Clune Wind Farm

Technical Appendix 9.3

Schedule of Watercourse Crossings

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1 Introduction

1.1.1 This Technical Appendix contains information relating to the proposed new watercourse crossings at the Proposed Development and existing watercourse crossings which are scheduled to be upgraded as part of the Proposed Development. The numbers of crossings have been minimised as far practicable through design iterations and through utilising existing tracks and crossings where feasible.

1.1.2 Where a crossing is required, this appendix presents photographs and dimensions for each crossing point. The report also details the likely form of the track crossing solution (e.g., culvert, arch culvert, or bridge), however, the final design of each crossing solution would be agreed with Scottish Environment Protection Agency (SEPA) prior to construction and be determined as part of the detailed site design.

1.1.3 Twelve new watercourse crossings and two existing crossings associated with existing tracks which are proposed to be upgraded are required to facilitate the Proposed Development. A hydrological assessment of the larger watercourse crossings identified on OS 1:50,000 mapping, nine in total, has also been undertaken.

1.1.4 A series of surveys of the proposed watercourse crossings were undertaken in May 2024 by experienced SLR hydrologists.

1.1.5 The location of the watercourse crossings is shown in **Figure 9.1** of the EIA Report. Details of the hydrological setting of the Proposed Development are outlined in **Chapter 9** of the EIA Report.

1.2 Relevant Legislation

1.2.1 The Water Framework Directive (2000/60/EC) (WFD) has been transposed into Scottish legislation as the Water Environment and Water Services (Scotland) Act 2003 (or WEWS) and has given Scottish ministers powers to introduce regulatory controls over activities in order to protect and improve Scotland's water environment. The water environment includes wetlands, rivers, lochs, transitional waters (estuaries), coastal waters and groundwater. These regulatory controls, known as the Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR) came into force in 2011 and have since been amended in 2013, 2017, and 2021.

1.2.2 With respect to watercourse crossings, CAR requires that all engineering works in inland surface waters and wetlands are subject to authorisation and allow for proportionate risk-based regulation which is outlined in the CAR Practical Guide. The authorisation process operates at three levels:

- General Binding Rules (GBR):
  - Minor bridges with no construction on bed or banks.
- Registration:
  - Bridges across rivers and lochs where no part of the structure encroaches on the bed (e.g., no piers or in-channel supports). In addition, the total length of the structures on both banks should not be more than 20m. This category includes bottomless arch culverts; and
  - Closed culverts used for single-track tracks, footpaths and/or cycle routes, where the affected river is not more than 2m wide.
- Licence (Simple/Complex):
  - All other bridges, fords or causeways; and
  - This category would include bridges affecting more than 20m total bank lengths, bridges with in-stream supports or closed culverts for crossings not specified above.

1.2.3 SEPA provide authorisation for watercourse crossings shown on the 1:50,000 scale Ordnance Survey (OS) maps (Landranger Series). All other watercourses are classed as “minor watercourse” and are exempt under CAR.

2 Hydrology Assessment

2.1 Surface Water Catchment Areas

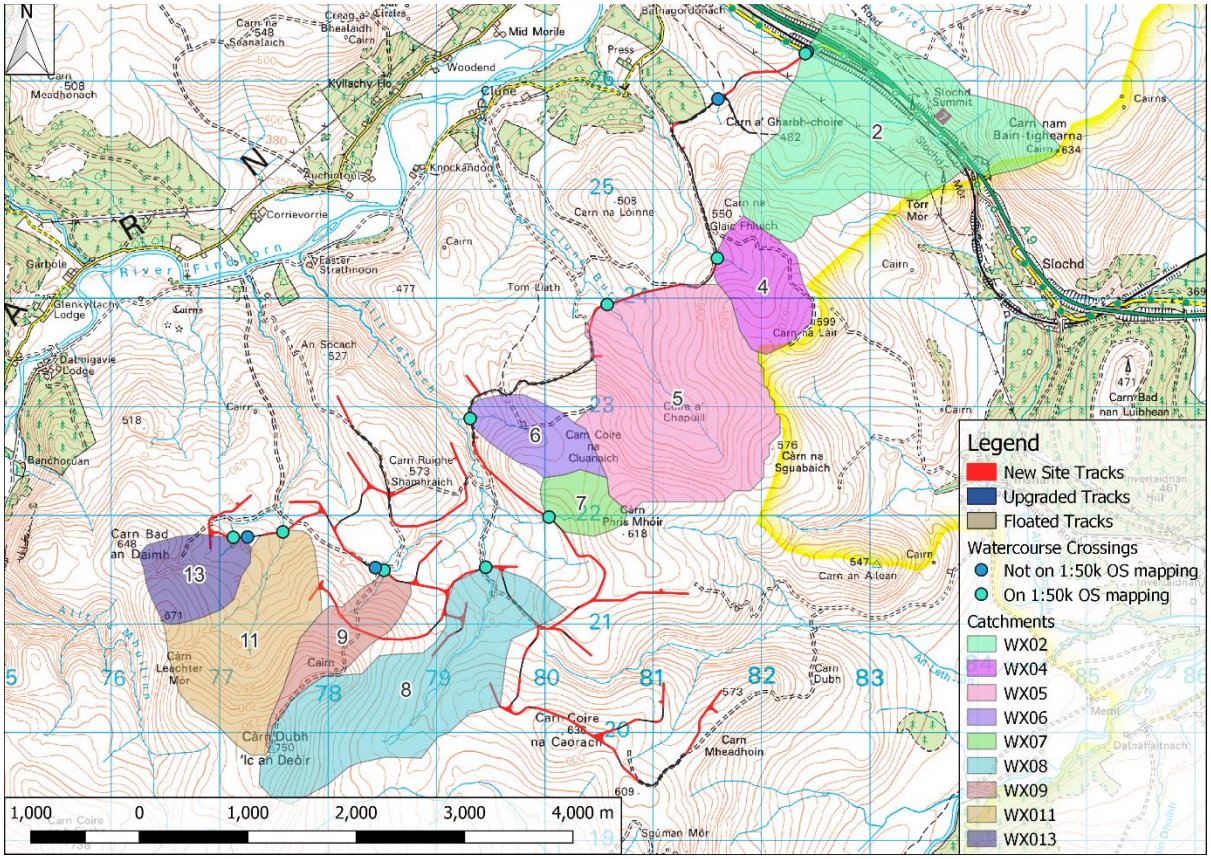
2.1.1 For large crossings, which are shown on 1:50,000 OS mapping, an assessment of the potential flows which the crossings will need to convey has been carried out. Nine of the watercourse crossings surveyed are shown on the 1:50,000 OS mapping. These crossings and their associated upstream catchments are outlined in **Table 2-1** and shown on **Figure 2-1**.

2.1.2 A hydrological assessment has not been carried out on watercourses not shown on the 1:50,000 OS mapping, as these are considered minor watercourses and are exempt under CAR.

Table 2-1: Surface Water Catchment Areas

Crossing ID (see Figure 9.1 of the EIAR)	Catchment Area (km^2)
WX02	3.17
WX04	0.74
WX05	2.92
WX06	0.59
WX07	0.35
WX08	2.43
WX09	0.63
WX11	1.65
WX13	0.63

Figure 2-1: Watercourse Crossing Catchments



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2.2 Design Flood Event

2.2.1 Under National Planning Framework 4 (NPF4)[1], any land at risk of flooding must be assessed to the 200-yr or 0.5% Annual Exceedance Probability (AEP) event with an appropriate allowance for climate change (CC).

2.2.2 A wind farm development falls under the definition of "essential infrastructure" under NPF4, for which development in a flood risk area may be supported. The Site is therefore required under NPF4 to be safe and operational during flood events, and a design event of 0.5% AEP + CC has therefore been applied to further analysis.

2.2.3 The latest SEPA guidance on climate change allowances[2] recommends that for river catchments smaller than 30km^2, an allowance for an increased in

[1] Scottish Government (2023), National Planning Framework 4 (www.gov.scot)
[2] Scottish Environment Protection Agency (2023), Climate Change Allowances for Flood Risk Assessment in Land Use Planning (V.4)

peak rainfall intensity should be applied. For the North Highland river basin the peak rainfall intensity allowance uplift is specified as 42%.

2.2.4 Therefore, a design flood event of 0.5% AEP + 42% CC has been adopted for the peak flow estimation.

2.3 Hydrology and Estimation of Peak Flow Rates

2.3.1 It is understood that there are no publicly available flow gauging records for the watercourses upstream of the crossing locations. The Ungauged Flood Estimation Handbook (FEH) methodology has therefore been applied.

2.3.2 Due to the minor catchment areas, as well as the low attenuation in the catchments[3], it was deemed appropriate to estimate the peak flows at each watercourse crossing using the Rainfall-Runoff Method in ReFH2 (v4.1) software.

2.3.3 The FEH2022 depth-duration-frequency model has been used to generate the design storm rainfall profile. The critical storm duration for each catchment area has been estimated in ReFH2 using catchment descriptors for the selected donor catchment. The selected donor catchment has been selected as the Clune Burn catchment (upstream of WX05) which is considered to be representative of the hydrology at the Site.

2.3.4 The DPLBAR (FEH mean drainage path length index (km)) has been adjusted using the below equation to reflect the changes in catchment areas for each crossing.

$$x = log_{AREA}\, DPLBAR$$

Where $DPLBAR = AREA^{x}$.

2.3.5 The parameters applied to the ReFH2 analysis are summarised in **Table 2-2.**

[3] FEH Flood Attenuation by Rivers and Lake (FARL) value is shown as 1 for all catchments. FARL values of 0.9 or less require additional hydrological assessment.

Table 2-2: ReFH2 Catchment Parameters

Crossing ID (see Figure 9.1 of the EIAR)	Watercourse Name	Catchment Area (km^2)	FEH Delineation	Donor Catchment	Critical Duration	Timestep
WX02	None	3.17	No	WX05	2.25	0.25
WX04	Allt Phris	0.74	No	WX05	2.10	0.1
WX05	Clune Burn	2.92	Yes[4]	Donor catchment	2.25	0.25
WX06	Allt Lathach	0.59	No	WX05	2.10	0.1
WX07	Allt Lathach	0.35	No	WX05	2.10	0.1
WX08	Allt Lathach	2.43	No	WX05	2.25	0.25
WX09	Caochan-nan Gamhainn	0.63	No	WX05	2.10	0.1
WX11	Wester Strathnoon Burn	1.65	No	WX05	2.10	0.1
WX13	Wester Strathnoon Burn	0.63	No	WX05	2.10	0.1

2.3.6 The estimated peak flow rates for the design event of 0.5% AEP + 42%CC are shown in **Table 2-3**.

Table 2-3: Peak Flow Results

Crossing ID	Peak Flow Rate (m^3/s)
WX02[5]	15.85
WX04	3.92
WX05	14.74
WX06	3.14
WX07	1.87
WX08	12.49
WX09	3.35
WX11	8.64
WX13	3.35

[4] Note area of catchment was decreased from FEH delineation from 3.04km^2 to 2.92km^2 following review of topographic contours.
[5] The flows estimated for WX02 also account for the flows from the WX01 catchment, as the watercourse which is crossed by WX01 is a minor tributary of the watercourse crossed by WX02.

3 Watercourse Crossing Details

Watercourse Crossing ID	WX01
Watercourse Crossing Details	Grid Reference: E 282425 / N 826267 Status: New Watercourse Width: 0.5m Watercourse Depth: 0.2 to 0.4m Notes: Watercourse noted in a wider channel which is approximately 1.5m and partially reinforced with a stone wall. An existing concrete culvert is noted immediately downstream of proposed crossing point which has a diameter of 825mm.
Photograph Looking Upstream	
Photograph Looking Downstream	
Proposed Crossing Type	Open culvert or span bridge to accommodate flows estimated for WX02.
Likely Required CAR Authorisation	Minor watercourse – General Binding Rules

Watercourse Crossing ID	WX02
Watercourse Crossing Details	Grid Reference: E 282405 / N 826250 Status: New Watercourse Width: 0.4m Watercourse Depth: 0.3m Notes: None.
Photograph Looking Upstream	
Photograph Looking Downstream	
Proposed Crossing Type Likely Required CAR Authorisation	Open culvert or span bridge, as suitable from a design perspective, to convey peak flow of 15.85m^3/s. Registration.

Watercourse Crossing ID	WX03
Watercourse Crossing Details	Grid Reference: E 281600 / N 825831 Status: Existing to be upgraded Culvert Type: Three corrugated plastic circular culverts. Culvert Diameter: 300mm to 375mm Watercourse Width: 0.4m Watercourse Depth: 0.5m Notes: Water pools up to 2m in width immediately upstream and downstream of existing culvert.
Photograph Looking Upstream	
Photograph Looking Downstream	
Proposed Crossing Type	Culvert.
Likely Required CAR Authorisation	Minor watercourse – General Binding Rules

Watercourse Crossing ID	WX04
Watercourse Crossing Details	Grid Reference: E 281594 / N 824365 Status: New Watercourse Width: 0.5m Watercourse Depth: 0.3 to 0.4m Notes: Crossing noted immediately upstream of an existing crossing which comprises a 900mm plastic culvert. Water pools up to 1.5m wide upstream and downstream of culvert.
Photograph Looking Upstream	
Photograph Looking Downstream	
Proposed Crossing Type	Open span culvert to convey peak flow of 3.92m^3/s.
Likely Required CAR Authorisation	Registration.

Watercourse Crossing ID	WX05
Watercourse Crossing Details	Grid Reference: E 280578 / N 823939 Status: New Watercourse Width: 1m Watercourse Depth: 0.4m Notes: Watercourse surveyed approximately 250m upstream of proposed crossing location.
Photograph Looking Upstream	
Photograph Looking Downstream	
Proposed Crossing Type	Open-span culvert to convey peak flow of 14.74m^3/s.
Likely Required CAR Authorisation	Registration.

Watercourse Crossing ID	WX06
Watercourse Crossing Details	Grid Reference: E 279314 / N 822889 Status: New Watercourse Width: 0.5m Watercourse Depth: 0.6m Notes: Channel densely vegetated at crossing location. Existing crossing approximately 20m upstream of the proposed crossing point which comprises a 900mm corrugated metal culvert.
Photograph Looking Upstream	
Photograph Looking Downstream	
Proposed Crossing Type	Open span culvert to convey peak flow of 3.14m^3/s.
Likely Required CAR Authorisation	Registration.

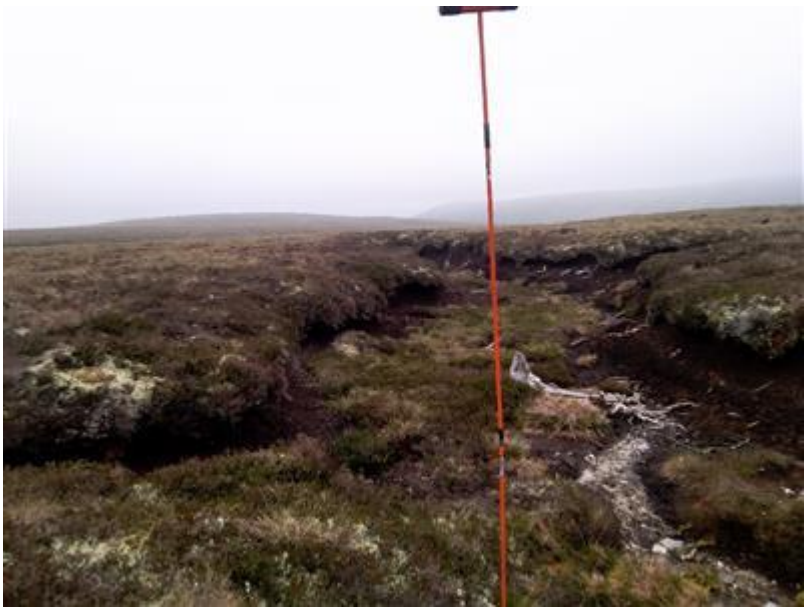
Watercourse Crossing ID	WX07
Watercourse Crossing Details	Grid Reference: E 280041 / N 821981 Status: New Watercourse Width: 1m Watercourse Depth: 0.3m Notes: Watercourse incised in peat.
Photograph Looking Upstream	
Photograph Looking Downstream	
Proposed Crossing Type	Open span culvert to convey peak flow of 1.87m^3/s.
Likely Required CAR Authorisation	Registration.

Watercourse Crossing ID	WX08
Watercourse Crossing Details	Grid Reference: E 279458 / N 821519 Status: New Watercourse Width: 2 to 3m Watercourse Depth: 0.5m Notes: None.
Photograph Looking Upstream	
Photograph Looking Downstream	
Proposed Crossing Type Likely Required CAR Authorisation	Open-span culvert or bridge to convey peak flow of 12.49m^3/s. Licence.

Watercourse Crossing ID	WX09
Watercourse Crossing Details	Grid Reference: E 278519 / N 821491 Status: New Watercourse Width: 1.2m Watercourse Depth: 0.1m Notes: None.
Photograph Looking Upstream	
Photograph Looking Downstream	
Proposed Crossing Type	Open span culvert to convey peak flow of 3.35m^3/s.
Likely Required CAR Authorisation	Registration.

Watercourse Crossing ID	WX10
Watercourse Crossing Details	Grid Reference: E 278439 / N 821515 Status: Existing to be upgraded Culvert Type: Corrugated plastic circular culvert Culvert Diameter: 350mm Watercourse Width: 0.3m Watercourse Depth: 0.1m Notes: Existing culvert with stone headwall.
Photograph Looking at Culvert Entrance from Upstream	
Photograph Looking at Culvert Exit from Downstream	
Proposed Crossing Type	Culvert.
Likely Required CAR Authorisation	Minor watercourse – General Binding Rules

Watercourse Crossing ID	WX11
Watercourse Crossing Details	Grid Reference: E 277586 / N 821844 Status: New Watercourse Width: 1.5m Watercourse Depth: 0.2m Notes: Proposed crossing point located in incised gulley approximately 7m deep.
Photograph Looking Upstream	
Photograph Looking Downstream	
Proposed Crossing Type Likely Required CAR Authorisation	Open span culvert or bridge, as suitable from a design perspective, to convey peak flow of 8.64m^3/s. Registration.

Watercourse Crossing ID	WX12
Watercourse Crossing Details	Grid Reference: E 277260 / N 821797 Status: New Watercourse Width: 0.4m Watercourse Depth: 0.3m Notes: Watercourse dry at time of survey. Located in a wider channel which is 1.7m high and approximately 5m wide and watercourse is incised in peat.
Photograph Looking Upstream	
Photograph Looking Downstream	
Proposed Crossing Type	Culvert.
Likely Required CAR Authorisation	Minor watercourse – General Binding Rules.

Watercourse Crossing ID	WX13
Watercourse Crossing Details	Grid Reference: E 277129 / N 821794 Status: New Watercourse Width: 0.2m Watercourse Depth: 0.4m Notes: Watercourse located in a wider channel up to 20m wide and 3m deep.
Photograph Looking Upstream	
Photograph Looking Downstream	
Proposed Crossing Type Likely Required CAR Authorisation	Open culvert or span bridge, as suitable from a design perspective, to convey a peak flow of 3.35m^3/s. Registration.

Watercourse Crossing ID	WX14
Watercourse Crossing Details	Grid Reference: E 280698 / N 819728 Status: New Watercourse Width: 0.5m Watercourse Depth: 0.2m Notes: Watercourse incised in peat.
Photograph Looking Upstream	
Photograph Looking Downstream	
Proposed Crossing Type	Culvert
Likely Required CAR Authorisation	Minor watercourse – General Binding Rules

4 Summary and Conclusion

4.1.1 Twelve new watercourse crossings and two existing crossings associated with existing tracks which are proposed to be upgraded as part of the Proposed Development. The locations of the proposed crossings are shown on **Figure 9.1**.

4.1.2 The crossings would be designed to pass the 200-yr flood event plus an allowance for climate change. The crossings will be designed in accordance with best practice methods and their design and construction details would be agreed with SEPA and THC as part of the final CEMP.

4.1.3 Good practice methods during construction and operation of the Proposed Development are outlined in Chapter 9 of the EIA Report.