Chapter 7

Hydrology, Hydrogeology, Geology and Soils

SCOTTISHPOWER RENEWABLES

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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 slide, are also assessed.

2. As part of the EIA for the Operational Kilgallioch Windfarm, extensive survey work was undertaken within the proposed Development application boundary, providing relevant baseline data for this assessment. This included peat depth survey work and National Vegetation Classification (NVC) survey to identify potential groundwater dependent terrestrial ecosystems (GWDTE). This previous work has been updated and expanded upon through additional surveys and consultations, as part of the EIA process for the proposed Development.

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 **Figure 7.2**). 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)) provides 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 geology, hydrology, hydrogeology 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, 4th 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); and
- Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments (Second Edition) (Scottish Government, 2017).

7.3 Consultation

11. **Table 7.1** 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.

Consultee (Date)	Issues Raised	Response / Action Taken
Scottish Government Energy Consents Unit (ECU), 10 June 2019	Scottish Water should be consulted to confirm whether there any Scottish Water assets which may be affected by the proposed Development and investigate the presence of any private water supplies which may be impacted by the proposed Development.	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).
	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 *Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments* (Second Edition), should be followed.	A peat landslide hazard and risk assessment has been undertaken and is reported in **Technical Appendix 7.2: Peat Slide Hazard and Risk Assessment**, summarised in **Section 7.5.1.2**.
Scottish Natural Heritage (SNH), 9 May 2019	The scope of the assessments appears to be comprehensive. It is crucial to establish that there is no hydrological link between the proposed Development and the Kirkcowan Flow Site of Special Scientific Interest (SSSI)/Special Area of Conservation (SAC) which would lead to an adverse impact on both	The proposed Development design has avoided areas of hydrological connectivity with the Kirkcowan Flow SSSI/SAC, as discussed further in **Section 7.6.1**.
SEPA, 1 May 2019	Areas identified as GWDTE must be mapped (including updated NVC survey work for any areas which may have changed since previous surveys were undertaken). A buffer of 100 m around GWDTE for all excavations shallower than 1 m, and 250 m for excavations deeper than 1 m, should be applied. If not achievable, a detailed site specific risk assessment will be required	**Figure 7.6** provides a map of all identified areas of potential GWDTE, based on updated NVC survey work. Habitats indicative of potentially moderate groundwater dependency have been identified extensively across the Site although they are likely to be largely or entirely rainwater/surface water fed. These areas are too extensive to be avoided however given the assessment of being surface water fed rather than groundwater fed, detailed risk assessment is not considered to be required.
	Private water supplies (PWS) should be assessed and included within the scope of the assessment. If no additional PWS are identified then no further assessment of impact is required but this can only be determined once an updated assessment is undertaken.	Consultation with Dumfries and Galloway Council's (DGC's) Environmental Health Officer identified no known PWS within influencing distance of any proposed infrastructure. No PWS were identified from other desk study or Site survey works.
	Areas which may have changed since previous peat depth survey	A programme of peat depth survey work has been undertaken to supplement and update the previous survey data. These surveys were undertaken to ensure appropriate data coverage in line with current guidance, as discussed further in **Section 7.4.3** and in **Technical Appendix 7.2: Peat Slide Hazard and Risk Assessment**.
Galloway Fisheries Trust (GFT), 27 April 2019	There are significant amounts of deep peats in the proposed work area. The development should consider undertaking peatland restoration in appropriate areas to compensate for any peat damage caused by the wind farm construction. The upper Tarf Water catchment suffers from acidification … The disruption of peat soils would be expected to deteriorate water quality particularly by lowering pH… GFT request the opportunity to comment on any water quality monitoring plan as we have extensive experience monitoring acidification in Galloway.	All except one of the turbine locations and most associated infrastructure locations have avoided areas of deep peat. Some peat excavation and disturbance will be unavoidable, and appropriate management, restoration and re-use proposals are discussed in **Section 7.7** and **Technical Appendix 7.1: Outline Peat Management Plan**. Further information, including an outline Habitat Management Plan, is provided in **Technical Appendix 8.7**. The Applicant will be happy to engage with GFT in respect of peat excavation and restoration proposals, and water quality monitoring plans.
Scottish Water, 17 April 2019	There is no public Scottish Water infrastructure within the vicinity of this development. There are no Scottish Water drinking water catchments or water abstraction sources, which are designated as Drinking Water Protected Areas under the *Water Framework Directive*, in the area that may be affected by the proposed activity.	Noted.
D&GC Environmental Health Officer, 18 July 2019	No record of any private water supplies within the area bounded by the black dashed line (500 m buffer around the proposed Development).	Noted.

Table 7.1: Consultation Responses

7.4 Assessment Methodology and Significance Criteria

7.4.1 Study Area

12. The study area has incorporated the area within the Site boundary and this assessment also considers any potential hydrological and hydrogeological effects up to 1 km from proposed turbines and other infrastructure (see **Figure 7.1**). Hydrological and hydrogeological effects within the proposed access and grid connection route, along

the existing track through the Operational Kilgallioch Windfarm, have not been considered in detail as part of the assessment given that the existing track would be re-used with significant effects on hydrological and hydrogeological receptors not anticipated.

13. Efforts have been made, via consultations, Site survey work and review of OS mapping, to identify any PWS for an area within 500 m of the proposed Development boundary.

14. 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

15. Baseline conditions have been established primarily through desk-based research which has included:

- consultation with SEPA, SNH, and D&GC;
- 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 online SEPA flood mapping;
- review and collation of pertinent information on surface hydrology, flooding, climate, etc.;
- review of online 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 03 June 2019. Field notes were taken onsite, noting ground constraints and details of ground and surface water conditions not apparent on available mapping.

17. Stage 1 peat depth probing was undertaken by a team of surveyors, including the lead hydrologist, on 11 July 2019. The surveys aimed to supplement available peat depth data from previous surveys (undertaken as part of the EIA process for the Operational Kilgallioch Windfarm), to provide as near to a 100 m spaced grid as possible. Due to significant onsite access difficulties resulting from high vegetation limiting ground visibility, uneven and boggy ground, numerous drains and watercourses, and extensive brash from felled forestry in the north west Site area, a return visit was required on 05 August 2019 to complete the Stage 1 peat depth survey programme.

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 geology, hydrology, hydrogeology and soils resources.

20. A Stage 2 peat depth probing exercise was subsequently undertaken on 03 to 06 September, 01 and 02 October 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 compound, operations building, and borrow pit search areas. The following pattern of probing was adopted for Stage 2:

- probe at each proposed turbine location with a 10 m spaced cross-grid out to 50 m from the turbine centre to the north, south, east and west;
- at least four probes at each proposed turbine hardstanding area;
- nine probes at/adjacent to the proposed operations building location and construction compound;
- three probes in the immediate vicinity of the proposed permanent met mast;
- generally every 50 m along proposed access tracks, plus approximately 10 m 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 and earlier probing data from the Operational Kilgallioch Windfarm development; and
- probes on an at least a 100 m grid within the two proposed borrow pit search areas.

21. The potential solar array areas were not specifically targeted for detailed survey during Stage 2 given that construction of the solar arrays would involve considerably less peat disturbance and excavation, with the built footprint occupying a small proportion of the development area. However, numerous probe points were available from the Stage 1 surveys, providing sufficient information on the depth and distribution of peat within the solar area areas.

22. 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 Slide Hazard and Risk Assessment**.

23. The data were subsequently used to inform the final design freeze and to inform a Peat Slide 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 Slide Hazard and Risk Assessment**.

24. 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 11 June and 21 August 2019.

25. An NVC survey was undertaken by ITPEnergised on 16 and 21 May 2019. This survey work included identification of habitats which may be groundwater dependent, in accordance with SEPA guidance document LUPS-GU4.

7.4.4 Assessment of Effect Significance

26. The sensitivity characteristics of hydrological, hydrogeological, geological and soils resources have been guided by the matrix presented in **Table 7.2**, which lists indicative criteria.

Sensitivity	Description
High	Areas containing geological, geomorphological or hydrological features considered to be of national interest, for example, Aquatic Natura 2000 Sites, SACs, SSSIs. Highly permeable superficial deposits allowing free transport of contaminants to groundwater and surrounding surface waters. Wetland/watercourse of High or Good Ecological Status. Raised or blanket bog. High risk of flooding. Land capable of supporting Arable Agriculture i.e. Class 1, 2 and 3.1.
Medium	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. Moderately permeable superficial deposits allowing some limited transport of contaminants to groundwater and surrounding surface waters. Wetland/watercourse of Moderate Ecological Status. Significant peat deposits. Moderate risk of flooding. Land capable of supporting Mixed Agriculture i.e. Class 3.2, 4.1 and 4.2.
Low	Geological features not currently protected and not considered worthy of protection.

Sensitivity	Description
	Low permeability superficial deposits likely to inhibit the transport of contaminants. Wetland/watercourse of Poor or Bad Ecological Status or no WFD classification. Thin superficial peat deposits. Low risk of flooding. Land capable of supporting improved grassland or rough grazing only i.e. Class 5.1 to 7.

Table 7.2: Sensitivity Criteria (Hydrology, Hydrogeology, Geology and Soils)

27. 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.

28. 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 7.3**. 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.

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.

Table 7.3: Magnitude of Change Criteria (Hydrology, Hydrogeology, Geology and Soils)

29. 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**.

30. 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** below.

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

Table 7.4: Significance of Effect Matrix

31. The guideline criteria for the various categories of effect are provided in **Table 7.5**.

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.
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.

Table 7.5: Significance Criteria (Hydrology, Hydrogeology, Geology and Soils)

32. 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.

33. 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.

34. Cumulative effects have been accounted for through the prediction and evaluation of effects within the hydrological study area.

7.4.5 Requirements for Mitigation

35. 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

36. An assessment of predicted residual effects on sensitive geological, hydrological or hydrogeological receptors is presented within this chapter.

7.4.7 Limitations to Assessment

37. 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

38. There are no geological SSSIs nor GCR sites within the study area.

39. BGS online mapping for the area shows that the bedrock geology underlying the Site comprises Ordovician sedimentary strata (wacke) of the Kirkcolm Formation (northern Site area) and Portpatrick Formation (southern Site area). The Moffat Shale Group separates these two formations, sub-cropping across an approximately 100 m swathe in the south central part of the Site. The boundary between the Moffat Shale Group and the Portpatrick Formation is marked by a fault.

40. The bedrock geology as shown on BGS 1:50,000 scale mapping is shown on **Figure 7.3**.

41. BGS mapping shows that bedrock across most of the Site area is overlain by peat. Localised areas across the north and central Site areas are indicated to be underlain by till, which in this area would typically be expected to comprise stiff to hard clay with variable inclusions of sand, gravel and boulders. Much of the south east Site area, around High Eldrig and Eldrig Fell, is shown as having little or no superficial geology cover over bedrock. The exception is the far south east edge of the Site, which is indicated to be underlain by peat.

42. 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. The till appears to be discontinuous, based on some peat probes encountering rock directly below the peat.

43. In respect of the soil resource across the Site, it is noted that soils across most of the Site are dystrophic (acidic and low in oxygen) semi-confined peat. The south east Site area, with the exception of the northern Site boundary and the far south east edge of the Site, has soils classified as peaty gleyed podzols (poorly drained, acidic, organic-rich soils).

44. The superficial geology as shown on BGS 1:50,000 scale mapping is shown on **Figure 7.4**.

7.5.1.1 Mining

45. The Site is not within an area which has been subject to historical coal mining.

46. No evidence of any substantial historical quarrying has been observed through review of current and historical mapping, aerial photography, and Site survey work.

7.5.1.2 Peat

47. Parts of the west, central, and far south east Site areas are identified as being within areas 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.” A small area of Class 2 Peat (“nationally important carbon-rich soils, deep peat and priority peatland habitat; areas of potentially high conservation value and restoration potential”) is identified west of Eldrig Loch, mostly off-Site but encroaching slightly into the eastern Site boundary. Most of the remaining Site area is shown as Class 3 (“predominantly peaty soil with some peat soil”) or Class 5 (“peat soil”). The area in the south east, broadly coincident with the area where BGS mapping shows no superficial deposits, is shown on the SNH Carbon and Peatlands Map as Class 4 (“predominantly mineral soil with some peat soil”).

48. Peat depth surveys were undertaken as described in **Section 4.3**, to identify the extent, depth and nature of peat across the Site. Peat depths were recorded varying from nil to over 3 m.

49. Peat in the area of the proposed north west track linking the Site to the Operational Kilgallioch Windfarm, where plantation forestry has recently been felled, was observed to be disturbed and modified by the presence of tree roots and uprooted stumps. Elsewhere across the Site, ground conditions were generally boggy and poorly drained, with areas of flush and standing/slow-flowing water. Numerous man-made drains have been cut across the Site, exhibiting exposures of peat and underlying clay, however the Site generally remains very wet. The south east Site area, around Eldrig Fell, was observed to be driest, with little or no observable peat. Additionally, the area around Ha’ Hill in the north west of the Site was observed to have bedrock at or near the surface, with little or no peat recorded.

50. The locations and findings of the peat probes are illustrated on **Figure 7.5**.

51. The *Guidance on Developments on Peatland - Site Surveys* (Scottish Government, SNH and SEPA 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.

52. Of 3,011 probes advanced during all peat depth surveys, the peat depth was zero at 1,825 probes (60.5 %) and less than 0.5 m at 552 probes (18.3 %), the latter defined as peaty or organo-mineral soil. At 227 probes (7.5 %), peat depth between 0.5 m and 1.0 m was recorded, and at the remainder of probes (409, or 13.6 %), the peat depth was recorded to be over 1.0 m, defined as deep peat. The occurrence of deep peat is variable across the Site, located mainly in the flat and low-lying central, south and south west areas of the Site and separated by areas of shallow or no peat generally on sloping ground.

53. Full details of the peat depth survey, risk assessment and peat management proposals are provided in **Technical Appendix 7.1: Outline Peat Management Plan** and **Technical Appendix 7.2: Peat Slide Hazard and Risk Assessment**.

54. 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

55. The groundwater body beneath the study area is indicated by SEPA to comprise the Galloway groundwater (ID 150694). This groundwater body was classified by SEPA in 2017 as having an overall status of good, a water flows and levels status of good and a quality status of good.

56. 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.

57. Till, where present, is anticipated to be relatively low permeability, inhibiting groundwater flow. Peat and peaty soils would also be expected to inhibit groundwater flow.

7.5.2.2 Potential Groundwater Dependent Habitats

58. Habitats indicative of GWDTE were identified during NVC survey work (see **Figure 7.6** for a summary of potential GWDTE within the Site area and see **Chapter 8: Ecology and Biodiversity** and **Figure 8.4** for further detail).

59. Within the Site, habitats indicative of potentially high groundwater dependency were identified along the banks of surface watercourses (namely the Tarf Water along the south and west boundary, Ha’ Hill Strand, the Monandie

Burn, and Loch Strand), drains and minor tributaries, and localised low-lying areas around Monandie Rig and north of High Eldrig.

60. Habitats indicative of potentially moderate groundwater dependence were identified across much of the rest of the Site area, largely comprising mire communities.

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 likely to be mainly or entirely surface-water dependent, with those within the potentially high GWDTE category being located along surface watercourses and drainage routes (refer to **Figure 7.6**). Water contained within the peat soils across the Site is considered to be rainwater fed.

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. DGC was consulted regarding the presence of PWS in the vicinity of the proposed turbines and associated infrastructure. DGC confirmed that it holds no records of current or historical PWS in the vicinity. Furthermore, there are no residential properties within 250 m of any proposed infrastructure, which have the potential to be served by PWS.

64. A feature identified as Wells of the Rees is located in the northern part of the study area, outside the Site application boundary. This is near a former structure and may have once been a PWS. However, there is no evidence of this being in continued use for water supply, and it is over 450 m from the Site boundary and over 1.4 km from any proposed turbines. This potential former PWS is therefore not considered further within this assessment.

65. No other wells, springs or features suggesting the potential presence of a PWS have been identified from a review of OS mapping, within the Site boundary or study area. No evidence of potential PWS has been observed during Site survey work. An assessment of effects on PWS is therefore not considered further within this chapter.

7.5.2.4 Hydrogeology Baseline Summary

66. 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 permeability where present (peat and/or till). The groundwater body underlying the Site is classified as having a good overall status.

67. 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.

68. Overall, the sensitivity of baseline hydrogeological resources beneath this Site is considered to be medium.

7.5.3 Hydrology

69. As shown on **Figure 7.2**, the Tarf Water forms part of the Site's western and southern boundary, flowing from north to south, then south east. The following four smaller watercourses flow generally from north to south across the Site, into the Tarf Water:

- Back Burn rises within the woodland to the north east of the Site and flows south west along the southern edge of the recently felled plantation forestry, towards the north west of the main body of the Site.
- Ha' Hill Strand rises near the northern Site boundary and flows south into the Tarf Water on the western Site boundary, with several smaller tributaries entering the Ha' Hill Strand from points further east.
- Monandie Burn rises near the eastern corner of the northern Site boundary and flows south into the Tarf Water.
- Loch Strand flows essentially parallel to the Monandie Burn, approximately 200 to 400 m to the east. The low-lying, boggy area between these two watercourses is identified as Monandie Rig. Loch Strand is joined by numerous small drains and tributaries in its southern reaches.

70. Virtually all drainage from the main body of the Site is anticipated to flow to the Tarf Water, either directly or via the above three watercourses, or minor field drains. Eldrig Loch is located just outside the northern Site boundary towards the south east of the Site. This appears to collect drainage from the nearby Site area (northern slopes of Eldrig Fell), from there draining into Loch Strand and ultimately the Tarf Water.

71. Only the eastern slopes of Eldrig Fell in the south east Site area are anticipated to drain towards the Black Burn rather than the Tarf Water. An unnamed tributary of the March Burn rises on Eldrig Fell and flows north east to the Site boundary where it enters the March Burn, itself flowing into the Black Burn approximately 850 m south east of the Site. An unnamed tributary of the Black Burn itself rises on the southeast Site boundary and also flows north east, joining the Black Burn some 375 m from the Site.

72. The Tarf Water and Black Burn both flow into the River Bladnoch, approximately 11 km and 8 km south east of the Site, respectively. The River Bladnoch is designated as a SAC, principally for Atlantic salmon. The Tarf Water adjacent to the Site forms part of the SAC designation.

73. The 2014 SEPA classification of the Tarf Water at this location is good. The Black Burn was classified in 2014 as poor, with unknown pressures on its ecological condition. Objectives for 2021 and onward were to meet good status however it is unclear whether this has been or will be met. The smaller watercourses on the Site are not classified, but given that they flow into the Tarf Water they are anticipated to have a similar overall status i.e. good.

74. As noted above, all of the watercourses onsite, and into which the Site drains, form part of the wider catchment of the River Bladnoch.

75. Some of the proposed access tracks to turbines would require new watercourse crossings to be constructed. Nine proposed new water crossings are proposed, with one existing crossing, on the farm track in the south east of the Site, requiring to be upgraded. Eleven existing water crossings on the track through the Operational Kilgallioch Windfarm would be unchanged. The locations of these proposed water crossings are shown on **Figure 7.2**. Indicative water crossing designs are included in **Technical Appendix 7.3: Water Crossing Schedule**.

76. For the purposes of this assessment, taking account of the SAC designation applicable to the Tarf Water and the good water quality classification, the sensitivity of baseline hydrological resources at the Site is considered to be high.

77. The proposed access and grid connection route through the Operational Kilgallioch Windfarm is also partly within the Tarf catchment, although the area north of approximately Benbrake Hill drains to the Pollgowan Burn and/or Lavery Burn, itself flowing north into the Duisk River and eventually draining into the River Stinchar at Pinwherry. The far north east stretch of track drains to the River Cree. Drainage from the proposed access and grid connection route is not considered in detail within this assessment, given that there is an existing access track which would be used for the proposed Development, with only minor upgrades required. This is discussed in the Arecleoch Windfarm Extension EIA Report (SLR, June 2019), for which access is also proposed to be taken along the Operational Kilgallioch Windfarm access road from the A714. The EIA Report for that project notes that no significant engineering works are anticipated to be required, and no significant effects on hydrology, hydrogeology, geology and soils are predicted. It is therefore considered that no significant effects are anticipated from construction or operation of the proposed Development site area comprising the existing access track within the Operational Kilgallioch Windfarm site.

7.5.4 Flooding

78. The online SEPA Flood Map shows most of the Site as being outside any area of identified flood risk. The immediate banks of the Tarf Water and south west stretch of the Ha' Hill Strand are shown as being at up to high risk of flooding, however this risk classification generally does not extent more than 100 m from the edge of the watercourse.

79. An exception is within the meander of the Tarf Water just east of the Ha' Hill Strand, where an area up to approximately 175 m from the edge of the Tarf Water (i.e. the area surrounded by the meander) is shown as having at least a low risk of flooding, with higher risk nearer the watercourse. No proposed turbines or other infrastructure are located within 500 m of this area.

80. Highly localised areas of up to high risk of surface water flooding are shown on the map, along the course of Ha' Hill Strand, the Monandie Burn and Loch Strand. With the exception of two small areas near in the northern stretch of Ha' Hill Strand, these areas of surface water flood risk are essentially confined to the width of the watercourses themselves.

81. A SNH representative met SPR team members onsite in June 2019 and anecdotally reported that the existing track to Eldrig in the south east Site area has been known to flood. A stretch of the track approximately 150 m long is very close to the unnamed tributary of the March Burn, and this watercourse is crossed by the track some 250 m to the south east. It is not clear whether reported flooding has resulted from the banks of the burn near the track over-topping, or the watercourse crossing causing a blockage. This crossing (WX21 on **Figure 7.2**) has been identified as requiring upgrade for use as part of the proposed Development (refer to **Technical Appendix 7.3: Water Crossing Schedule**).

82. The sensitivity of the Site with respect to flooding is generally considered to be low, however given the anecdotal reports of localised flooding on in the south east Site area, the sensitivity of that Site area is considered to be medium.

7.6 Potential Effects

83. 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

84. 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 50 m buffer has been maintained around all surface watercourses, except where watercourse crossings are required. A 100 m buffer has been maintained around the Tarf Water.
- A 50 m buffer has been maintained between all turbines and the Kirkcowan Flow SSSI/SAC. All of the turbines in nearest proximity to the SSSI/SAC are sited on areas of no or shallow peat, and none are within areas of peat which extend into the SSSI/SAC, in order to avoid hydrological connectivity with the SSSI/SAC and the potential for localised drawdown of the shallow water table in the vicinity of excavations to result in drying of shallow peat deposits within the SSSI/SAC.
- The number of watercourse crossings has been minimised as far as possible.
- Areas of deep peat have been avoided in siting all turbines except Turbine 8, which is sited on an area with measured peat depths just over 1 m in order to avoid other constraints. Deep peat areas have also been avoided as far as possible in siting all other proposed Development infrastructure, taking account of other environmental and technical constraints. The construction compound, operations building, the permanent met mast, 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 slide risk.

85. 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 to inform suitable micro-siting of the turbines and associated infrastructure. Any deep peat identified in the borrow pit search areas would be avoided for 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 Tarf Water, Back Burn, Ha' Hill Strand, Monandie Burn, Loch Strand, and March Burn. 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 Construction Environmental Management Plan (CEMP), agreed with SEPA, SNH and DGC 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;
  - ensuring that concrete batching is undertaken only at a designated area at the temporary construction compound, 100 m 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.
- 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 DGC. 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 one proposed open arch/bridge water crossing, seven proposed new culverts, and one proposed upgraded water crossing, 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 Dumfries & Galloway, 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

86. 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 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 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.

87. Given that all turbines have been sited outside areas of deep peat except Turbine 8 where peat depth is only slightly greater than 1 m, and none are sited in deposits which would indicate hydraulic continuity with the adjacent Kirkcowan Flow SSSI/SAC, the sensitivity of receptor (groundwater and shallow peat deposits) is low to medium.

88. 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** adverse significance (not significant).

7.6.2.2 Removal of and Impact on Peat

89. Although all proposed turbine locations avoid identified areas of deep peat, there would be a requirement for excavation of 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**.

90. 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** adverse significance (not significant) in the absence of mitigation.

7.6.2.3 Pollution Impact from Sediment Runoff/Transport

91. 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.

92. However, as noted in **Section 7.6.1**, a minimum buffer of 50 m around all watercourse and 100 m around the Tarf Water has been maintained in siting all infrastructure except where watercourses need to be crossed, and good construction practice measures would be set out in a CEMP and fully implemented to minimise the risk of pollution to surface watercourses.

93. The magnitude of change, prior to any additional mitigation, is therefore considered to be negligible, on a high sensitivity receptor. Therefore, there is potential for a direct, temporary, short-term effect of **minor** adverse significance (not significant).

7.6.2.4 Pollution Impact from Chemical Contaminated Runoff

94. Pollutants such as oils, fuel and cement may be mobilised through mechanical leaks or spillage and carried in surface drainage. Unless managed appropriately, the pollutants could be washed into watercourses, impacting on freshwater quality and ecological value. However, as noted in **Section 7.6.1**, a minimum buffer of 50 m around all watercourse and 100 m around the Tarf Water has been maintained in siting all infrastructure except where watercourses need to be crossed, and good construction practice measures would be set out in a CEMP and fully implemented to minimise the risk of pollution to surface watercourses.

95. The magnitude of change, prior to any additional mitigation, is therefore considered to be negligible, on a high sensitivity receptor. Therefore, there is potential for a direct, temporary, short-term effect of **minor** adverse significance (not significant).

7.6.2.5 Impact on the Integrity of Banking

96. Permanent new watercourse crossings would be required at nine locations (one new open arch/bridge and eight new culverts) and at one additional location the existing water crossing would need to be upgraded.

97. 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.

98. 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.

99. The potential magnitude of impact is therefore negligible, on high sensitivity receptors, resulting in potential for a direct, permanent effect of **minor** adverse significance (not significant) prior to the implementation of any additional mitigation measures.

7.6.2.6 Compaction of Soils

100. 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.

101. Taking account of embedded mitigation set out in **Section 7.6.1**, and the inferred low 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 on-site and adjacent watercourses is high, therefore there is potential for an indirect, temporary, short-term effect of **minor to moderate** adverse significance (not significant).

7.6.3 Operation

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

102. 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 DGC to ensure that runoff from hard surfaces would be appropriately controlled.

103. The magnitude of change, prior to any additional mitigation, is therefore negligible, on a high sensitivity receptor (local watercourses). Therefore, there is potential for an indirect, long-term effect of **minor** adverse significance (not significant).

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

104. 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 deposits, with flow likely to be limited and slow.

105. Taking account of embedded mitigation measures set out in **Section 7.6.1**, the magnitude of impact is assessed as low, on a medium sensitivity receptor. There is therefore potential for an indirect, long-term effect of **minor** adverse significance (not significant) in the absence of any additional, specific mitigation.

7.6.3.3 Impacts on fluvial geomorphology

106. 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 DGC, including detail of the dimensions and final design of the new and 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.

107. The magnitude of change, prior to any additional mitigation, is negligible, on a high sensitivity receptor. Therefore, there is potential for a direct, permanent effect of **minor** adverse significance (not significant).

7.6.3.4 Impact on fluvial flood risk onsite and downstream

108. 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. Although no areas of proposed infrastructure development are within potential fluvial flood risk areas identified by SEPA flood risk mapping, the existing track in the south east site area has been anecdotally identified as being susceptible to flooding. This may be as a result of the existing culvert, which has been identified as requiring upgrade as part of the proposed Development. 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 medium sensitivity receptor, resulting in a direct, long-term effect of **negligible** adverse significance (not significant).

109. The Tarf Water downstream of the Site is only susceptible to flooding in the immediate vicinity of its banks. Taking account of the embedded mitigation set out in **Section 7.6.1**, there is potential for a low magnitude impact on a low sensitivity receptor, resulting in an indirect, long-term effect of negligible adverse significance (not significant).

7.7 Mitigation

110. 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. Although no significant potential effects have been identified (refer to Section 7.6), the following measures are proposed to further minimise the potential for adverse effects to arise.

111. 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.

112. Where excavation of localised, shallow 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 Plan**.

113. 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.

114. Where topography dictates that working platforms are needed, these would be formed to ensure that surface water drains away from watercourses.

115. 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**.

116. A Habitat Management Plan (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 D&GC prior to construction and would be implemented during the operation of the proposed Development. This would involve blocking of drains in an identified area of the Kirkcowan Flow SSSI/SAC, allowing the drains to gradually infill naturally and result in re-wetting of peat deposits in the vicinity of drains, which had been dewatered at shallow depth. The proposed Habitat Management Area has been selected as an area affected by artificial drainage and 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, providing biodiversity enhancement through improvement of blanket bog habitat to mitigate losses of modified bog. The key objectives of the HMP are to raise the water table within the bog, and to improve the quality of modified bog habitat. 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 (Loch Strand, March Burn, Polbae Burn and Loddens Burn). All of these are within the wider River Bladnoch catchment, therefore an indirect hydrological benefit to the SAC designated River Bladnoch is anticipated.

7.8 Residual Effects

117. 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 locally improve blanket bog habitat.

118. 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

119. The only windfarms within the study area are operational developments (Kilgallioch Windfarm to the west-north west and Airies Windfarm to the south east). Although these windfarms are within the catchment of the Tarf Water 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.

120. 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 the operation of above-noted developments is taken into account.

7.10 Summary

121. The proposed Development is located within the catchment of the River Bladnoch, with drainage across the majority of the Site being to the Tarf Water on the western and southern Site boundary. The River Bladnoch is designated as a SAC, principally for Atlantic salmon, and the designation includes the Tarf Water adjacent to the site. The Tarf Water and the onsite watercourses draining into it are considered within the assessment to have good water quality.

122. The rock beneath the Site is sedimentary, forming a low productivity aquifer. Superficial deposits comprise variable thicknesses of peat, with localised till and in some areas rock at surface. Groundwater may be somewhat mobile within shallow peat deposits, but is expected to be substantially less so in deeper, catotelmic peat and till, and is indicated to be largely confined to fissures and other discontinuities within the underlying bedrock.

123. Habitats indicative of potential groundwater dependence have been identified across much 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 wetland habitats identified, it is clear that the habitats are likely to be mainly or entirely surface-water dependent, with those within the potentially high GWDTE category being located along surface watercourses and drainage routes. Water contained within the peat soils across the Site is considered to be rainwater fed.

124. No PWS have been identified within the study area.

125. A peat depth survey has identified peat across much of the proposed Development area, locally over 3 m thick but often thinner and sometimes absent. Areas of deep peat are avoided by all proposed turbine locations and most Site infrastructure, although several short stretches of access track would need to cross deep peat.

126. No turbines are sited on areas of peat which extend into the Kirkcowan Flow SSSI/SAC which is adjacent to the northern Site boundary, in order to avoid construction in areas with hydrological connectivity to the SSSI/SAC and

the potential for localised drawdown of the shallow groundwater table to result in drying of shallow peat deposits within the SSSI/SAC. It is also noted that the SSSI/SAC is up-gradient from the Site.

127. A peat slide risk assessment has identified negligible or low risks across the Site with the exception of a very small number of localised points, more than 300 m from any proposed infrastructure.

128. 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, effects on the integrity of watercourse banks, compaction of soils, long-term effects on fluvial geomorphology, and effect on onsite and downstream flood risk.

129. 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 slide 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.

130. 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; and establishing and demarcating working areas and corridors. Additionally, a Habitat Management Plan would be implemented, to facilitate re-wetting of peat in the vicinity of artificial drains across a specified area of the Kirkcowan Flow SAC/SSSI and provide hydrological benefit to the local watercourses, which are all within the River Bladnoch catchment.

131. 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 10.6**.

Description of Effect	Significance of Potential Effect		Mitigation Measure	Significance of Residual Effect	
	Significance	Beneficial / Adverse		Significance	Beneficial / Adverse
During Construction					
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	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 chemical contaminated runoff	Minor	Adverse	No specific measures beyond embedded mitigation.	Minor	Adverse
Impact on the integrity of banking	Minor	Adverse	No specific measures beyond embedded mitigation.	Minor	Adverse
Compaction of soils	Minor to moderate	Adverse	Restriction of works to set construction areas and corridors.	Minor	Adverse
During Operation					
Increased rate of surface water runoff	Minor	Adverse	No specific measures beyond embedded mitigation.	Minor	Adverse
Long-term changes to groundwater flow regime and dewatering of peat	Minor	Adverse	HMP implementation (within Kirkcowan Flow SAC/SSSI).	Negligible	Adverse
Impacts on fluvial geomorphology	Minor	Adverse	No specific mitigation measures beyond embedded mitigation.	Minor	Adverse
Impacts on onsite and downstream fluvial flood risk	Negligible	Adverse	No specific mitigation measures beyond embedded mitigation.	Minor	Adverse
Cumulative Effects					
No significant cumulative effects are predicted.					

Table 7.10.6: Summary Table

7.11 References

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Kilgallioch Windfarm Extension Project Team

ScottishPower Renewables
9th Floor Scottish Power Headquarters
320 St Vincent Street
Glasgow
G2 5AD

kilgalliochextension@scottishpower.com

www.scottishpowerrenewables.com

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