15 Hydrology and Hydrogeology

15.1 Introduction

15.1.1 Since the submission of the previous application for Beaw Field, there have been no changes to the hydrology and hydrogeology baseline and given that the infrastructure of the Consented Development is not changing, there would be no hydrology effects. The findings of the previous hydrology and hydrogeology assessment therefore remain valid, and the previous hydrology and hydrogeology chapter is set out in full below, with a brief update included in relation to planning policy.

15.1.2 This chapter provides an assessment of the potential impact of the Consented Development on the water resources of the Site and has been undertaken by Wardell Armstrong. A qualitative impact assessment has been undertaken using a combination of professional judgement, legislation and other statutory policy and guidance. The assessment focuses on potential impacts on the water environment, which may change the hydrological and hydrogeological regime or cause pollution and degradation in water quality. **Error! Reference source not found.** considers the potential flood risk to the Site and the potential risk of the Consented Development to contribute to offsite flood risk. Chapter 11: Ecology includes an assessment of GWDTEs, onsite soils and peat are assessed in Chapter 12: Soils and Peat and further details of the geology underlying the Site is contained in Chapter 13: Geology of this EIAR.

15.2 Legislative framework

15.2.1 The assessment has taken into account the requirements of the Water Framework Directive (WFD) (2000/60/EC), which was transposed into Scottish law as the Water Environment and Water Services (Scotland) Act 2003 (the "WEWS Act"). The WEWS Act is supported by the Water Environment (Controlled Activities) (Scotland) Regulations 2011 – more commonly referred to as the Controlled Activity Regulations (CAR).

15.2.2 The controlled activities are defined within the WEWS Act 2003 and are modified by CAR. Those activities relevant to this assessment are:

- engineering activities in the vicinity of rivers, lochs and wetland which are likely to have a significant adverse impact upon the water environment;
- activities liable to cause pollution; and
- any other activities which directly or indirectly is liable to cause a significant adverse impact upon the water environment.

15.2.3 Scottish Planning Policy (SPP) June 2014 provides further guidance on the requirement to protect aspects of the environment and at paragraph 194 states that the planning system should '*promote protection and improvement of the water environment, including rivers, lochs, estuaries, wetlands, coastal waters and groundwater, in a sustainable and co-ordinated way*'. This is reinforced by advice given in paragraph 202 '*The siting and design of development should take account of local landscape character. Development management decisions should take account of potential effects on landscapes and the natural and water environment, including cumulative effects. Developers should seek to minimise adverse impacts through careful planning and design, considering the services that the natural environment is providing and maximising the potential for enhancement.*'

15.2.4 National Planning Framework 3 also recognises the importance of the water environment at paragraph 4.11 '*Climate change means that sustainable management of the water environment is not just a national opportunity, but a global issue.*'

15.2.5 Draft National Planning Framework 4 is under preparation and will include all aspects of national planning policy as per the provisions of the Planning (Scotland) Act 2019. Draft NPF4 requires that development proposals for renewable energy developments must take into account effects on hydrology, the water environment and flood risk.

15.2.6 A more comprehensive list of relevant planning policies is provided at Chapter 4. In addition to the above, the following were also considered:

- The Groundwater Daughter Directive (2006/118/EC);
- The Priority Substances Directive (2008/105/EC);
- Water Environment and Water Services (Scotland) Act 2003;
- The Water Environment (Controlled Activities) (Scotland) Regulations 2011;
- The Water Environment (Drinking Water Protected Areas) (Scotland) Order 2013; and
- Flood Risk Management (Scotland) Act 2009.

The Water Framework Directive (2000/60/EC)

15.2.7 Directive 2000/60/EC of the European Parliament and Council established a framework for community action in the field of water policy. It is also known as the Water Framework Directive (WFD) and came into force on the 22nd December 2000. The WFD requires member states to aim to reach good chemical and ecological status in inland and coastal waters. The WFD is designed to enhance the status and prevent further deterioration of aquatic ecosystems and associated wetlands, to promote sustainable water use, to reduce pollution of water and to ensure progressive reduction of groundwater pollution. The WFD established a strategic framework for managing the water environment and requires a management plan for each river basin to be developed every six years. In cases where good status/potential cannot be achieved by 2015, a provision is given under Article 4.4 of the WFD extending the deadline to 2021 or 2027. The date has been extended to 2027 in respect of a large number of waterbodies. Within Scotland, the competent authority for delivering the Directive is the Scottish Environment Protection Agency (SEPA).

The Groundwater Daughter Directive (2006/118/EC)

15.2.8 Directive 2006/118/EC of the European Parliament and Council of 12th December 2006 on the protection of groundwater against pollution and deterioration (Daughter to 2000/60/EC), also known as the Groundwater Daughter Directive (2006/118/EEC) was developed in response to the requirements of Article 17 of the WFD (2000/60/EC). The Groundwater Daughter Directive specifies measures to prevent and control groundwater pollution such as providing criteria for the assessment of good groundwater chemical status and provides criteria for the identification and reversal of significant and sustained upward trends and for defining a baseline status.

The Priority Substances Directive (2008/105/EC)

15.2.9 Directive 2008/105/EC of the European Parliament and Council of 16th December 2008 on environmental quality standards in the field of water policy, amended and subsequently repealed

Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 86/280/EEC and amended Directive 2000/60/EC of the European Parliament and Council. It is also known as the Priority Substances Directive (2008/105/EC) and was developed in response to the requirements of Article 16 of the WFD (2000/60/EC). The Priority Substances Directive requires the identification of priority substances to set Environmental Quality Standards (EQSs) for the concentrations of the priority substances in surface waterbodies and to review periodically the list of priority substances.

Water Environment and Water Services (Scotland) Act 2003

15.2.10 The WFD (2000/60/EC) is transposed into Scottish law by the Water Environment and Water Services (Scotland) Act 2003 (WEWS 2003). The WEWS Act 2003 aims to protect the water environment and to establish a community action in the field of water policy. Protection of the water environment relates to prevention of further deterioration and enhancing the status of aquatic ecosystems, promoting sustainable water use, reduction in pollution of groundwater, and contributing to mitigating the effects of floods and droughts. The WEWS Act 2003 also established river basin management planning. Under river basin management plans, key water bodies in each catchment are monitored and their baseline status recorded. These water bodies are also assigned a target status and the progress to meeting these target statuses is reviewed.

The Water Environment (Controlled Activities) (Scotland) Regulations 2011

15.2.11 The Water Environment (Controlled Activities) (Scotland) Regulations 2011, commonly known as Controlled Activities Regulations (CAR), requires activities that may affect the water environment to be authorised by SEPA. This includes discharges, disposal to land, abstractions, impoundments and engineering works. In 2013, changes were made to CAR (2011) under the Water Environment (Controlled Activities) (Scotland) Amendment Regulations 2013.

The Water Environment (Drinking Water Protected Areas) (Scotland) Order 2013

15.2.12 The Water Environment (Drinking Water Protected Areas) (Scotland) Order 2013 (WEDWPA Order 2013) came into force on 11th March 2013 and identified water bodies used for the abstraction of drinking water as required by section 6(1) of the Water Environment and Water Services (Scotland) Act 2003. By doing so it identified Drinking Water Protection Areas (DWPAs), which include surface water and groundwater water bodies. The WEDWPA Order 2013 revoked the Water Environment (Drinking Water Protected Areas) (Scotland) Order 2007.

Flood Risk Management (Scotland) Act 2009

15.2.13 Flood Risk Management (Scotland) Act 2009 (FRM Act 2009) was enacted on 16th June 2009, repealing the Flood Prevention (Scotland) Act 1961. The FRM Act 2009 includes measures for a framework for co-ordination and co-operation between organisations involved in flood management and details additional responsibilities for the Scottish Environment Protection Agency (SEPA), Scottish Water and Local Authorities in relation to flood management. The FRM Act 2009 also required SEPA to provide an assessment of flood risk and measures to assist in the preparation of flood risk management plans.

15.3 Methodology

Study area

15.3.1 The baseline study comprised two components: a desk based study and a field survey. The desk based study examined the wider catchment surroundings of the Site, as shown on **Error! Reference source not found.**, i.e. layout, scale and presence of water related infrastructure, water management and water sensitive ecological areas. A field survey of the watercourses within and adjacent to the Site was undertaken in June/July 2015. The field survey consisted of a walkover inspection focusing on geomorphological (landscape) and hydrological features i.e., catchments and their boundaries, watercourses and waterbodies, evidence of fluvial (river) processes (erosion and deposition) and topography.

Desk study

15.3.2 The following sources of information were used to determine the impact of the Consented Development on the water environment:

- British Geological Survey topographic, geology and hydrogeology maps;
- British Geological Survey Groundwater Vulnerability (Scotland) map, Version 2;
- Scottish Environment Protection Agency (SEPA)'s flood maps;
- Preliminary consultations with statutory bodies including SEPA, Scottish Water (SW) and Shetland Island Council (SIC);
- Data requested from SEPA and SIC, including information on Private Water Supplies and abstractions and discharges; and
- SEPA's River Basin Management Plans.

Field survey

15.3.3 The field survey consisted of:

- Identification of constraints on waterbodies and watercourses within and adjacent to the Site, such as discharges and water uses;
- Measurements of onsite hydrological features, such as channel width, bank height and depth of water;
- Review of surface drainage network on and adjacent to the Site; and
- A photographic record of the hydrological features observed.

Impact assessment methodology

Sensitivity

15.3.4 The sensitivity of receptors to hydrological and hydrogeological impacts has been determined by reference to Table 15.1, which documents a hierarchy of factors relating to the water environment. Examples of the environmental criteria contained within Table 15.1 include international and national designations; the WFD status of watercourses and waterbodies; and work undertaken by SEPA, along with the professional judgement of the assessment team. When a receptor meets multiple criteria or

there is an absence of verified published data, the highest applicable sensitivity category is assigned to allow an assessment of the worst-case scenario.

Table 15.1: Sensitivity classification

Sensitivity category	***Sensitivity criteria examples***
Very high	Natura 2000 sites; Special Protected Area (SPA) and Special Areas of Conservation (SAC), Ramsar sites, where hydrology is a key factor in designation. Protected water-sensitive species (e.g. otter, water vole) are present. Salmonid, Cyprinid and/or Shellfish Waters. Commercial fishery including salmon pens. Groundwater Dependent Terrestrial Ecosystems (GWDTE). Bathing waters, Surface Water Drinking Water Protected Areas and/or Safeguard Zones and/or Urban Waste Water Treatment Directive Areas. Public or private surface water abstractions and water supplies. WFD overall status of High. Groundwater Vulnerability: Class 5. Groundwater Drinking Water Protected Areas and/or groundwater safeguard zones. Public or private groundwater abstractions and water supplies. WFD overall status of High. Peat deposits >3m in depth.
High	Sites of Special Scientific Interest (SSSI), National Nature Reserves (NNR) and Local Nature Reserves (LNR) where hydrology is a key factor in designation. WFD overall status of Good. Groundwater Drinking Water Protected Areas and/or Groundwater Safeguard Zones. WFD overall status of Good. Groundwater Vulnerability: Class 4a and 4b. Highly productive aquifers. Peat deposits of 1-3 m in depth.
Medium	Site of Nature Conservation Interest (SNCI) or Local Wildlife site where hydrology is a key factor in designation. Sites owned by conservation organisations such as the National Trust, Royal Society for the Protection of Birds (RSPB), Woodland Trust, Wildlife Trusts where hydrology is a key factor in designation. Watercourses and waterbodies with no designations. Nitrate Vulnerable Zones (NVZ) (surface water or eutrophic). WFD overall status of Moderate. Groundwater Vulnerability: Class 2-3. Moderately productive aquifers. Nitrate Vulnerable Zones (groundwater). WFD overall status of Moderate.
Low	WFD overall status of Poor. Groundwater Vulnerability: Class 1. Low productivity aquifers. WFD overall status of Poor. Moderately well drained silty soils. Discharge consents.
Negligible	No aquatic habitats or watercourses present or shallow, low organic matter soils, bare rock or rocks with essentially no groundwater or surface water and groundwater quality: WFD overall status of Bad.

Magnitude of Change

15.3.5 Table 15.2 describes the guideline criteria used to assess the magnitude of change from the baseline condition that may occur due to the Consented Development.

Table 15.2: Guideline Criteria to Determine Magnitude of Change

Magnitude of Change from Baseline Condition	***Guideline Criteria***
High	Total loss of, or alteration to, the baseline resource such that post- development characteristics or quality would be fundamentally and irreversibly changed.
Medium	Loss of, or alteration to, the baseline resource such that post-development characteristics or quality would be partially changed.
Low	Small changes to the baseline resource, which are detectable but the underlying characteristics or quality of the baseline situation would be similar to pre-development conditions.
Negligible	A very slight change to the baseline conditions, which is barely distinguishable, and approximates to the 'no change' situation.

Scale of impact

15.3.6 The scale of impact is determined in relation to the sensitivity of the receptor and the magnitude of change from baseline conditions, using the matrix shown in Table 15.3. Impacts are beneficial, adverse (minor, moderate or major), or negligible.

Table 15.3: Matrix for determining scale of impact

Magnitude of change from baseline condition	***Sensitivity***				
	Very high	***High***	***Medium***	***Low***	***Negligible***
High	Major	Major	Major	Moderate	Minor
Medium	Major	Major	Moderate	Minor	Minor
Low	Moderate	Moderate	Minor	Minor	Negligible
Negligible	Minor	Minor	Minor	Negligible	Negligible

Assessment of cumulative impacts

15.3.7 The assessment of cumulative impacts on the water environment considers the combined potential impact of other developments, with the potential to impact the water environment, within the same catchment(s) as the Consented Development. This included consideration of other developments currently in the planning process and within the same catchment(s) as the Consented Development. Table 15.1 to Table 15.3 are used to determine the scale of cumulative impacts.

Statement of significance

15.3.8 Guideline criteria for categories of significant effect are included in Table 15.4. Impacts and cumulative impacts that have been determined to be major or moderate are considered to have a significant effect and require specific mitigation in addition to good design and measures in the Outline Construction Environment Management Plan (OCEMP) to address them. Impacts that are identified as minor or negligible are not considered to have a significant effect and no further mitigation is required.

Table 15.4: Guideline criteria for categories of significant effect

Scale of Impact	***Definition***	***Guideline Criteria***
Major	A fundamental change to the environment	Changes in water quality or quantity affecting widespread catchment or groundwater reverses of strategic significance or changes resulting in substantial loss of conversation value to aquatic habitats and designations.
Moderate	A large, but non-fundamental change to the environment	Changes in water quality or quantity affecting part of a catchment or groundwaters of moderate vulnerability, or changes resulting in loss of conservation value to aquatic habitats or designated areas.
Minor	A small but detectable change to the environment	Localised changes in drainage patterns or groundwater flow, or changes resulting in minor and reversible impacts on surface and groundwater quality or aquatic habitats.
Negligible	No detectable change to the environment	No impact on drainage patterns, surface and groundwater quality or aquatic habitat.

15.4 Consultation

15.4.1 The Applicant submitted an EIA Scoping Request to Scottish Ministers in April 2015 and a Scoping Opinion was subsequently issued in May 2015. The Scoping Opinion from Shetland Island Council (SIC) (17th April 2015), Scottish Environment Protection Agency (SEPA) (8th May 2015) and Scottish Water (8th May 2015), identified areas concerning hydrology and hydrogeology for discussion and/or consideration within the EIAR. Their comments are summarised below.

- SIC requested that the EIAR should demonstrate that the water quality should be safeguarded during all phases of the Consented Development. The mitigation section of Chapter 15 discuses pollution prevention and sediment management measures that are likely to be incorporated within the Consented Development. The Consented Development would be constructed in accordance with industry best practise.
- SIC and SEPA requested that a 1 in 200 year rainfall event flood risk scenario is considered. **Error! Reference source not found.** considers the flood risk from and to the Consented Development. All watercourse crossings have been designed to accommodate a 1 in 200 year flood event.
- SEPA requested that all groundwater abstractions are identified within 250m of excavations of deeper than 1m and within 100m of excavations of less than 1m deep. A data request to SIC confirmed that there are no groundwater abstractions within the requested search radii.

- SEPA requested a table which details the justification for engineering activities in the water environment and how any adverse impact will be mitigated. The table should be accompanied by a photograph of each affected water body along with its dimensions. Appendix 3.1 provides the information requested by SEPA.
- SEPA requested details of any proposed abstractions. The Consented Development does not include any abstractions.
- Scottish Water suggested that the EIAR should provide detailed information on Scottish Water assets. Scottish Water asset plans were obtained and a water main was identified within the Site. The Consented Development (access tracks) were located outwith Scottish Water's specified avoidance buffer from their assets to prevent damage.

15.5 Baseline

15.5.1 This section addresses the hydrological and hydrogeological baseline condition of the Site and the surrounding area based on desk and field studies undertaken. **Error! Reference source not found.** and **Error! Reference source not found.** show the surface water features on and offsite in relation to the Site layout and the catchments that are within the Site. Appendix 11.2 identifies the location of likely Groundwater Dependant Terrestrial Ecosystems (GWDTE) in relation to the Consented Development. The Site is described in Chapter 2: Site Description and shown in Figure 1.2.

Topography

15.5.2 The Site is characterised by undulating hilly terrain. The topography ranges from approximately 200m Above Ordnance Datum (AOD) at the Hill of Arisdale in the north, to less than 10mAOD in the south, however, the majority of the Site lies between 80 to 150mAOD, with the summit of Beaw Field at 120mAOD (see Figure 1.2). The majority of the Site is heather moorland, which has been heavily grazed to habitats that are characterised by degraded blanket bog habitat and moorland pastures. In-bye crofting land is typically found on lower lying land close to settlements.

Rainfall

15.5.3 Average monthly rainfall data for the standard period 1981 to 2010 has been obtained from Meteorological Office stations at Baltasound[1] on Unst, which is approximately 28km northeast of the Site and Lerwick[2], which is approximately 42km south of the Site. The data is presented in Table 15.5.

15.5.4 The UK Climate Projection (2009)[3] has predicted a +/-10% change in rainfall for low, medium and high emissions scenarios for the periods 2010 to 2039 and 2012 to 2049. Table 15.5 identifies the indicative estimated rainfall values as a result of climate change.

Table 15.5: Average rainfall for Baltasound (Unst) and Lerwick for the period 1981 to 2010

Month	*Baltasound average rainfall (mm)[1]*	*Baltasound predicted -10% change in rainfall due to climate change (mm)*	*Baltasound predicted +10% change in rainfall due to climate change (mm)*	*Lerwick average rainfall (mm)[2]*	*Lerwick predicted -10% change in rainfall due to climate change (mm)*	*Lerwick predicted +10% change in rainfall due to climate change (mm)*
January	123.0	110.7	135.3	142.6	128.3	156.9
February	95.7	86.1	105.3	120.8	108.7	132.9
March	107.4	96.7	118.1	124.6	112.1	137.1
April	64.7	58.2	71.2	70.4	63.4	77.4
May	52.3	47.1	57.5	53.4	48.1	58.7
June	56.6	50.9	62.3	58.2	52.4	64.0
July	59.9	53.9	65.9	66.8	60.1	73.5
August	82.1	73.9	90.3	83.7	75.3	92.1
September	96.0	86.4	105.6	106.3	95.7	116.9
October	122.6	110.3	134.9	141.5	127.4	155.7
November	128.0	115.2	140.8	146.0	131.4	160.6
December	119.8	107.8	131.8	142.6	128.3	156.9
Annual Total	1108.1	997.3	1,218.9	1,256.8	1,131.1	1,382.5

Surface water features and surface water quality

15.5.5 Within the Site, there are a number of watercourses and waterbodies, **Error! Reference source not found.** illustrates the catchments and sub-catchments, which have been identified within the Site. The Burn of Arisdale flows north to south along the western boundary of the Site and discharges into Hamna Voe[a]. Hydrological characterises for the Burn of Arisdale, observed during the field walkover survey (29th June to 1st July 2015), are presented in Table 15.6. The Burn of Arisdale is monitored by SEPA under the Water Framework Directive (WFD) as part of SEPA's River Basin Management Plans (RBMP). In 2012, SEPA classified the Burn of Arisdale (SEPA ID 20668) as having 'good' overall status with high confidence, 'good' overall ecology with high confidence and a 'pass' status for overall chemistry with low confidence, see **Error! Reference source not found.**.

15.5.6 The Burn of Hamnavoe and its tributaries (including the Burn of Evrawater) drain the centre area of the Site and flows in a general north to south direction and discharges into Hamna Voe near the settlement

[a] Local place names for bays and inlets end with 'Voe'

of Hamnavoe. Hydrological characterises for the Burn of Hamnavoe and its tributaries are presented in Table 15.6.

15.5.7 In the east of the Site a network of lochs and interconnected watercourses discharge into the Bay of Whinnifirt. The Green Burn flows northeast and discharges into the Wick of Gossbrough. Hydrological characterises for the Green Burn and the Burn of Horsewater are presented in Table 15.6.

15.5.8 Adjacent to the Site is the Loch of Kettlester and Loch of Neapaback, which drain into the Burra Voe (bay).

Table 15.6 Summary of hydrological characteristics (June / July 2015)

Figure 15.1 ID	*Watercourse*	*Grid reference of survey location*	*Height of left bank (m)*	*Height of right bank (m)*	*Channel width (m)*	*Approximate flow speed (m/s)*	*Approximate depth of water (m)*
W1	Burn of Arisdale	HU 48584 81288	0.4	0.4	2.5	0.5	0.2
W2	Burn of Arisdale	HU 48530 81188	0.4	0.9	4.5	0.2	0.3
W3	Burn of Hamnavoe	HU 50327 83179	0.2	0.2	0.2	0.1	0.1
W4	Burn of Hamnavoe	HU 49714 81615	0.8	1.0	3.6	0.3	0.3
W5	Burn of Hamnavoe	HU 49700 81252	0.7	0.1	2.0	0.4	0.3
W6	Tributary of Burn of Hamnavoe	HU 49832 82594	0.3	1.0	1.9	0.3	0.1
W7	Tributary of Burn of Hamnavoe	HU 49794 82417	0.3	1.0	1.9	0.3	0.1
W8	Tributary of Burn of Hamnavoe	HU 50697 82955	0.2	0.2	0.2	0.1	0.1
W9	Burn of Evrawater	HU 50373 81323	0.1	0.15	0.9	0.2	0.1
W10	Burn of Evrawater	HU 50434 81430	0.4	0.1	0.7	0.3	0.2
W11	Burn of Evrawater	HU 50666 81422	0.3	0.3	0.4	Not Perceived	0.2

Table 15.6 Summary of hydrological characteristics (June / July 2015)

Figure 15.1 ID	*Watercourse*	*Grid reference of survey location*	*Height of left bank (m)*	*Height of right bank (m)*	*Channel width (m)*	*Approximate flow speed (m/s)*	*Approximate depth of water (m)*
W12	Burn of Horsewater	HU 52729 81705	0.8	0.8	1.9	Not Perceived	0.0
W13	Green Burn	HU 51805 82657	1.5	1.2	2.2	0.6	0.2

15.5.9 On the 22nd June 2011, EnviroCentre Ltd carried out surface water quality monitoring at four locations as shown on **Error! Reference source not found.**. The results of this monitoring are presented in Table 15.7. EnviroCentre Ltd reported that at all sampling points the water was found to be clear and free from sediment.

Table 15.7: Surface water quality result 22nd June 2011 (EnviroCentre Ltd)

Sample number	*Watercourse*	*Grid reference*	*pH*	*Electric conductivity, EC (µS/cm)*	*Dissolved oxygen, DO (mg/l)*
WQ1	Green Burn	HU 51634 82474	6.68	218.2	10.14
WQ2	Burn of Evra Water	HU 49487 80875	7.21	268.0	10.24
WQ3	Burn of Hamnavoe	HU 49482 80902	6.86	188.6	10.09
WQ4	Burn of Arisdale	HU 48558 81221	6.60	197.0	11.50

Flood risk

15.5.10 The Stage 1 Flood Risk Assessment (FRA) takes account of the Consented Development and is reported in **Error! Reference source not found.**. The Turbines 1 to 17 (inclusive) and associated infrastructure are located in an area at little to no risk (less than 0.1% annual probability) of fluvial and pluvial flooding according to SEPA flood maps[4]. The FRA shows that the Consented Development is not at risk of flooding from artificial sources; and the risk of flooding from fluvial, pluvial / runoff, sewers and groundwater is considered to be low.

15.5.11 The vulnerability classification of wind turbine developments is ‘essential utility infrastructure,’ which is an appropriate development type within all flood zones. The SEPA flood map shows that there is little to no risk of fluvial or pluvial flooding to the proposed turbines. There are no local site-specific conditions that would adversely affect SEPA’s published flood risk categorisation. There would be no significant increase in flood risk to areas beyond the Site boundary as a result of the Consented Development. The Site is considered suitable, in terms of flood risk, for the type of development required to construct and operate the wind farm.

Soils and peat

15.5.12 Peat depths across the peat study area vary from 0m to 4.35m, with an arithmetic average across the Consented Development footprint of 1.1m (see Chapter 12: Soils and Peat).

15.5.13 The soils that underlie the majority of the Site are blanket peat of the organic soils association[5]. Blanket peat tends to be waterlogged for long periods of the year. To the south of the Site and north of the settlements Hamnavoe and Burravoe is an area of noncalcareous gleys of the Arkaig soil association[5]. Along the Burn of Arisdale and the Hill of Arisdale are podzols soils of the Durnhill soil association[5]. Ground conditions are likely to exhibit variable rates of infiltration with lower rates occurring where superficial deposits (soil/peat and superficial geology) with high percentage of clay predominates (see Chapter 12: Soils and Peat).

Geology, aquifer type and groundwater quality

15.5.14 Available geological mapping of superficial deposits from the British Geological Society (BGS)[6] indicates that the Site is underlain by a mosaic of peat and glacial till.

15.5.15 Available geological mapping of the bedrock geology from the BGS[6] shows that the Site is underlain by metamorphic rocks of the following formations:

- Boundary Zone Complex – Gneiss, Plagioclase;
- Boundary Zone Complex – Psammite, Gneissose;
- Lewisian Complex – Orthogneiss, Hornblende-bearing;
- Lewisian Complex – Gneiss, Quartzofeldspathic;
- Otterswick Psammite Formation – Psammite;
- Sound 'division' – Gneiss, Microcline-plagioclase;
- Sound 'division' – Pelite;
- Sound 'division' – Pelite and Quartzite;
- Sound 'division' – Psammite;
- Sound Psammite Formation – Psammite, Gneissose;
- Sound 'division' – Semipelite;
- Sound 'division' – Quartzite; and
- Valayre Gneiss Formation – Gneiss, Microcline-porphyroblastic.

15.5.16 See Chapter 13: Geology for further details of the geology underlying the Site.

15.5.17 The metaphoric bedrock underlying the Site is a low productive aquifer[7] where the groundwater is in the near surface weathered zone and secondary fractures. According to BGS[8], across the Site the groundwater vulnerability is Class 4, which means the groundwater is vulnerable to those pollutants that are not readily adsorbed or transformed. The bedrock is classified by SEPA as the 'Yell' aquifer (SEPA ID 150001).

15.5.18 In 2011, SEPA classified the Yell groundwater aquifer as having 'good' overall status with high confidence, good quantitative status with medium confidence and 'good' groundwater chemistry with high confidence, see **Error! Reference source not found.**.

CAR licenses and private water supplies

15.5.19 A request was made to SIC on 3rd June 2015 for information on private water supplies in the vicinity of the Site. SIC confirmed that there are no known private water supplies within 5km of the centre of the Site via email 15th June 2015 (**Error! Reference source not found.**).

15.5.20 An information request was made to SEPA on 1st June 2015 regarding CAR licenses; data was received on 14th July 2015. There are 21 CAR registered activities within 1km of the Site as shown on **Error! Reference source not found.** and in Table 15.8.

Table 15.8: CAR registered activities within 1km of the Site

Error! Reference source not found. ***ID***	***Licence number***	***National Grid reference of activity***	***Type***	***Description***	***Approximate distance from the Site***
CAR1	CAR/L/1002361	HU 48575 81322	Abstraction	Arisdale Smolt Hatchery, abstraction from Burn of Arisdale	15m west
CAR2	CAR/R/1078612	HU 51510 80150	Discharge	Burravoe Public Hall, Sewage Treatment Effluent to Soakaway, Yell, Shetland	535m southeast
CAR3	CAR/R/1069793	HU 51240 80040	Discharge	Leaside, Sewage Treatment Effluent to soakaway, Burravoe, Yell, Shetland	375m southeast
CAR4	CAR/R/1078708	HU 51400 80030	Discharge	Heatherlea, Kruss, Klellerlea & Leabrek, Sewage Treatment Effluent to Soakaway, Yell, Shetland	485m southeast
CAR5	CAR/R/1093647	HU 50470 79980	Discharge	Houlland, Sewage Treatment Effluent to soakaway, Burravoe, Shetland	75m south
CAR6	CAR/R/1098381	HU 51210 79950	Discharge	The Schoolhouse & 1 & 2 Old School, Sewage Treatment Effluent to soakaway, Burravoe, Shetland	425m southeast

Table 15.8: CAR registered activities within 1km of the Site

Error! Reference source not found. ***ID***	***Licence number***	***National Grid reference of activity***	***Type***	***Description***	***Approximate distance from the Site***
CAR7	CAR/R/1010061	HU 51560 80010	Discharge	Roseville, Burravoe, Yell, Shetland, Sewage Treatment Effluent to soakaway	630m southeast
CAR8	CAR/R/1076441	HU 50470 79917	Discharge	Hamerslea, Sewage Treatment Effluent to soakaway, Yell, Shetland	135m south
CAR9	CAR/R/1078610	HU 50778 79753	Discharge	Westerloch, Sewage Treatment Effluent to Soakaway, Yell, Shetland	350m south
CAR10	CAR/L/1002263	HU 49604 80149	Discharge	Hamnavoe Sewage Treatment Works, Final Effluent to Loch of Galtagarth, Yell, Shetland	515m southwest
CAR11	CAR/R/1109079	HU 51930 79770	Discharge	Park Cottage, Sewage Treatment Effluent to land, Burravoe	945m southwest
CAR12	CAR/L/1002361	HU 48698 80890	Discharge	Arisdale Smolt Farm, Yell - Fish farm effluent.	35m west
CAR13	CAR/L/1016128	HU 50507 78745	Fish farm	Ness of Copister Marine Cage Fish Farm, Yell Sound, E of Longa Tonga Pt, Yell	890m south
CAR14	CAR/L/1002347	HU 48800 79400	Fish farm	Hamna Voe 1 Marine Cage Fish Farm, Yell, Shetland	535m south
CAR15	CAR/R/1096583	HU 51802 82639	Engineering works	Gossabrough Dale Engineering Works, removal of bridge on Green Burn	Within the Site
CAR16	CAR/R/1069995	HU 51829 82673	Engineering works	Yell Regional Water Treatment Works, pipe crossing (17) on Green Burn	Within the Site
CAR17	CAR/R/1069995	HU 51616 80777	Engineering works	Yell Regional Water Treatment Works, pipe	170m southwest

Table 15.8: CAR registered activities within 1km of the Site

Error! Reference source not found. ***ID***	***Licence number***	***National Grid reference of activity***	***Type***	***Description***	***Approximate distance from the Site***
				crossing (18) on Burn of Kettlestar	
CAR18	CAR/R/1069995	HU 51768 83310	Engineering works	Yell Regional Water Treatment Works, pipe crossing (16) on Burn of Holligarth	465m north
CAR19	CAR/R/1096584	HU 52000 83168	Engineering works	Gossaburgh Dale Engineering Works, bridging culvert on Green Burn	470m north
CAR20	CAR/R/1056864	HU 49340 80436	Engineering works	Hamnavoe Culvert Engineering Works, bridging culvert on Burn of Hamnavoe	325m southwest
CAR21	CAR/R/1056864	HU 48575 81322	Engineering works	Arisdale Smolt Hatchery, impoundment on Burn of Arisdale	15m west

Designations

15.5.21 The Site is not in or near Shellfish Growing Waters, Bathing Waters, Cyprind Waters, Salmonid Waters, an Urban Waste Water Treatment Area, a Nitrate Vulnerable Zone or a river Drinking Water Protection Area (DrWPA) according to SEPA's RBMP interactive map[9]. The Site is in a groundwater DrWPA and adjacent to the Site is the Loch of Kettlester, which is a lake DrWPA.

Hydro-ecological designated areas

15.5.22 Hydro-ecological designated areas include internationally, nationally and locally designated ecological areas where hydrology is a key factor in their designation. Designation areas include, but are not limited to, Ramsar sites, Special Protection Areas (SPA), Special Areas of Conservation (SAC), Sites of Special Scientific Interest (SSSI), National Nature Reserves (NNR), Sites of Nature Conservation Interest (SNCI) and Local Nature Reserves (LNR).

15.5.23 The Otterswick and Graveland Special Protection Area (SPA) and Otterswick Site of Special Scientific Interest (SSSI) are adjacent to the northern boundary of the Study Area. Both the Yell Sound Coast Special Area of Conservation (SAC) and SSSI and the East Mires and Lumbister SAC and SSSI also lie within 10km of the Site.

15.5.24 The Otterswick and Graveland SSSI and SPA are adjacent to the northern area of the Site. The SSSI and SPA is covered in an extensive peat layer with lochans and peatland pools, which supports a nationally important breeding population of red-throated diver.

Groundwater Dependant Terrestrial Ecosystems (GWDTE)

15.5.25 Appendix 11.2 shows the location of the identified GWDTEs across the Site as determined by a National Vegetation Classification (NVC) survey. Seven NVC communities recorded on the Site are considered to constitute potential GWDTE, as defined by SEPA[10]. These are:

- M6 *Carex echinata* –Sp*hagnum recurvum* mire.
- M15 *Scirpus cespitosus –Erica tetralix* wet heath.
- M28 *Iris Pseudacorus – Fillipendula ulmaria* mire.
- M29 *Hypericum elodes – Potamogeton polygonifolius* soakway.
- MG10 *Holcus lanatus – Juncus effuses* rush-pasture.
- CG10 *Festuca ovina – Agrostis capillaris – Thymus praecox* grassland.
- U6 *Juncus squarrosus – Festuca ovina* grassland.

15.5.26 SEPA's guidance suggests that the NVC communities M29 and CG10 should be considered likely to be highly groundwater dependant. Additionally, the MG10 and M28 communities were considered to be in hydrological setting (i.e. by streams/ditches) that resulted in them likely to be moderately groundwater dependant.

15.5.27 The U6 and M15 communities were found in a variety of setting, only some of which were judged to be groundwater dependant. Where the U6 community was found along stream sides or flushes it was considered to be likely to be moderately groundwater dependant as water from the surrounding habitat would seep into them through the peat. Where the U6 was found at transitions between grassland and heath/bog or in areas affected by peat cutting activities it was considered be part of the peatland complex and so rainwater fed. These areas were considered to be unlikely to be groundwater dependant. Likewise, the M15 that was located in areas with modified bog surrounding it and/or was formed as part of the historic peatland management was likely to be rainwater fed. The small areas of M15 not associated with the peatland management, may be low-moderately dependent on groundwater. For further details, see Chapter 11: Ecology and Appendix 11.2.

Conceptual site hydrological model

15.5.28 The Conceptual Site Hydrological Model (CSHM) (**Error! Reference source not found.**) illustrates the water movement pathways from the ground surface to the bedrock. There are three main pathways: surface runoff, peat water movement (infiltration, throughflow, percolation) and; groundwater flow.

15.5.29 The key features of water movement through the Site include:

- Superficial deposits (peat and superficial geology) which underlie the Site include blanket peat of the organic soils association, of noncalcareous gleys of the Arkaig soil association, podzols soils of the Durnhill soil association, peat and glacial till deposits. Due to peat's water retention pseudo-aquifer properties, local perched water tables can form. Superficial deposits with high clay content tend to have small pore spaces, reducing the rate of infiltration and percolation, and can thereby lead to surface rainfall runoff.
- Metamorphic bedrock comprised of interbedded geologies of varying hydraulic conductivity, typically groundwater is found in the near surface weathered zone and the groundwater aquifer has low productivity.

Modifying influences

15.5.30 The UK Climate Projections[3] have predicted an increase of up to 10% in rainfall values over the project lifetime. An increase in rainfall may affect runoff across the Site and could alter river processes such as erosion, deposition and the frequency and intensity of river flooding.

Information gaps and assumptions

15.5.31 The baseline surveys did not include a Ground Investigation (GI), therefore data relating to borehole logs and the groundwater quality was not available and has not been included in the assessment. The programme for GI would take place post consent and prior to construction.

15.6 Embedded mitigation

15.6.1 Throughout the pre-application design stage the initial layout and locations of the turbines and access track have been adjusted to avoid hydrologically sensitive areas. A minimum 50m exclusion buffer was applied along or around every onsite watercourse and waterbody. The Consented Development was designed to avoid the 50m exclusion buffer as far as possible.

15.6.2 Sensitive habitats (GWDTE) were identified within 100m of excavations less than 1m in depth (roads, tracks and trenches) and within 250m of excavations deeper than 1m (borrow pits and foundations). This is in accordance with SEPA Guidance Note 4 (May 2014, Reference: LUPS-GU4) and SEPA Guidance Note 31 (October 2014, Reference LUPS-GU31). The Consented Development was designed to avoid potential GWDTE as far as possible.

15.7 Assessment of impacts

Receptors

15.7.1 Table 15.9 summarises the potential receptors and the reasons for inclusion or exclusion from the detailed impact assessment.

Table 15.9: Summary of receptors and sensitivity

Receptors	***Distance from site activities***	***Summary of receptor characteristics***	***Receptor sensitivity***	***Is this receptor at risk from the*** Consented ***Development?***
Burn of Arisdale catchment (surface waters)	Site is within this catchment	WFD overall status of 'good' Watercourses and waterbodies with no designations	High	Yes
Burn of Lungaskolla Sub-catchment of Burn of Arisdale Catchment (surface waters)	150m west	WFD overall status of 'good' Watercourses and waterbodies with no designations	High	No
		WFD overall status of 'good'	High	No

Table 15.9: Summary of receptors and sensitivity

Receptors	***Distance from site activities***	***Summary of receptor characteristics***	***Receptor sensitivity***	***Is this receptor at risk from the*** Consented ***Development?***
Burn of Sligatu Sub-catchment of Burn of Arisdale Catchment (surface waters)	Adjacent to the Site	Watercourses and waterbodies with no designations		
Burn of Hamnavoe catchment (Surface Waters) including Burn of Evrawater sub-catchment	Site is within this catchment	Watercourses and waterbodies with no designations	Medium	Yes
Green Burn and Burn of Holligarth catchment (Surface Waters) including Burn of Gudon sub-catchment	Site is within this catchment	Watercourses and waterbodies with no designations	Medium	Yes
Burn of Horsewater and Burn of Hummelton catchment (surface waters)	Site is within this catchment	Watercourses and waterbodies with no designations	Medium	Yes
Burn of Neapaback catchment (surface waters)	Site is within this catchment	Watercourses and waterbodies with no designations	Medium	Yes
Burn of Kettlester catchment (surface waters)	Site is within this catchment	Loch of Kettlester, is a Drinking Water Protection Area	Very high	Yes
Cada Burn catchment (surface waters)	85m west	Watercourses and waterbodies with no designations	Medium	No
South Burn of Otterwick catchment (surface waters)	775m north	Watercourses and waterbodies with no designations	Medium	No
Burn of Ulsta catchment (surface waters)	1.2km southwest	Watercourses and waterbodies with no designations	Medium	No
Otterswick and Graveland SSSI and SPA	Adjacent to the northern boundary of the Site and upslope of the Site	SSSI and SPA Extensive peat layer, lochans and peatland pools, supports a nationally important breeding birds	Very high	No
Water in peat	Across the Site	Peat retains water and can act as a pseudo-aquifer Peat Depths of up to 4.35m	Very high	Yes

Table 15.9: Summary of receptors and sensitivity

Receptors	***Distance from site activities***	***Summary of receptor characteristics***	***Receptor sensitivity***	***Is this receptor at risk from the*** Consented ***Development?***
'Yell' bedrock aquifer	Underlies the Site	Groundwater Vulnerability Of Class 4 Low Productivity Aquifer WFD Overall Status of 'Good' Groundwater Drinking Water Protection Area	Very high	Yes
Arisdale Smolt Hatchery Abstraction (Licence No. CAR/L/1002361)	15m west of the Site	Surface Water Abstraction from Burn of Arisdale	Very high	No
Discharge Consents (Licence No. CAR/R/1078612 CAR/R/1069793 CAR/R/1078708 CAR/R/1093647 CAR/R/1098381 CAR/R/1010061 CAR/R/1076441 CAR/R/1078610 CAR/L/1002263 CAR/R/1109079 CAR/L/1002361)	Closest is 35m west	Sewage Treatment Effluents	Low	No
Ness of Copister Marine Cage Fish Farm (Licence No. CAR/L/1016128)	890m south	Fish farm	Very high	No
Hamna Voe 1 Marine Cage Fish Farm (Licence No. CAR/L/1002347)	535m south	Fish farm	Very high	No

15.7.2 Water resources receptors in Table 15.9 which are not at risk from the Consented Development have been scoped out of the detailed impact assessment and are not considered further.

15.7.3 The Consented Development comprises 17 wind turbines with associated hardstanding area, new access track, underground cabling, six watercourse crossings, four borrow pits, site office, substation and control building, met mast and construction compound. Appendix 3.2 summarises the characteristics of the proposed watercourse crossing. Table 15.10 and **Error! Reference source not found.** details the potential impacts that may arise from the components of the Consented Development.

Potential impacts

Table 15.10: Summary of component features of the Consented Development relevant to the water environment

Project component	*Activities*	*Potential impacts*	*Comments/observations*
Access track and underground cabling	Use of access track	Increased sediment mobilisation and transport from road material through surface wash.	Access track drains and pot holes would be regularly inspected and cleared/infilled/repaired. This would reduce the potential for sediment to mobilise and wash off from the access track surface.
	Vegetation removal	Removal of vegetation reduces interception and evapotranspiration rates and increases runoff.	The total area of the access tracks compared to the associated catchments is low. Therefore, any interception and evapotranspiration rates are unlikely to substantially alter the runoff within the catchments.
	Peat removal	Removal of peat may disrupt and/or disconnect the hydraulic connectivity of the peatland in the surrounding area.	The total amount of peat to be removed compared to the associated catchments is low. Therefore, the loss of peat from the associated catchments will not substantially alter the overall lateral flow and hydraulic connectivity at the catchment scale.
	Placement of aggregate	Disruption to lateral flow (throughflow in peat and runoff) from the placement of aggregate.	The access track would be composed of permeable aggregate (compacted stone). As a result water would be able to flow through the hardstanding and reach the surrounding undisrupted peat, thus maintaining the hydraulic connectivity of the peatland.
	Use of machinery	Pollution from spills or leakage of fuel and oil from use of machinery.	Good industry practice such as pollution prevention measures detailed in Pollution Prevention Guidelines PPG1, PPG21 and PPG22 would reduce the risk and the overall impact if a spill or leakage were to occur.
Watercourse crossings	Construction of watercourse crossing	Disruption/blockage of watercourse flow from watercourse crossing.	Watercourse crossings have been designed to accommodate a 1 in 200 year flood event. All watercourse crossings will be design and build in accordance with SEPA's Engineering in the water environment: good practice guide: River Crossings (2010) and other industry best practise.
	Use of machinery	Pollution from spills or leakage of fuel and oil from use of machinery.	Good industry practice such as pollution prevention measures detailed in Pollution Prevention Guidelines PPG1, PPG21 and PPG22 would reduce the risk and the overall impact if a spill or leakage were to occur.
Turbines and associated hardstanding area	Vegetation removal	Removal of vegetation reduces interception and evapotranspiration rates and increases runoff.	The total area of the turbine and hardstanding areas compared to the associated catchments is low. Therefore, any interception and evapotranspiration rates are unlikely to substantially alter the runoff within this catchment.

Table 15.10: Summary of component features of the Consented Development relevant to the water environment

Project component	*Activities*	*Potential impacts*	*Comments/observations*
	Peat removal	Removal of peat may disrupt and/or disconnect the hydraulic connectivity of the peatland in the surrounding area.	The total amount of peat to be removed compared to the associated catchments is low. Therefore, the loss of peat from this catchment will not substantially alter the overall lateral flow and hydraulic connectivity at the catchment scale.
	Construction of turbine foundations	Increased impermeable area may lead to increased runoff and shorter rainfall-runoff response time.	The area of impermeable foundations compared to the associated catchments is low. Therefore, this is low potential for the foundations to substantially alter the runoff within this catchment.
		Impermeable underground structure that may disrupt and/or disconnect the hydraulic connectivity of the peatland in the surrounding area.	The foundations of the proposed turbines may cause localised diversions in subsurface flow pathways within the peat around the foundations, but would not substantially alter the overall flow direction within the peat of the Burn of Hamnavoe catchment from high elevations to how elevations and towards watercourses.
	Placement of aggregate for hardstanding	Placement of aggregate may disrupt and/or disconnect the hydraulic connectivity of the peatland in the surrounding area.	The hardstanding areas would be composed of permeable aggregate (compacted stone). As a result water would be able to flow through the hardstanding and reach the surrounding undisrupted peat, thus maintaining the hydraulic connectivity of the peatland.
	Use of machinery and use of concrete or equivalent	Pollution from spills or leakage of concrete or equivalent and fuel, and oil from use of machinery.	Good industry practice such as pollution prevention measures detailed in Pollution Prevention Guidelines PPG1, PPG21 and PPG22 would reduce the risk and the overall impact if a spill or leakage were to occur.
Borrow pits	Vegetation removal	Removal of vegetation reduces interception and evapotranspiration rates and increases runoff.	The total area of the borrow pit areas compared to the associated catchments is low. Therefore, any interception and evapotranspiration rates are unlikely to substantially alter the runoff within this catchment.
	Peat removal	Removal of peat may disrupt and/or disconnect the hydraulic connectivity of the peatland in the surrounding area.	The total amount of peat to be removed compared to the associated catchments is low. Therefore, the loss of peat from this catchment will not substantially alter the overall lateral flow and hydraulic connectivity at the catchment scale.
	Stone extraction	Removal of overburden and stone may cause changes to the groundwater recharge.	The total extraction of aggregate is unlikely to substantially alter the groundwater recharge of the low productive metaphoric bedrock aquifer.

Table 15.10: Summary of component features of the Consented Development relevant to the water environment

Project component	*Activities*	*Potential impacts*	*Comments/observations*
	Use of machinery	Pollution from spills or leakage of fuel and oil from use of machinery.	Good industry practice such as pollution prevention measures detailed in Pollution Prevention Guidelines PPG1, PPG21 and PPG22 would reduce the risk and the overall impact if a spill or leakage were to occur.
Site compound and substation	Vegetation removal	Removal of vegetation reduces interception and evapotranspiration rates and increases runoff.	The total area of the substation compared to the associated catchments is low. Therefore, any interception and evapotranspiration rates are unlikely to substantially alter the runoff within these catchments.
	Peat removal	Removal of peat may disrupt and/or disconnect the hydraulic connectivity of the peatland in the surrounding area.	The total amount of peat to be removed compared to the associated catchments is low. Therefore, the loss of peat from this catchment will not substantially alter the overall lateral flow and hydraulic connectivity at the catchment scale.
	Placement of aggregate for hardstanding	Placement of aggregate may disrupt and/or disconnect the hydraulic connectivity of the peatland in the surrounding area.	The hardstanding areas would be composed of permeable aggregate (compacted stone). As a result water would be able to flow through the hardstanding and reach the surrounding undisrupted peat, thus maintaining the hydraulic connectivity of the peatland.
	Use of machinery	Pollution from spills or leakage of fuel and oil from use of machinery.	Good industry practice such as pollution prevention measures detailed in Pollution Prevention Guidelines PPG1, PPG21 and PPG22 would reduce the risk and the overall impact if a spill or leakage were to occur.
Anemometry Telecommunications Tower	Vegetation removal	Removal of vegetation reduces interception and evapotranspiration rates and increases runoff.	The total area of the substation compared to the associated catchments is low. Therefore, any interception and evapotranspiration rates are unlikely to substantially alter the runoff within these catchments.
	Peat removal	Removal of peat may disrupt and/or disconnect the hydraulic connectivity of the peatland in the surrounding area.	The total amount of peat to be removed compared to the associated catchments is low. Therefore, the loss of peat from this catchment will not substantially alter the overall lateral flow and hydraulic connectivity at the catchment scale.
	Use of machinery	Pollution from spills or leakage of fuel and oil from use of machinery.	Good industry practice such as pollution prevention measures detailed in Pollution Prevention Guidelines PPG1, PPG21 and PPG22 would reduce the risk and the overall impact if a spill or leakage were to occur.

Table 15.10: Summary of component features of the Consented Development relevant to the water environment

Project component	*Activities*	*Potential impacts*	*Comments/observations*
Maintenance	Site inspection by vehicle/foot	Pollution from spills and leaks of fuel and oil from vehicles.	Good industry practice such as pollution prevention measures detailed in Pollution Prevention Guidelines PPG1, PPG21 and PPG22 would reduce the risk and the overall impact if a spill or leakage were to occur.
Decommission of principal features and restoration	Removal of principle features	Decrease in impermeable area leading to pre-development runoff conditions and pre-development rainfall-runoff response time.	No further comments.
	Revegetation	Re-vegetation may lead to pre-development interception and evapotranspiration rates and pre-development runoff conditions.	No further comments.
	Backfilling	Reinstatement of peat profile may lead to pre-development infiltration rates and to pre-development runoff conditions.	No further comments.
	Use of machinery	Pollution from spills or leakage of fuel and oil from use of machinery.	Good industry practice such as pollution prevention measures detailed in Pollution Prevention Guidelines PPG1, PPG21 and PPG22 would reduce the risk and the overall impact if a spill or leakage were to occur.

15.8 Cumulative impacts

15.8.1 It is generally agreed that developments within the same catchment and at the construction stage need to be taken into consideration when assessing the potential for cumulative impacts.

15.8.2 '*It is conceivable that two or more wind farms (or indeed other developments) in the catchment of a water receptor could result in combined runoff impacts to water quality, which then exceed Environmental Quality Standard thresholds. It is generally the case that in such circumstances any such effect is only likely to have the potential to be significant during the construction period. Once operational, any effects are likely to be restricted to high rainfall events when the level of dilution of impact is proportionately increased by higher flow levels that can be anticipated under these circumstances. Despite this theoretical potential impact, it is possible to control construction effects by good management techniques and therefore in practice significant effects, either individually or cumulatively, will rarely occur. Where such impacts occur, other regulation provides additional controls. Due to the existing regulation over water environment, there are absolute controls on the manner in*

which developments are constructed and operated in respect of the water environment which result in any potential effect being designed out. In this way it is unlikely that any cumulative effect would be significant.' [11]

15.8.3 There are no other major developments within the same catchments as the Site within the planning process. However, other future major developments would have to comply with strict planning guidance and regulation in regard to the water environment. This means that the design of other major developments would mostly likely incorporate appropriate mitigation (such as pollution prevention measures) and discharges from these sites would be restricted to the sites' greenfield runoff rates, as is the case for the Consented Development. Additionally, any development requiring permitted activities, e.g. water discharges, would be subject to control and regulation by the relevant issuing authority. Therefore, there potential for cumulative impact arising from other major developments within the same catchment as the Site is considered to be negligible, which has no significant effect.

15.9 Mitigation

15.9.1 Underground cabling would wherever possible follow the same route as the access tracks in order to reduce the ground disturbance across the Site. The routing of both access tracks and cabling has been designed to minimise the overall impact and to limit the number of watercourse crossings.

15.9.2 The retention and regeneration of vegetation cover through reduced grazing pressure (as discussed in the Outline Habitat Management Plan, Appendix 10.4) where possible across the Site would prevent erosion; maintain the existing pre-development greenfield runoff characteristics; control sediment potentially released from Site activities; and retain drainage routes and pathways for water movement. There are no proposed large scale changes to ground levels which could potentially alter surface runoff rates or the capacity of watercourses. It is therefore considered that there would be no significant change to the hydrology or flood risk upstream or downstream of the Site.

15.9.3 The Consented Development would be undertaken in accordance with the guidance and codes of best practice specified in Table 15.11 to limit the potential for disturbance or contamination of water resources.

Table 15.11: Good practice guides and guidance documents to protect water resources

Good practice guides and guidance documents
PPG1 General Guide to the Prevention of Pollution.
PPG2 Above Ground Oil Storage.
PPG4 Treatment and Disposal of Sewage where no Foul Sewer.
PPG5 Works and Maintenance In, or Near Water.
PPG6 Working at Construction and Demolition Sites.
PPG8 Safe Storage and Disposal of Used Oils.
PPG21 Polluting Incident Response Planning.
PPG22 Dealing With Spills.
SEPA WAT-SG-26 Good Practice Guide – Sediment Management.
SEPA WAT-SG-29 Good Practice Guide – Construction Methods.
SEPA WAT-PS-10-01 Assigning Groundwater Assessment Criteria for Pollutant Inputs.
SEPA LUPS-GU4 SEPA Guidance Note 4: Planning Advice on Windfarm Developments.
SEPA LUPS-GU31 SEPA Guidance Note 31: Guidance on Assessing the Impact of Windfarm Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems.
Forestry Commission, Forest and Water Guidelines 2011.
CIRIA C502 Environmental Good Practice on Site.
CIRIA C515 Groundwater Control-Design and Practice.
CIRIA C521 Sustainable Urban Drainage Systems Design Manual for Scotland and England.
CIRIA C532 Control of Water Pollution from Construction Sites.
CIRIA C650 Environmental Good Practice on Site (Expansion of C502).
CIRIA C689 Culvert Design and Operational Guide.
UK Technical Advisory Group on the WFD, UK Environmental Standards and Conditions (Phase 2), Final, March 2008.

15.9.4 The Construction Environmental Management Plan (CEMP) would incorporate the principals of good practice, legislation, regulations and guidance. With respect to protection of water resources, the CEMP would provide practical measures to avoid and minimise the impact of the Consented Development on ground and surface waters, as well as providing emergency preparedness and corrective actions together with measures for monitoring, recording and disseminating of information. An outline CEMP (OCEMP) has been prepared Wardell Armstrong for the Consented Development (Appendix 3.6).

15.9.5 The principles of the water related components of the OCEMP include the following:

- Construction design to minimise disruption to the natural flow regime. Watercourses, drains etc. to be avoided as far as possible in the Site layout;
- A number of measures can be adopted to prevent and control the release of sediment. Surface water can be directed across vegetated zones, or through mesh fencing, to capture sediment. Alternatives, such as sediment traps or settlement lagoons, may also be considered if the quantity

of sediment laden water is anticipated to be large. A OCEMP would specify maintenance to ensure that sediment control measures, drains and pot holes would be regularly inspected and cleared/infilled/repaired;

- All fuel, oils and other polluting substances would be securely stored in suitably bunded containers on impermeable surfaces in accordance with PPG2 and PPG8. The total quantity and range of potential pollutants to be used onsite is anticipated to be small. Static machinery and plant would, where practicable, have integral drip trays of 110% of the capacity of the fuel tank. The use of biodegradable oils and lubricants would also be considered where practicable. All plant, vehicles and machinery would be inspected regularly for leaks. Refuelling would be undertaken in a designated refuelling area; and
- Pollution incident response plans would be prepared, identifying the type and location of onsite resources (e.g. spill kits, absorbent materials, oil booms etc.) available for the control of accidental releases of pollution and other environmental incidents. These resources would be available to contractors at all times of operation. Cement/concrete mixes would be calculated to ensure that sufficient quantities are supplied (without needing disposal of excess), and that the cement/sand mix ratio would be monitored for consistency and suitability.

15.10 Residual impact assessment

15.10.1 The implementation of good practice that is defined in the outline CEMP either avoids or minimises the potential impacts set out in **Error! Reference source not found.**. As a result of the described mitigation, the magnitude of change from the baseline condition caused by the potential impacts identified in **Error! Reference source not found.** have been assessed as negligible for all impacts. The potential change to the water environment is likely to be slight and barely distinguishable from the current baseline condition due to the implementation of measures such as pollution incident response plans and sediment runoff containment and treatment.

15.10.2 **Error! Reference source not found.** and Table 15.12 details the findings of the impact assessment with mitigation.

Table 15.12: Summary of impact assessment with mitigation

Project component	***Potential impacts***	***Nature and geographical significance of impact***	***Receptors***	***Sensitivity of receptor (Table 15.1)***	***Magnitude of change from baseline* (Table 15.2)***	***Scale of impacts (Table 15.3)***	***Significant effect?** (Table 15.4)***
Access track and underground cablings	Increased sediment mobilisation and transport from road material through surface wash.	Short-term, reversible, and local adverse	Burn of Arisdale, Burn of Hamnavoe, Green Burn, Burn of Holligarth, Burn of Horsewater, Burn of Hummelton, Burn of Neapaback and Burn of Kettlester Catchments (Surface Waters) 'Yell' Bedrock Aquifer Water in peat	Medium to very high	Negligible	Minor	No
	Removal of vegetation reduces interception and evapotranspiration rates and increases runoff.	Long-term, reversible, and local adverse					
	Removal of peat may disrupt and/or disconnect the hydraulic connectivity of the peatland in the surrounding area.	Long-term, reversible, and local adverse					
	Disruption to lateral flow (throughflow in peat and runoff) from the placement of aggregate.	Long-term, reversible, and local adverse					
	Pollution from spills or leakage of fuel and oil from use of machinery.	Short-term, reversible, and local adverse					
Watercourse crossings	Disruption/blockage of watercourse flow from watercourse crossing.	Short-term, reversible, and local adverse	Burn of Hamnavoe, Burn of Kettlester, Burn of Horsewater,	Medium to very high	Negligible	Minor	No

Table 15.12: Summary of impact assessment with mitigation

Project component	*Potential impacts*	*Nature and geographical significance of impact*	*Receptors*	*Sensitivity of receptor (Table 15.1)*	*Magnitude of change from baseline* (Table 15.2)*	*Scale of impacts (Table 15.3)*	*Significant effect?** (Table 15.4)*
	Pollution from spills or leakage of fuel and oil from use of machinery.	Short-term, reversible, and local adverse	Burn of Hummelton Catchments (Surface Waters)				
Turbines and associated hardstanding areas	Removal of vegetation reduces interception and evapotranspiration rates and increases runoff.	Long-term, reversible, and local adverse	Burn of Hamnavoe, Green Burn, Burn of Holligarth, Burn of Horsewater, Burn of Hummelton, Burn of Kettlester Catchments (Surface Waters) 'Yell' Bedrock Aquifer Water in Peat	Medium to very high	Negligible	Minor	No
	Removal of peat may disrupt and/or disconnect the hydraulic connectivity of the peatland in the surrounding area.	Long-term, reversible, and local adverse					
	Increased impermeable area may lead to increased runoff and shorter rainfall-runoff response time.	Long-term, reversible, and local adverse					
	Impermeable underground structure that may disrupt and/or disconnect the hydraulic connectivity of the peatland in the surrounding area.	Long-term, reversible, and local adverse					
	Placement of aggregate may disrupt and/or disconnect the hydraulic connectivity of the peatland in the surrounding area.	Long-term, reversible, and local adverse					

Table 15.12: Summary of impact assessment with mitigation

Project component	*Potential impacts*	*Nature and geographical significance of impact*	*Receptors*	*Sensitivity of receptor (Table 15.1)*	*Magnitude of change from baseline* (Table 15.2)*	*Scale of impacts (Table 15.3)*	*Significant effect?** (Table 15.4)*
	Pollution from spills or leakage of concrete or equivalent and fuel, and oil from use of machinery.	Short-term, reversible, adverse and local					
Borrow pits	Removal of vegetation reduces interception and evapotranspiration rates and increases runoff.	Long-term, reversible, adverse and local	Burn of Arisdale, Burn of Hamnavoe, Green Burn and Burn of Holligarth Catchments (Surface Waters) 'Yell' Bedrock Aquifer Water in Peat	Medium to very high	Negligible	Minor	No
	Removal of peat may disrupt and/or disconnect the hydraulic connectivity of the peatland in the surrounding area.	Short-term, reversible, adverse and local					
	Removal of overburden and stone may cause changes to the groundwater recharge.	Long-term, irreversible, adverse and local					
	Pollution from spills or leakage of fuel and oil from use of machinery.	Short-term, reversible, adverse and local					
Site compound and substation	Removal of vegetation reduces interception and evapotranspiration rates and increases runoff.	Long-term, reversible, adverse and local	Green Burn, Burn of Holligarth and Burn of	Medium to very high	Negligible	Minor	No

Table 15.12: Summary of impact assessment with mitigation

Project component	*Potential impacts*	*Nature and geographical significance of impact*	*Receptors*	*Sensitivity of receptor (Table 15.1)*	*Magnitude of change from baseline* (Table 15.2)*	*Scale of impacts (Table 15.3)*	*Significant effect?** (Table 15.4)*
	Removal of peat may disrupt and/or disconnect the hydraulic connectivity of the peatland in the surrounding area.	Short-term, reversible, adverse and local	Kettlester catchments (Surface Waters) Water in Peat 'Yell' Bedrock Aquifer				
	Placement of aggregate may disrupt and/or disconnect the hydraulic connectivity of the peatland in the surrounding area.	Long-term, reversible, adverse and local					
	Pollution from spills or leakage of fuel and oil from use of machinery.	Short-term, reversible, adverse and local					
Anemometry mast and radio communications tower	Removal of vegetation reduces interception and evapotranspiration rates and increases runoff.	Long-term, reversible, adverse and local	Burn of Neapaback and Hamnavoe catchments (surface waters) Water in peat 'Yell' bedrock aquifer	Medium to very high	Negligible	Minor	No
	Removal of peat may disrupt and/or disconnect the hydraulic connectivity of the peatland in the surrounding area.	Short-term, reversible, adverse and local					
	Pollution from spills or leakage of fuel and oil from use of machinery.	Short-term, reversible, adverse and local					

Table 15.12: Summary of impact assessment with mitigation

Project component	*Potential impacts*	*Nature and geographical significance of impact*	*Receptors*	*Sensitivity of receptor (Table 15.1)*	*Magnitude of change from baseline* (Table 15.2)*	*Scale of impacts (Table 15.3)*	*Significant effect?** (Table 15.4)*
Maintenance	Pollution from spills and leaks of fuel and oil from vehicles.	Short-term, reversible, adverse and local	Burn of Arisdale, Burn of Kettlester, Burn of Hamnavoe, Green Burn, Burn of Holligarth, Burn of Horsewater and Burn of Hummelton catchments (surface waters) Water in peat 'Yell' bedrock aquifer	Medium to very high	Negligible	Minor	No
Decommission of principal features and restoration	Decrease in impermeable area leading to pre-development runoff conditions and pre-development rainfall-runoff response time.	Long-term, irreversible, neutral and local	Burn of Arisdale, Burn of Kettlester, Burn of Hamnavoe, Green Burn, Burn of Holligarth, Burn of Horsewater and Burn of Hummelton catchments (surface waters) Water in peat	Medium to very high	Negligible	Minor	No
	Re-vegetation may lead to pre-development interception and evapotranspiration rates and pre-development runoff conditions.	Long-term, irreversible, neutral and local					
	Reinstatement of peat profile may lead to pre-development infiltration rates and to pre-development runoff conditions.	Long-term, irreversible, neutral and local					

Table 15.12: Summary of impact assessment with mitigation

Project component	*Potential impacts*	*Nature and geographical significance of impact*	*Receptors*	*Sensitivity of receptor (Table 15.1)*	*Magnitude of change from baseline* (Table 15.2)*	*Scale of impacts (Table 15.3)*	*Significant effect?** (Table 15.4)*
	Pollution from spills or leakage of fuel and oil from use of machinery.	Short-term, reversible, adverse and local	'Yell' bedrock aquifer				

Note

* Mitigation measures have been incorporated into the design of the Consented Development and during construction measures in the OCEMP would prevent harm to the water environment. The impact assessment has considered the magnitude of change from the baseline with mitigation in place.

** Impacts that have been determined to be major or moderate are considered to have a significant effect. Impacts that are identified as minor or negligible are not considered to have a significant effect.

Micro-siting

15.10.3 The location of the proposed turbines and associated infrastructure would be subject to micro-siting to achieve the most appropriate location whilst remaining in an area of little to low flood risk. Therefore, micro-siting is not expected to affect the impact assessment.

Monitoring

15.10.4 Water quality monitoring points upstream and downstream of the proposed watercourse crossings as shown on **Error! Reference source not found.**, will be undertaken. Monitoring would take place before, during and for one year after construction. Analysis would include both a visual and field monitoring using portable water sampling equipment undertaken by an experienced hydrologist. The following determinants would be monitored: pH; turbidity; dissolved oxygen (% saturation), Dissolved Organic Compounds (DOC) and; suspended solids (µS).

15.11 Summary and conclusions

15.11.1 Retention of the vegetation cover across the majority of the Site would reduce erosion; maintain existing pre-development greenfield runoff characteristics; control sediment potentially released from Site activities; and retain drainage routes and pathways for water movement. There are no proposals for large scale changes to ground levels, which could alter surface runoff rates and the capacity of watercourses. Watercourse crossings will be designed to convey 1 in 200 year flood event. It is therefore considered that there would be no large scale change to hydrology or flood risk upstream or downstream of the Site.

15.11.2 The key principles of the water related components of the OCEMP for the Site would include the careful design and control of sediment and potential pollutants. The OCEMP would draw upon good industry guidance and best practice measures. Mitigation measures, such as the avoidance of hydrologically sensitive areas, have been incorporated into the design of the Consented Development. The impact assessment has assumed the implementation of such measures to avoid and reduce the likelihood of a potential impact occurring.

15.11.3 Potential impacts on the water environment are those, which may change the hydrological and hydrogeological flow regime, and those, which may cause pollution and a degradation in water quality.

15.11.4 With mitigation incorporated into the Consented Development design and the use of appropriate methodologies and mitigation measures during the construction, operational and decommissioning phases, all impacts were assessed as being minor adverse. Therefore, the Consented Development would have no significant effects on the water environment.

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[2] Met Office (2015) Lerwick climate http://www.metoffice.gov.uk/public/weather/climate/gfxnjyxk4

[3] UK Climate Projections (2009) UK Climate Projections User Interface http://ukclimateprojections.metoffice.gov.uk/23698?emission=low http://ukclimateprojections.metoffice.gov.uk/23698?emission=medium http://ukclimateprojections.metoffice.gov.uk/23698?emission=high

[4] Scottish Environment Protection Agency (2015) Flood Maps: http://map.sepa.org.uk/floodmap/map.htm

[5] Soil Survey of Scotland Staff (1981) Soil maps of Scotland at a scale of 1:250000 Macaulay Institute for Soil Research, Aberdeen.

[6] British Geological Survey (2015) Geology of Britain Viewer: http://mapapps.bgs.ac.uk/geologyofbritain/home.html

[7] British Geological Survey (2015) Geoindex Onshore: Hydrogeology 1:625,000 Scale Map: http://mapapps2.bgs.ac.uk/geoindex/home.html

[8] British Geological Survey (2011) Groundwater Vulnerability (Scotland) GIS Dataset, Version 2.

[9] Scottish Environment Protection Agency (2015) River Basin Management Plan Interactive Map: http://map.sepa.org.uk/rbmp/

[10] SEPA (October 2014) Land Use Planning System Guidance Note 31 Guidance on Assessing the Impacts of Windfarm Development Proposals on Groundwater Abstractions and Groundwater Dependant Terrestrial Ecosystems (Reference LUPS-GU31)

[11] Entec UK Limited (2008) Review of Guidance on the Assessment of Cumulative Impacts of Onshore Windfarms: Phase 1 Report: https://www.og.decc.gov.uk/EIP/pages/windfarm-cumulative-impacts-report.pdf