VESB Asset Development UK Limited

Millmoor Rig Wind Farm: Drainage Impact & Watercourse Crossing Assessment

Technical Appendix 10.4

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RSK GENERAL NOTES

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CONTENTS

TABLES

FIGURES

1 INTRODUCTION

1.1 This report provides a Drainage Impact and Watercourse Crossing Assessment for Millmoor Rig Wind Farm (hereafter the 'Proposed Development').

1.2 The report forms a Technical Appendix to the Environmental Impact Assessment (EIA) Report for the Proposed Development and should be read in conjunction with the EIA Report. It has been produced to address the requirement 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.

Drainage Impact Assessment

1.4 This document will assess how the Proposed Development may affect the existing drainage system within the Proposed Development site ('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

1.5 Watercourse crossings will be required on the proposed 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

1.6 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 from any wetland, surface water or groundwater;
- impoundment (dam or weir) of any river, loch, wetland or transitional water;
- engineering works in any inland water or wetland.

1.7 With respect to drainage infrastructure, any formal discharge to water or to land may require authorisation. The developer has a duty to manage water within the site and discharging 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.

1.8 With respect to watercourse crossings, any engineering works in inland waters or wetlands may require authorisation. The Scottish Environment Protection Agency's (SEPA) 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, 2022a).

1.9 On this basis, some watercourse crossings required to provide access to the Proposed Development would require authorisation. Additional crossing of minor watercourses would also be necessary but would not require authorisation.

1.10 This report is produced in compliance with the requirements of the Scottish Borders Council and SEPA and is in line with current best practice.

Development Proposals

1.11 The Proposed Development infrastructure would include:

- up to 13 wind turbines, of approximately 6 MW each, five with a maximum tip height of 180 m, two with a maximum tip height of 200 m, four with a maximum tip height of 210 m and two with a maximum tip height of 230 m;
- hardstanding areas at the base of each turbine, with a permanent area of approximately 2,156 m^2;
- site entrance and access track from the A6088 using the route of an existing forestry track, and access track linking the turbine locations. Total length of access tracks is 14,909.9 m, of which 3,897.7 m is new access track with associated new watercourse crossings and 11,012.2 m is existing access track and watercourse crossings which will need to be upgraded;
- an operations control building with parking and welfare facilities;
- two potential substation compounds;
- an energy storage facility with a capacity of *c*. 14.8 MW;
- telecommunications equipment;
- up to two temporary construction compounds;
- three borrow pit search areas, to provide suitable rock for access tracks, turbine bases and hardstandings; and
- underground cabling linking the turbines with the substation.

1.12 Full details of the Proposed Development design are provided in **Chapter 2** of the EIA Report.

Study Area

1.13 The study area for this Technical Appendix includes the land within the application boundary plus a buffer zone of 2 km around the boundary. Within this area, two sub-areas are described:

- the turbine area refers to everything within the application boundary except for the access route to the site; and
- the access area refers to the land within the access corridor from the A6088 to the turbine area.

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 the site topography, existing drainage features and natural catchment areas, site 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 The turbine area lies on relatively high ground, with elevations over 200 m above Ordnance Datum (AOD). The topography is characterised by higher ground in the south east and western sections, and lower ground in the north east in the Jed Water and Black Burn valleys. Five prominent hills surround the site: Green Law (368 m AOD) in the south, Wardmoor Hill (365 m AOD) in the west, Highlee Hill (307 m AOD) in the north, and Charlie's Knowe (258 m AOD) and Tamshiel Rig (280 m AOD) in the east.

2.4 The highest point in the site is the eastern slope of Wardmoor Hill (located in the west) standing at (365 m AOD). The lowest elevations within the site are primarily located around the Jed Water, in the north east of the site, with elevations below 200 m in the north eastern corner.

2.5 The land within the application boundary covers approximately 917 ha. Proposed infrastructure and borrow pits have a total land take of 24.8 ha, of which 1.2 ha would be temporary working areas during the construction phase and 23.6 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.

Existing Drainage and Natural Catchments

2.6 The site lies across two main watercourse catchments: the Jed Water catchment and the Catlee Burn catchment. Most of the site lies within the Jed Water catchment, although the north west part of the site is drained by the Catlee Burn catchment. Catchments are shown on **Figure 10.4**.

Jed Water Catchment

2.7 The Jed Water catchment has a total area of 49.5 km^2 and drains 95.5% of the site.

2.8 The Jed Water provides the main drainage for the site, the watercourse flows north-east through the site. The Rough Sike and Westshiels Burn tributaries drain the central region of the turbine area into the Jed Water at Westshiels, while the Battling Sike tributary drains the northern and central regions of the turbine area into the Jed Water. Several smaller

unnamed tributaries drain into to the Jed Water as it flows north-east. The Black Burn and its tributary, the Fell Burn, drain the eastern region of the site around the hill called Millmoor Rig. The Black Burn and Jed Water merge in the very north-eastern region of the turbine area, flowing out of the site northwards.

Catlee Burn Catchment

2.9 The Catlee Burn catchment has a total area of 18.3 km^2 and drains 4.5% of the site.

2.10 Within the turbine area, key watercourses in the Catlee Burn catchment are the Hass Sike and Harecairn Sike which drain the very south western section. Both watercourses drain into the Hyndlee Burn. The very north western part of the turbine area is drained by the Wolfehopelee Burn and its tributaries. The Wolfehopelee Burn drains directly into the Catlee burn.

Table 10.4.1: Overview of Watercourse Catchment Areas and Infrastructure

Catchment	Total Area (km^2)	% of Site Within Catchment	% of Catchment Within Site	Comments
Jed Water	49.5	4.9	16.3	The Jed Water catchment includes all the infrastructure except for turbine T9 and associated access
Catlee Burn	18.3	95.1	2.3	Turbine T9 and 150 m of its access track are located within the Catlee Burn catchment

Rainfall Characteristics

2.11 A review of the watercourse catchment and rainfall characteristics was undertaken using data from the Flood Estimation Handbook (FEH) web service (CEH, 2022).

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

- Jed Water: 1044 mm; and
- Catlee Burn: 1055 mm.

2.13 The calculations in **Section 3** below make use of the figures for the Jed Water, as this covers the vast majority of the site and is considered to be the most representative.

Catchment Land Use

2.14 The study area is located in the Scottish Borders, within a large area of commercial forestry in Wauchope Forest. The land consists of Short Rotation Forestry (SRF), with some sections that have been felled, and other areas that host recent crop plantations. Only a few parts of the site are not covered by forestry.

2.15 The Jed Water catchment is an upland region characterised by moorland and commercial forestry in the south and agricultural fields in the north. The watercourses appear to be in their natural or near-natural conditions, with generally high levels of sinuosity, defined as having lots of river meanders.

2.16 The Catlee Burn catchment is also an upland region characterised by moorland, commercial forestry and agricultural fields in the north-central region. The study area watercourses appear to be in their natural or near-natural conditions, with generally high levels of sinuosity.

Existing Drainage Infrastructure

Waste Water

2.17 There is no existing waste water infrastructure, either foul drainage or surface water drainage, present within the site.

Surface Water

2.18 The site has been modified considerably for commercial forestry land use, with evidence of artificial drainage infrastructure including ditches, bridges and culverts for drainage.

2.19 There is some evidence that a small number of natural watercourse channels have been modified and straightened to improve drainage. In addition, a considerable network of artificial drainage ditches has been installed to provide drainage for the forestry areas.

2.20 Some artificial surface drainage infrastructure is associated with the existing access tracks throughout the site, including ditches alongside the tracks, bridges or large-diameter culverts at main watercourse crossings and smaller culverts for additional drainage channels. The drainage infrastructure is largely in good condition.

Private Water Supplies

2.21 There are 15 private water supplies (PWS) within a 2 km buffer of the application boundary with one, Dykeraw (362800 608300), being within the application boundary (**Figure 10.5**).

2.22 None of the 15 PWS has been identified as having any linkage to the Proposed Development as a result of their location being upslope or upstream of the proposed works, or within a separate catchment or subcatchment and, therefore, separated from all construction work required for the Proposed Development. The PWS are not considered to be at risk from the Proposed Development.

3 OUTLINE DRAINAGE STRATEGY

Introduction

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

Waste Water Drainage

3.2 There are no plans to provide a foul drainage network within the site.

3.3 Welfare facilities for use during construction would have a suitably sized holding tank and waste water would be removed by tanker for disposal at a suitably licensed disposal facility.

3.4 It is anticipated that operational phase welfare facilities at the substation control building would use either a suitably sized holding tank with waste water removed offsite by tanker for disposal at a licensed disposal facility, or would install a waste treatment package plant with associated discharge. Should the package plant option be identified as the preferred solution, any required water environment authorisation would be put in place prior to installation of the plant.

Surface Water Drainage

3.5 The surface water drainage network for the site would be designed taking into account the Scottish Borders Council Renewable Energy Supplementary Guidance (SBC, 2018) and CIRIA Publication C753 – the SuDS Manual (CIRIA, 2015).

3.6 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

3.7 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.

3.8 In line with current best practice guidelines for development, it is anticipated that the allowable discharge from the site would match that of the existing one-in-two year greenfield runoff rate. This is discussed in the following sections.

Post-development Discharge Criteria

3.9 Post-development surface water flows would be restricted to the discharge levels set out in SEPA's Water Assessment and Drainage Assessment Guide (SEPA, 2016) and be in line with best practice. The Proposed Development design recognises SEPA's requirements, within which three key design principles are noted:

- the post-development runoff rate and volume should not exceed the Greenfield runoff rate for previously undeveloped sites. However, if infiltration to ground is not feasible, the additional runoff generated should be discharged from the site at flow rates below 2 l/s/ha;
- formal on-site storage should be provided up to the 1-in-30 year return period rainfall 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 flood 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 a flood risk elsewhere.

Greenfield Runoff Assessment

3.10 A review of the catchment characteristics relating to the site was undertaken using the FEH Web Service (CEH, 2022). Catchment statistics for the Jed Water are considered to be representative as most of the study area lies within this catchment. The following catchment statistics have been used in calculations:

- Standard average annual rainfall (SAAR) of 1,044 mm for the site area;
- Standard percentage runoff (SPR) of 50.03%.

3.11 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 (HR Wallingford, 2022), which gives the IH124 model[1] results for the site.

3.12 The Proposed Development covers 917 ha. Proposed infrastructure and borrow pits have a total land take of 24.8 ha, including temporary infrastructure required only during the construction phase. In order to allow for land take for drainage ditches and settlement ponds, a total land take of 50 ha has been used in calculations, equivalent to twice the total land take specified above.

3.13 The land take includes all impermeable or reduced permeability surfaces including turbine foundations, buildings, hardstanding areas, borrow pits and access tracks plus an allowance for the long-term drainage infrastructure required to maintain site drainage to an acceptable level for operations.

3.14 The 1-in-2 year Greenfield Runoff Rate Q_{bar} has been calculated to be **441 l/s** based on a total drained area of **50 ha**.

3.15 The output from the Greenfield Runoff Estimation for Sites tool is provided in **Annex TA10.4A**.

Attenuation

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

[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).

3.17 The outline drainage strategy for the site aims to promote attenuation within the SuDS proposals to mitigate any additional surface water runoff generated as a result of the Proposed Development. 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 SEPA's guidance.

3.18 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 **6,600 m^3** is required.
- For a 1-in-200 year return period event plus climate change allowance, storage of approximately **4,200 m^3** is required.

4 SUSTAINABLE DRAINAGE SYSTEMS

4.1 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 area and that runoff quality would not risk any reduction in the water quality of the receiving waterbody.

Quality of Receiving Waterbodies

4.2 SEPA's Water Classification (SEPA, 2022b) and Water Environment Hubs (SEPA, 2022c) have been consulted to determine the existing baseline water quality for the main watercourses and waterbodies within the site. Key details are summarised in **Table 10.4.2**.

Table 10.4.2: Baseline Surface Water Quality Status, Summarised

Waterbody Name and ID	Status		Pressures
Jed Water/ Raven Burn (ID 5232)	**Condition in 2014**	Overall: Good Water flows & levels: High Physical condition: Good Water quality: Good	None
	Classification in 2018	Overall: Good Biology (fish): High Hydromorphology: Good	
Black Burn (ID 5235)	**Condition in 2014**	Overall: Good Water flows & levels: High Physical condition: Good Water quality: Good	None
	Classification in 2018	Overall: Good Biology (fish): High Hydromorphology: Good	
Hyndlee Burn (ID 5245)	**Condition in 2014**	Overall: Good Water flows & levels: High Physical condition: Good Water quality: High	None
	Classification in 2018	Overall: Good Biology (fish): High Hydromorphology: Good	

4.3 The watercourses within the site all form part of the River Tweed catchment, draining initially into the Teviot Water near Jedburgh and subsequently joining the River Tweed near Kelso. Key details of these receiving waterbodies are summarised in **Table 10.4.3**.

Table 10.4.3: Receiving Waterbody Quality Status, Summarised

Waterbody Name and ID	Status		Pressures
Teviot Water (ID 5220)	**Condition in 2014**	Overall: Good Water flows & levels: High Physical condition: Good Water quality: High	None
	Classification in 2018	Overall: Good Biology (fish): High Hydromorphology: Good	
River Tweed (ID 5201)	**Condition in 2014**	Overall: Good Water flows & levels: Good Physical condition: Good Water quality: High	None
	Classification in 2018	Overall: Good Biology (fish): High Hydromorphology: Good	

Treatment

Levels of Treatment

4.4 Surface water treatment systems should be based on catchment characteristics and the sensitivity of the receiving watercourse (CIRIA, 2015). Treatment would be required during the entire lifetime of the Proposed Development, from construction through to decommissioning. Much of the construction phase surface water treatment would provide suitable water treatment for the operational phase.

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

4.6 All operations within the Proposed Development during construction and decommissioning 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 Proposed Development 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.

4.7 During operation, one level of treatment, such as swales or filter drains, should be sufficient for most of the Proposed Development 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

4.8 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

4.9 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.

4.10 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

4.11 Filter drains are also linear drainage features, but rather than incorporating vegetation they include coarse graded rock which provides good drain stability whilst 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

4.12 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.

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

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

Silt Fences and Straw Bales

4.15 Silt fences, constructed from a closely woven synthetic geotextile material, and straw bales both provide flow attenuation and particulate filtration treatment for surface water runoff. These are particularly valuable as additional treatment measures for sediment management in runoff during construction works, as silt fences and pegged straw bales 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.

4.16 Silt fences and straw bales are not usually suitable for use as a single level of treatment, but are best used as additional treatment within a wider drainage management system.

Settlement Ponds

4.17 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.

Sump

4.18 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.

Drainage Strategy

4.19 The surface of the access tracks would have a cross fall in order to encourage runoff to drain into trackside ditches on the downhill 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.

4.20 Settlement ponds would be used at the borrow pit sites, the construction cand mobilisation compounds, and substation areas for storage, attenuation and treatment of surface water. The ponds would be established during construction to provide water management for the construction phase works. The settlement ponds may be retained if water storage is required at these locations during the operational phase.

4.21 Swales and filter strips would provide attenuation, storage and treatment for access tracks and turbine hardstanding areas. 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.

4.22 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 at the end of the construction phase if long-term drainage is required. Settlement ponds may also be used at turbine base and hardstanding areas if ground conditions require.

Authorisation

4.23 Where proposals have potential to affect the water environment, the design of any works required to mitigate these effects must take into account the Proposed Development 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 detailed drainage design would be put in place prior to work beginning on site.

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 access route, to connect the 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 including areas of deep peat, habitats and potential receptors downstream of crossing structures;
- whole-life costs for construction and maintenance.

5.2 With these factors in mind, a preferred track geometry has been determined to connect the 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 the track geometry is constrained by ecological and hydrological features.

5.3 There is no direct 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, which developed in an iterative manner in parallel with the turbine layout and associated infrastructure. As part of this process, use of existing forestry tracks within the site has been maximised in order to minimise the requirement for completely new track.

5.5 Use of existing track also allows existing watercourse crossings to be incorporated into the design. Of the ten proposed crossings, only two would be of new construction. All required new or existing crossings are shown on **Figure 10.4.1**.

Access Route

5.6 As discussed in **Chapter 2 The Proposed Development** and **Chapter 12 Traffic and Transport**, Volume 1, access to the Proposed Development will be from the A6088 to the north-east of the site via the upgrading of the existing access track into the forestry plantations. One existing watercourse crossing of the Carter Burn (WC01) would require upgrading. Two short sections of new track, including one new crossing of the Black Burn (WC02), would be required to complete the access route into the turbine area.

5.7 Once within the turbine area, extensive use is made of existing forestry tracks which would be upgraded as necessary. Short linking sections of new track to give access to the turbine hardstandings would be required, with additional sections to facilitate access into the main turbine area from the access area and where existing track corners require regrading.

5.8 Within the turbine area, eight watercourse crossings are required. Of these, one crossing of the Fell Burn (WC04) would be a new crossing. All others are existing crossings that may require upgrading. It is anticipated that the crossing of the Jed Water (WC06) would not require any upgrading work, although this would be subject to engineering verification.

Removal or Modification of Existing Structures

5.9 Where a proposed new crossing is located adjacent to an existing crossing, it is considered best practice to remove the redundant structure. There are no planned crossings adjacent to existing crossings.

5.10 Seven watercourse crossings on the existing track would require upgrading as part of the track upgrading process. It is proposed to widen the crossings, rather than replace the existing structures.

Cable Crossing Locations

5.11 As cables would generally be laid alongside access tracks, cable crossings would normally be incorporated as part of track crossing structures (please refer to **Figure 2.7**, Volume 2. There are no plans for any separate cable crossings over watercourses.

Crossing Descriptions

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

Desk-Study

5.13 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.

5.14 The presence of a network of existing forestry tracks has allowed use to be made of existing crossing structures for most of the Proposed Development, keeping new crossings to a practical minimum.

Walkover Survey

5.15 A walkover survey of the site was undertaken in November 2021, during which the identified crossings were visited to obtain specific information about each crossing location. This walkover was undertaken in relatively wet period and was able to provide a good indication of high water level activity. This information was recorded to inform future decisions regarding crossing structures and sizing.

5.16 During both the walkover and peat surveys, photographs and detailed field notes were taken to record dimensions of the existing crossing structure, watercourse channel and flood channel, 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

5.17 **Chapter 8: Ecology**, Volume 1, indicates that larger waterbodies on site are likely to support small populations of native brown trout and other fish species typical of upland watercourses. All watercourses on site are tributaries to the River Tweed SAC which supports a range of native fish species. The Black Water forms part of the River Tweed SAC.

5.18 Otters are known to use the Jed Water and some of the larger tributaries for foraging and commuting.

5.19 No evidence of water vole was found within the site and are considered unlikely to be present.

5.20 It is assumed that all watercourse crossings will require ecological provision for mammal species.

Crossing Details

5.21 The following table 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.

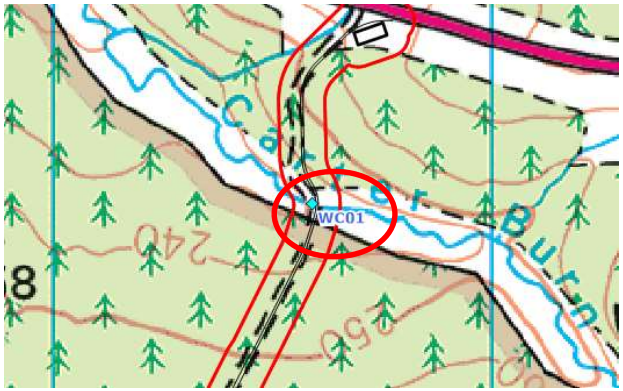
Table 10.4.4: Watercourse Crossing Details

Watercourse Crossing Details	
Crossing:	WC01
Location:	Main site access track
Watercourse:	Carter Burn
NGR:	365587 607536
Description:	Moderately large and relatively well-defined channel in shallow till overlying bedrock. Channel approximately 1-2 m wide and roughly 0.5 m deep although variable. Channel contains cobbles and gravel with muddy substrate in places. Banks are undercut in places. Both banks are well vegetated banks with grass and bracken, trees and scrub in places.
Catchment Area:	7.44 km^2
Crossing Type:	Existing bridge, requires upgrade.

Photograph of existing bridge

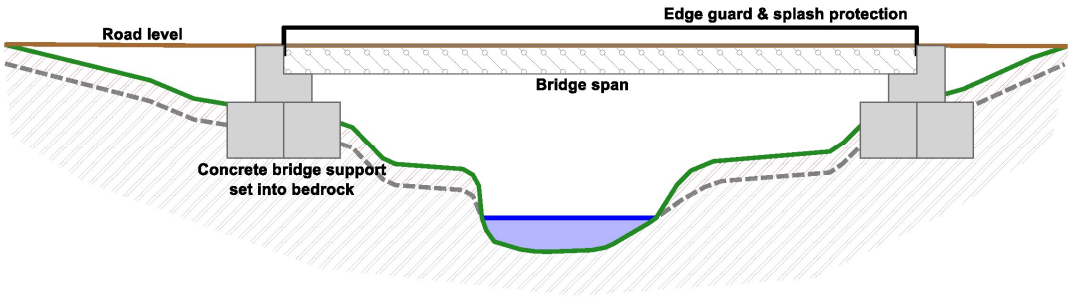
View upstream (SE) showing vegetated banks and existing bridge

View downstream (NW) showing vegetated banks



Watercourse Crossing Details

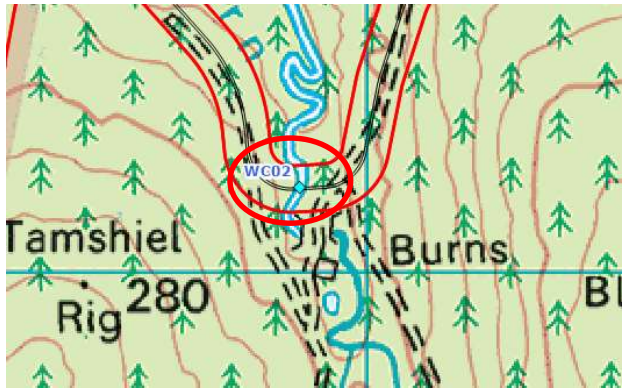
Crossing:	WC02
Location:	Main site access
Watercourse:	Black Burn
NGR:	364844 606196
Description:	Moderately large and well-defined rocky channel. Main channel 2-4 m wide and 0.5-1 m deep with pools in places. Channel contains cobbles and gravel. Banks are gently sloping, undercut in places and well vegetated with grass, shrubs and trees. Downstream of crossing the channel includes substantial meanders. Flood debris was apparent in channel margins and vegetation.
Catchment Area:	8.7 km^2
Crossing Type:	New crossing. Bridge or bottomless culvert



Indicative cross-section, not to scale

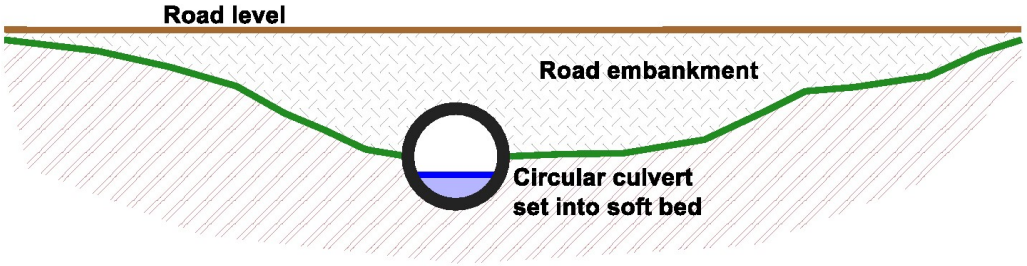
View upstream (S) showing vegetated banks and rocky channel

View downstream (N) showing vegetated banks and rocky channel



Watercourse Crossing Details

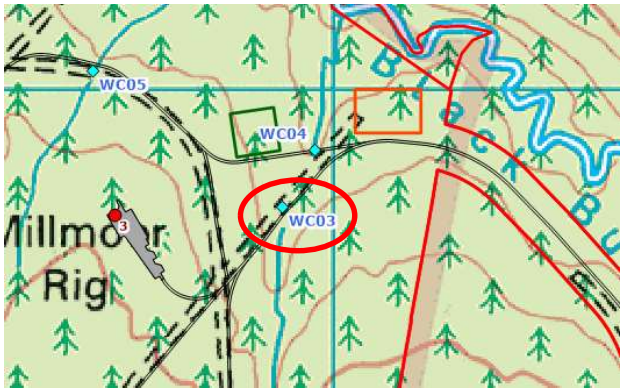
Crossing:	WC03
Location:	East of Turbine T3, south of substation
Watercourse:	Fell Burn
NGR:	363881 606736
Description:	Small watercourse with narrow, meandering but relatively well-defined channel. 0.5-1 m wide and up to 0.5 m deep. Channel contains cobbles and gravel with muddy substrate and mossy boulders in places. Banks undercut, exposing till, with heavy vegetation cover.
Catchment Area:	1.3 km^2
Crossing Type:	Existing crossing – circular closed culvert. May require upgrade.



Indicative cross-section, not to scale

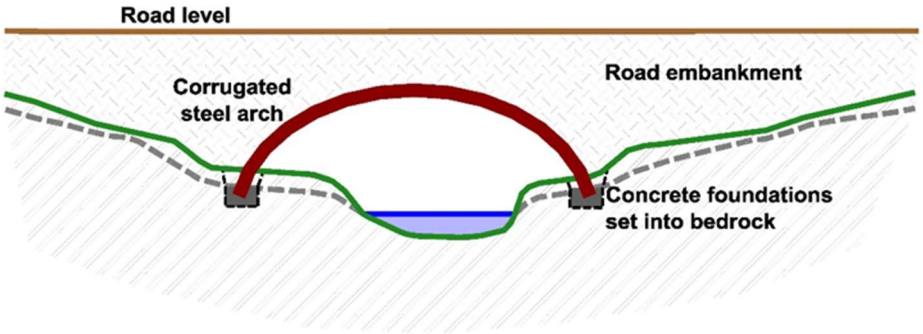
View upstream (S) showing heavily vegetated banks and narrow channel

View downstream (N) showing pipe culvert and mossy boulders



Watercourse Crossing Details

Crossing:	WC04
Location:	Between substation and construction compound
Watercourse:	Fell Burn
NGR:	363956 606865
Description:	Small watercourse with narrow, meandering but relatively well-defined channel. 0.5-1 m wide and up to 0.5 m deep. Channel contains cobbles and gravel with muddy substrate and mossy boulders in places. Banks undercut, exposing till, with heavy vegetation cover.
Catchment Area:	1.4 km^2
Crossing Type:	New crossing required. Bottomless culvert.



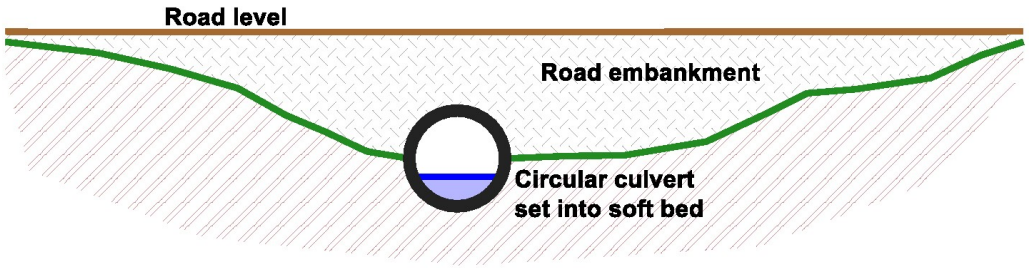
Indicative cross-section, not to scale

View upstream (S) showing heavily vegetated banks and moderately well-defined channel

View downstream (N) of vegetated channel showing cobbly substrate

Watercourse Crossing Details

Crossing:	WC05
Location:	Between construction compound and Borrow Pit BP2
Watercourse:	Unnamed tributary to Black Burn
NGR:	363450 607045
Description:	Minor watercourse in a narrow well-defined and relatively straight channel. May have been straightened as part of forestry works. 0.5-1 m wide by 0,3-0.5 m deep. Banks are heavily vegetated and channel is very overgrown, with open water difficult to observe.
Catchment Area:	0.2 km^2
Crossing Type:	Existing crossing – circular closed culvert. May require upgrade.



Indicative cross-section, not to scale

View upstream (SW) showing narrow channel with vegetated banks

View downstream (NE) showing narrow channel with vegetated banks

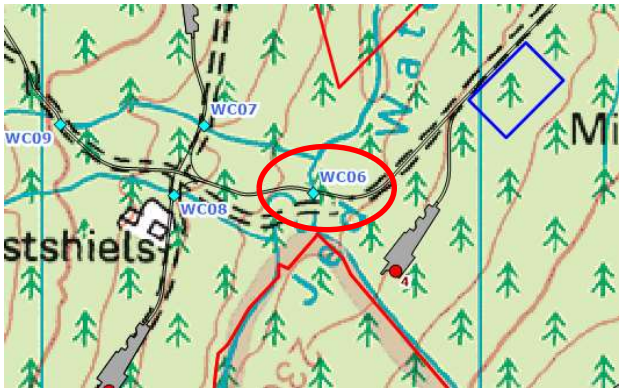
Watercourse Crossing Details

Crossing:	WC06
Location:	North west of Turbine T4
Watercourse:	Jed Water
NGR:	362616 606535
Description:	Moderate to large watercourse with well-defined channel. Width variable, often >3 m; depth around 0.5 m. Channel contains cobbles and gravel with mossy boulders in places. Banks are stable and vegetated with herb and shrub vegetation. Flood debris visible in some areas in bankside vegetation indicating flood level over 1 m above normal flow.
Catchment Area:	11.8 km^2
Crossing Type:	Existing crossing – large closed culvert. No upgrades required.

Photograph of existing crossing

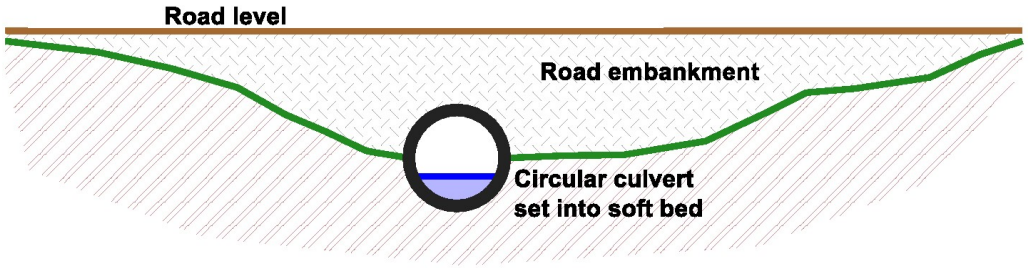
View upstream (N) showing well-defined and relatively straight channel

View downstream (S) showing well-defined channel with bankside vegegation



Watercourse Crossing Details

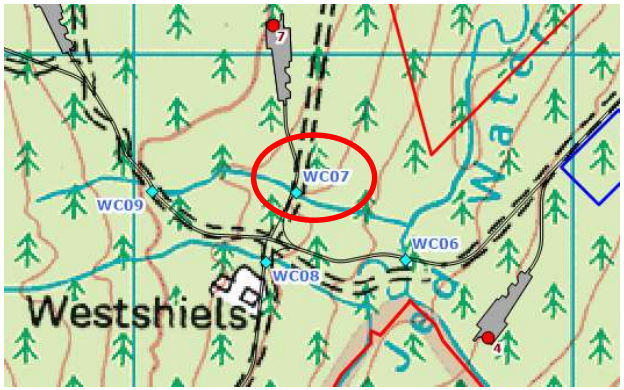
Crossing:	WC07
Location:	On access to Turbine T7
Watercourse:	Rough Sike
NGR:	632368 606688
Description:	Small watercourse in a narrow rocky channel within a wider valley. Channel 0.5-1 m wide by 0.3-0.5 m deep; valley approximately 10-20 m wide by 3-4 m deep. Channel has angular rocky bed although grass and vegetation within channel suggests it is relatively stable under normal flow conditions. Banks are well-vegetated with grass and herb vegetation.
Catchment Area:	0.25 km^2
Crossing Type:	Existing crossing – circular closed culvert. May require upgrade.



Indicative cross-section, not to scale

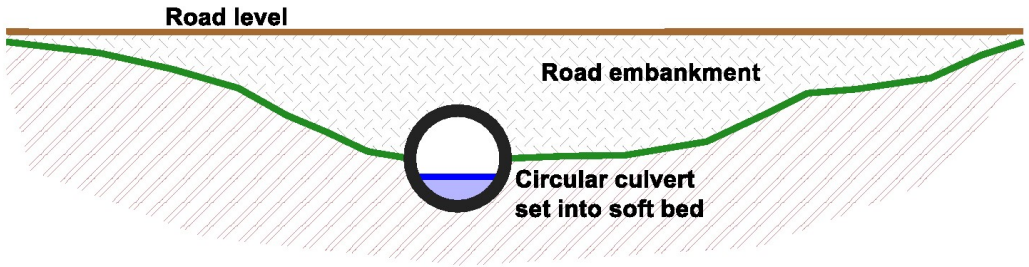
View upstream (NW) showing watercourse valley with narrow channel

View downstream (SE) showing watercourse valley, rocky channel and existing culvert pipe



Watercourse Crossing Details

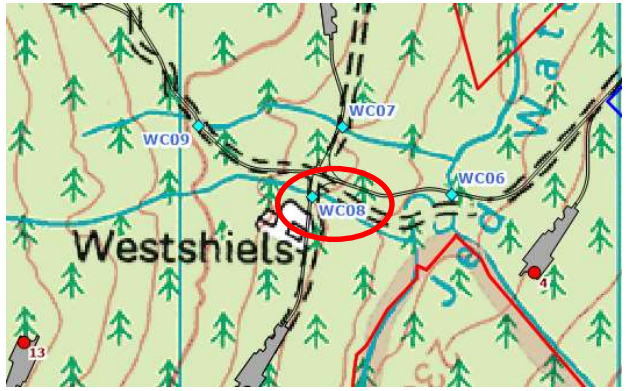
Crossing:	WC08
Location:	On access to Turbine T5
Watercourse:	Westshiels Burn
NGR:	362299 606529
Description:	Small watercourse within narrow channel. A narrow valley is clear upstream but undefined downstream into the forestry. Channel is 0.5 m wide and 0.3 m deep. Banks are low with grass and herb vegetation. Channel contains cobbles and gravel with variable muddy substrate in places. Channel may have been straightened.
Catchment Area:	0.34 km^2
Crossing Type:	Existing crossing – circular closed culvert. May require upgrade.



Indicative cross-section, not to scale

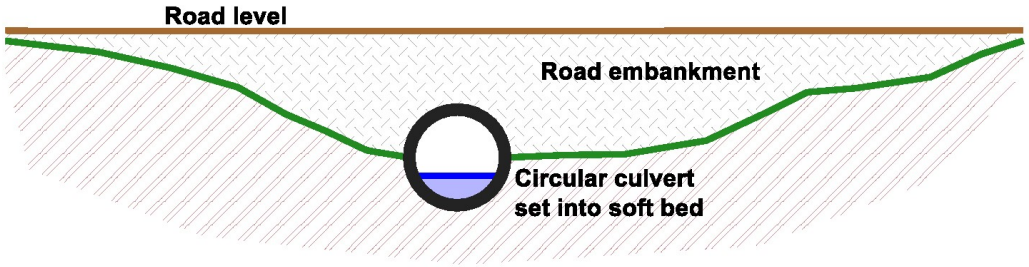
View upstream (W) showing watercourse channel and narrow valley

View downstream (E) showing variable substrate and grassy margins



Watercourse Crossing Details

Crossing:	WC09
Location:	On access east of WC07 and WC08
Watercourse:	Tributary to Jed Water
NGR:	362039 606691
Description:	Small watercourse within narrow, meandering channel. Channel is 0.3-0.5 m wide by 0.3 m deep. Banks are incised and partially undercut; with heavy grass and herb vegetation which partially conceals channel.
Catchment Area:	0.16 km^2
Crossing Type:	Existing crossing – circular closed culvert. May require upgrade.



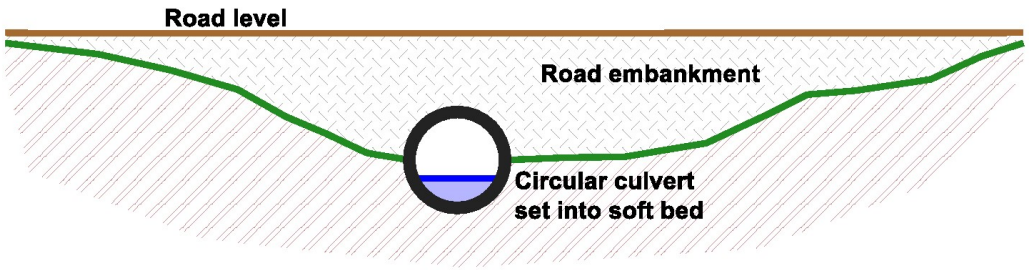
Indicative cross-section, not to scale

View upstream (W) showing heavily overgrown channel

View downstream (E) showing small, meandering channel through heavily vegetated banks

Watercourse Crossing Details

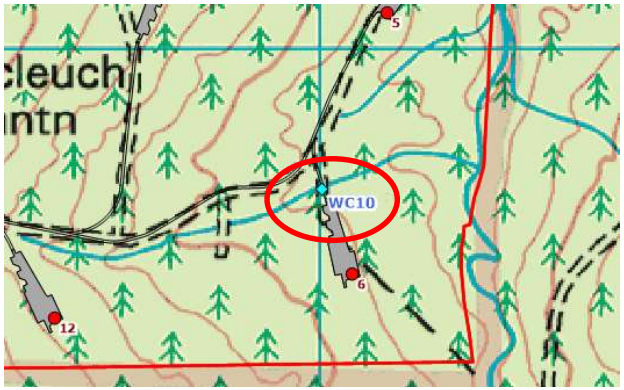
Crossing:	WC10
Location:	On access to Turbine T6
Watercourse:	Tributary to Jed Water
NGR:	362002 605683
Description:	Small watercourse with poorly defined and heavily overgrown channel. Channel is 0.3-0.5 m wide by 0.3 m deep. Banks are heavily vegetated with grass and rushes. Forestry brash is present in places, further obscuring the channel and causing potential obstruction to flow.
Catchment Area:	0.35 km^2
Crossing Type:	Existing crossing – circular closed culvert. May require upgrade.



Indicative cross-section, not to scale

View upstream (SW) showing culvert pipe and narrow overgrown channel

View downstream (NE) showing narrow overgrown channel and forestry brash



Additional Watercourse Crossings

5.22 In addition to the ten watercourse crossings detailed above, 13 minor watercourse crossings would be required. Location and details are provided in **Table 10.4.5**.

Table 10.4.5: Overview of Minor Watercourse Crossings

Name	NGR	Comments
X01	363762 606412	On access to Turbine T1. Existing crossing, pipe culvert, on tributary to Fell Burn
X02	363770 606139	On access to Turbine T1. Existing crossing, pipe culvert, on tributary to Fell Burn
X03	361963 606816	On access to Turbine T8. Existing crossing, pipe culvert, on Rough Sike
X04	361918 606909	On access to Turbine T8. New crossing, bottomless culvert preferred, on tributary to Battling Sike
X05	361209 607015	On access to Turbine T9. Existing crossing, pipe culvert, on tributary to Battling Sike
X06	360899 607057	On access to Turbine T9. Existing crossing, pipe culvert, on tributary to Battling Sike
X07	360875 607086	On access to Turbine T9. Existing crossing, pipe culvert, on tributary to Battling Sike
X08	361542 605655	On access to Turbine T13. Existing crossing, pipe culvert, on tributary to Jed Water
X09	361550 605740	On access to Turbine T13. Existing crossing, pipe culvert, on tributary to Jed Water
X10	361558 605782	On access to Turbine T13. Existing crossing, pipe culvert, on tributary to Jed Water
X11	361727 605650	On access to Turbines T5 and T6. Existing crossing, pipe culvert, on tributary to Jed Water
X12	361992 605808	On access to Turbine T5. Existing crossing, pipe culvert, on tributary to Jed Water
X13	362032 605901	On access to Turbine T5. Existing crossing, pipe culvert, on tributary to Jed Water

5.23 All but one of these crossings is an existing crossing put in place for forestry access. It is anticipated that these crossings would be upgraded as necessary to provide suitable crossings for the Proposed Development. One crossing, X04, is anticipated to be a new crossing. The preferred crossing type would be a bottomless arch culvert. Details would be provided as part of the detailed design process.

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 SBC and SEPA and taking current best practice guidance into account.

6.2 The site currently drains naturally via overland flow, drainage ditches and natural channels to the existing watercourses in and around the area. The proposed 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 designed to prevent any detrimental effects to the water quality or quantity of existing waterbodies. The proposed strategy makes use of SuDS features within the detailed engineering design to mimic the existing runoff characteristics.

6.3 Proposed SuDS to be incorporated into the detailed drainage strategy include use of settlement ponds, swales, filter strips, check dams/berms, sumps and silt fences/straw bales at different stages of the 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 for new crossings appropriate conceptual crossing designs have been suggested to ensure that the watercourses retain their natural hydromorphology and ecological characteristics. New crossing design would take account of flood water conveyance. Details would be provided within the detailed design specifications.

6.5 Should any existing crossings be identified as undersized for their location, consideration would be taken to identifying suitable upgrade or replacement options to ensure that water conveyance capacity is appropriate. Crossing replacements would consider use of bottomless culverts rather than the current closed pipe culverts in order to provide environmental benefits.

6.6 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 TA10.4A

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Catherine Isherwood
Site name:	Millmoor Rig
Site location:	Scottish Borders

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:	55.35141° N
Longitude:	2.59057° W
Reference:	76697704
Date:	Aug 23 2022 12:41

Runoff estimation approach IH124

Site characteristics

Total site area (ha): 70.4

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	0.5

Hydrological characteristics	Default	Edited
SAAR (mm):	1025	1044
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.

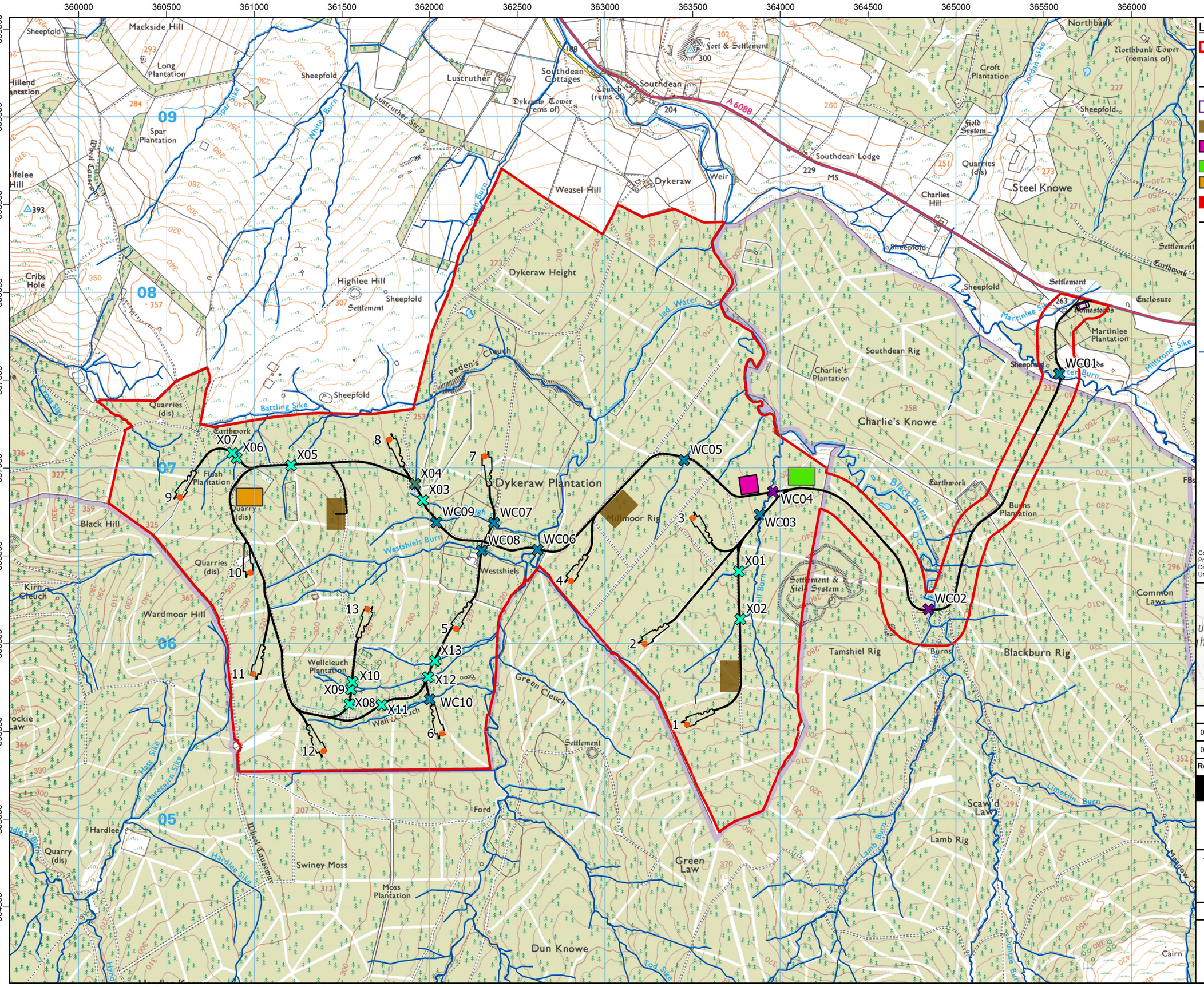
(2) Are flow rates < 5.0 l/s?

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):	663.73	597.6
1 in 1 year (l/s):	577.44	519.91
1 in 30 years (l/s):	1294.27	1165.31
1 in 100 year (l/s):	1745.6	1571.68
1 in 200 years (l/s):	1984.54	1786.81



Legend:

- Application Boundary
- Turbine
- Hardstands
- Mobilisation Compound
- Borrow Pit Search Areas
- Construction Compound
- Substation Compound
- Alternate Substation Option
- Temporary Turbine Layover Area
- Access Track
- Existing Main Watercourse Crossing
- New Main Watercourse Crossing
- Existing Minor Watercourse Crossing
- New Minor Watercourse Crossing
- Watercourses

Coordinate System: British National Grid
Projection: Transverse Mercator
Datum: OSGB 1936
Units: Meter

Rev	Date	Description	Drn	Chk	App
01	16/11/2022	Revised Symbology	DL	RB	RB
00	10/11/2022	First Draft	DL	CI	CI

Millmoor Rig Wind Farm

TITLE: Figure 10.4.1
Watercourse Crossings

ID:P663320 Hydrology_Watercourse Crossings

0 0.5 1
Kilometres
Scale: 1:20,000 @ A3

REV 01

Path: H:\600000 - Glasgow\663320 Millmoor Rig Wind Farm EIA\01 - GIS\03Figures\02Draft