12 HYDROLOGY AND HYDROGEOLOGY

12.1 INTRODUCTION

This Chapter of the Environmental Impact Assessment Report (EIA Report) evaluates the effects of the Ackron Wind Farm (the Development) on the hydrology (surface water) and hydrogeology (groundwater) resources. This assessment was undertaken by Holly Clark BSc MSc MCIWEM, Hydrologist, of Arcus Consultancy Services Limited (Arcus) and technically reviewed by Liam Nevins BSc MCIWEM C.WEM, who is a chartered member of CIWEM. The Chapter has been reviewed Heather Kwiatkowski, Principal EIA Consultant at Arcus and by Stuart Davidson, Registered EIA Practitioner and Operational Director at Arcus.

This Chapter is supported by the following figures provided in Volume 2a Figures excluding Landscape and Visual:

- Figure 12.1: Hydrology Study Area;
- Figure 12.2: Hydrological Catchments;
- Figure 12.3: Hydrology Features; and
- Figure 12.4: Watercourse Crossings.

This Chapter is also supported by the following Technical Appendix documents provided in Volume 3 Technical Appendices:

- A12.1: Private Water Supply Risk Assessment (PWSRA).

This chapter includes the following elements:

- Legislation, Policy and Guidance;
- Assessment Methodology and Significance Criteria;
- Baseline Conditions;
- Sensitivity of Receptors
- Assessment of Potential Effects;
- Mitigation and Residual Effects;
- Cumulative Effect Assessment;
- Summary of Effects; and
- Statement of Significance.

12.2 LEGISLATION, POLICY AND GUIDANCE

The following guidance, legislation and information sources have been considered in carrying out this assessment:

- The Water Framework Directive (WFD) (2000/60/EC)[1] establishes a framework for the protection, improvement and sustainable use of all water environments. It is transposed within Scotland by the Water Environment and Water Services (Scotland) Act 2003[2] and subsidiary Regulations;
- The Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003[3];

[1] European Commission (2000) The Water Framework Directive (2000/60/EC). Available at: http://ec.europa.eu/environment/water/water-framework/index_en.html Accessed on: 23/06/2020
[2] Scottish Government (2003) The Water Environment and Water Services (Scotland) Act 2003. Available at: http://www.legislation.gov.uk/asp/2003/3/contents Accessed on: 23/09/2020
[3] Scottish Government (2003) Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003. Available at: http://www.opsi.gov.uk/legislation/scotland/acts2003/asp_20030015_en_1 Accessed on: 23/09/2020

- The Water Intended for Human Consumption (Private Supplies) (Scotland) Regulations 2017[4]; and
- The Public and Private Water Supplies (Miscellaneous Amendments) (Scotland) Regulations 2017[5].

12.2.1 Scottish Planning Policy and Guidance

The Scottish Planning Policy (SPP)[6] was published in 2014 and replaces the previous SPP (published in 2010). SPP is a non-statutory document which sets out the Scottish Government's policy on how nationally important land use planning matters should be addressed.

In paragraphs 255 to 268, the SPP sets out guidance for development within areas of flood risk, including the responsibilities of planning authorities in regulating and controlling development in such areas, in order to prevent increased risk of flooding in the future. SPP emphasises the need to apply sustainability principles to the prevention of flooding and the control of future development.

The consultation on the proposed revised SPP does not influence flood risk.

12.2.2 Pollution Prevention Guidelines (PPGs) and Guidance for Pollution Prevention (GPPs)

Pollution Prevention Guidelines (PPGs) and the replacement series Guidance for Pollution Prevention (GPPs) give advice on statutory responsibilities and good environmental practice. Each PPG and GPP addresses a specific industrial sector or activity. SEPA are in the process of replacing the PPGs with GPPs. The following guidance are of relevance principally to surface water, however as surface water has the potential to affect groundwater, they are also of relevance to the assessment of groundwater:

- SEPA PPGs and replacement GPPs[7]:
- - GPP1: A general guide to preventing pollution (October 2020);
  - GPP2: Above ground oil storage tanks (January 2018);
  - GPP4: Treatment and disposal of wastewater where there is no connection to the public foul sewer (November 2017);
  - GPP5: Works and maintenance in or near water (January 2017);
  - PPG6: Working at construction and demolition sites (2012);
  - GPP8: Safe storage and disposal of used oils (July 2017);
  - PPG18: Managing fire water and major spillages (June 2000);
  - GPP21: Pollution incident response planning (July 2017); and
  - GPP22: Dealing with spills (October 2018).

[4] Scottish Government (2017) the Water Intended for Human Consumption (Private Supplies) (Scotland) Regulations 2017. Available at: https://www.legislation.gov.uk/ssi/2017/282/note/made Accessed on: 23/09/2020

[5]Scottish Government (2017) the Private and Public Water Supplies (Miscellaneous Amendments) (Scotland) Regulations 2017. Available at: http://www.legislation.gov.uk/ssi/2017/321/made Accessed on: 21/04/2020

[6] UK Government (2014) Scottish Planning Policy. Available at: https://www.gov.scot/publications/scottish-planning-policy/ Accessed on: 22/09/2019

[7] SEPA (various) Pollution Prevention Guidelines and Guidance on Pollution Prevention. Available at: https://www.netregs.org.uk/environmental-topics/pollution-prevention-guidelines-ppgs-and-replacement-series/ Accessed on: 23/09/2020

12.2.3 Other Relevant Guidance

Other relevant guidance comprises the following:

- The Scottish Government (2001), PAN 61: Planning and Sustainable Urban Drainage Systems[8];
- SEPA (2010) Land Use Planning System Guidance Note 2, Version 8 (LUPS-GU2)[9];
- SEPA (2010) Engineering in the water environment: good practice guide: River crossings[10];
- SEPA (2015) Culverting of watercourses: position statement and supporting guidance[11];
- SEPA (2017), Land Use Planning System Guidance Note 31, Version 3, (LUPS-GU31)[12];
- SEPA (2019) Climate change allowances for flood risk assessment in land use planning (LUPS-CC1)[13];
- SEPA (2002), Managing River Habitats for Fisheries[14];
- The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (the CAR Regulations)[15];
- SEPA (2019), CAR - A Practical Guide, Version 8.4[16];
- The Water Environment (Drinking Water Protected Areas) (Scotland) Order 2013[17];
- SEPA (2009), River Basin Management Plan[18];
- Scottish Natural Heritage (SNH[19]) (2019), Good Practice During Wind Farm Construction[20];
- The Construction Industry Research and Information Association (CIRIA) (2015), Environmental Good Practice on Site (C741)[21];

[8] The Scottish Government (2001) PAN61 Planning and Sustainable Urban Drainage Systems. Available at: http://www.scotland.gov.uk/Publications/2001/07/pan61 Accessed on: 23/09/2020
[9] SEPA (2010) Land Use Planning System Guidance Note 2, Planning advice on Sustainable Drainage Systems (SUDS), Version 8. Available at: https://www.sepa.org.uk/media/143195/lups-gu2-planning-guidance-on-sustainable-drainage-systems-suds.pdf Accessed on: 23/09/2020
[10] SEPA (2010) Engineering in the water environment good practice guide: River Crossings, WAT-SG-25. Available at: http://www.sepa.org.uk/regulations/water/engineering/engineering-guidance/ Accessed on: 23/09/2020
[11] SEPA (2015) Culverting of watercourses: position statement and supporting guidance WAT-PS-06-02, Version 2.0. Available at: https://www.sepa.org.uk/media/150919/wat_ps_06_02.pdf Accessed on: 24/09/2020
[12] SEPA (2017) Land Use Planning System Guidance Note 31.
Guidance on Assessing the Impacts of Windfarm Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems. Version 3. Available at: https://www.sepa.org.uk/media/144266/lups-gu31-guidance-on-assessing-the-impacts-of-development-proposals-on-groundwater-abstractions-and-groundwater-dependent-terrestrial-ecosystems.pdf Accessed on: 24/09/2020
[13] SEPA (2019) Climate Change Allowances for Flood Risk Assessment in Land Use Planning (LUPS-CC1). Available: https://www.sepa.org.uk/media/426913/lups_cc1.pdf Accessed on: 24/09/2020
[14] SEPA (2002) Managing River Habitats for Fisheries: a guide to best practice. Available at: https://www.sepa.org.uk/media/151323/managing_river_habitats_fisheries.pdf Accessed on: 24/09/2020
[15] Scottish Government (2011) the Water Environment (Controlled Activities) (Scotland) Regulations 2011. Available at: http://www.legislation.gov.uk/ssi/2011/209/pdfs/ssi_20110209_en.pdf Accessed on: 24/06/2020
[16] SEPA (2015a) Controlled Activities Regulations - A Practical Guide, Version 8.4. Available at: https://www.sepa.org.uk/media/34761/car_a_practical_guide.pdf Accessed on: 24/09/2020
[17] Scottish Government (2013) The Water Environment (Drinking Water Protected Areas) (Scotland) Order 2013. Available at: http://www.legislation.gov.uk/ssi/2013/29/introduction/made Accessed on: 24/09/2020
[18] SEPA (2009) River Basin Management Plan. Available at: http://www.sepa.org.uk/water/river_basin_planning.aspx Accessed on: 24/09/2020
[19] Scottish Natural Heritage (SNH) rebranded in August 2020 as NatureScot. Where relevant reference is still made to SNH within this chapter in respect of guidance which remains valid and is yet to be republished etc.
[20] SNH (2019) Good Practice During Wind Farm Construction. Available at: https://www.nature.scot/guidance-good-practice-during-wind-farm-construction Accessed on: 21/09/2020
[21] CIRIA (2015) Environmental Good Practice on Site. Available at: https://www.ciria.org/Training/Training_courses/Environmental_good_practice_on_site.aspx Accessed on: 21/04/2020

- CIRIA (2001), Control of Water Pollution from Construction Sites (C532)[22]; and
- CIRIA (2015), The SuDS Manual (C753).

12.3 ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA

12.3.1 Scoping Opinion and Consultations

Consultation for this EIA Report topic was undertaken with the organisations shown in Table 12.1.

Table 12.1: Consultation Responses

Consultee	Summary of Consultation Response	Response to Consultee
SEPA Scoping Opinion 17th April 2019	Engineering activities which may have adverse effects on the water environment.	The site layout and infrastructure and hydrological features is provided in Figure 12.3. Details on the mitigation measures to be employed in regards to site drainage and pollution prevention are detailed in Appendix A4.1: CEMP.
	Disruption to GWDTE.	Details of excavations within 100 m radius and 250 m radius of identified GWDTE are detailed in Section 12.6.1.5. A map of identified GWDTE is provided in **Chapter 7: Ecology** as Figure 7.3.
	Disruption to groundwater abstractions.	A private water supply risk assessment has been provided as Appendix A12.1. No groundwater abstractions for water supply are identified within 2 km of the red line boundary (the Site Boundary). A map detailing the identified private water supply abstractions and 100 m and 250 m buffers of is provided as Figure 12-2.1, and are also shown on Figure 12.3: Hydrology Features.
	If battery storage is included then the EIA Report should include information on how the facilities will be bunded and drained.	Acknowledged. Battery storage not included in EIA Report.
	SEPA are pleased to note that the revised turbine layout includes a significant buffer to the water environment. Two of the turbines are located on the east of Giligill Burn. If Drum Hollistan windfarm gains planning permission then these turbines should be accessed from the east via that windfarm, unless it is clearly demonstrated that this is not the best environmental options.	50 m watercourse buffer is applied around watercourses. Where watercourses are within a steep-sided gully, the 50 m buffer will extend from the top of the bank as outlined in Section 12.3.9. All turbine infrastructure is outside of the 50 m watercourse buffer with the exception of T7 which encroaches 8.2 m into the 50 m buffer to avoid deep peat. All wind turbines are located to the west of Giligill Burn as shown in Figure 12.1.

[22] CIRIA (2001), Control of Water Pollution from Construction Sites (C532) Available at: https://www.ciria.org/ProductExcerpts/C532.aspx Accessed on: 23/09/2020

Consultee	Summary of Consultation Response	Response to Consultee
SEPA Updated Scoping Opinion 11th November 2019	It should be ensured that T1 is located so that there is a buffer of at least 50 m between the edge of an excavation works and the top of the banks of the watercourse.	T1 is located in excess of 80 m from the top of the watercourse banks.
Scottish Water Scoping Opinion 18th April 2019	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. For reasons of sustainability and to protect our customers from potential future sewer flooding, Scottish Water will not accept any surface water connections into our combined sewer system.	This is acknowledged. Public water supplies have been scoped-out of the assessment as outlined in Section 12.3.3. No drainage measures are proposed to connect into Scottish Water assets.
Scottish Water Updated Scoping Opinion 3rd November 2019	The Development Proposal impacts on existing Scottish Water assets. The Applicant must identify any potential conflicts with Scottish Water assets.	This is acknowledged.
NatureScot[23] Scoping Opinion 6th May 2019	NatureScot advise that the hydrological effects on the peatlands habitats of Caithness and Sutherland Peatlands SAC should be scoped in. NatureScot note that due to the apparent continuity of blanket bog habitat between Turbines 13 & 14, it is likely there is also hydrological continuity with this SAC.	The Caithness and Sutherland Peatlands statutory designations are scoped into the assessment (Table 12.7) and the effects on the hydrological function of these have been assessed in Section 12.6.1.6. T13 & T14 have since been removed from the design.

[23] Scottish Natural Heritage (SNH) rebranded in August 2020 as NatureScot. Where relevant reference is still made to SNH within this chapter in respect of guidance which remains valid and is yet to be republished etc.

Consultee	Summary of Consultation Response	Response to Consultee
The Highland Council Scoping Opinion 6th June 2019	The hydrology assessment should include potential impacts on water courses, water supplies including private supplies, water quality, water quantity, groundwater and on aquatic flora and fauna. The need for, and information on, abstractions of water supplies for concrete works or other operations should also be identified. Assessment will need to recognise periods of high rainfall which will impact on any calculations of run-off, high flow in watercourses and hydrogeological matters. Measures to prevent erosion, sedimentation or discolouration will be required, along with monitoring proposals and contingency plans. If culverting should be proposed, then it should be noted that SEPA has a general presumption against modification, diversion or culverting of watercourses. Schemes should be designed to avoid crossing watercourses, and to bridge watercourses where this cannot be avoided. Early Stage consultation with SEPA is highly recommended.	Embedded design and mitigation measures, outlined in Section 12.3.9, will reduce the effect of the Development on watercourses and groundwater. A PWSRA is provided as Appendix A12.1: PWSRA. A summary of which and the assessment of effects is provided in Section 12.6.1.4. Increases in surface run-off and potential for flood risk is outlined in Section 12.6.1.7. The Development design will require one watercourse crossing, shown in Figure 12.4, which will cross in culvert. An indicative culvert design is discussed in Appendix 4.1 CEMP.
The Highland Council Updated Scoping Opinion 11th December 2019	The need for, and information on, abstractions of water supplies for concrete works or other operations should also be identified. The ES should identify whether a public or private source is to be utilised. If a private source is to be utilised, full details on the source and details of abstraction need to be provided.	The requirements for water supply on the site will be determined prior to construction, and consultation with SEPA will be conducted prior to construction regarding license requirements.

12.3.2 Scope of Assessment

The key issues for the assessment of potential hydrological effects relating to the Development include short-term (construction) and long-term (operation) potential effects.

Short-term potential effects arising from the construction phase are as follows:

- Chemical pollution and sedimentation of watercourses and the wider hydrological environment as a result of construction works;
- Impediments to watercourse and near-surface water flow from wind turbine foundations and shallow excavation works, including changes in soil and peat interflow patterns;

- Compaction of soils and superficial deposits and reduction in ability of such deposits to store water;
- Effects on Private Water Supplies (PWS);
- Potential effects on the hydrological function of groundwater dependent terrestrial ecosystems (GWDTEs);
- Potential effects of the hydrological function of designated hydrological receptors connected to the Development, as outlined in Table 12.7; and
- Increased run-off and flood risk from increased hardstanding and reduction in soils ability to store water.

Long-term effects arising from operational phase are as follows:

- Increased run-off and flood risk from increased hardstanding including permanent access tracks, and long-term alterations or impediments to near-surface water flow;
- Potential partial or complete loss of PWS infrastructure and / or source; and
- Potential effects on the hydrological function of groundwater dependent terrestrial ecosystems.

The key sensitive receptors are considered to be:

- Surface watercourses of Akran Burn, Giligill Burn and the unnamed watercourse and associated tributaries;
- Moderately productive aquifer of the Lower Old Red Sandstone unit;
- Near-surface water in peatland soils;
- PWS at Ackron Farm;
- GWDTEs;
- Caithness and Sutherland Peatlands SAC, SPA and Wetland of International Importance (Ramsar); and
- East Halladale SSSI and Strathy Coast SSSI.

12.3.3 Elements Scoped Out of Assessment

The following effects are scoped out of the assessment:

- Pollutants from contaminated land as the site has not previously been developed and there are no identified pollutant releases within the Site Boundary;
- Public water supplies have been scoped out of the assessment as Scottish Water have confirmed there are no public supply abstractions or drinking water protected areas (DWPA) hydrologically connected to the Development; and
- Designated receptors which are not hydrologically connected to the Development, as outlined in Table 12.8.

12.3.4 Study Area / Survey Area

The hydrology and hydrogeology study area (the Core Study Area) is defined by the Site Boundary and is shown in Figure 12.1.

A wider study area of 10 km from the Site Boundary is defined to assess the potential effects on downstream water environment (the Wider Study Area). A study area of 2 km from the Site Boundary is defined to identify and assess the potential effects on PWS (the PWS Study Area). Study areas are shown in Figure 12.1.

12.3.5 Design Parameters

The hydrology and hydrogeology assessment is based on the design parameters set out in **Chapter 4: Development Description** of this EIA Report.

No additional design parameters are required for the assessment presented in this Chapter.

The infrastructure and turbines may be micro-sited up to 50 m, only where constraints allow. All assessment for hydrology and hydrogeology is based on the locations of turbines as detailed in Table 4.1 of Chapter 4 of this EIA Report.

12.3.6 Baseline Survey Methodology

A desk-based assessment, consultation and site walkover have been conducted to inform the hydrology and hydrogeology assessment.

12.3.6.1 Desk-Based Assessment

The desk-based assessment includes:

- Identification of watercourses, surface water catchments and springs;
- Identification of underlying geology and hydrogeology and connectivity to the Development;
- Assessment of topography and slope to inform drainage patterns;
- Collation of data provided through consultation, including details on PWS and sources;
- Assessment of flood risk data and mapping; and
- Assessment of potential for the presence of GWDTEs.

The following sources of information were used to inform the desk-based assessment:

- The Ordnance Survey (OS) 1:50,000 (Digital);
- OS 1:25,000 Map (Digital);
- National River Flow Archive (NRFA)[24];
- SEPA Flood Map 2019[25];
- Meteorological Office Rainfall Data[26];
- Scotland's Environment web-based maps[27];
- Drinking Water Quality Regulator (DWQR) Private Water Supply map[28];
- The British Geological Survey (BGS) GeoIndex onshore geology viewer[29];
- Groundwater Vulnerability (Scotland) GIS dataset, Version 2 and user guide[30];
- The UK Centre for Ecology and Hydrology (CEH) environmental information platform (EIP)[31]; and
- Historic Land-use Assessment project (HLA) maps[32].

12.3.6.2 Consultation

In addition to Scoping consultation outlined in Section 12.3.1, the following consultees were contacted to inform the hydrology and hydrogeology assessment:

- The Highland Council (the Council) Environmental Health Office (EHO) on 17th September 2019 via email to obtain information on registered PWS within the PWS Study Area; and

[24] Centre for Ecology and Hydrology (n.d.) National River Flow Archive. Available at: http://nrfa.ceh.ac.uk/ Accessed on: 25/04/2020
[25] SEPA (2019) Flood Maps. Available at: http://map.sepa.org.uk/floodmap/map.htm Accessed on: 25/04/2020
[26] Met Office (2019) Climate Data. Available at: http://www.metoffice.gov.uk/public/weather/climate Accessed on: 24/04/2020
[27] Scotland's Environment (n.d.) Available at: https://www.environment.gov.scot/legal/terms-and-conditions/ Accessed on: 24/04/2020
[28] DWQR (n.d.) Private Water Supply maps. Available at: https://dwqr.scot/private-supply/pws-location-map/ Accessed on: 23/04/2020
[29] BGS (2019) GeoIndex Onshore. Available at: https://mapapps2.bgs.ac.uk/geoindex/home.html Accessed on: 24/04/2020
[30] British Geological Survey (2011) User Guide: Groundwater Vulnerability (Scotland) GIS dataset, Version 2. Available at: http://nora.nerc.ac.uk/id/eprint/17084/1/OR11064.pdf Accessed on: 30/04/2020
[31] CEH (n.d.) Environmental Information Platform. Available at: https://eip.ceh.ac.uk/ Accessed on: 28/04/2020
[32] Historic Environment Scotland (2020) HLAmap. Available at: https://map.hlamap.org.uk/ Accessed on: 28/04/2020

- Residents and owners of properties which are identified as being supplied by a PWS were contacted via mailshot to obtain information on the source and supply of the PWS.

Further information on this consultation is provided as part of the PWSRA in Section 12.4.5 and Appendix A12.1: PWSRA.

12.3.6.3 Site Walkover

A site walkover was conducted on 23rd October 2019 to visually inspect surface water features, obtain an understanding of the local topography and drainage patterns and to ground-truth the information reviewed and collated in the desk-based assessment.

The site walkover was conducted within the Core Study Area, as shown in Figure 12.1, including the banks of the Akran Burn and associated tributaries and the north-western banks of Caol-Loch. The Giligill Burn was assessed where accessible at the northern extent of the Core Study Area.

Properties identified as being supplied by a PWS were visited on the 23rd October 2019 in order to obtain further information and identify the source and related infrastructure of PWS.

12.3.7 Methodology for the Assessment of Effects

The significance of the potential effects of the Development has been classified by professional consideration of the sensitivity of the receptor and the magnitude of the potential effect.

The assessment follows the systematic approach outlined in **Chapter 5: EIA Methodology.**

The assessment methodology specific to hydrology and hydrogeology is outlined in the following sections and has been developed by Arcus in consultation with SEPA, NatureScot, Marine Scotland and the Council. The assessment is based on a source-pathway-receptor methodology, where the sensitivity of the receptors and the magnitude of potential effect upon those receptors is assessed.

12.3.7.1 Sensitivity of Receptors

The sensitivity of the baseline conditions, including the importance of environmental features on or near to the Site or the sensitivity of potentially affected receptors, will be assessed in line with best practice guidance, legislation, statutory designations and / or professional judgement.

Table 12.2 details the framework for determining the sensitivity of receptors.

Table 12.2: Framework for Determining Sensitivity of Receptors

Sensitivity of Receptor	Definition
Very High	• A large, medium or small waterbody with a SEPA water quality classification of 'High'. • The hydrological receptor is used for recreational use (e.g. bathing waters). • The hydrological receptor and downstream environment have no capacity to attenuate natural fluctuations in hydrochemistry and cannot absorb further changes without fundamentally altering its baseline characteristics / natural processes. • Local groundwater constitutes a valuable resource because of its high quality and yield. Aquifer classified by the British Geological Survey (BGS) as 'highly productive aquifer' and is of regional importance. Statutorily designated nature conservation sites dependent on groundwater.

Sensitivity of Receptor	Definition
	• Groundwater vulnerability class 5: vulnerable to most pollutants, with rapid impact in many scenarios. • The hydrological receptor will support abstractions for public water supply or private water abstractions for the production of mass-produced food and drinks. • Groundwater dependent terrestrial ecosystems (GWDTEs) which are classified by SEPA as "highly groundwater dependent" and have no functional impairment by man-made influence (such as drainage or forestry). • The hydrological receptor is of high environmental importance or is designated as European or international importance, such as a Special Area of Conservation (SAC), Special Protections Areas (SPA), a Site of Special Scientific Interest (SSSI) or Wetland of International Importance (Ramsar). • The receptor acts as an active floodplain or other flood defence, in accordance with SPP 2014.
High	• Land use are highly sensitive to hydrological change (e.g. peat and blanket bog). • A large, medium or small waterbody with a SEPA water quality classification of 'Good'. • The hydrological receptor and downstream environment have limited capacity to attenuate natural fluctuations in hydrochemistry and cannot absorb further changes without fundamentally altering its baseline characteristics / natural processes. • Aquifer of local importance. Groundwater body is classified by the BGS as a 'moderately productive aquifer', with moderate yield from secondary fractures and near-surface weathering. Exploitation of local groundwater is not far-reaching. Local areas of nature conservation known to be sensitive to groundwater effects. • Groundwater vulnerability class 4a – 4b: vulnerable to those pollutants not readily adsorbed or transformed. • Class 1 or 2 priority peatland, carbon-rich and peaty soils) and covers >20% of the Development Area. • The hydrological receptor will support abstractions for any public water supply, or private water abstractions which supply more than 25 people and / or 100 livestock (at any given point in the year). • GWDTEs which are classified by SEPA as "highly groundwater dependent" have minor (<25 %) functional impairment by man-made influence (such as drainage or forestry). • The hydrological receptor is designated as national environmental importance, such as a Site of Special Scientific Interest (SSSI) and National Nature Reserves (NNR). • The receptor is located within an active flood plain, in accordance with SPP 2014.
Medium	• Land use are moderately sensitive to hydrological change (e.g. commercial forestry). • A large, medium or small waterbody with a SEPA water quality classification of 'Moderate'. • The hydrological receptor and downstream environment will have moderate capacity to attenuate natural fluctuations in hydrochemistry but cannot absorb certain changes without fundamentally altering its baseline characteristics / natural processes. • Aquifer of limited value (less than local) and is classified by the BGS as a 'low productivity aquifer' as water quality does not allow potable or other quality sensitive uses. Exploitation of local groundwater is not far-reaching. Local areas of nature conservation known to be sensitive to groundwater effects. • Groundwater vulnerability class 2-3: vulnerable to some pollutants.

Sensitivity of Receptor	Definition
	• Class 1 or 2 priority peatland, carbon-rich and peaty soils cover <20 % of the Development Area, or Class 3 and 5 peatland areas, carbon rich and peaty soils. • The hydrological receptor supports abstractions for private water supply for up to 25 people and / or 100 livestock. • GWDTEs / wetlands which are classified by SEPA as "highly groundwater dependent" but have moderate (25 % - 50 %) functional impairment by man-made influence (such as drainage or forestry). • GWDTEs which are classified by SEPA as "moderately groundwater dependent" have no functional impairment by man-made influence (such as drainage or forestry). • The hydrological receptor is of local environmental importance (such as Local Nature Reserves (LNR).
Low	• Land use not sensitive to change in hydrological regime (e.g. intensive grazing). • The hydrological receptor is not used for recreational use. • A large, medium or small waterbody with a SEPA water quality classification of 'Poor' or 'Bad'. • The hydrological receptor and downstream environment will have capacity to attenuate natural fluctuations in hydrochemistry but can absorb any changes without fundamentally altering its baseline characteristics / natural processes. • Poor groundwater quality and / or very low permeability make exploitation of groundwater unfeasible. Changes to groundwater not expected to affect local ecology. • Groundwater vulnerability class 1: vulnerable to conservative pollutants. • Receptor contains Class -2, -1, 0, and 4 non-peatland areas, with no carbon-rich and/or peaty soils. • The hydrological receptor does not support abstractions for public water supply or private water abstractions. • GWDTEs which are classified by SEPA as "highly groundwater dependent" but have major (>50 %) functional impairment by man-made influence (such as drainage or forestry). • GWDTEs which are classified by SEPA as "moderately groundwater dependent" but have functional impairment by man-made influence (such as drainage or forestry). • GWDTEs which are classified by SEPA as "highly or moderately groundwater dependent" but are ombrotrophic. • The hydrological receptor does not act as an active floodplain or other flood defence. • The hydrological receptor is not of regional, national or international environmental importance. • The hydrological receptor is not designated for supporting freshwater ecological interest.
Negligible	The receptor is resistant to change and is of little environmental value.

12.3.7.2 Magnitude of Effect

The magnitude of potential effects will be identified through consideration of the Development, the degree of change to baseline conditions predicted as a result of the Development, the duration and reversibility of an effect and professional judgement, best practice guidance and legislation.

The criteria for assessing the magnitude of an effect are presented in Table 12.3.

Table 12.3: Framework for Determining Magnitude of Effects

Magnitude of Effects	Definition
High	• A short or long-term major shift in hydrochemistry or hydrological conditions sufficient to negatively change the ecology of the receptor. This change will equate to a downgrading of a SEPA water quality classification by two classes e.g. from 'High' to 'Moderate'. • A sufficient material increase in the probability of flooding onsite and offsite, adding to the area of land which requires protection by flood prevention measures or affecting the ability of the functional flood plain to attenuate the effects of flooding by storing flood water (in accordance with SPP). • A major (greater than 50 %) or total loss of a geological receptor or peat habitat site, or where there will be complete severance of a site such as to fundamentally affect the integrity of the site (e.g. blocking hydrological connectivity). • A major loss of (greater than 50 % of study area) or total loss of highly dependent and high value GWDTE, or where there will be complete hydrological severance which will fundamentally affect the integrity of the feature. • A major permanent or long-term negative change to groundwater quality or available yield. • A permanent change (from baseline conditions) or loss in water supply. Permanent defined as post-construction phase of works. • A major permanent or long-term negative change to geological receptor, such as the alteration of pH or drying out of peat. • Changes to groundwater quality or water table level that will negatively alter local ecology or will lead to a groundwater flooding issue.
Medium	• A short or long term non-fundamental change to the hydrochemistry or hydrological environment, resulting in a change in ecological status. This change will equate to a downgrading of a SEPA water quality classification by one class e.g. from 'High' to 'Good.' • A moderate increase in the probability of flooding onsite and offsite, adding to the area of land which requires protection by flood prevention measures or affecting the ability of the functional flood plain to attenuate the effects of flooding by storing flood water (in accordance with SPP). • A loss of part (approximately 5 % to 50 %) of a geological receptor or peat habitat site, major severance, major effects to its integrity as a feature, or disturbance such that the value of the site will be affected, but could still function. • A loss of part (approximately 10 % to 50 % of study area) of a moderately dependent and moderate value GWDTE – significant hydrological severance affects the integrity of the feature, but it could still function. • Changes to the local groundwater regime that may slightly affect the use of the receptor. • A temporary change (from baseline conditions) or loss in water supply. Temporary defined as during construction phase of the works. • The yield of existing supplies may be reduced or quality slightly deteriorated. • Fundamental negative changes to local habitats may occur, resulting in impaired functionality.
Low	• A detectable non-detrimental change to the baseline hydrochemistry or hydrological environment. This change will not result in a downgrading of the SEPA water quality classification. • A marginal increase in the probability of flooding onsite and offsite, adding to the area of land which requires protection by flood prevention measures or affecting the ability of the functional flood

Magnitude of Effects	Definition
	plain to attenuate the effects of flooding by storing flood water (in accordance with SPP). • A detectable but non-material effect on the receptor (up to 5 %) or a moderate effect on its integrity as a feature or where there will be a minor severance or disturbance such that the functionality of the receptor will not be affected. • A detectable effect on a GWDTE (loss of between 5 % - 10 % of study area) or a minor effect on a GWDTE's integrity as a feature or where there will be a minor severance or disturbance such that the functionality of the receptor will not be affected. • Changes to groundwater quality, levels or yields do not represent a risk to existing baseline conditions or ecology.
Negligible	• No perceptible changes to the baseline hydrochemistry or hydrological environment. • No change to the SEPA water quality classification. • No increase in the probability of flooding onsite and offsite. • A slight or negligible change from baseline condition of geological resources. • Change hardly discernible, approximating to a 'no change' in geological condition. • Minimal detectable effect on a GWDTE (between to 0.1 % - 5 % of study area) or no discernible effect on its integrity as a feature or its functionality.

12.3.7.3 Significance of Effect

The sensitivity of the asset and the magnitude of the predicted effects will be used as a guide, in addition to professional judgement, to predict the significance of the likely effects. Table 12.4 summarises guideline criteria for assessing the significance of effects.

Table 12.4: Framework for Assessment of the Significance of Effects

Magnitude of Effect	Sensitivity of Resource or Receptor				
	Very High	**High**	**Medium**	**Low**	**Negligible**
High	Major	Major	Moderate	Moderate	Minor
Medium	Major	Moderate	Moderate	Minor	Negligible
Low	Moderate	Moderate	Minor	Negligible	Negligible
Negligible	Minor	Minor	Negligible	Negligible	Negligible

Effects predicted to be of major or moderate significance are considered to be 'significant' in the context of the EIA Regulations, and are shaded in light grey in the above table.

12.3.8 Assessment Limitations

All data considered necessary to identify and assess the potential significant effects resulting from the Development was available and was used in the assessment reported in this Chapter.

12.3.9 Embedded Mitigation

The following mitigation measures relating to the hydrological environment are embedded into the design and construction of the Development:

- 50 m watercourse buffers, taken from the tops of stream banks, where no construction works are to be conducted with the exception of watercourse crossings and infrastructure associated with T7;
- Relocation of T8 from the north side of Akran Burn to minimise requirement for additional watercourse crossing;
- Extended watercourse buffer from the Giligill Burn to 150 m; and
- Good practice methods and works for protection of hydrological receptors as outlined in the Appendix A4.1: Construction and Environment Management Plan (CEMP).

Accordingly, the identification of likely significant effects from the Development is considered following implementation of the measures in Appendix A4.1: CEMP.

The WCEMP describes water management measures to control surface water run-off and drain hardstanding's and other structures during the construction and operation of the Development. Although the WCEMP is draft and will evolve to take account of consultee feedback and detailed design, there is sufficient confidence in the effectiveness of the measures set out in the WCEMP for them to be treated as part of the Development for the purposes of this assessment.

Measures and procedures outlined in the WCEMP will be adopted and incorporated into a single working document to be agreed with statutory consultees and the planning authority following consent by way of an appropriately worded planning condition. Measures will also be incorporated into a Pollution Prevention Plan (PPP) to be implemented for the Development. The PPP will set out measures to be employed to avoid or mitigate potential effects for all phases of the Development, and will also include an Incident Plan to be followed should a pollution event occur. This plan will be produced following consultation and agreement with SEPA and all appropriate personnel working on the construction site will be trained in its use.

Method statements will also be applied, which will follow the principles laid out in relevant SEPA Pollution Prevention Guidelines.

A 50 m watercourse buffer zone in conjunction with the measures set out in the WCEMP is implemented for the majority of infrastructure. Where steep stream banks or gullies are present, the watercourse buffer will extend 50 m from the top of the stream bank. Through consultation with SEPA, it is considered infrastructure associated with the Development may infringe upon the outer 10 m of the 50 m watercourse buffer in order to avoid infrastructure being sited in areas of deep peat or GWDTE. This is avoided where possible.

12.4 BASELINE CONDITIONS

12.4.1 Topography and land use

The Core Study Area is formed of series of low hills rising to the east and south of the Site and slope down to the north-west into the valley of the River Halladale. To the south, the elevation rises to the topographic high of Golval Hill at 127 m above ordnance datum (AOD) and Cnoc an Achadh at 123 m AOD. The Core Study Area rises to 163 m AOD in the east and to the hills of Cnocan Ruadh and Beinn Ruadh in the north-east.

The UK CEH land cover maps define the Core Study Area as a mixture of heather grassland and calcareous grassland with patches of marsh and bog to the west and bog (peatland) to the east.

The 2015 HLA map outlines the land use for the entirety of the Core Study Area as Rough Grazing which is defined as 'hill ground or lower-lying land that shows no evidence of recent agricultural improvement and can be used for rough grazing'. Such areas are

largely heather moorland or rough grassland'[33]. An area of Rectilinear Fields and Farms is located to the immediate west of the Development. There is a small area of forestry plantation and semi-natural woodland to the immediate west of the Core Study Area.

Chapter 7: Ecology of this EIA Report details the habitats and botany of the site following the results of the Phase 1 Habitat Survey. The majority of the site was identified to be peatland habitat with areas of broadleaved and coniferous woodland, acid grassland, shrub heath and marshy grassland.

The NatureScot Carbon and Peatland 2016 dataset[34] identifies the majority of the Core Study Area as Class 2 peatland, and defined as 'peatland or area with high potential to be restored to peatland'. The eastern extent of the Site is underlain by Class 1 peatland. On steeper slopes (≥ 10 degrees) there is no peatland vegetation, defined as Class 5.

Chapter 13: Geology and Peat outlines the soil types and peatland on the site including the depth of peat.

12.4.2 Climate

The nearest MetOffice climate observation station is Strathy East located at BNG NC 84299 65413 at 68 m AOD, approximately 6 km north-west of the Development. The 30-year climate averages for the period 1981-2010 are outlined in Table 12.5.

Table 12.5: Climate Averages for Strathy East Station (1981-2010)

	Max Temp (°C)	**Min Temp (°C)**	**Days of air frost (days)**	**Sunshine (hours)**	**Rainfall (mm)**
Annual Average (1981 – 2010)	11.0	4.9	43.5	1240.5	1002.4

A SEPA river gauging station is located at BNG NC 89100 56000, approximately 5 km south of the Development, on the River Halladale (NRFA Station No. 96001). The station is located upstream of the Development within the River Halladale catchment at 23.2 m AOD. The station records predominantly natural flows with a mean flow rate for the period 1976 – 2018 of 5.014 m^3 / s and an annual average rainfall (AAR) for the 30-year period 1961-1990 of 1096 mm.

12.4.3 Surface Hydrology

The Core Study Area lies within the catchment of the Akran Burn to the south, the Giligill Burn to the north and an unnamed watercourse which flows through the centre of the Core Study Area. The watercourses flow east to west across the site from higher ground in the east to the Halladale River (downstream Forsinain Burn) which flows south to north approximately 250 m to the west of the Development. The Halladale River flows into the North Sea at Melvich Bay, approximately 1.7 km north-west of the Core Study Area.

Figure 12.2 shows the main watercourses and their catchments.

Halladale River has a SEPA overall status of 'Moderate', with 'High' status for water quality and access for migratory fish and a 2027 objective of 'Good' status. The Halladale River drains into the 'Strathy Point to Dunnet Head' coastal water body which has an overall SEPA classification of 'Good'.

The Akran Burn issues from the Caol Loch, located on higher ground to the immediate east of the Site Boundary, and Loch Akran to the south-east of the Site. The Akran Burn

[33] Historic Environment Scotland (n.d.) HLAmap: HLA Type – Rough Grazing. Available at: https://hlamap.org.uk/types/7/Moorland-and-Rough-Grazing/Rough-Grazing Accessed on: 28/04/2020
[34] Scottish Natural Heritage (2016) Carbon and Peatland 2016. Available at: https://map.environment.gov.scot/sewebmap/ Accessed on: 30/04/2020

flows through the south of the Site and drains to the Halladale River 0.5 km west of the Site Boundary.

The Akran Burn is a typical upland stream, it was fast-flowing on the day of the site visit. The upper reaches of the burn consist of a narrow-incised channel surrounded by saturated peat soils and marsh. Overland surface water run-off channels are evident as discussed in Section 12.4.3.1. The Akran Burn has a slight peaty colouration suggesting contribution of water from the surrounding soils.

Plate 12.1 and Plate 12.2: Lower reaches of Akran Burn looking upstream (NC 90282 290282 , 962599) (left) and downstream (right)

The Akran Burn channel becomes more developed in the west of the Core Study Area, as shown in Plate 12.1 and Plate 12.2: Lower reaches of Akran Burn looking upstream (NC 90282 290282 , 962599) (left) and downstream (right) A minor tributary drains into the burn from the north, before the channel flows west offsite to the Halladale River. The channel is approximately 1.3 m wide and 0.4 m deep at this location, with a rock-based streambed. Evidence of bracken on the banks of the lower reaches of the burn suggests free-draining soils.

The Giligill Burn is located in the north of the Core Study Area, it rises in the south-east and flows north-west to converge with the unnamed watercourse at the western boundary before discharging to the Halladale River, approximately 1.4 km west of the Development.

The Giligill Burn is located within a steep-sided gully, as shown in Plate 12.3. At NC 91597 63761 where the burn exits the Core Study Area, the channel is slow moving and relatively deep (0.7 m) with a rock-based streambed. The burn width varies from 0.3 m to 1.5 m in width and the banks are heavily vegetated with grasses and bracken, as shown in Plate 12.3 and Plate 12.4: Giligill Burn steep-sided gully looking downstream (north-west) (NC 91699 63613) (left), and looking upstream (south-east) (NC 91597 63761) (right), suggesting free-draining soils.

The unnamed watercourse rises within the centre of the Core Study Area before flowing north-west and flowing into the Giligill Burn. The unnamed watercourse varies from an undefined channel of slow flowing pools heavily vegetated with mosses, to small narrow fast-flowing channels through areas of heathland, as shown in

Plate 12.5 and Plate 12.6: Unnamed watercourse at looking north-west (NC 91141 63042) (left) and looking west (NC 91141 63042) (right). The watercourse is fed by rain and surface water run-off. Due to the lack of well-defined channel, it is likely an intermittent flow regime.

Plate 12.3 and Plate 12.4: Giligill Burn steep-sided gully looking downstream (north-west) (NC 91699 63613) (left), and looking upstream (south-east) (NC 91597 63761) (right)

Plate 12.5 and Plate 12.6: Unnamed watercourse at looking north-west (NC 91141 63042) (left) and looking west (NC 91141 63042) (right)

12.4.3.1 Site Drainage

The majority of the Core Study Area is drained naturally by surface water run-off and near-surface water in peatland. Where existing tracks are present, man-made ditches run parallel to the tracks and discharge to watercourses, mainly offsite.

Higher ground in the east of the Core Study Area is mainly as surface water run-off. Saturated peat bog in this area results in the formation of ephemeral and intermittent

surface watercourses and run-off channels, as shown in Plate 12.7. Peaty soils act as a store of water and release rainwater for a considerable time following rainfall events.

To the west of the Core Study Area where soils are drier and free-draining, water is largely contained within soils and well-developed watercourse channels.

Plate 12.7: Intermittent surface run-off channel looking north-east (NC 91159 61786)

A minor artificial drainage channel which drains to the Giligill Burn is located approximately 30 m to the north of the Development (track between T10 and T12) at its closest point. The drainage channel discharges to the Giligill Burn approximately 500 m downstream of this location.

12.4.4 Hydrogeology

The groundwater units underlying the Core Study Area are identified by Scotland's Environment mapping service as the Northern Highland groundwater body[35] which has an overall SEPA classification of 'Good'.

BGS 1:50,000 digital mapping and the BGS GeoIndex shows the bedrock aquifer underlying the majority of the Core Study Area to consist of psammites (metamorphosed sedimentary rocks) of the Portskerra Formation of the Moine Supergroup. These rocks are classified by the BGS as a 'low productivity aquifer' with small amounts of groundwater in the near-surface weathered zone and secondary fractures.

The north and north-east of the Core Study Area is underlain by a sequence of sedimentary rocks consisting of the Luachar Sandstone and interbedded Tobaireach conglomerate of the Lower Old Red Sandstone unit, which is classified by the BGS as a 'moderately productive aquifer' of local importance.

There are small areas of granite intrusions across the Core Study Area, which effectively hold little water and do not act as productive aquifers. The west of the Core Study Area is bound by a large granite intrusion of the Strath Halladale, underlying the River Halladale channel. There are a number of faults across the north of the Core Study Area.

The Core Study Area is overlain by superficial deposits of hummocky glacial till deposits consisting of sand, gravel and boulders across the majority of the Core Study Area, with peat deposits to the eastern, northern and southern extents on areas of higher ground.

[35] SEPA (undated) Groundwater classification. Available at: https://map.environment.gov.scot/sewebmap/ Accessed on: 28/04/2020

The BGS groundwater vulnerability[36] classes range from 1 to 5, with 5 being most vulnerable. The groundwater vulnerability is classified as ranging from 4a to 4b across the site, defining the underlying rocks as vulnerable to pollutants not readily adsorbed.

12.4.5 Private Water Supplies

Through consultation with the Council, EHO, five PWS have been identified within the PWS Study Area, which is defined as a 2 km radius from the Site Boundary.

A detailed PWSRA is provided as Appendix A12.1.

The PWSRA identifies one PWS in hydrological connectivity with the Development and this supply is associated with Ackron Farm, with the supply point located at NC 90002 62547. The source water of the PWS is surface water run-off and near-surface water collecting from an area of forestry plantation, at approximately NC 90607 62983. The water drains to existing trackside drainage channels and is collected in a pipe at NC 90480 62900.

The location of identified PWS and sources are shown in Figure 12.3 and in Appendix A12.2.

12.4.6 Groundwater Dependent Terrestrial Ecosystems (GWDTEs)

In accordance with SEPA guidance[37] a Phase 1 habitat survey was undertaken to identify wetland habitats occurring within the Core Study Area. Wetland habitats were identified in line with the criteria outlined in 'A Functional Wetland Typology for Scotland'[38]. Where wetland habitats were identified, further detailed habitat assessment was undertaken, with identification of National Vegetation Classification (NVC) communities. The survey methods employed for this assessment are outlined in **Chapter 7: Ecology** and the full assessment provided as Appendix A7.1.

The groundwater dependency of NVC communities are defined by Appendix 4 of SEPA LUPS-GU31, and are classed as moderately or highly groundwater dependent. Site-specific desk- and site-based assessment determines the potential for GWDTE habitats to be truly groundwater dependent. The identified GWDTE and groundwater dependency is outlined in Table 12.6.

The probable Groundwater Dependent Terrestrial Ecosystems as identified as part of the Phase 1 habitat survey are presented in Figure 7.3 as part of **Chapter 7: Ecology**.

The nature of the groundwater outlined in Section 12.4.4 defines the groundwater unit (aquifer) as 'low productivity' with small amounts of groundwater in the near-surface weathered zone and secondary fractures. The bedrock unit is overlain by relatively impermeable till (glacial) deposits and extensive areas of peat soil which act as a barrier to vertical flow of groundwater. Identified water dependent habitats are located in areas of lower lying topography and topographic depressions and reflect surface water drainage patterns. Therefore, the majority of water dependent habitats identified within the NVC survey are considered to be fed by rain, surface run-off and near-surface through flow and ombrotrophic in nature.

[36] BGS (2015) Groundwater Vulnerability (Scotland) GIS dataset, Version 2. Available at: http://nora.nerc.ac.uk/id/eprint/509618/1/OR15002.pdf Accessed on: 25/03/2020
[37] SEPA (2017) Land Use Planning System Guidance Note 31.
Guidance on Assessing the Impacts of Windfarm Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems. Version 3. Available at: https://www.sepa.org.uk/media/144266/lups-gu31-guidance-on-assessing-the-impacts-of-development-proposals-on-groundwater-abstractions-and-groundwater-dependent-terrestrial-ecosystems.pdf Accessed on: 24/04/2020
[38] SNIFFER (2009) WFD95 A Functional Wetland Typology for Scotland Field Report 2009. Available at: https://www.sniffer.org.uk/wfd95-a-functional-wetland-typology-for-scotland Accessed on: 25/03/2020

Table 12.6: Potential GWDTE NVC communities identified

NVC Community	Potential groundwater dependency (LUPS-GU31)	Site-specific groundwater dependency	Hydrogeological Characteristics
MG10c – rush pasture	Moderate	Ombrotrophic – not groundwater dependent.	Located in lower-lying areas and depressions, follows drainage patterns associated with Akran Burn tributary. Habitat forms where rainwater and surface water run-off collects. Habitat underlain low productivity aquifer and impermeable till (superficial) deposits.
M25a – mire	Moderate	Ombrotrophic – not groundwater dependent.	Associated with flatter topography and depressions, habitat forms in areas of surface water run-off and rainwater collects. The habitat is underlain by low productivity aquifer and peat deposits.
M15a & b – wet heath	Moderate	M15b sub-community ombrotrophic – not groundwater dependent. M15a sub-community – potential to be partially dependent on groundwater.	The habitat underlain by low productivity aquifer and areas of glacial till (superficial) deposits. M15a habitat associated with presence of faults which have potential to yield small quantities of groundwater. The type of species present (nutrient poor) indicate that groundwater dependency is minimal, with majority of water supporting the habitat sourced from rain and surface water run-off.
M6 – mire	High	Ombrotrophic – not groundwater dependent.	Associated with location of stream channels (riparian).
M10a – mire	High	Partially dependent on groundwater. Mainly dependent on surface water run-of and rainwater.	Associated with unnamed watercourse. The habitat underlain by low productivity aquifer and areas of glacial till (superficial) deposits. Associated with presence of faults which have potential to yield small quantities of groundwater. The type of species present (nutrient / base-rich) indicate there is some degree of groundwater dependency, with groundwater sourced from shallow faults in glacial deposits. The habitat is mainly supported by rainwater and surface water run-off.

NVC Community	Potential groundwater dependency (LUPS-GU31)	Site-specific groundwater dependency	Hydrogeological Characteristics
M32b – spring	High	Potential to be partially dependent on groundwater. Mainly dependent on surface water run-of and rainwater.	Associated with unnamed watercourse and ephemeral/ intermittent watercourse. The habitat underlain by low productivity aquifer and areas of glacial till (superficial) deposits. Associated with presence of faults which have potential to yield small quantities of groundwater.

The GWDTE habitats of NVC community classification M15a, M10a and M32b are considered to be or have the potential to be partially dependent on groundwater. Due to the unproductive aquifer unit, the majority of the water supporting such habitats is likely sourced from rainwater and surface water run-off.

NVC community M15a (wet heath) is classified by SEPA as having the potential to be moderately groundwater dependent, and has minimal impairment from man-made influences, and is therefore classed as a medium sensitivity receptor.

NVC communities M10a and M32b are classified by SEPA as having the potential to be highly groundwater dependent and have minimal impairment (<25 %) from man-made influences such as drainage, and is therefore classed as a high sensitivity receptor.

12.4.7 Designated hydrological receptors

The statutory designated sites relating to water within the Wider Study Area of 10 km, identified through the use of NatureScot[39] and SEPA[40] GIS datasets. The statutory designations that are considered hydrologically connected to the Development are listed in Table 12.7.

A total of two SSSI designations, and one SAC, SPA and Ramsar site were identified as hydrologically connected to the Development. The designated sites are located upstream of the Development with regards to hydrology, however due to the close proximity of the designated sites to the Core Study Area and the potential for hydrological continuity, they have been scoped-in for assessment of the potential hydrological effects arising as a result of the Development.

Statutory designations which were identified within the 10 km Study Area but were deemed not hydrologically connected to the Development are listed in Table 12.8, and have been scoped out of further assessment.

[39] SNH (2019) Natural Spaces. Available at: http://gateway.snh.gov.uk/natural-spaces/index.jsp Accessed on: 23/04/2020
[40] SEPA (2019) Datasets. Available at: https://www.sepa.org.uk/data-visualisation/water-classification-hub/ Accessed on: 23/04/2020

Table 12.7: Statutory Designated Sites hydrologically connected to the Development (within 10 km Study Area)

Designation	Distance from the Development	Qualifying Interest	Hydrologically Connected to the Development
East Halladale SSSI	Adjacent to east and south	Blanket bog, breeding bird assemblage (Dunlin & Golden plover).	Yes – Adjacent of the Core Study Area, south-east of the Site Boundary
Caithness and Sutherland Peatlands SAC, SPA and Wetland of International Importance (Ramsar)	Adjacent to east and south	Blanket bog, Breeding bird assemblage (Black-throated diver, Common scoter, Dunlin, Greylag Goose and Golden Eagle).	Yes – Adjacent of the Core Study Area, east of the Site Boundary
Strathy Coast SSSI	0.8 km north-west	Saltmarsh and plant assemblages	Yes – downstream of Development. Connected by the River Halladale.

Table 12.8: Statutory Designated Site not hydrologically connected to the Development (within 10 km Study Area)

Designation	Distance from the Development	Qualifying Interest	Hydrologically Connected to the Development
Red Point Coast SSSI	1.3 km north	Breeding guillemot	No – separated by River Halladale catchment boundary
West Halladale SSSI	1.9 km south-west	Blanket Bog	No – hydrologically separated by River Halladale

12.4.8 Flood risk

The Indicative River and Coastal Flood Map (Scotland) produced by SEPA shows the areas of Scotland with a 0.5 % (1:200) or greater chance of flooding. These areas are known as medium to high risk areas for flooding.

The SEPA Flood Map shows that minor areas either side of the Akran Burn in the south-western section of the Core Study Area is classed as having a "High" annual probability of river flooding in any year.

Caol Loch in the south of the Core Study Area is classed as having a "High" annual probability of surface water flooding in any year.

The flood maps show flooding is restricted to the waterbodies and do not indicate widescale flooding across the Core Study Area. The Site does not act as an active floodplain or flood defence but is considered to provide some degree of natural flood attenuation due to the presence of peat soils.

12.5 SENSITIVITY OF RECEPTORS

Table 12.9: Sensitivity of Receptors

Receptor	Potential Effects	Sensitivity	Sensitivity Description
Surface hydrology	Increased run-off, erosion and sedimentation, stream flow impediments and pollution as a result of construction groundworks and chemical handling and storage.	High	A large, medium or small waterbody draining to a river of SEPA water quality classification 'Good'.
Groundwater	Pollution as a result of erosion and sedimentation from construction activities and uncontained spills from chemical handling and storage.	High	Groundwater body is classified by the BGS as a 'moderately productive aquifer'. Groundwater vulnerability is classified as 4a to 4b (high).
Near-surface Water	Diversion of near-surface flow as a result of track construction and the installation of wind turbine foundations / hardstanding.	High	Class 1 and class 2 peat soils which cover > 20% of Core Study Area.
PWS	Pollution as a result of track upgrades and uncontained spills from vehicles, and chemical handing/ storage. Drying out or changes to quantity as a result of upgrades to access track.	High	The hydrological receptor supports abstractions for public water supply or private water abstractions for up to 25 people. It supplies 100 livestock.
GWDTE (not groundwater dependent – ombrotrophic)	Pollution as a result of track construction and uncontained spills from chemical handling / storage. Drying out or changes to groundwater interflow patterns as a result of construction.	Low	GWDTEs which are classified by SEPA as "highly or moderately groundwater dependent" but are ombrotrophic.
GWDTE (moderately groundwater dependent)	Pollution as a result of track construction and uncontained spills from chemical handling / storage. Drying out or changes to groundwater interflow patterns as a result of construction.	Medium	GWDTEs which are classified by SEPA as "moderately groundwater dependent" have no functional impairment by man-made influence (such as drainage or forestry).
GWDTE (highly groundwater dependent)	Pollution as a result of track construction and uncontained spills from chemical handling / storage. Drying out or changes to groundwater interflow patterns as a result of construction.	High	GWDTEs which are classified by SEPA as "highly groundwater dependent" have minor (<25 %) functional impairment by man-made influence (such as drainage or forestry).

Receptor	Potential Effects	Sensitivity	Sensitivity Description
Designated Hydrological Receptors	Chemical pollution as a result of construction works altering chemical make-up of soils and surface water (e.g. pH). Diversion of near-surface / surface and ground water as a result of track construction and the installation of wind turbine foundations / hardstanding.	Very High	The hydrological receptor is designated as SAC, SPA and / or Wetland of International Importance (Ramsar).

12.6 ASSESSMENT OF POTENTIAL EFFECTS

The potential effects of the Development on hydrological receptors has been considered for the construction, operation and decommissioning phases. Effects occurring during construction and decommissioning are considered to be short-term effects, with those occurring as a result of the operational phase of the Development being considered to be long-term effects.

12.6.1 Potential Construction Effects

The nature and magnitude of effects that could result from construction activities, as described in **Chapter 4: Development Description**, are assessed in the following paragraphs, which includes construction of wind turbines and foundations, crane hardstanding, new and upgraded access tracks and temporary construction compounds for the Development.

Potential effects associated with the management of construction are a risk management issue, with the effects being assessed should the risk be realised.

12.6.1.1 Chemical Pollution

Potential risks include the spillage or leakage of chemicals, fresh concrete, foul water, fuel or oil, during use or storage onsite. These pollutants have the potential to adversely affect soils, subsurface water quality, peat, surface water quality, and groundwater, and hence effects on the biodiversity of receiving watercourses.

Surface Hydrology

Watercourses have the potential to be at risk from a chemical pollution incident during construction. All watercourses are of high sensitivity.

Buffer distances between proposed construction works and watercourses and the top of watercourse banks have been set at 50 m to reduce the potential for chemical pollutants transferring to the water environment if mobilise.

T7 crane hardstanding extends 8.2 m into the Akran Burn 50 m watercourse buffer, as shown in Figure 12.3. There is a slope gradient of 2-5 degrees between the T7 and the watercourse and, as such, the potential for rapid transfer of pollutants between works associated with T7 and the watercourse is considered to be minimal. The measures outlined in the Section 3.3 of the CEMP, found in Appendix A4.1, will effectively limit the release of chemicals to fugitive releases.

Regular monitoring of watercourses and drainage systems will provide an indication of the effectiveness of pollution prevention measures and detect any releases of chemicals, with the aim of intercepting such releases prior to discharge to the natural water environment.

Following measures outlined in the WCEMP, the magnitude of this effects is classed as negligible on a high sensitivity receptor. In accordance with Table 12.4, the potential effect is of minor significance, which is **not significant** in terms of the EIA regulations.

Hydrogeology

Pollutants coming into contact with bedrock also have the potential to indirectly alter the pH of the groundwater resource. pH and chemical alterations to bedrock are difficult to rectify due to the fractured nature of the rock and the lengthy attenuation and dispersal of chemicals.

The majority of infrastructure associated with the Development is underlain by a low productivity aquifer which locally yields small amounts of water. Approximately 0.2 ha of wind turbine foundations and hardstanding associated with T8, is underlain by moderately productive aquifer and potentially water yielding fractures in the bedrock.

The overall groundwater vulnerability to pollutants ranges from 4a to 4b, suggesting low permeability soil and vulnerability to pollutants not readily adsorbed. In areas where the bedrock is overlain by thick peat soils (>1 m) and / or superficial deposits (till), the potential for pollutants to come into contact with groundwater is limited. In areas where superficial deposits are absent and peat soils are thin (<0.5 m), the potential for pollutants to come into contact with groundwater is increased.

The majority of infrastructure associated with the Development is underlain by relatively impermeable glacial till deposits and peat deposits. T11 and T8 and associated foundations and hardstanding are not underlain by superficial deposits, and peat deposits underlying T11 and T8 are relatively thin, ranging from <0.5 m to 1 m deep with deeper peat (1m – 3m deep) to the east of T8. As T8 is underlain by a moderately productive aquifer of high sensitivity and is not underlain by superficial deposits or thick peat soils, the effect of chemical pollution on the groundwater resource at T8 is of medium magnitude.

Measures outlined in Section 3.3 of the WCEMP will minimise the release of chemicals to ground. Prior to pouring of concrete within excavations, the degree of weathering or fracturing of bedrock and the requirement for dewatering will be assessed. This will be determined by an intrusive ground investigation prior to works commencing. Installation of a geotextile barrier or sand layer would be necessary if working within an aquifer unit or if there was evidence of significant fracturing which could give rise to a potential for vertical groundwater flow. Employing best practice for dewatering of groundwater units will minimise the release of chemicals and concrete to groundwater, further details on dewatering is provided in Section 3.4.5 of the WCEMP.

Following implementation of good practice measures, the magnitude of effect is negligible on a high sensitivity receptor. In accordance with Table 12.4, the potential effect is of minor significance, which is **not significant** in terms of the EIA regulations.

12.6.1.2 Erosion and sedimentation

Erosion and sedimentation can occur from excavations, stone winning, ground disturbance and overburden stockpiling. Sediment entering watercourses and shallow groundwater has the potential to affect water quality, ecology and flood storage capacity.

Surface Hydrology

The topography across the Core Study Area has moderate slopes with areas of steep gully slopes at Giligill Burn, increasing the potential for sediment transfer to watercourses under gravity. The closest infrastructure associated with the Development (access track from T10 to T12) is located 150 m from the top of the slopes at the Giligill Burn. This is considered a sufficient distance that under best practice methods of construction onsite,

as outlined in the WCEMP, the potential for release of sediments to the Giligill burn is negligible.

Excavations >1 m at T7 are required within 8.2 m of the 50 m watercourse buffer for Akran Burn, and have the potential to increase the risk of sediment transfer to the watercourse. Implementation of measures outlined in Section 3.1 of the WCEMP will minimise the release of sediments from construction works. Given the nature of wet modified bog and peat deposits across the Core Study Area, any inadvertent release of silt or other materials are likely to be entrained in vegetation and existing drainage ditches before reaching watercourses.

As part of the sustainable drainage systems (SuDS) to be employed onsite, as detailed in Section 3.1 and 3.2 of the WCEMP, all site drainage will be diverted from the watercourse and treated for excess sediment prior to discharge to the water environment and will effectively limit any sediment entering watercourses.

A water quality monitoring programme will monitor the effectiveness of SuDS systems and pollution prevention onsite as detailed in Section 3.8 of the WCEMP.

Following implementation of measures outlined in the WCEMP, the magnitude of effects is negligible on a high sensitivity receptor, and the significance of effects in accordance with Table 12.4 is assessed as being of minor significance. This is **not significant** in terms of the EIA Regulations.

Hydrogeology

Sediment also has the potential to change near-surface water flow in superficial geology deposits and peaty soil characteristics by creating a physical barrier within naturally occurring drainage micropores. Sediment entering near-surface water in superficial deposits also has the potential to effect groundwater quality within bedrock deposits and fissures.

The groundwater unit underlying T8 and associated foundations, is a moderately productive aquifer and is of high sensitivity, as outlined in Table 12.2. The groundwater unit underlying all other infrastructure associated with the Development is of low productivity and therefore of medium sensitivity.

Measures described in the WCEMP, such as impermeable ground membrane layers and bunded areas, will effectively prevent sediment entering sub-surface water in superficial deposits (and groundwater) and peat. Following implementation of such measures, the magnitude of effects is negligible on a high sensitivity receptor and the significance of effects is of minor significance. This is **not significant** in terms of the EIA Regulations.

12.6.1.3 Impediments to flow

Impediments to flow can occur from excavations and installation of linear infrastructure such as access tracks. Impediments to flow has the potential to alter drainage patterns on site and reduce the flow of water to some receptors and increase to others, temporarily or permanently altering the hydrological environment.

Surface Hydrology

The access tracks will require the installation of one new watercourse crossing at an unnamed tributary of the Giligill Burn, as shown in Figure 12.4.

The indicative culvert design is outlined in the WCEMP, and detailed design will be carried out prior to the construction phase in line with good practice i.e. to accommodate the 1:200-year flow plus a peak river flow allowance of 37 %[41] and will be agreed with SEPA.

[41] SEPA (2019) Guidance on Climate Change Allowances for Flood Risk Assessment in Land Use Planning. Available at: https://www.sepa.org.uk/media/426913/lups_cc1.pdf Accessed on: 30/04/2020

As discussed in Section 12.3.5, T7 is sited in an area of surface water and near-surface drainage and has the potential to cause a barrier to existing flow patterns. The crane hardstanding, laydown area and access tracks are positioned perpendicular to a minor intermittent watercourse, discussed in Section 12.3.9 and shown in Figure 12.2.

In order to maintain continuity of the drainage pattern, drainage measures outlined in Section 3.1 and Section 3.4 of Appendix 4.1: CEMP are to be employed and include cross-drainage, installation of culvert and use of floating tracks. It is considered a culvert will be emplaced immediately north of the crane hardstanding and a diversion of the intermittent watercourse may be required to this culvert. The requirement for a watercourse diversion will be agreed in consultation with SEPA.

Following measures outlined in the WCEMP, the magnitude of effect is negligible on a high sensitivity receptor and the significance of effect is minor. This is **not significant** in terms of the EIA regulations.

Hydrogeology

Some wind turbine base excavations may need temporary sub-surface water controls, such as physical cut-offs or de-watering. These temporarily divert flows away from the excavation, and temporarily lower the local water table and sub-surface water levels in peat. Localised temporary changes to soil and peat interflow patterns may therefore arise. Wind turbine foundations and crane hardstanding's also have the potential to change sub-surface water flow by creating physical barriers within naturally occurring drainage macropores in soil or peat. Further details on dewatering is provided in Section 3.4.5 of the WCEMP

The drying out of peaty soil can result from alterations to the natural drainage regime. Measures set out in the WCEMP, such as the re-wetting of peat through controlled irrigation techniques, are considered sufficient, and sufficiently reliable, to avoid substantial alterations to the natural drainage regime. No substantial impediments to near-surface water flow will be created as the detailed site drainage design will consider any severance of saturated areas to ensure hydrological connectivity is maintained, in accordance with SEPA guidance.

Following mitigation, the magnitude of effects is reduced to negligible on a high sensitivity receptor and therefore of minor significance. This is **not significant** in terms of the EIA Regulations.

12.6.1.4 Effects on the Hydrological Function of Private Water Supplies (PWS)

PWS could be at risk from a pollution incident or impediments to flow patterns during construction.

One PWS has been identified in hydrological connectivity to the Development:

- PWS Ackron Farm (NC 90002 62547).

The PWS supply is sourced from surface water and near-surface water and is a medium sensitivity receptor, supplying to less than 25 people and a varying number of livestock.

The source catchment for the supply is shown on Figure 12-2.1 and further details are provided in Appendix A12-2.

The distribution infrastructure (pipe network) is located immediately south of infrastructure associated with the Development, including upgraded access tracks and the substation compound. The pipe network is within 100 m of excavations of less than 1 m, as shown on Figure 12.3.

Due to the proximity of the distribution infrastructure to access tracks and the substation compound it is considered the pipe network could be partially lost during construction works. An alternative potable water supply will be required for Ackron Farm during the

construction phase. Provision of alternative temporary or alternative potable supplies is discussed further in Appendix A12.1 and Section 3.6 of the WCEMP. All other infrastructure within the catchment for the PWS Source is considered to be a sufficient distance from the PWS infrastructure that any effects from wind turbine excavations and foundations will be negligible. Mitigation measures outlined in the WCEMP will minimise the release of chemical pollutants and silt to minor releases and any inadvertent release of silt or other materials are likely to be entrained in vegetation before reaching PWS infrastructure.

It is to be noted that consultation with the resident of Ackron Farm has fed into the Site design including the siting of the substation compound. The provision of an alternative supply has been agreed with the resident of Ackron Farm who is the landowner for the Site and financially involved.

The magnitude of effects on PWS Ackron Farm is medium on a high sensitivity receptor, which is of moderate significance.

Following implementation of mitigation measures and agreed provision of an alternative temporary or permanent alternative supply, that is comparable or better in quality and quantity to the current supply, the magnitude of effects on the PWS is negligible, which is of minor significance. This is **not significant** in terms of the EIA Regulations.

12.6.1.5 Effects on the Hydrological Function of Groundwater Dependent Terrestrial Ecosystem (GWDTE)

The effects of the Development on the habitats and ecology of GWDTE are assessed in **Chapter 7: Ecology** and Appendix A7.1. The effects of the Development on the hydrological function of GWDTE are discussed in this section. The GWDTE identified in Section 12.4.6 are assessed with regards to effects arising from construction of infrastructure associated with the Development.

GWDTE have the potential to be at risk from a chemical pollution incident, sedimentation and erosion and impediments and alteration to flow patterns which can indirectly alter the habitat and plant species supported.

SEPA LUPS-GU31 guidance outlines the requirement for qualitative and/ or quantitative assessment of effects of all infrastructure associated with the Development on GWDTE, if the GWDTE is located:

- Within 100 m radius of all excavations less than 1 m in depth; and
- Within 250 m radius of all excavations deeper than 1m.

Description of the Development infrastructure and proposed excavation depths is outlined in **Chapter 4: Development Description.**

An NVC survey has been conducted for the Core Study Area and all potential effects on the hydrological function of GWDTE as a result of the Development will be considered, with quantitative and qualitative assessment provided for infrastructure located within the 100 m and 250 m buffer zones, as outlined in Table 12.10 and Table 12.11.

Good practice design and construction and measures outlined in the WCEMP will minimise potential indirect effects of the Development on GWDTEs during construction phase.

Prior to access track construction, site operatives will identify flush areas, depressions or zones which may concentrate water flow. These sections will be spanned with plastic pipes or drainage matting to ensure hydraulic conductivity under the road, and reduce water flow over the road surface during heavy precipitation.

Additionally, the following design measures will ensure that effects on wetland habitats are minimised:

- A PPP is implemented to ensure good practice working methods are followed throughout construction works;
- Silt traps will be deployed to trap and filter sediment-laden run-off throughout the construction phase of the Development;
- Settlement lagoons will be constructed and actively managed to control water levels and ensure that any run-off is contained, especially during times of rainfall;
- Wind turbine foundations are constructed in holes in the ground that will be de-watered, and hence water flow is typically into the foundation area. This will prevent concrete leaching into groundwater or surface water in the event of shutter collapse; and
- All excavations will be sufficiently dewatered before concrete pours begin and that dewatering continues while the concrete cures. However, construction good practice will be followed to ensure that fresh concrete is isolated from the dewatering system.

If required, wind turbine foundations may be dewatered, temporarily lowering water levels in the superficial deposits and near-surface groundwater. The dewatering process would involve the treatment of any extracted water to remove any sediment and redistributing the water onto a vegetated surface in proximity to the excavation. This process would not involve any net loss of water from the hydrological system and would ensure that the water being treated is of the same (or similar) quality to what was extracted. Hence, there would not be an unacceptable effect on groundwater or near-surface water supplying GWDTEs.

Moderately Groundwater Dependent GWDTE

The SEPA classified 'Moderately Groundwater Dependent' GWDTE habitats which are identified as having the potential to be at risk from effects arising from the Development are outlined in Table 12.10: Moderately Groundwater Dependent GWDTE. This assessment is used to inform the magnitude of effects on GWDTE arising from construction phase of the Development.

Table 12.10: Moderately Groundwater Dependent GWDTE at potential risk of effects from the Development

NVC Community	Location	Within 250 m of excavations > 1 m depth	Within 100 m of excavations < 1 m depth	Intersect with Development
M15a – wet shrub heath	NC 91028 63131	Yes – T8 foundations	Yes – access track to T8	No
M15a mosaic – wet heath	NC 91029 63111	Yes – T8 foundations	No	No

Following the implementation of mitigation measures, the magnitude of effects from construction works is negligible in accordance with Table 12.3 with minimal detectable effect on GWDTE, with no discernible effect on its integrity as a feature or hydrological functionality.

Therefore, the magnitude of effects is low on moderately groundwater dependent GWDTEs M25a (mire) and M15b (wet heath), both classed as low sensitivity receptors due to the ombrotrophic nature of the habitats, which is of minor significance.

Similarly, following mitigation of measures outlined in the WCEMP, the magnitude of effects is negligible on M15a (wet heath), a medium sensitivity receptor, and is of minor significance.

This is **not significant** in terms of the EIA Regulations.

Highly Groundwater Dependent GWDTE

The SEPA classified 'Highly Groundwater Dependent' GWDTE habitats which are identified as having the potential to be at risk from effects of the Development are outlined in Table 12.11.

Table 12.11: Highly Groundwater Dependent GWDTE at potential risk of effects from the Development

NVC Community	Location	Within 250 m of excavations > 1 m depth	Within 100 m of excavations < 1 m depth	Intersect with Development
M10a - mire	NC 91057 63195	Yes – T8 foundations	Yes – access tracks	No
	NC 91111 63072	Yes – T8 foundations	No	No
M32b – spring	NC 91127 63057	Yes – T8 foundations	No	No

Following the implementation of mitigation measures, the magnitude of effects from construction works is negligible in accordance with Table 12.3 with minimal detectable effect on GWDTE, with no discernible effect on its integrity as a feature or hydrological functionality.

A negligible effect on a M10a (mire) and M32b (spring) GWDTE, which are high sensitivity receptors is of minor significance.

A negligible effect on M6 (mire), a low sensitivity receptor in accordance with Table 12.9 due to the ombrotrophic nature of the habitat, and is therefore of negligible significance.

This is **not significant** in terms of the EIA Regulations.

12.6.1.6 Effects on the Function of Hydrologically Connected Statutory Designations

There are three statutory designations of international and / or European importance located immediately to the east and south of the Development, associated with the Caithness and Sutherland peatlands which have SAC, SPA and Ramsar designations. The Caithness and Sutherland peatland receptor are of very high sensitivity in accordance with Table 12.2. The habitat and ecology of the designated sites are discussed further in **Chapter 7: Ecology**.

Whilst in close proximity to the Site Boundary, the designations are located hydrologically upstream of all infrastructure associated with the Development. The infrastructure closest to the Caithness and Sutherland designations are foundations for T2, T3, T5 and T6 and new access track connecting T3 and T5, which is 93 m to the west of the designation at the nearest point. All infrastructure is located downgradient of the designations and the hydrological connectivity to the Development is therefore considered minimal.

There are two designations of national importance associated with the East Halladale SSSI and Strathy Coast SSSI. The SSSI designations of national importance are of high sensitivity.

The East Halladale SSSI occupies the same geographical area as the Caithness and Sutherland Peatland designations outlined above, and as such is located upgradient and upstream of the Development infrastructure. The Strathy Coast SSSI located downgradient and downstream of the Development and connected hydrologically by surface waters draining to the River Halladale which discharges to the SSSI. The qualifying interests of hydrological note is saltwater marsh at the River Halladale estuary.

The statutory designations have potential to be at risk from effects of chemical pollution associated with construction works which can result in changes to pH of the habitats supported by the hydrological environment. The excavation and construction of wind turbine foundations and installation of linear infrastructure such as access tracks can cause alterations or impediments to near-surface flow and drainage patterns. This can result in drying out of peat soils and reduced quantity of water supporting wetland habitats. Measures outlined in the WCEMP to protect chemical pollution of watercourses and impediments to flow of near-surface and groundwaters, as discussed in Sections 12.6.1.1 to 12.6.1.3, would ultimately reduce the magnitude of effect on any downstream or indirectly hydrologically connected designation.

Following implementation of measures outlined in the WCEMP, the magnitude of effects is negligible on a high to very high receptor, which is of minor significance. This is **not significant** in terms of the EIA regulations.

12.6.1.7 Increased run-off and flood risk

Surface Hydrology

The increase in hardstanding area associated with construction and operation of the Development could increase the volume and rate of localised surface run-off, although a large proportion of the proposed infrastructure hardstanding, including access tracks and crane hardstanding, would be permeable to some extent.

The low permeability of peat soils onsite and the underlying geology means that run-off will be relatively low and hence the addition of the Development would have minimal effect on the existing run-off scenario. The majority of the onsite topography is gently sloping and undulating and as such, any additional run-off is unlikely to be transferred at a rapid rate. The watercourses and surrounding land onsite do not act as active floodplain or form of flood defence, and are of low sensitivity.

Embedded measures, including 50 m watercourse buffers, and measures outlined in the WCEMP such as SuDS will allow for attenuation and interception of run-off to reduce the volumes of run-off direct to watercourses and reduce the flow rates of any run-off discharging to watercourses.

No infrastructure associated with the Development is located within areas described as having a high, medium or low probability of river, surface water or coastal flooding in any given year. Therefore, the magnitude of effect of increased run-off and flood risk on surface hydrology is negligible on a low sensitivity receptor, which is of negligible significance and **not significant** in terms of the EIA regulations.

Hydrogeology (near-surface groundwater)

The presence of Class 1 and 2 peatlands allow for a degree of water storage and attenuation reducing the risk of downstream flooding. Loss of peatland, compaction of peat soils or impediments to near-surface groundwater flow patterns as a result of construction of infrastructure associated with the Development could reduce the peatlands ability to store water and increase the risk of run-off and flooding both within the Core Study Area and downstream of the Development.

Embedded design, including the use of floating tracks, is considered to minimise effects of linear structures such as the access tracks on near-surface drainage patterns. The effects of the Development on soil and peat is discussed in **Chapter 13: Geology and Peat** and no significant effects or deterioration in the peatland soils are identified. Therefore, it is considered that there is minimal change in the ability of the peatland to store water as a result of the Development.

The WCEMP incorporates measures to prevent the drying out of peatland soils and manage site drainage. A peatland restoration programme is recommended as part of a

Habitat Management Plan to ensure no net loss of peatland and water storing GWDTE habitat, as detailed in **Chapter 7: Ecology**.

The magnitude of effect is negligible on a medium sensitivity receptor is of minor significance. This is **not significant** in terms of the EIA regulations.

12.6.2 Potential Operational Effects

12.6.2.1 Long-term alteration to natural flow pathways

The majority of infrastructure will remain in place for the operational phase. Alterations to natural flow pathways will be reduced through adopting good practice design and construction, as set out in the outline WCEMP, such as cross drainage, use of shallow drainage ditches and prevention of blockages.

As a result, the magnitude and significance of all effects associated with operation of the Development are assessed as being negligible, and not significant in terms of the EIA Regulations.

12.6.2.2 Increased run-off and flood risk

The nature of these effects has been discussed in relation to the construction phase in Section 12.6.1.7.

Embedded design, including the installation of permanent cross-drainage and culverting on roads and watercourse crossings to maintain hydrological continuity and reduce the run-off from hardstanding. The use of floating tracks onsite will also result in minimal operational effects.

12.6.2.3 Long-term effects on the functionality of PWS

The presence of the substation compound and access tracks during the operation phase of the Development are likely to result in partial loss of existing PWS infrastructure associated with Ackron Farm PWS.

An alternative temporary or permanent supply will be provided by the Applicant.

A permanent supply would be instated prior to construction and be sited in an area not hydrologically connected to the Development. The quality and quantity of the supply would be comparable or better than that provided by the existing supply.

A temporary alternative supply would be provided for the construction phase of the Development, and for any additional period until the existing supply is reinstated and of a comparable quality and quantity to that of the baseline (pre-construction). It is recommended the pipe infrastructure of the reinstated supply is extended upgradient of the access track and substation compound to minimise potential for chemical pollution of the supply during the operational phase of the Development.

Implementation of a post-construction water quality monitoring programme will monitor the quality of the water provided to Ackron Farm following reinstatement and ensure water is supplied at a quality comparable to pre-construction (baseline).

Following reinstatement of the PWS as recommended, the operational effect on the quantity, quality and continuity of the source water of the PWS will be negligible, and **not significant** in terms of the EIA Regulations.

12.6.3 Potential Decommissioning Effects

Potential effects of decommissioning the Development are similar in nature to those during construction, as some ground-work would be required to remove wind turbine foundations and hardstanding to 1 m below ground level. These effects would be substantially lesser in magnitude than during construction, and would be controlled by a

PPP, as discussed previously. Where infrastructure would be left in place, drainage features would also be left in place, where this is compatible with the PPP.

During decommissioning, the bases would be broken out to below ground level. All cables would be cut off below ground level, de-energised, and left in the ground. Access tracks would be left for use by the landowner. No stone would be removed from the Site. This approach is considered to be less environmentally damaging than seeking to remove foundations, cables and roads entirely. Therefore, it is considered that decommissioning, activities would be less intrusive and would not disturb peat, therefore no significant effects are anticipated.

As a result, the magnitude and significance of all effects associated with decommissioning are assessed as being negligible, and not significant in terms of the EIA Regulations.

12.7 MITIGATION AND RESIDUAL EFFECTS

Embedded mitigation measures as discussed in Section 12.6 and outlined in Appendix A4.1: CEMP are considered to result in negligible to minor residual effects, as outlined in Table 12.12.

In addition to the embedded measures outlined in Appendix 4.1, the following specific mitigation is to be employed in regards to the Private Water Supply at Ackron Farm:

- Baseline water quality monitoring of existing private water supply;
- Provision of an alternative supply from appropriate source during construction works at the same or better quality and quantity as recorded during baseline;
- Provision of an alternative permanent supply into post-construction phase or reinstatement of current private water supply post-construction ensuring it is of the same or better quality and quantity as baseline;
- Monitoring of the alternative water supply quality and quantity during construction and post-construction phase should also be conducted as per the mitigation measures in Appendix A12.1 and Appendix 4.1 in regards to PWS monitoring (unless mains supply, e.g. Scottish Water, is provided as the alternative supply).

No additional residual effects are predicted for the operational phase of Development.

12.8 CUMULATIVE EFFECT ASSESSMENT

The methodology followed to assess the cumulative effects is the same as that used for the Development in isolation.

A cumulative effect is considered to be an additional effect on hydrological resources (within the same hydrological catchment) arising from the Development in addition to the combination of other developments likely to affect the hydrological environment. At distances greater than 10 km, it is considered that schemes are unlikely to contribute to a cumulative hydrological effect due to attenuation and dilution over distance of potentially polluting chemicals. Therefore, for the purposes of the assessment of potential cumulative effects on the immediate catchment and hydrological regime, only proposed developments, which require large scale construction / excavation, within approximately 10 km of the Development have been considered.

12.8.1 Predicted Cumulative Effects

The greatest potential for cumulative effects arises when the construction phase of another development overlaps with the construction phase of the Development. Cumulative effects are considered to have the potential to be significant only where such an overlap may exist, as activities that could be potentially detrimental to the hydrological environment are greatly reduced during the operational phase of developments (e.g. excavation works, concrete pouring etc.).

The following developments are identified partially within the same catchment of the Development.

Drum Hollistan Wind Farm

Drum Holliston Wind Farm is a scheme under application[42] located adjacent to the Development to the north-west.

The majority of the scheme is not hydrologically connected to the Development. A small section of access track associated with the Drum Hollistan Wind Farm is located within the Giligill Burn catchment.

The assessment of effects as a result of the Development on surface hydrology (watercourses) including the Giligill Burn is negligible to minor. The Giligill Burn is located 150 m from infrastructure associated with the Development (access track from T10 to T12) at its closest point. Mitigation measures outlined in the WCEMP will minimise release of sediments and chemical pollution to the Giligill Burn as a result of the Development.

The Drum Hollistan Wind Farm EIA[43] states the effect of pollution and impediments on watercourses as minor. Good practice mitigation measures are to be employed during construction.

A water quality monitoring programme, as outlined in Section 3.8 of the WCEMP will monitor the Giligill Burn to monitor run-off from the Development upstream of the Drum Hollistan Wind Farm and downstream to monitor any cumulative effects.

Following implementation of good practice for construction of wind farm developments on both developments, the cumulative effect is considered to be minor. This is **not significant** in terms of the EIA Regulations.

12.8.2 Residual Cumulative Effects

No significant residual cumulative effects are predicted.

12.9 SUMMARY OF EFFECTS

Table 12.12: Summary of Effects provides a summary of the effects detailed within this Chapter.

Table 12.12: Summary of Effects

Receptor	Potential Effect	Significance of Effect	Mitigation Proposed	Residual Effect
Construction Phase				
Surface hydrology (watercourses)	Chemical pollution	Minor	None	Minor
	Erosion and sedimentation	Minor	None	Minor
	Impediments to flow	Minor	None	Minor
	Increased run-off and flood risk	Negligible	None	Negligible
Hydrogeology (groundwater and	Chemical pollution	Minor	None	Minor
	Erosion and sedimentation	Minor	None	Minor

[42] Status of wind farms is as of 15 September 2020.
[43] Drum Hollistan Renewables LLP (2020) Drum Hollistan 2 Wind Farm EIA Report Volume 2: Written Statement

Receptor	Potential Effect	Significance of Effect	Mitigation Proposed	Residual Effect
Construction Phase				
near-surface water)	Impediments to flow	Minor	None	Minor
	Increased run-off and flood risk	Minor	None	Minor
GWDTE (moderate)	Chemical pollution	Minor	None	Minor
	Impediments to flow resulting in loss or reduction in water dependent habitat.	Minor	None	Minor
GWDTE (high)	Chemical pollution.	Negligible to Minor	None	Negligible to Minor
	Impediments to flow resulting in loss or reduction in water dependent habitat.	Negligible to Minor	None	Negligible to Minor
Private water supplies	Chemical pollution.	Moderate	Provision of alternative permanent supply. Provision of alternative temporary supply during construction phase works and reinstatement of supply infrastructure following completion of works. Water quality and quantity monitoring.	Minor
	Erosion and sedimentation			
	Impediments to flow resulting in loss or reduction in yield.			
Statutory Designations with hydrological qualifying interest	Chemical pollution.	Minor	None	Minor
	Impediments to flow resulting in loss or reduction in water dependent habitat.	Minor	None	Minor
Operational Phase				
Surface hydrology (watercourses)	Impediments to flow & alterations to drainage patterns.	Minor	None	Minor
Hydrogeology (groundwater and near-surface water)		Minor	None	Minor
Private water supplies		Minor	Provision of alternative permanent supply; Reinstatement of existing supply following completion	Minor

Receptor	Potential Effect	Significance of Effect	Mitigation Proposed	Residual Effect
Construction Phase				
			of construction phase. Water quality and quantity monitoring.	
GWDTE (moderate)	Loss of hydrological functionality.	Negligible	None	Negligible
GWDTE (high)	Loss of hydrological functionality.	Minor	None	Minor
Cumulative				
Surface hydrology (watercourse) – Giligill Burn	Cumulative sediment & chemical pollution from Drum Hollistan Wind Farm.	Minor	None	Minor

12.10 STATEMENT OF SIGNIFICANCE

This Chapter has assessed the likely significance of effects of the Development on hydrology and hydrogeology. The Development has been assessed as having the potential to result in effects of negligible to minor significance.

Given that only effects of moderate significance or greater are considered significant in terms of the EIA Regulations, the potential effects on hydrology and hydrogeology are considered to be not significant.