENEWABLES