ESB Asset Development UK Limited

Chleansaid Wind Farm: Drainage Impact & Watercourse Crossing Assessment

Technical Appendix 10.5

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1 INTRODUCTION

1.1 This report provides a Drainage Impact and Watercourse Crossing Assessment for the Proposed Development and associated development infrastructure.

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 this document. It has been produced to address the requirement for new drainage infrastructure, including new 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 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, 2019).

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 formal authorisation beyond compliance with the General Binding Rules set out in SEPA (2019).

1.10 This report is produced in compliance with the requirements of The Highland Council (THC) and SEPA and is in line with current best practice.

Development proposals

1.11 The Proposed Development infrastructure would include:

- Up to 16 wind turbines, of approximately 6 MW each, 12 with a maximum tip height of 200 m and four with a maximum tip height of 180 m;
- Hardstanding areas at the base of each turbine, with a permanent area of approximately 2156 m^2;
- One permanent meteorological mast and hardstanding areas for up to two permanent Lidar masts;
- Total length of access tracks is 17,002 m, of which 11,121 m is new access track with associated watercourse crossings and 5,881 m is existing access track and watercourse crossings which will need to be upgraded;
- An operations control building with parking and welfare facilities;
- A substation compound;
- An energy storage facility;
- Telecommunications equipment;
- Up to four temporary construction compounds;
- Two borrow pits, 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.

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 Proposed Development lies on relatively high ground, with elevations close to or above 200 m above Ordnance Datum (AOD). The turbine area lies on the south-western slope of Leathad Chleansaid, a prominent ridge extending south-east from the higher ground of Creag Riabhach na Greighe. The highest point within the turbine area is immediately south of the summit at Sròn Leathad Chleansaid, where the application boundary reaches an elevation of 335 m above Ordnance Datum (AOD). From the ridge crest, the ground slopes south-east towards the Allt nan Con-uisge and east towards the River Brora. The lowest ground is located along the Allt nan Con-uisge in the south-eastern part of the turbine area, at 195 m AOD. The access area to the west falls to an elevation of 140 m AOD when it joins the A836 adjacent to the River Tirry.

2.4 The turbine area drains principally towards the south-east via the Allt nan Con-uisge to join the River Brora just downstream of the application boundary.

Existing drainage and natural catchments

2.4.1 The Proposed Development lies across two main watercourse catchments: the River Brora and the River Tirry catchments.

2.4.2 Most of the Proposed Development lies within the River Brora catchment, with the north-west part drained by the River Tirry catchment.

2.4.3 The Allt nan Con-uisge provides the main drainage for the turbine area. It is located within the broad valley south-west of Leathad Chleansaid and drains south-east into the River Brora approximately 800 m upstream of Dalnessie. A number of minor tributaries and drainage ditches drain into the Allt nan Con-uisge from the slopes of Leathad Chleansaid and the low, poorly defined hills to the south-west of the main channel.

2.4.4 The River Brora provides the drainage for the eastern end of the turbine area, including the lower slopes of Sròn Leathad Chleansaid. The River Brora heads mainly south-east, to reach the North Sea at Brora.

2.4.5 The Abhainn Sgeamhaidh, a tributary to the River Tirry, drains the northernmost part of the turbine area, around A' Chleansaid and the slopes below Creag Dhubh. It flows mainly south-west to join the River Tirry west of the A836 before it reaches Loch Shin.

2.4.6 The Fèidh Osdail provides the drainage for the access area. This watercourse drains west and joins the River Tirry near the junction where the access area leaves the A836.

2.4.7 The Brora and Tirry catchments are not entirely independent. The weir at Dalnessie and associated artificial channel provide a cross-link from the River Brora into the River Tirry catchment via the Fèidh Osdail. This was established to support the hydro-electric scheme downstream of Loch Shin during periods of high flow in the River Brora.

2.5 Details and site drainage are provided in **Table 10.5.1**. Catchment areas are shown on **Figure 10.5.1**.

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
River Brora	67.48	86.1%	1.1%	Turbines T1-T13, both borrow pits, met mast, lidar locations, compound areas, substation, laydown areas, and associated access tracks and crane pads lie in this catchment.
River Tirry	163.3	13.9%	2.7%	Turbines T15 and T16 and associated crane pads and access tracks lie within the catchment.

Rainfall characteristics

2.6 A review of the watercourse catchment and rainfall characteristics was undertaken using data from the FEH web service (CEH, 2021).

2.7 Standard average annual rainfall (SAAR) for the site catchments are as follows:

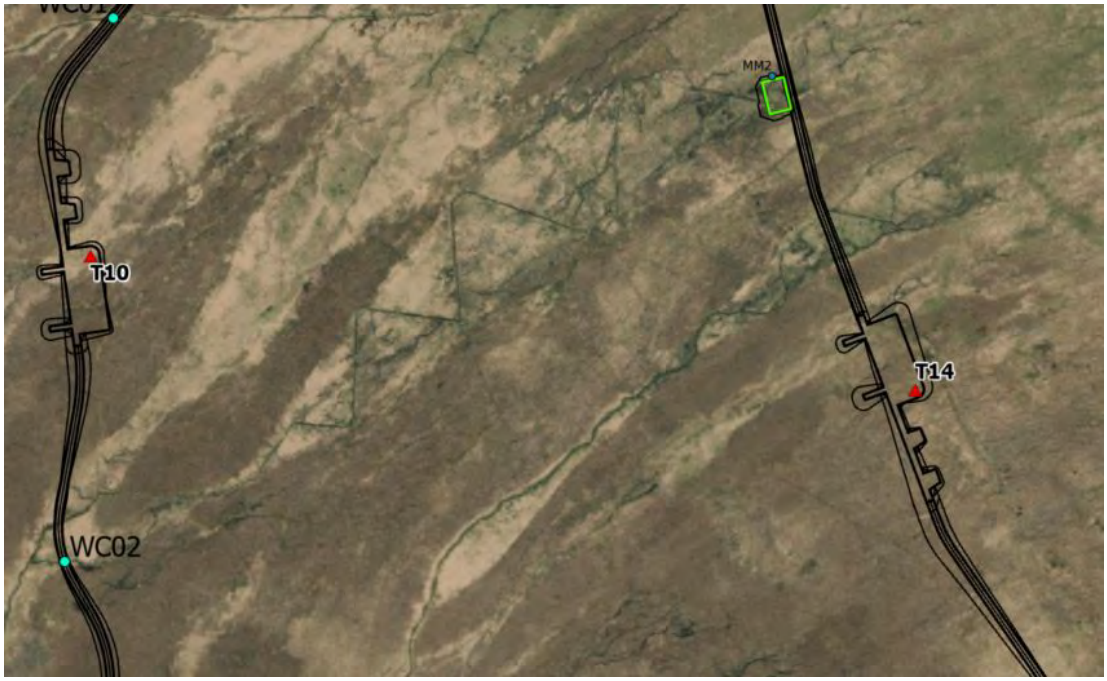
- River Brora: 1,242 mm
- River Tirry: 1,148 mm

2.8 The calculations in Section 3 below make use of the figures for the River Brora, as this covers the vast majority of the Proposed Development and is considered to be the most representative.

Catchment land use

2.9 The site consists of near-natural upland moorland. Site watercourses are mainly in their natural or near natural condition (aside from hydro-electric pressures), with generally high levels of sinuosity. The River Brora catchment reflects the land use described within the site.

2.10 There is some limited evidence of channel modification, straightening and artificial drainage within the River Brora catchment within the site, as shown in Photograph 10.5.1.



Photograph 10.5.1: Zig-zag drainage channels on the slopes of Leathad Chleansaid. Base imagery: ESRI World Imagery (2021).

2.11 The River Tirry catchment is primarily commercial forestry and upland moorland, with agricultural land in the south-western part of the catchment. The majority of the land immediately west of the application boundary is under commercial forestry. Much of the forestry bordering the site has recently been clear-felled.

Existing drainage infrastructure

Waste water

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

Surface water

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

2.14 There is some evidence that a small number of natural watercourse channels have been modified and straightened to improve drainage. Some parts of these have had additional drainage in the form of ditches installed, in an attempt to improve the ground.

2.15 Additionally, there was some peat damming observed south-east of the application boundary and north-west of Dalnessie. This work has been undertaken by the Dalnessie estate to try and encourage peatland restoration in areas that had previously been partially drained.

2.16 Some artificial surface drainage infrastructure is associated with the existing access track into Dalnessie, including ditches alongside the track, bridges at main watercourse crossings and culverts for drainage. The infrastructure is largely in good condition.

2.17 Directly west of the site, drainage has been significantly modified for all commercial forestry land use areas.

Private water supplies

2.18 The properties at Dalnessie make use of a groundwater abstraction via a borehole at NGR NC 6309 1524. The borehole is housed in an enclosed building with fully protected headworks.

2.19 There are no other properties within 5 km of the Proposed Development and no other private water supplies were identified by THC following an information request. It remains possible that some properties take water from the River Brora or the River Tirry downstream of the Proposed Development.

2.20 The Ordnance Survey mapping identifies a well approximately 350 m west of Dalnessie (NC 6309 1524); however, upon inspection during the site visit in June 2020, no PWS infrastructure was identified at this location. Consultation with the estate manager confirmed that there was no well at this location.

3 OUTLINE DRAINAGE STRATEGY

Introduction

3.1 This section provides an outline drainage strategy for the Proposed Development. The objective 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 It would not be practical to connect the Proposed Development to the mains sewerage network as a result of the distances involved. Alternative arrangements would therefore be required.

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 offsite.

3.4 It is unlikely that ground conditions within the site would be suitable for a soakaway. Therefore, 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 THC's Supplementary Guidance: Flood Risk and Drainage Impact Assessment (THC, 2013) 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 THC's guidelines for development (THC, 2013), it is anticipated that the 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

3.9 Post-development surface water flows would be restricted to the discharge levels set out in THC's supplementary guidance document (THC, 2013). The Proposed Development design recognises THC'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 period event 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 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

3.10 A review of the catchment characteristics relating to the Proposed Development was undertaken using the FEH Web Service (CEH, 2021). Catchment statistics for the River Brora are considered to be representative as most of the Proposed Development lies within this catchment. The following catchment statistics have been used in calculations:

- Standard average annual rainfall (SAAR) of 1,242 mm for the site;
- Standard percentage runoff (SPR) of 55.44%.

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, 2021), which gives the IH124 model[1] results for the site.

3.12 The Proposed Development covers 511.8 ha. Proposed infrastructure and borrow pits have a total land take of 17.7 ha, of which 1.13 ha would be temporary working areas during the construction phase and 16.58 ha would be required for the operational lifetime of the site.

3.13 The operational land take includes all impermeable or reduced permeability surfaces including turbine foundations, buildings, hardstanding areas, borrow pits and access tracks.

3.14 The construction phase land take is considered to represent the total area requiring drainage for the purposes of Greenfield Runoff calculations.

3.15 The 1-in-2 year Greenfield Runoff Rate has been calculated to be **235.1 l/s**.

3.16 The output from 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

3.17 THC'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.

3.18 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 THC's documents.

3.19 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 **3,000 m^3** is required.
- For a 1-in-200 year return period event plus climate change allowance, storage of approximately **4,500 m^3** is required.

3.20 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 THC's documents.

Sustainable drainage systems

3.21 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 the water quality of the receiving waterbody.

Quality of receiving waterbodies

3.22 SEPA's Water Classification (SEPA, 2021a) and Water Environment Hubs (SEPA, 2021b) have been consulted to determine the existing baseline water quality for the main watercourses and waterbodies within the site.

3.23 The River Brora has been classified by SEPA in 2018 as having 'good' overall ecological status with respect to its condition resulting from diffuse and point source pollution, modification to its bed, banks and shores, alterations to water levels and flows, and the presence of invasive non-native species (SEPA, 2021a). It was also designated by SEPA in 2014 as having 'good' overall condition and 'good' physical condition, water quality, and water flows and levels with a 'high' status for fish migration access and freedom from invasive species (SEPA, 2021b).

3.24 The River Tirry which drains the northernmost part of the site, has been classified by SEPA in 2018 as having 'poor' overall ecological status with respect to its condition resulting from diffuse and point source pollution, modification to its bed, banks and shores, alterations to water levels and flows, and the presence of invasive non-native species (SEPA, 2021a). It was designated by SEPA in 2014 as having a 'poor' overall condition and 'good' physical condition. It was also characterised as having 'high' water

quality, water flows and levels, and freedom from invasive species with 'poor' status for fish migration access (SEPA, 2021b).

3.25 The River Brora catchment (including the Allt nan Con-uisge and associated tributaries) drains south-east into the sea, into the Helmsdale to Brora coastal waterbody. This waterbody has been classified by SEPA as having 'good' overall ecological status (SEPA, 2021a) and 'good' overall condition and water quality (SEPA, 2021b).

3.26 River Tirry (including the Abhainn Sgeamhaidh) drains south-west into Loch Shin. This waterbody has been classified by SEPA as having 'poor' overall ecological status (SEPA, 2021a) and 'poor' overall condition and water quality (SEPA, 2021b).

Levels of treatment

3.27 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 a development, from construction through to decommissioning. Much of the construction phase surface water treatment could provide suitable water treatment for the operational phase.

3.28 SEPA (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.'

3.29 All operations on 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.

3.30 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

3.31 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

3.32 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.

3.33 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

3.34 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

3.35 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.

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

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

Silt fences and straw bales

3.38 Silt fences, constructed from a closely woven synthetic geotextile material, and straw bales both 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 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.

Settlement ponds

3.39 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

3.40 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

3.41 The surface of the site access tracks will 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 will also be installed where required. Drainage outlets will be carefully located with erosion protection if required.

3.42 Settlement ponds would be used at the two proposed borrow pit locations, the construction compounds, laydown areas and substation 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 pond for Borrow Pit BP1 is likely to be retained to provide attenuation and settlement for the control building and battery storage area throughout the operational phase of the Proposed Development. Other settlement ponds may also be retained if water storage is required at these locations during the operational phase.

3.43 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 swales and filter strips has become established.

3.44 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.

Authorisation

3.45 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 drainage strategy would be put in place prior to work beginning on site.

4 WATERCOURSE CROSSING ASSESSMENT

Route selection

4.1 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 including areas of deep peat, habitats and potential receptors downstream of crossing structures; and
- Whole-life costs for construction and maintenance.

4.2 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 peatland, 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.

4.3 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

4.4 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. As part of this process, an initial loop track section has been removed following feedback from SEPA relating to concerns over additional construction in peatland as well as an extra watercourse crossing location (please see **Figure 2.14** for design evolution).

Access route

4.5 As discussed in **Chapter 2**, **Section 2.6** of the EIA Report, access to the Proposed Development will be from the A836 to the west of the site via the upgrading of the existing access track leading to the Dalnessie Estate through commercial forestry. This will involve one new watercourse crossing of the Fèith Osdail (WC04) and upgrading of an existing crossing to a tributary to the Fèith Osdail (WC05).

4.6 Please refer to Figure 10.5.2 for locations of all watercourse crossings.

4.7 A new section of access track will begin approximately 330 m south-west of Dalnessie. The track will initially head north and then curve north-west, travelling parallel to the Allt nan Con-uisge. Just before Turbine T2, the access track splits, with one track continuing north-west and the other heading north-east and crossing the Allt nan Con-uisge at WC03 (a new crossing).

4.8 The north-west branch from Turbine T2 leads up to Turbines T3 and T4 and the proposed met mast.

4.9 The main, north-eastern, branch crosses the Allt nan Con-uisge before heading north then north-west along the slopes of Leathad Chleansaid. Turbines T14, T15, T10 and T11 are all accessed directly from this main track, with short link track sections providing access to Turbines T5, T6, T7, T8, T9, T12, T13 and T16.

4.10 Between Turbines T10 and T15 the track crosses a tributary to the Abhainn na Bruaiche Duibhe, part of the River Tirry catchment, at WC01 (a new crossing).

4.11 Between Turbines T10 and T11 the track crosses one of the headwater tributaries to the Allt nan Con-uisge at WC02 (a new crossing).

4.12 The proposed access track to the turbine area required for would be a total of 11.12 km. Of this, 5.78 km is excavated road and 5.34 km is rock filled road. In addition, 5.88 km of existing track would require upgrading.

Removal or modification of existing structures

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

4.14 One watercourse crossing (WC05; **Figure 10.5.2**) on the existing track would require upgrading as part of the track upgrading process. It is proposed to lengthen the crossing rather than replace the existing structure.

Cable crossing locations

4.15 As cables would generally be laid alongside access tracks (see **Figure 2.6**), 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

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

Desk study

4.17 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.

4.18 Following issue of the initial track layout, discussions were held with the design team in order to revise the layout to reduce the number of watercourse crossings required for the development. Please refer to **Figure 2.14** for illustration of the design evolution process.

Walkover survey

4.19 Subsequent to the issue of the revised track layout, a walkover survey of the Proposed Development was undertaken in September 2020, during which the identified crossings were viSited to obtain specific information about each crossing location. This walkover was undertaken in dry weather but following a comparatively wet period. Information regarding previous high-water activity including flooding was recorded in order to allow an informed decision-making process with regard to crossing structures and sizing.

4.20 During the walkover survey and the peat surveys, photographs and detailed field notes were taken to record dimensions of the 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

4.21 The Fish Habitat Survey (Technical Appendix 8.3) indicates that functional fish habitat is relatively restricted within the site, largely as a result of the impoundment weir on the River Brora at Dalnessie which does not have a fish pass. There is considered to be little suitable habitat for migratory fish upstream of the impoundment, although brown trout, a non-migratory species, was noted to be present and it is likely that other non-migratory species are present within the site watercourses.

4.22 Evidence of water vole activity was identified within the site and signs of otter have been recorded on the Fèith Osdail within the access area. It is considered likely that otter foraging and commuting takes place within the site.

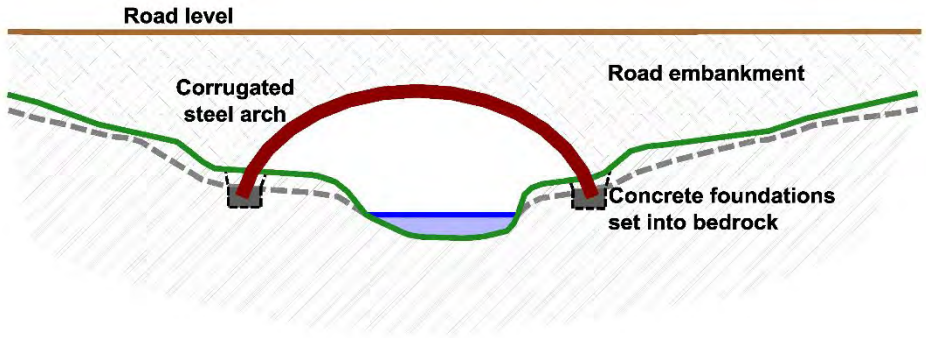
4.23 It is assumed, therefore, that all watercourse crossings will require ecological provision for mammal species.

Crossing details

4.24 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. All crossings are shown on **Figure 10.5.2**.

Watercourse Crossing Details

Crossing:	WC01
Location:	Between Turbines T10 and T15
Watercourse:	Tributary of Abhainn na Bruaiche Duibhe (Tirry catchment)
NGR:	NC 6058 1850
Description:	Boggy area in heavily vegetated wide flood channel without a well-defined flow channel or banks. Channel 2.5 m wide and 0.6 m deep, with water depths at the time of survey in May 2021 recorded at 0.2 m depth. Peaty around and below watercourse (peat depth 0.30 m atop assumed bedrock). Area is well-vegetated with rushes, sedges and grass.
Catchment Area:	0.47 km^2
Crossing Type:	Bottomless arch or box culvert



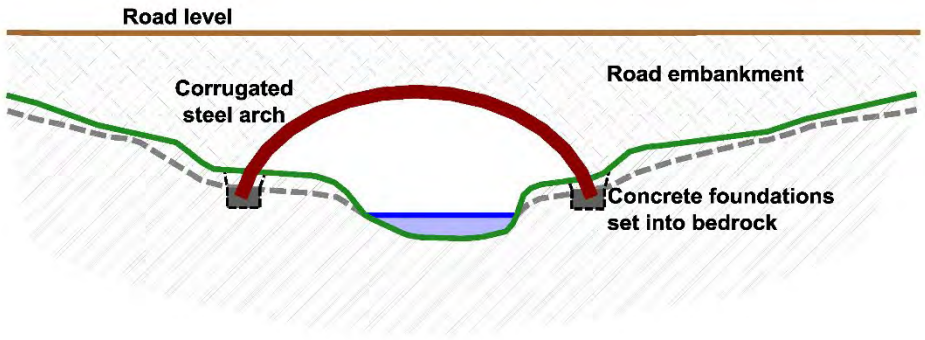
Indicative cross-section, not to scale

View upstream (E) from NC 6058 1849 showing boggy channel within wider area.

View downstream (W) from NC 6058 1849 showing boggy channel within wider area.

Watercourse Crossing Details

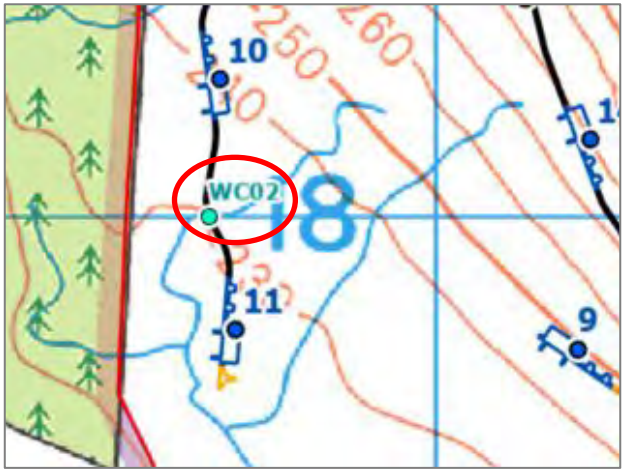
Crossing:	WC02
Location:	Between Turbines T10 and T11
Watercourse:	Headwaters tributary to the Allt nan Con-uisge (Brora catchment)
NGR:	NC 6054 1800
Description:	Vegetated watercourse with grasses within channel. Generally gently sloping banks; watercourse would easily spill out onto floodplain. Channel within peat with depth of 2.25 m. Channel is variable in definition and width, but at the location of the crossing the channel is 2.0 m wide and 0.8 m deep with water depth recorded in May 2021 as 0.2 m.
Catchment Area:	0.21 km^2
Crossing Type:	Bottomless arch or box culvert



Indicative cross-section, not to scale

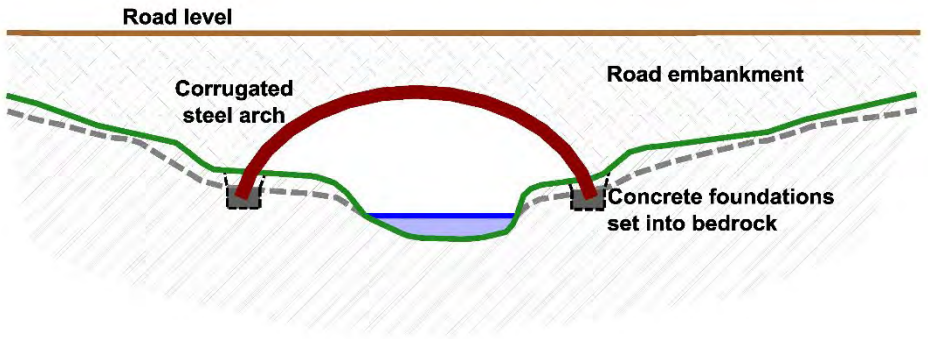
View upstream (E) from NC 6054 1800 showing channel and vegetated banks.

View downstream (W) from NC 6054 1800 showing channel and vegetated banks in wider floodplain.



Watercourse Crossing Details

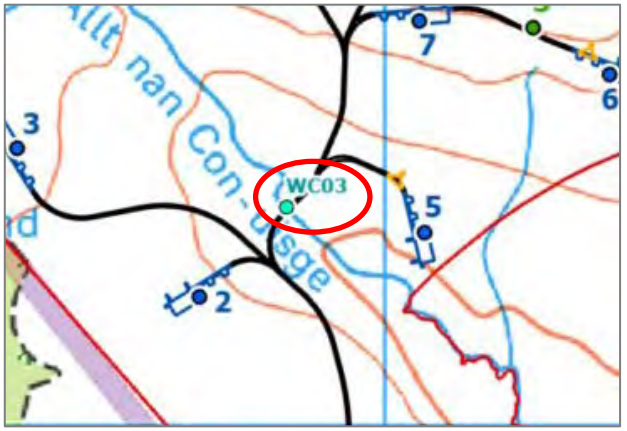
Crossing:	WC03
Location:	Between Turbine T02 and the substation
Watercourse:	Allt nan Con-uisge (Brora catchment)
NGR:	NC 6177 1651
Description:	Well-defined channel in shallow peat overlying bedrock. Channel 1.6 m wide and 0.6 m deep, with water measured at 0.3 m depth at time of survey in May 2021. Bedrock is exposed within shallow water and at the banks. Right bank is steep and incised into bedrock of small hill. Left bank is low with a broad floodplain. Both banks are generally well vegetated with grass and shrub vegetation.
Catchment Area:	3.14 km^2
Crossing Type:	Bottomless arch or box culvert



Indicative cross-section, not to scale

View upstream (NW) from NC 6058 1849 showing well-defined channel and shallow peat along banks.

View downstream (SE) from NC 6058 1849 showing well-defined channel and steep right bank incised in bedrock.



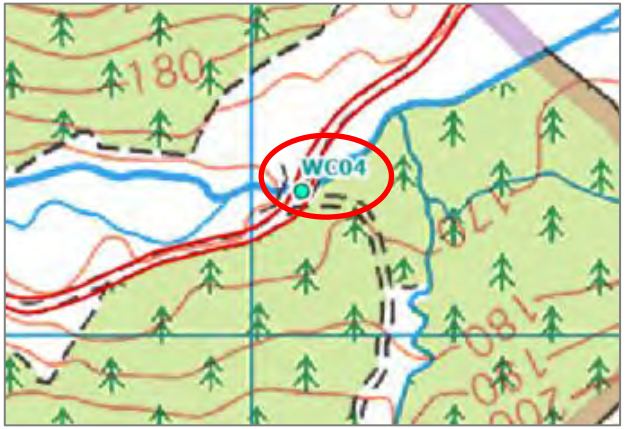
Watercourse Crossing Details

Crossing:	WC04
Location:	Along access track
Watercourse:	Fèith Osdail (Tirry catchment)
NGR:	NC 6211 1432
Description:	Moderately large and relatively well-defined channel in shallow till and morainic superficial deposits overlying bedrock. Channel approximately 6 to 9 m wide and roughly 0.5 m deep. Channel filled with cobbles and boulders and bedrock is exposed in the channel bed. Banks are gently sloping. Both banks are generally well vegetated with grass and shrub vegetation.
Catchment Area:	7.14 km^2
Crossing Type:	Replacement crossing, bridge

Photograph of existing bridge

View upstream (E) from NC 6211 1432 showing well-defined rocky channel and vegetated banks.

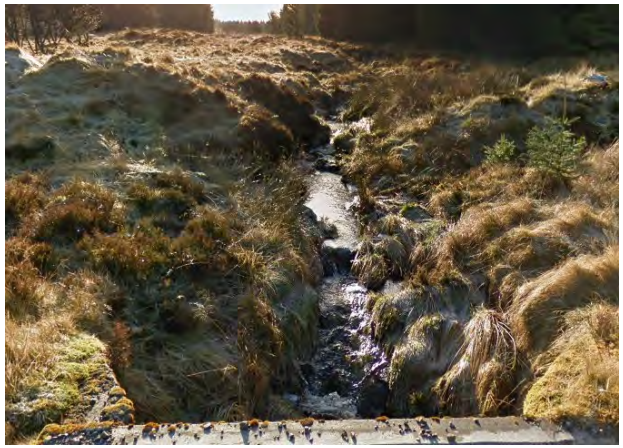
View downstream (W) from NC 6211 1432 showing rocky channel and vegetated bank.



Watercourse Crossing Details

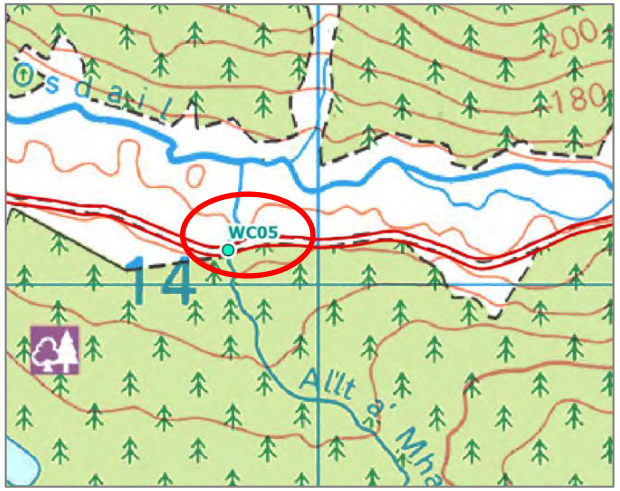
Crossing:	WC05
Location:	Along access track
Watercourse:	Allt a' Mhadaidh-ruaidh (Tirry catchment)
NGR:	NC 6071 1408
Description:	Relatively minor watercourse in a well-defined narrow rocky channel. Channel 0.5-1 m wide and up to 0.5 m deep in pool areas. Well vegetated banks with grass and heather vegetation. Shows signs of high water flow to either side of the main channel
Catchment Area:	1.88 km^2
Crossing Type:	Existing bridge, requires upgrade.

Photograph of existing bridge



View upstream (S) from NC 6071 1408 showing rocky channel and vegetated banks.

View downstream (N) from NC 6071 1408 showing main channel and high water flow signs on the banks.



Additional watercourse crossings

4.25 In addition to the five watercourse crossings detailed above, a crossing of one minor watercourse would be required. Location and details are provided in Table 10.5.2.

Table 10.5.2: Overview of minor watercourse crossings

Name	NGR	Comments
X01	NC 6053 1804	Headwaters tributary to the Allt nan Con-uisge (Brora catchment). This watercourse is characterised by a boggy area in a heavily vegetated wider flood channel. Fluctuation in channel width and definition, with channel more defined upstream (width just upstream of crossing is 4.5 m, depth 1.2 m). At location of watercourse crossing there is some ponding and some evidence of peat channel incision and bank collapse. Peaty around and below watercourse (peat depth 1.45 m above assumed bedrock). Area is well-vegetated with rushes, sedges and grass.

4.26 X01 is located between Turbines T10 and T11 and approximately 35 m north of WC02. This watercourse, although a minor watercourse, still poses a design constraint due to the width of the main drainage area, its relatively diffuse flow and the boggy nature of the ground.

Photograph 10.5.2: (a) View upstream (E) from X01 showing the boggy nature of the ground and its relatively well-defined channel immediately upstream; (b) View downstream (S) showing the wider diffuse flow area and the partly undercut peat banks further downstream.

4.27 Small-scale drainage features are common across the turbine area, particularly in the northern part where there are no defined watercourses but many small networks of drainage. There would be further drainage requirements along the proposed access track

route to maintain existing drainage capacity in these areas, particularly during periods of wetter weather.

4.28 Some areas within the turbine area have had artificial drainage ditches created, as part of historical efforts to improve the land quality. This is particularly the case on the lower slopes of Leathad Chleansaid in the area extending from Turbines T10 and T15 in the north-west to Turbines T8 and T13 in the south-east. Some channel blocking may be undertaken as part of peatland habitat restoration plans, with artificial channels targeted for this work.

4.29 Irregular channels are also present in some peaty areas, notably in the area around Turbines T2, T3 and T4, and between Turbines T5, T6 and T8. Where appropriate, these would be targets for peatland restoration.

4.30 **Figure 10.5.3** shows examples of two minor drainage channels observed within the turbine area during surveys. Channels such as these will require crossing structures under the track to ensure that drainage continuity can be maintained. The Environmental Clerk of Works (ECoW) would be consulted with respect to drainage infrastructure for minor channels.

Photograph 10.5.3: Examples of drainage channels from the Proposed Development. (a) View upstream from NC 6056 1828; (b) View upstream from NC 6256 1695.

5 CONCLUSIONS

5.1 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 THC and SEPA and taking current best practice guidance into account.

5.2 The Proposed Development currently drains naturally via overland flow, drainage ditches and natural channels to the existing watercourses in and around the area. 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.

5.3 Proposed SuDS to be incorporated in 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 Proposed Development. During construction, small sumps with silt fencing would be established periodically along track routes.

5.4 Watercourse crossing locations have been identified and assessed, and appropriate conceptual crossing designs have been suggested to ensure that the watercourses retain their natural hydromorphology and ecological characteristics. A total of four new crossings and one crossing requiring upgrading have been identified. Crossing design would take account of flood water conveyance. Details would be provided post-consent within the detailed design specifications.

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

6 REFERENCES

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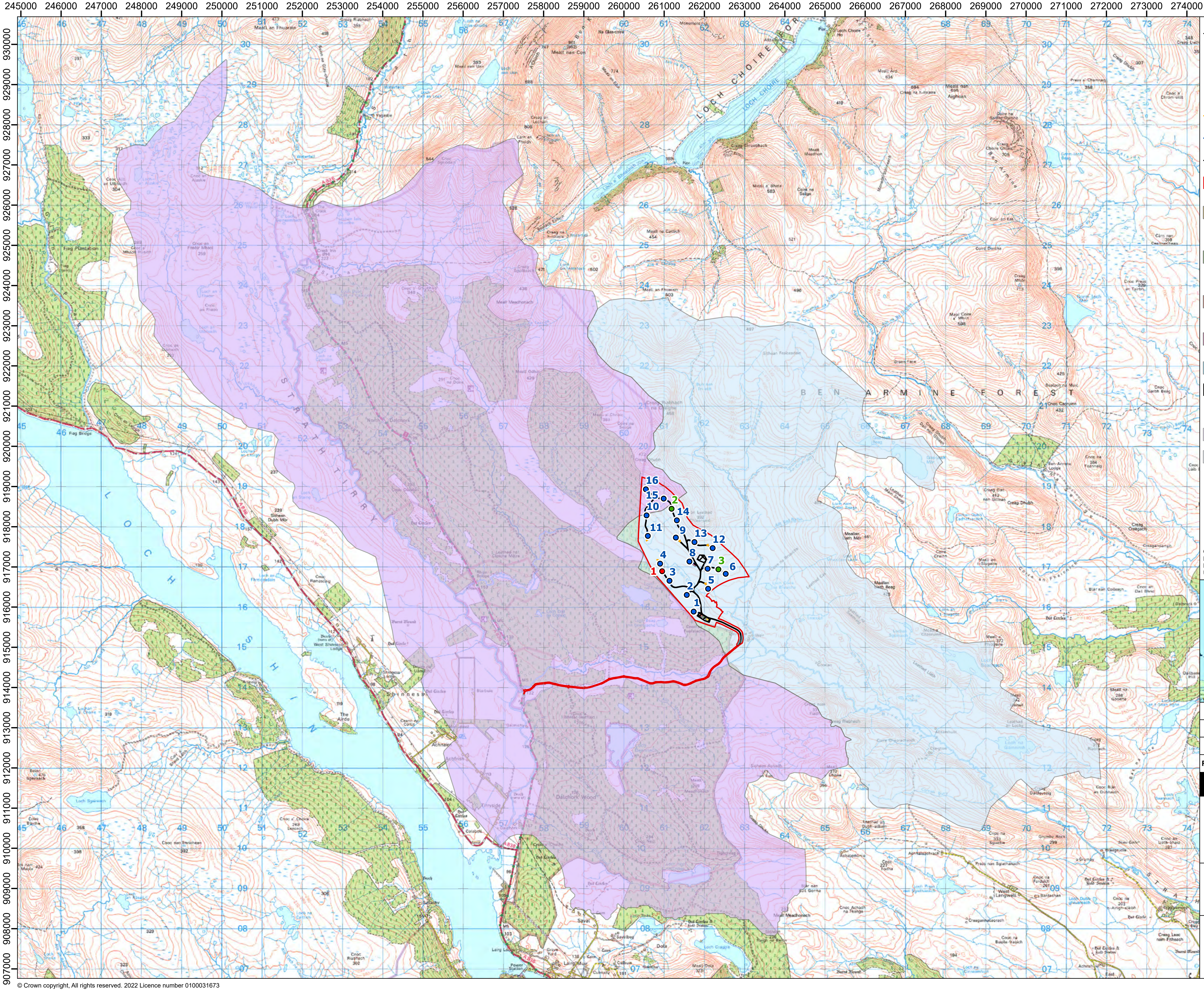
7 FIGURES



Legend:

- Proposed Turbine Locations
- Permanent Lidar Location
- Permanent Met Mast
- Turning Head
- Hardstanding
- Access Track
- Application Boundary
- Control Building and Substation Compound (100m x 75m)
- Substation Construction Compound and Battery Energy Compound (75m x 45m)
- Main Construction Compound (100m x 40m)
- Additional Construction Compound (100m x 40m)
- Mobilisation Compounds
- Borrow Pit

Hydrological Catchments

- River Tirry Catchment
- River Brora Catchment

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

Rev	Date	Description	Drn	Chk	App
00	17/11/2021	First Draft	CM	CI	CI
01	20/01/2022	Update BP1 and Figure No.	CM	CI	CI
02	25/01/2022	Mobilisation Compounds	CM	CI	CI

Chleansaid Wind Farm

TITLE:

Figure 10.5.1:
Hydrological Catchments

0 1.5 3
Kilometres
SCALE: 1:87,000 @ A3

REV 02

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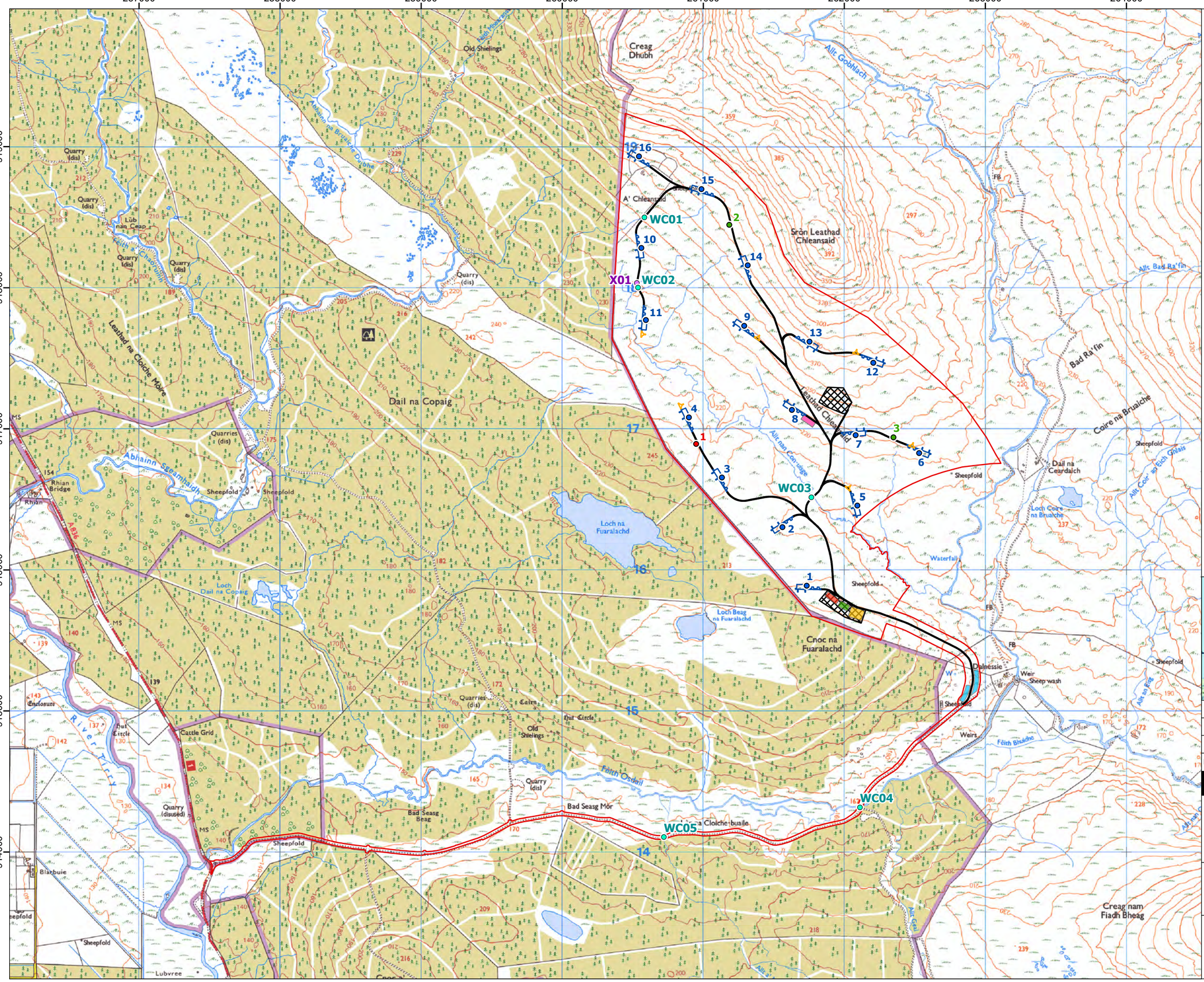

Legend:

- Minor Watercourse Crossing
- Watercourse Crossing
- Proposed Turbine Locations
- Permanent Lidar Location
- Permanent Met Mast
- Turning Head
- Hardstanding
- Access Track
- Application Boundary
- Control Building and Substation Compound (100m x 75m)
- Substation Construction Compound and Battery Energy Compound (75m x 45m)
- Main Construction Compound (100m x 40m)
- Additional Construction Compound (100m x 40m)
- Mobilisation Compounds
- Borrow Pit

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

Rev	Date	Description	Drn	Chk	App
00	01/12/2021	First Draft	CM	CI	CI
01	20/01/2022	Update BP1 and Figure No.	CM	CI	CI
02	25/01/2022	Mobilisation Compounds	CM	CI	CI

Chleansaid Wind Farm

TITLE:

Figure 10.5.2:
Watercourse Crossings

0 0.5 1
Kilometres
SCALE: 1:25,000 @ A3

N W E S

REV 02

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8 ANNEX A

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Eilidh Vass Payne
Site name:	Chleansaid 23.11
Site location:	Chleansaid 23.11

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:	58.08954° N
Longitude:	4.26467° W
Reference:	1459896381
Date:	Nov 23 2021 12:09

Runoff estimation approach IH124

Site characteristics

Total site area (ha): 17.7

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	0.55

Hydrological characteristics	Default	Edited
SAAR (mm):	1172	1242
Hydrological region:	1	1
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 30 years:	1.95	1.95
Growth curve factor 100 years:	2.48	2.48
Growth curve factor 200 years:	2.84	2.84

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):	202.69	235.08
1 in 1 year (l/s):	172.29	199.82
1 in 30 years (l/s):	395.25	458.41
1 in 100 year (l/s):	502.67	583
1 in 200 years (l/s):	575.64	667.63