

Chapter 9: Hydrology, Hydrogeology and Geology

9.1	Executive Summary	9-1
9.2	Introduction.....	9-1
9.3	Scope of Assessment.....	9-2
9.4	Policy, Legislation & Guidance	9-4
9.5	Methodology	9-5
9.6	Baseline Conditions	9-10
9.7	Potential Effects	9-24
9.8	Mitigation	9-27
9.9	Residual Effects	9-32
9.10	Cumulative Effects.....	9-36
9.11	Conclusions.....	9-36
9.12	Statement of Significance	9-36
9.13	References.....	9-37

Figures

- Figure 9.1: Local Hydrology
- Figure 9.2: Drift Geology
- Figure 9.3: Solid Geology
- Figure 9.4: Regional Hydrogeology
- Figure 9.5: Groundwater Vulnerability

Appendices

- Appendix 9.1: Peat Landslide Hazard Risk Assessment
- Appendix 9.2: Groundwater Dependent Terrestrial Ecosystems Risk Assessment
- Appendix 9.3: Peat Management Plan
- Appendix 9.4: Borrow Pit Assessment

THIS PAGE IS INTENTIONALLY BLANK

9 Hydrology, Hydrogeology and Geology

9.1 Executive Summary

- 9.1.1 The potential effects associated with the construction, operation and decommissioning of the Development on hydrology, hydrogeology and geology have been assessed in this Chapter.
- 9.1.2 The solid geology underlying the site is psammite and micaceous psammite of the Kildonan Psammite Formation, which is classified as a low productivity aquifer and is generally without groundwater except at shallow depth. The majority of the site is overlain by Glacial Till and peat deposits. The peat deposits are shallow across much of the site, with pockets of thicker peat (in excess of 2m) confined to topographic hollows. The Till and peat is absent from the highest parts of the site and in stream valleys.
- 9.1.3 The site and surrounding area can be split into two catchment areas based on the surface topography and drainage patterns. These are the Allt a' Mhuilinn catchment, draining the west of the site and the Allt Smeorail catchment, draining the east of the site. Both catchments are tributaries of the River Brora to the south, which flows in an easterly direction and discharges to the sea at Brora. The River Brora is an important salmonid fishery and has good overall water quality.
- 9.1.4 One licensed surface water abstraction and six private water supplies have been identified within 5km of the Development site boundary. None of these water supplies are at risk from the Development.
- 9.1.5 A number of potential groundwater dependent terrestrial ecosystems (GWDTE) were identified within the site boundary. The Development has been designed to avoid any direct impacts on potential highly dependent GWDTE habitats. Further detailed assessment has been undertaken and mitigation measures proposed where appropriate to avoid potential effects on areas of possible GWDTE.
- 9.1.6 Best practice measures to mitigate against all potential effects during the construction, operation and decommissioning phases have been outlined. In order to ensure that these measures are carried out, a detailed site-specific Construction Environmental Management Plan (CEMP) will be prepared prior to construction and adhered to by all site contractors (a draft CEMP is provided in Appendix 4.1).
- 9.1.7 With the adoption of the proposed mitigation measures, the Development has been assessed as having the potential to give rise to no significant effects to hydrological, hydrogeological or geological receptors in terms of the EIA Regulations.

9.2 Introduction

- 9.2.1 This Chapter assesses the effects of the Development on hydrology, hydrogeology and geology. The assessment of effects has been undertaken on the basis of the proposed turbine and associated infrastructure layout at described in Chapter 4 (Description of Development). Information on the habitats within the site boundary and surrounding area is contained within Chapter 8 (Ecology and Nature Conservation).
- 9.2.2 This Chapter is supported by:

- Appendix 9.1 (Peat Landslide Hazard Risk Assessment);
- Appendix 9.2 (Groundwater Dependent Terrestrial Ecosystems Risk Assessment);
- Appendix 9.3 (Peat Management Plan); and
- Appendix 9.4 (Borrow Pit Assessment).

9.3 Scope of Assessment

Study Area

- 9.3.1 The study is mainly concerned with the Development site area, but for the assessment of the water environment, a buffer zone of approximately 2km outside the site boundary has also been included. The likelihood of effects occurring beyond this distance is also considered, where appropriate.

Scoping and Consultation

- 9.3.2 Account has been taken of the scoping responses and other consultation undertaken and, with respect to geology and the water environment, the responses in Table 9.1 are considered to be relevant.

Table 9.1: Summary of Consultation Responses relating to Geology and the Water Environment

Consultee	Summary Response	Comment/Action Taken
Scottish Environment Protection Agency (SEPA)	<p>Disruption to wetlands</p> <p>The layout of the scheme should avoid impacts on highly groundwater dependent terrestrial ecosystems (GWDTE) such as M6c (even if species poor) and minimise impacts on those habitats that are considered moderately groundwater dependent such as M15b and U6.</p> <p>The route of roads, tracks or trenches within 100m of GWDTEs should be reconsidered. The locations of borrow pits or foundations within 250m of such ecosystems should be reconsidered. If infrastructure cannot be relocated outwith the buffer zones of these ecosystems then the likely impact on them will require further assessment. For areas where avoidance is clearly demonstrated to be impossible, details of how impacts upon GWDTEs are minimised and mitigated should be provided within the ES.</p>	Effects on GWDTE are assessed in Appendix 9.2 and summarised in paragraphs 9.6.52 to 9.6.62.
	<p>Disturbance and re-use of excavated peat</p> <p>Where the proposed infrastructure will impact upon peatlands, a Peat Management Plan should be produced for inclusion in the ES.</p>	A draft Peat Management Plan is included in Appendix 9.3.
	<p>Existing groundwater abstractions</p> <p>A list of groundwater abstractions both within and outwith the site boundary, within a radius of i) 100m from roads, tracks and trenches and ii) 250m from borrow pits and foundations) should be provided.</p> <p>If groundwater abstractions are identified within these buffer zones, then either the applicant should ensure that the route or location of engineering operations avoid this buffer area or further information and investigations will be required to show that impacts on abstractions are acceptable.</p>	Groundwater abstractions are listed in Tables 9.10 and 9.11 and their locations are shown on Figure 9.1.

Consultee	Summary Response	Comment/Action Taken
	<p>Engineering activities in the water environment A site survey of existing water features and a map of the location of all proposed engineering activities in the water environment should be included in the ES. A systematic table detailing the justification for the activity and how any adverse impact will be mitigated should also be included. The table should be accompanied by a photograph of each affected water body along with its dimensions.</p>	<p>No new watercourse crossings or other engineering activities in the water environment are proposed as part of the Development.</p>
	<p>Water abstraction Where water abstraction is proposed the ES should detail if a public or private source will be used. If a private source is to be used then information should be provided on the source, location, volume, timing and nature of abstraction, proposed operating regime and impacts of the proposed abstraction on the surrounding water environment.</p>	<p>Effects of the proposed water abstraction are assessed in paragraphs 9.8.24 to 9.8.25.</p>
	<p>Pollution prevention and environmental management The applicant should systematically identify all aspects of site work that might impact upon the environment, potential pollution risks associated with the proposals and identify the principles of preventative measures and mitigation. A draft Schedule of Mitigation and draft Construction Environmental Management Plan should be produced as part of this process.</p>	<p>The assessment of effects on the water environment and proposed mitigation measures are provided in Sections 9.7 to 9.10. A draft Schedule of Mitigation is provided in Appendix 4.3. A draft Construction Environmental Management Plan is provided in Appendix 4.1.</p>
	<p>Flood risk The site should be assessed for flood risk from all sources in line with Scottish Planning Policy (Paragraphs 196-211). If all infrastructure, apart from watercourse crossings, are located well away from the watercourses and the crossings themselves are designed to allow passage of the 1 in 200 year flood event, there is no requirement for detailed consideration of the issue.</p>	<p>Flood risk is assessed in paragraph 9.6.41 and Table 9.9.</p>
<p>The Highland Council</p>	<p>The Flood Team advised that the development should not lead to an increase in runoff and the pre-development drainage conditions should be mimicked for all storm events up to and including the 1:200 return period (with 20% climate change allowance). Culverting of watercourses should be avoided unless there is no practical alternative. Any new culverts or upgrades to existing bridges should be adequately designed to accommodate the 1 in 200 year flow.</p>	<p>Flood risk is assessed in paragraphs 9.6.41. No new watercourse crossings / culverts are proposed.</p>
	<p>A minimum buffer strip of 10m should be kept free from development from the top of bank(s) of any watercourse/waterbody. Storage of materials within this area during construction is not permitted.</p>	<p>A buffer zone of 50m has been applied around all watercourses visible on OS 1:50,000 mapping.</p>

9.3.3 Additional detailed consultation has been undertaken with SEPA in relation to the distribution of GWDTE at the site and the potential for this habitat to be sustained by groundwater (see Appendix 9.2). The Development takes account of the findings of the GWDTE assessment agreed with SEPA as part of this consultation.

9.4 Policy, Legislation & Guidance

European Legislation

- 9.4.1 The key piece of European Legislation that protects the UK's water environment is the Water Framework Directive (WFD) (2000/60/EC). This Directive protects all elements of the water cycle and enhances the quality of groundwaters, surface waters, estuaries and coastal waters.

National Legislation and Policy

- 9.4.2 Key national legislation and policy relevant to this proposed Development includes:
- The Water Environment and Water Services (Scotland) Act 2003;
 - The Water Environment (Controlled Activities) (Scotland) Regulations 2011;
 - The Flood Risk Management (Scotland) Act 2009;
 - Scottish Planning Policy (SPP), Scottish Government, June 2014;
 - Planning Advice Note (PAN) 51 Planning, Environmental Protection and Regulation, Scottish Government 2006; and
 - PAN 69 Planning and Buildings Standards Advice on Flooding, Scottish Government 2004.

Guidance

- 9.4.3 Guidance on good practice for wind farm construction, which is relevant to this Development, is detailed in the following documents:
- Good Practice During Wind Farm Construction, 2nd Edition. Scottish Renewables, Scottish Natural Heritage, Scottish Environment Protection Agency, Forestry Commission Scotland and Historic Scotland, 2013;
 - Land Use Planning System SEPA Guidance Note 4 (Planning guidance on onshore windfarm developments), Version 7. SEPA, May 2014;
 - Land Use Planning System SEPA Guidance Note 31 (Guidance on Assessing the Impacts of Development on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems), Version 1. SEPA, October 2014; and
 - Developments on Peatland: Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and the Minimisation of Waste, Version 1. Scottish Renewables and SEPA, January 2012.
- 9.4.4 Relevant UK guidance on good practice for construction projects is detailed in the following documents:
- Control of Water Pollution from Construction Sites - Guide to Good Practice, CIRIA 2002;
 - Control of Water Pollution from Linear Construction Projects C649, CIRIA 2006; and
 - Environmental Good Practice on Site C650, CIRIA 2005.

9.4.5 The Pollution Prevention Guidelines (PPGs) identified below are the principal guidance documents for preventing water pollution and erosion from construction activities and are jointly produced by the Environment Agency, Scottish Environment Protection Agency and the Environment and Heritage Service in Northern Ireland:

- PPG 1: General Guide to the Prevention of Pollution (PPG1, July 2013);
- PPG 2: Above Ground Oil Storage Tanks (PPG2, August 2011);
- PPG 3: Use and Design of Oil Separators in Surface Water Drainage Systems (PPG3, April 2006);
- PPG 4: Treatment and disposal of sewage where no foul sewer is available (PPG4, July 2006);
- PPG 5: Works and maintenance in or near water (PPG5, October 2007);
- PPG 6: Working at Construction and Demolition Sites (PPG6, May 2012);
- PPG 7: The safe Operation of Refuelling Facilities (PPG7, July 2011);
- PPG 8: Safe Storage and disposal of used oils (PPG8, February 2004);
- PPG 13: Vehicle washing and cleaning (PPG13, July 2007);
- PPG 18: Managing Fire Water and Major Spillages (no date given);
- PPG 20: Dewatering Underground Ducts and Chambers (no date given);
- PPG 21: Pollution Incident Response Planning (PPG 21, March 2009);
- PPG 22: Incident Response – dealing with spills (PPG22, March 2011); and
- PPG 26: Safe storage - Drums & intermediate bulk containers (PPG 26, May 2011).

9.4.6 Guidelines for surface water management and flood risk assessment include:

- The SuDS Manual (Report C697). CIRIA, 2007.
- Technical Flood Risk Guidance for Stakeholders, Version 8. SEPA, February 2014

9.5 Methodology

Overview

9.5.1 The assessment has involved:

- consultation with relevant statutory and non-statutory bodies as part of the scoping exercise;
- a detailed desk study of available information for the Development and surrounding area to establish the hydrological and geological setting;
- site visits to establish the distribution of peat at the site, assess possible borrow pit locations and peat slide risk, as well as current hydrological conditions at the site and surrounding area;
- identification of the potential effects of the Development and assessment of the significance of the effect that these could have on the current conditions, prior to mitigation;

- identification of possible measures to avoid and mitigate against any significant adverse effects resulting from the proposed Development; and
- evaluation of the residual significance of these effects by consideration of the sensitivity of the baseline features, potential magnitude of the effects and the probability of these effects occurring, following mitigation.

Desk Study

9.5.2 A desk study to establish the baseline conditions within the immediate vicinity of the site was undertaken to:

- assess the potential distribution of peat at the site and topographical gradients;
- describe surface water hydrology, including watercourses and springs within and adjacent to the site boundary;
- identify private and licensed groundwater and surface water abstractions and discharges within 5km of the site;
- confirm surface water catchment areas and watersheds;
- identify sensitive water-dependent ecological features and designated ecological sites which may potentially be impacted by the Development; and
- identify areas at risk of flooding.

9.5.3 The following data sources have been used to inform the desk study:

- SSE Renewables Developments (UK) Ltd (2003). Gordonbush Wind Farm Environmental Statement: Chapter 14 – Hydrology and Hydrogeology;
- Ordnance Survey 1:25,000 and 1:50,000 scale mapping data;
- British Geological Survey (BGS) 1:50,000 scale superficial and solid geology mapping data;
- BGS Hydrogeological Map of Scotland, 1998;
- Scottish Environment Protection Agency (SEPA) Groundwater Vulnerability Map of Scotland, SNIFFER, 2004;
- Hydrogeology of Scotland, BGS, 1988;
- Macaulay Institute for Soil Research 1:250,000 Soil Map of Scotland (viewed online at <http://preview.scottishsoils.aea.com/data/soil-survey>);
- The SEPA website (www.sepa.org.uk) for details of flood risk at the site;
- The Scotland's Environment website (www.environment.scotland.gov.uk) for details of the current status of surface water and groundwater quality;
- Correspondence with SEPA (beyond initial scoping consultation) regarding details of licensed abstractions and discharges (April 2014);
- Correspondence with The Highland Council Environmental Services Department for details of historic flooding records and private water abstractions, (March 2014);
- Centre for Ecology and Hydrology and BGS Wallingford Hydrometric Register and Statistics 1996-2000, 2008;

- Institute of Hydrology Flood Estimation Handbook CD-ROM, Version 3, 2009;
- The Gordonbush Wind Farm Water Quality Monitoring Final Report, Northern Ecological Services, 2012;
- The Gordonbush Wind Farm Habitat Management Plan – report of survey to identify ditches for blocking, Northern Ecological Services, 2010; and
- Interim progress reports from the Gordonbush collaborative carbon research project: assessing carbon and nutrient leakage from peatland soils arising from the Gordonbush Renewable Energy Development, Smith, B., 2012.

Field Survey

9.5.4 A field survey was completed at the site by experienced SLR geologists and hydrologist/hydrogeologists in order to:

- verify the information collected during the desk study;
- allow appreciation of the site, including watercourses, groundwater conditions, geology and peat distribution; and
- assess the relative location of the components of the proposed Development to water and geological features and any sensitive geological, hydrogeological and hydrological features identified as part of the desk study.

Assessment of Effects

9.5.5 The significance of potential effects of the 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 experience of carrying out such assessments for a range of wind farm and other developments, knowledge of soils, geology and the water environment characteristics and cognisance of best practice.

9.5.6 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 Development.

9.5.7 Criteria for determining the significance of effect are provided in Table 9.2, Table 9.3 and Table 9.4.

Sensitivity/Importance

9.5.8 The sensitivity of the receiving environment (i.e. the baseline quality of the receiving environment as well as its ability to absorb the effect without perceptible change) is defined in Table 9.2. Receptors in the receiving environment only need to meet one of the defined criteria to be categorised at the associated level of sensitivity.

Table 9.2: Sensitivity Criteria for Receptor

Sensitivity of Receptor	Definition
Very High	<ul style="list-style-type: none"> • International importance. • Receptor is of high ecological quality and rarity, regional or national scale value and limited potential for substitution/replacement, e.g. Ramsar site, water or geological based Special Protection Area (SPA) and Special Area of Conservation (SAC). • SEPA WFD Water Body Classification: 'High' or 'Good' or close to the boundary of a classification: 'Moderate' to 'Good' or 'Good' to 'High'. • 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'. • Habitat classified as a 'Highly Groundwater Dependent Terrestrial Ecosystem'.
High	<ul style="list-style-type: none"> • National importance. • Receptor is of high ecological quality, local scale value and limited potential for substitution / replacement; or receptor is of medium ecological quality and rarity, regional or national scale value and limited potential for substitution / replacement, e.g. water-based National Nature Reserve (NNR) or Site of Special Scientific Interest (SSSI); • SEPA WFD Water Body Classification: 'Moderate' or is close to the boundary of a classification: 'Poor' to 'Moderate'. • Receptor is at moderate risk of flooding (0.1% to 0.5% AEP) but does not act as an active floodplain or flood defence. • Moderate classification of groundwater aquifer vulnerability.
Medium	<ul style="list-style-type: none"> • Regional importance. • Receptor is of medium ecological quality and rarity, local scale value and limited potential for substitution / replacement; or receptor is of low ecological quality and rarity, regional or national scale and limited potential for substitution / replacement, e.g. non-statutory water-based wildlife sites and area of local importance for nature conservation. • SEPA WFD Water Body Classification: 'Poor' or 'Bad'. • Receptor is at low risk from flooding (less than 0.1% AEP). • Receptor is not used for water supplies (public or private).
Low	<ul style="list-style-type: none"> • Local importance. • Receptor with a low quality and rarity, local scale. • Environmental equilibrium is stable and is resilient to changes that are greater than natural fluctuations, without detriment to its present character, e.g. pond or surface water feature with no significant sensitivity to water based ecological or water supply function.

Magnitude of Effect

9.5.9 The criteria that have been used to assess the magnitude of the change are defined in Table 9.3. The magnitude of change reflects the permanence, size and scale of a change on an attribute.

Table 9.3: 'Magnitude of Change' Criteria and Definitions

Magnitude of Change	Criteria	Definition
Major	Results in total loss of attribute.	<ul style="list-style-type: none"> • Fundamental (long term or permanent) changes to geology, hydrology and hydrogeology, such as: • Permanent degradation and total loss of soil habitats; • 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 or hydroecology; or • Major changes to groundwater levels, flow regime and risk of groundwater flooding.
Moderate	Results in effect on the integrity of attribute or loss of part of attribute.	<ul style="list-style-type: none"> • Material but non-fundamental and short to medium term changes to geology, hydrology and hydrogeology, such as: • Loss of extensive areas of soil, damage to important geological structures/features; • Some fundamental changes to watercourses, hydrology or hydrodynamics. Changes to the 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; or • Moderate changes to groundwater levels, flow regime and risk of groundwater flooding.
Minor	Results in minor effect on attribute.	<ul style="list-style-type: none"> • Detectable but non-material and transitory changes to geology, hydrology and hydrogeology, such as: • Loss of small areas of soil, and minor damage to important geological structures/features; • Minor or slight changes to the watercourse, hydrology or hydrodynamics; • Changes to the 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; or • Minor changes to groundwater levels, flow regime and risk of groundwater flooding.
Negligible	Results in an effect on attribute but of	<ul style="list-style-type: none"> • No perceptible changes to geology, hydrology and hydrogeology, such as:

Magnitude of Change	Criteria	Definition
	insufficient magnitude to affect the use/integrity.	<ul style="list-style-type: none"> No effect or alteration to existing important geological environs; No alteration or very minor changes with no effect to watercourses, hydrology, hydrodynamics, erosion and sedimentation patterns; No alteration to groundwater recharge or flow mechanisms; No pollution or change in water chemistry to either groundwater or surface water; or No changes to groundwater levels, flow regime and risk of groundwater flooding.

Significance of Effect

9.5.10 The sensitivity of the receiving environment together with the magnitude of the change defines the significance of the effect, as identified within Table 9.4. The following table is used as a guide and is not a substitute for professional judgement.

Table 9.4: Significance of Effect

Magnitude of Change	Sensitivity of Receptor			
	<i>Very High</i>	<i>High</i>	<i>Medium</i>	<i>Low</i>
<i>Major</i>	Major	Major	Moderate	Minor
<i>Moderate</i>	Moderate	Moderate	Moderate	Minor
<i>Minor</i>	Minor	Minor	Minor	Not significant
<i>Negligible</i>	Not significant	Not significant	Not significant	Not significant

Limitations to the Assessment

9.5.11 This assessment is based on the assumption that data provided by third parties is accurate and complete. The assessment also assumes that the geological, hydrological and hydrogeological conditions observed at the time of the site visits are representative of typical site conditions.

9.6 Baseline Conditions

9.6.1 This section presents information gathered regarding the existing geological, hydrogeological and hydrological conditions at the site and its immediate surroundings.

Site Setting

9.6.2 The application site is located approximately 9.5km to the north-west of Brora in the Highlands of Scotland and is centred at National Grid Reference (NGR) NC 84737 13302 (Figure 9.1: Local Hydrology). The site occupies an area of approximately 730ha, although only a small proportion of this will be occupied by the wind farm infrastructure.

9.6.3 Ground elevations range from approximately 150m Above Ordnance Datum (AOD) in the south-west of the site to approximately 330m AOD in the north-east of the site. The centre

of the site comprises a plateau, which falls towards the south-west and south-east of the site.

- 9.6.4 The existing land use of the site is predominantly open moorland. There are two small coniferous forestry plantations in the south-east of the site and the operational Gordonbush Wind Farm is located in the north-east of the site. Parts of the plateau area have been subject to grip cutting, the majority taking place in the 1950s (NES, 2010).

Geology and Soils

Soils

- 9.6.5 Published soils mapping indicates that the western boundary and south-east of the site is underlain by peaty gleyed podzols of the Arkaig soil association, with parent material derived from schists, gneisses, granulites and quartzites principally of the Moine Series. The far north of the site is underlain by dystrophic deep blanket peat soils. The soil type across the centre of the site has not been recorded.

Superficial Geology

- 9.6.6 The BGS 1:50,000 superficial geology map (Figure 9.2: Drift Geology) shows that the north, centre and south-west of the site is underlain by peat deposits, much of the remainder of the site is underlain by Glacial Till. Bedrock is found at or near the surface in a few localised areas, including areas surrounding the main watercourses draining the site. Deposits of alluvium are found adjacent to larger streams to the east and west of the site.
- 9.6.7 A comprehensive programme of peat depth probing has been completed and has included a Phase I and Phase II peat survey (see Appendix 9.1). The peat depth survey confirmed that, over much of the site, the peat thickness is most likely dictated by bedrock topography, with pockets of thicker peat (in excess of 2m) confined to local topographic hollows. All other areas of identified peat on inspection are generally less than 1m thick, with very localised thicker areas of peat. The steep slopes have little or no peat, where bedrock is close to the surface; however, this is very limited in extent. The average peat depth across the site, calculated from the data collected as part of the peat depth survey, is 0.8m.

Solid Geology

- 9.6.8 The BGS 1:50,000 solid geology map (Figure 9.3) indicates that the solid geology beneath the majority of the site comprises psammite and micaceous psammite of the Kildonan Psammite Formation, which is part of the Loch Eil Group and Moine Supergroup. The psammite is a metamorphosed sedimentary rock.
- 9.6.9 A granite intrusion (of the Moine Supergroup) is located in the north-west of the site.

Hydrogeology

Aquifer Characteristics and Groundwater Vulnerability

- 9.6.10 Groundwater bodies are defined as distinct volumes of groundwater within an aquifer. The different drift and solid geology characteristics within the study area, as described

above, will result in different hydrogeological characteristics and behaviours and, as such, influence their value as an aquifer. A description of the hydrogeological characteristics of the geological units at the site is presented in Table 9.5. This is based on BGS hydrogeological mapping (Figure 9.4: Regional Hydrogeology) and SEPA's aquifer productivity and groundwater vulnerability maps (Figure 9.5: Groundwater Vulnerability).

- 9.6.11 The regional hydrogeological data provided by BGS indicates that the bedrock beneath the site is impermeable, generally without groundwater except in the near surface weathered zone and secondary fractures. SEPA's aquifer productivity map similarly classifies the bedrock as a fracture flow aquifer of very low productivity. The superficial Glacial Till deposits are classified by SEPA as a low productivity intergranular flow aquifer.
- 9.6.12 SEPA's groundwater vulnerability map 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 the least vulnerable and 5 being the most vulnerable. The vulnerability map shows that the groundwater in the underlying bedrock is of moderate to high vulnerability (Class 4d to 4b) due to the dominance of fracture flow with limited opportunity for attenuation of pollutants. The lowest vulnerability (Class 4d) is found in the north and south-west of the site due to the presence of superficial peat deposits above.

Table 9.5: Hydrogeological Characteristics of Geological Units

Period	Geological Unit	Hydrogeological Characteristics	Groundwater Vulnerability
Pleistocene to recent	Peat	Characteristically wet underfoot and generally dominated by carpets of Sphagnum moss. Peat comprises two hydrogeological layers: the upper very thin (about 30 cm) acrotelm layer contains upright stems of Sphagnum mosses and allows relatively free water movement and the lower catotelm layer comprising the thicker bulk of peat where individual plant stems have collapsed. Water movement in the catotelm layer is very slow and normally the water table in peat deposits never drops below the acrotelm layer. Artificial drainage of deposits of peat can locally dewater water normally retained in the catotelm layer.	Not classified
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
Precambrian	Kildonan Psammite Formation	Generally without groundwater except at shallow depth in the near surface weathered zone and secondary fractures. Very low productivity.	Moderate to high vulnerability due to dominance of fracture flow and depending on
	Granite intrusion		

Period	Geological Unit	Hydrogeological Characteristics	Groundwater Vulnerability
			thickness of superficial peat and glacial till deposits.

Groundwater Levels and Flows

- 9.6.13 SEPA has confirmed that it does not hold any records of groundwater level monitoring within the vicinity of the site nor does it hold any other historical groundwater data.
- 9.6.14 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 (sands and gravels) of the Glacial Till and within weathered zones, fractures or fault zones within the bedrock deposits. Any groundwater flow in shallow weathered deposits is likely to locally follow topography.
- 9.6.15 As part of a wider research project assessing carbon and nutrient leakage from peatland soils (Smith, 2012), water table depth has been monitored across a transect of existing ditches within the peat deposits on the operational Gordonbush Wind Farm site to the north of the Development site. Water level monitoring commenced in June 2011, a year prior to commencement of ditch blocking activities as part of the existing wind farm Habitat Management Plan.
- 9.6.16 Monitoring indicates that the water table depth within the peatland area varies from at or near the ground surface to a maximum of 40cm below the ground surface, with the lowest water table depths recorded in dip-wells closest to the drainage ditches. The generally high water table is to be expected in areas of peat deposits, where water is perched above low permeability clay horizons of the underlying Glacial Till.
- 9.6.17 There was a drawdown of water table around each of the ditches monitored from June 2011 through to August 2011. This is attributed to lower rainfall and increased evapotranspiration rates, leading to drying out of the peat deposits. From August 2011 to December 2011, water table depths rose to be near the peat surface. This represents a transition between summer and winter, with increasing rainfall and decreasing evapotranspiration rates.

Groundwater Quality

- 9.6.18 SEPA has confirmed that it does not hold any information regarding groundwater quality at the site. It is anticipated that any groundwater present at the site would be of good quality, given the unmodified nature of land use.
- 9.6.19 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.
- 9.6.20 The current status of groundwater bodies in Scotland has been classified by SEPA in accordance with the requirements of the WFD. The classification of bodies of groundwater describes whether or not they are polluted and whether or not the volume of any water being abstracted from them is sustainable without significant impacts on rivers or wetlands

that depend on the groundwater. The status of a groundwater body is classified as either 'Good' or 'Poor'. The site is located within the Northern Highlands Drinking Water Protection Area, which has been classified by SEPA as being of 'Good' overall status.

Hydrology and Flood Risk

Local Hydrology

9.6.21 The site and surrounding area can be split into two catchment areas based on the surface topography and drainage patterns. These are the Allt a' Mhuilinn catchment, draining the west of the site and the Allt Smeorail catchment, draining the east of the site. Both catchments are tributaries of the River Brora, which flows in an easterly direction approximately 1.5km to the south of the Development. The River Brora discharges into the sea at Brora.

9.6.22 Each catchment area is shown in Figure 9.1: Local Hydrology and described in further detail below.

Allt a' Mhuilinn Catchment

9.6.23 The western half of the Development site is located within the Allt a' Mhuilinn catchment area. The Allt a' Mhuilinn watercourse flows in a southerly direction approximately 200 – 400m to the west of the site boundary (see Photograph 9.1), to its confluence with the River Brora at NGR NC 827 106. Approximately 469ha of the Development site is located within the Allt a' Mhuilinn catchment area.

9.6.24 Several tributaries of the Allt a' Mhuilinn rise within the site boundary, including the Allt nan Nathraichen in the north of the site and two unnamed tributaries in the south-west of the site. A network of man-made drainage ditches (grips) are present across the site within the catchment area (see Photograph 9.2).

9.6.25 A small reservoir on the Allt a' Mhuilinn watercourse (Loch Mhuilinn) was originally created as part of Gordonbush Estate's hydroelectric scheme, constructed in the 1930s. The scheme was decommissioned in the 1980s and the dam has recently been removed.

Photograph 9.1: Allt a' Mhuilinn watercourse to the west of the site, looking north towards Gordonbush Wind Farm



Photograph 9.2: Example of man-made drainage ditch (grip) within an area of peat



Allt Smeorail Catchment

- 9.6.26 The eastern half of the Development site is located within the Allt Smeorail catchment area. The Allt Smeorail watercourse flows southwards immediately to the east of the site boundary (Photograph 9.3), and discharges into Loch Brora near Gordonbush at NGR NC 844 092. Approximately 259ha of the Development site is located within the Allt Smeorail catchment area.
- 9.6.27 A number of tributaries of the Allt Smeorail rise within the site boundary, including Badan Burn, Ristocky Burn, Allt a' Bhreac-achaidh and three small unnamed tributaries. Man-made drainage ditches are present across the site within the catchment area.



Photograph 9.3: View eastwards towards Allt Smeorail watercourse, looking across borrow pit utilised during construction of Gordonbush Wind Farm

Surface Water Flow

- 9.6.28 Table 9.6 shows catchment areas and the key catchment descriptors from the Flood Estimation Handbook (FEH) CD-ROM for the Allt a' Mhuilinn and Allt Smeorail catchments, which can be used to describe the catchments' anticipated response to rainfall.
- 9.6.29 The runoff regime is likely to be flashy (i.e., with a short lag time to peak discharge and a quick return to average flow) due to the high drainage density created by the numerous drainage ditches and minor watercourses and the presence of peat and Glacial Till.

Table 9.6: Catchment Descriptors

Watercourse	Downstream Point ¹	Area (km ²)	SAAR (mm)	ALTBAR (mASL)	DPSBAR (m/km)	LDP (km)	BFIHOST (dim)
Allt a' Mhuilinn	NC 827 106	29.37	1121	233	64.0	10.77	0.308
Allt Smeorail	NC 844 093	15.68	1203	300	153.6	9.22	0.327

Notes:

¹ Grid reference of downstream maximum extent of catchment as denoted by either the application boundary or confluence with another watercourse.

SAAR – surface average annual rainfall between 1941 and 1970.

ALTBAR – mean catchment altitude (metres above sea level).

DPSBAR – index of catchment steepness.

LDP – longest drainage path.

BFIHOST – base flow index derived using the HOST classification.

Surface Water Quality

- 9.6.30 Water quality of the Allt a' Mhuilinn, Allt Smeorail, River Brora and Loch Brora is monitored by SEPA and classified annually in accordance with the requirements of the WFD. Table 9.7 provides summary details of the classifications reported in 2013. The smaller tributary watercourses within the site boundary are not monitored or classified by SEPA.

Table 9.7: Watercourse Water Quality Classifications

Watercourse	Catchment	Monitoring Location	Channel Length/Water Body Area Monitored	Overall Watercourse Classification (2012)
Allt a' Mhuilinn	River Brora	NC 85094 16467	15.88km	Good with high confidence
Allt Smeorail	River Brora	NC 85422 12696	8.45km	Good with high confidence
River Brora (u/s Loch Brora)	River Brora	NC 82177 10478	3.96km	Good with high confidence
Loch Brora (North Basin)	River Brora	NC 84020 09306	1.01km ²	Good with high confidence

- 9.6.31 A key objective of the WFD (implemented in Scotland by the Water Environment and Water Services (Scotland) Act 2003) is the achievement as a minimum of 'good ecological status' of all natural watercourses by 2015. A risk based system is used to highlight pressures on watercourses which may affect the ability of watercourses to achieve a good ecological status or potential.
- 9.6.32 No pressures have been identified by SEPA on the Allt a' Mhuilinn, Allt Smeorail or Loch Brora. One pressure has been identified on the River Brora upstream of Loch Brora, relating to changes from natural flow conditions due to abstraction associated with a hydroelectric scheme.
- 9.6.33 Baseline water quality monitoring was undertaken at several locations on the Allt a' Mhuilinn and Allt Smeorail watercourses prior to construction of Gordonbush Wind Farm, over the period between December 2009 and August 2010 (NES, 2012). Construction

period monitoring was undertaken at the same locations between August 2010 and May 2012.

- 9.6.34 The baseline results showed that site waters were normally very clean and showed little or no turbidity or suspended solids. The Allt Smeorail usually showed exceptionally clean water. Slightly elevated turbidity and suspended solids were more common in the Allt a' Mhuilinn and a major poor water quality event was recorded after heavy rainfall on 15 July 2010.
- 9.6.35 Monthly laboratory chemical analysis showed two different sets of seasonal trends in determinands. An organic set showed increasing levels of dissolved organic carbon (DOC) and other determinands through the summer, which achieved maximum values when washed out of the catchments in heavy early autumn rains. This pattern is known to be typical of peat-dominated upland catchments. The second trend showed a summer increase in mainly cations. Early autumn rains diluted this trend and concentrations fell, the opposite effect to the organic trend.
- 9.6.36 Ecosystem nutrients were not detected in significant quantities in site watercourses.
- 9.6.37 There was little difference between baseline and construction period results for daily and weekly water sampling, and only marginally higher average turbidity values during construction, indicating only a very minor effect on site water quality during construction (NES, 2012).

Discharge Consents

- 9.6.38 SEPA holds records of 14 CAR registrations to discharge within 5km of the site centre; these are summarised in Table 9.8 and illustrated on Figure 9.1: Local Hydrology.
- 9.6.39 Three of these discharges (D11, D12 and D13) were for sewage disposal from the temporary construction compounds used during construction of Gordonbush Wind Farm. These discharges are no longer operational. A fourth discharge (D14) is associated with sewage disposal from the welfare facilities at the Gordonbush Wind Farm substation.
- 9.6.40 The remaining discharges are associated with domestic sewage disposal from private properties.

Table 9.8: Summary of Discharge Consents within 5km of the Site Centre

Figure Reference	Registration Number	Site Name	NGR	Type
D1	CAR/R/1021055	Ascoile Cottage	NC 82440 11109	Sewage (private) primary
D2	CAR/R/1065709	Struan Lodge	NC 84570 09450	Sewage (private) secondary
D3	CAR/R/1065745	Oldtown Cottage	NC 85171 08937	Sewage (private) primary
D4	CAR/R/1068479	Kilbraur Shepherd's Cottage	NC 82310 10060	Sewage (private) primary
D5	CAR/R/1069382	Keeper's House	NC 80614 11072	Sewage (private) primary
D6	CAR/R/1069393	School House	NC 84501 09798	Sewage (private)

Figure Reference	Registration Number	Site Name	NGR	Type
				primary
D7	CAR/R/1069407	No. 1 Old Town Cottages	NC 85200 088898	Sewage (private) primary
D8	CAR/R/1069745	Gordonbush Lodge	NC 84497 09791	Sewage (private) primary
D9	CAR/R/1069752	Factors House	NC 84441 09593	Sewage (private) primary
D10	CAR/R/1069765	Gardeners Cottage	NC 84456 09668	Sewage (private) primary
D11	CAR/R/1087840	Site Compound, Gordonbush Wind Farm	NC 82610 11400	Sewage (private) primary
D12	CAR/R/1087841	Temporary Compound, Gordonbush Wind Farm	NC 84940 08990	Sewage (private) primary
D13	CAR/R/1092871	Temporary Compound, Gordonbush Wind Farm	NC 87030 14880	Sewage (private) primary
D14	CAR/R/1093043	New Welfare Building	NC 84780 15830	Sewage (private) secondary

Flood Risk

9.6.41 A summary of the potential sources of flooding and a review of the potential risk posed by each source at the Development site is presented in Table 9.9. It is confirmed that there are no potential sources of flood risk to the Development site.

Table 9.9: Potential Risk posed by Flooding Sources

Potential Source	Potential Flood Risk to Application Site?	Reasoning for Decision
Fluvial/tidal flooding	No	Review of the SEPA Flood Map 200-year flood outline indicates that the western and eastern boundaries of the site lie adjacent to areas potentially at risk of flooding from the Allt a' Mhuilinn watercourse to the west and the Allt Smeorail to the east, but this envelope does not extend within the site boundary or near proposed site infrastructure.
Flood defence breach (failure)	No	There are no records of flood defences near to the site.
Flooding from rising/high groundwater	No	No instances of groundwater flooding have been recorded within or near to the site. The site lies on elevated ground which is likely to be above the regional groundwater table.
Overland flow flooding	No	The site is located on the slopes of a hill, therefore there is the possibility of overland flow being generated within the site. However, as the site is located in the upper reaches of the catchments draining the area, it is unlikely that large volumes of surface water runoff will be generated from upstream of the site.
Flooding from artificial drainage	No	There are no artificial drainage systems located within or upstream of the site boundary. There are many drainage grips and any

Potential Source	Potential Flood Risk to Application Site?	Reasoning for Decision
systems		flooding associated with these will be local to the grips.
Flooding due to infrastructure failure	No	There are no impoundments or water storage facilities located within or upstream of the site boundary.

Water Resources

9.6.42 SEPA provided details of one licensed abstraction located within 5km of the site centre. Details of the supply are provided in Table 9.10 and its location is shown in Figure 9.1: Local Hydrology.

9.6.43 The abstraction is located in a separate surface water catchment area to the proposed Development infrastructure and is not considered to be at risk from the Development.

Table 9.10: Licensed Abstractions within 5km of Site Centre

Figure Reference	Licence Number	Site Name	NGR	Source and Details
A1	CAR/S/1004406	Gordonbush Estate	NC 85184 08937	Abstraction from surface water (Allt an t-Seana-bhaile) for fish production

9.6.44 The Highland Council provided details of six private water supplies located within 5km of the site centre. Details of each supply are provided in Table 9.11 and their locations are shown in Figure 9.1: Local Hydrology.

9.6.45 One private water supply (P6, Moulin Cottage) is located in close proximity to the Development. However, a new supply to this property was installed by the Applicant during construction of the neighbouring Gordonbush Wind Farm to prevent any impacts associated with the adjacent access track. The new supply is not considered to be at risk from the Development, as no changes to the existing access track are proposed in this location.

Table 9.11: Private Water Supplies within 5km of Site Centre

Figure Reference	Property	NGR	Source	Number of Properties Served	Details
P1	Brora Scout Centre	NC 83591 10255	Stream	1	Supply is located approx. 1.4km to the south of the site boundary and is located in a separate catchment area from the Development. Not at risk.
P2	Oldtown House	NC 85285 08991	Borehole	2	Supply is located over 2km from the site boundary and is not in hydrological connectivity with the Development. Not at risk.
P3	Gordonbush Estate	NC 87083 09760	Borehole	7	Supply is located over 2km from the site boundary and is not in hydrological connectivity with the Development. Not at risk.
P4	Balnacoil Estate	NC 80764	Borehole	5	Supply is located over 2km from the site boundary and is not in hydrological

		11298			connectivity with the Development. Not at risk.
P5	Ascoile Cottage	NC 82162 11327	Hill run-off/ stream	1	Supply is located approximately 485m to the west of the site boundary. The supply is located on a hillside which does not receive runoff from the Development area and is therefore not at risk.
P6	Moulin Cottage	NC 82545 11271*	Hill run-off/ stream	1	A new supply was installed at this location during construction of Gordonbush Wind Farm. The supply comprises a lagoon formed by a weir on a minor surface watercourse. A new alkathene pipe with filter has been fitted to connect the supply to a new 2,700 litre storage tank, which in turn connects via a new pipe to the property. A new paper and UV filter has been fitted within the property. The new supply is at a location that is not affected by the existing access track, which will also be utilised for the proposed Development.

*Location of new supply installed during construction of Gordonbush Wind Farm

Designated Sites

- 9.6.46 The locations of nearby designated sites are shown on Figure 9.1.
- 9.6.47 Coir' an Eoin Site of Special Scientific Interest (SSSI) is located immediately to the west of the Development site, on the opposite side of the Allt a' Mhuilinn watercourse. The site is designated for its nationally important blanket bog habitat and its breeding population of golden plover. The site is not in hydrological connectivity with the Development, therefore it is not considered further within this Chapter.
- 9.6.48 The same area is also designated as part of the Caithness and Sutherland Peatlands Special Area of Conservation (SAC), Special Protection Area (SPA) and Ramsar site. The SAC is designated for its upland bog, dwarf shrub heath, fen, marsh and swamp habitats, as well as its otter population, acid peat-stained lakes and ponds, clear-water lochs and marsh saxifrage vascular plants. The SPA and Ramsar sites are designated for the area's breeding bird populations. As with the SSSI designation, these sites are not in hydrological connectivity with the Development and are therefore not considered further in this Chapter.
- 9.6.49 The Moray Firth SAC is located approximately 9km to the south-east of the site and downstream of the watercourses draining the site via the River Brora. The site is designated for its subtidal sandbanks and bottlenose dolphin population. Although the Moray Firth SAC is in hydrological connectivity with the Development, its qualifying features are not considered to be at risk of potential impacts from the Development on the water environment, therefore this SAC is not considered further within this Chapter.
- 9.6.50 Carrol Rock SSSI is located approximately 3km to the south of the Development site, on the southern shore of Loch Brora. The site is designated for its upland birch woodland and is

not in hydrological connectivity with the Development and therefore this SSSI is not considered further within this Chapter.

- 9.6.51 Inverbrora SSSI is located approximately 8km to the south-east of the site and comprises three parts: two on the banks of the River Brora and one on the foreshore near the outflow of the River Brora. The site contains nationally important exposures of middle-late Jurassic rocks and abundant fossilised plant remains. The designated features of this site are not considered to be at risk from the Development and therefore this SSSI is not considered further within this Chapter.

Groundwater Dependent Terrestrial Ecosystems

- 9.6.52 A detailed assessment of groundwater dependent terrestrial ecosystems (GWDTE) at the Development site is provided in Appendix 9.2. A summary of the baseline conditions is provided in the following paragraphs.
- 9.6.53 Areas of potential GWDTE are shown in Drawing No. 1 of Appendix 9.2, based on the NVC survey completed for the site and SEPA's list of NVC communities that are dependent on groundwater (Appendix 2 of Land Use Planning System Guidance Note 4 (SEPA, 2014)).
- 9.6.54 Much of the potential highly GWDTE (comprising NVC habitat type M6c) is associated with streams (e.g. bounds the streams or is found in stream corridors). This habitat could potentially be sustained by groundwater, as there is alluvium present or bedrock is exposed in the stream channels.
- 9.6.55 The majority of the moderately GWDTE (comprising NVC habitat type M15 and M25) is remote from streams and may be rainwater fed, where water ponds above the low permeability Glacial Till and peat deposits.
- 9.6.56 A number of hand dug trial pits were advanced at the site to assess the soils beneath the areas of potential high and moderate GWDTE. Ground conditions at all of the trial pit locations were dry underfoot, with peat recorded below the ground surface. Little or no water ingress was recorded in the trial pits and, where water was recorded, it was witnessed as seepage from the surface of the peat rather than from the deposits beneath the peat. These observations suggest that groundwater does not sustain the majority of potential GWDTE identified at site.
- 9.6.57 Very wet ground conditions and the possible absence of peat and presence of granular material were recorded at one location in the west of the site (see Observation Point 3 on Drawing No. 1 in Appendix 9.2), which coincides with an area of potential high GWDTE. There is potential, therefore, that this location reflects the emergence of groundwater. This is the only area on site apart from the watercourse corridors that has been identified as possibly being sustained by groundwater.
- 9.6.58 A further site survey was undertaken in January 2015 to assess areas of potential high GWDTE. In addition to mapping local catchment areas to this habitat, water samples were obtained and subject to major ion analysis. Two water samples were taken from surface water streams downstream (SW1) and upstream (SW2) of the site. Seven water samples were obtained from within areas of potentially high GWDTE (F1 – F7). The analysis results are provided in Appendix 9.2, with the sampling locations shown on Drawing No. 5 of Appendix 9.2.

- 9.6.59 The analysis results indicate that the samples have a low major ion content approximate to that of rain water. Samples were slightly acidic in nature, which may be attributed to a larger rain water component or perhaps, as suggested by elevated Total Organic Carbon (TOC), drainage from peat forms a component of the water. The majority of water samples were of a similar chemistry and therefore it is most likely that they are from the same source and considered likely to be surface rainfall-runoff dominated rather than groundwater dominated.
- 9.6.60 The water sample collected at location F4 (at Observation Point 3) was found to have elevated iron, calcium and sodium concentrations and elevated alkalinity compared to the other sampling points. The water chemistry could indicate it has originated within a host rock which contains carbonates or psammities with a higher proportion of that mineralogy. While the chemical signature at F4 does not strongly reflect groundwater, the sample does suggest that the water found within this GWDTE habitat may be partly sustained by groundwater (e.g. it is sustained by a limited groundwater flux in addition to surface water rainfall-runoff). A short distance down from F4, and within the same GWDTE habitat, the water sample collected at F5 shows a water chemistry dominated by surface water rainfall-runoff, which confirms the localised nature of the F4 discharge.
- 9.6.61 In summary, the majority of the potential GWDTE habitat at the site is considered to be sustained by surface rainfall-runoff rather than groundwater. The exceptions to this are the areas of highly GWDTE located along watercourse corridors, and the highly GWDTE located at Observation Point 3 in the west of the site, both of which may be sustained at least in part by groundwater flow.
- 9.6.62 The distribution of GWDTE at the site and the potential for this habitat to be sustained by groundwater has been discussed in detail with SEPA as part of pre-application consultation (see Appendix 9.2). The Development takes account of the findings of the GWDTE assessment agreed with SEPA as part of this consultation.

Fisheries

- 9.6.63 The River Brora is designated as a Salmonid Water under the Surface Waters (Fishlife) (Classification) (Scotland) Direction 1999. The River Brora and Loch Brora are both important salmonid fisheries, and confirmed salmonid spawning gravels occur on the Allt a’Mhuilinn near Ascoile, downstream from the site.
- 9.6.64 There are natural waterfalls on the Allt a’ Mhuilinn and Allt Smeorail watercourses, which will restrict upstream migratory salmonid fish passage. However, self-sustaining populations of wild brown trout are considered likely to occur in suitable burns above these waterfalls (see Appendix 8.3: Fish and Fish Habitat Survey Report).

Modifying Influences

- 9.6.65 Available information does not indicate that there will be any future changes to the ground conditions and hydrology at the site, from those detailed above, in the absence of the Development.

9.7 Potential Effects

9.7.1 This section identifies the likely potential effects of the Development on geology and the water environment, in the absence of mitigation. Significance of effects has not been attributed in this section, but is included under residual effects (Section 9.10).

Overview of Potential Effects

9.7.2 Table 9.12 provides an overview of the potential generic effects of wind farm construction, operation and decommissioning on geology and soils, groundwater levels and flows, groundwater quality and surface water hydrology and quality. This provides a useful framework for assessing potential effects of the wind farm on the water environment.

Table 9.12: Overview of Potential Generic Effects associated with Wind Farm Development

Potential Receptors of Effect	Activities and Potential Effects		
	Construction Phase	Ongoing Site Maintenance	Decommissioning
Geology and soils	<u>Excavation and removal by earthworks</u> Loss of soil and bedrock Loss of peat Ground instability	No effects	No effects
Groundwater levels and flows and GWDEs	<u>Earthworks and site drainage</u> Impact on water table Changes to groundwater distribution and flow <u>Water abstraction</u> Localised reduction in groundwater levels	<u>Physical presence of turbine foundations</u> Possible alterations to groundwater flow <u>Water abstraction</u> Localised reduction in groundwater levels	<u>Physical presence of former turbine foundations</u> Possible alterations to groundwater flow
Groundwater quality	<u>Earthworks</u> Disturbance of contaminated soil and subsequent groundwater pollution <u>Materials management</u> Pollution from spills or leaks of fuel, oil and building materials <u>Use of vehicles and machinery</u> Contamination from spills or leaks of fuel and oil	<u>Materials management</u> Contamination from spills or leaks of fuel and oil <u>Use of vehicles and machinery</u> Contamination from spills or leaks of fuel and oil	<u>Use of vehicles and machinery</u> Contamination from spills or leaks of fuel and oil <u>Materials management</u> Contamination from spills or leaks of fuel and oil
Surface water flows and flood risk	<u>Use of vehicles and machinery</u> Increase in surface water runoff from soil compaction <u>Watercourse crossing points</u> Possible increased flood risk <u>Water abstraction</u> Reduction in flows in surface watercourses <u>Materials management</u> Contamination from spills or leaks of fuel and oil	<u>Use of vehicles and machinery</u> Increase in surface water runoff from soil compaction Runoff from access roads Contamination from spills or leaks of fuel and oil <u>Site drainage</u> Rapid transfer of rainwater to watercourses via drains <u>Watercourse crossing points</u> Increased flood risk <u>Water abstraction</u> Reduction in flows in surface	<u>Use of vehicles and machinery</u> Temporary increase in surface runoff from soil compaction <u>Materials management</u> Contamination from spills or leaks of fuel and oil

Potential Receptors of Effect	Activities and Potential Effects		
	Construction Phase	Ongoing Site Maintenance	Decommissioning
		watercourses	
Surface water quality	<u>Earthworks</u> Pollution from suspended sediments Disturbance of contaminated soil and subsequent pollution of watercourse <u>Materials management</u> Pollution from spills or leaks of fuel, oil and construction materials <u>Use of vehicles and machinery</u> Contamination from spills or leaks of fuel and oil	<u>Materials management</u> Pollution from maintenance work spills or leaks of fuel and oil <u>Use of vehicles and machinery</u> Sediment loading of watercourses Contamination from spills or leaks of fuel and oil	<u>Use of vehicles and machinery</u> Contamination from spills or leaks of fuel and oil

Geology and Soils

Loss of Rock and Soils

- 9.7.3 The geology of the site will be impacted by excavation of superficial deposits (e.g. peat and Glacial Till) to enable construction of the Development. Excavations for wind turbine foundations and the Operations Building foundations may also extend into the underlying bedrock. Excavation of rock from the borrow pits will result in the permanent loss of rock, to be used to construct new access tracks and hardstanding areas.
- 9.7.4 Peat deposits may be impacted either through excavation (e.g. for installation of Development components) or through degradation (e.g. through changes to hydrological flow paths following dewatering operations and installation of drainage, leading to potential drying out or erosion of peat deposits).
- 9.7.5 Soils will be stripped to enable construction of access tracks, the temporary construction compound, crane hardstandings, wind turbine foundations and borrow pit excavations.
- 9.7.6 Soils stripped from areas for temporary use (e.g., the construction compound and borrow pits) will be stockpiled in storage bunds and replaced following completion of construction. Potential effects include loss of soil fertility due to poor storage and handling practices, leading to associated effects on habitat restoration potential.
- 9.7.7 Installation of the wind turbine foundations, access tracks, Operations Building and other permanent infrastructure will require the permanent excavation and removal of surface soil. Potential effects include loss of alternative land uses within the affected areas, and loss of carbon stored within peat deposits.

Ground Stability

- 9.7.8 Without due regard to stability, ground instability and settlement could occur as a result of construction of the Development.

Groundwater Regime

- 9.7.9 Without mitigation, the Development has the potential to impact groundwater in terms of both groundwater recharge and groundwater flows throughout the lifetime of the development. These factors are considered separately below.

Groundwater Recharge

- 9.7.10 The construction of the wind turbines, access tracks and infrastructure for the Development have the potential to reduce the amount of recharge to the shallow groundwater system within the permeable horizons of the Glacial Till, thereby locally affecting shallow groundwater levels and flow regime.
- 9.7.11 The bedrock beneath the site is impermeable, generally without groundwater except in the near surface weathered zone and secondary fractures. Under baseline conditions, groundwater recharge from the surface will be restricted by the presence of low permeability Glacial Till and peat deposits above. Construction of the Development is therefore considered unlikely to impact groundwater recharge of the bedrock beneath the site.

Groundwater Flows

- 9.7.12 Construction of access tracks and other areas of hardstanding, although only excavated to shallow depths, may impact on groundwater flows within areas of peat deposits due to seepage of water from the excavated edge of the peat deposit. This could lead to drying out of the surrounding peat deposits and potential impacts on any nearby GWDTEs.
- 9.7.13 The construction of the Operations Building and wind turbines on the site will require foundations to be placed into the underlying geology. Foundation excavations may require temporary dewatering during construction, leading to a localised lowering of the water table. Dewatering may also be required at the borrow pits.
- 9.7.14 Following installation (i.e. during operation), foundations placed below the shallow or superficial groundwater table may locally alter shallow groundwater levels and flow pathways in the vicinity of the foundation.

Groundwater Quality

- 9.7.15 During the construction phase of the Development, there is a risk of contaminated runoff being generated from the following potential sources and entering the underlying groundwater systems:
- accidental spillage of fuels and lubricants, required over the short term by construction plant moving around the site; and
 - the use of concrete to form foundations.
- 9.7.16 During operation, the risk of contamination is considerably lower due to the limited number of vehicles on site and limited maintenance activities. Potential sources of contamination during operation include:
- accidental spillage of fuels and lubricants from operational vehicles; and

- accidental spillage of hydraulic oil used in turbine gearboxes.

Surface Water Flows and Flood Risk

9.7.17 The Development has the potential to alter the hydrological regime of the site due to:

- compaction of soils by construction traffic, leading to reduced permeability and infiltration capacity of the soil, with resulting increased surface runoff volumes and potential for increased flood risk in downstream watercourses;
- construction of impermeable surfaces such as wind turbine foundations again leading to increased surface runoff;
- installation of new drains and other structures leading to modification of surface drainage patterns; and
- abstraction of water to provide a drinking water supply or for use in construction.

Surface Water Quality

9.7.18 During the construction phase of the Development, there is a risk of contaminated runoff being generated from the following potential sources and entering surface water receptors adjacent to the site:

- accidental spillage of fuels and lubricants, required over the short term by construction plant moving around the site;
- the use of concrete to form foundations;
- increase in suspended solids resulting from exposure of soils during the proposed earthworks; and
- increase in suspended solids due to erosion caused by increased surface water runoff from the site.

9.7.19 Potential sources of surface water contamination during operation would be limited to:

- accidental spillage of fuels and lubricants from operational vehicles;
- accidental spillage of hydraulic oil used in turbine gearboxes; and
- erosion and sedimentation effects associated with access track maintenance works.

9.8 Mitigation

Development Design

9.8.1 The Development design has been progressed to ensure that infrastructure, comprising the wind turbines, crane hardstandings, new access tracks, Operations Building, temporary construction compound, borrow pits, meteorological mast and concrete batching plant are located at least 50m away from all watercourses, surface water drainage features or ponds visible on OS 1:50,000 mapping.

9.8.2 The new access tracks have been designed to ensure that no new watercourse crossings are required, with the existing access tracks constructed as part of the adjacent Gordonbush Wind Farm utilised where possible.

9.8.3 The presence of peat within the site boundary formed a key consideration in the design of the Development. Informed by the extensive programme of peat probing undertaken across the site, the development of the design minimised the location of wind turbines and associated infrastructure within areas of deep peat.

9.8.4 Where possible, the site layout has been designed to provide sufficient buffer zones from potential GWDTE in accordance with SEPA guidance (SEPA, 2014) (100m for all excavations less than 1m in depth and 250m for all excavations deeper than 1m). Where it has not been possible to adhere to these buffer zones, assessment of the potential impact on GWDTE has been undertaken and is presented below and in Appendix 9.2.

Good Practice Measures

9.8.5 The relevant PPGs, CIRIA guidance and Good Practice During Wind Farm Construction guidance will be adhered to, ensuring that construction and decommissioning works are undertaken in an environmentally responsible manner.

9.8.6 Good practice measures will be applied in relation to soil/peat storage, ground stability, pollution risk, sediment management and management of surface water runoff rates and volumes. These measures will form part of the CEMP to be implemented for the Development. A draft CEMP is included in Appendix 4.1 of this ES. The draft CEMP contains details on the general approach to environmental management and standard good practice requirements implemented on all SSE wind farm sites; the CEMP will be developed with detailed site-specific information following detailed intrusive ground investigations and other pre-commencement updated surveys as required post-consent and prior to commencement of construction.

General Measures

9.8.7 There are several general measures which cover all effects assessed within this Chapter, details of which are given below.

9.8.8 Prior to construction, site specific drainage arrangements would be determined during detailed design. This would take into account any existing local drainage which may not be mapped and incorporate any specific mitigation measures identified during the assessment.

9.8.9 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.

9.8.10 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. A specialist spill response contractor would be identified to deal with any major environmental incidents.

9.8.11 The Contractor would develop 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 to different personnel and the inspection and

maintenance regimes of sediment and runoff control measures will be adopted during these periods.

- 9.8.12 In extreme cases, the procedures would dictate that work on-site may have to be temporarily suspended until weather / ground conditions allow or additional mitigation is put in place.

Soil Storage and Peat Management

- 9.8.13 Soils in areas taken for temporary use (e.g. the borrow pits) will be stockpiled close to the excavation location in storage bunds and replaced following completion of construction. Topsoil and subsoil will be stripped and stored separately following best practice for re-use.
- 9.8.14 Installation of building and wind turbine foundations, access tracks and cable trenches will require the permanent excavation and removal of surface soil and peat. Where appropriate and agreed with landowners, soils excavated from these areas will be stockpiled and reinstated or reused within the development area as the construction works are completed (e.g. used for reinstatement of borrow pits and landscaping along road verges).
- 9.8.15 A draft Peat Management Plan (PMP) is included as Appendix 9.3. The draft PMP expands on the information obtained as part of the survey work and includes the following information:
- an overview of peat conditions on-site;
 - the activities that will require peat excavation along with associated volumes;
 - the classification of this peat and its suitability for re-use;
 - identification of restoration and reinstatement options including the volumes of peat required and the likely source; and
 - details on the handling and storage of excavated peat.
- 9.8.16 Further information management of excavated materials and reinstatement is also contained within the CEMP (Appendix 4.1).

Ground Stability

- 9.8.17 Good construction practice and methodologies to prevent peat instability within areas that contain peat deposits are identified in the Peat Landslide Hazard Risk Assessment (Appendix 9.1). 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 wind turbine bases, crane hardstandings and access track alignments to minimise effects on the prevailing surface and sub-surface hydrology;
 - raising peat instability 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 accelerated 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 will require minimal maintenance; and
- developing drainage systems that will not create areas of concentrated flow or cause over-, or under-saturation of peat habitats.

9.8.18 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 will be appointed as a supervisor, to provide advice during the setting out, micro-siting and construction phases of the Development.

Pollution Risk

9.8.19 Good practice measures in relation to pollution prevention include the following:

- foul water generated on site will be managed in accordance with PPG 4;
- drip trays will be placed under vehicles which could potentially leak fuel/oils;
- concrete will be batched at the designated batching location only;
- areas will be designated for washout of vehicles which are a minimum distance of 50m from a surface watercourse;
- washout water will be stored in the washout area before being treated and disposed of;
- any water contaminated with silt or chemicals will not be discharged directly or indirectly to a watercourse without treatment;
- procedures will be adhered to for storage of fuels and other potentially contaminative materials in line with the Water Environment (Oil Storage) (Scotland) Regulations 2006, to minimise the potential for accidental spillage; and
- a plan for dealing with spillage incidents will be designed prior to construction for inclusion in the CEMP.

9.8.20 In order to minimise the potential for accidental spills of potentially contaminating substances (including fuels, oils and solvents) during the construction, operation and decommissioning phases, the relevant PPGs will be adhered to.

Erosion and Sedimentation

9.8.21 Good practice measures for the management of erosion and sedimentation are detailed in the draft CEMP (Appendix 4.1) and will include the following:

- all stockpiled materials will be located outwith a 50m buffer from surface watercourses;
- stockpiled material will be either seeded or appropriately covered;

- water will be prevented from entering excavations, such as borrow pits, as far as possible through the use of appropriate cut-off drainage;
- where the above is not possible, water that enters the borrow pit will pass through a number of settlement lagoons to remove silt prior to discharge into the surrounding drainage system with further incorporated silt mitigation measures before discharge over vegetation away from watercourses or sensitive habitats;
- where other means are not practicable, flocculation stations will be used to capture suspended sediments;
- clean and dirty water will be separated through use of cut-offs and diversion drains, and dirty water will be filtered before discharge;
- where material is stockpiled on a slope, silt fences will be located at the base of the slope to reduce sediment transport;
- the amount of ground exposed, and the time period during which it is exposed, will be kept to a minimum and appropriate drainage will be in place to prevent surface water entering deep excavations, specifically borrow pit excavations;
- section specific temporary drainage arrangement drawings may be produced prior to construction in sensitive areas and will incorporate measures to minimise release of sediments into surface watercourses – this may include silt traps, check dams, diffuse drainage, geotextiles or straw bales;
- activities involving the movement or use of fine sediment will avoid periods of heavy rainfall where possible; and
- tracks will be kept as free as possible from excessive mud deposits.

Maintenance of Existing Surface Water Flow Paths

- 9.8.22 The following best practice measures will be adopted to ensure that existing water catchment areas to the areas of highly GWDTE are maintained:
- adequate cross drains will be installed beneath the proposed access track that lies within these surface water catchments to ensure current surface water flow paths are maintained;
 - any temporary dewatering from the proposed wind turbines within the surface water catchments will be discharged locally to ground and within the same surface water catchments as it is abstracted from;
 - during construction and decommissioning an Ecological Clerk of Works (ECoW) will be deployed to assess the effectiveness of the drainage measures; and
 - drainage and water monitoring protocols will be specified in the CEMP that will allow the contractor and ECoW to monitor and maintain drainage paths and water quality.

Surface Water Runoff

- 9.8.23 The following measures will be built into the Development design to ensure no increase in surface water runoff from the site:

- 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;
- appropriate use of Sustainable Drainage Systems (SuDS) such as cut-off ditches and attenuation features 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
- new site access tracks will be constructed of inert granular material to promote infiltration of incident rainfall and will have ditches or similar alongside the track construction.

Water Abstractions

- 9.8.24 Abstraction of water for construction activities and to supply the Operations Building is proposed from a suitable source to be identified during the detailed design stage. An application for a CAR Licence would be submitted to SEPA and managed through the regulation of the CAR Licence.
- 9.8.25 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.

9.9 Residual Effects

Geology and Soils

Loss of Rock and Soils

- 9.9.1 During construction, the main effect on solid geology will be the localised removal of in-situ geological deposits during earthwork excavations. The geological deposits at the site do not have any particular geological rarity value and do not display any significant features which cannot be observed elsewhere. Therefore, their sensitivity is considered to be low. The magnitude of change is considered to be negligible, as the volume of rock that will be excavated as part of the Development is very small when compared to the overall area of the underlying bedrock deposits. Therefore the residual effect associated with loss of rock is assessed as **not significant**.
- 9.9.2 Peat deposits may be excavated and/or degraded in localised areas as a result of construction of access tracks, turbine foundations, borrow pits and other infrastructure. Review of the baseline conditions indicates that the majority of the site is underlain by peat deposits of varying depth, and the peat deposits are considered to be of high sensitivity to the Development. However, the design of the Development has been progressed to minimise the number of wind turbines and associated infrastructure within areas of deep peat, and a 'floating track' design, which does not involve any excavation,

will be utilised in areas where the peat depth is greater than 1m. Furthermore, a PMP will be implemented to ensure maximum re-use, reinstatement and restoration of excavated peat. Therefore the overall magnitude of change is considered to be minor and the residual effect associated with loss of peat is assessed to be of **minor** significance.

- 9.9.3 Soils will be stripped to enable construction of access tracks, the construction compound, crane hardstandings, wind turbine foundations and borrow pit excavations. Following the implementation of appropriate mitigation measures to enable re-use of soils on-site, the magnitude of change is considered to be negligible. The sensitivity of soils is considered to be low, therefore the residual effect associated with loss of soils is assessed as **not significant**.

Ground Stability

- 9.9.4 The Peat Slide Risk Assessment (see Appendix 9.1) has shown that the majority of the site is located in an area assessed at negligible or low risk of ground instability. No development is proposed in areas assessed of medium or high ground instability.
- 9.9.5 Subject to the best practice construction techniques and mitigation (see Appendix 9.1) which would include intrusive site investigation to inform the detailed site design, the magnitude of change is considered to be negligible. The sensitivity of soils is considered to be low, therefore the residual effect associated with ground instability is assessed as **not significant**.

Groundwater Levels and Flows

Groundwater Recharge

- 9.9.6 The construction of the wind turbines, access tracks and infrastructure for the Development have the potential to reduce the amount of recharge to the shallow groundwater system within the permeable horizons of the Glacial Till, thereby locally affecting shallow groundwater levels and flow regime. The magnitude of change is considered to be negligible, because the combined footprint of impermeable development is very small when compared to the overall area of the Glacial Till deposits. In addition, the proposed new tracks will be constructed from inert site won aggregate, which will encourage infiltration of rainfall and maintain recharge. The sensitivity of the shallow groundwater system receptor, where present below the wind farm infrastructure, is considered to be low due to its local importance and scale. Therefore, the residual significance of effect is assessed as **not significant**.
- 9.9.7 The bedrock beneath the site is impermeable, generally without groundwater except in the near surface weathered zone and secondary fractures. Under baseline conditions, groundwater recharge from the surface will be further restricted by the presence of low permeability Glacial Till and peat deposits above. Therefore, the magnitude of change of recharge to the bedrock aquifer without mitigation is also considered to be negligible. The sensitivity of the bedrock aquifer receptor is considered to be low, given its low permeability and lack of groundwater to support local supplies. The residual significance of effect is therefore assessed as **not significant**.

Groundwater Flow

- 9.9.8 Drainage activities during construction of the Development (e.g. dewatering of wind turbine foundation excavations and borrow pits) may lead to temporary changes in the surrounding water table. Construction of access tracks and other areas of hardstanding, although only excavated to shallow depths, may also impact on local shallow groundwater flows.
- 9.9.9 Wind turbine foundation excavations may require temporary dewatering during construction, leading to a localised lowering of the water table. Any groundwater entry into shallow excavations is expected to be readily controlled by temporary pumping over a very short timescale, and resulting in temporary and very localised minor magnitude effect on groundwater levels and flow regime immediately adjacent to the foundation excavations. The sensitivity of shallow groundwater levels and flow regime to temporary dewatering is considered to be low, given their local importance and scale. The residual effect of dewatering is therefore assessed as **not significant**.
- 9.9.10 Foundations placed below the shallow or superficial groundwater table may locally alter shallow groundwater flow pathways in the vicinity of the foundation, due to the impermeable nature of concrete foundations. The magnitude of change is assessed as negligible, reflecting the small localised footprint of each of the proposed foundations compared to the extent of the underlying deposits. Groundwater in these deposits, where present, will readily flow around the turbine foundations. Therefore the residual effect is assessed as **not significant**.
- 9.9.11 As construction of some of the proposed infrastructure is required through the buffers associated with GWDTEs, there is potential to disrupt water contributions to these habitats. A detailed assessment of effects on the GWDTEs identified at the site is provided in Appendix 9.2. In summary:
- the areas of M15 habitat (listed as moderately groundwater dependent in SEPA guidance) are, in this hydrological setting, likely to be rainwater fed and therefore avoidance of disturbance of M15 habitat at this site is not required;
 - some of the areas of M6c habitat recorded at the site are considered likely to be at least partially supported by groundwater, and are therefore potential GWDTE;
 - the areas of potential GWDTE are considered to be of very high sensitivity;
 - with adoption of best practice construction techniques to maintain existing surface water flow paths, the magnitude of change associated with the Development is considered to be negligible; and
 - the residual effect on GWDTE is therefore assessed to be **not significant**.

Groundwater Quality

- 9.9.12 The sensitivity of the groundwater receptors in terms of groundwater quality is assessed as medium, given the following:
- the protection of groundwater and surface water quality as required by the EC Water Framework Directive (2000/60/EC) and the classification of the underlying Northern Highlands Drinking Water Protection Area as being of 'Good' overall status;

- the presence of impermeable psammite bedrock beneath the site, which is generally without groundwater except at shallow depth; and
 - the absence of any licensed or private water supplies within hydraulic continuity with the site.
- 9.9.13 The magnitude of change to groundwater quality due to spillage of fuels, lubricants and other potentially contaminative liquids during the construction phase is considered to be negligible, given the following:
- the pollution control and environmental measures included within the CEMP;
 - the relatively small areas of the site where spillage of fuels, lubricants and other potentially contaminative liquids could potentially occur; and
 - the relatively small number of vehicles that will be using the site.
- 9.9.14 Given the above, the significance of effect to groundwater quality is assessed as **not significant**.

Surface Water Flows and Flood Risk

- 9.9.15 The Development has the potential to alter the hydrological regime of the site due to construction of impermeable surfaces such as the wind turbine bases, construction of site drainage and abstraction of water to provide a water supply. However, following the implementation of mitigation measures outlined above, the magnitude of change is considered to be negligible.
- 9.9.16 The sensitivity of the surface water receptors to flow regime change is assessed as high. The residual significance of effect is therefore assessed as **not significant**.

Surface Water Quality

- 9.9.17 The sensitivity of the surface water receptors in terms of water quality is assessed as very high, given the following:
- the protection of surface water quality as required by the EC Water Framework Directive (2000/60/EC);
 - the classification of surface watercourses draining the site as being of 'Good' overall status; and
 - the designation of the River Brora as a Salmonid Water under the Surface Waters (Fishlife) (Classification) (Scotland) Direction 1999.
- 9.9.18 The magnitude of change to surface water quality due to spillage of fuels, lubricants and other potentially contaminative liquids such as suspended solids is considered to be negligible, given the following:
- the pollution control and environmental measures included within the CEMP;
 - the relatively small areas of the site where spillage of fuels, lubricants and other potentially contaminative liquids could potentially occur;
 - the relatively small number of vehicles that will be using the site; and

- the distances between the proposed infrastructure and the surface water drainage network at the site.

9.9.19 The residual effect associated with surface water quality is therefore assessed as **not significant**.

9.10 Cumulative Effects

9.10.1 This section considers the potential cumulative effect of the Development on hydrology, hydrogeology and geology taking into consideration other developments within the same hydrological catchments as the Development and within 5km downstream of any proposed infrastructure. Any developments which are outwith the study area are not considered.

9.10.2 Gordonbush Wind Farm is located adjacent to the north of the Development and lies within the Allt a' Mhuilinn and Allt Smeorail catchments.

9.10.3 No other developments are proposed within the study catchments (the Allt a' Mhuilinn and Allt Smeorail catchments).

9.10.4 Gordonbush Wind Farm has already been constructed and is now operational. There will therefore be no cumulative effects associated with concurrent construction of the Development on geology and the water environment.

9.10.5 Each of the developments has the potential for a pollution event during operation. The surface water catchments and groundwater are considered to be of high sensitivity. The magnitude of a potential pollution event at each development should be negligible following good practice measures. This would result in a cumulative effect which is negligible and **not significant**.

9.10.6 There is potential for an increase in runoff associated with areas of hardstanding at each development during operation, which may increase the peak runoff received in catchments draining the site. The potential increase in peak runoff from each development will be mitigated through the detailed design of the individual drainage systems. The developments will be managed to ensure there is no increased downstream flood risk. The cumulative effect of the developments on surface water runoff is therefore considered to be **not significant**.

9.10.7 It is concluded that there would be no significant cumulative effects, as the cumulative effect of these two developments would be unlikely to be greater than that of either of the developments individually.

9.11 Conclusions

9.11.1 The assessment has confirmed, subject to best practice measures, that the proposed Development will not have any significant effects on hydrology, hydrogeology and geology.

9.12 Statement of Significance

9.12.1 An assessment of the potential effects of the Development on hydrology, hydrogeology and geology within a defined study area (comprising land within 2km of the site boundary)

has been undertaken and no *significant* impacts in terms of the EIA Regulations have been identified.

9.13 References

British Geological Survey (1990). Hydrogeology of Scotland.

British Geological Survey (1998). Hydrogeological Map of Scotland.

Centre for Ecology and Hydrology (2009). Flood Estimation Handbook CD ROM Version 3.

Construction Industry Research and Information Association (2002), Control of Water Pollution from Construction Sites - Guide to Good Practice.

Construction Industry Research and Information Association (2005), Environmental Good Practice on Site C650.

Construction Industry Research and Information Association (2006), Control of Water Pollution from Linear Construction Projects C649.

Construction Industry Research and Information Association (2007), The SuDS Manual.

Northern Ecological Services (2012). Gordonbush Wind Farm Water Quality Monitoring Final Report. Report to SSE.

Northern Ecological Services (2010). Report to SSE: Gordonbush Wind Farm Habitat Management Plan; Report of survey to identify ditches for blocking.

Scottish Environment Protection Agency, Environment Agency and the Environment and Heritage Service in Northern Ireland Pollution Prevention Guidelines (PPG).

Scottish Environment Protection Agency (2014). Land Use Planning System – SEPA Guidance Note 4: Planning guidance on onshore windfarm developments, Version 7.

Scottish Environment Protection Agency (2014). Land Use Planning System – SEPA Guidance Note 31: Guidance on assessing the impacts of development on groundwater abstractions and groundwater dependent terrestrial ecosystems, Version 1.

Scottish Environment Protection Agency (2014). Technical Flood Risk Guidance for Stakeholders, Version 8.

Scottish Environment Protection Agency (2004). Groundwater Vulnerability Map of Scotland.

Scottish Government (2004), Planning Advice Note 69: Planning and Buildings Standards Advice on Flooding.

Scottish Government (2006), Planning Advice Note 51: Planning, Environmental Protection and Regulation.

Scottish Government (2014), Scottish Planning Policy.

Scottish Renewables, Scottish Natural Heritage, Scottish Environment Protection Agency, Forestry Commission Scotland and Historic Scotland, (2013), Good Practice During Wind Farm Construction (2nd Edition).

Scottish Renewables and Scottish Environment Protection Agency 2012), Developments on Peatland: Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and the Minimisation of Waste, Version 1.

Smith, B. (2012). Gordonbush collaborative research project: Assessing carbon and nutrient leakage from peatland soils arising from the Gordonbush Renewable Energy Development. 6 month progress report July 2011 – December 2011. Report 3 to SSE Renewables Development (UK) Ltd, March 2012.