ScottishPower Renewables

Harestanes West Windfarm: Drainage Impact & Watercourse Crossing Assessment

Technical Appendix 10.5

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RSK GENERAL NOTES

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Author	Chris Palmer	**Technical reviewer**	Catherine Isherwood
Date:	06/11/2024	Date:	06/11/2024

Project manager	Giles Exley
Date:	06/11/2024

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1 INTRODUCTION

1.1 This report provides a Drainage Impact and Watercourse Crossing Assessment for Harestanes West Windfarm (hereafter, the 'proposed Development' and associated infrastructure.

1.2 This report forms a Technical Appendix to the Environmental Impact Assessment (EIA) Report for the proposed Development and should be read in conjunction with this document. It has been produced to address the requirements for new drainage infrastructure, including new and upgraded watercourse crossing structures, for the proposed Development.

1.3 This document covers site drainage and watercourse crossings. These topics are interlinked and important to understand, as each has the potential to have significant environmental effects if not adequately addressed.

1.4 Within this Technical Appendix, the following definitions will be used. The 'proposed Development' refers to infrastructure within the Application Boundary. 'Site' refers to the area within the Application Boundary within which the proposed Development lies. 'Access track to the turbine area' refers to the route from the A701 to the 'turbine area', which is the area of the Site in which the proposed Development turbines are located.

1.5 This document will assess how the proposed Development may affect the existing drainage system within the Site from both a water quality and a water quantity perspective. This assessment will identify any drainage issues, as well as appropriate mitigation measures to address these issues. This will ensure that drainage infrastructure is suitable for the proposed Development and keep changes to the natural drainage to a practical minimum.

Watercourse Crossing Assessment

1.6 Watercourse crossings will be required as part of the access track layout for the proposed Development. This document will provide background descriptions of the watercourse crossing locations and the process of layout design that has resulted in these crossings being proposed; it will also provide sufficient background information to support future applications for authorisation under the *Water Environment (Controlled Activities) (Scotland) Regulations 2011* as amended, (known as CAR).

Regulatory Background

1.7 Under the terms of CAR, it is an offence to undertake the following activities without an appropriate authorisation in place:

- Discharge to any wetland, surface water or groundwater;
- Disposal of waste water or effluent to land;
- Abstraction of wetland, surface water or groundwater;
- Impoundment (dam or weir) of any river, loch, wetland or transitional water; and

- Engineering works in any water or wetland.

1.8 With respect to drainage infrastructure, any formal discharge to water or to land may require authorisation. The Applicant and their appointed contractors have a duty to manage water within the Site and discharge from the Site in a compliant manner. The drainage strategy provided here will establish the design requirements in order to manage post-construction water flows within and deriving from the proposed Development.

1.9 With respect to watercourse crossings, any engineering works in inland waters or wetlands may require authorisation. The Scottish Environment Protection Agency (SEPA)'s document '*The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended): A Practical Guide*' specifies that authorisations are not normally required for engineering works on minor watercourses, where a minor watercourse is defined as one not shown on the 1:50,000 scale Ordnance Survey (OS) maps (Landranger series) (SEPA, 2024a).

1.10 On this basis, up to 18 watercourse crossings required for access to the proposed Development would require authorisation. Additional crossings of minor watercourses would also be necessary but would not require formal authorisation beyond compliance with the General Binding Rules set out by SEPA (2024a).

1.11 This report is produced in compliance with the requirements of Dumfries and Galloway Council (DGC) and SEPA and is in line with current best practice.

Development Proposals

1.12 The proposed Development infrastructure would include:

- 12 wind turbines, six with a maximum height of 220 m and six with a maximum height of 200 m to blade tip;
- 12 No hardstanding areas at the base of each turbine, with an approximate total area of 3,856 m^2;
- transformer/switchgear housings located adjacent to turbines;
- site entrance from the A701, and 31.5 kilometres (km) of access track with associated watercourse crossings – of which 10.5 km are new access tracks and 21.0 km are upgrades to existing tracks;
- underground cabling linking the turbines with the substation;
- a permanent meteorological mast (PMM) and associated hardstanding area;
- an operations control building with parking and welfare facilities;
- a substation compound;
- a bellmouth and parking area adjacent to the A701;
- two temporary construction compound areas;
- extraction of material from up to three existing quarries owned and operated by Forestry and Land Scotland to provide suitable rock for access tracks, turbine bases and hardstanding;
- health & safety and other directional site signage; and

- additional development components to improve the overall ecological and environmental benefits accruing from the proposed Development in the form of peatland restoration, habitat improvement and native woodland planting.

1.13 Full details of the proposed Development design are provided in **Chapter 3: Proposed Development** of the EIA Report.

2 DRAINAGE CHARACTERISTICS

2.1 This section of the document outlines the existing drainage characteristics of the Site and the wider study area in order to determine a baseline against which to assess changes to the drainage regime. Natural drainage characteristics are determined by topography, existing drainage features and natural catchment areas, rainfall characteristics, current land use and any existing drainage infrastructure.

2.2 For the purposes of this document, the study area is considered to be the Application Boundary plus a buffer zone of 2 km. Areas downstream, to a distance of 5 km from the Application Boundary, are also considered as effects can be transmitted downstream for greater distances than 2 km.

Site Topography

2.3 Topography within the Application Boundary is variable, with elevations ranging from 140 m to 380 m above Ordnance Datum (AOD). The highest point on Site is towards the north east of Holehouse Hill, situated within the eastern portion of the access track, lying at 380 m AOD. Topography undulates across the Site with scattered peaks including: Auchengeith (299 m) in the south west, Shiel Cleuch (300 m AOD) to the east, and Hound Knowe (340 m AOD) to the north.

2.4 The lowest point within the Site is to the south east of the access track where it meets the A701, lying at 108 m AOD. Valleys caused by the incision of river systems account for several other areas of low elevation on Site, at roughly 200 m AOD.

2.5 Threap Moor is found to the north outwith the Application Boundary, with a series of peaks including Queensberry (697 m AOD), Wee Queensberry (512 m AOD) and Earncraig (611 m AOD). The operational Harestanes Windfarm is found to the east, along with several hills and fells including Green Hill (314 m AOD), Knockespen (344 m AOD) and Brownmoor Hill (347 m AOD). The south is bounded by the village of Ae, Cocklet Hill (269 m AOD), and the operational Dalswinton Windfarm. Three hills; Dins Rig (324 m AOD), Great Hill (353 m AOD) and White Hill (302 m AOD), as well as Loch Ettrick, are found to the west.

2.6 The majority of the Site drains towards the south-east via Windyhill Burn into the Water of Ae, just downstream of the Application Boundary.

2.7 The Application Boundary covers 1,243 ha. Proposed infrastructure and borrow pits have a total land take of 36.59 ha, of which 1.95 ha would be temporary working areas during the construction phase and 34.64 ha would be long-term. The long-term land take includes all impermeable or reduced permeability surfaces including turbine foundations, buildings, hardstanding areas, borrow pits and access tracks.

3 EXISTING DRAINAGE AND NATURAL CATCHMENTS

3.1 Catchment data have been derived from the Flood Estimation Handbook Web Service (UKCEH, 2024). The Application Boundary is situated across five catchment areas: Water of Ae (u/s Goukstane Burn), Goukstane Burn, Pennyland Burn, Glenkiln Burn and Garrel Water. The catchment areas are shown on **Figure 10.5.1**. The Water of Ae, Goukstane Burn, Glenkiln Burn and Garrel Water are all tributaries to the River Annan. The Pennyland Burn is a tributary to the River Nith.

Table 10.5.1: Overview of watercourse catchment areas and infrastructure

Catchment	Total area (km^2)	% of site within catchment	% of catchment within site	Comments
Water of Ae (u/s Goukstane Burn)	72.68	52.50	8.89	Turbines 1, 2, 3, and 5, both construction compounds, site compound, met mast, two borrow pits, and associated laydown areas, access tracks and crane pads lie in this catchment.
Goukstane Burn	11.43	29.24	31.81	Turbines 4, 6, 7, 8 and 10, and associated laydown areas, access tracks and crane pads lie in this catchment.
Pennyland Burn	29.60	6.03	2.53	Turbines 9, 11 and 12, substation and substation construction compound, and associated laydown areas, access tracks and crane pads lie in this catchment.
Garrel Water	25.15	9.59	4.74	Access tracks and a parking area lie in this catchment.
Glenkiln Burn	15.12	3.13	2.58	Access tracks lie in this catchment.

**The % area does not total 100% due to rounding.*

Rainfall Characteristics

3.2 A review of the watercourse catchment and rainfall characteristics was undertaken using data from the FEH web service (UKCEH, 2024).

3.3 Standard average annual rainfall (SAAR) for the study area catchments are as follows:

- Water of Ae: 1,503 mm;
- Goukstane Burn: 1,312 mm;
- Pennyland Burn: 1,189 mm;
- Garrel Water: 1,236 mm; and

- Glenkiln Burn: 1,402 mm.

3.4 The calculations in Section 4 below make use of the figures for the Water of Ae, as this covers the vast majority of the development area and is considered to be the most representative.

Catchment Land Use

3.5 Within the Application Boundary the land use is primarily commercial conifer forestry. The access track runs through a large part of the operational Harestanes Windfarm. The Water of Ae, Pennyland Burn and Garrel Water are designated as heavily modified water bodies on account of physical alterations that cannot be addressed without significant impact on the drainage of agricultural land. Modifications to beds, banks and shores are present due to urban and rural land use.

Existing Drainage Infrastructure

Wastewater

3.6 There is no existing wastewater infrastructure, either foul drainage or surface water drainage, present within the Site.

Surface Water

3.7 The Site currently drains primarily naturally via infiltration and overland flow to the existing watercourse network.

3.8 There is some evidence that a small number of natural watercourse channels have been modified or straightened to improve drainage.

3.9 Some artificial surface drainage infrastructure is associated with the existing access track via the operational Harestanes Windfarm, namely with the presence of culverts for drainage and extensive trackside drainage ditches. Two culverts are also present within the central part of Site between T04 and T07 along existing access tracks. The infrastructure is largely in good condition.

3.10 The Site is primarily coniferous forest plantation, which has resulted in a network of drainage channels in the form of ditches.

Private Water Supplies

3.11 No wells, springs or boreholes are identified on OS 1:25,000 scale mapping within the Site. One well and five springs were identified within 2 km of the Site.

3.12 Data obtained from DGC regarding private water supplies (PWS) indicates that no PWS are present within the Application Boundary. There are six PWS identified within 2 km of the Application Boundary, however these are without potential linkage to proposed infrastructure.

3.13 There is one PWS within 5 km of the Application Boundary immediately downstream of the Site, along the Water of Ae. This is noted to supply a property called Tharpaland,

Glenkiln. However, an alternative and more practical PWS source location is present closer to the property and it is likely that the supplied location is incorrect.

3.14 In addition to the PWS, there are four locations immediately downstream of the Site where SEPA has granted CAR licences, two of which are in relation to water abstraction for fish farming.

4 OUTLINE DRAINAGE STRATEGY

Introduction

4.1 This section provides an outline drainage strategy for the proposed Development. The objective is to maintain site runoff within natural catchment areas, and to maintain drainage to the study area watercourses following treatment and attenuation in order to mimic natural flow as closely as possible.

Wastewater Drainage

4.2 There is not currently a foul drainage network within the Site; this may be implemented as part of the development and would be confirmed post-consent.

4.3 Welfare facilities for use during construction would have suitably sized holding tanks and wastewater would be removed by tanker for disposal at a licensed disposal facility.

4.4 It is unlikely that ground conditions within the Site would be suitable for a soakaway. Therefore, operational phase welfare facilities would utilise one of the following:

- A suitably sized holding tank with waste water removed from the Site by a tanker for disposal at a licensed disposal facility in line with construction phase proposals;
- A waste treatment package plant with associated discharge as a longer-term alternative; or
- Waterless composting toilet facilities with bottled water provided for washing and drinking.

Surface Water Drainage

4.5 The surface water drainage network for the Site would be designed taking into account DGC's Supplementary Guidance: Surface Water Drainage and Sustainable Drainage Systems (SuDS) (2020), the Sustainable Urban Drainage Scottish Working Party's (SUDSWP) Water Assessment and Drainage Assessment Guide (2016) and CIRIA Publication C735 – the SuDS Manual (2015).

4.6 The following sections describe the requirements that lead to determination of the proposed outline drainage strategy and which inform sustainable drainage systems (SuDS) provision recommendations.

Allowable Discharge

4.7 Surface water flows from the Site would be directed, following appropriate treatment and attenuation, to the existing Site watercourses in order to maintain pre-development water quality characteristics and flow rate.

4.8 In line with DGC's guidance for development, runoff rates and volumes post-development should not exceed the pre-development greenfield runoff rate. It is anticipated that

allowable discharge from the Site would match that of the existing 1-in-2 year greenfield runoff rate. This is discussed in the following sections.

Post-development discharge criteria

4.9 Post-development surface water flows would be restricted to discharge levels set out in DGC's supplementary guidance document (DGC, 2020) and would be in line with best practice. The development proposals recognise DGC's requirements, within which three key design principles are noted:

- The post-development runoff rate and volume do not exceed the greenfield runoff rate for previously undeveloped sites;
- Formal on-site storage should be provided up to the 1-in-30 year return periods event (3.33% annual exceedance probability) and attenuation measures should be designed such that SuDS features would not surcharge during a 1-in-30 year return period rainfall event; and
- The 1-in-200 year event (0.5% annual exceedance probability) should be contained on Site, unless it can be demonstrated that the 1-in-200 year event could be managed appropriately without causing increased flood risk elsewhere.

Greenfield runoff assessment

4.10 A review of catchment characteristics relating to the proposed Development was undertaken using the FEH Web Service (UKCEH, 2024). Catchment statistics for the Water of Ae catchment were considered to be representative for the Site as most of the proposed Development lies within this catchment. The following catchment statistics have been used in the calculations:

- Standard annual rainfall (SAAR) of 1,503 mm for the Site; and
- Standard percentage runoff (SPR) of 48.12%.

4.11 This information has been used to determine the Greenfield Runoff Rate that corresponds to the Site's existing characteristics. This has been calculated using the online Greenfield Runoff Estimation for Sites tool (UK SuDS, 2023), which gives the IH124[1] model results for the Site.

4.12 The construction phase land take is considered to be representative of the total area requiring drainage for the purposes of Greenfield Runoff calculations. To ensure that the value of this area incorporates the edges of tracks and hardstandings, as well as any drainage that is required for the proposed infrastructure, this is considered to be double the infrastructure footprint. Therefore, 73.19 ha is considered to represent the total area requiring drainage for the purposes of greenfield runoff calculations.

4.13 The 1-in-2 year Greenfield Runoff Rate has been calculated to be **871.88 l/s** based on a total area drained of **73.19 ha**.

4.14 The output for the Greenfield Runoff Estimation for Sites tool is provided in **Annex A**.

[1] The IH124 model provides a method for estimation of flow characteristics and flooding for small, ungauged catchments, derived by the institute of Hydrology (now Centre for Ecology and Hydrology). Details can be found in Marshall & Bayliss (1994).

Attenuation

4.15 DGC's current guidance document (2020) requires that formal on-site storage is provided up to 1-in-30 year return period event and attenuation measures should be designated such that SuDS features will not surcharge during a storm of this magnitude.

4.16 The drainage strategy for the proposed Development aims to promote attenuation within the SuDS proposals to mitigate any additional surface water runoff generated as a result of the proposed Development.

4.17 Approximate attenuation and storage volumes have been calculated as follows, using guidance provided in the SuDS Manual (CIRIA, 2015):

- For a 1-in-30 year return period event plus climate change allowance, storage of approximately 6,828 m^2 is required; and
- For a 1-in-200 year return period event plus climate change allowance, storage of approximately 9,253 m^2 is required.

4.18 Attenuation volumes would be reviewed at the detailed design stage in order to ensure compliance with the 1-in-30 year and 1-in-200 year requirements as specified within DGC's guidance documents.

Sustainable Drainage Systems

4.19 The outline drainage strategy seeks to implement a design that would match the pre-development Site characteristics. Site drainage is intended therefore to provide an appropriate degree of treatment and attenuation such that runoff discharge is no greater than pre-development greenfield runoff for the Site and that runoff quality would not risk any reduction in water quality of the receiving waterbody.

Quality of Receiving Waterbodies

4.20 SEPA's Water Classification (SEPA, 2024b) and Water Environment (SEPA, 2024c) Hubs have been consulted to determine existing baseline water quality for the main watercourses and waterbodies within the Site.

Table 10.5.2: Baseline surface water quality status, summarised

Waterbody name and ID	Status		Pressures
Goukstane Burn (ID 10664)	**Condition in 2014**	Overall: Poor Biology (Fish): Poor Hydromorphology: Good Water Quality: Good	None
	Condition in 2022	Overall: Good Biology (Fish): High Hydromorphology: Good Water Quality: Good	

Waterbody name and ID	Status		Pressures
Capel Water/Garroch Water (ID 10663)	**Condition in 2014**	Overall: Poor Biology (Fish): Poor Hydromorphology: Good Water Quality: Good	None
	Condition in 2022	Overall: Good Biology (Fish): High Hydromorphology: Good Water Quality: Good	
Water of Ae (u/s Goukstane Burn; ID 10661)	**Condition in 2014**	Overall: Poor Biology (Fish): Poor Hydromorphology: Good Water Quality: High	None
	Condition in 2022	Overall: Good Biology (Fish): High Hydromorphology: Good Water Quality: High	
Glenkiln Burn (ID 10662)	**Condition in 2014**	Overall: Poor Biology (Fish): Poor Hydromorphology: Good Water Quality: Good	None
	Condition in 2022	Overall: Good Biology (Fish): High Hydromorphology: Good Water Quality: Good	
Garrel Water (u/s Kirland Burn; ID 10659)	**Condition in 2014**	Overall: Poor Biology (Fish): Poor Hydromorphology: Moderate Water Quality: Data Unavailable (2015: Good)	The watercourse has been designated as heavily modified because of physical alteration that cannot be addressed without a significant impact on the drainage of surrounding agricultural land.
	Condition in 2022	Overall: Good ecological potential Biology (Fish): High Hydromorphology: Poor Water Quality: Good	

4.21 SEPA's Water Classification and Water Environment Hubs have also been consulted to determine the existing baseline water quality for receiving waterbodies (SEPA, 2024b; SEPA, 2024c). The majority of the watercourses on Site drain into the Water of Ae (d/s Goukstane Burn), with one watercourse draining into the Pennyland Burn. The details are summarised in Table 10.5.3.

Table 10.5.3: Receiving Waterbody Quality Status, Summarised

Waterbody Name and ID	Status		Pressures
Water of Ae (d/s Goukstane Burn; ID 10657)	**Condition in 2014**	Overall: Bad Biology (Fish): Poor Hydromorphology: Bad Water Quality: Good	The watercourse has been designated as heavily modified because of physical alteration that cannot be addressed without a significant impact on the drainage of surrounding agricultural land.
	Condition in 2022	Overall: Moderate ecological potential Biology (fish): High Hydromorphology: Bad Water Quality: Good	
Pennyland Burn (ID 10634)	**Condition in 2014**	Overall: Poor Biology (Fish): Poor Hydromorphology: Good Water Quality: Good	The watercourse has been designated as heavily modified because of physical alteration that cannot be addressed without a significant impact on the drainage of surrounding agricultural land.
	Condition in 2022	Overall: Poor ecological potential Biology (Fish): Poor Hydromorphology: Poor Water Quality: Good	

Levels of Treatment

4.22 Surface water treatment systems should be based on catchment characteristics and the sensitivity of receiving watercourse (CIRIA, 2015). Treatment would be required during the entire lifetime of a development, from construction and throughout operation. Much of the construction phase surface water treatment could provide suitable water treatment for the operational phase.

4.23 SEPA's planning guidance on SuDS (2010) states that *'Each individual type of SUDS feature, such as a filter drain, detention basin, permeable paving or swale, provides one level of treatment.'*

4.24 All operations on the Site during construction would require at least two levels of treatment prior to discharge, as a result of the high sensitivity of the receiving waterbodies and the high potential for generating loose sediment associated with construction and excavation works. Areas of the Site with a higher pollution risk, notably concrete batching (if used) and any areas used for plant maintenance and refuelling, would require three levels of treatment.

4.25 During operation, one level of treatment, such as swales or filter drains, should be sufficient for most of the Site apart from any areas where potentially polluting materials such as fuel, oils and lubricants, are used or stored. These areas would require at least two levels of treatment as a result of their higher pollution risk.

SuDS Components

4.26 The following SuDS features have been considered for inclusion within certain sections of the proposed Development's drainage infrastructure in order to control, manage and treat surface water runoff during construction, operation and decommissioning of the proposed Development.

Swales and Filter Strips

4.27 Swales are shallow, broad and linear vegetated drainage features that can be designed to store and/or convey surface runoff as well as providing water treatment. Where soil and groundwater conditions allow, swales can also promote infiltration. Vegetation within swales varies but typically comprises grass or dense vegetation that can act to slow down flow rates and trap particulate pollutants in the water.

4.28 Filter strips are gently sloping vegetated strips of land that provide off-the-edge diffuse drainage. They provide some flow attenuation and treatment, but little or no water storage.

Filter Drains

4.29 Filter drains are also linear features, but rather than incorporating vegetation they include coarse graded rock which provides good drain stability while also providing water storage and conveyance. Filter drains have a narrower footprint than swales and can be used in areas where space constraints prevent wider swales from being used. Filter drains provide some limited water treatment.

Check Dams

4.30 For either swales or filter drains that cross slopes, check dams provide a valuable means of attenuating water flow. These are typically placed across the swale or drain at intervals of 10-20 m. The design is such that the toe of the upstream dam is level with the crest of the next downstream dam. A small opening or pipe is placed at or near the base of each dam to allow limited flow to pass through rather than over the dam, in order to maintain low flow conveyance.

4.31 Check dams should be built into the sides of the swale or filter drain, to ensure that water flow cannot bypass the dam.

4.32 When made of soil (as opposed to rock), check dams are often called bunds or berms.

Silt Fences

4.33 Silt fences, constructed from a closely woven synthetic geotextile material, provide temporary flow attenuation and excellent particulate filtration treatment for surface water runoff. These are particularly valuable for sediment management in runoff during construction works, as silt fences can be positioned along the main runoff routes to capture, slow and treat runoff. They can also provide temporary check dams if required in short-term drainage infrastructure.

Settlement Ponds

4.34 Settlement ponds provide storage for site runoff and are a highly effective method of treatment and attenuation of surface water. They are particularly useful for developments where bulk earthworks form a significant part of the works.

Sumps

4.35 Sumps are essentially small settlement ponds, located in areas where there are space restrictions preventing use of a larger pond, or where large volumes of water or sediment are not anticipated. Water can either discharge naturally from a sump or can be pumped out to an alternative location for discharge or further treatment.

Outline Drainage Strategy

4.36 The surface of access tracks would have a cross-fall in order to encourage runoff to drain into trackside ditches along the side of the track where necessary, and lateral and cross-drains would also be installed where required. Drainage outlets would be carefully located with erosion protection if required.

4.37 Settlements ponds would be used at all the borrow pit sites, the construction compounds, laydown areas and substation for storage, attenuation and treatment of surface water. Settlement ponds may also be required at turbine and hardstanding locations, depending on the ground conditions present. The ponds would be established during construction to provide water management for the construction phase works.

4.38 Swales, filter strips and filter drains would provide attenuation, storage and treatment for access tracks and turbine hardstanding areas. Swales would form the preferred option where space and ground slopes are suitable, although it is likely that filter strips and filter drains would have to be used in some areas as a result of space and slope constraints. When providing drainage across slopes, check dams and berms would be used across the flow path of swales and filter strips to promote settling and infiltration. During construction, small sumps with silt fencing would be established periodically along track routes in order to manage entrained sediment within the surface water. The sumps and silt fencing would be removed at the end of the construction phase, once vegetation on the filter strips and swales has become established.

4.39 Temporary cut-off drains and bunds would be required around excavation areas including turbine bases and borrow pits, to capture clean runoff and divert it around construction areas. These may be converted into swales or filter drains at the end of the construction phase if long-term drainage is required.

Authorisation

4.40 Where proposals have potential to affect the water environment, the design of any works required to mitigate these effects must take into account the Site's characteristics and existing drainage conditions. Treatment and discharge of surface water to the water environment is regulated under CAR (*Water Environment (Controlled Activities) (Scotland) Regulations 2011* as amended) and forms an additional requirement to planning consent. Any formal authorisations under CAR that are needed for the drainage

strategy would be put in place prior to work beginning on-site. It is anticipated that a Construction Runoff Permit would be required for the proposed Development.

5 WATERCOURSE CROSSING ASSESSMENT

Route Selection

5.1 Prior to consideration of watercourse crossings in detail, SEPA would wish to ensure 'good practice' has been followed, including avoidance or minimisation of the number of crossings. The number of crossings is a function of the proposed access route, to connect the proposed turbines and other essential infrastructure for construction and operational purposes. Route selection takes into consideration a number of key factors including:

- Maximum track gradient suitable for the required traffic and loads for construction purposes;
- Track geometry including bend radii, junction layouts, passing infrastructure and turning circles;
- Stability and bearing capacity of the ground and adjacent slopes;
- The volumes of 'cut' and 'fill' required to ensure a suitable horizontal and vertical track alignment;
- Land take, determined by route length and other aspects of track geometry;
- The type and nature of bridging structures;
- Sensitivity of environmental receptors such as areas of deep peat or sensitive habitats; and
- Whole-life costs for construction and maintenance.

5.2 With these factors in mind, a preferred track geometry has been determined to connect the proposed turbines and other essential development infrastructure. Compromise is always required between competing constraints and concerns. The desire to site turbines and associated hardstanding areas on areas of shallow or no peat, plus a series of environmental and engineering constraints requiring avoidance of sensitive areas and potentially unstable or waterlogged ground, means that track geometry is constrained by ecological and hydrological features.

5.3 There is no link between 'optimum', in terms of a balance between environmental and engineering constraints, and 'best practice' in the Water Framework Directive context, which is oriented towards the water environment. However, there should not be obvious redundant crossings or crossings that are readily avoidable.

Access Track Design

5.4 The water environment and associated concerns formed an integral part of the track design process for the proposed Development, which developed in an iterative manner in parallel with the proposed turbine and associated infrastructure layout. Options for limiting watercourse crossings on tracks have been restricted owing to other site constraints; however, the number of entirely new watercourse crossings has been kept to a practical minimum through careful design.

5.5 One key decision was to modify the preferred route of the access track to the turbine area to avoid the requirement for a major crossing of the Water of Ae, for combined hydrological and engineering reasons. While a new crossing of the Water of Ae would still be necessary, the proposed crossing location is in an area where the watercourse channel is much narrower and with a less significant area of flood plain, helping to minimise potential disruption to the watercourse and future flow patterns.

Access Route

5.6 Access to the proposed Development would be from the A701 to the east of the Site via sections of existing, new and upgraded track. Please refer to **Figure 10.5.2** for locations of all watercourse crossings.

5.7 From the A701 to just north of Hound Knowe and the operational Harestanes Windfarm substation, a section of upgraded track is required, expanding the operational Harestanes Windfarm tracks. Five existing watercourse crossings are accounted for in this section of track.

5.8 The route then diverges from the existing track requiring a section of new and floating tracks for a watercourse crossing (WC06) over the Water of Ae at the northernmost point of the proposed Site Access.

5.9 From here, the access track is proposed to be upgraded for the remainder of the access route, with a smaller section of proposed track to take the proposed access route into the Site, including a new crossing to pass the Capel Water (WC14).

5.10 Within the Site, new track is primarily required, with smaller lengths of proposed upgrades to existing tracks and new floating tracks. Sections of proposed track between T04 and T07 will pass two existing watercourse crossings of Braidlane Burn (WC17) and Kingstand Burn (WC18). A new crossing over Corse Burn (WC16) is required for the proposed track between T04 and T06.

Removal or Modification of Existing Structures

5.11 Where a proposed new crossing is located adjacent to an existing crossing, it is considered best practice to remove the redundant structure.

5.12 It is anticipated that most of the existing crossings would be extended or upgraded as necessary to accommodate the proposed track, as this option provides the least additional disturbance to the water environment.

Cable Crossing Locations

5.13 As cables would generally be laid alongside access tracks, cable crossings would normally be incorporated as part of track crossing structures. There are no plans for additional cable crossings of watercourses shown on OS 1:50,000 mapping.

Crossing Descriptions

5.14 The proposed crossings have been assessed using a catchment-based approach, involving a desk study and a walkover survey.

Desk Study

5.15 The desk study consisted of a review of the information regarding the proposed Development, principally involving an examination of the proposed track layout and the identification of watercourses marked on the OS 1:50,000 scale maps which would require crossings.

Walkover Survey

5.16 Walkover surveys were undertaken in March and July 2024, during which the identified crossings were visited to obtain specific information about each crossing location. The walkover surveys were undertaken in wet and overcast weather conditions. Information regarding previous high-water levels including flooding was recorded in order to allow an informed decision-making process with regard to crossing structures and sizing.

5.17 During the walkover survey, photographs and detailed field notes were taken to record dimensions of the watercourse channels and flood channels, where apparent the type of substrate and any other local information required to inform the proposed crossing type. Locations were recorded using a hand-held GPS unit, with better than 5 m accuracy.

Ecological Provision

5.18 The minor watercourses draining the Site are likely to include habitats of conservation importance in a local context, supporting populations of salmonid fish, otter and other aquatic species. Connectivity via these minor tributaries to larger watercourses in the wider catchment increases their sensitivity.

5.19 It is advisable, as a result, that ecological considerations are included in crossing designs. New or replacement crossings would make use of open-bottomed arch or box culverts or bridge structures in order to minimise disturbance of watercourse channels and banks. Where opportunities exist, existing crossings would be modified to make them more suitable for freshwater species.

Crossing Details

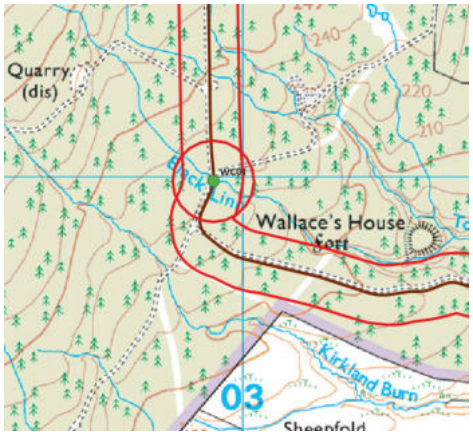
5.20 The following table, **Table 10.5.4**, includes details of all the crossings which require authorisation, together with photographs of the watercourse and a recommendation of the crossing type to be used. All crossings are shown on **Figure 10.5.2**.

Table 10.5.4 Details of crossings requiring authorisation

Watercourse Crossing Details		
Crossing:	WC01	
Location:	Towards start of access track	Photograph of existing culvert
Watercourse:	Black Linn	
NGR:	NY 0292 9099	
Description:	Existing crossing, large pipe culvert approximately 1.5 m diameter. Channel 0.5-1 m wide, valley 3-5 m wide by about 2 m deep. Rocky channel. Woodland scrub on banks, willow, bracken. Concrete apron present at outflow end of culvert.	
Catchment area:	0.7 km^2	
Crossing type:	Existing - culvert	

View upstream (NW) showing rocky channel and woodland scrub.

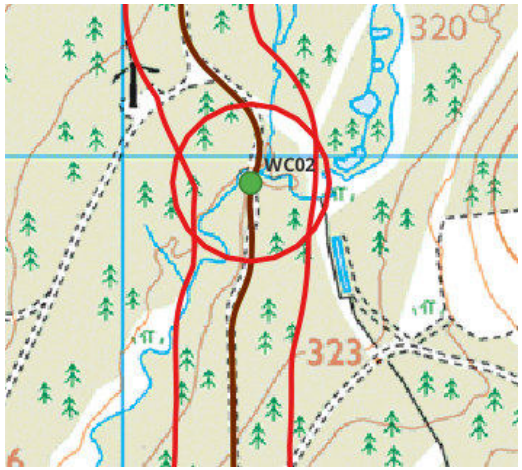
View downstream (E) showing woodland scrub and ferns on banks.



Watercourse Crossing Details		
Crossing:	WC02	
Location:	Site Access	
Watercourse:	Auchencaigroch Burn	
NGR:	NY 0216 9396	
Description:	Existing concrete bridge across deep channel with a rocky bed and vegetated banks.	
Catchment area:	3.31 km^2	
Crossing type:	Existing crossing - bridge	Photograph of existing crossing

View downstream (W)

View upstream (E)



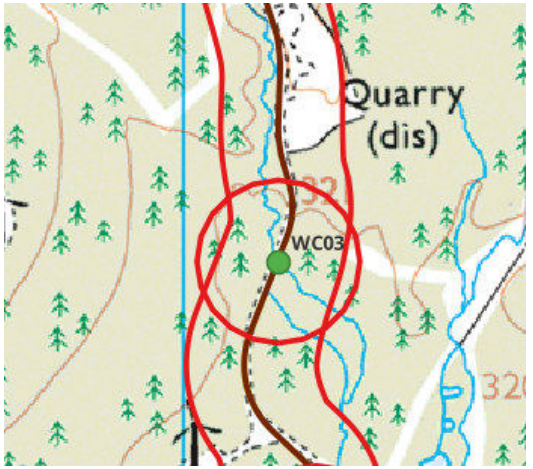
Watercourse Crossing Details

Crossing:	WC03
Location:	Site Access
Watercourse:	Auchencaigroch Burn
NGR:	NY 0211 9431
Description:	Existing crossing c 1.5-2 m diameter in deep channel. Well-vegetated banks.
Catchment area:	0.78 km^2
Crossing type:	Existing crossing - culvert

Photograph of existing culvert

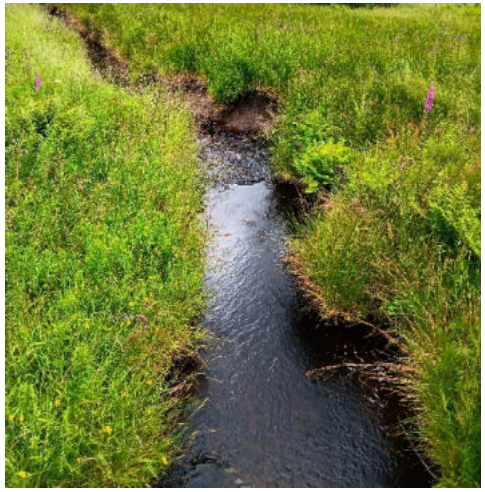
View upstream (NW)

View downstream (SE)



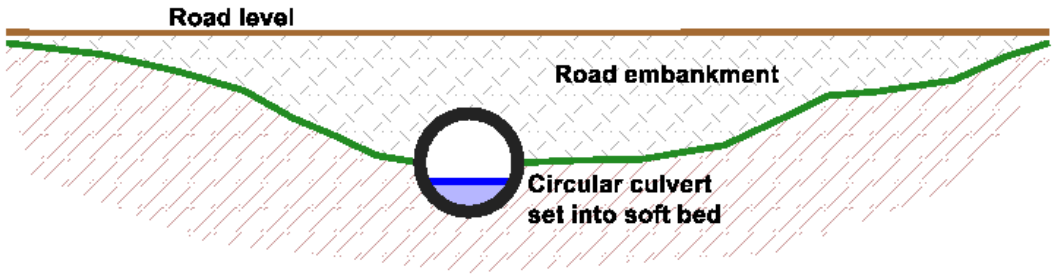
Watercourse Crossing Details		
Crossing:	WC04	 Photograph of existing crossing
Location:	Site Access	
Watercourse:	Deer Burn	
NGR:	NY 0082 9657	
Description:	Existing concrete bridge over well-defined, deep channel with a rocky bed.	
Catchment area:	2.81 km^2	
Crossing type:	Existing crossing – bridge	


View upstream (NE)


View downstream (SW)

Watercourse Crossing Details

Crossing:	WC05
Location:	Site Access
Watercourse:	Unnamed tributary of Water of Ae
NGR:	NY 0037 9729
Description:	Existing culvert c. 1.5 m diameter providing drainage through existing track into well-vegetated, narrow channel.
Catchment area:	4.28 km^2
Crossing type:	Existing crossing - culvert



Indicative cross-section, not to scale

View upstream (NE)

View downstream (SW)

Watercourse Crossing Details

Crossing: WC06

Location: Northernmost point of Site Access

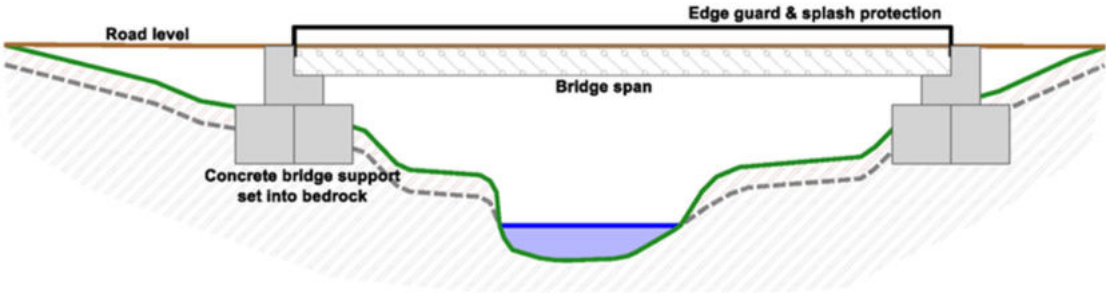
Watercourse: Water of Ae

NGR: NY 0035 9810

Description: New crossing required for channel 4-6 m wide. Vegetated banks with a clear, well-defined channel and a rocky bed.

Catchment area: 3.74 km^2

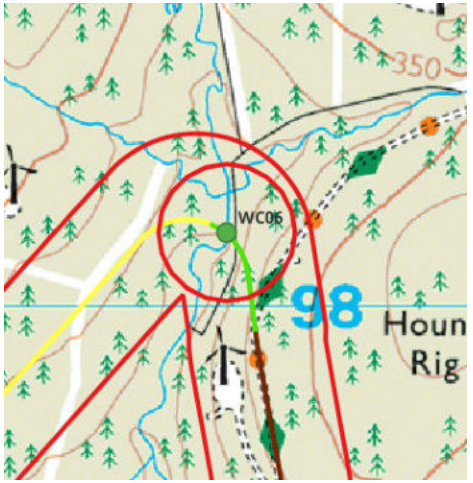
Crossing type: New crossing – bridge



Indicative cross-section, not to scale

View upstream (N)

View downstream (S)



Watercourse Crossing Details

Crossing: WC07

Location: Site Access

Watercourse: Clerk Grain

NGR: NX 9983 9764

Description: Existing culvert c. 1.5 m diameter through heavily vegetated channel and bank.

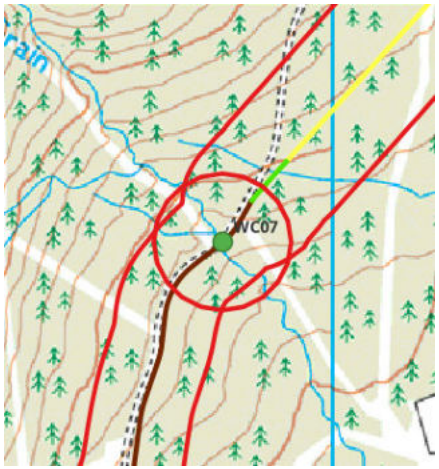
Catchment area: 1.07 km^2

Crossing type: Existing crossing - culvert

Photograph of existing culvert

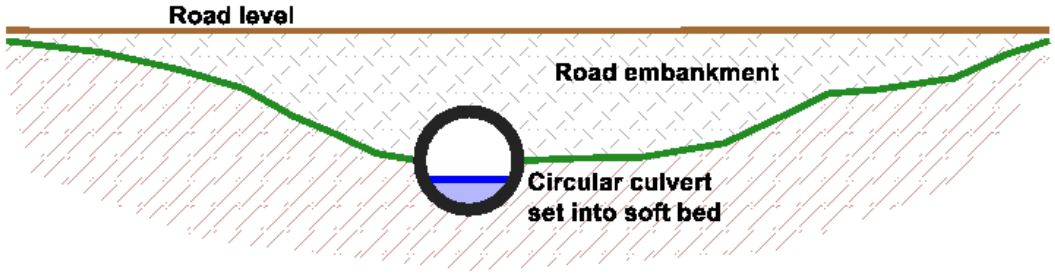
View upstream (NW)

View downstream (SE)



Watercourse Crossing Details

Crossing:	WC08
Location:	Site Access
Watercourse:	Grindstone Cleuch
NGR:	NX 9964 9718
Description:	Narrow, vegetated channel. Culvert of c. 1.5 m diameter providing drainage through existing track.
Catchment area:	6.3 km^2
Crossing type:	Existing crossing - culvert



Indicative cross-section, not to scale

View upstream (NW)

View downstream (SE)

Watercourse Crossing Details

Crossing: WC09

Location: Site Access

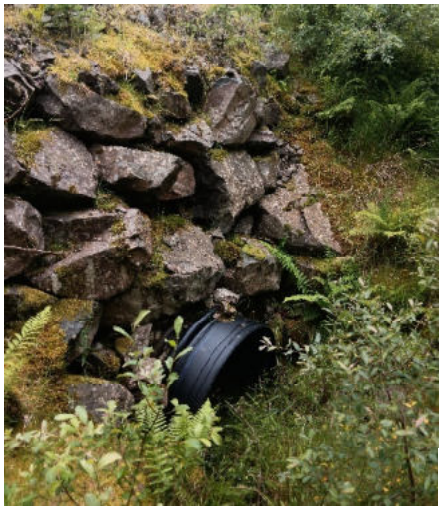
Watercourse: Unnamed tributary of Water of Ae

NGR: NX 9941 9674

Description: Narrow channel c. 1 m wide, small culvert (1.5 m diameter) providing drainage through existing track.

Catchment area: 6.47 km^2

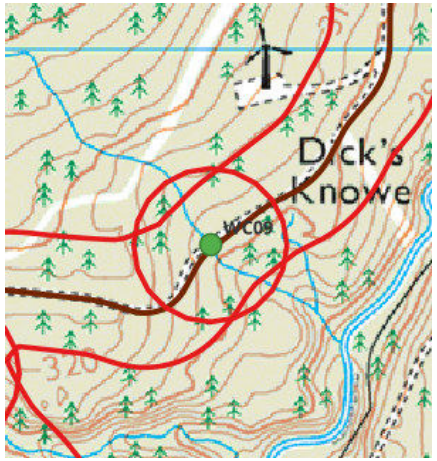
Crossing type: Existing crossing - culvert



Photograph of existing culvert

View upstream (NW)

View downstream (SE)



Watercourse Crossing Details

Crossing: WC10

Location: Site Access

Watercourse: Pishnack Burn

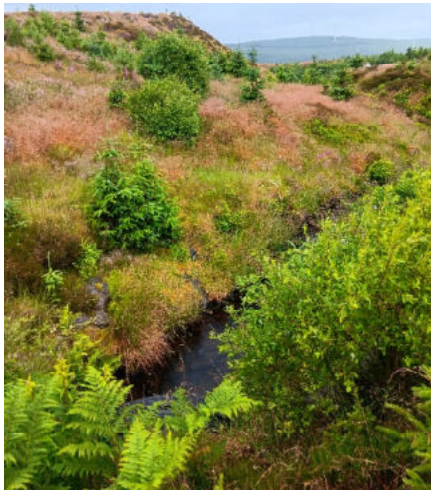
NGR: NX 9906 9658

Description: Existing crossing c. 1 m diameter. Vegetated channel banks with a rocky bed.

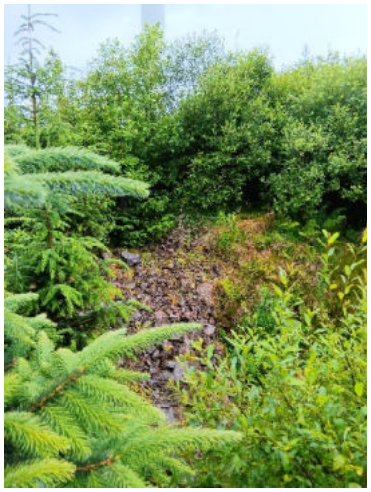
Catchment area: 0.91 km^2

Crossing type: Existing crossing - culvert

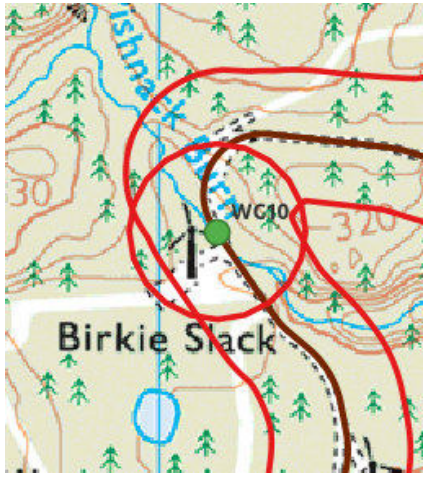
Photograph of existing culvert



View downstream (SE)



View upstream (NW)

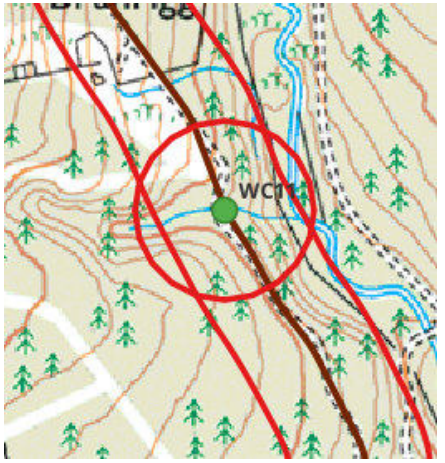


Watercourse Crossing Details

Crossing:	WC11
Location:	Site Access
Watercourse:	Unnamed tributary of Water of Ae
NGR:	NX 9940 9564
Description:	Existing crossing in heavily vegetated area, unkown diameter due to access limitations.
Catchment area:	8.2 km^2
Crossing type:	Existing crossing - culvert

Photograph of existing culvert (E)

Culvert and view East



Watercourse Crossing Details

Crossing: WC12

Location: Site Access

Watercourse: Bran Burn

NGR: NX 9801 9569

Description: Existing crossing, pipe culvert approx 2 m diameter. Rocky, vegetated bank.

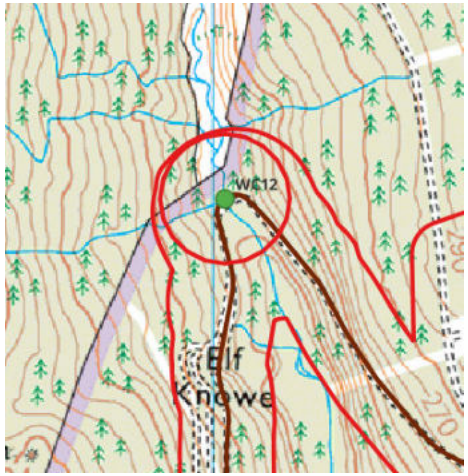
Catchment area: 0.5 km^2

Crossing type: Existing crossing - culvert

Photograph of existing culvert

View of embankment down to watercourse (S)

View downstream (SE)



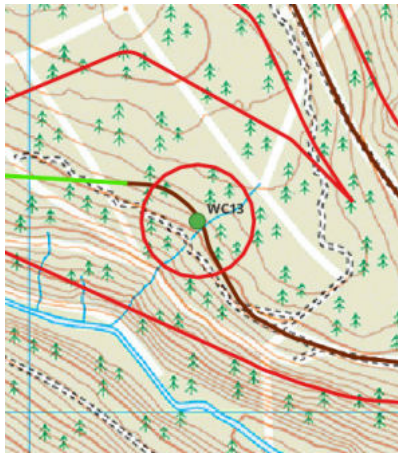
Watercourse Crossing Details

Crossing:	WC13
Location:	Site Access towards north of Site
Watercourse:	Unnamed tributary to Capel Water
NGR:	NX 9829 9433
Description:	Existing crossing, pipe culvert approx 1.5 m diameter. Rocky channel and bank with significant vegetation present.
Catchment area:	4.89 km^2
Crossing type:	Existing crossing - culvert

Photograph of existing culvert

View upstream (NE)

View downstream (SW)



Watercourse Crossing Details

Crossing: WC14

Location: Site Access at north of Site

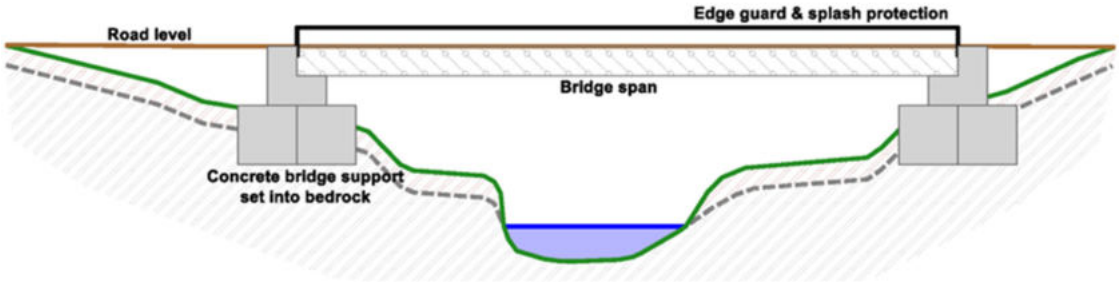
Watercourse: Capel Water

NGR: NX 9746 9463

Description: New crossing required for well-defined, channel 5-6 m across with vegetated banks.

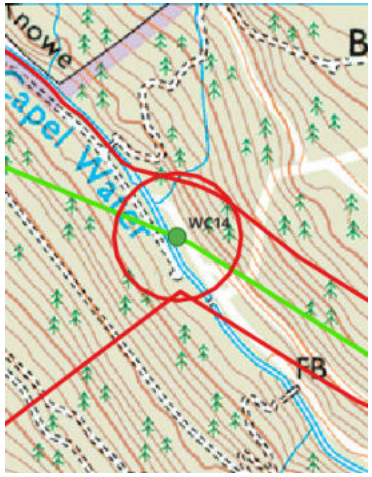
Catchment area: 30.74 km^2

Crossing type: New crossing - bridge



Indicative cross-section, not to scale

View downstream (SE) showing well-defined channel and vegetated banks.



Watercourse Crossing Details

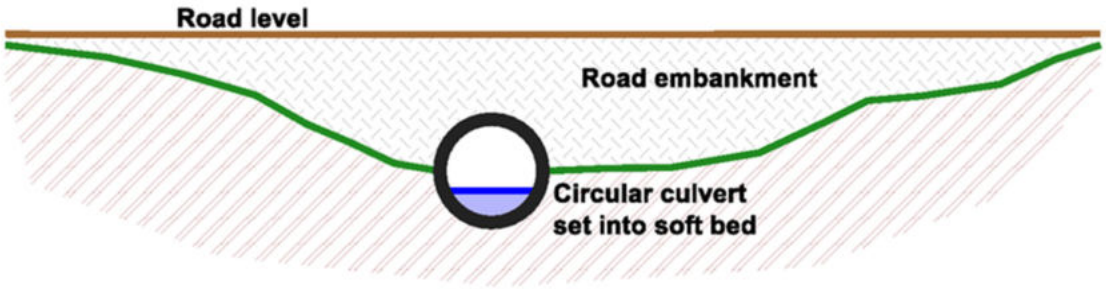
Crossing: WC15 (

Location: East of T01

Watercourse: Bluid Sike

NGR: NX 9665 9372

Description: Existing culvert c. 1 m in diameter across existing track.

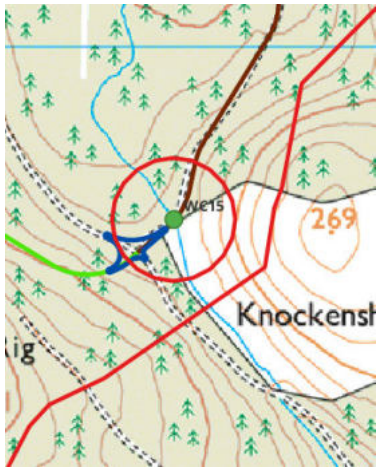


Indicative cross-section, not to scale

Catchment area: 0.74 km^2

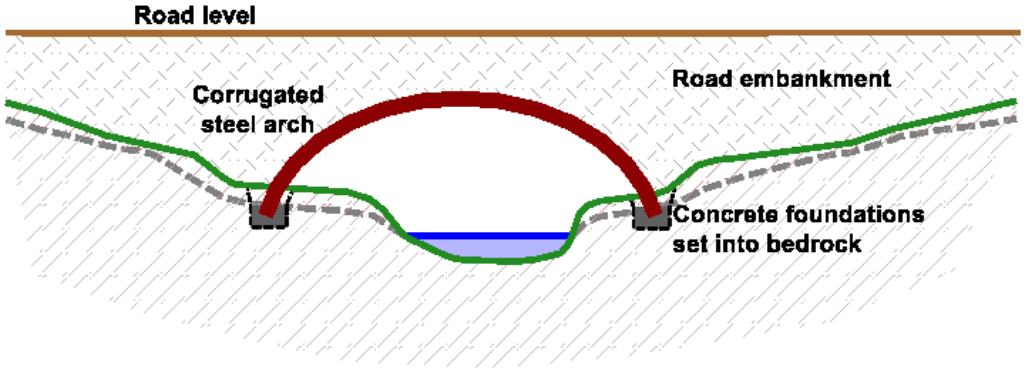
Crossing type: Existing crossing - culvert

Headwaters of watercourse looking downstream (NW) towards crossing



Watercourse Crossing Details

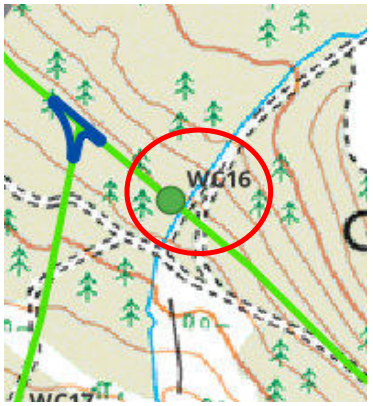
Crossing:	WC16
Location:	Southern part of Site between T04 and T06
Watercourse:	Corse Burn
NGR:	NX 9562 9126
Description:	New crossing. Exact location under fallen trees. Nearest accessible point: channel braided with 2 main channels both c. 0.3 m wide. Good flow in channels. Rocky channel with moss and grass banks. Incised to about 1-2 m. Adjacent to track.
Catchment area:	0.93 km^2
Crossing type:	New crossing – open-bottomed arch or box culvert



Indicative cross-section, not to scale

View upstream (NE) showing mossy banks and channel underneath fallen trees.

View downstream (S) showing mossy banks and channel underneath fallen trees.



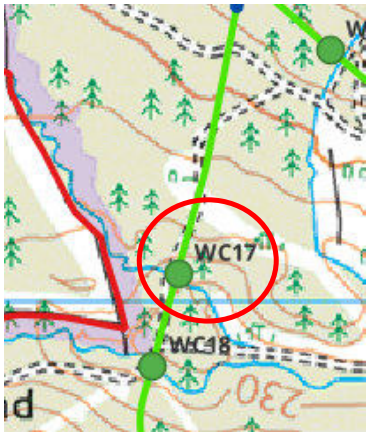
Watercourse Crossing Details

Crossing:	WC17
Location:	Southern part of Site between T04 and T07
Watercourse:	Braidlane Burn
NGR:	NX 9546 9102
Description:	Existing crossing, corrugated iron pipe culvert c. 1.5-1.6 m diameter. Channel 0.5-1.5 m wide by 0.3-0.8 m deep. Signs of out of bank flow. Vegetation rushes, grass, willow scrub. Bed is rocky, cobbles, gravel, sand.
Catchment area:	1.18 km^2
Crossing type:	Existing - culvert

Photograph of existing culvert crossing

View upstream (W) showing well-defined channel and vegetated banks.

View downstream (E) showing rocky channel bed.



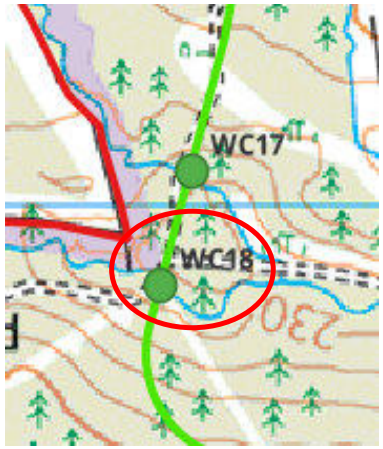
Watercourse Crossing Details

Crossing:	WC18
Location:	Southern part of Site between T04 and T07
Watercourse:	Kingstand Burn
NGR:	NX 9543 9093
Description:	Existing crossing, corrugated iron pipe culvert c. 2 m diameter. Channel 1.5-3 m across by 0.5 m deep. Some flood flow evidence. Bed is sand, gravel, cobbles. Vegetation willow scrub, rushes, bracken, grass. Muddy clay banks.
Catchment area:	1.24 km^2
Crossing type:	Existing culvert

Photograph of existing culvert

View upstream (W) showing well-defined channel and vegetated steep right bank.

View downstream (E) showing well-defined channel and muddy clay banks.



6 CONCLUSIONS

6.1 This report has assessed the relevant aspects of drainage associated with the proposed Development. It sets out an outline drainage strategy on which to base detailed design plans, recognising the requirements of DGC and SEPA, and taking current best practice guidance into account.

6.2 The Site currently drains semi-naturally via infiltration, overland flow, drainage ditches and natural channels to the existing watercourses in and around the area. Some artificial surface drainage infrastructure is associated with existing access tracks via Harestanes Windfarm and there is an extensive network of ditches relating to the commercial forestry that dominates the Site. The outline drainage strategy promotes maintenance of natural runoff characteristics where possible, and drainage infrastructure to mimic these characteristics where required. Runoff attenuation and treatment proposals are to be designed to prevent any detrimental effects to the water quality or quantity of existing waterbodies. The outline drainage strategy makes use of SuDS features within the detailed engineering design to mimic the existing runoff characteristics.

6.3 Proposed SuDS to be incorporated in the detailed drainage strategy include use of swales and filter strips, filter drains, check dams, silt fences, settlements ponds and sumps at different stages of the proposed Development. During construction, small sumps with silt fencing would be established periodically along track routes.

6.4 Watercourse crossing locations have been identified and assessed, and appropriate conceptual crossing designs have been suggested for new crossings to ensure that the watercourses retain their natural hydromorphology and ecological characteristics. A total of three new regulated crossings have been identified. Crossing design would take account of flood water conveyance. Details would be provided post-consent within the detailed design specifications, including any proposals for replacement of existing structures that may be in poor condition or under-sized in terms of their conveyance capacity.

6.5 All necessary authorisations under CAR would be put in place prior to any site works taking place.

7 REFERENCES

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8 ANNEX A

hr wallingford

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Chris Palmer
Site name:	Harestanes West
Site location:	Forest of Ae

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude:	55.22741° N
Longitude:	3.63335° W
Reference:	2427838785
Date:	Sep 10 2024 12:59

Runoff estimation approach

IH124

Site characteristics

Total site area (ha): 73.1862838

Methodology

Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Specify SPR manually

Soil characteristics

	Default	Edited
SOIL type:	5	5
HOST class:	N/A	N/A
SPR/SPRHOST:	0.53	0.4812

Hydrological characteristics

	Default	Edited
SAAR (mm):	1383	1503
Hydrological region:	2	2
Growth curve factor 1 year:	0.87	0.87
Growth curve factor 30 years:	1.95	1.95
Growth curve factor 100 years:	2.63	2.63
Growth curve factor 200 years:	2.99	2.99

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):	975.45	871.88
1 in 1 year (l/s):	848.64	758.53
1 in 30 years (l/s):	1902.14	1700.16
1 in 100 year (l/s):	2565.44	2293.03
1 in 200 years (l/s):	2916.61	2606.91

This report was produced using the greenfield runoff tool developed by HR Wallingford and available at www.uksuds.com. The use of this tool is subject to the UK SuDS terms and conditions and licence agreement , which can both be found at www.uksuds.com/terms-and-conditions.htm. The outputs from this tool are estimates of greenfield runoff rates. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CEH, Hydrosolutions or any other organisation for the use of this data in the design or operational characteristics of any drainage scheme.

288000 297000 306000 315000

594000

585000

Legend

N

Infrastructure

- Application Boundary
- Proposed Turbine Location
- Proposed Hardstanding
- Proposed Junction
- Existing Borrow Pit
- Proposed Meterological Mast
- Proposed Substation and Control Building Compound
- Proposed Construction Compound
- Proposed Parking Area
- Proposed New Access Track
- Proposed New Floating Access Track
- Proposed Upgraded Track
- Habitat Management Plan Area

Hydrological Catchments

- Pennyland Burn
- Goukstane Burn
- Water of Ae
- Glenkiln Burn
- Garrel Water

Branrigg Quarry
Mitchelslacks
Quarriebraes
Area B
T01
T02
T03
T04
T05
T06
T07
T08
T09
T10
T11
T12

288000 297000 306000 315000

ScottishPower Renewables

Rev	Date	By	Comment
B	02/12/24	CP	Revised Legend and Symbology
A	16/09/24	CP	First Issue.

1:92000 Scale @A3

0 2.5 5 Km

Harestanes West Windfarm

Figure 10.5.1

Hydrological Catchments

Drg No	HSTW-WRC-10.5.1	
Rev	B	Datum: OSGB36
Date	02/12/24	Projection: TM
Figure	10.5.1	

292000 294000 296000 298000 300000

594000 592000 590000

Legend

Infrastructure

- Application Boundary
- Proposed Turbine Location
- Proposed Hardstanding
- Proposed Junction
- Existing Borrow Pit
- Proposed Meterological Mast
- Proposed Substation and Control Building Compound
- Proposed Construction Compound
- Proposed New Access Track
- Proposed New Floating Access Track
- Proposed Upgraded Track
- Habitat Management Plan Area
- Watercourse Crossings

N

Mitchelslacks
Quarriebraes
Area A
T01 T02 T03 T04 T05 T06 T07 T08 T09 T10 T11 T12
WC14 WC15 WC16 WC17 WC18
Forest of Ae

Rev	Date	By	Comment
B	02/12/24	CP	Revised Legend and Symbology
A	16/09/24	CP	First Issue.

1:26500 Scale @A3

0 0.5 1 Km

Harestanes West Windfarm

Figure 10.5.2a
Watercourse Crossings

Drg No	HSTW-WRC-10.5.2a
Rev	B
Date	02/12/24
Figure	10.5.2a

Datum: OSGB36
Projection: TM

296000 300000 304000 308000

596000 592000

Legend

Infrastructure

- Application Boundary
- Proposed Turbine Location
- Proposed Hardstanding
- Proposed Junction
- Existing Borrow Pit
- Proposed Meterological Mast
- Proposed Substation and Control Building Compound
- Proposed Construction Compound
- Proposed Parking Area
- Proposed New Access Track
- Proposed New Floating Access Track
- Proposed Upgraded Track
- Habitat Management Plan Area
- Watercourse Crossings

N

WC01 WC02 WC03 WC04 WC05 WC06 WC07 WC08 WC09 WC10 WC11 WC12 WC13 WC14 WC15 WC16 WC17 WC18

T01 T02 T03 T04 T05 T06 T07 T08 T09 T10 T11 T12

Area A Area B

Branrigg Quarry Mitchelslacks Quarriebraes

Harestanes Wind Farm Forest of Ae

ScottishPower Renewables

Rev	Date	By	Comment
B	02/12/24	CP	Revised Legend and Symbology
A	16/09/24	CP	First Issue.

1:41000 Scale @A3

0 0.75 1.5 Km

Harestanes West Windfarm

Figure 10.5.2b

Watercourse Crossings

Drg No	HSTW-WRC-10.5.2b
Rev	B
Date	02/12/24
Figure	10.5.2b

Datum: OSGB36 Projection: TM