



# Chapter 7

Hydrology, Hydrogeology, Geology and  
Soils

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# Chapter 7

## Hydrology, Hydrogeology, Geology and Soils

### 7.1 Introduction

1. This chapter assesses the potential impacts of the proposed Development on hydrology, hydrogeology, geology and soil resources. This includes detailed consideration of potential impacts on surface watercourses, groundwater and the local geology in and around the Site and any potential impacts on flood risk in the local area. Potential impacts on peat deposits, and risks associated with peat landslide, are also assessed.
2. This chapter presents the current environmental setting (baseline) for the related environmental topics and associated links to other chapters such as **Chapter 8: Ecology & Biodiversity**. Desktop and Site-based surveys, including peat depth surveys, have been carried out to inspect and identify potentially sensitive hydrogeological, hydrological and geological receptors.
3. For the purposes of this assessment, watercourses have been identified as those which appear on the Ordnance Survey (OS) 1:50,000 scale maps (refer to **Figures 7.2a and 7.2b**). However, onsite observations of man-made field drains have also been made and the presence of these has been taken into account in the design of the proposed Development and any mitigation measures.

### 7.2 Legislation, Policy and Guidelines

#### 7.2.1 Legislation

4. Regulation of activities relating to the water environment in Scotland is the responsibility of the Scottish Environment Protection Agency (SEPA) and the relevant local authorities.
5. The European Union (EU) *Water Framework Directive* (WFD) has been implemented in Scotland through the *Water Environment and Water Services (Scotland) Act 2003* (WEWSA). This Act introduced a regulatory system for the water environment with SEPA as the lead authority working alongside the public, private and voluntary sectors. The Act ensures that all human activities with the potential to cause a harmful effect on the water environment can be controlled by establishing a framework for co-ordinated controls on water abstraction and impoundment, engineering works affecting watercourses, and discharges to the water environment.
6. The European Commission (EC) Groundwater Directive provides specific measures to protect groundwater against pollution and deterioration. This Directive is implemented through the *Water Environment (Controlled Activities) (Scotland) Regulations 2011* (CAR) (as amended), introduced under WEWSA to provide the main regulatory controls for protecting the water environment from harm. CAR introduced specific controls for activities affecting watercourses and waterbodies.
7. SEPA maintains water monitoring and classification systems that provide the data to support the aim of the WFD, namely that all waterbodies would have good ecological status, or similar objective, by 2015. The *River Basin Management Plan for the Solway Tweed River Basin District: 2015 update* (Environment Agency and the Scottish Government, 2015) and *River Basin Management Plan for the Scotland River Basin District: 2015-2027* (Scottish Government, 2015) provide updated improvement objectives for water bodies and protected areas for the period 2015 to 2027. The classification system covers all rivers, lochs, transitional, coastal and groundwater bodies.

8. The relevant legislation relating to flood prevention is the *Flood Risk Management (Scotland) Act 2009*, which replaces the *Flood Prevention (Scotland) Act 1961* (as amended).

#### 7.2.2 Policy

9. The policies set out below include those from the *Dumfries and Galloway Local Development Plan 2* (LDP, 2019). This section also considers the relevant aspects of *Scottish Planning Policy* (SPP), Planning Advice Notes (PAN) and other relevant guidance. Of relevance to the hydrological, hydrogeological, geological and soils assessment presented within this chapter are the following policies and advice notes:
  - LDP, Policy OP1 Development Considerations, parts (a) General Amenity, (d) Biodiversity and Geodiversity, (f) Sustainability, and (g) Water Environment;
  - LDP, Policy NE6 Sites of National Importance for Biodiversity and Geodiversity;
  - LDP, Policy IN2 Wind Energy;
  - LDP, Policy NE11 Supporting the Water Environment;
  - LDP, Policy NE12 Protection of Water Margins;
  - LDP, Policy IN7 Flooding and Development;
  - LDP, Policy NE14 Carbon Rich Soil;
  - LDP, Policy NE15 Protection and Restoration of Peat Deposits as Carbon Sinks;
  - LDP, Policy IN8 Surface Water Drainage and Sustainable Drainage Systems (SuDS);
  - LDP, Policy IN1 Renewable Energy;
  - PAN 51: Planning, Environmental Protection and Regulation (Scottish Executive, 2006);
  - Scottish Government Online Planning Advice on Flood Risk (2015);
  - PAN 79: Water and Drainage (Scottish Executive, 2006) and
  - Scottish Planning Policy (Scottish Government, 2014).

#### 7.2.3 Guidance

10. The following relevant guidance has been considered as part of the assessment of hydrology, hydrogeology, geology, and soils effects and stipulation of appropriate mitigation measures:
  - SEPA Supporting Guidance (SAT-SG-75) – Sector Specific Guidance: Construction Sites (2018);
  - SEPA Pollution Prevention Guideline (PPG) 1: Understanding your environmental responsibilities - good environmental practices (2013);
  - Special Requirements for Civil Engineering Contracts for the Prevention of Pollution v2 (SEPA, 2006);
  - SEPA GPP 5: Works and maintenance in or near water (SEPA, 2018);
  - SEPA Policy 19: Groundwater Protection Policy for Scotland (Version 3, 2009);
  - SEPA Policy 41: A Planning Authority Protocol Development at Risk of Flooding: Advice and Consultation (SEPA, 2016);
  - Good practice during wind farm construction, 4<sup>th</sup> edition (Scottish Renewables, Scottish Natural Heritage, SEPA, Forestry Commission Scotland and Historic Scotland, 2019);
  - CIRIA C532: Control of Water Pollution from Construction Sites - Guidance for Consultants and Contractors (CIRIA, 2001);
  - SEPA Guidance Note 4: Planning advice on wind farm developments, LUPS-GU4 (SEPA, 2017);
  - SEPA Guidance Note 31: Guidance on assessing the impacts of development proposals on groundwater abstractions and Groundwater Dependent Terrestrial Ecosystems (SEPA, 2017);
  - Guidance on Developments on Peatland - Site Surveys (Scottish Natural Heritage, SEPA and The James Hutton Institute, 2017);
  - Developments on Peatland: Guidance on the assessment of peat volumes, reuse of excavated peat and the minimisation of waste (Scottish Renewables and SEPA, 2012);
  - Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments (Second Edition) (Scottish Government, 2017); and
  - The UK Forestry Standard (Forestry Commission 2017).

## 7.3 Consultation

11. **Table 7.3.1** summarises the consultation responses received from relevant regulatory consultees, and provides information on where and how they have been addressed in the assessment, where relevant.

Table 7.3.1 Consultation Responses

Consultee (Date)	Issues Raised	Response / Action Taken
Scottish Government Energy Consents Unit (ECU) – May 2019	Request that Scottish water is consulted, and any Scottish Water assets identified.	This consultation has been undertaken and Scottish Water has reported no infrastructure in the vicinity of the proposed Development which could be affected by it (see Scottish Water consultation section below, in this table).
	Advise that where there is a demonstrable requirement for peat landslide hazard and risk assessment, the assessment should be undertaken as part of the EIA process. The <i>Peat Landslide Hazard and Risk Assessment: Best Practice Guide for Proposed Electricity Generation Development (Second Edition)</i> should be followed.	A peat landslide hazard and risk assessment has been undertaken and is reported in <b>Technical Appendix 7.2: Peat Landslide Hazard and Risk Assessment</b> , summarised in <b>Section 7.5.1.2</b> .
South Ayrshire Council (SAC) – May 2019	Prior to commencement of works, Applicant to submit for approval the following: <ul style="list-style-type: none"> <li>- detailed method statement, detailing all proposed mitigation related to the protection of watercourses and water supplies; and</li> <li>- management plan for minimising the emission of dust</li> </ul>	Detailed method statements would be included in the Construction Environmental Management Plan (CEMP) (refer to <b>Section 7.6.1</b> ).
	To have a proposed site in perpetuity will require robust risk assessment measures, and clear, detailed plans relating to proposed future construction which could also have the potential to affect Private Water Supplies (PWS).	Potential effects of the construction and operation (in perpetuity) of the proposed Development on PWS have been assessed, with appropriately mitigation stipulated and residual effects assessed (refer to <b>Sections 7.6 to 7.8</b> ).
SAC Environmental Health Officer (EHO) – June 2019	Consultation with SAC EHO to identify any PWS within the study area.	No PWS have been identified within the study area. The locations of identified PWS in the vicinity (within approximately 2.5km of the Site) are shown on <b>Figure 7.3</b> . The identified PWS are discussed in <b>Section 7.5.2.3</b> .
Scottish Environmental Protection Agency (SEPA) – April 2019	Advise that the EIA includes the following: <ul style="list-style-type: none"> <li>- Map and assessment of all engineering activities in or impacting on the water environment;</li> <li>- Map and assessment of impacts upon groundwater abstraction and buffers;</li> <li>- Peat depth survey and table detailing re-use proposals;</li> <li>- Borrow Pit Site Management Plan and a map of borrow pits locations;</li> <li>- Schedule of mitigation including pollution prevention measures; and</li> <li>- Map of proposed waste water and surface water drainage layouts, and proposed water abstractions.</li> </ul>	Details of proposed new and altered water crossings are provided in <b>Technical Appendix 7.3: Water Crossing Schedule</b> .
		No groundwater abstractions have been identified within influencing distance of the proposed Development (refer to <b>Section 7.5.2.3</b> ).  Full details of peat surveys and re-use proposals are in <b>Technical Appendix 7.1: Outline Peat Management</b> and

Consultee (Date)	Issues Raised	Response / Action Taken
		<p><b>Restoration Plan and Technical Appendix 7.2: Peat Landslide Hazard and Risk Assessment.</b></p> <p>Borrow pit search area locations are shown on <b>Figures 7.2a and 7.2b</b>. They are also shown on <b>Figure 4.1</b> and described in <b>Chapter 4: Description of Development</b>. An outline CEMP, including borrow pit management measures, is included as <b>Technical Appendix 4.1</b>. If the proposed Development is granted consent, a Borrow Pit Management Plan will be produced, including additional details to be agreed prior to commencement of construction.</p> <p>A summary of mitigation measures applicable to hydrology, hydrogeology, geology and soils is included within <b>Table 7.10.1</b>. A full schedule of all committed mitigation measures is given in <b>Chapter 15: EIA Summary</b> of this EIA Report.</p> <p>Outline drainage arrangements are discussed in <b>Section 7.6.1</b> and would be developed further as part of a detailed Drainage Strategy to be agreed prior to commencement of construction.</p> <p>As noted in <b>Chapter 4: Description of Development</b>, water would be required for onsite batching. An abstraction licence, if required, would be carried out under authorisation from SEPA, with relevant regulation/permits to be obtained by SPR.</p>
	Expect sufficient detail to be provided in the EIA which will ensure that the site activities will not exacerbate the existing flood risk extent and highlight SEPA guidance of Flood Risk Assessment.	Potential flood risk is discussed in <b>Section 7.5.4</b> .
	Peat Disturbance to be minimised and where it cannot be avoided expect full details to be provided on the proposed reuse of the peat arising. To be addressed in a Peat Management Plan.	Refer to <b>Technical Appendix 7.1: Outline Peat Management and Restoration Plan</b> .
	A Controlled Activities Regulations (CAR) construction site licence may be required, and the Applicant is advised to engage in pre-CAR application discussions with the local SEPA office.	Noted.
SEPA – July 2019	Consultation regarding the approach to Stage 1 peat survey due to dense forestry across majority of the Site impeding access. SEPA confirmed that the “proposed	Noted. The peat survey methodology is outlined in <b>Section 7.4.3</b> and detailed in full in <b>Technical Appendix 7.2: Peat</b>

Consultee (Date)	Issues Raised	Response / Action Taken
	<i>approach for the coarse site level peat survey seems sensible, pragmatic and acceptable</i> .	<b>Landslide Hazard and Risk Assessment.</b>
SEPA – October 2019	Further consultation with SEPA to confirm Stage 2 peat probing methodology and data collected provides sufficient information for the assessment. SEPA confirmed that <i>“we are satisfied that the data presented is satisfactory for our purposes”</i> .	Noted, as above.
SEPA – October 2019	Responded to Gatecheck report advising that they were satisfied with comments previously offered in their Scoping Response.	Noted.
Scottish Natural Heritage (SNH) – May 2019	Recommend that SEPA are consulted and that all works should be carried out in accordance with relevant hydrological legislation and SEPA’s Pollution Prevention Guidelines.	Noted. <b>Section 7.2</b> details the legislation and guidance referred to through this assessment.
	Advise that detailed peat surveys of the Site, measuring the peat deposit to full depth, should be undertaken in accordance with Scottish Government guidance. The results should be used to inform a peat landslide risk assessment and to inform the design and layout process. Welcome the proposals for a Peat Management Plan (PMP)/Habitat Management Plan (HMP)	Detailed peat surveys have been undertaken as part of the assessment, as outlined in <b>Section 7.4.3</b> below. An Outline PMP and a Peat Landslide Hazard and Risk Assessment are included as <b>Technical Appendices 7.1 and 7.2</b> . An HMP is also included as <b>Technical Appendix 8.7</b> .
Cree Valley Community Council (CVCC) – May 2019	Assessment to include impacts of increased surface water run-off which may increase flood risk to River Cree catchment, and mitigation measures considered. Do not agree that operational effects upon hydrology should be scoped out.	Potential flood risk is discussed in <b>Section 7.5.4</b> , with mitigation outlined in <b>Sections 7.6.1 and 7.7</b> .
	State that the effects of peat disturbance upon the hydrology of the River Cree must be considered and that peat disturbance during clear felling should be considered.	A Peat Landslide Hazard and Risk Assessment is included as <b>Technical Appendix 7.2</b> . This considers the River Cree as a sensitive receptor.
	Recommend that Dumfries & Galloway Council - and the flood studies carried by Consultants on their behalf in respect to the recent flood events and flood prevention scheme - are consulted.	Dumfries & Galloway Council has been consulted as part of this EIA process.
Galloway Fisheries Trust (GFT) – May 2019	There are significant amounts of deep peats in the proposed work area. Peat depth surveys will be important and development should aim to avoid deep peat damage and consider undertaking peatland restoration in appropriate areas to compensate for any peat damage.  Highlights that risk of acidification of watercourses associated with conifer afforestation and the drainage of the deep peats, which impacts of fish populations. This acidification has impacted on wild fish populations. Recommend constant water quality monitoring equipment would be required. Request the opportunity to comment on any water quality monitoring plan based on extensive experience monitoring acidification in Galloway.	Findings of detailed peat surveys have guided proposed Development design iteration, together with other environmental and technical constraints. Some peat excavation and disturbance would be unavoidable, and appropriate management, restoration and re-use proposals are discussed in <b>Section 7.7</b> and <b>Technical Appendix 7.1: Outline Peat Management and Restoration Plan</b> . Further information, including an outline HMP, is provided in <b>Technical Appendix 8.7</b> . The Applicant will be happy to engage with GFT in respect of peat excavation and restoration proposals, and water quality monitoring plans.

Consultee (Date)	Issues Raised	Response / Action Taken
RSPB	Concerns over the potential impacts to deep peat and would wish to see this as a focus for any mitigation and habitat enhancement.	An Outline PMP and HMP are included within <b>Technical Appendices 7.1 and 8.7</b> .
Scottish Water – March 2019	No objection to the proposed Development. There is no public Scottish Water, Waste Water infrastructure within the vicinity of this proposed Development. There are no Scottish Water drinking water catchments or water abstraction sources in the area that may be affected by the proposed Development.	Noted.
	There is currently sufficient capacity in the Penwhapple Water Treatment Works. Note that Scottish Water are unable to reserve a capacity at their water and/or waste water treatment works and will not accept any surface water connection into their combined sewer system.	Noted.
	Advise that development proposals may impact on existing Scottish Water assets. The applicant should contact Scottish Water Asset Impact Team to identify any potential conflicts.	Scottish Water has been consulted regarding assets. Response below.
Scottish Water - October 2019	Updated application boundary sent to Scottish Water by ITPEnergised to confirm if assets may be impacted by proposed Development. Response from planning team confirmed that there is no Scottish Water infrastructure within the vicinity of the final proposed Development boundary.	No further action required.

## 7.4 Assessment Methodology and Significance Criteria

### 7.4.1 Study Area

- The study area has incorporated the area within the application boundary and this assessment also considers any potential hydrological and hydrogeological effects up to 1km from the application boundary (see **Figure 7.1**).
- Efforts have been made, via consultations, Site survey work and review of OS mapping, to identify any PWS for an area within 500m of the proposed Development boundary.
- The criteria for defining the study area have been established based on the professional judgement and experience of the technical authors with regard to likely access and working areas, and with due consideration to the relevant guidance on hydrological and geological assessment.

### 7.4.2 Desk Study

- Baseline conditions have been established primarily through desk-based research which has included:
  - consultation with SEPA, SNH, and SAC;
  - identification of the locations and characteristics of catchments and principal watercourses and waterbodies, as shown on 1:50,000 scale OS mapping which may be affected by construction activities;
  - identification of SEPA/WFD watercourse and waterbody classification;
  - review of on-line SEPA flood mapping;
  - review and collation of pertinent information on surface hydrology, flooding, climate, etc.;
  - review of on-line British Geological Survey (BGS) geological mapping of the area; and
  - review of drainage / surface water and hydrogeological characteristics and groundwater resource.

### 7.4.3 Field Surveys

16. A preliminary Site visit was undertaken by an experienced geo-environmental specialist on 16 May 2019. Field notes were taken onsite, noting information on ground and surface water conditions as appropriate.
17. Stage 1 peat depth probing was undertaken by a team of surveyors over a series of Site visits on 3 to 5 June 2019, 9 to 10 June 2019, 10 to 13 June 2019 and 6 to 9 August 2019. The surveys aimed to achieve a good coverage of the Site in line with guidance provided in *Guidance on Developments on Peatland - Site Surveys* (Scottish Natural Heritage, SEPA and The James Hutton Institute, 2017), while recognising the access restrictions resulting from dense conifer forestry cover across much of the Site area. Surveys targeted breaks in the forestry where possible (e.g. forestry rides and watercourses) although wind-blow had resulted in substantial blockage of many forestry rides. Return visits over the above time periods served to ensure that a suitable coverage of the developable areas of the Site was achieved, in consultation with SEPA (refer to Table 7.3.1).
18. Data obtained from the peat depth surveys were used to plot the presence and distribution of peat across the proposed infrastructure development areas at the Site, create a contour plan, and feed into detailed design iteration.
19. Following the second design iteration workshop, a “design chill” was agreed, considered by the project team to represent the best possible turbine and infrastructure layout to optimise yield whilst minimising environmental effects, including effects on hydrology, hydrogeology, geology and soils resources.
20. A Stage 2 peat depth probing exercise was subsequently undertaken on 9 to 13 September 2019 and 23 to 27 September 2019, to record peat depth at each proposed turbine and hardstanding location, along the route of proposed access tracks, and at proposed infrastructure locations including construction compounds and laydown area, substation, and control compound. The following pattern of probing was adopted for Stage 2:
  - probe at each proposed turbine location with a 10m spaced cross-grid out to 50m from the turbine centre to the north, south, east and west;
  - several probes at each proposed turbine hardstanding area;
  - seven probes at the proposed substation and permanent compound location;
  - six probes at each proposed temporary construction compound;
  - several probes at each proposed new borrow pit location, equivalent to approximately a 50m grid or better, with the exception of borrow pit BP-F;
  - three probes in the immediate vicinity of the proposed permanent met mast;
  - generally, every 50m along proposed new access tracks, plus approximately 10m either side of each probe, perpendicular to the route of the track, with some minor exceptions where access was particularly challenging and sufficient data was available from Stage 1 probing in nearby, relatively accessible locations; and
  - probes on either side of the existing Drumjohn access road, approximately every 200m to 330m and targeting proposed lay-by areas (in addition to borrow pit search areas and proposed construction compound locations along this road).
21. Peat sampling was undertaken using a hand auger, at proposed turbine and infrastructure locations. Peat samples were collected and dispatched to Envirolab laboratory and tested for moisture content, bulk density, and carbon content, in order to help characterise the peat at different locations and depths across the Site. Further detail is provided in **Technical Appendix 7.2: Peat Landslide Hazard and Risk Assessment**.
22. The data were subsequently used to inform the final design freeze and to inform a Peat Landslide Hazard and Risk Assessment (PSHRA) and development of an outline Peat Management Plan; refer to **Technical Appendix 7.1: Outline Peat Management Plan** and **Technical Appendix 7.2: Peat Landslide Hazard and Risk Assessment**.
23. A review of surface watercourses including existing and proposed water crossings was also undertaken, although a more detailed review of proposed water crossings, to input to their siting and outline design, was undertaken by the project engineer (SSG Projects) on 22 May 2019.
24. A National Vegetation Classification (NVC) survey was undertaken by ITP Energised, included identification of habitats which may be groundwater dependent, in accordance with SEPA guidance document LUPS-GU4 (SEPA, 2017).

### 7.4.4 Assessment of Effect Significance

25. The sensitivity characteristics of hydrological, hydrogeological, geological and soils resources have been guided by the matrix presented in **Table 7.4.1**, which lists indicative criteria.

Table 7.4.1: Sensitivity Criteria (Hydrology, Hydrogeology, Geology and Soils)

Sensitivity	Description
High	<p>Areas containing geological, geomorphological or hydrological features considered to be of national interest, for example, Aquatic Natura 2000 Sites, SACs, SSSIs.</p> <p>Highly permeable superficial deposits allowing free transport of contaminants to groundwater and surrounding surface waters.</p> <p>Wetland/watercourse of High or Good Ecological Status.</p> <p>Raised or blanket bog.</p> <p>High risk of flooding.</p> <p>Land capable of supporting Arable Agriculture i.e. Class 1, 2 and 3.1.</p>
Medium	<p>Areas containing features of designated regional importance, for example, Regionally Important Geological and Geomorphological Sites (RIGS) considered worthy of protection for their educational, research, historic or aesthetic importance.</p> <p>Moderately permeable superficial deposits allowing some limited transport of contaminants to groundwater and surrounding surface waters.</p> <p>Wetland/watercourse of Moderate Ecological Status.</p> <p>Significant peat deposits.</p> <p>Moderate risk of flooding.</p> <p>Land capable of supporting Mixed Agriculture i.e. Class 3.2, 4.1 and 4.2.</p>
Low	<p>Geological features not currently protected and not considered worthy of protection.</p> <p>Low permeability superficial deposits likely to inhibit the transport of contaminants.</p> <p>Wetland/watercourse of Poor or Bad Ecological Status or no WFD classification.</p> <p>Thin superficial peat deposits.</p> <p>Low risk of flooding.</p> <p>Land capable of supporting improved grassland or rough grazing only i.e. Class 5.1 to 7.</p>

26. The criteria for sensitivity have been developed based on a hierarchy of factors relating to quality of the aquatic and geological environment including international and national designations, water and soil quality information, waterbody status from the WFD review work undertaken to date by SEPA, consultations, Site visits, and the professional judgement of the assessment team.
27. The prediction and assessment of effects on hydrology, hydrogeology, geology and soils has been undertaken using a series of tables to document the various potential impacts from aspects of the construction and operational

phases of the proposed Development. Impacts have been predicted based on the guidance criteria for the magnitude of change set out in **Table 7.4.2**. The consent being sought for the proposed Development is in perpetuity, however in the event that the Site is to be decommissioned in future, impacts from aspects of decommissioning are considered to be the same as or lesser than for construction.

Table 7.4.2: Magnitude of Change Criteria (Hydrology, Hydrogeology, Geology and Soils)

Magnitude of Change	Guidance Criteria
High	Total loss of, or alteration to key features of the baseline resource such that post development characteristics or quality would be fundamentally and irreversibly changed, for example, extensive excavation of peatland or watercourse realignment.
Medium	Loss of, or alteration to key features of the baseline resource such that post development characteristics or quality would be partially changed, for example, in-stream permanent bridge supports or partial excavation of peatland.
Low	Small changes to the baseline resource, which are detectable but the underlying characteristics or quality of the baseline situation would be similar to pre-development conditions e.g. culverting of very small watercourses/drains.
Negligible	A very slight change from baseline conditions, which is barely distinguishable, and approximates to the 'no change' situation, for example short term compaction from machinery movements.

28. Using these criteria, potential effects resulting from the proposed Development have been assessed. These effects are presented in **Section 7.6**. Details of generic and embedded (design-related) mitigation measures are given in **Section 7.6.1** and additional, site-specific mitigation measures are given in **Section 7.7**. The remaining residual effects detailed in **Section 7.8**.
29. The significance of the predicted effects has been assessed in relation to the sensitivities of the baseline resource. A matrix of significance, based on the combination of magnitude of change and sensitivity of receptor, was developed to provide a consistent framework for evaluation. This is shown in **Table 7.4.3** below.

Table 7.4.3: Significance of Effect Matrix

Sensitivity of Receptor	Magnitude of impact			
	High	Medium	Low	Negligible
High	Major	Major	Moderate	Minor
Medium	Major	Moderate	Minor	Negligible
Low	Moderate	Minor	Negligible	Negligible
Negligible	Minor	Negligible	Negligible	Negligible

30. The guideline criteria for the various categories of effect are provided in **Table 7.4.4**.

Table 7.4.4: Significance Criteria (Hydrology, Hydrogeology, Geology and Soils)

Significance	Definition	Guidance Criteria
Major	A fundamental change to the environment.	Changes in water quality or quantity affecting widespread catchments or groundwater reserves of strategic significance, or changes resulting in substantial loss of conservation value to geological or aquatic habitats and designations.

Significance	Definition	Guidance Criteria
Moderate	A large, but non-fundamental change to the environment.	Changes in water quality or quantity affecting part of a catchment or groundwaters of moderate vulnerability, or changes resulting in loss of conservation values to geological or aquatic habitats or designated areas.
Minor	A small but detectable change to the environment.	Localised changes resulting in minor and/or reversible effects on soils, surface and groundwater quality or habitats.
Negligible	No detectable change to the environment.	No effects on geological resources, drainage patterns, surface and groundwater quality or aquatic habitats.

31. In the above classification, fundamental changes are those which are permanent, either adverse or beneficial, and would result in widespread change to the baseline environment. For the purposes of this assessment, those effects identified as being major or moderate have been evaluated as significant environmental effects.
32. These matrices have been used to guide the assessment, though they have been applied with a degree of flexibility, since the evaluation of effects will always be subject to location-specific characteristics which must be taken into account. For this reason, the evaluation of the significance of effects in particular will not always correlate exactly with the cells in the relevant matrix, especially where professional judgement and knowledge of local conditions may result in a slightly different interpretation of the impact concerned.
33. Cumulative effects have been accounted for through the prediction and evaluation of effects within the hydrological study area.
- 7.4.5 Requirements for Mitigation**
34. Committed mitigation measures are presented within this chapter where the potential to affect sensitive geological, soils, hydrological or hydrogeological receptors has been predicted. These may include temporary effects from construction or permanent/longer term effects associated with the operational phase of the proposed Development and its associated infrastructure. To a large extent, mitigation has been embedded or incorporated into the design process through appropriate siting of infrastructure, buffering of sensitive receptors, and stipulating good construction practice (refer to Section 7.6.1).
- 7.4.6 Assessment of Residual Effect Significance**
35. An assessment of predicted residual effects on sensitive geological, hydrological or hydrogeological receptors is presented within this chapter.
- 7.4.7 Limitations to Assessment**
36. No water quality monitoring or intrusive investigations, other than peat depth survey work as described in **Section 7.4.3**, have been undertaken.

## 7.5 Baseline Conditions

### 7.5.1 Geology and Soils

37. There are no geological SSSIs nor Geological Conservation Review sites within the study area.
38. BGS online mapping for the area shows that the bedrock geology underlying the Site comprises Ordovician sedimentary strata (wacke) of the Kirkcolm Formation, with localised occurrences of Galdenoch Formation (slightly younger wacke) around proposed Turbine 8 towards the west of the site and at proposed Borrow Pit B towards the

south of the Drumjohn Road access. A number of igneous intrusions (microdiorite of the North Britain Siluro-Devonian Calc-Alkaline Dyke Suite) are present towards the north end of the Drumjohn Road access and to the east of the Site. Immediately to the north west of the Site, bedrock comprises the Dalreoch Formation, which is also Ordovician age wacke with beds of chert.

39. The bedrock geology as shown on BGS 1:50,000 scale mapping is shown on **Figure 7.4**.
40. BGS mapping shows that the superficial geology across most of the study area is hummocky glacial deposits (till, comprising clays, sands and gravels), with localised deposits of peat. The highest areas of the Site in the north west are shown to have little or no superficial deposits.
41. Site observations support the mapping, with peat recorded to variable depth across much of the Site (see **Section 7.5.1.2** below), and exposures of till observed locally along the banks of watercourses (refer to **Photographs 7.5.1 and 7.5.2** below). The till appears to be discontinuous, based on some peat probes encountering rock at surface or directly below the peat (e.g. in the central area north east of proposed Turbine 9, south of proposed Borrow Pit H, near the southern Site boundary south west of proposed Turbine 2, and in the north east of the Site between and north of proposed Turbines 14 and 15).



Photograph 7.5.1: Exposed till on watercourse bank



Photograph 7.5.2: Exposed till on watercourse bank

42. In respect of the soil resource across the Site, it is noted that soils across most of the Site are defined as dystrophic blanket peat. Localised areas of poorly drained peaty gleys, non-calcareous gleys, and peaty gleyed podzols are present in the north and west. Much of the land around the Drumjohn Road access is identified as being underlain by peaty gleyed podzols, peat, and peaty gleys.

43. The superficial geology as shown on BGS 1:50,000 scale mapping is shown on **Figure 7.5**.

#### 7.5.1.1 Mining

44. The Site is not within an area which has been subject to historical coal mining. No evidence of underground mining for other minerals on any substantial scale has been identified.

45. No evidence of any large-scale historical quarrying has been observed through review of mapping, aerial photography, and Site survey work, although localised borrow pits have been identified as shown on **Figures 7.2a and 7.2b**, understood to have been excavated for use as part of the forestry operations onsite.

#### 7.5.1.2 Peat

46. Areas of peat shown on the BGS mapping include: in the west between Pindonnan Craigs and Loch Hill; several locations between and on the north side of the northern hills; several localised areas around proposed Turbines 15 and 16 and either side of the access track nearby; and a large area in the south, which the existing Drumjohn Road access crosses.

47. An area in the west of the Site (partly coincident with the area of peat shown on BGS mapping as noted above) is identified as being within an area of Class 1 Peat based on the SNH *Carbon and Peatlands Map* (2016). This is defined as “nationally important carbon-rich soils, deep peat and priority peatland habitat; areas likely to be of high conservation value.” Several other, smaller areas of Class 1 Peat are shown in the north and east of the Site, at least 150 m from any proposed infrastructure.

48. Much of the remaining Site area is shown as Class 5 (“peat soil”), with areas of Class 3 (“predominantly peaty soil with some peat soil”) in the north-central area, and Class 0 (“mineral soil”) across the north west, and Class 4 (“predominantly mineral soil with some peat soil”) in the north east.

49. Peat depth surveys were undertaken as described in Section 7.4.3, to identify the extent, depth and nature of peat across the Site. Peat depths were recorded varying from nil to 3 m, with a small proportion of survey points (five of 1,950 probe locations) recording peat depth over 3m.

50. Peat across the Site was observed to be disturbed and modified by the presence of tree roots and, in some areas uprooted due to wind blow. Numerous drainage ditches were observed to have been cut into the peat, particularly in the western Site area (refer to **Photographs 7.5.3 and 7.5.4** below). Despite the presence of drainage ditches, ground conditions were generally boggy and poorly drained, with areas of flush and standing/slow-flowing water.



Photograph 7.5.3: Drainage ditch in peat, SW Site area



Photograph 7.5.4: Drainage ditch in peat, W Site area

51. The locations and findings of the peat probes are illustrated on **Figures 7.6a and 7.6b**.

52. The *Guidance on Developments on Peatland - Site Surveys* (2017) uses the definition of peat, deep peat and organo-mineral (peaty) soils which is presented in the Joint Nature Conservation Committee (JNCC) report 445 *Towards an Assessment of the State of UK Peatlands* (2011). This definition, which has been used within this chapter, is summarised below:

- **Peaty (or organo-mineral) soil:** a soil with a surface organic layer less than 0.5 m deep;
- **Peat:** a soil with a surface organic layer greater than 0.5 m deep which has an organic matter content of more than 60 %;
- **Deep peat:** a peat soil with a surface organic layer greater than 1.0 m deep.

53. Of 1,950 probes advanced during all peat depth surveys, the peat depth was less than 0.5m at 815 probes (41.8 %), defined as peaty or organo-mineral soil. At 695 probes (35.6 %), peat depth between 0.5m and 1.0m was recorded, and at the remainder of probes (440, or 22.6 %), the peat depth was recorded to be over 1.0m, defined as deep

peat. The occurrence of deep peat is variable across the Site, located mainly in the south west, and localised areas of the centre and east, separated by areas of shallow or no peat.

54. Full details of the peat depth survey, risk assessment and peat management proposals are provided in **Technical Appendix 7.1: Outline Peat Management and Restoration Plan** and **Technical Appendix 7.2: Peat Landslide Hazard and Risk Assessment**.
55. Overall, the sensitivity of the baseline geological resources at this Site are considered to be low to medium.

### 7.5.2 Hydrogeology

#### 7.5.2.1 Groundwater Body, Productivity and Permeability

56. The groundwater body beneath the study area is indicated by SEPA to mostly comprise the Galloway groundwater (ID 150694), with the South Ayrshire Hills groundwater (ID 150660) across the north west and west of the Site. These groundwater bodies were both classified by SEPA in 2017 as having an overall status of good, with good water flows and levels, and good quality.

57. Hydrogeology mapping data from the BGS shows the bedrock beneath the study area to comprise a low productivity aquifer in which flow is virtually all through fractures and other discontinuities.

58. Hummocky glacial deposits, where present, are anticipated to be of variable permeability, with clays inhibiting groundwater flow but pockets and lenses of sands and gravels likely to more readily transmit groundwater. Peat and peaty soils are likely to be of low permeability, inhibiting the flow of groundwater.

#### 7.5.2.2 Potential Groundwater Dependent Habitats

59. Habitats indicative of Groundwater Dependent Terrestrial Ecosystems (GWDTE) were identified during NVC survey work (see **Figure 7.7** for a summary of potential GWDTE within the Site area and see **Chapter 8: Ecology and Biodiversity** and **Figure 8.4** for further detail).

60. Within the Site, habitats indicative of potentially high or moderate groundwater dependency were identified predominantly along the banks of surface watercourses, drains and valleys, along forestry breaks, alongside existing tracks, at the base of Fell Hill and Cairn Hill in the north of the Site, and in the relatively flat and low-lying areas adjacent to the southern stretch of the main Drumjohn access road.

61. With bedrock across the Site comprising a low productivity aquifer, and superficial geology across much of the Site likely to inhibit groundwater flow, there is limited potential for substantial groundwater to be present near the surface, feeding the observed habitats. Furthermore, given the pattern of wetland habitats identified, it is clear that the habitats are highly modified and likely to be mainly or entirely surface-water dependent, being located along surface watercourses and drainage routes (refer to **Figure 7.7**). The base of the hills in the north of the Site, and low-lying area on the southern part of the access road, between hill slopes to the east and the River Cree to the west, are also considered to be areas where surface runoff from the hills will naturally shed and gather.

62. It is therefore considered that GWDTE are not present at the Site, and impacts on GWDTE are not considered further.

#### 7.5.2.3 Private Water Supplies

63. SAC was consulted in June 2019 regarding the presence of PWS in the vicinity of the proposed turbines and associated infrastructure. SAC highlighted two properties which were within 500m of the application boundary at that time (noting that the boundary was larger than the final application boundary), plus an additional two properties which are located further from the boundary, but the residents of which had raised concerns with SAC regarding the impact of the proposed Development on their respective PWS.

64. An additional potential PWS was identified by Forestry Land Scotland (FLS) at Shalloch Well, 500 m from the Site boundary. No PWS was identified by SAC at this location, and no further information has been provided as to the source or status of any PWS at Shalloch Well. Given the name of the property it may be surmised that a well (i.e. groundwater source) is or was present, however current details are not known. Therefore, for completeness, the potential for a PWS sourced from groundwater or surface water has been considered.

65. Details of the above-noted known or potential PWS are provided in **Table 7.5.1** and their locations are shown on **Figure 7.3**. Each PWS is discussed in turn in the following paragraphs.

Table 7.5.1 PWS Information Provided by SAC and FLS

Property Name	Easting	Northing	Source (based on SAC information)	Catchment (based on SAC information)
Laglanny	235517	590549	Unknown	Unknown
Craigenrae	235445	589241	Groundwater	Unknown
White Clauchrie	229509	586363	Groundwater	Burns north of property
Ferter	230762	587484	Groundwater	Burns north of property
Shalloch Well	227124	586148	Unknown	Unknown (potentially burns rising north or north-east of property)

66. The reported PWS at Laglanny is located approximately 1.7km east of the Site boundary, and over 2.5km from any proposed infrastructure. The PWS source is unknown. If it is groundwater, there is negligible potential for any activities associated with the proposed Development to impact on the quantity or quality of water. SEPA guidance recommends undertaking an assessment of risk to groundwater PWS within 250m of any proposed excavations deeper than 1m, for example excavations for turbine foundations. This reflects the maximum likely area within which any localised water table drawdown (for example due to temporary dewatering of excavations) or other development-related impacts could realistically affect the PWS.

67. If the source of the PWS at Laglanny is surface water, this would be either the Rowantree Burn or the Water of Minnoch, both of which flow in close proximity past the reported PWS location. The Rowantree Burn rises in the hills to the north east of the Site, flowing south east. The origins of several small tributaries are just within the Site boundary; however, these are all over 1km away from, and over 10 m higher elevation than, any proposed turbines or infrastructure. The Water of Minnoch rises in the hills more than 1km north east of the Site boundary, and is never closer than 2.5km from any proposed infrastructure. There is essentially no potential for the proposed Development to impact on the water quality or flow within the Rowantree Burn or the Water of Minnoch.

68. The PWS at Laglanny is therefore not considered further in this assessment.

69. The reported PWS at Craigenrae is approximately 2.0km east of the Site boundary and over 2.3km from any proposed infrastructure. As noted above, this is well outside the distance within which a groundwater PWS could realistically be affected by excavations or other development activities. Therefore, similarly to Laglanny, the PWS at Craigenrae is not considered further in this assessment.

70. The lead hydrologist visited Ferter in July 2019 to assess the location and condition of the PWS at this residence.

71. The PWS was observed to be a well, housed in a purpose-built structure adjacent to the house, used to provide drinking water for the property. A second, older well is located nearby, reportedly not used for drinking water. Details of the wells' construction are unknown; however, it is considered likely that the water will be drawn from the sedimentary bedrock beneath the Site. The wells are approximately 1km from the Site boundary, and 1.1km from the nearest proposed infrastructure (proposed Turbine 12 and its associated hardstanding). As noted above, this is well outside the distance within which a groundwater PWS could realistically be affected by excavations or other development activities, and the groundwater PWS at Ferter are therefore not considered further in this assessment.

72. In addition to the groundwater PWS at Ferter, the resident noted that several large, decorative ponds at the property are fed by surface water streams. These were observed during the visit to the property. The upper (northern-most) pond is fed by a small watercourse which rises in the woodland approximately 500m to the north, flowing south into the pond. A separate tributary has its origins slightly further east, joining the main stream approximately 70m north east of the pond. Both of these watercourses originate and flow entirely outside the proposed Development

boundary. They would not be crossed by any access tracks or otherwise directly affected by the proposed Development, and at their nearest points they are approximately 500m from any proposed infrastructure.

73. The western-most pond is fed by a separate watercourse which rises within the woodland approximately 750m to the north-north west. The origin of this watercourse is its nearest point to the proposed Development, located approximately 250m outside the Site boundary and approximately 630m from any proposed infrastructure (a proposed stretch of track to the east of proposed Turbine 6). It is noted that this proposed stretch of track would cross the Clauchrie Burn to the west of this location, but the watercourse which feeds the pond at Ferter is entirely separate from the Clauchrie Burn and would not be crossed by any access tracks or directly affected by the proposed Development.
74. The other ponds at Ferter are fed by small streams which link them to the above-noted ponds.
75. Given the substantial distance between the proposed Development and the watercourses which feed the ponds at Ferter, there is not considered to be a credible risk of development-related activities significantly affecting their water quality or flow. The potential for indirect effects on the ponds at the property are therefore not considered further in this assessment, although embedded mitigation in the form of good construction practice and implementation of a CEMP (refer to Section 7.6.1), would be employed.
76. The residents at White Clauchrie declined a request for access to the property to view the PWS, therefore the assessment has been based on the information provided by the SAC EHO that the PWS is a tank near the house (1.3km from any proposed Development infrastructure) with a surface spring at the tank which is fed by groundwater. This being the case, then similarly to the other groundwater PWS noted above, this supply is well outside the distance within which a groundwater PWS could realistically be affected by excavations or other development activities.
77. Information from the SAC EHO made reference to the spring's catchment being a collection of burns a mile north of the tank. It is not clear what this means, given that the spring will be fed by groundwater, not surface water. If there is any question of the PWS at White Clauchrie being fed by surface water, then this could be derived from either the Clauchrie Burn or the small tributary which rises approximately 300m north of the property and flows south into the Clauchrie Burn. Given that the Clauchrie Burn is proposed to be crossed by a new access track within the proposed Development, the potential effects on this watercourse, and therefore a possible surface-water derived supply at White Clauchrie, are considered further in this assessment.
78. Shalloch Well is over 1.3 km from any proposed Development infrastructure, and therefore well outside the distance within which a groundwater PWS could realistically be affected by excavations or other development activities. Effects on a potential groundwater PWS at Shalloch Well are therefore not considered further in this assessment.
79. If there is any question of an operational PWS at Shalloch Well being fed by surface water, then this could be derived from one of three minor watercourses in the immediate proximity of the property. These watercourses all rise approximately 500 to 530 m north or north-east of the property, over 800 m from any proposed Development infrastructure. Given the substantial distance between the proposed Development and the watercourses which could potentially be abstracted for private use at Shalloch Well, there is not considered to be a credible risk of development-related activities significantly affecting their water quality or flow. Effects on a potential surface water PWS at Shalloch Well are therefore not considered further in this assessment, although embedded mitigation in the form of good construction practice and implementation of a CEMP (refer to Section 7.6.1), would be employed.

#### 7.5.2.4 Hydrogeology Baseline Summary

80. As described in the above paragraphs, the Site is underlain by a low permeability bedrock aquifer with flow restricted to fissures and discontinuities. Overlying surface geology is low or variable permeability (peat and/or glacial deposits) and discontinuous. The groundwater body underlying the Site is classified as having a good overall status.
81. Although habitats indicative of potential groundwater dependency have been identified onsite, these have been assessed as likely to be largely or entirely surface water fed.
82. No groundwater abstractions (PWS) have been identified within influencing distance of the Site.

83. The overall sensitivity of groundwater resources at the Site is therefore considered to be low to medium.

#### 7.5.3 Hydrology

84. As shown on Figures 7.2a and 7.2b, the River Cree (including its northern tributary the Cairnfore Burn) flows generally north to south on the eastern side of the Site, into which flow the Clauchrie Burn and the Fardin Burn from the main body of the proposed Development area. The following describes the main watercourses present within the study area:

##### *River Cree Catchment*

- The Cairnfore Burn, which is a direct tributary to the River Cree and is defined as part of the River Cree in terms of SEPA's water quality classification, rises in the north-east Site area and flows south into the main River Cree channel, then south west. This watercourse system is mostly outside the Site boundary but crosses the Site along the Drumjohn Road access. The Cree empties into the Solway Firth some 25km south east of the Site.
- The Fardin Burn/Polmaddie Burn rises by Cairn Hill near the northern Site boundary, west of the River Cree/Cairnfore Burn. It flows south to join the Cree just west of the Drumjohn Road access. Several smaller tributaries flow from north to south into the Fardin Burn, generally between the proposed locations of Turbine 17 and Turbines 15 and 16.
- The Clauchrie Burn rises on the south west slopes of Cairn Hill near the northern Site boundary, flowing south into the Cree downstream of where it is joined by the Fardin Burn.
- A smaller, unnamed watercourse rises in the north west of the Site (west of the Clauchrie Burn) and flows south into the Clauchrie Burn, just south of the western part of the study area.
- The Scalloch Burn flows from Loch Scalloch (a small loch in the north west Site area), south to join the Clauchrie Burn to the south of the study area.

##### *River Stinchar Catchment*

- The Feoch Burn/Roughlea Burn rises just west of Pindonn Craigs in the north west of the Site, from where it flows south into the Duisk River to the south west of the Site. The Duisk River eventually empties into the River Stinchar to the west of the Site.
  - The Muck Water rises near the northern Site boundary north of Mid Hill, and flows south west along the Site boundary to join the Duisk River to the west of the Site.
  - Gowan's Burn flows west from Pindonn Craigs into the Muck Water on the north-west Site boundary.
  - The Water of Gregg (also known as Lead Mine Burn at this location) rises near the northern Site boundary, east of the Muck Water, and flows north into the River Stinchar, to the north of the Site. Several smaller, unnamed tributaries of the Water of Gregg also rise in the northern extents of the Site and flow north.
85. The majority of the Site drainage is anticipated to flow to the River Cree, either directly or via the Cairnfore Burn, Fardin Burn, Clauchrie Burn, or smaller, unnamed watercourses and drainage ditches.
86. However, drainage from the far north, north west and west of the Site is anticipated to flow to the River Stinchar, via the Feoch Burn, Muck Water, Water of Gregg, Gowan's Burn, and small watercourses on the northern and western slopes of the hills which form the Site high points. The proposed Site infrastructure considered to be within the River Stinchar catchment includes Turbines 1, 2, 4, 5 and 7. All other proposed turbines, access tracks (except the immediate approaches to the above-named turbines) and other infrastructure would be located within the River Cree catchment.
87. The 2014 SEPA classification of the River Cree (including the Cairnfore Burn) is bad due to water quality and ecological conditions. The main cause of this is identified as many decades of acid rain. The physical condition of the watercourse is classified as good.
88. The Fardin Burn is classified as poor overall (poor water quality and good physical condition), also with pressures from acid rain. The Clauchrie Burn is classified as poor overall, mainly due to poor access for fish migration and acid rain. Proposed measures to remove barriers to fish migration were initially intended to have restored this parameter to good by 2015, however SEPA reports that this has been unfeasible, due to the complexity of the process and civil engineering works required.

89. The Feoch Burn, Muck Water and Water of Gregg (all within the River Stinchar catchment) are classified as good.
90. Some of the proposed access tracks to turbines would require new watercourse crossings to be constructed. Nine proposed new water crossings are proposed, with nine existing crossings also to be used as part of the proposed Development. The locations of these proposed water crossings are shown on **Figures 7.2a and 7.2b**. Indicative water crossing designs are included in **Technical Appendix 7.3: Water Crossing Schedule**.
91. For the purposes of this assessment, the sensitivity of baseline hydrological resources at this Site is considered to be medium, reflecting the poor/bad quality of the watercourses within the River Cree catchment, and the good quality of the watercourses in the small area of the Site that falls within the River Stinchar catchment. It is noted that, although unlikely, it has not been possible to rule out the potential for the reported PWS at White Clauchrie to be a surface water source, derived from the Clauchrie Burn. Given that the property location is approximately 2.7km downstream any proposed Development infrastructure in close proximity to the Clauchrie Burn, and given the baseline poor quality of the Clauchrie Burn, this potential is not considered to increase the sensitivity of the onsite watercourses beyond medium.

#### 7.5.4 Flooding

92. The online SEPA Flood Map shows most of the Site as being outside any area of identified flood risk. The immediate banks of the River Cree and Cairnfore Burn are shown as being at up to high risk of flooding, however this risk classification does not extend more than approximately 100 m from the edge of the watercourse, within the study area. Similarly, the immediate banks of the southern stretches of the Fardin Burn and Clauchrie Burn (generally outside the Site boundary) are shown as being at up to high risk of flooding, however these areas are remote from any proposed infrastructure.
93. Highly localised areas of up to high risk of surface water flooding are shown on the map, mainly associated with small watercourses and water bodies (including Loch Scalloch). An area towards the east of the Site, in the location of several branches of the Fardin Burn/Polmaddie Burn system, is shown as being at high risk of surface water flooding. This area is over 300m from any proposed turbines and over 100m from any other proposed infrastructure.
94. The sensitivity of the Site with respect to flooding is considered to be low.

## 7.6 Potential Effects

95. The potential effects resulting from the proposed Development are detailed below. Effects have been separated into those which occur during the construction and operation phases individually. The consent being sought for the proposed Development is in perpetuity. However, in the event that the development was to be decommissioned in the future, the effects arising from decommissioning are considered to be the same or less significant than those arising from the construction phase.

#### 7.6.1 Mitigation by Design and Embedded Mitigation

96. The following considerations have been taken into account in the iterative design of the proposed Development, considered as embedded mitigation (mitigation by design):
- Existing tracks have been incorporated into the Site design as far as possible, minimising the requirement for new road construction.
  - A 50m buffer has been maintained around all surface watercourses, except where watercourse crossings are required, and a small number of other exceptions described below. In all of the cases noted below, good construction practices would be implemented, as described in Paragraph 94 (below), to ensure suitable protection of the relevant watercourses.
    - The proposed laydown area east of proposed Turbine 18 in the south west of the Site, and a short stretch of existing track requiring upgrade immediately north of the proposed laydown area, encroach into the 50m buffer around a small tributary of the Scalloch Burn. The laydown area has been sited to avoid deeper peat nearby and to avoid unnecessary disruption to forestry management. The stretch of track has been sited to make use of the existing track. This is a minor drain/watercourse, and it is

considered that a 50m buffer between it and an existing track requiring upgrade, and a proposed laydown area (on a fairly flat area of land, where no substantial excavation works would be required), is unnecessary.

- A short stretch of proposed new track north of proposed Turbine 17 encroaches into the 50m buffer around a minor tributary of the Fardin Burn. The track layout has been designed to provide a straight route which works with the contour of the hillside. This is a minor drain/watercourse, and it is considered that a 50m buffer between it and a short stretch of new track is unnecessary.
  - A stretch of existing track south of proposed Construction Compound 2 encroaches into the 50m buffer around a tributary of the Fardin Burn. This has been sited to make use of the existing track, and although upgrade would be required, a 50m buffer between the track and this minor watercourse is considered to be unnecessary.
  - Several localised stretches of the existing Drumjohn Road access, and part of the location of the proposed Construction Compound 1 at the south end of this road, encroach into the 50m buffer around minor watercourses. As above, given that this is an existing road and that proposed works would be limited to upgrading the road and construction of a compound on the opposite side of the road from a small watercourse, 50m buffers around minor watercourses/drains are considered unnecessary.
  - The number of watercourse crossings has been minimised as far as possible.
  - Areas of deep peat have been avoided in siting most turbines, tracks and other infrastructure. Only proposed Turbines 7 and 18 are sited at locations where deep peat has been identified (sited to maintain effective spacing and avoid other local constraints), however some probes in the immediate vicinity of these locations recorded shallow peat, suggesting good potential for micro-siting to avoid or minimise deep peat excavation following further detailed site investigations. The construction compounds, substation, control compound, and the majority of the borrow pit search areas are in areas of no identified deep peat. The majority of new access tracks also avoid areas of deep peat although total avoidance was not feasible.
  - No infrastructure is proposed in or near areas of identified medium or higher peat landslide risk, with the exception of the crane hardstanding at proposed Turbine 14, which would be subject to further detailed investigation to clarify the risk and confirm mitigation or micro-siting to address the risk as appropriate.
97. In undertaking this assessment of effects, the following standard good practice measures are assumed to be incorporated as embedded mitigation:
- Detailed pre-construction site investigations would be conducted, focusing on areas where construction is proposed to be undertaken and informing suitable micro-siting of the turbines and associated infrastructure. Any deep peat identified in the borrow pit search areas would be avoided for actual borrow pit excavation.
  - Targeted monitoring and assessment of the groundwater levels and flows beneath the Site would also be carried out to inform micro-siting and to assist in the detailed design of infrastructure and selection of appropriate materials for use during the construction process.
  - Pre-construction baseline water quality sampling and analysis would be undertaken at the River Cree/Cairnfore Burn, Clauchrie Burn, Fardin Burn, Polmaddie Burn, Scalloch Burn, and Muck Water. A programme of regular monitoring and analysis of the water quality of the watercourses would be implemented throughout the construction period.
  - With specific reference to the SEPA guidance '*Prevention of Pollution from Civil Engineering Contracts: Special Requirements*' (SEPA, 2006), the Principal Contractor would implement a CEMP, agreed with SEPA, SNH and SAC prior to the commencement of construction activities, which contains a construction method statement that includes:
    - a detailed breakdown of the phasing of construction activities;
    - a pollution risk assessment of the Site and the proposed activities;
    - identification of all Controlled Waters that may be affected by the works and temporary discharge points to these watercourses;
    - planning and design of appropriate pollution control measures during earthworks and construction;
    - storage of all fuel and other chemicals in accordance with best practice procedures;
    - borrow pit management measures;
    - ensuring that concrete batching is undertaken only at a designated area at the temporary construction compound, 100m from the nearest watercourse;
    - management of the pollution control system, including dewatering of excavations (if required) away from watercourses;

- contingency planning and emergency procedures; and
  - on-going monitoring of construction procedures to ensure management of risk is maintained.
- Forestry felling works would be undertaken in accordance with good practice set out in the Forestry Commission's UK Forestry Standard (Forestry Commission, 2017). This includes appropriate buffering of watercourses and management of riparian zone vegetation, implementation of a suitable drainage plan, keeping watercourses and buffer areas clear of brash as far as practicable, removing any accidental blockages, and employing methods to minimise soil damage and subsequent erosion. Stumps would be left in situ outside the proposed Development footprint. Further information on forestry management is provided in **Chapter 14: Other Issues**.
- All earthmoving works or similar operations would be carried out in accordance with BSI Code of Practice for Earth Works BS6031:2009.
  - Prior to construction, a detailed Drainage Strategy (DS) would be developed and agreed with SEPA and SAC. The DS would detail the Site drainage design, including the type of surface to be used for the access track, the soft engineering and habitat enhancement measures proposed to slow surface water flows and any necessary ponds, swales, cross drains and bunds, to ensure that runoff from hard surfaces and borrow pit excavations would be controlled. The DS would also detail the dimensions and final design of the new and upgraded water crossings, which would be designed to maintain continuous flows.
  - All watercourse crossings, Site discharges, and temporary water abstraction would be regulated under the CAR licensing regime and all necessary licences would be sought from SEPA prior to the commencement of any operations onsite.
  - While it is acknowledged that best practice to minimise run-off would be to undertake construction and dismantling during the driest period of the year, given the location of the proposed Development in South Ayrshire, there are likely to be significant periods of rainfall throughout the year. Therefore, Site management would check the local weather forecast daily and prime all Site staff to ensure that everyone is aware of their responsibilities to maintain the pollution control system during wet weather or suspend sensitive operations during adverse weather conditions.

## 7.6.2 Construction

### 7.6.2.1 Changes to Groundwater Flow

98. Excavations would be required to form turbine foundations, and shallower excavations would be required to form platforms for the temporary construction compound and operations building. These excavations would result in localised changes to groundwater conditions, including potential requirement for dewatering of excavations. There is anticipated to be perched groundwater within peat and glacial deposits at the Site, with near-surface deposits likely to allow transmission of groundwater, therefore dewatering of excavations would likely result in localised drawdown of the water table and resultant dewatering of peat in the vicinity. Deeper, catotelmic peat deposits and more cohesive glacial deposits are typically much less permeable with extremely slow transmission of groundwater. Therefore, water table drawdown is likely to be localised to the area of excavations, recovering following completion of construction. The potential magnitude of impact is therefore assessed as low.
99. Given that all turbines have been sited outside areas of deep peat except proposed Turbines 7 and 18, where peat depth is variable and there is good opportunity for micro-siting to avoid or minimise infrastructure footprint within deep peat, the sensitivity of receptor (groundwater and peat deposits) is low to medium.
100. The potential for construction-phase changes to the groundwater flow regime, including localised dewatering of peat, is therefore assessed as a direct, short-term, temporary effect of **negligible to minor** significance.

### 7.6.2.2 Removal of and Impact on Peat

101. Although the locations of most proposed turbines and other infrastructure avoid identified areas of deep peat, there would be a requirement for excavation of at least shallow peat deposits at most turbine and infrastructure locations, including borrow pits. A small number of stretches of access track would need to cross areas of deep peat. Further detail on the estimated volume of peat to be excavated, and the management of excavated peat, is given in **Technical Appendix 7.1: Outline Peat Management Plan**.
102. The excavation of localised peat deposits to allow construction of the proposed Development is assessed as an impact of low magnitude, on a medium sensitivity receptor, resulting in a direct, permanent effect of **minor** significance in the absence of mitigation.

### 7.6.2.3 Pollution Impact from Sediment Runoff/Transport or Chemical Contaminated Runoff

103. Surface runoff containing silt and other sediments, particularly during and after rainfall events, has the potential to enter the watercourses and field drains on and adjacent to the Site. Silt and sediment laden surface water runoff is predicted to arise from excavations, exposed ground and any temporary stockpiles. This has the potential to temporarily impact on the water quality and hydrological and ecological function of the receiving watercourse at and downstream of the works in the absence of any mitigation. Additionally, pollutants such as oils, fuel and cement may be mobilised through mechanical leaks or spillage and carried in surface drainage.
104. As noted in **Section 7.6.1**, a minimum buffer of 50 m around all watercourses has been maintained in siting all infrastructure except where watercourses need to be crossed and a small number of exceptions where proposed tracks and compounds are slightly less than 50 m from minor drains and tributaries. Furthermore, as noted in **Section 7.6.1**, good construction practice measures would be set out in a CEMP and fully implemented to minimise the risk of pollution to surface watercourses.
105. The magnitude of change, prior to any additional mitigation, is considered to be low, on a medium sensitivity receptor. Therefore, there is potential for a direct, temporary, short-term effect of **minor** adverse significance.

### 7.6.2.4 Pollution Impact from Forestry Felling

106. Onsite forestry would be felled as part of the normal plantation life-cycle and approved forest plan and/or a revised plan to allow areas of early harvesting where required to construct Site infrastructure. Removal of mature trees may lead to direct impacts on the water environment through forestry material and brash entering local watercourses, and loss of structure of the underlying soils, with increased risk of erosion.
107. However, as noted in **Section 7.6.1**, good construction practice measures would be set out in a CEMP and fully implemented to minimise the risk of pollution to surface watercourses, and forestry felling works would be undertaken in accordance with good practice set out in the Forestry Commission's UK Forestry Standard.
108. The magnitude of change, prior to any additional mitigation, is therefore considered to be low, on a medium sensitivity receptor. Therefore, there is potential for a direct, temporary, short-term effect of **minor** adverse significance.

### 7.6.2.5 Peat Landslide Impact on Watercourses

109. Construction on peat soils, and associated activities including localised removal of forestry, can result in destabilisation of peat deposits on slopes and lead to slope failure, with subsequent potential for peat and soils to reach watercourses downslope and cause pollution/sedimentation and changes to fluvial geomorphology. A detailed assessment of peat landslide risk has been undertaken as presented in **Technical Appendix 7.2: Peat Landslide Hazard and Risk Assessment**. This has identified negligible or low peat landslide risk at all proposed turbine and hardstanding locations, with the exception of the crane hardstanding for proposed Turbine 14, where several peat probe locations have recorded conditions indicating a medium risk. The medium risk rating at this location results from a combination of peat depth (probe points within the proposed hardstanding footprint recorded peat depths ranging from 25 cm to 160 cm), slope angle (approximately 8 to 9 degrees) and a slightly elevated "consequence" ranking given that a peat landslide could directly impact on the proposed Development infrastructure itself and an existing forestry road. The nearest surface watercourses to this location are approximately 210m downslope (minor tributaries of the Polmaddie Burn/Fardin Burn system). These points and additional isolated medium-risk points outside the proposed turbine and hardstanding locations are discussed in more detail in **Technical Appendix 7.2: Peat Landslide Hazard and Risk Assessment**.
110. As noted in **Section 7.6.1**, detailed site investigations would be undertaken prior to commencement of construction, in part to clarify and refine the peat landslide risk assessment. This would include detailed topographical survey work to supplement the OS terrain data used for the risk assessment undertaken to date, and additional intrusive investigations to clarify the distribution, depth and nature of peat across proposed infrastructure areas. Any site-specific geotechnical mitigation measures, or micro-siting to reduce risks, would be stipulated based on the findings of these further investigations. Additionally, it should be noted that proposed turbines and hardstandings would not be constructed on peat, rather any peat within the footprints of turbines and hardstandings would be excavated to allow construction on a suitable founding stratum (i.e. bedrock).

111. The overall potential magnitude of impact from peat landslide resulting from construction activities at the Site is assessed as low, on a medium sensitivity receptor, resulting in a direct, temporary, short-term effect of **minor** adverse significance.

#### 7.6.2.6 Impact on the Integrity of Banking

112. Permanent new watercourse crossings would be required at 18 locations (nine new crossings and nine existing crossings to be replaced or upgraded). Construction activities on or close to the sides of watercourses can detrimentally affect the structural integrity of the burn banks, either through direct damage to bankside material or indirect loosening of soil structure thus impacting on the localised morphology and water quality of the watercourse through erosion or even collapse of the banking.
113. The banks of the watercourses where water crossings are proposed are generally low-gradient and shallow, thereby reducing the potential for bank collapse. Furthermore, as noted in **Section 7.6.1**, detailed intrusive site investigation work would be undertaken prior to construction to ensure design and installation of new water crossings suitable to the local ground conditions, and good construction practice measures would be set out in a CEMP and fully implemented.

114. The potential magnitude of impact is therefore low, on medium sensitivity receptors, resulting in potential for a direct, permanent effect of **minor** adverse significance prior to the implementation of any additional mitigation measures.

#### 7.6.2.7 Compaction of Soils

115. There is potential for construction of permanent tracks and movement of construction vehicles and plant to result in soil compaction, reducing the ability of water to permeate the ground and increasing the potential for contaminated or sediment-laden surface runoff. Reduced permeability in soils also reduces the site's flood storage capacity, which could increase the potential for localised flooding incidents.
116. Taking account of embedded mitigation set out **Section 7.6.1**, and the inferred low/variable permeability of superficial deposits at the Site, the magnitude of change prior to any additional, specific mitigation is negligible to low. The sensitivity of the onsite and adjacent watercourses is medium, therefore there is potential for an indirect, temporary, short-term effect of **negligible to minor** significance.

### 7.6.3 Operation

#### 7.6.3.1 Surface Water Drainage (Increased Rate of Surface Water Runoff)

117. The access tracks and crane hardstandings for the wind turbines could result in an increased rate of surface water run-off from the Site, increasing downstream flood risk and potentially resulting in soil erosion and silt-laden runoff, which could pollute watercourses, ditches and ponds. However, as set out in **Section 7.6.1**, a detailed DS would be developed and agreed with SEPA and SAC to ensure that runoff from hard surfaces would be appropriately controlled.
118. The magnitude of change, prior to any additional mitigation, is therefore negligible, on a medium sensitivity receptor (local watercourses). Therefore, there is potential for an indirect, long-term effect of **negligible** adverse significance.

#### 7.6.3.2 Long-term Changes to Groundwater Flow Regime and Dewatering of Peat

119. The presence of turbine foundations, access tracks and other infrastructure has the potential to interrupt groundwater flow; for example, impermeable concrete foundations can act as barriers to flow. This could result in drying of peat deposits. However, given the nature of the superficial geology at the Site, groundwater is anticipated to be limited to perched water in near-surface peat and glacial deposits, with flow likely to be limited and slow.
120. Taking account of embedded mitigation measures set out in **Section 7.6.1**, the magnitude of impact is assessed as low, on a low to medium sensitivity receptor. There is therefore potential for an indirect, long-term effect of **negligible to minor** significance in the absence of any additional, specific mitigation.

#### 7.6.3.3 Impacts on fluvial geomorphology

121. If new watercourse crossings are not designed properly to ensure continuous flows, this could potentially adversely affect the geomorphology of watercourses by reducing heterogeneity. However, as noted in **Section 7.6.1**, a

detailed DS would be developed and agreed with SEPA and SAC, including detail of the dimensions and final design of the new and replaced/upgraded water crossings. All watercourse crossings would be regulated under the CAR licensing regime and all necessary licences would be sought from SEPA prior to the commencement of any operations onsite.

122. The magnitude of change, prior to any additional mitigation, is negligible, on a medium sensitivity receptor. Therefore, there is potential for a direct, permanent effect of **negligible** adverse significance.

#### 7.6.3.4 Impact on fluvial flood risk onsite and downstream

123. The proposed Development has the potential to generate increased runoff through introduction of hardstanding areas, and to increase flood risk through creation of new water crossings. No areas of proposed infrastructure development are within potential fluvial flood risk areas identified by SEPA flood risk mapping. Furthermore, as described in **Section 7.6.1**, a suitable DS would be developed and implemented, and all water crossings would be regulated under the CAR licensing regime and would be designed to allow continuous flow. There is therefore potential for a negligible magnitude impact on a low sensitivity receptor, resulting in a direct, long-term effect of **negligible** adverse significance.
124. The local watercourses downstream of the Site are largely only susceptible to flooding in the immediate vicinity of their banks, although there are some localised areas of up to high flood risk beyond the immediate banks. Taking account of the embedded mitigation set out in **Section 7.6.1**, there is potential for a negligible magnitude impact on a medium sensitivity receptor, resulting in an indirect, long-term effect of **negligible** adverse significance.

## 7.7 Mitigation

125. In addition to the mitigation by design and embedded mitigation set out in **Section 7.6.1** (standard good construction practices set out in and implemented in accordance with a CEMP), the following additional mitigation measures would be implemented in the construction and operation of the proposed Development.
126. Where it is not possible to avoid routing tracks over localised areas of deep peat, tracks would be floated to avoid the requirement for excavation of peat. As set out in **Chapter 4: Development Description**, this would involve placing of a geotextile membrane on existing topsoil and vegetation followed by aggregate layers. Floating roads would be designed to ensure suitability for Site traffic during construction and operation.
127. Where excavation of peat is required for construction of turbines and other infrastructure, excavated peat would be re-used onsite as set out in **Technical Appendix 7.1: Outline Peat Management and Restoration Plan**.
128. The requirement for dewatering would be minimised in all locations by timely and efficient excavation of the foundation void and subsequent concrete pouring and backfilling.
129. Where topography dictates that working platforms are needed, these would be formed to ensure that surface water drains away from watercourses.
130. To avoid unnecessary compaction and disturbance to Site soils, working areas and corridors would be established and demarcated, with construction operatives appropriately inducted and trained to avoid work outside the designated work areas. Further detail is provided in the **Technical Appendix 7.1: Outline Peat Management Plan**.
131. An HMP has been developed in outline, given as **Technical Appendix 8.7**. This would be updated to a detailed plan and agreed with SNH, SEPA and SAC prior to construction and would be implemented during construction and operation of the proposed Development. This would involve blocking of drains and removal of regenerating conifers in an approximately 45 ha area on the unforested lower slopes of Cairn Hill. The proposed Habitat Management Area has been selected as an area of degraded peatland habitat, likely to benefit from the proposed HMP actions, although this is not considered to be a required mitigation measure with respect to hydrological, geological or hydrogeological effects, it has been committed to by the Applicant in order to offset ecological effects from the proposed Development, provide biodiversity enhancement through improving the condition of degraded

peatland habitat. The key objectives of the HMP are to raise the water table within the bog, and to promote the development of sphagnum and peat. Implementation of the HMP is expected to result in a beneficial, though not material, hydrological effect on the watercourses local to the proposed Habitat Management Area (Fardin Burn system). The Fardin Burn and tributaries are within the wider River Cree catchment, therefore an indirect hydrological benefit to the River Cree is anticipated.

## 7.8 Residual Effects

132. No significant potential effects on hydrological, geological and hydrogeological receptors have been predicted when taking account of mitigation by design and embedded mitigation set out in **Section 7.6.1**. However, some additional, specific mitigation measures are proposed as described in **Section 7.7**, to further reduce effects and to provide biodiversity enhancement as set out in the HMP.
133. Taking account of the above-noted mitigation commitments, all residual effects on hydrological, geological and hydrogeological receptors are assessed as being **negligible** or **minor**, and not significant.

## 7.9 Cumulative Assessment

134. The only windfarm within the study area is the operational Mark Hill Windfarm immediately to the west. Although this windfarm is within the catchment of the River Stinchar and therefore could in theory give rise to cumulative effects together with the proposed Development, there is little potential for this to be realised in practice given that construction periods would not overlap with the proposed Development, and no significant effects are likely during operation.
135. No significant residual effects are predicted resulting from the construction or operation of the proposed Development in isolation, and there is considered to be **negligible** potential for significant cumulative effects to arise when operation of Mark Hill Windfarm is taken into account.

## 7.10 Summary

136. The majority of the proposed Development area is located within the catchment of the River Cree, with Site drainage reaching the Cree via the Cairnfore Burn, Clauchrie Burn, Fardin Burn, Scalloch Burn, and smaller drains and tributaries. These watercourses are considered within the assessment to have poor water quality, with SEPA reporting pressures including acid rain. The far north and west Site areas are within the River Stinchar catchment, with drainage from these areas reaching the Stinchar via the Feoch Burn, Muck Water, Gowan's Burn, and Water of Gregg. These watercourses are all considered within the assessment to have good water quality.
137. The rock beneath the Site is sedimentary, forming a low productivity aquifer. Superficial deposits comprise variable thicknesses of hummocky glacial deposits and peat, rock at surface in some areas. Groundwater may be somewhat mobile within shallow peat deposits and lenses or pockets of sand and gravel within the glacial deposits, but is expected to be substantially less so in deeper, catotelmic peat and more cohesive till, and is indicated to be largely confined to fissures and other discontinuities within the underlying bedrock.
138. Habitats indicative of potential groundwater dependence have been identified in localised areas of the Site. However, with bedrock across the Site comprising a low productivity aquifer, and superficial geology across much of the Site likely to inhibit groundwater flow, there is limited potential for substantial groundwater to be present near the surface, feeding the observed habitats. Furthermore, given the pattern of the identified wetland habitats being largely along watercourses, forestry breaks, other drainage routes, and at the bases of slopes where surface drainage is likely to shed from the hills, the habitats are likely to be mainly or entirely surface-water dependent. Water contained within the peat soils across the Site is considered to be rainwater fed.

139. No PWS have been identified within the study area. Reported PWS outside the study area (within approximately 2.5km of the Site) have been noted and considered, however no potential for significant effects was identified, therefore detailed assessment was scoped out. The exception is a reported PWS at White Clauchrie, to the south of the Site, where access to the property was denied and therefore the specific nature of the PWS could not be determined. The PWS is reported by SAC to be groundwater-fed and if this is the case then due to the distance from the Site, there is no realistic potential for it to be impacted by the proposed Development. However, the potential for the PWS to be surface-water fed could not be entirely ruled out, therefore it has been considered in assessing the sensitivity of watercourses, specifically the Clauchrie Burn.
140. A peat depth survey has identified peat across much of the proposed Development area, locally over 3m thick but often thinner and sometimes absent. Areas of deep peat are avoided by all but two proposed turbine locations and most Site infrastructure.
141. A peat landslide risk assessment has identified negligible or low risks across the Site with the exception of a small number of localised points where a medium risk was identified, including points at the crane hardstanding for proposed Turbine 14.
142. Potential construction and operational effects include changes to the groundwater flow regime, excavation of and impact on peat deposits, the risk of siltation and pollution of watercourses resulting in adverse effects on water quality (including potential for pollution or sedimentation arising from forestry felling works or peat landslide), effects on the integrity of watercourse banks, compaction of soils, long-term effects on fluvial geomorphology, and effect on onsite and downstream flood risk.
143. The iterative design process for the proposed Development has ensured embedded mitigation, including appropriate buffering of sensitive watercourses, minimising the need for new watercourse crossings, and avoidance of areas of deep peat or elevated peat landslide risk in siting turbines. Standard good construction and design practice has also been considered as embedded mitigation, including detailed pre-construction site investigations, agreement and implementation of a CEMP, and appropriate design of watercourse crossings, regulated under the CAR licensing regime.
144. The detailed pre-construction site investigations would include topographical survey work to supplement the OS terrain data used for the peat landslide risk assessment undertaken to date, and additional intrusive investigations to clarify the distribution, depth and nature of peat across proposed infrastructure areas. Any site-specific geotechnical mitigation measures, or micro-siting to reduce risks, would be stipulated based on the findings of these further investigations. Additionally, it should be noted that proposed turbines and hardstandings would not be constructed on peat, rather any peat within the footprints of turbines and hardstandings would be excavated to allow construction on a suitable founding stratum (i.e. bedrock).
145. Potential effects on hydrological, geological and hydrogeological receptors, taking account of the above-noted embedded mitigation, have been assessed as negligible to minor, and not significant. However, some additional specific mitigation measures have been proposed to further reduce effects. These include: floating road construction for localised track segments, in order to avoid the requirement to excavate deep peat; appropriate management and re-use of peat onsite in accordance with a Peat Management Plan; minimising the requirement for dewatering; ensuring that working platforms are formed so that surface runoff drains away from watercourses; establishing and demarcating working areas and corridors; and implementing a Habitat Management Plan involving blocking of drains and removal of regenerating conifers to improve hydrological conditions on degraded peatland habitat within the River Cree catchment.
146. The significance of residual effects on hydrological, geological and hydrogeological receptors is considered to be minor or negligible and therefore not significant. A summary of the residual effects on hydrology, hydrogeology, geology and soil resources at the Site are shown in **Table 7.10.1**.

Table 7.10.1: Summary Table

Description of Effect	Significance of Potential Effect		Mitigation Measure	Significance of Residual Effect	
	Significance	Beneficial / Adverse		Significance	Beneficial / Adverse
<i>During Construction</i>					
Changes to groundwater flow including localised drying of peat	Negligible to minor	Adverse	Minimising dewatering requirement by timely and efficient excavation and subsequent concrete pouring and backfilling. HMP implementation.	Negligible	Adverse
Removal of and impact on peat	Minor	Adverse	Floating road segments over deep peat. Appropriate management and onsite re-use of peat (Peat Management Plan). Restriction of works to set construction areas and corridors.	Minor	Adverse
Pollution impact from sediment runoff/ chemical contaminated runoff	Minor	Adverse	Form any working platforms to ensure runoff away from watercourses. Restriction of works to set construction areas and corridors.	Minor	Adverse
Pollution impacts from forestry felling	Minor	Adverse	No specific measures beyond embedded mitigation.	Minor	Adverse
Peat landslide impact on watercourses	Minor	Adverse	Restriction of works to set construction areas and corridors.	Minor	Adverse
Impact on the integrity of banking	Minor	Adverse	No specific measures beyond embedded mitigation.	Minor	Adverse
Compaction of soils	Negligible to Minor	Adverse	Restriction of works to set construction areas and corridors	Negligible	Adverse
<i>During Operation</i>					
Increased rate of surface water runoff	Negligible	Adverse	No specific measures beyond embedded mitigation.	Negligible	Adverse
Long-term changes to groundwater flow regime and dewatering of peat	Negligible to Minor	Adverse	HMP implementation	Negligible	Adverse
Impacts on fluvial geomorphology	Negligible	Adverse	No specific mitigation measures beyond embedded mitigation.	Negligible	Adverse
Impacts on onsite and downstream fluvial flood risk	Negligible	Adverse	No specific mitigation measures beyond embedded mitigation.	Negligible	Adverse
<i>Cumulative Effects</i>					
No significant cumulative effects are predicted.					

## 7.11 References

British Standards Institute. (2009). *BSI 6031:2009 Code of Practice for Earthworks*. BSI, London.

CIRIA. (2001). *C532 Control of water pollution from construction sites: guidance for consultants and contractors*. CIRIA, London.

Dumfries and Galloway Council. (2019). *Local Development Plan*. Available at: <https://www.dumgal.gov.uk/ldp2>

The Forestry Commission. (2017). *The UK Forestry Standard: The Governments' Approach to Sustainable Forestry*.

Joint Nature Conservation Committee. (2011). *Towards an Assessment of the State of UK Peatlands*. JNCC, Peterborough.

NERC. (2012). *Geology of Britain*. Available at: <http://mapapps.bgs.ac.uk/geologyofbritain/home.html>. Accessed in June 2019, July 2019 and October 2019.

Scottish Executive. (2006). *Planning Advice Note 51: Planning, Environmental Protection and Regulation*. Available at: <https://www.gov.scot/publications/planning-advice-note-pan-51-revised-2006-planning-environmental-protection/>

Scottish Executive. (2006). *Planning Advice Note 79: Water and Drainage*. Available at: <https://www.gov.scot/publications/planning-advice-note-pan-79-water-drainage/>

Scottish Government (2014). *Scottish Planning Policy*. 2014. Available at: <https://www.gov.scot/publications/scottish-planning-policy/>

Scottish Government. (2015). *Online Planning Advice on Flood Risk*. Available at: [https://www.webarchive.org.uk/wayback/archive/20160107180134mp\\_/http://www.gov.scot/Resource/0047/00479774.pdf](https://www.webarchive.org.uk/wayback/archive/20160107180134mp_/http://www.gov.scot/Resource/0047/00479774.pdf) Accessed in October 2019.

Scottish Government (2015). *The River Basin Management Plan for the Scotland River Basin District: 2015-2027*.

Scottish Government. (2017). *Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments*. Available at: <https://www.gov.scot/publications/peat-landslide-hazard-risk-assessments-best-practice-guide-proposed-electricity/>

Scottish Government and Natural England (2015). *The River Basin Management Plan for the Solway Tweed River Basin District: 2015 Update*.

Scottish Government, SNH and SEPA. (2017). *Guidance on Developments on Peatland - Site Surveys*. Available at: <https://www.gov.scot/binaries/content/documents/govscot/publications/advice-and-guidance/2018/12/peatland-survey-guidance/documents/peatland-survey-guidance-2017/peatland-survey-guidance-2017/govscot%3Adocument/Guidance%2Bon%2Bdevelopments%2Bon%2Bpeatland%2B-%2Bpeatland%2Bsurvey%2B-%2B2017.pdf>

Scottish Renewables and SEPA. (2014). *Developments on Peatland: Guidance on the assessment of peat volumes, reuse of excavated peat and the minimisation of waste*. Available at: <https://www.gov.scot/Topics/Business-Industry/Energy/Energy-sources/19185/17852-1/CSavings/guidancepeatwaste>

Scottish Natural Heritage (SNH) (2016). *Carbon and Peatland Map*. SNH, Scotland.

Scottish Renewables, SNH, SEPA, Forestry Commission Scotland, Historic Environment Scotland, Marine Scotland Science and AEECoW. (2019). *Good practice during wind farm construction, 4<sup>th</sup> edition*. Available at: <https://www.nature.scot/guidance-good-practice-during-wind-farm-construction>

SEPA. (2006). *Prevention of Pollution from Civil Engineering Contracts: Special Requirements*. Available at: [https://www.sepa.org.uk/media/152220/wat\\_sg\\_31.pdf](https://www.sepa.org.uk/media/152220/wat_sg_31.pdf)

SEPA. (2009). *Groundwater Protection Policy for Scotland, Version 3*. Available at: <https://www.sepa.org.uk/media/34371/groundwater-protection-policy-for-scotland-v3-november-2009.pdf>

SEPA. (2013). *Pollution Prevention Guidelines: PPG! – Understanding your Environmental Responsibilities: Good Environmental Practices*. Available at: <http://www.netregs.org.uk/media/1686/ppg-1.pdf>

SEPA. (2014). *Online Water Environment Hub*. Available at: <https://www.sepa.org.uk/data-visualisation/water-environment-hub/> Accessed in July 2019 and October 2019.

SEPA. (2014). *Land Use Planning System SEPA Guidance Note 31: Guidance on Assessing the Impacts of Windfarm Development on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems*. Available at: [https://www.sepa.org.uk/media/143868/lupsqu31\\_planning\\_guidance\\_on\\_groundwater\\_abstractions.pdf](https://www.sepa.org.uk/media/143868/lupsqu31_planning_guidance_on_groundwater_abstractions.pdf)

SEPA. (2017). *Land Use Planning System SEPA Guidance Note 4: Planning advice on windfarm developments (LUPS-GU4)*. Available at: <https://www.sepa.org.uk/media/136117/planning-guidance-on-on-shore-windfarms-developments.pdf>

SEPA. (2018). *Guidance for Pollution Prevention: GPP 5 – Works and Maintenance in or Near Water*. Available at: [http://www.netregs.org.uk/media/1418/gpp-5-works-and-maintenance-in-or-near-water.pdf?utm\\_source=website&utm\\_medium=social&utm\\_campaign=GPP5%2027112017](http://www.netregs.org.uk/media/1418/gpp-5-works-and-maintenance-in-or-near-water.pdf?utm_source=website&utm_medium=social&utm_campaign=GPP5%2027112017)

SEPA. (2018). *Supporting Guidance (WAT-SG-75) – Sector Specific Guidance: Construction Sites*. Available at: <https://www.sepa.org.uk/media/340359/wat-sg-75.pdf>

SEPA. (2019). *Online Flood Risk Maps*. Available at: <http://map.sepa.org.uk/floodmap/map.htm> Accessed in July 2019 and October 2019.

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