

Chapter 10: Hydrology, Hydrogeology and Geology

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10 Hydrology, Hydrogeology and Geology

10.1 Executive Summary

- 10.1.1 SLR Consulting Ltd (SLR) was commissioned to undertake a Hydrology, Hydrogeology and Geology assessment of the construction and operation of the proposed realignment of the B9075 Sandwater Road, hereafter referred to as the Proposed Development. The assessment has been carried out in accordance with the requirements of Scottish Planning Policy and associated guidance of relevance to the Proposed Development.
- 10.1.2 The assessment reflects an update to a similar assessment undertaken in 2016 (the 2016 Application) in relation to the widening and upgrade of approximately 730m of the existing B9075 and the realignment of approximately 1,530m. The 2016 Application was withdrawn in 2017 due to a decision made by VEFW to review the proposed upgrade and realignment options. However, much of the survey and assessment work undertaken for the 2016 Application remains relevant to the Proposed Development and is referred to as such throughout this Chapter.
- 10.1.3 The Proposed Development is located within the catchments of the Burn of Weisdale and Burn of Sandwater characterised by two valleys defined by the river systems, rising from 20 metres Above Ordnance Datum (mAOD) to 80m AOD.
- 10.1.4 Geological mapping indicates that the majority of the Proposed Development is underlain by peat which lies on metamorphosed sedimentary rocks.
- 10.1.5 As a consequence of the Proposed Development there is the potential to impact on the existing geological, hydrogeological and hydrological environment. The potential impacts required to be assessed are; alteration of natural drainage patterns and run-off volumes/rates, pollution impact from silt-laden run-off, chemical contaminated run-off/pollution, groundwater disruption and watercourse bank integrity.
- 10.1.6 A site specific Peat Landslide Hazard Risk Assessment was prepared as part of the 2016 Application (included as Appendix 10.3 to this Chapter) which concluded that there are three sections within the vicinity of the Proposed Development that have a medium to high risk of peat slide. This risk is caused by increased surface slope angles, greater peat thicknesses and proximity to the proposed excavation works by tributaries of the Burn of Weisdale. The risk of instability in other sections of the proposed route has been assessed as very low to low risk. However the new track design incorporating sections of floating road will reduce the risk significantly, primarily due to reduced excavation of peat.
- 10.1.7 Excavated peat is expected to be re-used on site and is detailed in a Stage 1 Peat Management Plan prepared for the Proposed Development (see Appendix 10.4).
- 10.1.8 In order to reduce the impacts on the local environment a series of mitigation measures and techniques have been incorporated into the Outline Draft Construction Environmental Management Plan (CEMP) (Appendix 4.2). These measures reduce the impact of the development, with each residual effect in relation to Hydrology, Hydrogeology and Geology having been determined as not significant in EIA terms.

10.2 Introduction

10.2.1 SLR was commissioned to undertake a Hydrology, Hydrogeology and Geology assessment for the construction and operation of the proposed realignment of the B9075 Sandwater Road, hereafter referred to as the Proposed Development.

10.2.2 As part of the assessment SLR has reviewed the geology, hydrology and hydrogeology baseline reports prepared by Environ in 2013 and by RPS in 2016 (the 2016 Application). Using these reports, publicly available data and reporting submitted to support the application for the Viking Wind Farm project, a revised assessment of the Proposed Development has been completed.

10.2.3 The revised assessment takes cognisance of updated and recent best practice guidance and current legislation.

10.2.4 The chapter assesses the likely significant effects on surface water and groundwater resources expected as a result of the construction and operation of the Proposed Development. The specific objectives of the assessment are to:

- review and update the baseline assessment;
- review and update the likely significant effects;
- review and update any mitigation measures required to avoid or reduce significant effects; and
- review and update the significance of residual effects.

10.2.5 The chapter is supported by the following appendices:

- Appendix 10.1: Water Crossing Schedule (as per the 2016 Application);
- Appendix 10.2: Catchment Descriptors (as per the 2016 Application);
- Appendix 10.3: Peat Landslide Hazard Risk Assessment (PLHRA) (as per the 2016 Application);
- Appendix 10.4: Stage 1 Peat Management Plan (PMP); and
- Appendix 10.5: Figures 10.1 to 106 from the 2016 ES.

10.3 Scope of Assessment

Study Area

10.3.1 The study area was defined as land at and within a 1km radius of the Proposed Development (see Appendix 10.5, Figure 10.1). However, there is potential for the Proposed Development to impact on the hydrology of waterbodies with downstream connectivity to the site, including the Burn of Weisdale and Burn of Sandwater. Such potential effects have also been considered within this assessment.

Pre Application Briefing Note

10.3.2 A Pre-Application Briefing Note was prepared by VEFW and issued to SIC, SNH and SEPA. This Briefing Note is included in Appendix 6.1 of this EIA Report. The briefing note outlined

the proposed scope of the EIA Report for the Proposed Development. In relation to hydrology, hydrogeology and geology, the briefing note confirmed:

The EIA Report will include an assessment of geology, hydrogeology and hydrology.

A draft PMP will be prepared and included with the EIA Report. It is not proposed to update the PLHRA from the 2016 ES as the results of this assessment will not change and have been considered in the development of the PMP, and design of the road.

Response to Pre-Application Briefing Note

- 10.3.3 Consultation with SIC, SNH and SEPA confirmed that, for the majority of subject areas, the scope of works proposed in the Pre-Application Briefing Note was considered appropriate. SEPA requested that more information be included on Ground Water Dependent Terrestrial Ecosystems (GWDTE) including a comparison with the effects of 2016 Application. This is included in Chapter 9: Ecology.

Use of Existing Survey Data

- 10.3.4 The surveys undertaken for the 2016 ES are still applicable and relevant to the Proposed Development, given that the application boundary remains largely the same, and therefore the previous study areas are sufficient to assess the Proposed Development.
- 10.3.5 Further peat probing has been undertaken during 2018 to inform the PMP and redesign of Sandwater Raod.

10.4 Methodology

Legislation, Policy and Guidance

- 10.4.1 The Hydrology, Hydrogeology, Geology and Soils assessment has had regard to the following European legislation:
- EC Water Framework Directive (2000/60/EC);
 - EC Groundwater Directive (2006/118/EC); and
 - Freshwater Fish Directive (2006/44/EC).
- 10.4.2 The principal legislation is provided by the Water Framework Directive (WFD). The aim of the WFD is to protect and enhance the quality of surface freshwater (including lakes, rivers and streams), groundwater, Groundwater Dependent Terrestrial Ecosystems (GWDTEs), estuaries and coastal waters.
- 10.4.3 The assessment takes into account the following national legislation, policy and guidance:

Legislation

- Flood Risk Management (Scotland) Act 2009;
- Water Environment and Water Services (Scotland) Act 2003;
- Water Environment (Controlled Activities) (Scotland) Regulations 2011;
- The Public Water Supplies (Scotland) Regulations 2004; and

- The Private Water Supplies (Scotland) Regulations 2006.

Policy

- Scottish Planning Policy 2014; and
- SEPA Policy No. 19: Groundwater Protection Policy for Scotland v3, November 2009.

Guidance

- PAN 61 Planning and Sustainable Urban Drainage Systems;
- PAN 79 Water and Drainage;
- SEPA Controlled Activities Regulations: A Practical Guide, Version 8.3, February 2019;
- SEPA Pollution Prevention Guidelines and Guidance for Pollution Prevention as relevant; and
- SEPA Position Statement: Culverting of Watercourses (WAT-PS-06-02), June 2015.

10.4.4 In addition, the assessment has been undertaken cognisant of the following CIRIA guidance for development:

- CIRIA C741 Environmental Good Practice on Site (2015);
- CIRIA C753 The SUDS Manual (2015);
- CIRIA C532 Control of Water Pollution from Construction Sites (2001); and
- CIRIA C648 Control of Water Pollution from Linear Construction Projects (2006).

Assessment of Baseline Conditions

10.4.5 The methodology for baseline characterisation comprised a combination of a review of previous data (i.e. the previously submitted Viking Wind Farm (2009) and 2016 Application for Sandwater Road) and desk based study of publicly available information.

10.4.6 SLR has assumed that all data is correct. No independent checks have been undertaken on the information provided. No field surveys were carried out for this assessment, although additional peat probing was carried out specifically to assist in road design.

10.4.7 The main steps in the baseline characterisation were as follows:

- describe surface water hydrology, including watercourses, springs and ponds;
- identify existing catchment pressures;
- identify private drinking water abstractions and public water supplies within 1km of the Proposed Development;
- identify any flood risks;
- describe the hydromorphological conditions of watercourses;
- collect information relating to recreational and fisheries resources;
- collate historic hydrological flow and flooding data for the immediate area and main downstream watercourses;

- collect soil, geological and hydrogeological information;
- confirm surface water catchment areas and watersheds; and
- confirm the extent and nature of peat deposits across the Proposed Development.

Desk Study

10.4.8 The desk based analysis considered the following sources of information:

- Ordnance Survey (OS) mapping at 1:50,000 and 1:10,000 scale;
- British Geological Survey (BGS), 1:50,000 mapping (<http://mapapps2.bgs.ac.uk/geoindex/home.html>);
- B9075 Sandwater Road Environmental Statement (Viking Energy Wind Farm LLP, 2016);
- SIC records of private water supplies;
- SEPA records on Controlled Activities Regulations (CAR) authorisations;
- SEPA water environment hub (<https://www.sepa.org.uk/data-visualisation/water-classification-hub>);
- SEPA Flood Maps (<http://map.sepa.org.uk/floodmap/map.htm> and <http://map.sepa.org.uk/reservoirsfloodmap/Map.htm>);
- SEPA rainfall data (<https://apps.sepa.org.uk/rainfall/>);
- Viking Wind Farm Environmental Statement (Viking Energy Partnership, 2009); and
- Viking Wind Farm Environmental Statement Addendum (Viking Energy Partnership, 2010).

Assessment of Effects

10.4.9 Effects on water resources are described as positive, neutral or adverse. In describing a potential effect and residual effect, consideration has been given to its duration, and geographical scale, sensitivity and magnitude, which have been defined as follows:

- the duration of an effect can be described as: short to long term, permanent or reversible;
- the geographical scale of an effect refers to the zone of influence. Geographical scale could be described as: local, county level e.g. Shetland Islands, regional e.g. northern isles, national, global;
- the sensitivity of the receptor is described with reference to Table 10.2; and
- the size or magnitude of each impact is determined as a predicted deviation from the baseline conditions during construction, operation and decommissioning with reference to Table 10.3.

Sensitivity/Importance

10.4.10 The sensitivity or value of a hydrological receptor or attribute is largely determined by its quality, rarity and scale.

- 10.4.11 The determination of value or sensitivity takes into account the scale at which the attribute is important. This can be defined as being at a local level (e.g. on development site or immediately adjacent); district level (beyond development site boundary but within the district); county level (e.g. Weisdale); regional level (e.g. Shetland Island); national (e.g. Scotland) or international level (e.g. United Kingdom).
- 10.4.12 The definitions set out in Table 10.2 below have been followed in the consideration of sensitivity for this project. This table takes into account guidance provided in Table 2.1 and A4.3 of the Design Manual for Roads and Bridges (DMRB) (Highways Agency et al., 2009) and the authors professional judgement.
- 10.4.13 Table 10.1 sets out the criteria used to define the sensitivity of water resource receptors.

Table 10.1: Sensitivity of Water Resource

Sensitivity of Receptor	Criteria
High	EC Designated Salmonid /Cyprinid fishery Surface water WFD class 'High' Scottish Government Drinking Water Protected Areas Aquifer providing regionally important resource such as abstraction for public water supply, abstraction for private water supply supplying more than 10m ³ / day for human consumption or serves more than 50 persons or supporting a site protected under EC or UK habitat legislation/species protected by EC legislation Protected Bathing Water Area
Medium	Surface water WFD class 'Good' or 'Moderate' Aquifer providing water for agricultural or industrial use or for individual household private water supply supplying less than 10m ³ /day for human consumption or serves less than 50 persons.
Low	Surface water WFD class 'Poor' Unproductive strata

Magnitude of Effect

- 10.4.14 Table 10.2 sets out the criteria used to define the magnitude of change to water resource receptors.

Table 10.2: Sensitivity of Water Resource

Magnitude of Effect	Criteria
High	Total loss of ability to carry on activities. Impact is of extended temporal or physical extent and of long term duration (i.e. approximately 50 years duration).
Medium	Loss or alteration to significant portions of key components of current activity. Impact is of moderate temporal or physical extent and of medium term duration (i.e. less than 20 years).
Small	Minor shift away from baseline, leading to a reduction in level of activity that may be undertaken. Impact is of limited temporal or physical extent and of short term duration (i.e. less than 2 years).
No change	No alteration/change detectable in the quality or quantity of controlled waters and/or to the physical or biological characteristics of surface waters.

Significance of Effect

- 10.4.15 The final significance of the residual effects upon the baseline environment is defined as a function of the sensitivity of receptors and the magnitude of change, as presented in Table

10.4. Moderate or Major effects are deemed significant in terms of the EIA Regulations; while Minor, Negligible or No change are judged to be not significant. Differentiations between categories and thus, the final significance ratings, are based upon professional judgement.

10.4.16 The assessment of residual effects takes account of the design of the Proposed Development as described in Chapter 4 (Description of Development), the implementation of construction mitigation measures set out in Appendix 4.1, which provide details of the Outline Draft Construction Environmental Management Plan (CEMP), the Stage 1 Peat Management Plan (Appendix 10.4), and mitigation set out in this chapter.

Table 10.3: Significance of Effects

Sensitivity \ Magnitude	High	Medium	Low	No change
	High	Major	Major	Minor
Medium	Moderate	Moderate	Minor	No change
Low	Minor	Minor	Negligible	No change

10.5 Limitations to the Assessment

10.5.1 The assessment is primarily based on publicly available data sources, including but not limited to SEPA, Met Office, Local Authority and commercial data supply companies, as well as additional information supplied from stakeholders during the scoping and consultation stages. It is considered that the individual data items provided are robust.

10.5.2 However the assessment is limited by a lack of:

- flow data for water courses and drainage channels;
- water quality data for specific locations; and
- details on any temporary constructions within the study area.

10.5.3 Overall a moderate to high level of certainty has been applied to the study, and the limitations are not significant, nor do they effect the findings of the assessment.

10.6 Baseline Conditions

Topography and Land Use

10.6.1 The Proposed Development lies primarily on an area of non-plantation open ground with OS mapping showing the highest point to be located in the centre of the Proposed Development, at between 70m and 80m Above Ordnance Datum (AOD). This location is on the watershed between the catchments of the Burn of Weisdale (to the west) and the Burn of Sandwater (to the east).

10.6.2 From the central point the topography slopes to a minimum elevation of approximately 20m AOD at the western extent, in close proximity to the Burn of Weisdale. The topography also slopes to the east with a minimum contour level of 40m AOD shown in close proximity to Sand Water Loch.

10.6.3 The immediate surroundings of the Proposed Development are as follows:

- north - predominantly modified bog subject to grazing;
- east - the A970 with grazing land beyond;
- south - predominantly modified bog and unimproved grassland subject to grazing. Sand Water Loch is located to the south of the eastern extent of the Proposed Development; and
- west - semi-improved grassland with residential properties at Springfield, Setter House and South Setter located approximately 350m from the Proposed Development.

Precipitation

10.6.4 Standard annual average rainfall (SAAR) for the Proposed Development has been derived from the Flood Estimation Handbook (FEH) to be between 1,276 – 1,339mm. To put this in context, rainfall in Scotland varies from under 800mm per year on mainland eastern Scotland in areas such as Fife to over 3,000mm per year on the mainland Western Highlands.

10.6.5 There is also a SEPA rain gauge and river flow gauging station situated at Weisdale Mill approximately 2.5km downstream (1.6km south) of the Proposed Development. Monthly rainfall totals (mm) have been proved by SEPA. From these datasets, annual rainfall totals were 1,339.6 mm in 2016, 1,524.8 mm in 2017 and 1,133.6 mm in 2018 with an annual average rainfall of 1,332.7 mm derived. This annual average rainfall for the past three years is within the range of values for SAAR extracted from the FEH which were derived between 1961 and 1990.

Geology, Hydrogeology and Soils

10.6.6 Table 10.4 presents a summary of the stratigraphy of the area.

Table 10.4: Site Stratigraphy (British Geological Survey, 2013)

Age	Unit	Typical Description
Recent Quaternary	Peat	An accumulation of variable thickness of dark brown, partially decomposed vegetation.
	Alluvium Glacial Till (Diamicton) Lacustrine Deposits	Hill wash/stream deposits of clay, silt and stone. Generally tough, well consolidated deposits of silty clay or sandy clay, containing numerous rounded pebbles and boulders.
Devonian	Walls Boundary Fault Zone	Metalmestone with bands of calcsilicate rock.
Neoproterozoic Era	Colla Firth group	Permeation And Injection Belt, consisted by gneissose granite.
	Weisdale Limestone Member Whiteness Limestone Member	Colla Firth Formation, consisting of granofelsic psammite and granofelsic semipelite. Metalmestone with bands of calcsilicate-rock. Metalmestone.

Superficial Deposits

- 10.6.7 BGS mapping (see Appendix 10.5, Figure 10.3) indicates that superficial deposits cover the majority of the study area with only a few small areas mapped as having no superficial deposits, generally around stream beds and ridges and summits of local hills.
- 10.6.8 Peat is the most extensive superficial deposit mapped across the study area, and covers approximately 90% of the area. An area of alluvium deposits (comprising clay, silt, sand and gravel) is mapped associated with river terrace deposits of the Burn of Weisdale.
- 10.6.9 A small area of Devensian glacial till (comprising clay, sand and gravel) is mapped near the junction of the B9075 Sandwater Road and the A970, while a more extensive area of Devensian glacial till is mapped to the west of the Burn of Weisdale. A small area of lacustrine deposits (comprising silt and clay, including organic and/or calcareous muds, of lacustrine origin) are present to the south-west of Sand Water Loch.

Solid Geology

- 10.6.10 BGS mapping indicates that the solid geology of the study area comprises mainly metamorphosed sedimentary rocks with some small areas of metamorphosed igneous rocks, which are part of The Walls Boundary Fault (WBF) zone (see Appendix 10.5, Figure 10.4). As a result, groundwater is likely to be restricted to fractures and joints.
- 10.6.11 BGS rock samples (BGS Geoindex Onshore) situated within the site area consists of Pelite and Semi Pelite.

Hydrogeology

- 10.6.12 BGS hydrogeological mapping shows that the Proposed Development overlies a 'Low Productivity Aquifer' which has small yields where fractured near surface and from springs locally.
- 10.6.13 Drift deposits consisting of glacial and periglacial deposits are relatively thin and discontinuous. As such, they have limited storage potential. Glacial till or solifluction deposits are likely to form the impermeable layer on which many of the lochs and lochans are formed.
- 10.6.14 The crystalline meta-sedimentary bedrock does not have a significant weathered horizon and as a result groundwater is likely to be restricted to fractures and joints only to a depth of a few metres below surface. Groundwater may also be found associated with the Walls Boundary Fault and other minor faults in the area. Some formations can locally yield water supplies in sufficient amounts for private use.
- 10.6.15 Groundwater within peat is generally perched on less permeable underlying geology or drift. Where the peat is thick and located in areas of low relief, as observed on valley floors and saddles in elevated areas, it provides baseflow to local streams. While peat in some areas might have sufficient storage to ensure perennial flow, flow in the majority of watercourses is ephemeral and restricted to periods during, and immediately following, prolonged wet weather.

- 10.6.16 In lower-lying areas of lesser relief and where peat is relatively thin, the groundwater generally occurs at shallow depth. Groundwater may rise above the surface for short periods following extended rainfall. These areas are often defined by the presence of sphagnum species on the site surface.
- 10.6.17 In relation to vulnerability, the groundwater in the vicinity of the Proposed Development is predominantly classed as 4d ('Vulnerable') (British Geological Survey, 2004). Class 1 areas are designated by SEPA as having the lowest risk of groundwater pollution and Class 5 the highest. This classification reflects the low permeability and low groundwater storage capacity of the metamorphic and igneous bedrock combined with the very variable soil and drift cover, meaning that any contaminant could potentially enter groundwater rapidly but would be slow to disperse or dilute once in the aquifer. In areas with deep peat, the peat would act as a barrier to the entry of contaminants into the groundwater although it would also serve to restrict access of water into the bedrock for dilution purposes.
- 10.6.18 SEPA's Water Environment Hub shows the Proposed Development to overlie the Shetland Groundwater Body (SEPA ID 150687), which is classified by SEPA as being a Drinking Water Protection Zone (DWPZ). SEPA has classified this water body as having an overall status of Good, a chemical status of Good and the DWPZ area with a status of Good in 2017.

Surface Hydrology and Drainage

Surface Water Features

- 10.6.19 There are a number of watercourses draining the Proposed Development area, the major streams tending to run north-south or south-north due to the topography of the area. These are summarised in the following paragraphs.

Burn of Weisdale Catchment

- 10.6.20 The west of the Proposed Development lies within the Burn of Weisdale catchment as shown in Appendix 10.2. The Burn of Weisdale flows in a general north to south orientation before discharging into Weisdale Voe approximately 3km south-west of the Proposed Development.
- 10.6.21 This catchment is bound between the parallel north-south ridges of West Kame and Mid Kame, known as the Valley of Kergord. The Valley of Kergord is a glaciated 'u-shaped' valley feature which collects drainage from both slopes, with run-off draining to the south. The total catchment area is approximately 13.17km² (1317 hectares). Approximately 6.7 km² of the total catchment is upstream of the Proposed Development. The watercourses in this catchment total 7.26km in length.
- 10.6.22 The Valley of Kergord presently contains a number of channels such as the Burn of Kergord, the Burn of Droswall and the Burn of Swirtas. These streams meet to become known as the Burn of Weisdale. The Burn of Weisdale flows on to the south, meeting Weisdale Voe at the settlement of Weisdale.
- 10.6.23 The relatively impermeable nature of the geology (and low water bearing capacity of the underlying bedrock) and low potential for rainfall infiltration means that the river flow is dominated by surface water inputs rather than baseflow. Further catchment descriptors are provided in Appendix 10.2.

- 10.6.24 There are areas along the Burn of Weisdale which are designated within SEPA's indicative Flood Map as being land at risk of flooding from rivers. The indicative Flood Map shows the possible extent of flooding from rivers and/or the sea and primarily focuses on the 200 year flood event (an event with a 0.5% chance of occurring any year) in line with Scottish Planning Policy. The Flood Map provides a national assessment of the extent of flooding which may be experienced from rivers and/or the sea. The areas of flood risk along the Burn of Weisdale are, however, to the west of the Proposed Development and the floodplain does not intersect with any areas within the development area. The flood extents in this area are contained along the banks of the Burn of Weisdale and do not form large floodplains.
- 10.6.25 There is a weir located at Weisdale (HU39470 53000). This structure will influence flow regime in this catchment. There is a SEPA rain gauge and river flow gauging station situated at Weisdale Mill on this catchment.
- 10.6.26 SEPA has classified the Burn of Weisdale (SEPA ID 20679) as having an overall status of Good with overall ecological status of Good, Physico-Chem status of Good and no pressures have been identified.
- 10.6.27 Weisdale Voe (SEPA ID 200258), the tidal water downstream of the Burn of Weisdale catchment, has been classified as having an overall status of Good in 2017 with overall ecological status of Good and Physico-Chem status of High. Weisdale Voe is also recognised as a shellfish water (SEPA ID SWPA82) and in 2014 was given an overall status of Fair.
- 10.6.28 The current status of Weisdale Voe meets the requirements of the Water Framework Directive, thus SEPA must ensure that no deterioration from Good status occurs, unless caused by a new activity providing significant specified benefits to society or the wider environment. The future objectives for Weisdale Voe are, therefore, to maintain the Good ecological status through the 2008, 2015 and 2021 RBMP cycles.

Burn of Sandwater Catchment

- 10.6.29 The east of the Proposed Development lies within the Burn of Sandwater catchment as shown in Appendix 10.2. This watercourse is annotated as Burn of Pettawater to the north of the Proposed Development and flows in a general north to south orientation before discharging into Sand Water Loch, approximately 30m south-west of the Proposed Development. Downstream of Sand Water Loch the watercourse is annotated as Burn of Sandwater. The watercourse ultimately discharges into the Loch of Strom. Under SEPA's classification process, the watercourse is referred to as Stromfirth Burn (SEPA ID 20678). For the purposes of this assessment, the entire watercourse is referred to as Burn of Sandwater due to its connectivity with Sand Water Loch adjacent to the Proposed Development.
- 10.6.30 This catchment covers a total area of approximately 14.69km² (1469 hectares) within the fjord-like valley known as Petta Dale. Approximately 6.7km² of the total catchment is upstream of the Proposed Development (as derived from the FEH CD-ROM). There is 33.98km of watercourse length and loch frontage in this catchment. Water flows through this valley from north to south with the wide, flat valley floor bound by steep slopes to the east and west.

- 10.6.31 The relatively impermeable nature of the geology (and low water bearing capacity of the underlying bedrock) and low potential for rainfall infiltration means that the river flow is dominated by surface water inputs rather than baseflow. Further catchment descriptors are provided in Appendix 10.2.
- 10.6.32 There are two notable waterbodies in the catchment; Petta Water (0.11 km²) which is upstream of the Proposed Development, and Sand Water Loch (0.37km²), immediately downstream of the Proposed Development. Sand Water Loch is a shallow loch, classed as being 'mesotrophic', which represents natural, mid-productivity, mid-nutrient status lochs which are generally very sensitive to nutrient-enrichment. Sand Water Loch is designated as a Site of Special Scientific Interest (SSSI) due to its mesotrophic nature and is, therefore, susceptible to pollution and, particularly, nutrient-enrichment. Further information with regard to the ecological value of Sand Water Loch is provided in Chapter 9 (Ecology).
- 10.6.33 The Burn of Sandwater flows southward from Sandwater to reach the coast at Stromfirth, approximately 4.3km south of the Proposed Development. The Proposed Development also passes through the catchments of several smaller unnamed watercourses which discharge directly into Sand Water Loch.
- 10.6.34 There are areas of land around Sand Water Loch which are shown in SEPA's indicative Flood Map as being at risk of flooding from rivers. As set out previously, the indicative Flood Map shows the possible extent of flooding from rivers and/or the sea for the 200 year flood event (an event with an annual probability of occurrence of 0.5%). Although these areas include the existing B9075, the Proposed Development is located to the north of the existing road and is therefore outside the area of flood risk associated with Sand Water Loch. However, the SEPA Flood Map also shows that areas along the course of the Burn of Pettawater, upstream of the Loch, are at risk of flooding. The Proposed Development, at the location it crosses the Burn of Pettawater, is therefore in an area of perceived fluvial flood risk.
- 10.6.35 SEPA has classified the Burn of Pettawater as having an overall status of Good, with overall ecological status of Good and Physico-Chem status of Good and no pressures have been identified.
- 10.6.36 The current status of the Burn of Pettawater meets the requirements of the Water Framework Directive, thus SEPA must ensure that no deterioration from Good status occurs, unless caused by a new activity providing significant specified benefits to society or the wider environment.
- 10.6.37 The Loch of Strom (SEPA ID 200254), the tidal water downstream of the Burn of Sandwater catchment has been classified by SEPA as having an overall status of Good, with overall ecological status of Good and Physico-Chem status of High. Loch of Strom in turn discharges to Stromness Voe, recognised as a shellfish water (SEPA ID SWPA76) and in 2014 was given an overall status of Fair.
- 10.6.38 The current status of the Loch of Strom meets the requirements of the Water Framework Directive, thus SEPA must ensure that no deterioration from good status occurs, unless caused by a new activity providing significant specified benefits to society or the wider environment.

10.7 Watercourse Crossings

10.7.1 A total of seven existing watercourse crossings were identified as part of the 2016 ES associated with the existing B9075 Sandwater Road (see Appendix 10.1 and Appendix 10.5, Figure 10.6). These culverts and one bridge crossing (Point G) all appeared to be conveying flow although specific capacity or condition surveys were not undertaken. Table 10.5 below identifies the grid references of each crossing point.

Table 10.5: Sandwater Road surface water crossing points

Description	Grid Reference	X	Y
Point A	HU 40075 54773	440075	1154773
Point B	HU 40089 54778	440089	1154778
Point C	HU 40339 55006	440339	1155006
Point D	HU 40444 55100	440444	1155100
Point E	HU 41272 55166	441272	1155166
Point F	HU 41325 55196	441325	1155196
Point G	HU 41532 55269	441532	1155269

10.7.2 Further detail on the location and observations on the existing crossings is provided in Appendix 10.1 (Schedule of Watercourse Crossings).

10.7.3 The drainage provisions for the existing B9075 typically comprise of a ditch on the up-gradient side of the road which intercepts upstream greenfield run-off. These ditches connect with cross drain culverts which discharge this run-off to down-gradient areas. Such cross drains should discharge diverted greenfield run-off into an area of vegetation for dispersion or infiltration as close as possible to the location of interception in order to ensure that there is no effect on soil moisture regimes downstream. However, in some locations along the existing B9075 these drains connect with small ditches which flow from the road to surrounding waterbodies such as the Burn of Weisdale or the Burn of Sandwater or directly to Sand Water Loch. It is not clear if these ditches have been deliberately created as part of the road's drainage regime or have been caused by erosion. The majority of the cross drains were not observed to have appropriate scour control and energy dissipation measures at the discharge point. As a result, erosion was observed at a number of locations.

10.7.4 Run-off from the road itself was observed to discharge directly to surrounding vegetation along long stretches of the road. However, in some areas, downstream ditches were observed which connected with cross drains and downstream waterbodies. It is not clear if these ditches have been engineered or have been caused by erosion.

10.8 Flow Characteristics

10.8.1 There is a SEPA rain gauge and river flow gauging station situated at Weisdale Mill within the Burn of Weisdale catchment. This gauge is approximately 2.5km downstream (1.6km south) of the Proposed Development.

10.8.2 This is a velocity-area station which was commissioned in 2002 to obtain continuous flow data for Shetland. The gauging station details describe the watercourse as having steep banks at the gauge location which contain the majority of flows. The bed is described as

being gravel and small boulders with consistent depth. There is reported to be weed growth in summer; therefore, a second rating curve has been developed by SEPA to calculate flows in 'weedy' conditions. The gauging station details confirm that there is a fish hatchery nearby which abstracts and discharges water although the rates of each are not given.

- 10.8.3 Table 10.6 presents the mean and peak flow estimates derived by SEPA based on gauged daily flow:

Table 10.6: Mean and Peak Flow Estimates for Burn of Weisdale (at Weisdale Mill gauging station)

Flow Scenario	Flow Rate
Mean Flow	0.639m ³ /s
95% Exceedance (Q95)	0.042m ³ /s
70% Exceedance (Q70)	0.122m ³ /s
50% Exceedance (Q50)	0.227m ³ /s
10% Exceedance (Q10)	1.355m ³ /s

- 10.8.4 The ratio of peak flow from observed data and estimates from catchment descriptors at the Weisdale Mill gauge have been used to calibrate peak flow estimates from catchment descriptors for the Burn of Weisdale and the Burn of Sandwater at the location of the Proposed Development.

- 10.8.5 Table 10.7 sets out the estimate of 95th Percentile Exceedance Flow (Q95) for Weisdale Mill from observed data and from catchment descriptors and provides the ratio of difference between the two. This is the 10 day average flow exceeded by 95% of 10 day average discharges as defined in Low Flow Estimation in Scotland (Gustard et al, 1987).

Table 10.7: Ratio of Observed Flow (m³/s) and Catchment Descriptor Derived Low Estimate (m³/s) at Weisdale Mill

	Observed Flow Estimates	Catchment Descriptor Flow Estimates	Ratio
Q95*	0.042	0.025	1.68

*Asset out in Institute of Hydrology Report 101 (Low Flow Estimation in Scotland)

- 10.8.6 Table 10.8 sets out the Q95 and the Mean Annual Flood (Qbar) estimates for the Burn of Weisdale and the Burn of Sandwater. This is the Mean of Annual Maximum Flood Flows as defined in Estimating Flood Flows for Small Catchments (1994). These have then been adjusted according to the ratio in Table 10.7.

Table 10.8: Calibrated Peak Flow Estimates (m³/s) for Burn of Weisdale and Burn of Sandwater at Sandwater Road

	Burn of Weisdale Peak Flows		Burn of Sandwater	
	Catchment Descriptor	Adjusted	Catchment Descriptor	Adjusted
Q95*	0.012	0.21	0.011	0.019
QBAR**	5.72	10.07	5.51	9.70

*As set out in Institute of Hydrology Report 101 (Low Flow Estimation in Scotland)

** Mean Flow as set out in Institute of Hydrology Report 124 (Estimating Flood Flows for Small Catchments)

Water Quality

- 10.8.7 The WFD came into force in December 2003 and is implemented in Scotland through the Water Environment and Water Services (Scotland) Act 2003. A key objective of this Directive is the achievement of 'good ecological status' (as a minimum) of all natural waterbodies by 2015.
- 10.8.8 To achieve this, a move towards a risk-based classification system was adopted. This risk-based system highlights additional issues such as stream morphology and existing artificial structures.
- 10.8.9 As part of the original Viking Wind Farm ES (2009), Mouchel undertook a water quality assessment for a number of catchments which fall within the development study area. Mouchel agreed with SEPA that the former 2006 River Water Quality Classification system, using a 5 point scale to define water quality as being 'Excellent' (A1), 'Good' (A2), 'Moderate' (B), 'Poor' (C) and 'Seriously Polluted' (D) (SEPA 2008b) was most appropriate. This system excludes issues such as obstructions in streams within the overall classification.
- 10.8.10 As part of this study, samples were collected from streams in December 2008 and January 2009. These samples were analysed for the parameters used by SEPA in their 2006 chemical classification of water quality. Those pertinent to the Proposed Development have been extracted from the report and outlined below.
- Burn of Weisdale, 2006 SEPA Class A2, Equivalent to 2006 SEPA Class A1
 - Burn of Pettawater, 2006SEPA Class A2, Equivalent to 2006 SEPA Class A1
- 10.8.11 Catchment water quality within the Proposed Development study area is assessed as Excellent to Good.

Artificial Subsurface Land Drainage

- 10.8.12 Given that the Proposed Development area is characterised by wet modified bog, it is considered unlikely that there will be any underground artificial land drainage assets within the Proposed Development. No such assets were observed during the site walkover.

Water Supplies

- 10.8.13 Information provided by Site Investigation Services (UK) Limited, on behalf of Scottish Water, was used to identify the mains supply's route and asset locations (valves) (see Appendix 10.5, Figure 10.5). The mains supply is located south of the existing B9075 and generally follows the route of the road, although it deviates from the road for a 500m stretch between the Burn of Weisdale and Sand Water Loch. The locations of four of the Asset Locations were confirmed during site visits undertaken by Environ (2013). Access to the remaining two assets was restricted.
- 10.8.14 Information supplied by the Environmental Health & Trading Standards Department at SIC has confirmed that there are no Private Water Supplies (PWS) within the 1km study area for the Proposed Development. This is consistent with the information provided by Scottish Water, which confirms the presence of a mains supply in the study area.

10.8.15 There is only one PWS within a 5km radius of the Proposed Development located in close proximity to Hellister (grid reference HU393496) approximately 5km south of the Proposed Development. The council has reported that the PWS comprises a reservoir tank fed by various springs which supplies four properties, two of which are vacant. The zone of contribution for the springs would be limited to the Hill of Hellister immediately to the east of the PWS which is, therefore, not in hydraulic connectivity with the Proposed Development. It is not therefore considered necessary to undertake a specific PWS Risk Assessment.

10.9 Modifying Influences

10.9.1 There is potential for climate change to impact on future baseline conditions. Climate change studies predict a decrease in summer precipitation and an increase in winter precipitation alongside slightly higher average temperatures. This suggests that there may be greater pressures on PWS in summer months in the future. However, as mentioned previously, no PWS have been identified in hydraulic connectivity with the Proposed Development.

10.9.2 In addition, summer storms are predicted to be of greater intensity. Therefore, peak fluvial flows associated with extreme storm event may also increase in volume and velocity.

Table 10.9: Summary of Sensitive Receptors

Receptor	Sensitivity	Justification
Burn of Weisdale catchment	High	The Burn of Weisdale is classified as having an overall status of Moderate but discharges into the Weisdale Voe which is classified as having an overall status of Good.
Burn of Sandwater catchment	Very High	The Burn of Sandwater catchment contains Sand Water Loch which is designated as a Site of Special Scientific Interest (SSSI). The loch is designated as a SSSI due to its mesotrophic nature and is, therefore, susceptible to pollution and, particularly, nutrient-enrichment.
Shetland Groundwater Body	High	The Site overlies the Shetland Groundwater Body which is classified by SEPA as being a Drinking Water Protection Zone (DWPZ), with the exception of the Solway and Tweed catchments and some intermediate areas in Dumfries & Galloway and the Borders, the whole of Scotland is designated as a DWPZ for groundwater. Therefore, the groundwater beneath the Site is considered to be of High Sensitivity.
Highly groundwater dependent terrestrial ecosystems (SEPA, 2014)	Moderate	The Site overlies areas of habitat which are deemed to be High GWDTE. These are deemed to be of local ecological value and are, therefore, of Moderate Sensitivity.
Moderately groundwater dependent terrestrial ecosystems (SEPA, 2014)	Low	These are deemed to have lower dependence on groundwater and, therefore, are considered to be of Low Sensitivity in terms of Geology, Hydrogeology and hydrology. Please see Ecology Chapter 9 for details of habitats with the potential to be classified as GWDTEs along with the assessment of potential effects to these.

10.10 Potential Effects

10.10.1 The potential effects (i.e. in the absence of mitigation) are described in general terms in the following paragraphs, providing justification for the mitigation developed for the project which is described in the following sections of the chapter. The significance of

effects is not attributed in this section, but included under the residual effects (Section 10.9).

- 10.10.2 The Proposed Development will be constructed in accordance with relevant legislation and guidance. Therefore, there is potential for the operation phase of the Proposed Development to represent betterment on the baseline conditions as a result of the design of each proposed watercourse crossing to allow for free passage of fish and mammal species and having sufficient capacity to pass the 1:200 year flood, and include an allowance for potential partial blockage and the potential effects of climate change.

Alteration of Natural Drainage Patterns and Run-off Volumes/Rates

- 10.10.3 During construction, in-channel or overland flow regimes can be altered through excavations, exposure of bare earth or rock, poor maintenance of drainage ditches or inappropriate water crossing design. This can impact on watercourses upstream and downstream of the Proposed Development and therefore affect flood risk, aquatic ecology and water resources.
- 10.10.4 Potential effects on flood risks may appear during the operation phase, affecting aquatic ecology and water resources by modifying surface water run-off responses to precipitation.

Pollution Impact from Silt-Laden Run-off

- 10.10.5 Potential increased erosion and transport of sediment to watercourses may appear during the construction phase. This can impact adversely on flood risks, aquatic ecology and water resources.
- 10.10.6 During operation, effects may include concentration of surface water flows as a result of poorly designed site infrastructure, leading to potential long term increases in erosion and sediment transport.

Chemical Contaminated Run-off/Pollution

- 10.10.7 During construction, accidental release of chemicals stored and used on-site could affect the water quality of receiving soils, groundwater and watercourses; therefore, impacting ecological and water resource receptors.
- 10.10.8 There would remain a potential risk of spills of hydrocarbons associated with vehicles during operation.

Groundwater Disruption

- 10.10.9 Changes to the soil interflow regime as a result of construction, excavation and foundation works, in particular associated with watercourse crossings, can lead to increased localised flood risks and alterations to downstream flow regimes.
- 10.10.10 There is also potential for works to cause long term alterations to soil interflow regimes of the Burn of Weisdale and the Burn of Sandwater during operation.

Watercourse Bank Integrity

- 10.10.11 Direct damage could occur to the banks of watercourses as a result of construction works and indirect effects could be caused as a result of alterations to natural drainage patterns or the sediment transport regime of the watercourse.
- 10.10.12 Permanent infrastructure should have little direct impact on bank integrity apart from at watercourse crossings where changes to fluvial morphology could occur. There could, however, be indirect impacts as a result of alterations to natural drainage patterns and sediment transport regimes during operation.

Peat Landslide Hazard Risk

- 10.10.13 The PLHRA undertaken for the 2016 ES (see Appendix 10.3) indicated that there are three sections within the vicinity of the Proposed Development that present a medium to high risk of peat sliding. The three areas are located within the vicinity of the Burn of Pettawater, Sandwater Loch and Burn of Weisdale and reflect areas of deep peat recorded at these locations. However the new track design incorporating extensive floating road will reduce the risk significantly, primarily due to reduced excavation of peat.
- 10.10.14 The recent peat data has been incorporated into the road design construction. The redesign utilises extensive sections of floating road which will ultimately reduce risk of peat slide significantly.

10.11 Mitigation

Mitigation During Construction

Alteration of Natural Drainage Patterns and Run-off Volumes/Rates

- 10.11.1 Consideration will be given to natural drainage paths within the catchment during development of the permanent drainage design, prior to construction commencing, to ensure they are not altered by construction.
- 10.11.2 Where watercourses and ditches are to be crossed, new culverts would be required. Culverts would be designed in accordance with industry good practice to accommodate the design axle loads of construction traffic and necessary capacity of the watercourses / ditch. Culverts would be subject to suitable provision being made for flood flows and ecological and geomorphological mitigation, and compliance with the environmental commitments detailed within this EIA Report.

Pollution Impact from Silt Laden Run-off

- 10.11.3 Sustainable drainage system (SUDS) principles have been adopted in the road design. Rainfall would be managed as close to its source as possible and would not be conveyed over long distances unless unavoidable.
- 10.11.4 Pollution control measures would be implemented with specific reference to best practice, and incorporated within the CEMP (see Appendix 4.2). At all locations where proposed infrastructure is in close proximity to a watercourse, appropriate silt entrapment measures would be provided.

- 10.11.5 All temporary stockpiles associated with construction will be located at least 50m from the edge of watercourses. All excavations will be backfilled as soon as practicable.
- 10.11.6 Soil compaction and disturbance will be controlled by limiting vegetation and soil stripping to essential areas only. Topsoil will be stripped and stored according to good practice guidelines prior to allowing excavation of sub-soils in order to preserve the soil resource. The movement of construction plant will be controlled and limited to defined areas, with tracking routes agreed by an Ecological Clerk of Works (ECoW) as part of the CEMP. To ensure that all drainage measures employed during the construction phase of the Proposed Development are maintained appropriately and remain effective, the performance of the drainage measures will be monitored. The construction works will follow good practice principles as prescribed in the CEMP. The drainage management works will then be supervised by the ECoW. All monitoring and supervision of the drainage management works will be recorded.
- 10.11.7 No discharge of water from settlement ponds or temporary stockpiling of excavated material will be allowed within 50m of any of the watercourses or water bodies identified within the site, unless otherwise agreed with the ECoW.
- 10.11.8 Further details are provided in the Outline Draft CEMP (Appendix 4.2).

Clean Water Diversion

- 10.11.9 At all construction works areas, greenfield run-off (i.e. non-silty surface water flow that has not yet passed over any disturbed construction areas) will be kept separate from potentially contaminated water from construction areas where possible. Where appropriate, interceptor ditches and other drainage diversion measures will be installed, immediately in advance of any excavation works, in order to collect and divert greenfield run-off away from construction disturbed areas.
- 10.11.10 In accordance with industry guidance, ditches will follow the natural flow of the ground with a generally constant depth to ditch invert. They will have shallow longitudinal gradients and they will intercept any greenfield surface water run-off immediately upstream of any construction works areas. This will allow clean surface water flows to be transferred independently through the works without mixing with construction drainage. This will also reduce the flow of water onto any exposed areas of rock and soil, thereby reducing the potential volume of silt-laden run off requiring treatment.
- 10.11.11 Discharge of the diverted greenfield run-off will be into an area of vegetation for dispersion or infiltration and will occur as close as possible to the location of interception in order to ensure that there is no effect on soil moisture regimes downstream of the works. The interception and diversion of such greenfield run-off around site infrastructure will also occur at regular spatial intervals so that the volumes of water dispersed or infiltrated at each discharge point are not significant. Appropriate scour control and energy dissipation measures (e.g. use of regular cross culverts, rock check dams and other surface protection measures) will be used at the discharge point in order to attenuate flow, prevent erosion at the outlet and aid in-flow dispersion across a wider area of vegetation to prevent potential scour and remobilisation of deposited silt.
- 10.11.12 Discharge points (for clean run-off water) will be located at sufficient distance (minimum of 50m, unless otherwise agreed with the ECoW) from any watercourses to allow adequate

infiltration or settlement of suspended solids prior to any discharged surface run-off potentially entering watercourses.

Drainage Channels

- 10.11.13 Where possible, drains will be constructed so that the gradient does not exceed 2% in order to prevent rapid run-off rates, concentration of flow, erosion of the drain base and sides, and encourage establishment of terrestrial and aquatic vegetation where possible. The drainage channels will be checked regularly during the construction phase to ensure that the channels' side slopes remain stable and to ensure that debris is removed from the base of the channels. If instability is noted within the banks or bed of a drainage channel, appropriate erosion prevention measures will be implemented.
- 10.11.14 Temporary check dams (flow barriers or dams constructed across the drainage channel) will be installed at regular intervals within any clean water or dirty water cut off ditches to reduce the velocity of water and therefore allow settlement of coarser sediment particles as well as silt at low flow conditions. Reduction in flow velocity will also prevent scouring of the drainage channel itself.
- 10.11.15 Silt traps will be installed where required (and where practical for maintenance purposes) at intervals along drainage channels. Silt traps will also be constructed at the inlet and outlet of any pipe culverts to prevent the pipes becoming blocked and prevent erosion at the inlet and outlet points.
- 10.11.16 Check dams and silt traps will be maintained and monitored on a regular basis. Where check dams become fully laden with silt they will be replaced.

Settlement Ponds

- 10.11.17 Silt-laden run-off will be captured and directed via berms or ditches towards specially constructed sediment control structures for use during the construction phase. Additional filtration measures may include flow attenuation measures such as weirs, rock bars and/or anchored and embedded straw bales within ponds or between series of ponds. The specific approach shall be agreed between the Contractor and ECoW.
- 10.11.18 The use of synthetic liners within settlement ponds will be avoided, where practical, in order to reduce the impacts from disturbance of silt during liner removal and reinstatement of ponds on completion of construction. Any introduced or artificial materials required for temporary erosion or silt mitigation controls, such as silt fencing, straw bales, sand bags etc. will be removed upon completion of construction works.
- 10.11.19 Final discharge from any settlement pond will be over vegetated ground and away from surface water bodies (minimum distance 50m, unless otherwise agreed by the ECoW). Silt fences or other flow attenuation measures may be required at the discharge point in order to aid dispersal and prevent build-up of settled solids, which could be subject to remobilisation.
- 10.11.20 Settlement ponds will be designed and constructed with sufficient capacity for settlement and to allow contingency for unexpected increased rainfall events. Contingency measures will include additional capacity within an existing pond, or identification of additional areas within the vicinity which may be suitable for creation of additional ponds.

- 10.11.21 In the event that the natural or excavated ground profile in any area of the site does not lend itself easily to construction of an adequate settlement pond, water will be directed towards a sump area prior to being pumped away to a suitable settlement pond(s) or vegetated area with adequate silt mitigation measures well away from sensitive habitats or watercourses.
- 10.11.22 Silting of settlement ponds would take into consideration access requirements for reinstatement and maintenance (for example: periodic silt removal, expansion of ponds or incorporation of additional silt mitigation measures, etc.). Additional temporary silt mitigation measures will be provided during maintenance and reinstatement activities, as required.
- 10.11.23 Where water depth within settlement ponds has the potential to exceed 0.5m, the Contractor considers the use of perimeter safety fencing and appropriate warning signs. The Contractor will discuss and agree the location of lagoons and other drainage mitigation measures with the ECoW prior to associated works taking place.

Soil Storage and Reuse

- 10.11.24 The location of any temporary soil storage areas will be considered such that erosion and run-off is limited, leachate from the stored material is to be controlled and stability of the existing ground is not affected.
- 10.11.25 Surface water interceptor ditches (up slope), down slope drainage collection systems, containment berms (embedded where appropriate), and appropriate drainage mitigation measures may be required.
- 10.11.26 The Contractor, in conjunction with their ECoW will carefully select the locations and design the spoil storage requirements, including methods for reinstatement works and incorporated drainage elements. Such design shall be prepared and agreed in consultation with the ECoW and Contractor prior to works commencing.

Peat Storage and Reuse

- 10.11.27 The peat volumes for the Proposed Development have been calculated utilising the excavated areas identified along the route and modelling the cut volume of peat based on peat probing data. The total excavated peat volume along the route (with an overall length of 2090m), has been estimated to give rise to the temporary displacement of 31,150m³ of peat. The temporarily displaced peat is estimated to comprise approximately 28,450m³ of acrotelmic peat and 2,700m³ of catotelmic peat. The Proposed Development is expected to achieve an overall peat balance. All excavated material will be required for reuse as part of the works and no surplus peat is anticipated.
- 10.11.28 The storage and reuse of peat would be undertaken in line with guidance (Scottish Renewables and SEPA, 2012), such as dressing off and reinstating peat on the slopes and road verges as soon as practicable. Further detail on volumes and reuse of excavated peat is provided in Appendix 10.4: Peat Management Plan.

Chemical Contaminated Run-off/ Pollution

- 10.11.29 As set out previously, pollution control measures will be implemented with specific reference to best practice guidance and incorporated within the CEMP. Spill kits shall be provided at key locations, e.g. construction compounds and in vehicles to ensure timeous response to spills.
- 10.11.30 All fuel and other potential contaminative chemicals will be stored in accordance with good practice procedures, located at a safe distance minimum of 50m from existing watercourses. Fuel storage will be in accordance with good practice guidance and relevant legislation, with impermeable bunded containers/areas designed to capture any leakage, whether from a tank or from associated equipment such as filling and off-take points, sighting gauges.
- 10.11.31 Spill kits would be kept in all construction and plant vehicles to enable a rapid and effective response to any accidental spillage or discharge. Construction staff will be trained in the effective use of this equipment.
- 10.11.32 Construction vehicles and plant will be regularly maintained. Refuelling will be carried out at least 50m from watercourses. Where this buffer distance cannot be achieved a minimum distance will be agreed with the ECoW. Fuel pipes on plant, outlets at fuel tanks etc. will be regularly checked and maintained to ensure that no drips or leaks to ground occur.
- 10.11.33 Care will be taken to ensure that construction works for watercourse crossings use good practice measures. Freshly mixed concrete and/or dry cement powder will not be allowed to enter any watercourse. This shall be ensured by:
- allocating designated wash out areas at least 50m from watercourses;
 - concrete wagons will only be permitted to wash-out into specifically designed wash-out areas and predetermined at agreed locations site wide;
 - the drivers will be informed at their site induction of the location of the designated wash-out areas;
 - loads will be managed and assessed with regards to the size of vehicle and ground conditions whilst keeping at appropriate speed limits to avoid spillage;
 - tools and equipment will not be cleaned in watercourses. Should it be necessary to clean tools and equipment on-site, this will be done in the predetermined wash-out areas; and
 - wash out areas will be continually monitored and findings recorded to ensure effluent levels do not spill over into the environment.
- 10.11.34 There will be no unauthorised discharge of foul or contaminated drainage from the site either to groundwater or any surface waters, whether direct or via soakaway. Sanitary facilities will be provided and methods of disposal of all waste will be governed by the appropriate regulations and legislation.

Groundwater Disruption

10.11.35 Potential disruption to groundwater and soil interflows will largely be mitigated where possible through appropriate engineering design of the works. Excavation works will be undertaken in accordance with PAN 50. The condition of GWDTes on-site would be assessed by the ECoW throughout the construction phase in comparison with baseline conditions. There are no groundwater abstractions within 250m of excavations.

10.11.36 The finalised preconstruction CEMP will include plans to minimise potential problems related to dewatering such as:

- operating a 'permit to pump' system;
- reducing the inflow of water by sealing worked surfaces;
- managing spoil mounds and slope stability in line with industry good practice; and
- ensuring inert fill is used for backfilling purposes, where required.

Watercourse Bank Integrity

10.11.37 Micro-siting considerations for the road layout, construction vehicles and construction working areas will, where practicable, maintain a minimum stand-off distance of 50m from the edge of watercourses. In the event that construction activity is required within these limits the main Contractor shall agree a working method with the ECoW.

10.11.38 Temporary watercourse crossings may be required as part of construction. On sloping ground these watercourses will be crossed by tracked machines. Level water features will be crossed in accordance with published good practice to avoid any damage being caused to the bank or bed. Should any drainage ditches become damaged or blocked as a result of construction vehicles crossing them, these will be repaired or cleared by construction staff immediately.

10.11.39 All permanent watercourse crossings will be designed to maintain hydraulic conveyance therefore, each watercourse crossing will have sufficient capacity to pass the 1:200 year flood and include an allowance for potential partial blockage and the potential effects of climate change.

10.11.40 Detailed flow calculations will be undertaken in order to inform detailed design and to inform required CAR application(s). For any new crossings, consideration will be given to any local variations in channel dimensions and to bankside conditions. Where feasible within micro-siting allowances, the narrowest locations will be selected and the stability of the channel banks will also be considered.

10.11.41 Splash boards and run-off diversion measures, including silt fencing adjacent and parallel to watercourses beneath bridges and at culvert crossings, will be used at all crossings during construction to prevent direct siltation of watercourses.

Peat Landslide Hazard Risk

10.11.42 In the event that medium to high peat slide risk is confirmed during detailed pre-construction site investigation, mitigation measures should be implemented as follows:

- adequate staff training to raise awareness of the risks and tell-tale signs of peat slides;

- develop methodologies to ensure that accelerated degradation and erosion of exposed peat deposits does not occur;
- regular monitoring, for example, instrumentation regular visual and survey observations; and
- development of an emergency plan and procedures in the event of a peat slide.

Monitoring

- 10.11.43 To ensure construction works are compliant with the agreed preconstruction CEMP and pollution prevention requirements, regular monitoring would be undertaken.
- 10.11.44 The assigned Contractor would be required to nominate a site representative who takes responsibility for implementation and monitoring of the Site Waste Management Plan (SWMP).
- 10.11.45 The Contractor's Environmental Site Representative checks the contents of the site waste and recycling skips on a weekly basis. Non-compliance will be highlighted at the weekly progress meeting and appropriate actions taken, e.g. toolbox talks.
- 10.11.46 Monitoring of water quality will be carried out on selected watercourses; specific monitoring locations will be identified post-consent during the detailed design phase (pre-commencement of works). Surface water quality monitoring will be undertaken at the intervals as outlined in the agreed preconstruction CEMP (see also Chapter 9, paragraph 9.7.17). Monitoring will include pre-construction (baseline), during and post construction monitoring.

10.12 Residual Effects

Alteration of Natural Drainage Patterns and Run-off Volumes/Rates

- 10.12.1 Watercourses in the study area are deemed to be of low vulnerability, high recoverability and low value. The sensitivity of the receptor is therefore, considered to be Low.
- 10.12.2 The magnitude of impact is predicted to be of local spatial extent, short term duration, intermittent and reversible. The magnitude is therefore considered to be Low.
- 10.12.3 Taking into account the mitigation measures integrated as part of the project (see Section 10.11 and Appendix 4.2: Outline Draft CEMP) the effects are considered to be Negligible, and not significant.

Disruption to Artificial Drainage

- 10.12.4 Artificial drainage systems in the study area are deemed to be of low vulnerability, high recoverability and low value. The sensitivity of the receptor is therefore, considered to be Low.
- 10.12.5 The magnitude of impact is predicted to be of local spatial extent, short term duration, intermittent and reversible. The magnitude is therefore considered to be Low.

- 10.12.6 Taking into account the mitigation measures integrated as part of the project (see Section 10.11 and Appendix 4.2: Outline Draft CEMP) the effects are considered to be Negligible, and not significant.

Pollution Impact from Silt-Laden Run-off

- 10.12.7 Waters in the study area are deemed to be of high vulnerability, low recoverability and high value. The sensitivity of the receptor is therefore, considered to be High.
- 10.12.8 The impact is predicted to be of local spatial extent, short term duration, intermittent and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be Low.
- 10.12.9 Taking into account the measures integrated as part of the project outlined in Section 10.11 of this chapter and Appendix 4.2 (Outline Draft CEMP) the effects are considered to be of Minor adverse, and not significant.

Chemical Contaminated Run-off/Pollution

- 10.12.10 Watercourses in the study area are deemed to be of low vulnerability, high recoverability and low value. The sensitivity of the receptor is therefore, considered to be Low.
- 10.12.11 The magnitude of impact is predicted to be of local spatial extent, short term duration, intermittent and reversible. The magnitude is therefore considered to be Low.
- 10.12.12 Taking into account the mitigation measures integrated as part of the project (see Section 10.11 and Appendix 4.2: Outline Draft CEMP) the effects are considered to be Negligible, and not significant.

Groundwater Disruption

- 10.12.13 Groundwater has been assessed to be of high vulnerability, low recoverability and high value. The sensitivity of the receptor is therefore considered to be High.
- 10.12.14 The magnitude of impact is predicted to be of local spatial extent, short term duration, intermittent and reversible. The magnitude is therefore considered to be Low.
- 10.12.15 Taking into account the mitigation measures integrated as part of the project (see Section 10.11 and Appendix 4.2: Outline Draft CEMP) the effects are considered to be Minor adverse, and not significant.

Watercourse Bank Integrity

- 10.12.16 River and watercourse banks in the study area are deemed to be of low vulnerability, high recoverability and low value. The sensitivity of the receptor is therefore, considered to be Low.
- 10.12.17 The magnitude of impact is predicted to be of local spatial extent, short term duration, intermittent and reversible. The magnitude is therefore considered to be Low.

- 10.12.18 Taking into account the mitigation measures integrated as part of the project (see Section 10.11 and Appendix 4.2: Outline Draft CEMP the effects are considered to be Negligible, and not significant.

Peat Landslide Hazard Risk

- 10.12.19 The risk of peat landslide is not measured according to the sensitivity, magnitude and significance criteria that other receptors are assessed against. The conclusion of the PLHRA from the 2016 ES (see Appendix 10.3) is that there are three sections within the vicinity of the Proposed Development that have a medium to high risk of peat sliding. The three areas are located within the vicinity of the Burn of Pettawater, Sandwater Loch and Burn of Weisdale and reflect areas of deep peat recorded at these locations. This risk is caused by increased surface slope angles, greater peat thicknesses and proximity to the proposed excavation works by tributaries of the Burn of Weisdale. The risk of instability in other sections of the proposed route has been assessed as very low to low risk.
- 10.12.20 The new track design incorporates a floating road design in these sections which will reduce the risk significantly, primarily due to reduced excavation of peat.

10.13 Cumulative Effects

- 10.13.1 The implications of the Proposed Development and its potential effects in conjunction with the Viking Wind Farm development and the proposed Kergord Access Track application are considered with respect to hydrology, hydrogeology and geology.
- 10.13.2 The application of hydrological catchment assessment methodology enables a logical evaluation of the potential for cumulative effects on soil and water issues.
- 10.13.3 The two catchments encapsulated by the Proposed Development display limited development features.
- 10.13.4 Each development would be required to demonstrate that either there would be no significant adverse effects or that impacts are practicably mitigated, in line with Scottish Planning Policy and associated guidance.
- 10.13.5 Based on each application having to mitigate adverse impacts to not significant and incorporating individual flood risk, drainage and geological impact abatement measures the combined cumulative impact has been determined to be low.
- 10.13.6 Without exception, no significant residual effects are predicted on hydrological, hydrogeological and/or geological important features. Consequently, there are no features where significant cumulative impacts are likely.

10.14 Conclusion

- 10.14.1 The impacts on hydrology and flood risk for the Proposed Development has been assessed in line with the relevant legislation, guidance, planning policy and technical documentation.
- 10.14.2 The assessment has indicated that there are no significant effects arising from the Proposed Development once the proposed mitigation measures are put in place, however

there are three areas identified originally as medium to high risk of peat slide. Redesign of the Sandwater Road has been completed with a planned increase in floating road across the deep peat. This in turn will reduce the amount of excavated peat originally proposed and minimise potential disturbance. As a consequence potential peat landslide risk will be reduced across these areas. The appropriate construction techniques and mitigation for floating roads will be outlined in the CEMP and detailed prior to construction.

10.15 References

- British Geological Society (NERC) (2013) Online Geology of Britain Viewer ([http:// map apps.bgs.ac. uk/geologyofbritain/home.html](http://mapapps.bgs.ac.uk/geologyofbritain/home.html)) (accessed 23/11/2015).
- British Geological Survey/Scottish Environment Protection Agency (2004), Vulnerability of Groundwater in the Uppermost Aquifer ([www.sepa.org.uk/ water/ groundwater/i doc.ashxdocid=c830572f-0856-4350-991f-Of5e88lc869b&version1](http://www.sepa.org.uk/water/groundwater/doc.ashxdocid=c830572f-0856-4350-991f-Of5e88lc869b&version1))(accessed 21/08/2013).
- Centre for Ecology and Hydrology, National River Flow Archive, Gauging Station Details ([http:// www.ceh.ac.uk/data/nrfa/data/station.html](http://www.ceh.ac.uk/data/nrfa/data/station.html) 108001 (accessed 23/08/2013).
- Gustard, A. Marshall, D.C.W. and Sutcliffe, M.F. (1987) Low Flow Estimation in Scotland/ Institute of Hydrology Report 101
- Highways Agency, 2008. HA 216/06 Volume 11, Section 3, Part 10, Road Drainage and the Water Environment
- Marshall D C.W. & Bayliss A. C.. June (1994) Estimating Flood Flows for Small Catchments/ Institute of Hydrology Report 124
- Reed, D (1999) Flood Estimation Handbook, Institute of Hydrology Scottish Government (2010) Scottish Planning Policy.
- SEPA (2014). Landuse Planning System Guidance Note 4 - Planning Guidance on Wind Farm Development.
- SEPA (online) Water Environment Hub [<http://www.sepa.org.uk/data-visualisation/water-environment-hub/riverbasindistrict=Scotland>]
- Viking Energy Partnership (2009) Viking Wind Farm Environmental Statement, URL: [http:// www.vikingenergy.co.uk/ downloads.asp](http://www.vikingenergy.co.uk/downloads.asp)
- Viking Energy Partnership (2010) Viking Wind Farm Environmental Statement Addendum, URL: <http://www.vikingenergy.co.uk/downloads.asp>
- Viking Energy Wind Farm LLP (2016) B9075 Sandwater Road Environmental Statement. Accompanying the previous withdrawn planning application to Shetland Islands Council.