13 Hydrology and Hydrogeology

13.1 Introduction

13.1.2 This Chapter of the EIA Report evaluates the effects of the Proposed Development on hydrology and hydrogeology resources. This assessment was undertaken by Arcus Consultancy Services Limited (Arcus).

13.1.3 This chapter is supported by the following document provided in Volume 4 of this EIA Report:

- **Appendix 4.1**: Outline Construction Environmental Management Plan (CEMP).

13.1.4 This chapter is supported by the following figures:

- **Figure 13.1**: Hydrology Study Area; and
- **Figure 13.2**: Hydrological Catchments.

13.1.5 This Chapter should be read in conjunction with Chapter 7: Forestry, Chapter 9: Ecology, and Chapter 12: Geology and Peat.

13.1.6 This Chapter includes the following elements;

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

13.2 Legislation, Policy and Guidance

13.2.1 The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations (2017)[1] (the EIA Regulations) establish in broad terms what is to be considered when determining the effects of development proposals on hydrology and hydrogeology. The following legislation, guidance and information sources have been considered in carrying out this assessment.

Legislative Background

13.2.2 The Water Framework Directive (WFD) (2000/60/EC)[2] 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[3] and subsidiary Regulations.

13.2.3 Other relevant legislation includes:

[1] Scottish Government (2017) The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations [Online] Available at: http://www.legislation.gov.uk/ssi/2017/101/contents/made (Accessed 02/05/18)
[2] European Commission (2000) The Water Framework Directive (2000/60/EC) [Online] Available at: http://ec.europa.eu/environment/water/water-framework/index_en.html (Accessed 08/01/2018)
[3] Scottish Government (2003) The Water Environment and Water Services (Scotland) Act 2003 [Online] Available at: http://www.legislation.gov.uk/asp/2003/3/contents (Accessed 08/01/2018)

- The Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003[4];
- The Private Water Supplies (Scotland) Regulations 2006[5];
- The Water Intended for Human Consumption (Private Supplies) (Scotland) Regulations 2017[6]; and
- The Public and Private Water Supplies (Miscellaneous Amendments) (Scotland) Regulations 2015[7].

Scottish Planning Policy and Guidance

Scottish Planning Policy 2014 (SPP)

13.2.4 The Scottish Planning Policy (SPP)[8] 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.

13.2.5 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.

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

13.2.6 Produced by the Scottish Environment Protection Agency (SEPA), PPGs and GPPs[9] 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 however, this process is ongoing. The following 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:

- PPG1: General guide to the prevention of water pollution (July 2013);
- GPP2: Above ground oil storage tanks (January 2017);
- GPP4: Treatment and disposal of wastewater where there is no connection to the public foul sewer (October 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);

[4] Scottish Government (2003) Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003 [Online] Available at: http://www.opsi.gov.uk/legislation/scotland/acts2003/asp_20030015_en_1 (Accessed 08/01/2018)
[5] Scottish Government (2006) the Private Water Supplies (Scotland) Regulations 2006 [Online] Available at: http://www.legislation.gov.uk/ssi/2006/209/contents/made (Accessed 08/01/2018)
[6] Scottish Government (2017) the Water Intended for Human Consumption (Private Supplies) (Scotland) Regulations 2017 [Online] Available at: https://www.legislation.gov.uk/ssi/2017/282/note/made (Accessed 09/11/2018)
[7] Scottish Government (2015) the Private and Public Water Supplies (Miscellaneous Amendments) (Scotland) Regulations 2015 [Online] Available at: https://www.legislation.gov.uk/ssi/2015/346/contents (Accessed 09/11/2018)
[8] The Scottish Government (2014) Scottish Planning Policy [Online] Available at: http://www.gov.scot/Publications/2014/06/5823 (Accessed 08/01/2018)
[9] SEPA (various) Pollution Prevention Guidelines. PPG 1 to 21 [Online] Available at: http://www.sepa.org.uk/about_us/publications/guidance/ppgs.aspx (Accessed 08/01/2018)

- PPG18: Managing fire water and major spillages (June 2000);
- GPP21: Pollution incident response planning (July 2017); and
- GPP22: Dealing with spills (October 2018).

Other Guidance

13.2.7 Other relevant guidance comprises the following:

- The Scottish Government (2001), PAN 61: Planning and Sustainable Urban Drainage Systems[10];
- Scottish Water (2015), Sewers for Scotland, 3rd Edition[11];
- Conservation (Natural Habitats, & c.) Regulations 1994 (as amended 2012);
- SEPA (2010),Engineering in the water environment: good practice guide: River crossings[12];
- SEPA (2013), Aquifer and Vulnerability Maps[13];
- SEPA and Scotland and Northern Ireland Forum for Environmental Research (SNIFFER) (2004) Groundwater Vulnerability Maps;
- SEPA (2006) Culverting of Watercourses: Policy Statement and Supporting Guidance[14];
- SEPA (2014), Land Use Planning System Guidance Note 31, Version 2, (LUPS-GN31)[15];
- SEPA (2002), Managing River Habitats for Fisheries[16];
- The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (the CAR Regulations)[17];
- SEPA (2015), CAR - A Practical Guide, Version 7.2[18];
- The Water Environment (Drinking Water Protected Areas) (Scotland) Order 2013[19];
- SEPA (2009), River Basin Management Plan[20];

[10] The Scottish Government (2001) PAN61 Planning and Sustainable Urban Drainage Systems [Online] Available at: http://www.scotland.gov.uk/Publications/2001/07/pan61 (Accessed 08/01/2018)
[11] Scottish Water (2015) Sewers for Scotland 3rd Edition [Online] Available at: http://www.scottishwater.co.uk/business/connections/connecting-your-property/sewers-for-scotland-and-suds/sewers-for-scotland-v3 (Accessed 08/01/2018)
[12] SEPA (2010) Engineering in the water environment good practice guide: River Crossings, WAT-SG-25 [Online] Available at: http://www.sepa.org.uk/regulations/water/engineering/engineering-guidance/ (Accessed 08/01/2018)
[13] SEPA (2013) Aquifer and Vulnerability Maps [Online] Available at: http://www.sepa.org.uk/water/river_basin_planning.aspx (Accessed 08/01/2018)
[14] SEPA (2006) Culverting of Watercourses: Position Statement and Supporting Guidance, WAT-PS-06-02,Version 2.0 [Online] Available at: http://www.sepa.org.uk/media/150919/wat_ps_06_02.pdf (Accessed 08/01/2018)
[15] SEPA (2014) 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 2 [Online] Available at: https://www.sepa.org.uk/media/143868/lupsgu31_planning_guidance_on_groundwater_abstractions.pdf (Accessed 08/01/2018)
[16] SEPA (2002) Managing River Habitats for Fisheries: a guide to best practice [Online] Available at: http://www.sepa.org.uk/media/151323/managing_river_habitats_fisheries.pdf (Accessed 08/01/2018)
[17] Scottish Government (2011) the Water Environment (Controlled Activities) (Scotland) Regulations 2011 [Online] Available at: http://www.legislation.gov.uk/ssi/2011/209/pdfs/ssi_20110209_en.pdf (Accessed 08/01/2018)
[18] SEPA (2015a) Controlled Activities Regulations - A Practical Guide, Version 7.2 [Online] Available at: http://www.sepa.org.uk/media/34761/car_a_practical_guide.pdf (Accessed 08/01/2018)
[19] Scottish Government (2013) The Water Environment (Drinking Water Protected Areas) (Scotland) Order 2013 [Online] Available at: http://www.legislation.gov.uk/ssi/2013/29/introduction/made (Accessed 08/01/2018)
[20] SEPA (2009) River Basin Management Plan [Online] Available at: http://www.sepa.org.uk/water/river_basin_planning.aspx (Accessed 08/01/2018)

- Scottish Natural Heritage (SNH) (2015), Good Practice During Wind Farm Construction[21];
- The Scottish Government (2017),Peat Landslide Hazard and Risk Assessments - Best Practice Guide for Proposed Electricity Generation Developments[22];
- The Scottish Government (2009), The Scottish Soil Framework[23];
- The Construction Industry Research and Information Association (CIRIA) (2015), Environmental Good Practice on Site (C741)[24];
- CIRIA (2001), Control of Water Pollution from Construction Sites (C532)[25]; and
- CIRIA (2015), The SuDS Manual (C753).

13.3 Assessment Methodology and Significance Criteria

13.3.1 This assessment has involved the following elements, further details of which are provided in the relevant sections:

- consultation with relevant statutory and non-statutory bodies;
- desk study, including review of available maps and published information;
- site walkover (carried out during 2013, an Arcus Hydrologist visited the Site to conduct peat probing during August 2018 and verified findings of 2013 visit);
- input to design process to minimise effects;
- identification and evaluation of potential effects;
- evaluation of the significance of these effects;
- identification of measures to avoid and mitigate potential effects;
- assessment of residual effects;
- evaluation of potential cumulative effects;
- proposed monitoring; and
- statement of significance.

13.4 Scoping Responses and Consultations

13.4.1 Information has been provided by a range of organisations during the assessment, and this is summarised in Table 13.1. The response to each point raised by consultees is also presented within the table, demonstrating where the design of the Proposed Development has addressed the response to specific issues identified by SEPA, Scottish Water and Dumfries and Galloway Council (DGC) and other consultees.

[21] SNH (2015b) Good practice during windfarm construction, 3rd Edition [Online] Available at: http://www.snh.gov.uk/docs/A1168678.pdf (Accessed 08/01/2018)
[22] The Scottish Government (2017) Peat Landslide Hazard and Risk Assessments - Best Practice Guide for Proposed Electricity Generation Developments Guidance [Online] Available at: http://www.gov.scot/Resource/0051/00517176.pdf (Accessed 08/01/2018)
[23] The Scottish Government (2009) The Scottish Soil Framework [Online] Available at: http://www.gov.scot/Publications/2009/05/20145602/0 (Accessed 08/01/2018)
[24] The Construction Industry Research and Information Association (CIRIA) (2015) Environmental Good Practice on Site Guide (C741), CIRIA: London.
[25] CIRIA (2001) Control of Water Pollution from Construction Sites (C532), CIRIA: London.

Table 13.1: Consultation Responses

Consultee	Type and Date	Summary of Consultation Response	Response to Consultee
Marine Scotland	Scoping Response 28th March 2018	Marine Scotland made the following comments of relevance to Hydrology and Hydrogeology: Marine Scotland recommends the developer carry out the following: site characterisation surveys of water quality (including turbidity, macroinvertebrates and flow data) in addition to surveys proposed for fish populations; outline appropriate site specific mitigation measures; establish a robust integrated water quality and fish monitoring programme; and to consider the potential impacts on forestry and cumulative impacts on the water quality and the aquatic biota.	Mitigation measures and water quality monitoring recommendations are outlined in the outline CEMP, provided as **Appendix 4.1**. The impacts of forestry are assessed in Chapter 7, Forestry, of this EIA Report.
SEPA	Scoping Response 10th April 2018	SEPA made the following comments of relevance to Hydrology and Hydrogeology:	
		2.1 The site layout must be designed to avoid impacts on the water environment. Where activities such as watercourse crossings, watercourse diversions or other engineering activities in the water environment cannot be avoided then the submission must include a map showing the following: a) All proposed temporary or permanent infrastructure overlain with all lochs and watercourses. b) A minimum buffer of 50 m around each loch or watercourse. If this minimum buffer cannot be achieved each breach must be numbered on a plan with an associated photograph of the location, dimensions of the loch or watercourse, drawings of what	2.1 – The Proposed Development has been designed to avoid impacts on the water environment. A 50 m buffer of watercourses has been incorporated into the design of the Proposed Development. Proposed infrastructure, including watercourse crossings, are shown on **Figure 13.2** in relation to hydrological catchments. Measures within the outline CEMP, provided as **Appendix 4.1**, will safeguard watercourses and subsurface water. The final details on sizing of SuDS will be provided prior to the construction phase.

Consultee	Type and Date	Summary of Consultation Response	Response to Consultee
		is proposed in terms of engineering works. c) Detailed layout of all proposed mitigation including all cut off drains, location, number and size of settlement ponds.	
		2.2 If water abstractions or dewatering are proposed, a table of volumes and timings of groundwater abstractions and related mitigation measures must be provided.	No water abstraction is proposed as part of the Proposed Development. Measures within the outline CEMP describe how dewatering will be undertaken.
		2.4 Refer to Appendix 2 of our Standing Advice for advice on flood risk. Watercourse crossings must be designed to accommodate the 0.5% Annual Exceedance Probability (AEP) flows, or information provided to justify smaller structures. If it is thought that the development could result in an increased risk of flooding to a nearby receptor then a Flood Risk Assessment must be submitted in support of the planning application. Our Technical flood risk guidance for stakeholders outlines the information we require to be submitted as part of a Flood Risk Assessment.	Measures within the outline CEMP, provided as **Appendix 4.1**, will ensure flows are managed and released at greenfield rates and mitigate flood risk. The final design of watercourse crossings will be provided to SEPA prior to the construction phase and will be appropriately sized to convey the 1:200 year event plus an allowance for climate change. Regarding flood risk, given the remote nature of the Proposed Development and the distance to receptors, a standalone Flood Risk Assessment is not proposed. Flood risk and increased run-off is assessed in paragraphs 13.6.51 to13.6.58 of this Chapter.
		4.1 GWDTE are protected under the Water Framework Directive and therefore the layout and design of the development must avoid impact on such areas. The following information must be included in the submission: a) A map demonstrating that all GWDTE are outwith a 100 m radius of all excavations shallower than 1 m and outwith 250 m of all excavations	An Extended Phase 1 habitat survey has been undertaken and is detailed within Chapter 9 Ecology and **Appendix 9.1**. An assessment of the potential hydrological and hydrogeological effects arising from the Proposed Development on habitats and ecological communities (such as GWDTEs) is provided in

Consultee	Type and Date	Summary of Consultation Response	Response to Consultee
		deeper than 1 m and proposed groundwater abstractions. If micro-siting is to be considered as a mitigation measure the distance of survey needs to be extended by the proposed maximum extent of micro-siting. The survey needs to extend beyond the site boundary where the distances require it. b) If the minimum buffers above cannot be achieved, a detailed site specific qualitative and/or quantitative risk assessment will be required. We are likely to seek conditions securing appropriate mitigation for all GWDTE affected.	paragraphs 13.5.32 to 13.5.35 of this Chapter.
		5.1 Excavations and other construction works can disrupt groundwater flow and impact on existing groundwater abstractions. The submission must include: a) A map demonstrating that all existing groundwater abstractions are outwith a 100 m radius of all excavations shallower than 1m and outwith 250 m of all excavations deeper than 1 m and proposed groundwater abstractions. If micro-siting is to be considered as a mitigation measure the distance of survey needs to be extended by the proposed maximum extent of micro-siting. The survey needs to extend beyond the site boundary where the distances require it. b) If the minimum buffers above cannot be achieved, a detailed site specific qualitative and/or quantitative risk assessment will be required. We are likely to seek conditions securing appropriate mitigation for all existing groundwater abstractions affected.	Details of groundwater abstractions and the distances to the Proposed Development are presented in paragraphs 13.5.38 to 13.5.41 and Table 13.6. No groundwater abstractions exist within 250 m of Proposed Development infrastructure.
		6.1 Key holing must be used wherever possible as large scale felling can result in large amounts of waste material and in a peak release of nutrients	Key holing is to be used where possible rather than large scale felling, see paragraphs 7.9.4 – 7.9.5 in Chapter 7 Forestry.

Consultee	Type and Date	Summary of Consultation Response	Response to Consultee
		which can affect local water quality. The supporting information should refer to the current Forest Plan if one exists and measures should comply with the Plan where possible.	
		8.1 One of our key interests in relation to developments is pollution prevention measures during the periods of construction, operation, maintenance, demolition and restoration. A schedule of mitigation supported by the above site specific maps and plans must be submitted. These must include reference to best practice pollution prevention and construction techniques (for example, the maximum area to be stripped of soils at any one time) and regulatory requirements. They should set out the daily responsibilities of ECOWs, how site inspections will be recorded and acted upon and proposals for a planning monitoring enforcement officer.	Potential effects on the hydrological and hydrogeological environment from all aspects of the Proposed Development are assessed within section 13.6 of this Chapter. Measures within the outline CEMP, provided as **Appendix 4.1**, will safeguard watercourses and subsurface water and are based on good practice and industry guidance.
D&GC Environmental Health Department	Response to PWS information request – 3rd May 2018	Provided data on PWS within 2 km of the Proposed Development boundary.	PWS owners were contacted to ascertain the nature and location of the PWS. Measures within the outline CEMP, provided as **Appendix 4.1**, detail mitigation to safeguard PWS.
Scottish Water	Scoping Response	Scottish Water made the following comments of relevance to Hydrology:	
		The site boundary falls within a drinking water catchment where a Scottish Water abstraction is located. Scottish Water abstractions are designated as Drinking Water Protected Areas (DWPA) under Article 7 of the Water Framework Directive. The Water of Ken is adjacent to the site and Carsfad Loch is located on the Water of Ken downstream of the site. Raw water is pumped from Carsfad Loch to Lochinvar Loch which	Potential effects on the hydrological environment from all aspects of the Proposed Development are assessed within this Chapter in paragraphs 13.6.1 to 13.9.1. Measures within the outline CEMP, provided as **Appendix 4.1**, will safeguard watercourses and subsurface water and are based on good practice and industry guidance.

Consultee	Type and Date	Summary of Consultation Response	Response to Consultee
		supplies Lochinvar water treatment works (WTW). It is essential that water quality and water quantity in the area are protected.	
		6.7 The fact that this area is located within a drinking water catchment should be noted in future documentation and taken into account during environmental risk assessments. We would request further involvement at the more detailed design stages and once prepared to be sent the Construction Environmental Management Plan (CEMP) and any other associated documents such as a Pollution Prevention and Contingency Plan. This will enable Scottish Water to review the assessment of potential impacts and mitigation required to protect water quality and quantity.	The outline CEMP, provided as **Appendix 4.1**, acknowledges the location and sensitivity of the Proposed Development and proposed mitigation measures which will safeguard the water environment. The location of watercourses within a drinking water catchment is considered in the determination of the sensitivity of receptors detailed in Table 13.8, as such watercourses and lochs are considered as High sensitivity receptors. The potential effects of the Proposed Development on the drinking water catchment has been assessed in sections 13.6. Scottish Water will be consulted prior to the construction phase of the Proposed Development.
		6.8 Scottish Water have produced a list of precautions for a range of activities. This details protection measures to be taken within a DWPA, the wider drinking water catchment and if there are assets in the area. Please note that site specific risks and mitigation measures will require to be assessed and implemented. These documents and other supporting information can be found on the activities within our catchments page of our website at www.scottishwater.co.uk/slm.	Site specific risks are assessed and mitigation measures proposed within sections 13.6 to 13.8.1 of this Chapter. Consideration has been given to the Scottish Water guidance for development in DWPAs.
		6.9 Some of the soils in this catchment appear to be peat. Peat that is in unfavourable condition or disturbed can exacerbate the release of organic material into the water	Measures specific to management of soils are detailed in section 9 of the outline CEMP, provided as **Appendix 4.1**.

Consultee	Type and Date	Summary of Consultation Response	Response to Consultee
		environment. Water containing a high organic content can affect WTW processes and water supply. We would welcome consideration of the precautions specific to protecting drinking water in peatland areas and any opportunities for peat restoration.	
		6.10 We would also like to take the opportunity, to request that in advance of any works commencing on site, Scottish Water is notified at protectdwsources@scottishwater.co.uk. This will enable us to be aware of activities in the catchment and to determine if a site meeting would be appropriate and beneficial. Anyone working on site should be made aware that they are working within a DWPA. In the event of an incident occurring that could affect Scottish Water, we should be notified without delay using the Customer Helpline number 0800 0778 778.	The outline CEMP, **Appendix 4.1**, includes a mechanism for notifying Scottish Water prior to construction works commencing.
Galloway Fisheries Trust	Scoping Response 6th April 2018	Galloway Fisheries Trust made the following comments of relevance to Hydrology:	
		From experience with previous developments it is likely that much of the existing forestry track network will need to be upgraded (i.e. widened). It is therefore important that watercourses and the upgrading of watercourse crossings are acknowledged, adequate planning is undertaken and appropriate and sufficient mitigation measures are identified to protect watercourses, water quality and fish populations.	The design of watercourse crossings is described in Chapter 4, Description of the Proposed Development. The design of watercourse crossings will be determined individually to minimise potential impacts in line with the SEPA Good Practice Guide for the Construction of River Crossings and the CIRIA Culvert Design and Operation Guide.
		We would also raise concerns regarding nutrient input and acidification which may occur as a result of felling associated with the proposed development. Method	Measures, including keyhole felling outlined in Chapter 7, section 7.9 Forestry, will minimise nutrient loading and acidification of

Consultee	Type and Date	Summary of Consultation Response	Response to Consultee
		statements must be produced and agreed, site specific mitigation measures must be detailed and monitoring plans must be produced to assess water quality and protect watercourses.	watercourses. Further mitigation methods specific to forestry are provided in section 7 within the outline CEMP, provided as **Appendix 4.1**.
		We note that the EIA/ES will contain information regarding the identification of mitigation measures and any residual effects following mitigation. It is imperative that the EIA/ES contains details of all site specific mitigation measures to protect watercourses, water quality and fish populations, and must include details of all mitigation embedded into the design and construction of the proposed development. Details of all potential additional mitigation measures which may be employed further to the initial mitigation being deployed on site during construction.	Mitigation methods are provided within the outline CEMP, provided as **Appendix 4.1**. The outline CEMP is considered a live document and can be continually updated with appropriate mitigation which may be required.
		Any new access routes/tracks and watercourse crossings must also be detailed in the EIA/ES – their location and proposed type of crossing structure in particular. Details of mitigation methods which will be employed to minimise impacts on watercourses, water quality and fish populations during the construction of new tracks and watercourse crossings, as well as the upgrading of these, must be included.	Watercourse crossings and tracks are detailed in Chapter 4, Description of the Proposed Development. Mitigation methods are provided within the outline CEMP, provided as **Appendix 4.1**.

Study Area

13.4.2 The hydrology and hydrogeology study area (the Core Study Area) is defined by the Proposed Development application boundary. A wider study area of 10 km from the proposed wind turbine locations has also been considered to assess potential impacts on the downstream water environment (the Wider Study Area). Both study areas are shown in **Figure 13.1**. At distances greater than 10 km within upland catchments, it is considered that schemes are unlikely to contribute to a hydrological impact, in terms of chemical or sedimentation impacts, due to dilution over distance of potentially polluting chemicals.

13.4.3 A smaller 2 km study area is used to assess private water supplies (the PWS study area).

Survey Methodology/Scope

13.4.4 The key issues for the assessment of potential effects on the hydrological and hydrogeological resources relating to the Proposed Development include:

- potential chemical pollution effects on the hydrological environment;
- potential erosion and sedimentation effects on the hydrological environment;
- potential impediments to stream flow;
- potential effects on private and public water supplies;
- potential changes in soil and peat interflow patterns;
- potential for the compaction of soils;
- potential effects on the hydrological function of GWDTEs;
- acidification of watercourses;
- potential for peat destabilisation and disturbance; and
- potential for an increase in runoff and flood risk.

13.4.5 Effects during construction, operation and decommissioning have been assessed, as well as potential cumulative effects.

Elements Scoped Out of Assessment

13.4.6 The SEPA Landfill Map has not identified any areas of contaminated land within the Core Study Area and no effects are anticipated. Should potentially contaminated land be encountered during excavations; however, this would be tested and appropriate action taken in accordance with The Environmental Protection Act 1990. Potential effects arising from contaminated land have, therefore, been scoped out of this assessment.

Baseline Survey Methodology

Desk Study

13.4.7 The desk study included:

- identification of underlying geology and hydrogeology;
- collation of data provided through consultations;
- identification of groundwater vulnerability;
- assessment of topography and slope characteristics;
- identification of catchments, watercourses, springs and water features;
- collation of data provided through consultations; and
- collation of flood plain information and water quality data.

13.4.8 Reference was also made to the following sources of information:

- The Ordnance Survey (OS) 1:50,000 Landranger Map (Sheet 20);
- OS 1:25,000 Map (Digital);
- National River Flow Archive (NRFA)[26];
- SEPA Flood Map 2014[27];
- Meteorological Office Rainfall Data[28]; and

[26] Centre for Ecology and Hydrology (undated), National River Flow Archive [Online] Available at: http://nrfa.ceh.ac.uk/ (Accessed 08/01/2018)
[27] SEPA (2014) Flood Maps [Online] Available at: http://map.sepa.org.uk/floodmap/map.htm (Accessed 08/01/2018)

- The British Geological Survey (BGS) Geology Map (Digital)[29].

Site Walkover

13.4.9 A site walkover was undertaken on 24th October 2013 to visually inspect surface water features and to obtain an understanding of the local topography and hydrological regime.

13.4.10 The site walkover covered the areas surrounding the proposed turbine locations on the slopes of Craigengillan Hill and Marscalloch Hill. Visits to properties identified as having a PWS were also undertaken.

13.4.11 As the baseline hydrological environment has not substantially altered since the 2013 site walkover, the observations are considered to be appropriate to inform the assessment of potential hydrological effect. A member of Arcus' hydrology team was on Site during August 2018 to carry out peat probing and was able to verify the findings of the 2013 visit.

Assessment Methodology

13.4.12 The methodology outlined in paragraphs 13.4.13 to 13.4.21 has been developed by Arcus in consultation with SEPA, SNH, Marine Scotland and the Scottish Government. The assessment is based on a source-pathway-receptor methodology, where the sensitivity of the receptors and the magnitude of potential change upon those receptors identified within the study areas.

Sensitivity

13.4.13 The sensitivity of the receiving environment is defined as its ability to absorb an effect without perceptible change and can be classified as high, moderate or low. These classifications are dependent on factors such as the quality of the subsurface water within the receptor, their purpose (*e.g.* whether used for drinking, fisheries, *etc*.) and existing influences, such as land-use.

13.4.14 These criteria are outlined in Table 13.2 and are based on professional judgement and experience.

Table 13.2: Receptor Sensitivity Criteria

Receptor Sensitivity	Sensitivity Description
High	▪ A large, medium or small waterbody with a SEPA water quality classification of 'High' or 'Good'. ▪ The hydrological receptor and downstream environment has limited capacity to attenuate natural fluctuations in hydrochemistry and cannot absorb further changes without fundamentally altering its baseline characteristics / natural processes. ▪ The hydrological receptor is of high environmental importance or is designated as national or international importance, such as a Special Area of Conservation (SAC) or a Site of Special Scientific Interest (SSSI). ▪ The receptor acts as an active floodplain or other flood defence. ▪ The receptor is located within an active flood plain, in accordance with

[28] Met Office (2018) Climate Data [Online] Available at: http://www.metoffice.gov.uk/public/weather/climate (Accessed 08/01/2018)
[29] Available for purchase from BGS at http://www.bgs.ac.uk/products/onshore/home.html?src=topNav (Accessed 08/01/2018)

Receptor Sensitivity	Sensitivity Description
	SPP 2014. ▪ GWDTEs which are classified by SEPA as "highly groundwater dependent" have no functional impairment by man-made influence (such as drainage or forestry). ▪ The hydrological receptor will support abstractions for public water supply or private water abstractions for more than 25 people. ▪ Abstractions used for the production of mass produced food and drinks. ▪ Areas containing geological or geomorphological features considered to be of national importance (e.g. geological SSSIs). ▪ Local groundwater constitutes a valuable resource because of its high quality and yield. Aquifer(s) of local or regional value. Statutorily designated nature conservation sites (e.g. SACs and SSSIs) dependent on groundwater.
Moderate	▪ A large, medium or small waterbody with a SEPA water quality classification of 'Moderate'. ▪ The hydrological receptor and downstream environment will have some capacity to attenuate natural fluctuations in hydrochemistry but cannot absorb certain changes without fundamentally altering its baseline characteristics / natural processes. ▪ The hydrological receptor is of regional environmental importance (such as Local Nature Reserves), as defined by SEPA. ▪ The hydrological receptor does not act as an active floodplain or other flood defence. ▪ The hydrological receptor supports abstractions for public water supply or private water abstractions for up to 25 people. ▪ GWDTEs which are classified by SEPA as "highly groundwater dependent" but have 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). ▪ Areas containing geological features of designated regional importance including Regionally Important Geological/geomorphological Sites (RIGS), considered worthy of protection for their historic or aesthetic importance. ▪ Aquifer of limited value (less than local) 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.
Low	▪ 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. ▪ The hydrological receptor is not of regional, national or international environmental importance. ▪ The hydrological receptor is not designated for supporting freshwater ecological interest. ▪ GWDTEs which are classified by SEPA as "moderately groundwater dependent" but have functional impairment by man-made influence (such as drainage or forestry).

Receptor Sensitivity	Sensitivity Description
	▪ 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 used for recreational use. ▪ The hydrological receptor does not support abstractions for public water supply or private water abstractions. ▪ Geological features or geology not protected and not considered worthy of specific protection. ▪ Poor groundwater quality and / or very low permeability make exploitation of groundwater unfeasible. Changes to groundwater not expected to affect local ecology.

Magnitude

13.4.15 The magnitude is determined by the timing, scale, size and duration of the potential effect resulting from the Proposed Development. The magnitude of potential effects can be classified as major, moderate, minor or negligible, as outlined in Table 13.3.

Table 13.3: Criteria for Determining Magnitude

Magnitude of Effect	Magnitude Description
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 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.
Moderate	▪ 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.'

Magnitude of Effect	Magnitude Description
	▪ 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. ▪ 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 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.

Significance

13.4.16 The predicted significance of the effect is determined through a standard method of assessment and based on professional judgement, considering

both the sensitivity of receptor and the magnitude of the potential effect as defined in Table 13.4. Effects of moderate significance or greater are considered significant in terms of the EIA Regulations.

Table 13.4: Significance Matrix

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

13.4.17 Embedded design measures are set out within the outline CEMP (provided as **Appendix 4.1**) which sets out specific mitigation which relates to this Proposed Development. They comprise good practice methods and works that are established and effective measures to which the Developer will be committed through the development consent. Although the outline CEMP 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 outline CEMP for them to be treated as part of the Proposed Development for the purposes of this assessment. Measures and procedures outlined in the outline CEMP 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. For ease of reference through this Chapter, reference to specific sections in the outline CEMP, detailing the appropriate embedded mitigation measures, are provided.

13.4.18 Accordingly, the identification of likely significant effects from the Proposed Development is considered following implementation of the measures in **Appendix 4.1**

13.4.19 Effects assessed as major or moderate significance are considered to be significant for the purposes of The Environmental Impact Assessment (Scotland) Regulations 2017 ("the EIA Regulations"). Effects assessed as minor or less are considered to be not significant for the purposes of the EIA Regulations.

Assessment of Cumulative Effects

13.4.20 A cumulative effect is considered to be an additional effect on hydrological resources arising from the Proposed Development in combination with other proposed 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 Proposed Development have been considered. These developments have been identified through consultation with the relevant local authorities and statutory consultees, as outlined in Table 4.1, and are discussed in more

detail in Section 13.8. The methodology followed to assess the cumulative effects is the same as that used for the Proposed Development in isolation.

Assessment Limitations

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

13.5 Baseline Conditions

Topography and Land Use

13.5.1 The Core Study Area occupies an upland location which is used as a commercial forestry plantation, with areas of peat the site. The Core Study Area rises from approximately 200 m above ordnance datum (AOD, approximately equivalent to sea level) at the south eastern boundary of the Core Study Area to 401 m AOD at Craigengillan Hill in the northern section of the Site.

13.5.2 The Core Study Area is bounded to the south east by the B729 and by an unnamed road adjacent to the Water of Ken and by the Poliferrie Burn to the north east. The Core Study Area is bounded to the northwest by open moorland and by plantation forestry to the south west.

There are a number of existing tracks within the Core Study Area associated with commercial forestry operations, as shown in **Plate 13.3**.

Plate 13.2: Typical existing access tracks and associated drainage

Surface Hydrology

13.5.4 **Figure 13.2** shows the main watercourses and their catchments.

13.5.5 All turbines, crane pads, upgraded access road and the construction compound at the Proposed Development site lie within the primary catchment of the Water of Ken (downstream of Kendoon) and the Water of Deugh (Carsphairn Lane to Water of ken) and within their sub-catchments.

13.5.6 The Water of Ken is classified by SEPA in two sections relevant to the Core Study Area. The River Ken upstream of High Bridge of Ken flows south adjacent to the eastern boundary and converges with the Water of Deugh 1.7 km south west of the southern boundary. Downstream of this confluence the watercourse is classified as the Water of Ken downstream of Kendoon.

13.5.7 Black Burn originates on the northern side of Marscalloch Hill in the southwestern section of the Core Study Area and drains northeast before a confluence with the Water of Ken (upstream of High Bridge of Ken) at BNG 263465 593650. Dark, peaty, slow flowing water was observed within Black Burn during the site walkover.

13.5.8 **Plate 13.4** shows Black Burn.

Plate 13.3: Black Burn with dark, peaty water

13.5.9 Natural watercourses in the central and northwestern sections of the Core Study Area are generally slow flowing, due to the relatively gentle topography and follow a Dendritic catchment pattern. Morphology is typical of upland watercourses, which (as above) are generally fairly dispersed through steeper impermeable ground from their upper reaches, becoming less steep and slower flowing as they progress towards the primary watercourse within the catchment.

13.5.10 Goat Strand issues on the southern slope of Craigengillan Hill and drains south before joining Craigengillan Burn. The catchment of the Craigengillan Burn covers the majority of the northern and western section of the Core Study Area, which drains to the southeast before joining the Water of Ken at BNG 263480 593740. Craigengillan Burn measures approximately 2.5 m width and 0.75 m depth with a stony bed. Water within Craigengillan Burn was observed to be moderately fast flowing and of a dark, peaty colour, as shown in **Plate 13.5**.

Plate 13.4: Craigengillen Burn with dark, peaty water

13.5.11 The central section of the Core Study Area is drained by Hare Strand, which flows from west to east, before joining Craigengillen Burn. Hare Strand is a well-defined watercourse with grassed shallow sided banks, measuring approximately 1 m width by 0.5 m depth. Dark, peaty, slow flowing water was observed within Hare Strand during the site walkover, as shown in **Plate 13.6**.

Plate 13.5: Hare Strand with dark, peaty water

13.5.12 The southern section of the Proposed Development site is drained by Dry Burn, which originates on the eastern side of Marscalloch Hill and flows to the southeast before joining the Water of Ken (upstream of High Bridge of ken) at BNG 263260 591185.

13.5.13 The Water of Ken (upstream of High Bridge of Ken) has an overall SEPA classification of Poor.

13.5.14 Unnamed tributaries of Marbrack Burn issue in the northwestern section of the Proposed Development and drain to the south. These unnamed tributaries were observed to be heavily vegetated, slow flowing and had water of a dark, peaty colour with ochre ferrous deposits on the watercourse bed (possibly leaching from the surrounding peat).

13.5.15 The Marbrack Burn converges with the Water of Deugh at BNG 259051 592268. The Water of Deugh has an overall SEPA classification of Poor.

13.5.16 The Water of Deugh subsequently flows into Kendoon Loch which converges with the Water of Ken (downstream of Kendoon) which has an overall SEPA classification of Bad. An unclassified stretch of the Water of Deugh issues from Kendoon Loch flowing west around Dundeugh Hill before converging with the Water of Ken 4 km southwest of the Proposed Developments southern Boundary.

Climate

13.5.17 The National River Flow Archive (NRFA) report Average Annual Rainfall (AAR 1961 - 1990) at the Afton Water at Afton Reservoir gauging station, approximately 8 km north of the Core Study Area, as 2,165 millimetres (mm).

13.5.18 As monthly long term climate data is not freely available from the NRFA, long term average rainfall data (1981 to 2000) obtained by the Meteorological Office at the Glenlee gauging station, located 11 km south of the Core Study Area, are presented in Table 13.5.

Table 13.5: Long term average rainfall data (1981 – 2000), Glenlee

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	209.2	143.9	154.0	95.2	88.9	83.0	91.6	120.5	136.2	204.2	191.8	202.5

Hydrogeology

13.5.19 Data on hydrogeology was obtained from the SEPA and SNIFFER Groundwater Vulnerability Map. The Vulnerability Map represents the strata overlying the aquifer ('vertical pathway'). These maps provide the following information for the Core Study Area:

- Vulnerability Class: variable (5 to 4b).

13.5.20 Vulnerability classes range from 1 to 5, with 5 being most vulnerable. Class 4 is subdivided into 4a and 4b. It is the hydrogeological characteristics within the pathway rather than the 'importance' of a particular aquifer that results in the final vulnerability classification. The methodology behind the classification assumes that where contaminants move through unsaturated fractured bedrock, no attenuation of pollutants can take place. Large parts of Scotland show areas of Classes 4 and 5, reflecting the widespread occurrence of rocks dominated by fracture flow located exposed at the surface where the potential for attenuation of contaminants, from overlying strata, in the pathway is very limited.

13.5.21 The Hydrogeological Map of Scotland, 1:625,000 Series indicated the region to be underlain by low productivity aquifer of the Portpatrick and Glenwhargen Formations with limited groundwater in the near surface weathered zone and secondary fractures.

13.5.22 Within the Wider Study Area, aquifer vulnerability is similar to that underlying the Proposed Development, showing areas of Classes 5 to 4b.

13.5.23 The SEPA River Basin Management Plan (RBMP) map classes the groundwater body underlying the Proposed Development (Galloway, Solway) as having an overall status of 'Good'.

Site Drainage

13.5.24 The majority of the Core Study Area is drained by a series of forestry ditches which run parallel and discharge into the minor watercourses onsite.

13.5.25 Higher ground in the southern section of the Core Study Area drains initially by overland flow and small incised streams. Drainage across the non-forested areas of the Core Study Area is characterised by channels in the peaty soils and very occasional flushes within eroded peat / soil channels.

13.5.26 Peaty deposits may act as a store of water and release rainwater for a considerable time after significant rainfall. Observations made during the site walkover noted that no areas of the Core Study Area site were heavily saturated following the precipitation events preceding and during the site visit. This is due to the gently sloping topography of the Proposed Development and due to the extensive coverage of forestry drainage grips.

13.5.27 There are several anthropologically made drainage ditches (forestry grips) within the central, southeastern sections of the Core Study Area, associated with areas of forestry and relatively flat areas. During site visits, slow moving, or stationary, water was observed in land drainage ditches in the southern section of the Core Study Area, as it appears that they have become partially blocked with peaty soils and flora debris since their creation during the felling of the forest. Between the drainage ditches, water is channelled by the forestry plough furrows, which also hold standing and slow-moving water during wetter periods.

13.5.28 The forestry tracks are drained by minor man made drains which run parallel to the tracks and are linear and stone lined. The stone lined drainage generally discharge into minor tributaries onsite.

13.5.29 Several existing watercourse crossings were observed conveying water under the forestry track network. The majority of the existing crossings were noted as single circular culverts conveying minor forestry drains, while larger watercourses are conveyed by double circular culverts with stone headwalls, as shown in **Plate 13.7**.

Plate 13.6: Existing culverts at the site

Hydrological Regime and Surface Water Morphology

13.5.30 Morphology is typical of upland watercourses, which (as described in paragraphs 13.5.9 to 13.5.14) are generally evenly dispersed through flat boggy ground from their upper reaches, becoming increasingly steep and faster flowing as they progress downstream to the primary rivers.

13.5.31 Site observations from the Core Study Area indicate that morphology is relatively typical of Dendritic drainage network watercourses, which are steeper in their upper reaches and become increasingly flatter as they progress down slope.

Groundwater Dependent Terrestrial Ecosystems (GWDTEs)

13.5.32 An extended Phase 1 habitat survey was carried out during April 2018 and is detailed within Chapter 9, Ecology, and **Appendix 9.1**.

13.5.33 Of the habitats identified, marshy grassland has the potential to support groundwater dependent communities. This habitat was found within forestry rides and in close proximity to watercourses as shown in **Appendix 9.1**.

13.5.34 Superficial deposits are absent across much of the site and the bedrock aquifer is classified as low productivity as outlined in paragraph 13.5.21 and not likely to support groundwater dependent communities.

13.5.35 The occurrence of marshy grassland within forestry rides and in close proximity to surface water suggests this habitat is surface water fed and not groundwater dependent. As such GWDTEs have not been considered further.

Flooding

13.5.36 The Flood Map (2014) produced by SEPA shows the areas of Scotland with a 0.5% (1:200) or greater chance of flooding, identified as medium to high risk areas for flooding. No turbines, transformers, Proposed Development infrastructure, temporary construction compounds or borrow workings are located in areas classed as a medium to high risk for flooding from pluvial, fluvial or groundwater sources.

13.5.37 Minor areas of existing forestry track on the slopes of Marscalloch Hill and Craigengillan Hill are classified as having a medium to high risk of flooding from surface water.

Public and Private Water Supplies

13.5.38 The Private Water Supplies (Scotland) Regulations 2006 and the Water Intended for Human Consumption (Private Supplies) (Scotland) Regulations 2017 define supplies as either:

- Type A - Supplies providing 10 m^3 of water a day or serving 50 or more persons; and supplies to commercial or public activities irrespective of their size; or
- Type B - Supplies serving only domestic premises with less than 50 persons supplied.

13.5.39 Scottish Water confirmed that the Proposed Development lies within a designated Drinking Water Protected Area (DWPA) under the Water Framework Directive.

13.5.40 Carsfad Loch is located on the Water of Ken 5.3 km south of the site. Raw water is pumped from Carsfad Loch to Lochinvar Loch which supplies Lochinvar water treatment works (WTW).

13.5.41 During consultation at the scoping stage, DGC identified 35 abstractions for private water supply within 2 km of the Proposed Development boundary. Properties with potential hydrological connectivity were contacted to ascertain the location of their PWS source, as outlined in Table 13.6. Three PWS were identified to have infrastructure within their catchments as detailed in Table 13.6 Those properties not hydrologically connected to the Proposed Development are also detailed in Table 13.6, however, they havenot been considered further for assessment as they would not receive an effect from the Proposed Development..

Table 13.6: Private Water Supplies

Receptor	Source of Supply	Infrastructure in Catchment	Approximate Distance from Proposed Development Infrastructure	Comments
Properties Contacted to Determine Hydrological Connectivity				
Craigengillan PWS	Groundwater Spring	Yes	500 m	UV filter in use. Approximately 5 m^3 abstracted per day. Turbine 3 within catchment.
Craigengillan Cottage PWS	Well	Yes	500 m	UV filter in use. Turbine 3 within catchment.
1 Muirdochwood Farm PWS	Borehole (150 m depth)	No	550 m	Reported that a borehole also serves the neighbouring property at 2 Muirdochwood Farm.
Smittons PWS	Unknown	Yes	1.3 km	No response received from occupant. Turbines 14 and 17 within catchment.
Furmiston PWS	Borehole (150 m depth)	No	1.3 km	No water treatment in place.
Nether Loskie PWS	Well	No	1.5 km	UV Filter and Paper Filter reported to be in use by the occupant.
Kensglen PWS	Well	No	2.1 km	UV filter and a filter reported to be in use by the occupant.

Receptor	Source of Supply	Infrastructure in Catchment	Approximate Distance from Proposed Development Infrastructure	Comments
Marbrack and Marbrack Cottage PWS	Unknown	No	2.6 km	UV filter and a filter reported to be in use by the occupant. T1 and T4 located within this catchment however due to the distance being greater that 2 km effects from construction are unlikely.
Burnfoot PWS	Borehole (60 m depth)	No	3.6 km	UV Filter in use. T1 and T4 located within this catchment however due to the distance being greater that 2 km effects from construction are unlikely.
Old Burnfoot Cottage PWS	Unknown	No	3.6 km	No response received from occupant. T1 and T4 located within this catchment however due to the distance being greater that 2 km effects from construction are unlikely.
Burniston PWS	Unknown	No	3.6 km	No response received from occupant. T1 and T4 located within this catchment however due to the distance being greater that 2 km effects from construction are unlikely.
Properties within 2 km of Proposed Development without Hydrological Connectivity – Not Contacted				
Bridgemark PWS	Groundwater Spring	No	0.75 km	Hydrologically separated by Water of Ken.
Moorbrook PWS	Surface Watercourse	No	1.5 km	Hydrologically separated by surface

Receptor	Source of Supply	Infrastructure in Catchment	Approximate Distance from Proposed Development Infrastructure	Comments
				watercourses.
College Glen PWS	Groundwater Spring/ Surface Waterr	No	1.5 km	Hydrologically separated by Water of ken.
Knowehead PWS	Groundwater Spring/ Surface Water	No	1.6 km	Not within proposed Development catchment.
Glencairn PWS	Borehole	No	1.6 km	Hydrologically separated by Water of ken.
Shielhill PWS	Groundwater Spring/ Well	No	1.6 km	Hydrologically separated by Water of ken.
Strahanna PWS	Groundwater Spring	No	1.8 km	Not within proposed Development catchment.
River Ken Cottage PWS	Groundwater Spring	No	1.8 km	Not within proposed Development catchment.
Marscalloch Cottage PWS	Groundwater Spring/ Borehole	No	1.8 km	Not within proposed Development catchment.
Stroanfreggan Schoolhouse	Groundwater Spring	No	1.9 km	Not within proposed Development catchment.
Stroanpatrick	Groundwater Spring	No	1.9 km	Not within proposed Development catchment.
The Cottage Glenkens Fish Farm PWS	Borehole	No	1.9 km	Hydrologically separated by Kendoon Loch.
Glenkens Fish Farm PWS	Borehole	No	1.9 km	Hydrologically separated by Kendoon Loch.
Arndarroch Cottage PWS	Borehole	No	2 km	Hydrologically separated by Water of ken.
Arndarroch Farm PWS	Groundwater Spring	No	2 km	Hydrologically separated by Water of ken.
East Arndarroch PWS	Unknown	No	2.2 km	Hydrologically separated by Water of ken.
Carminnows Cottage PWS	Borehole	No	2.4 km	Hydrologically separated by

Receptor	Source of Supply	Infrastructure in Catchment	Approximate Distance from Proposed Development Infrastructure	Comments
				Kendoon Loch.
Carminnows House PWS	Borehole	No	2.4 km	Hydrologically separated by Kendoon Loch.
Culmark PWS	Groundwater Spring	No	2 km	Not within proposed Development catchment.
Auchrae Sauchs PWS	Groundwater Spring/Surface Water	No	2.25 km	Not within proposed Development catchment.
Auchrae Farm PWS	Unknown	No	2.6 km	Not within proposed Development catchment.
Blackmark PWS	Groundwater Spring	No	2.8 km	Not within proposed Development catchment.

Designations and Fisheries

13.5.42 There are no statutory designated sites relating to watercourses within the wider 10 km Study Area, identified through the use of SNH[30] and SEPA[31] GIS datasets, as shown in Table 13.7.

13.5.43 The Dee District Salmon Fisheries Board provided a consultation response requiring fisheries surveys to be carried out at the Proposed Development. Fish surveys are discussed in Chapter 9: Ecology.

Table 13.7: Statutory Designated Sites

Designation	Distance from Proposed Development	Qualifying Interest	Hydrologically Linked to Proposed Development
Cleugh SSSI	4.5 km south	Lowland grassland	No – outwith surface water catchment.
Hannahstown Woods SSSI	8.5 km south west	Lichen assemblages, lowland grassland and woodland	No – outwith surface water catchment.
Water of Ken Woods SSSI	9 km south west	Upland oak woodland, Lichen assemblages	No – outwith surface water catchment.

13.5.44 The hydrological designations are considered to be hydrologically disconnected from the Proposed Development Area (in terms of surface and sub-surface water effects, as development is proposed in areas that are hydrologically down-gradient) or are of sufficient distance to remain unaffected by the Proposed Development.

[30] SNH datasets available at http://gateway.snh.gov.uk/natural-spaces/index.jsp [website address checked 01/03/2018, datasets checked for updates as of 01/03/2018].

[31] SEPA datasets available at https://www.sepa.org.uk/data-visualisation/water-classification-hub/ [website address checked 01/03/2018, datasets checked for updates as of 01/03/2018].

Information Gaps

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

Sensitivity of Receptors

13.5.46 The sensitivities of the identified receptors, and their relationship to the potential effects from the construction of the Proposed Development, are outlined in Table 13.8.

Table 13.8: Sensitivity of Hydrological Receptors

Receptor	Potential Effects	Sensitivity	Comment
Watercourses	Increased run-off, erosion and sedimentation, stream flow impediments and pollution as a result of construction groundworks and chemical handling / storage.	High	Considered High sensitivity as although all classified watercourses have a classification of Poor or Bad, the Proposed Development is located within a DWPA.
Groundwater	Pollution as a result of erosion and sedimentation from construction activities and uncontained spills from chemical handling / storage.	High	Considered High sensitivity as hydrocarbon pollution in bedrock fissures has a lengthy attenuation period. Groundwater vulnerability is classified as 5 to 4b (high). The groundwater body underlying the Proposed Development (Galloway) has a 'Good' overall SEPA classification.
Public Water Supplies	Pollution as a result of erosion and sedimentation from construction activities and uncontained spills from chemical handling / storage.	High	Considered High sensitivity as the Proposed Development is located within the catchment of a Scottish Water DWPA protected under Article 7 of the Water Framework Directive.
PWS	Pollution as a result of erosion and sedimentation from construction activities and uncontained spills from chemical handling / storage.	High	Considered High sensitivity as PWS at Smittons and Craigengillan and Craigengillan cottage supply occupants with potable water.
Near-surface Water	Diversion of near-surface flow as a result of track construction and the installation of turbine foundations	High	Considered High sensitivity as near-surface water supplies flow to the watercourses within the Core Study Area, which in turn discharge into the Water of Deugh and the Water of Ken

Receptor	Potential Effects	Sensitivity	Comment
	/ hardstanding.		which are within the SW DWPA.

13.6 Assessment of Potential Effects

13.6.1 The effect of the Proposed Development on hydrological receptors has been considered for the construction, operation and decommissioning phases of the Proposed Development. 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 Proposed Development being considered to be long term effects.

Potential Construction Effects

13.6.2 The nature and magnitude of effects that could result from construction activities, as described in Chapter 4: Description of the Proposed Development, are assessed in the following paragraphs, which includes:

- The potential upgrade of forestry access tracks for the construction of the Proposed Development;
- New borrow pits for the construction of the Proposed Development. A search area of two locations has been identified; and
- Construction of new access tracks, turbines and associated infrastructure, hardstandings and temporary construction compounds for the Proposed Development.

Chemical Pollution

13.6.3 Potential effects involved with the management of construction are more a risk management issue, with the effects being assessed should the risk be realised. Should the Proposed Development proceed as described in Chapter 4: Project Description *i.e.* with no spills, there would be no effects.

13.6.4 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

13.6.5 Watercourses could be at risk from a pollution incident during construction. All surface watercourses and surface water bodies are considered to be of High sensitivity.

13.6.6 Buffer distances between proposed construction works and watercourses have been maximised to reduce the potential for chemical pollutants to be transferred to the water environment. A 50 m buffer between watercourses and infrastructure (excluding watercourse crossings) has been adopted where possible. It was not possible to locate the construction compound 50 m from the nearest watercourse due to its location at the existing forestry entrance where an unnamed watercourse is crossed by the existing track. The proposed construction compound is located adjacent to the existing track as shown in **Figure 13.2.**

13.6.7 Best practice construction methods as outlined in **Appendix 4.1** including use of impermeable membranes and bunding of the construction compound will safeguard water quality.

13.6.8 Throughout the Site, measures such as absorbent spill pads / kits and other measures highlighted within Sections the outline CEMP found in **Appendix 4.1** will effectively limit the uncontained release of chemicals to minor fugitive releases. These would be minimised through best practice construction methods such as vehicle speed limits and regular vehicle and machine maintenance.

13.6.9 Therefore, effects on these watercourses, of High sensitivity, have the potential to be of negligible magnitude and therefore (in accordance with Table 13.4) of negligible significance. This is not significant in terms of the EIA Regulations.

Groundwater and Near-Surface Water

13.6.10 Pollutants coming into contact with bedrock also have the potential to indirectly alter the quality of the groundwater resource. pH and chemical alterations to groundwater are difficult to rectify due to the fractured nature of the rock and the lengthy attenuation and dispersal of chemicals. As noted previously, due to the underlying hydrogeology consisting of low productivity aquifer with small amounts of groundwater in the near surface weathered zone and secondary fractures, groundwater is unlikely to be present near the surface, meaning there is limited potential for pollutants to come into contact with groundwater.

13.6.11 Measures such as spill pads, impermeable geotextile membranes and measures described within the outline CEMP, **Appendix 4.1**, will effectively limit the uncontained release of chemicals to minor fugitive releases. Therefore, effects on groundwater and near-surface water have the potential to be of negligible magnitude for receptors of High sensitivity and therefore (in accordance with Table 13.4) of negligible significance. This is not significant in terms of the EIA Regulations.

Private Water Supplies

13.6.12 PWS could be at risk from a pollution incident during construction. All PWS within the catchment of Proposed Development infrastructure are considered to be of High sensitivity.

13.6.13 None of the PWS within the catchment of Proposed Development infrastructure, as outlined in Table 13.6, are within 250 m of Proposed Development infrastructure and as such fall out with the recommended buffer to excavations greater than 1 m in depth as detailed in the SEPA guidance on assessing the impact of developments on groundwater abstractions[32]

13.6.14 Measures such as absorbent spill pads / kits and other measures highlighted within Sections the outline CEMP found in **Appendix 4.1** will effectively limit the uncontained release of chemicals to minor fugitive releases. These would

[32] SEPA (2014) 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 2 [Online] Available at: https://www.sepa.org.uk/media/143868/lupsgu31_planning_guidance_on_groundwater_abstractions.pdf (Accessed 08/01/2018)

be minimised through best practice construction methods such as vehicle speed limits and regular vehicle and machine maintenance.

13.6.15 Additionally, the construction compound, where the majority of potential pollutants will be stored, is located greater than 600 m from the sources of the supplies, therefore maximising the potential for attenuation and dilution even in the event of a minor spillage.

13.6.16 Therefore, effects on these PWS, of High sensitivity, have the potential to be of negligible magnitude and therefore (in accordance with Table 13.4) of negligible significance. This is not significant in terms of the EIA Regulations.

Public Water Supplies

13.6.17 The DWPA could be at risk from a pollution incident during construction as the entirety of the Proposed Development is located within this catchment and watercourses flowing from the Proposed Development to the Water of Ken provide hydrological connectivity to the DWPA.

13.6.18 Carsfad Loch is located 5.3 km south of the Proposed Development and Lochinvar Loch is located 5 km east of Carsfad Loch.

13.6.19 Measures described in the paragraphs 13.6.5 to 13.6.15 will safeguard surface water, near-surface and groundwater from chemical pollution and as a result will safeguard the wider DWPA catchment.

13.6.20 Additionally, a programme of water quality monitoring will ensure that any potential pollution incidents are identified and rectified at the earliest opportunity during the construction phase of the Proposed Development.

13.6.21 For these reasons, the magnitude of this effect will be negligible. Given the High sensitivity of public water supplies and negligible magnitude of effects, the significance of effects associated with chemical pollution is assessed as being negligible. This is not significant in terms of the EIA Regulations.

Erosion and Sedimentation

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

Surface Hydrology

13.6.23 Given the overland distance between construction areas and watercourses, any silt or other materials carried by overland flow as a result of construction are likely to be entrained in vegetation and existing drainage ditches (in the absence of intervening good practice measures) before reaching watercourses.

13.6.24 As outlined in Paragraphs 13.6.6 and 13.6.7 it was not possible to site the Proposed Construction compound 50 m from the nearest watercourse. Good practice construction measures will effectively prevent sediment entering the watercourse adjacent to the proposed construction compound.

13.6.25 Measures such as check dams, silt traps, settlement lagoons and buffer strips will minimise sedimentation and erosion; further details of these measures are detailed in the outline CEMP.

13.6.26 Other Sustainable Drainage System (SuDS) measures, such as the use of settlement lagoons, swales and interception bunds, will effectively prevent sediment entering watercourses via drainage ditches adjacent to access tracks. As such, there will be limited potential for sediment or erosion effects on watercourses in the Core Study Area, including the hydrology and water quality of onsite watercourses.

13.6.27 For these reasons, the magnitude of this effect will be negligible. Given the High sensitivity of the watercourses and negligible magnitude of effects, the significance of effects associated with erosion and sedimentation is assessed as being negligible. This is not significant in terms of the EIA Regulations.

Groundwater and Near Surface Water

13.6.28 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 impact on groundwater quality within bedrock deposits / fissures.

13.6.29 Measures described in **Appendix 4.1**, such as impermeable ground membrane layers and bunded areas, will effectively prevent sediment entering sub-surface water in superficial deposits (and groundwater) and peat. For these reasons, the magnitude of this effect will be negligible. Given the High sensitivity of near-surface water and High sensitivity of groundwater and negligible magnitude of effect, the significance of the effect associated with erosion and sedimentation is considered to be negligible. This is not significant in terms of the EIA Regulations.

Private Water Supplies

13.6.30 The quality of PWS could be affected by sediment mobilisation. All PWS within the catchment of Proposed Development infrastructure are considered to be of High sensitivity.

13.6.31 Measures detailed in the outline CEMP and in paragraphs 13.6.25 and 13.6.26 combined with monitoring as detailed in the outline CEMP will limit the potential for the mobilisation of sediment.

13.6.32 Therefore, effects on these PWS, of High sensitivity, have the potential to be of negligible magnitude and therefore (in accordance with Table 13.4.) of negligible significance. This is not significant in terms of the EIA Regulations.

Public Water Supplies

13.6.33 Public water supply treatment works could be affected by sediment mobilisation and increased organic content in water supplying Lochinvar WTW.

13.6.34 Measures described in paragraphs 13.6.25 to 13.6.31 will safeguard watercourses within the Core Study Area and as a result the wider DWPA catchment.

13.6.35 Therefore, effects on public water supplies, of High sensitivity have the potential to be of negligible magnitude and therefore of negligible significance. This is not significant in terms of the EIA Regulations.

Impediments to Flow

13.6.36 The access tracks will require the installation of nine watercourse crossings across all sections of the Proposed Development. The Proposed Development has been designed, as detailed in Chapter 4 Description of the Proposed Development, to minimise the number of watercourse crossings. The upgrade of the existing forestry access track, which serve the slopes of Marscalloch Hill and Craigengillan Hill will allow existing watercourse crossings to be retained or upgraded where possible.

13.6.37 The minimisation of the number of proposed watercourse crossings and the re-use of the existing watercourse crossing locations reduces one of the main activities that could give rise to impediment of flows. The indicative culvert design is outlined in Chapter 4, Description of the Proposed Development, detailed design will be carried out at the construction phase and will be agreed with SEPA.

13.6.38 In addition to watercourse crossings, felling of trees can increase surface water run-off and cause impediments to river flow through accumulation and transfer of brash. Brash build up within watercourses has the potential to impede the passage of waterborne ecology and divert / concentrate flow to river banks. In the long-term, however, it is generally accepted that, the removal of plantation forestry in proximity to watercourses can improve surface water conditions due to increased growth of bankside vegetation, improved ground level lighting and reduced potential for the introduction of impediments to flow.

13.6.39 Measures described in the outline CEMP, such as brash matting, not stockpiling brash and not allowing brash to block drainage ditches or enter watercourses, verified by visual inspections, further reduce the potential for this effect to occur.

13.6.40 Therefore, the effects on watercourses of High sensitivity are considered to be of negligible magnitude and, therefore of negligible significance. This is not significant in terms of the EIA Regulations.

Changes in Groundwater Interflow Patterns

Groundwater and Near Surface Water

13.6.41 Some 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. Localised temporary changes to groundwater and near surface water interflow patterns may therefore arise. Turbine foundations and crane hardstandings also have the potential to change sub-surface water flow by creating physical barriers within naturally occurring drainage macropores in superficial deposits.

13.6.42 No substantial impediments to near-surface water flow will be created as the detailed site drainage design will take into account any severance of saturated areas to ensure hydrological connectivity is maintained, in accordance with SEPA / SNH 'Good practice during wind farm construction'.

13.6.43 Consequently, effects on Groundwater and Near Surface Water (High sensitivity receptors) are considered to be of negligible magnitude and

therefore negligible significance. This is not significant in terms of the EIA Regulations.

Private Water Supplies

13.6.44 The quantity of PWS could be affected by changes in groundwater interflow patterns as a result of de-watering or the impact of turbine foundations and hardstandings on subsurface flow. Craigengillan and Craigengillan Cottage PWS are supplied by groundwater, the source of Smittons PWS is unknown however it is considered likely to have a groundwater source. All PWS within the catchment of Proposed Development infrastructure are considered to be High sensitivity.

13.6.45 No PWS are within the SEPA LUPSGU31 100 m and 250 m buffer zones of infrastructure that may require dewatering. Should dewatering be required measures detailed in the outline CEMP will maintain groundwater flow paths.

13.6.46 Therefore, effects on these PWS, of High sensitivity, have the potential to be of negligible magnitude and therefore (in accordance with Table 13.4) of negligible significance. This is not significant in terms of the EIA Regulations.

Acidification of Watercourses

13.6.47 Felling of forestry and the storage of brash could potentially result in a short-term increase in the acidity of watercourses within the immediate catchment of forested areas and have an effect on water quality and ecology. This can result from two possible processes:

- Nitrate leaching of stockpiled brash, if stored close to watercourses; and
- Disturbance of the ground due to felling activities very close to watercourses could lead to flushing of acid from groundwater, if measures to prevent run-off from entering the watercourses directly are not achieved.

13.6.48 Felling will also involve the movement of heavy machinery across a soft ground surface, and hence will lead to soil disturbance which could have the potential to lead to acidification and sedimentation.

13.6.49 Forestry good practice measures are set out in the **Appendix 4.1**, including specific measures for felling and for forestry activities within 50 m of a watercourse. These measures will be implemented and maintained, and this will be carried out during the construction phase under supervision of an ECoW, whose role is described in **Appendix 4.1**.

13.6.50 The adoption of these measures would mean that the magnitude and significance of resulting effects would be negligible. This is not significant in terms of the EIA regulations.

Increase in Runoff and Flood Risk

Increase in Runoff

13.6.51 The increase in hardstanding area associated with construction and operation of the Proposed 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 hardstandings, would be permeable to some extent. The impermeable nature of the thin soils onsite

and the underlying geology, however, means that, in the baseline scenario, there will be relatively low infiltration and relatively high run-off rates, and hence the addition of the Proposed Development would have minimal effect on the existing run-off scenario.

13.6.52 Measures, including SuDS measures, to attenuate run-off and intercept sediment prior to run-off entering watercourses are described in Section 2 of **Appendix 4.1** and form a part of the Proposed Development.

13.6.53 The Forests and Water Guidelines document reports that, due to rainfall interception losses:

13.6.54 "Research suggests there may be a 1.5-2.0% reduction of potential water yield [watercourse flow] for every 10% of a catchment under mature conifer forest".

13.6.55 It is assumed, therefore, that felling of mature forest may result in an average increase in water yield of up to 1.5 to 2 % for every 10 % of the catchment area that is subject to felling. It should be noted that, as interception loss has limited effect during the latter stages of periods of heavy rain, when the trees surfaces are saturated, this is likely to have a potential effect on average run-off, but not flood risk. As set out in Chapter 7; Forestry, the existing Wind Farm Felling Plan states that 32% of the area of mature forest is to be felled within the 2019 - 2023 timeframe. This coincides with the predicted start of the wind farm construction (currently programmed for 2021). Several forest 'coupes' which are identified as containing wind farm infrastructure are to be keyhole felled. As such, the Proposed Development will not lead to a net increase in forestry felling compared to the existing Forest Management Plan.

13.6.56 The large majority of areas of relatively mature trees that will be felled will be subsequently replanted. The majority of any effect that proposed felling will have on water yield is therefore temporary, and would reduce with time as the planted trees grow. As a worst-case approach, potential increases have been assessed by considering all felling proposed during the construction period, and by assessing these initially as mature trees.

13.6.57 This will result in a maximum potential increase in average water yield of 6.4% for the primary catchments in which the Proposed Development is located. This is a worst case, and effects during prolonged heavy rain would be less than during average rainfall, because the proportion of rainfall intercepted and the attenuating effects of bog vegetation would be less during prolonged heavy rain. Consequently, the magnitude of the effect of felling on watercourse flow would be negligible.

13.6.58 For these reasons, the effect on watercourses of High sensitivity are considered to be of negligible magnitude and therefore negligible significance. This is not significant in terms of the EIA Regulations.

Flood Risk

13.6.59 No construction compounds, substations or meteorological masts are located within areas described as having a 0.5 % or greater annual risk of flooding. However, turbines 3 and 5 are located in close proximity to areas described as having a 0.5 % or greater annual risk of flooding from surface water.

13.6.60 The design of the Proposed Development layout has incorporated a buffer zone between watercourses and turbine bases of 50 m to watercourses, meaning any overtopping of minor watercourses is unlikely to reach infrastructure.

13.6.61 Minor areas of the existing access tracks are within areas described as having a 0.5 % or greater annual risk of flooding from pluvial sources.

13.6.62 As the existing tracks will be retained, and pluvial flooding appears to be isolated to minor areas onsite in the vicinity of existing tracks, it is unlikely that pluvial flood water would be displaced by the Proposed Development.

13.6.63 As such, the Proposed Development is not considered to be at risk of flooding and is unlikely to contribute to the displacement of pluvial flood water.

Potential Operational Effects

13.6.64 Potential effects associated with the operation of the Proposed Development are:

- increased run-off rates and volume;
- continued erosion and sedimentation from runoff from areas of hardstanding;
- alterations to natural flow pathways from runoff from areas of hardstanding; and
- a risk of a pollution event from minor spills from maintenance vehicles.

13.6.65 The nature of these effects has been discussed in relation to the construction phase. As there would be substantially less activity during operation, and as there is unlikely to be any significant ground disturbance during operation, the magnitude of these effects is similarly reduced.

13.6.66 There will be a minor reduction in the potential for increased surface water run-off during the operational phase due to the reduction in hardstanding areas used during the construction phase, such as the removal of the construction compounds.

13.6.67 Whilst alterations to natural flow pathways will not be introduced during the operational phase, any changes during construction will continue through operation, as the majority of infrastructure will remain in place. Alterations to natural flow pathways will be reduced through adopting good practice design and construction, as set out in the outline CEMP, such as cross drainage, use of shallow drainage ditches and prevention of blockages.

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

Potential Decommissioning Effects

13.6.69 Potential effects of decommissioning the Proposed Development are similar in nature to those during construction, as some ground-work would be required to remove turbine foundations and hardstandings to 1 m below ground level. These effects would be substantially lesser in magnitude than during construction, and would be controlled by a pollution prevention plan (PPP) which would be incorporated into a full CEMP. Where infrastructure would be left in place, drainage features would also be left in place, where this is compatible with the PPP.

13.6.70 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.

13.7 Mitigation and Residual Effects

13.7.1 Embedded mitigation measures and construction good practice measures are included in **Appendix 4.1**. The embedded mitigation and construction good practice measures are based on experience of providing detailed site design for several wind farm developments across Scotland, in consultation with SEPA.

13.7.2 With the embedded mitigation measures described in **Appendix 4.1**, all identified potential effects have been assessed as being of negligible significance. The embedded mitigation measures proposed are established measures that are widely used in construction projects and which Infinergy and its contractors are well used to undertaking. Given the levels of certainty in the success of application of the mitigation measures and their effectiveness it is appropriate that the mitigation measures are taken into account and assumed to be fully effective in the determination of this application.

13.7.3 No residual effects are predicted for all phases of Proposed Development, and are therefore not significant in terms of the EIA Regulations.

13.8 Assessment of Cumulative Effects

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

13.8.2 A cumulative effect is considered to be an additional effect on hydrological resources (within the same hydrological catchment) arising from the Proposed 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 Proposed Development have been considered.

<u>Cumulative Developments within 10 km (consented or under construction)</u>

13.8.3 The following cumulative developments have been identified within 10 km of the Proposed Development:

- Windy Rig Wind Farm (consented in principle) 200 m east of the Development. Located within Development catchments of the Polliferrie Burn and Poldores Burns as sown in **Figure 13.2**, and is within the overall catchment of the Water of Ken.
- Afton Wind Farm (under Construction) 6 km north of the Proposed Development. Located in a separate surface water catchment however is partially within the overall catchment of the Water of Ken (2 turbines within Water of Ken catchment).
- South Kyle Wind Farm (consented) 9 km northwest of the Proposed Development. No construction program available. Located within a

separate surface water catchment, however is within the overall catchment of the Water of Ken.

- Benbrack Wind Farm (consented) 9 km northwest of the Proposed Development. No construction program available. Located within a separate surface water catchment, however is within the overall catchment of the Water of Ken.
- Knockman Hill Wind Farm (consented) 9 km southeast of the Proposed Development. No construction program available. Located within a separate surface water catchment, however is within the overall catchment of the Water of Ken.

13.8.4 Operational wind farms (Windy Standard I & II and Wether Hill) are considered to form part of the baseline for the purposes of cumulative assessment.

Predicted Cumulative Effects

13.8.5 The greatest potential for cumulative effects arises when the construction phase of another development overlaps with the construction phase of the Proposed 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.).

13.8.6 Assuming commencement of the construction of the Proposed Development in 2021, lasting for approximately 18 months, it is possible construction will coincide with the construction phase of Windy Rig, South Kyle, Benbrack of Knockman Hill Wind Farms as these have been consented however no construction program is publicly available. Therefore there is the potential for cumulative effects between these developments.

13.8.7 Construction of Afton Wind Farm is nearing completion and will be operational by 2021 and is unlikely overlap with the Proposed Development.

13.8.8 Given the respective locations of South Kyle, Benbrack and Knockman Hill Wind Farms, near the edge of the 10 km cumulative study area, within the overall catchment of the Water of Ken, cumulative effects are unlikely to occur due to the high potential for dilution and attenuation within the water environment. Additionally, it is unlikely that a sedimentation or chemical pollution event would occur at more than one cumulative wind farm site at the same time.

13.8.9 Windy Rig Wind Farm is located within the same hydrological catchment as the Development. Construction of the proposed Development and Windy Rig Wind Farm has the potential to cumulatively affect the Water of Ken, as the potential exists for erosion and sedimentation and increased run-off.

13.8.10 Implementation of the measures detailed in the outline CEMP, provided as **Appendix 4.1**, mean that the magnitude of any potential effects from the Proposed Development have been assessed as negligible as detailed in paragraphs 13.6.1 to 13.7.3 of this Chapter. Furthermore it is assumed that cumulative developments, will implement similar measures as required by

SEPA, while the EIA Report for Windy Rig Wind Farm makes specific reference and a commitment to construction good practice[33].

13.8.11 It is anticipated that there will be a minor reduction in the potential for increase in run-off rates during the operational phase of the identified wind farm developments, when compared to the construction phase, due to the reduction in overall hardstanding areas post-construction. Therefore, the magnitude of cumulative effects during the operational phase will be negligible, and the significance of these effects will also be negligible, being not significant in terms of the EIA Regulations.

13.8.12 Effects during the decommissioning phase are likely to be the same as during the construction phase.

13.8.13 Given the reasons outlined, the magnitude of cumulative impacts during the construction, operational and decommissioning phases will be negligible and therefore, of negligible significance. This is not significant in terms of the EIA Regulations.

Residual Cumulative Effects

13.8.14 No significant residual cumulative effects are predicted.

13.9 Summary of Effects

13.9.1 This Chapter identified no likely significant effects, through inclusion of the measures outlined in **Appendix 4.1** in the design of the Proposed Development.

[33] Windy Rig Wind Farm Environmental Statement Volume 2 Report (Atmos May 2015). [Online] Available at: https://eaccess.dumgal.gov.uk/online-applications/files/E1612A943233FA9CC909B6C295DA2A52/pdf/15_P_2_0155-ES_Vol_2_-_Report_Text-487150.pdf (Accessed 24/08/2018)

Table 13.9: Summary of Effects

Receptor	Potential Effect	Significance of Effect	Mitigation Proposed	Residual Significance
Construction				
Watercourses, Groundwater, Near-surface water, PWS and Public Water Supplies	Chemical Pollution	Negligible	None	Negligible
Watercourses, Groundwater, Near-surface water, PWS and Public Water Supplies	Erosion and Sedimentation	Negligible	None	Negligible
Watercourses	Impediments to Flow	Negligible	None	Negligible
Watercourses	Acidification as a result of felling	Negligible	None	Negligible
Groundwater, Near-surface water and PWS	Changes in Groundwater Interflow Patterns	Negligible	None	Negligible
Watercourses	Increase in Run-off and Flood Risk	Negligible	None	Negligible
Operation				
Watercourses	Increase in Run-off and Flood Risk	Negligible	None	Negligible
Watercourses, Groundwater , PWS and Near-surface water	Erosion and Sedimentation	Negligible	None	Negligible
Groundwater, Near-surface water and PWS	Changes in Groundwater Interflow Patterns	Negligible	None	Negligible
Watercourses, Groundwater, PWS and Near-surface water	Risk of a Pollution Event from Minor Spills from Maintenance Vehicles	Negligible	None	Negligible
Decommissioning				
Watercourses, Groundwater, PWS and Near-	Chemical Pollution	Negligible	None	Negligible

Receptor	Potential Effect	Significance of Effect	Mitigation Proposed	Residual Significance
surface water				
Watercourses, Groundwater, PWS and Near-surface water	Erosion and Sedimentation	Negligible	None	Negligible
Groundwater, Near-surface water and PWS	Changes in Groundwater Interflow Patterns	Negligible	None	Negligible

13.10 Statement of Significance

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

13.10.2 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.