Technical Appendix 9.2

Drainage Assessment

McCloy Consulting

Drainage Assessment

Dunbeg South Wind Farm Extension

M01616-31_DG02 | October 2024

WATER & ENVIRONMENTAL CONSULTANTS

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1 INTRODUCTION

1.1 Terms of Reference

This Drainage Assessment has been commissioned by RES, to support a planning application for the proposed Dunbeg South Wind Farm Extension development north-east of Limavady, Co. Derry/Londonderry, hereafter referred to as the 'Proposed Development'.

The purpose of this assessment is to address Revised Planning Policy Statement 15 (PPS15). The assessment will therefore determine potential sources of flooding at the site and their associated risk to life and property; and shall discuss the site suitability for development and outline proposed design and mitigation measures where appropriate.

1.2 Statement of Authority

This report and assessment have been prepared and reviewed by qualified professional civil engineers, specialising in the fields of hydrology, drainage and flood risk as required by DfI Rivers. The key staff members involved in this project are as follows:

- Kate Macartney BSc – Graduate Environmental Consultant with experience in flood risk assessments, environmental assessments, and surface water environments.
- Iain Muir MSc CEnv MIEnvSc – Senior Consultant and Chartered Environmentalist specialising in environmental assessment and applied hydrology, and particular experience in fluvial flood hydrology and modelling.
- Kyle Somerville BEng (Hons) CEng MIEI – Director and Chartered Engineer specialising in the fields of flood risk assessment; flood modelling, drainage, and surface water management design.

1.3 Approach to the Assessment

Consideration has been given to the sources and extent of fluvial and tidal flooding at the site, as well as flooding of the site from pluvial sources, infrastructure failure, overland flow, and ponding of localised rainfall within the site. The assessment is intended to be proportionate to the scale and nature of the development and the perceived risk to it.

For the purposes of this study the following have been considered:

- Available information on historical flooding in the area.
- Site level information based on a high-resolution digital terrain model.
- Detailed assessment of potential flooding from rivers, including fluvial flood modelling.
- Assessment of potential flooding to the site from overland sources.
- Assessment of potential flood risk to adjacent lands caused by development at the site; and
- Determination of the availability of safe discharge of surface water from the site.

In the absence of a local development plan strategy, the operational planning policy is retained PPS 15 (Revised) which has the same policy direction as the SPPS and is generally more prescriptive. Further guidance is also provided in:

- CIRIA Research Project 624 "Development and Flood Risk: Guidance for the Construction Industry"; and
- Technical Flood Risk Guidance in relation to Allowances for Climate Change in Northern Ireland.

1.4 Application Site

The development and application site (referred to as the 'Planning Application Boundary') lies within a surveyed site comprising a wider landholding (lands under applicant control) referred to as 'the Site' within which the 'Planning Application Boundary' lies. The site is located on elevated land north-east of Limavady.

Site context and location are shown on the drawings submitted in support of the application.

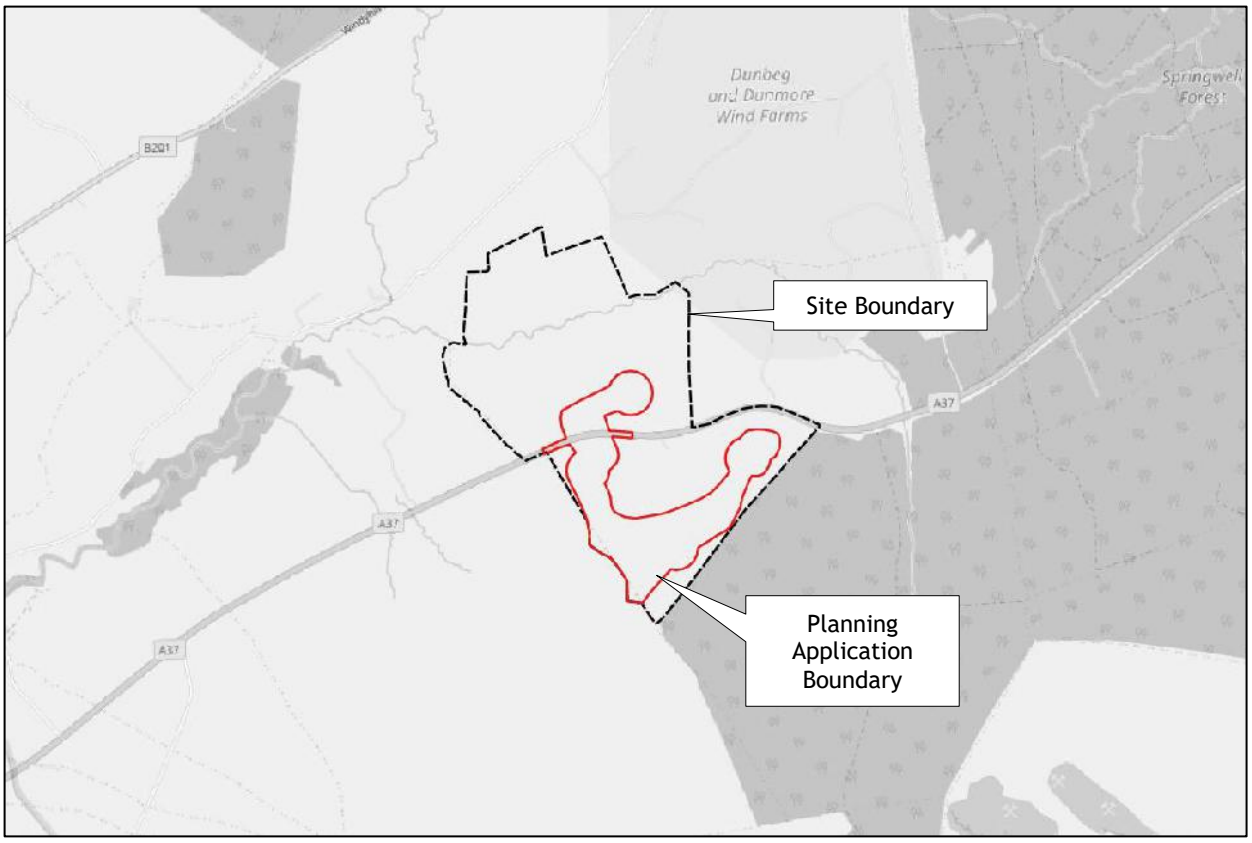

Figure 1-1 Site Location

1.4.1 Existing Land Use

The surveyed site comprises undeveloped grassland and moorland used for agricultural grazing. The site can be accessed from Broad Road (A37) which cuts through the northern part of the proposed development area.

1.4.2 Proposed Development

The proposed development involves the construction of 5 no. wind turbines with associated foundations, access tracks and electrical infrastructure, and the grid connection.

The proposed development footprint within the site is shown on the following figure.

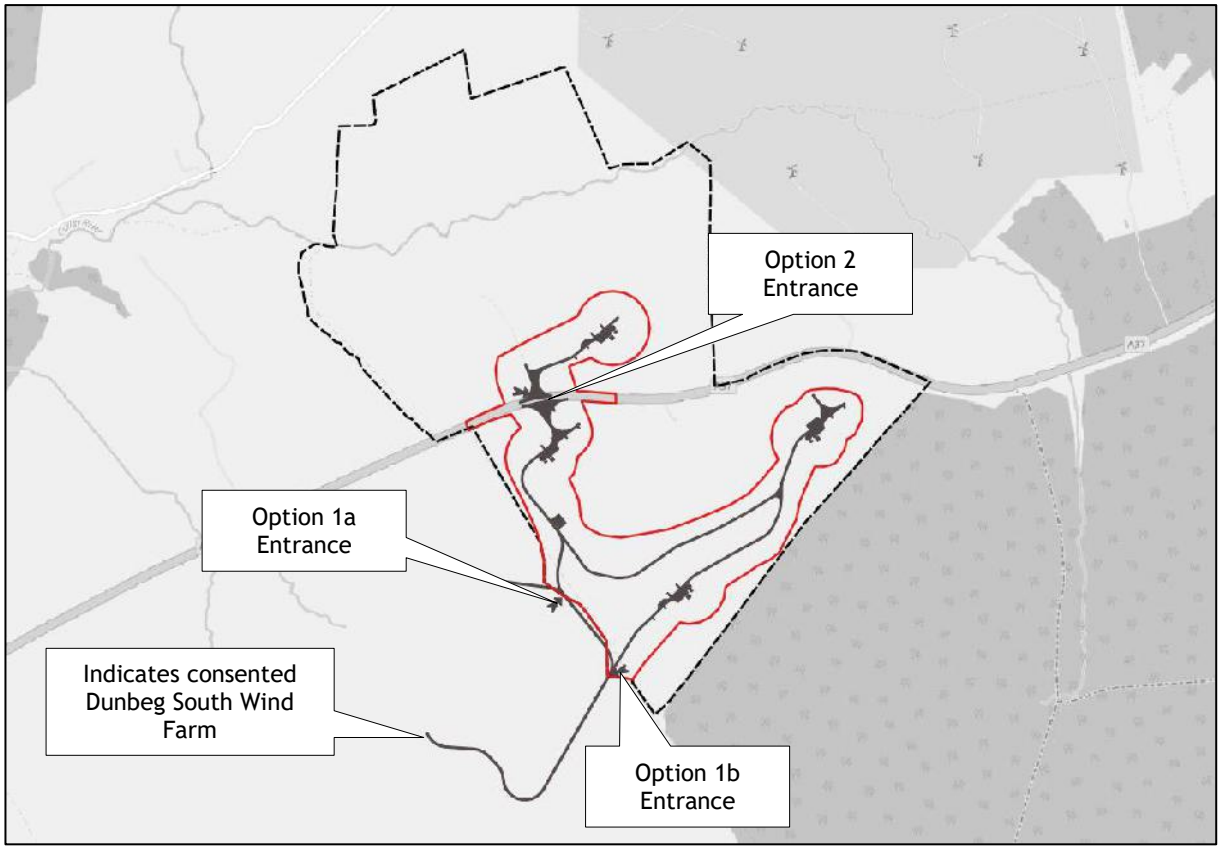

Figure 1-2 Proposed Site Layout

1.5 Site Characteristics

Site characteristics are more fully described within the Geology and Water Environment chapter within the Environmental Statement that this assessment is intended to support. Those aspects pertinent to flood risk and drainage are highlighted in the following sections.

1.5.1 Topography

Topography derived from the OSNI NI 10m DTM is shown on the following figure.

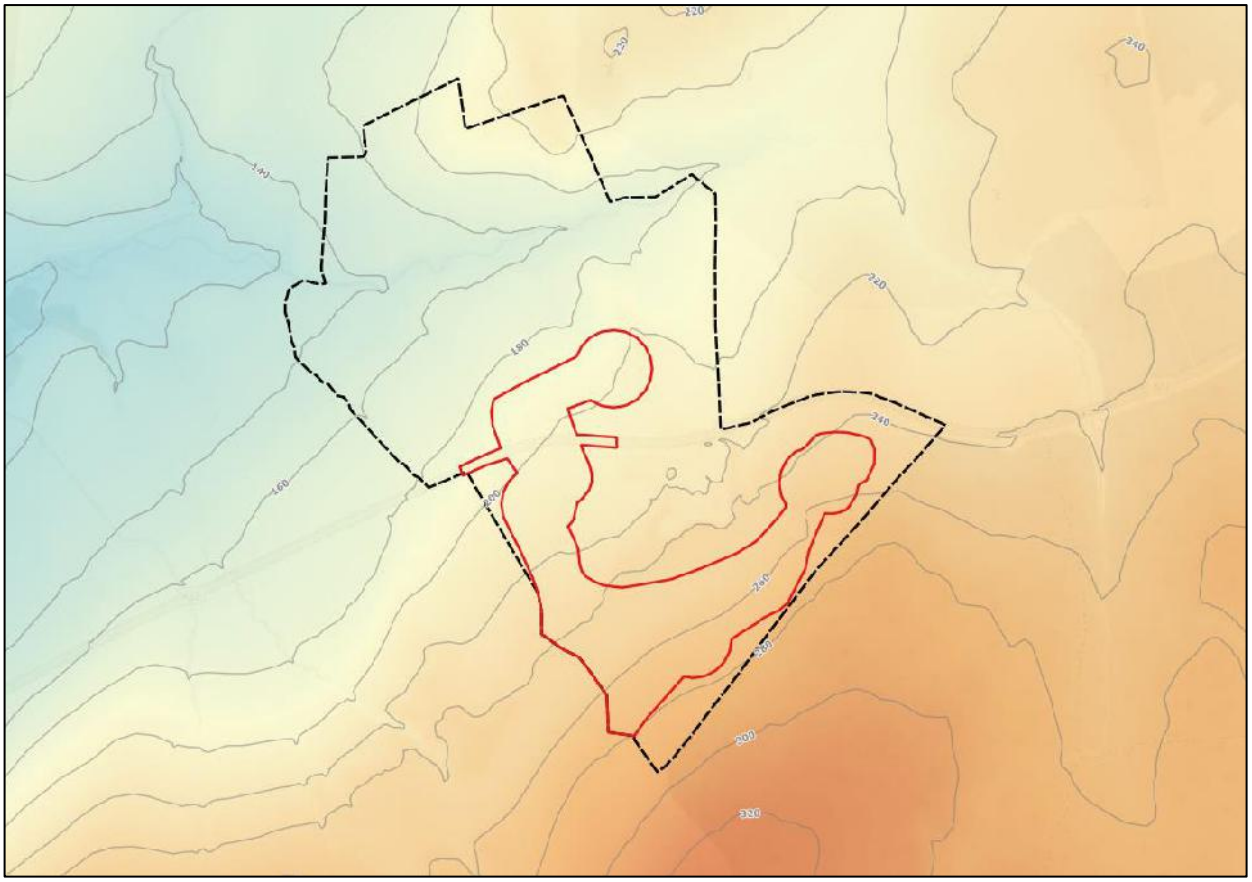

Figure 1-3 Site location and Topography

1.5.2 Hydrology and Watercourses

There are no watercourses designated under the Drainage Order within the site.

Undesignated / minor drainage has been mapped to inform the Environmental Statement.

The hydrology of the area where development is proposed falls within the Curly River drainage basin defined by the NIEA River Water Body dataset. The site drains to the Curly River located within the northern portion of the site, which flows in a westerly/south-westerly direction before joining the River Roe (in the River Roe (Ballycarton) waterbody) c. 7 km west of the site.

Watercourses, peat / land drainage and field boundary drainage, have been mapped as part of the wider hydrological assessment. Main water features on and adjacent to the site are shown on Figure 1-4. A detailed hydrology map is included at Appendix A (which is a duplicate of EIAR Figure 10.1).

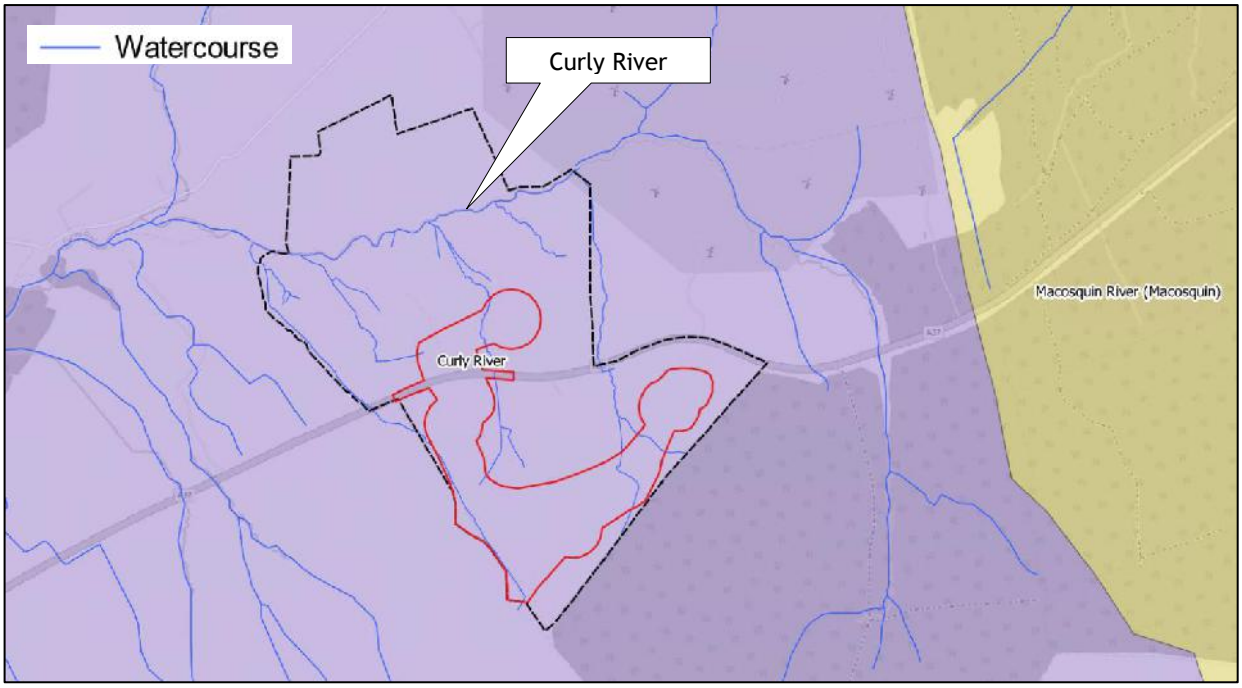

Figure 1-4 Site Hydrology

1.5.3 Geology

A review of GSNI geology data[1] has been undertaken to inform this assessment. Underlying superficial site geology based on GSNI 10k mapping is shown on the following figure. A refined description of ground cover is contained in the Environmental Statement.

[1] Department for the Economy. GSNI GeoIndex. Available from: https://mapapps2.bgs.ac.uk/GSNI_Geoindex/home.html. [Accessed: 28/1/2020].

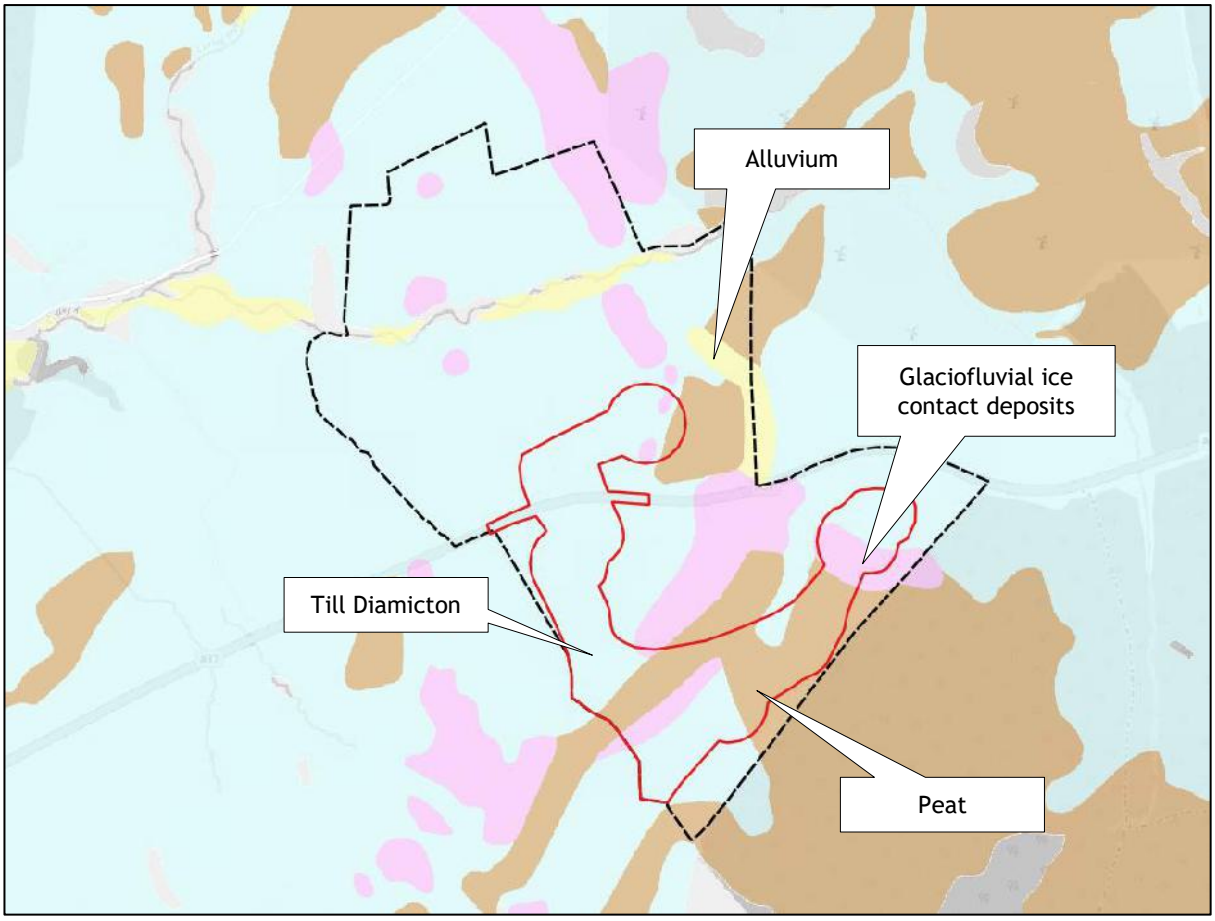

Figure 1-5 GSNI 1:10K Superficial Cover

2 BACKGROUND INFORMATION REVIEW

As part of the data collection phase, several sources of information were investigated to develop an understanding of the potential site flood risk. The following review highlights the findings of the anecdotal evidence collection exercise.

2.1 Internet/Media/Background Search

Preliminary consultation with online media sources indicates that there are no recorded flood incidents which have affected the site.

2.2 Northern Ireland Water

Review of asset information confirms that there are water mains and intakes from Curly River c. 70m west and downstream of the land ownership boundary. No NIW water supply or drainage assets are located within 800m of the proposed development and no further consideration has been given to flooding from such artificial sources.

2.3 DfI Rivers

2.3.1 Flood Maps NI

The extent of development was reviewed with reference to Flood Maps (NI). DfI Rivers in consultation will recommend that climate change is a material consideration, and therefore reference to flood maps is to climate change datasets. Information obtained from flood maps is summarised as follows:

- There is no record of historic flooding within or in proximity of the proposed development.
- DfI Rivers indicative fluvial flood maps indicates that a reach coinciding with the route of the Curly River is affected by the indicatively modelled 1% AEP fluvial flood extents.
- DfI Rivers indicative surface water flood maps – present day indicates that parts of the site are affected by the indicatively modelled 0.5% AEP surface water flood extent.
- The DfI Reservoir inundation maps confirms that the site is unaffected by the inundation zone of any controlled reservoir.

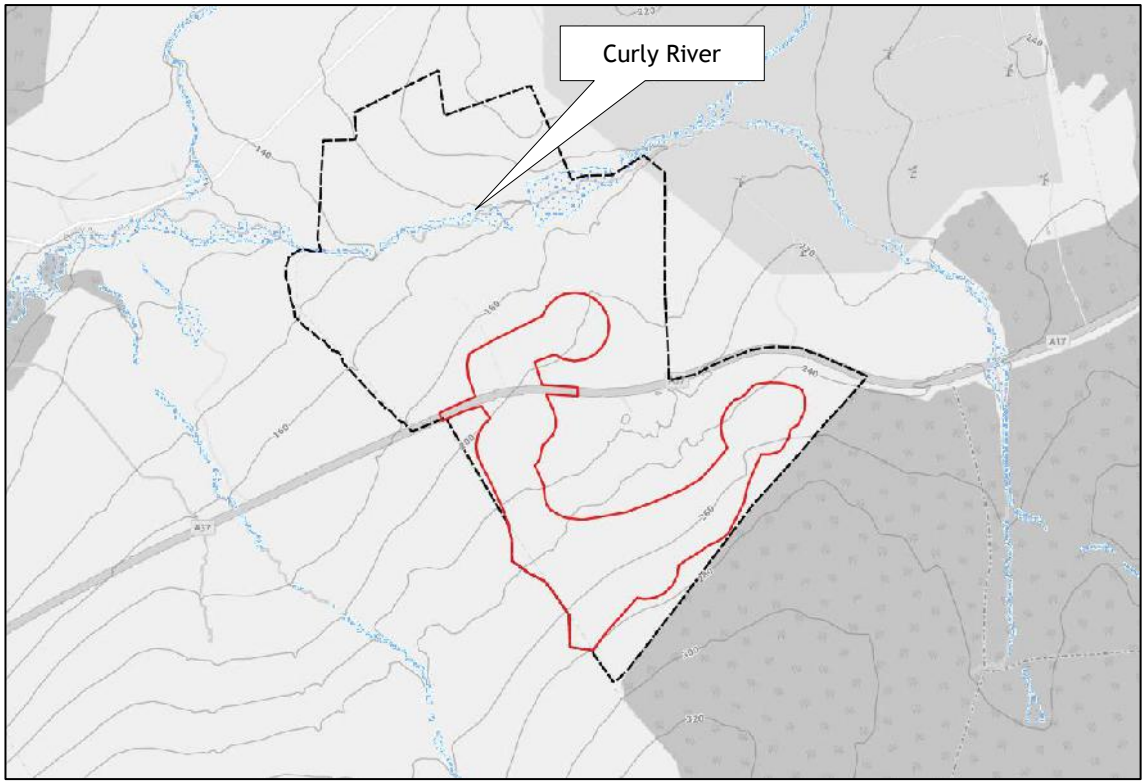

Figure 2-1 Extract from Flood Maps NI – Indicative 1% AEP Fluvial Flood Extent

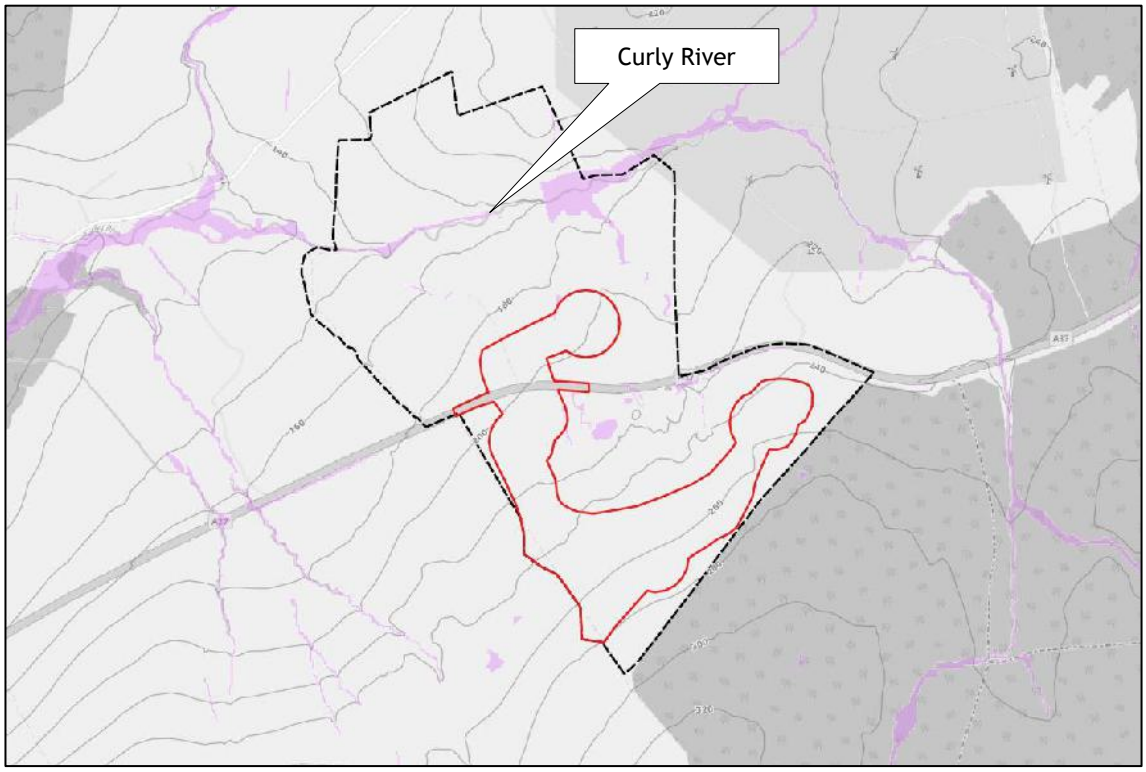

Figure 2-2 Extract from Flood Maps NI – Indicative 0.5% AEP Surface Water Flood Extent

3 FLOOD RISK ASSESSMENT

3.1 Initial Assessment

The following flood mechanism and policy screening is undertaken based on the initial information obtained and in the absence of any pre-application DfI Rivers Planning Advisory consultation response.

Table 3-1 Potential Flood Mechanism and Policy Screening

Policy	Flood Mechanism	Initial Assessment	Policy Applies?	Assess further?
FLD 1 - Development in Fluvial & Coastal Flood Plains	Fluvial Flooding	The site is unaffected by fluvial flooding shown on FMNI.	No	No
	Coastal Flooding	The site is unaffected by coastal flooding shown on FMNI.	No	
	Flood Defence / Failure	The site does not lie in a defended area.	No	
FLD 2 - Protection of Flood Defence & Drainage Infrastructure	Development near drainage or flood defence assets	The proposed development is located adjacent to and crosses several watercourses and minor drains.	Yes	Yes
FLD 3 – Development and Pluvial Flood Risk Outside Flood Plains	Surface water flooding	The proposed development is unaffected by predicted surface water flooding shown on FMNI.	No	Yes
	Surface water discharge	The development would potentially modify surface water run-off characteristics onsite/offsite. The scale and nature of the proposal triggers the need for a drainage assessment; development is required to demonstrate that safe discharge of surface water is feasible.	Yes	
	Culvert Blockage	No existing culverted watercourses have potential to affect the site in areas that would be of concern in relation to flood damage to the proposal.	No	
	Urban Drainage / Local Drainage Failure	No record of local drainage failures.	No	
	Groundwater	Topography does not indicate enclosed depressions where clear groundwater flooding could occur. The development includes no substantial below-ground development that would be prone to flood damage.	No	
FLD 4 – Artificial Modification of Watercourses	Development affecting watercourses	The development shall involve several crossings of undesignated watercourses and field drains to permit access.	Yes	Yes
FLD 5 - Development in Proximity to Reservoirs	Reservoir Flooding	The site is not located within a reservoir inundation zone.	No	No

3.2 Surface Water

3.2.1 Effect of the Development

The proposed development shall lead to an increase in the impermeable area of the site. Therefore, the risk of flooding from surface water run-off from the site shall be greater relative to the existing scenario without appropriate mitigation.

An estimate of the unmitigated post-development run-off for the footprint of the proposed development has been made as part of this assessment. A comparison of existing and proposed run-off rates in litres per second (lps) are provided in Table 3-2.

Table 3-2 Comparison of surface water run-off rates (Peak [1hr] Runoff rates)

Return Period	Existing Site (l/s)	Proposed Site (l/s)	Increase (l/s)
1 in 2 year	36	67	*32*
1 in 30 year	62	176	*114*
1 in 100 year	73	225	*151*

3.2.1.1 Potential for Overland Flooding

The site setting is rural, and the proposal is unlikely to cause any significant direct risk of surface water flooding to any receptor downgradient.

Routing of overland flooding from the site has been determined based on a "rolling ball" hydrological analysis, the outcome of which (showing key overland flow routes) is shown on the following Figure 3-1 (pg. 11). That analysis tends to confirm that all runoff from the site will be intercepted by the watercourse network prior to causing any effect of adjacent land.

Mitigation of surface water flood risk to adjacent lands shall be by provision of an adequate drainage system, see Section 4.2.2.

3.2.1.2 Effect on Downstream Watercourses

All runoff from the site will drain to downstream watercourses lands under control of the applicant.

The effect of the development has been assessed as causing an increased rate and volume of run-off. To mitigate this effect, it is proposed to use a rural SuDS approach to encourage dispersal of runoff over the land and discourage point discharges to watercourses; and to limit run-off from direct discharges to watercourses to a greenfield equivalent pre-development run-off rate.

Point discharges to watercourses will be attenuated to the DfI Rivers greenfield rate up to the 1% AEP + Climate Change. DfI Rivers consent for point discharges has been sought in parallel with submission of the planning application. A copy of the consent will be supplied separately when available.

Requirements for the attenuation and discharge of surface water based on the proposals at the site are discussed in Section 4.2.

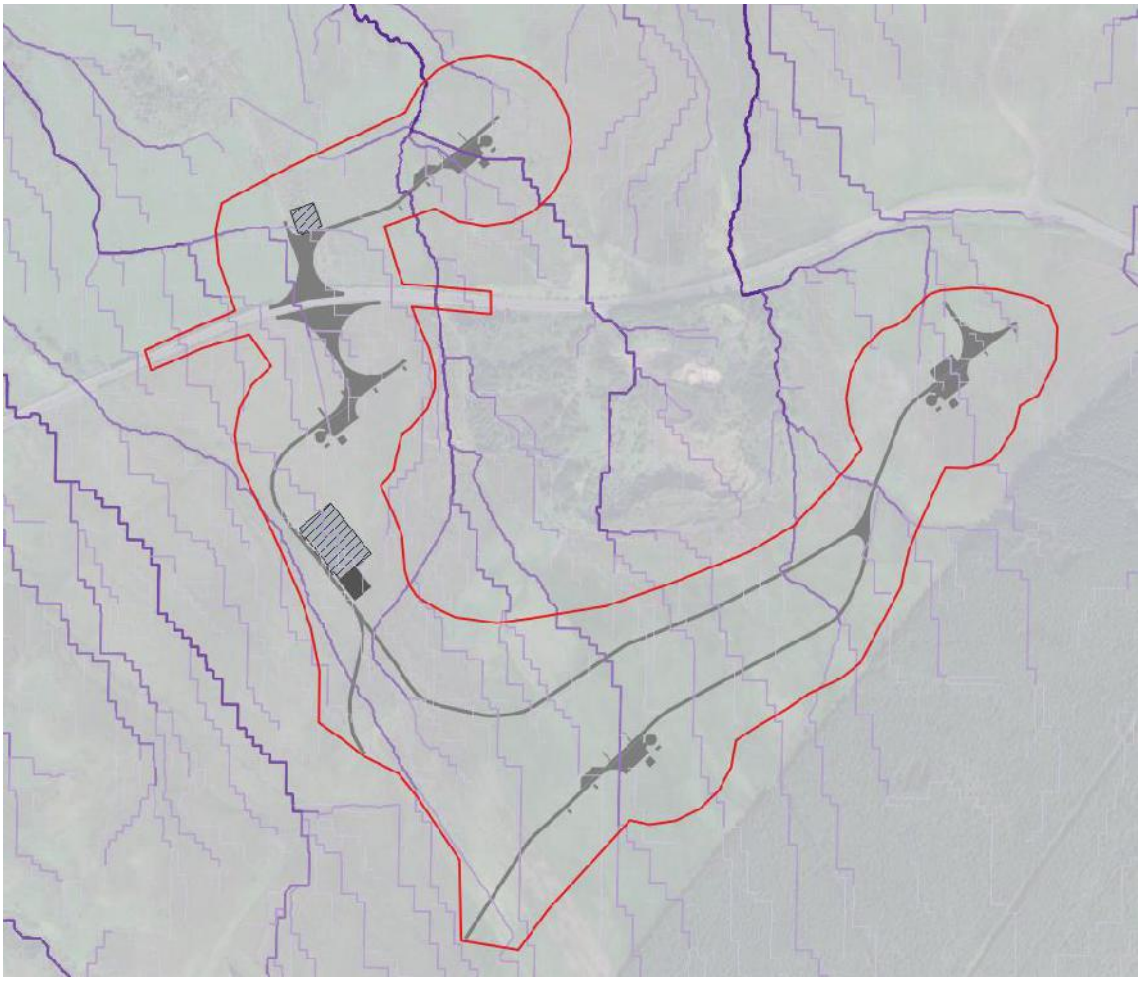

Figure 3-1 Indicative Overland Flow Paths

4 SUMMARY OF FINDINGS AND RECOMMENDATIONS

4.1 Summary of Findings

No r significant flood risk has been identified that could affect the Proposed Development.

The Proposed Development causes an increase in peak rate and volume of runoff from the site. Mitigation of surface water flood risk to the development by providing an adequate drainage system is discussed below.

4.2 Design Measures

This section details measures which have been incorporated into the proposal submitted in support of the planning application, and to be further developed in any detailed design or variation post-determination of the planning application.

4.2.1 Watercourse Crossings

The development shall involve the installation of new watercourse crossings at 6 locations across the site to permit access, all of which are at minor watercourses. A further culvert extension is proposed where an existing drain crosses the public road, to allow site access. All watercourses are generally characterised by from headwater channels to upland bog drainage, and one small (<1 m wide) natural stream.

The nature of the crossing proposed is dictated by other overriding environmental factors (fisheries and habitats requirements); the assessments in the Environmental Statement have determined that closed (piped) culverts are appropriate.

Piped crossings are designed as to mitigate potential for flooding of infrastructure. Culverts are designed to have free inlet conditions for an appropriate flood design standard, nominally 1% AEP / 1-in 100 years with climate change allowance or as may otherwise be required by DfI Rivers in consultation.

Any crossings required shall be designed to accommodate track crossings whilst limiting the length of the channel affected.

Hydraulic design of crossings has been undertaken as per the guidance and requirements provided in CIRIA Culvert, screen and outfall manual (C786F) (or other standard as may be required by DfI Rivers in post-consent consultation), with primary parameters likely to include:

Proposed culverts shall be subject to approval from DfI Rivers through a Schedule 6 application, under the Drainage Order (NI) 1973. Consent has been sought in parallel with the planning application. Consent will be forwarded when available if required.

A detailed schedule of culvert crossings and the watercourses affected is included at **Appendix E.**

4.2.2 Drainage Design

Drainage is to meet or exceed the hydraulic standards stated as follows:

• The drainage network / site layout ensures containment and control of the 100-year (1% AEP) return period storm within the site to ensure no offsite effect elsewhere. • The drainage network allows for a **20%** allowance for climate change for the flood protection standard.	To suit DfI Rivers flood protection standards.

Due to the nature of the development, a formalised conventional drainage system is not considered feasible or practical at the site. The design principles in summary are as follows:

- Runoff from the access track shall be collected via open swales. Run-off shall be attenuated with the use of check dams to reduce the peak rate of run-off and to encourage infiltration of surface water.
- Settlement/attenuation basins will be provided where drainage from significant areas of hardstanding discharge directly to streams and watercourses.
- If feasible at detailed design, run-off should be encouraged to discharge overland, rather than accumulate concentrated peak flows to discharge to watercourses.

The drainage networks should also allow for a 20% allowance for climate change at all the above listed return periods. SuDS features shall be designed in accordance with best practice guidance in The SuDS Manual (Document ref: C753; CIRIA).

4.2.2.1 Discharge Rate and Location

To demonstrate that the safe discharge of surface water from the proposed wind farm site is feasible, a preliminary drainage design has been prepared and is included in Appendix B. The proposal involves surface water from the proposed development discharging directly to the existing on-site watercourses and field drains, at the 10 no. locations indicated on the drainage design.

Point discharges to watercourses will be attenuated to the DfI Rivers greenfield rate up to the 1% AEP + Climate Change event. DfI Rivers consent for point discharges has been sought in parallel with submission of the planning application. A copy of the consent will be supplied separately when available.

Surface water run-off shall be limited as closely as feasible to the greenfield run-off rate of 10l/s/ha for the developed site area.

4.2.2.2 Attenuation Requirement

The planning drainage design shown intends surface water from the site to discharge into 14 no. attenuation basins at locations adjacent watercourses and field drains. Flows controls shall be installed at the pond outflow points to ensure that flows are limited to a greenfield rate as per Table 4-1, or at very small catchments at the minimum permissible rate to manage blockage risk (adopted as 1lps).

The storage calculation has not included the storage provided within the drainage conveyance system i.e. by check dams in swales, and loss of water by overland dispersal. The attenuation sizes required are therefore considered highly conservative. Attenuation calculations demonstrate that attenuation as scheduled on Table 4-1 (overleaf pg. 14) is required.

The attenuation volume stated is based on preliminary information; drainage catchments are subject to change dependent on the finalised layout of any drainage layout and finished ground levels. Volumes stated are dependent on the type and efficiency of the flow control method used. Ultimately the final design (to be completed and agreed post-consent) must comply with the limiting discharge rate (per hectare) applied to the drained development area.

The location of attenuation basins / configuration can be viewed in drawings included in Appendix B.

Table 4-1 Attenuation Requirements

Catchment	Comment	Drainage area (m2)	Attenuation storage required (m3)	Limiting rate @ 10lps/Ha / (Proposed Rate – allowing for minimum control for blockage) (l/s)
1	Discharge to minor watercourse / field drain	214	5	0.2 (1)
2	Discharge overland at level spreader	4167	90	4.2
3	Discharge to minor watercourse / field drain	355	8	0.4 (1)
4	Discharge to minor watercourse / field drain	2613	56	2.6
5	Discharge overland at level spreader	6452	139	6.5
6	Discharge to minor watercourse / field drain	915	20	0.9 (1)
7	Discharge to minor watercourse / field drain	663	14	0.7 (1)
8	Discharge to minor watercourse / field drain	212	5	0.2 (1)
9	Discharge to new manhole at culverted drain	6256	135	6.3
10	Discharge to land drain	4075	88	4.1
11	Discharge to minor watercourse	3374	73	3.4
12	Discharge overland at level spreader	949	20	0.9 (1)
13	Discharge to minor watercourse	242	5	0.2 (1)
14	Discharge to minor watercourse	2298	49	2.3
TOTAL		**32785 SQ M**	**705CU. M**	**32.8 lps / (36.2 lps)**

4.2.2.3 Exceedance

In the event of an unprecedented flood, any attenuation pond is expected to overtop and drain overland.

It has been demonstrated that flows from the site up to the flood protection design standard (1 in 100 year/1% AEP) can be safely contained within the system without flooding. Runoff in the event of other exceedance (i.e. blockage or other failure) will tend to follow flow routes north as per the present-day scenario (refer to Figure 3-1.) Exceedance routes coincide with the routes of existing minor watercourses.

Mitigation of such exceedance shall be by robust maintenance of the drainage network described subsequently.

4.2.3 Protection of Watercourses

The proposal includes measures that prevent development within 10m of minor watercourses and 50m of hydrologically significant water features, which ensure that the requirements of policy FLD2 are met. The

nature of the proposal causes no built development of a type that would impede riparian maintenance of watercourses, and as such meets the normal requirements stated in policy FLD2 in relation to watercourse maintenance.

4.3 Maintenance Requirements

4.3.1 Drainage System Maintenance

The developer/site operator is to ensure that the maintenance of the drainage system is included within the overall management plan for the site. Detailed drainage layouts for the site shall ensure that key features requiring maintenance (e.g. flow control devices) are in accessible locations.

Maintenance plans for SuDS are to include (where applicable):

- Cyclical (min. annual, or after significant storm event) check of any flow control device for damage, debris, or blockage.
- Seasonal maintenance of any surface water feature e.g. swales/ponds – nominally to include management of vegetation, clearing of obstructions, etc.

4.3.2 Drainage Feature Maintenance

The operator is reminded of their statutory obligations set out in the Drainage (Northern Ireland) Order 1973 in relation to their role as a riparian landowner to the watercourses and field drains located on site.

4.4 Flood Risk & Planning Policy Summary

The following table summarises the findings, mitigation, and policy context of those flood mechanisms and policies deemed to be required to be investigated further by the initial assessment.

Table 4-2 PPS15 Policy Summary

Policy	Assessment / Mitigation
FLD 1 - Development in Fluvial & Coastal Flood Plains	The proposed development is unaffected by any fluvial floodplain and the policy is not engaged.
FLD 2 - Protection of Flood Defence & Drainage Infrastructure	The proposals shall not impede riparian maintenance of watercourses. The proposal therefore complies with FLD2.
FLD 3 – Development and Pluvial Flood Risk Outside Flood Plains	Site drainage shall ensure that the site is adequately drained and flood resilient. Drainage design shall adopt suitable hydraulic standards in relation to standards of flood protection to the site and downstream watercourses. Surface water can be safely disposed of to existing field drains and watercourses subject to pending DfI Rivers consent. The proposal will comply with FLD3.
FLD 4 – Artificial Modification of Watercourses	The proposed development shall involve the construction of crossings to existing watercourses and field drains. The crossings shall be constructed to facilitate access only and are a permissible exception to policy FLD4. Crossing designs ensure flood risk outside the site / outside lands under control of the applicant is unaffected.
FLD 5 - Development in Proximity to Reservoirs	Does not apply (see Section 3.1)

Appendix A

Site Hydrology Map

427500

275000

MAP OVERVIEW

N

0 0.5 1 km

BACKGROUND MAPPING CONTAINS OPENSTREETMAP DATA © OSM CONTRIBUTORS

DUNBEG SOUTH WIND FARM EXTENSION

M01616-31 CHAPTER 9 EIAR_FIG_9.1

SITE HYDROLOGY

The Site
- Lands Under Applicant Control - as Site Boundary
- Planning Application Boundary

Hydrology
- Major Watercourse (>0.25km2)
- Minor Watercourse (<0.25km2)
- Other Watercourse
- Standing Water

Flood Maps NI
- FMNI Indicative 1% AEP Fluvial Flooding
- FMNI Indicative 0.5% AEP Surface Water

Height Data [OSNI 10m DTM)
- 20m Major Contour

M01616-31_FIG_9.1

SCALE - AS SHOWN

ENVIRONMENTAL STATEMENT

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Appendix B

Drainage Layouts

274100 274200 274300 274400 274500 274600

426500 426400 426300 426200 426100

NOTES
GENERAL
1. DRAWINGS ARE PRELIMINARY ONLY AND INTENDED TO INFORM THE PLANNING APPLICATION. DRAWINGS ARE NOT INTENDED FOR CONSTRUCTION AND SHOULD NOT BE USED AS SUCH. FOR AVOIDANCE OF DOUBT, SURFACE WATER MANAGEMENT DESIGN IS INTENDED TO BE FURTHER DEVELOPED POST-CONSENT OF THE PLANNING APPLICATION .
2. ALL LOCATIONS OF SUDS FEATURES IDENTIFIED ARE APPROXIMATE AND ARE LIMITED BY THE LEVEL OF INFORMATION AVAILABLE. DETAILED SITING OF SUDS FEATURES SHALL BE UNDERTAKEN ON AN OBSERVATIONAL BASIS DEPENDANT ON LOCAL TOPOGRAPHY AND CHANGES IN ROAD ALIGNMENT DESIGN.
3. ADDITIONAL TEMPORARY DRAINAGE / MITIGATION WILL BE PROVIDED DURING THE CONSTRUCTION PHASE ON AN OBSERVATIONAL BASIS.
4. BACKGROUND MAPPING REPRODUCED © OPENSTREETMAP CONTRIBUTORS
5. ALL DRAINAGE MANAGEMENT FEATURES SHOWN SHOULD BE READ IN CONJUNCTION WITH RELEVANT TYPICAL DETAIL DRAWINGS.

POLLUTION PREVENTION
6. ALL SETTLEMENT FEATURES SUBJECT TO DETAILED DESIGN.
7. DRAINAGE / SILT MANAGEMENT FEATURES INCLUDING SETTLEMENT FEATURES AND DRAINAGE CROSSINGS TO BE INSTALLED PRIOR TO OR IN PARALLEL WITH ROAD CONSTRUCTION.
8. INTERIM MEASURES TO BE EMPLOYED IN ALL INSTANCES WHERE WORK CARRIED OUT TO CONSTRUCT THE ACCESS ROAD IS LIKELY TO CAUSE ADVERSE ENVIRONMENTAL IMPACTS THROUGH INCREASED SILT LOADINGS BEING GENERATED DURING THE CONSTRUCTION PHASE.
9. SUITABLE PREVENTION MEASURES SHOULD BE IN PLACE AT ALL TIMES TO PREVENT THE CONVEYANCE OF SILTS TO RECEIVING WATERCOURSES.
10. OIL FUEL SHOULD BE STORED WITHIN CONTAINMENT AND CEMENT SHOULD BE MIXED WITHIN COMPOUND / CONTAINMENT. TOOLS WASHED IN THE SAME AREA AND WATER RECYCLED (IN THE CEMENT MIX).

TRACK / INFRASTRUCTURE DRAINAGE
11. TEMPORARY UPSLOPE CUTOFF / DIVERSION DRAINAGE TO BE INSTALLED IN ADVANCE OF MAIN EARTHWORKS IN AREAS INDICATED IN ORDER TO MINIMISE SURFACE WATER INGRESS TO EXCAVATIONS
12. SETTLEMENT/ATTENUATION PONDS ARE RETAINED FOLLOWING COMPLETION OF CONSTRUCTION ACTIVITIES.
13. BATTERS OF SWALES TO HAVE DIMENSIONS AS PER SEPARATELY ISSUED TYPICAL DETAIL DRAWING. SWALE TO BE RE-VEGETATED WITH LOCAL SPECIES.
14. SLOPES OF SWALES TO BE VEGETATED OR PROTECTED FROM EROSION UNTIL VEGETATION HAS BEEN ESTABLISHED. STRIPPED VEGETATIVE LAYER FROM EXCAVATIONS TO BE STORED LOCALLY AND USED TO LINE SLOPES AND BASE OF SWALE. VEGETATIVE LAYER TO BE PLACED INTO SWALE AFTER CONSTRUCTION OF THE SWALE.
15. CLEAN STONE CHECK DAMS TO BE INSTALLED IN ALL DRAINAGE CHANNELS IN ORDER TO PROMOTE SETTLEMENT OF SUSPENDED SOLIDS AND CONTROL FLOW RATES. CHECK DAMS GENERALLY TO BE LOCALLY WON WELL GRADED STONE. AGGREGATE SIZE FOR STONE CHECK DAMS TO BE TYPICALLY 5-40MM CLEAN STONE. ON STEEP SECTIONS SMALL STONE TO BE ANCHORED THROUGH THE PLACEMENT OF 100MM STONE ON THE DOWNHILL FACE OF THE CHECK DAM
16. SPACING AND FREQUENCY OF CHECK DAMS WILL BE DEPENDANT UPON LONGITUDINAL GRADIENT OF SWALE, TO BE DETERMINED AT DETAILED DESIGN.

WATERCOURSE & TRACK DRAINAGE CROSSINGS
17. THE MINIMUM PIPE DIAMETER FOR ANY TRACK DRAINAGE CROSSING SHALL BE 450MM.
18. ALL HDPE PIPES SHALL BE TWINWALL TYPE, BBA HAPAS APPROVED.
19. ALL CROSSINGS TO BE INSTALLED MIN. 0.15M BELOW EXISTING BED LEVEL AND TO SUIT EXISTING STREAM CHANNEL GRADIENTS.

MAINTENANCE
20. THE LEVEL OF SILT IN RUNOFF DURING CONSTRUCTION IS TO BE MONITORED VISUALLY AND EXCESSIVE SILT LEVELS IN ANY AREA TO BE TEMPORARILY MANAGED THROUGH USE OF SILT FENCES / ALUM FLOCCULANT / CONSTRUCTED SETTLEMENT FEATURES.
21. BUILD UP OF SILT LEVELS AT CHECK DAMS TO BE REMOVED AND DISPOSED OF APPROPRIATELY. SILT LEVELS AT CHECK DAMS TO BE VISUALLY INSPECTED AS PART OF AN ONGOING MAINTENANCE PROGRAMME DURING THE CONSTRUCTION PHASE. WHERE CHECK DAMS BECOME CLOGGED WITH SILT OR VEGETATION, STONE CHECK DAM TO BE REMOVED AND REPLACED SUBSEQUENT TO THE REMOVAL OF SILT

N

DEWATERING SETTLEMENT BASIN AT TURBINE BASE. BASINS USED FOR BASE POUR DEWATERING OR CONCRETE WASHOUT TO BE LINED AND WATER DISPOSED OF OFFSITE

T4

Basin 14

ATTENUATED DISCHARGE TO EXISTING DRAIN

FIELD DRAINS INTERCEPTED IN NEW CUTOFF DRAINAGE IN ADVANCE OF MAIN EARTHWORKS

ATTENUATED DISCHARGE TO EXISTING DRAIN

ATENUATED DISCHARGE OVER VEGETATION BY LEVEL SPREADER

SPOIL STORAGE AREA TO DRAIN TO TRACK DRAINAGE DOWNGRADIENT

Basin 13

Basin 12

WX07

Basin 11

ATTENUATED DISCHARGE TO EXISTING DRAIN

DEWATERING SETTLEMENT BASIN. BASINS USED FOR CONCRETE WASHOUT TO BE LINED AND WATER DISPOSED OF OFFSITE

NEW CULVERT EXTENSION TO BE INSTALLED ON DOWNSTREAM SIDE TO ALLOW ACCESS. ALIGNMENT TO SUIT EXISTING FIELD DRAIN CHANNEL. 750 DIA TO MATCH EXISTING ROAD CULVERT. NEW MIN. 1800 DIA. MANHOLE AT CONNECTION

EXISTING 750MM DIA. CULVERT UNDER EXISTING ROAD

WX06

ATTENUATED DISCHARGE TO NEW MANHOLE CHAMBER INSTALLED AT EXISTING CULVERT INLET

NEW CULVERT EXTENSION TO ALLOW ACCESS TO BE INSTALLED ON UPSTREAM SIDE TO COLLECT EX. FIELD DRAIN. 750 DIA. TO MATCH EXISTING CULVERT. NEW MIN. 1800DIA. MANHOLE AT POINT OF CONNECTION

Basin 9

TEMPORARY SILT FENCES AND IN-CHANNEL DAMS DOWNSTREAM OF SPOIL STORAGE

DEWATERING SETTLEMENT BASIN AT TURBINE BASE. BASINS USED FOR BASE POUR DEWATERING OR CONCRETE WASHOUT TO BE LINED AND WATER DISPOSED OF OFFSITE

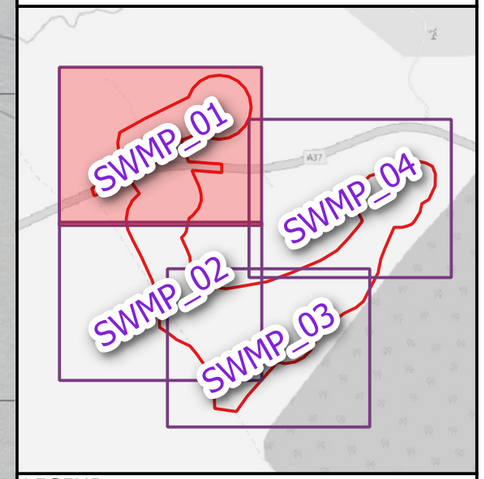
T1

PLANNING DESIGN

Basin ID	Outfall	Drained Area sqm	Discharge Rate lps	Volume cu.m	Dimensions LxWxD m
9	Discharge to new manhole at culverted drain	6256	6.3	135	20 x 10 x 0.8
11	Discharge to minor watercourse	3374	3.4	73	22 x 8 x 0.6
12	Discharge overland at level spreader	949	1.0	20	10 x 5 x 0.6
13	Discharge to minor watercourse	242	1.0	5	5 x 5 x 0.6
14	Discharge to minor watercourse	2298	2.3	49	24 x 5 x 0.6

0 50 100 150 200 m

KEY PLAN



LEGEND

Proposed Development
- Planning Application Boundary
- Turbine Locations
- Consented Dunbeg South WF
- Permanent Hardstanding & tracks
- Temporary Compound
- Substation Compound

Hydrology Constraints
- Significant Watercourse
- Minor Watercourse
- Abandoned
- Other Ephemeral / Minor drainage
- Hydrological Buffers

Proposed Drainage
- Track Drainage / Check Dam
- Dirty Drainage Pipe
- Clean Cutoff Drain
- Clean Drainage Pipe
- Attenuation Basin
- Foul Drainage
- Outfall to Watercourse
- Outfall - Level Spreader
- Silt Fence
- Spoil Storage
- Drainage Breakout
- New Culvert
- Existing Culvert
- Extended Culvert

REF	WATERCOURSE CROSSING DESC.
WX06	Extension to ex. 0.75m dia. culvert - Class 120 PCC or equivalent
WX07	New 1.2m dia. culvert - Class 120 PCC or equivalent

POLLUTION PREVENTION GUIDANCE NOTES:

1. Suitable SUDS prevention measures should be in place at all times to prevent the conveyance of silts to receiving watercourses.

2. Temporary or permanent SuDS features should be installed BEFORE or adjacent to construction of new access road and hardstanding.

3. Clean water cutoff ditch and crossing should be planned and installed BEFORE construction. Clean water management must consider spoil deposition on the site.

4. Direct discharge of road drainage to watercourses shall not be permitted.

5. Buffer zones are to be maintained around all relevant watercourses as indicated on this drawing. No excavated material is to be stored within the buffer zone.

6. DO NOT pump water direct to watercourses.

7. DO NOT strip vegetation from existing ditches unless absolutely necessary.

8. If water pollution is identified the following steps should be adhered to:

STOP - Work in the immediate area should be stopped and the source of the pollution identified

CONTAIN - The source of the pollution should be bunded using a suitable method. Natural watercourses should be temporarily diverted around the source of pollution.

NOTIFY - The relevant authorities (Site Manager / NIEA) and Client/Developer should be notified immediately to ensure that measures can be implemented downstream to protect fisheries and other sensitive areas.

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DESCRIPTION
DUNBEG SOUTH EXT. WIND FARM - DRAINAGE LAYOUT SHEET 1

PROJECT / FIGURE NO.
M01616-31_SWMP_01

DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	0	31/10/2024

res

NOTES
GENERAL
1. DRAWINGS ARE PRELIMINARY ONLY AND INTENDED TO INFORM THE PLANNING APPLICATION. DRAWINGS ARE NOT INTENDED FOR CONSTRUCTION AND SHOULD NOT BE USED AS SUCH. FOR AVOIDANCE OF DOUBT, SURFACE WATER MANAGEMENT DESIGN IS INTENDED TO BE FURTHER DEVELOPED POST-CONSENT OF THE PLANNING APPLICATION .
2. ALL LOCATIONS OF SUDS FEATURES IDENTIFIED ARE APPROXIMATE AND ARE LIMITED BY THE LEVEL OF INFORMATION AVAILABLE. DETAILED SITING OF SUDS FEATURES SHALL BE UNDERTAKEN ON AN OBSERVATIONAL BASIS DEPENDANT ON LOCAL TOPOGRAPHY AND CHANGES IN ROAD ALIGNMENT DESIGN.
3. ADDITIONAL TEMPORARY DRAINAGE / MITIGATION WILL BE PROVIDED DURING THE CONSTRUCTION PHASE ON AN OBSERVATIONAL BASIS.
4. BACKGROUND MAPPING REPRODUCED © OPENSTREETMAP CONTRIBUTORS
5. ALL DRAINAGE MANAGEMENT FEATURES SHOWN SHOULD BE READ IN CONJUNCTION WITH RELEVANT TYPICAL DETAIL DRAWINGS.

POLLUTION PREVENTION
6. ALL SETTLEMENT FEATURES SUBJECT TO DETAILED DESIGN.
7. DRAINAGE / SILT MANAGEMENT FEATURES INCLUDING SETTLEMENT FEATURES AND DRAINAGE CROSSINGS TO BE INSTALLED PRIOR TO OR IN PARALLEL WITH ROAD CONSTRUCTION.
8. INTERIM MEASURES TO BE EMPLOYED IN ALL INSTANCES WHERE WORK CARRIED OUT TO CONSTRUCT THE ACCESS ROAD IS LIKELY TO CAUSE ADVERSE ENVIRONMENTAL IMPACTS THROUGH INCREASED SILT LOADINGS BEING GENERATED DURING THE CONSTRUCTION PHASE.
9. SUITABLE PREVENTION MEASURES SHOULD BE IN PLACE AT ALL TIMES TO PREVENT THE CONVEYANCE OF SILTS TO RECEIVING WATERCOURSES.
10. OIL FUEL SHOULD BE STORED WITHIN CONTAINMENT AND CEMENT SHOULD BE MIXED WITHIN COMPOUND / CONTAINMENT. TOOLS WASHED IN THE SAME AREA AND WATER RECYCLED (IN THE CEMENT MIX).

TRACK / INFRASTRUCTURE DRAINAGE
11. TEMPORARY UPSLOPE CUTOFF / DIVERSION DRAINAGE TO BE INSTALLED IN ADVANCE OF MAIN EARTHWORKS IN AREAS INDICATED IN ORDER TO MINIMISE SURFACE WATER INGRESS TO EXCAVATIONS
12. SETTLEMENT/ATTENUATION PONDS ARE RETAINED FOLLOWING COMPLETION OF CONSTRUCTION ACTIVITIES.
13. BATTERS OF SWALES TO HAVE DIMENSIONS AS PER SEPARATELY ISSUED TYPICAL DETAIL DRAWING. SWALE TO BE RE-VEGETATED WITH LOCAL SPECIES.
14. SLOPES OF SWALES TO BE VEGETATED OR PROTECTED FROM EROSION UNTIL VEGETATION HAS BEEN ESTABLISHED. STRIPPED VEGETATIVE LAYER FROM EXCAVATIONS TO BE STORED LOCALLY AND USED TO LINE SLOPES AND BASE OF SWALE. VEGETATIVE LAYER TO BE PLACED INTO SWALE AFTER CONSTRUCTION OF THE SWALE.
15. CLEAN STONE CHECK DAMS TO BE INSTALLED IN ALL DRAINAGE CHANNELS IN ORDER TO PROMOTE SETTLEMENT OF SUSPENDED SOLIDS AND CONTROL FLOW RATES. CHECK DAMS GENERALLY TO BE LOCALLY WON WELL GRADED STONE. AGGREGATE SIZE FOR STONE CHECK DAMS TO BE TYPICALLY 5-40MM CLEAN STONE. ON STEEP SECTIONS SMALL STONE TO BE ANCHORED THROUGH THE PLACEMENT OF 100MM STONE ON THE DOWNHILL FACE OF THE CHECK DAM
16. SPACING AND FREQUENCY OF CHECK DAMS WILL BE DEPENDANT UPON LONGITUDINAL GRADIENT OF SWALE, TO BE DETERMINED AT DETAILED DESIGN.

WATERCOURSE & TRACK DRAINAGE CROSSINGS
17. THE MINIMUM PIPE DIAMETER FOR ANY TRACK DRAINAGE CROSSING SHALL BE 450MM.
18. ALL HDPE PIPES SHALL BE TWINWALL TYPE, BBA HAPAS APPROVED.
19. ALL CROSSINGS TO BE INSTALLED MIN. 0.15M BELOW EXISTING BED LEVEL AND TO SUIT EXISTING STREAM CHANNEL GRADIENTS.

MAINTENANCE
20. THE LEVEL OF SILT IN RUNOFF DURING CONSTRUCTION IS TO BE MONITORED VISUALLY AND EXCESSIVE SILT LEVELS IN ANY AREA TO BE TEMPORARILY MANAGED THROUGH USE OF SILT FENCES / ALUM FLOCCULANT / CONSTRUCTED SETTLEMENT FEATURES.
21. BUILD UP OF SILT LEVELS AT CHECK DAMS TO BE REMOVED AND DISPOSED OF APPROPRIATELY. SILT LEVELS AT CHECK DAMS TO BE VISUALLY INSPECTED AS PART OF AN ONGOING MAINTENANCE PROGRAMME DURING THE CONSTRUCTION PHASE. WHERE CHECK DAMS BECOME CLOGGED WITH SILT OR VEGETATION, STONE CHECK DAM TO BE REMOVED AND REPLACED SUBSEQUENT TO THE REMOVAL OF SILT

274100 274200 274300 274400 274500 274600
426000 425900 425800 425700 425600

ATENUATED DISCHARGE OVER VEGETATION BY LEVEL SPREADER
Basin 5
SPOIL STORAGE AREA TO DRAIN TO TRACK DRAINAGE DOWNGRADIENT
ANY OIL FUEL STORAGE OR LUBRICANTS, OR FUELLED TRANSFORMERS OR GENERATORS TO BE SITED IN BUNDED AREAS. UNLESS COVERED, BUNDS TO DRAIN TO SITE DRAINAGE VIA BYPASS SEPERATOR TO SUIT THE DESIGN FLOW - PER KLARGESTOR NSBP003 OR SIMILAR
TEMPORARY CONSTRUCTION COMPOUND WITH BUNDED REFUELLING AREA. BUNDED AREA TO DRAIN TO CLASS 1 FULL RETENTION SEPERATOR DRAINING TO 5X5X1M SOILED FILLED SOAKAWAY
TEMPORARY WASTEWATER FROM CONSTRUCTION COMPOUND TO BE TO SEALED CESSPOOL PER THE PERMANENT SUBSTATION / CONTROL BUILDING
DEWATERING SETTLEMENT BASIN AT SUBSTATION BASE. BASINS USED FOR CONCRETE WASHOUT TO BE LINED AND WATER DISPOSED OF OFFSITE
ATTENUATED DISCHARGE TO EXISTING DRAIN
Basin 4
ATTENUATED DISCHARGE TO EXISTING DRAIN
Basin 3
WX02
CONSENTED DUNBEG SOUTH WINDFARM INFRASTRUCTURE SHOWN THUS

205 210 215 220 225 230 235 240 245 255 260 265 270 275

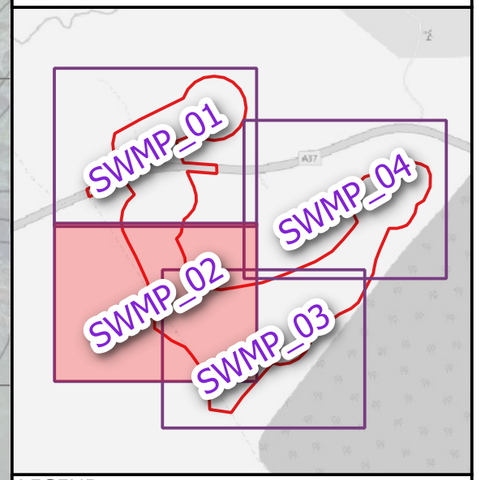
Basin ID	Outfall	Drained Area sqm	Discharge Rate lps	Volume cu.m	Dimensions LxWxD m
3	Discharge to minor watercourse / field drain	355	1.0	8	5 x 5 x 0.6
4	Discharge to minor watercourse / field drain	2613	2.6	56	17 x 8 x 0.6
5	Discharge overland at level spreader	6452	6.5	139	20 x 10 x 0.8

0 50 100 150 200 m

PLANNING DESIGN

N

KEY PLAN



LEGEND

Proposed Development
- Planning Application Boundary
- Turbine Locations
- Consented Dunbeg South WF
- Permanent Hardstanding & tracks
- Temporary Compound
- Substation Compound

Hydrology Constraints
- Significant Watercourse
- Minor Watercourse
- Abandoned
- Other Ephemeral / Minor drainage
- Hydrological Buffers

Proposed Drainage
- Track Drainage / Check Dam
- Dirty Drainage Pipe
- Clean Cutoff Drain
- Clean Drainage Pipe
- Attenuation Basin
- Foul Drainage
- Outfall to Watercourse
- Outfall - Level Spreader
- Silt Fence
- Spoil Storage
- Drainage Breakout
- New Culvert
- Existing Culvert
- Extended Culvert

REF	WATERCOURSE CROSSING DESC.
WX02	New 0.75m dia. culvert - Class 120 PCC or equivalent

POLLUTION PREVENTION GUIDANCE NOTES:

1. Suitable SUDS prevention measures should be in place at all times to prevent the conveyance of silts to receiving watercourses.

2. Temporary or permanent SuDS features should be installed BEFORE or adjacent to construction of new access road and hardstanding.

3. Clean water cutoff ditch and crossing should be planned and installed BEFORE construction. Clean water management must consider spoil deposition on the site.

4. Direct discharge of road drainage to watercourses shall not be permitted.

5. Buffer zones are to be maintained around all relevant watercourses as indicated on this drawing. No excavated material is to be stored within the buffer zone.

6. DO NOT pump water direct to watercourses.

7. DO NOT strip vegetation from existing ditches unless absolutely necessary.

8. If water pollution is identified the following steps should be adhered to:

STOP - Work in the immediate area should be stopped and the source of the pollution identified

CONTAIN - The source of the pollution should be bunded using a suitable method. Natural watercourses should be temporarily diverted around the source of pollution.

NOTIFY - The relevant authorities (Site Manager / NIEA) and Client/Developer should be notified immediately to ensure that measures can be implemented downstream to protect fisheries and other sensitive areas.

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DESCRIPTION
DUNBEG SOUTH EXT. WIND FARM - DRAINAGE LAYOUT SHEET 2

PROJECT / FIGURE NO.
M01616-31_SWMP_02

DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	0	31/10/2024

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NOTES
GENERAL
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5. ALL DRAINAGE MANAGEMENT FEATURES SHOWN SHOULD BE READ IN CONJUNCTION WITH RELEVANT TYPICAL DETAIL DRAWINGS.

POLLUTION PREVENTION
6. ALL SETTLEMENT FEATURES SUBJECT TO DETAILED DESIGN.
7. DRAINAGE / SILT MANAGEMENT FEATURES INCLUDING SETTLEMENT FEATURES AND DRAINAGE CROSSINGS TO BE INSTALLED PRIOR TO OR IN PARALLEL WITH ROAD CONSTRUCTION.
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9. SUITABLE PREVENTION MEASURES SHOULD BE IN PLACE AT ALL TIMES TO PREVENT THE CONVEYANCE OF SILTS TO RECEIVING WATERCOURSES.
10. OIL FUEL SHOULD BE STORED WITHIN CONTAINMENT AND CEMENT SHOULD BE MIXED WITHIN COMPOUND / CONTAINMENT. TOOLS WASHED IN THE SAME AREA AND WATER RECYCLED (IN THE CEMENT MIX).

TRACK / INFRASTRUCTURE DRAINAGE
11. TEMPORARY UPSLOPE CUTOFF / DIVERSION DRAINAGE TO BE INSTALLED IN ADVANCE OF MAIN EARTHWORKS IN AREAS INDICATED IN ORDER TO MINIMISE SURFACE WATER INGRESS TO EXCAVATIONS.
12. SETTLEMENT/ATTENUATION PONDS ARE RETAINED FOLLOWING COMPLETION OF CONSTRUCTION ACTIVITIES.
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16. SPACING AND FREQUENCY OF CHECK DAMS WILL BE DEPENDANT UPON LONGITUDINAL GRADIENT OF SWALE, TO BE DETERMINED AT DETAILED DESIGN.

WATERCOURSE & TRACK DRAINAGE CROSSINGS
17. THE MINIMUM PIPE DIAMETER FOR ANY TRACK DRAINAGE CROSSING SHALL BE 450MM.
18. ALL HDPE PIPES SHALL BE TWINWALL TYPE, BBA HAPAS APPROVED.
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MAINTENANCE
20. THE LEVEL OF SILT IN RUNOFF DURING CONSTRUCTION IS TO BE MONITORED VISUALLY AND EXCESSIVE SILT LEVELS IN ANY AREA TO BE TEMPORARILY MANAGED THROUGH USE OF SILT FENCES / ALUM FLOCCULANT / CONSTRUCTED SETTLEMENT FEATURES.
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CONSENTED DUNBEG SOUTH WINDFARM INFRASTRUCTURE SHOWN THUS

274400 274500 274600 274700 274800 274900 275000

425800 425700 425600 425500 425400

ATTENUATED DISCHARGE TO EXISTING DRAIN

ATENUATED DISCHARGE OVER VEGETATION BY LEVEL SPREADER

Basin 2

DEWATERING SETTLEMENT BASIN AT TURBINE BASE. BASINS USED FOR BASE POUR DEWATERING OR CONCRETE WASHOUT TO BE LINED AND WATER DISPOSED OF OFFSITE

T2

WX01 WX02 WX03 WX04

ATTENUATED DISCHARGE TO EXISTING DRAIN

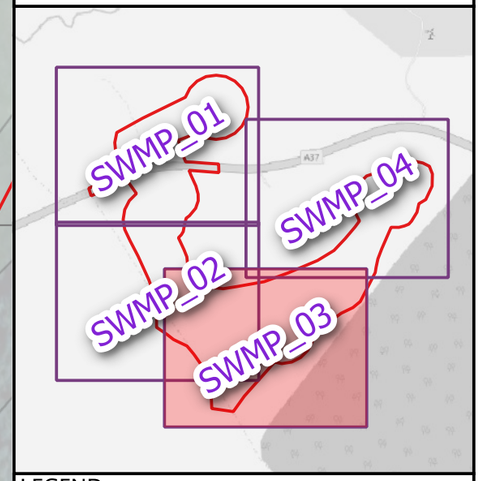
Basin 1

PLANNING DESIGN

N

0 50 100 150 200 m

KEY PLAN



LEGEND

Proposed Development
- Planning Application Boundary
- Turbine Locations
- Consented Dunbeg South WF
- Permanent Hardstanding & tracks
- Temporary Compound
- Substation Compound

Hydrology Constraints
- Significant Watercourse
- Minor Watercourse
- Abandoned
- Other Ephemeral / Minor drainage
- Hydrological Buffers

Proposed Drainage
- Track Drainage / Check Dam
- Dirty Drainage Pipe
- Clean Cutoff Drain
- Clean Drainage Pipe
- Attenuation Basin
- Foul Drainage
- Outfall to Watercourse
- Outfall - Level Spreader
- Silt Fence
- Spoil Storage
- Drainage Breakout
- New Culvert
- Existing Culvert
- Extended Culvert

REF	WATERCOURSE CROSSING DESC.
WX01	New 0.6m dia. culvert - Class 120 PCC or equivalent
WX02	New 0.75m dia. culvert - Class 120 PCC or equivalent
WX03	New 0.9m dia. culvert - Class 120 PCC or equivalent

Basin ID	Outfall	Drained Area sqm	Discharge Rate lps	Volume cu.m	Dimensions LxWxD m
1	Discharge to minor watercourse / field drain	214	1.0	5	5 x 5 x 0.6
2	Discharge overland at level spreader	4167	4.2	90	17 x 8 x 0.8
3	Discharge to minor watercourse / field drain	355	1.0	8	5 x 5 x 0.6
4	Discharge to minor watercourse / field drain	2613	2.6	56	17 x 8 x 0.6

POLLUTION PREVENTION GUIDANCE NOTES:

1. Suitable SUDS prevention measures should be in place at all times to prevent the conveyance of silts to receiving watercourses.

2. Temporary or permanent SuDS features should be installed BEFORE or adjacent to construction of new access road and hardstanding.

3. Clean water cutoff ditch and crossing should be planned and installed BEFORE construction. Clean water management must consider spoil deposition on the site.

4. Direct discharge of road drainage to watercourses shall not be permitted.

5. Buffer zones are to be maintained around all relevant watercourses as indicated on this drawing. No excavated material is to be stored within the buffer zone.

6. DO NOT pump water direct to watercourses.

7. DO NOT strip vegetation from existing ditches unless absolutely necessary.

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DESCRIPTION
DUNBEG SOUTH EXT. WIND FARM - DRAINAGE LAYOUT SHEET 3

PROJECT / FIGURE NO.
M01616-31_SWMP_03

DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	0	31/10/2024

NOTES
GENERAL
1. DRAWINGS ARE PRELIMINARY ONLY AND INTENDED TO INFORM THE PLANNING APPLICATION. DRAWINGS ARE NOT INTENDED FOR CONSTRUCTION AND SHOULD NOT BE USED AS SUCH. FOR AVOIDANCE OF DOUBT, SURFACE WATER MANAGEMENT DESIGN IS INTENDED TO BE FURTHER DEVELOPED POST-CONSENT OF THE PLANNING APPLICATION .
2. ALL LOCATIONS OF SUDS FEATURES IDENTIFIED ARE APPROXIMATE AND ARE LIMITED BY THE LEVEL OF INFORMATION AVAILABLE. DETAILED SITING OF SUDS FEATURES SHALL BE UNDERTAKEN ON AN OBSERVATIONAL BASIS DEPENDANT ON LOCAL TOPOGRAPHY AND CHANGES IN ROAD ALIGNMENT DESIGN.
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4. BACKGROUND MAPPING REPRODUCED © OPENSTREETMAP CONTRIBUTORS
5. ALL DRAINAGE MANAGEMENT FEATURES SHOWN SHOULD BE READ IN CONJUNCTION WITH RELEVANT TYPICAL DETAIL DRAWINGS.

POLLUTION PREVENTION
6. ALL SETTLEMENT FEATURES SUBJECT TO DETAILED DESIGN.
7. DRAINAGE / SILT MANAGEMENT FEATURES INCLUDING SETTLEMENT FEATURES AND DRAINAGE CROSSINGS TO BE INSTALLED PRIOR TO OR IN PARALLEL WITH ROAD CONSTRUCTION.
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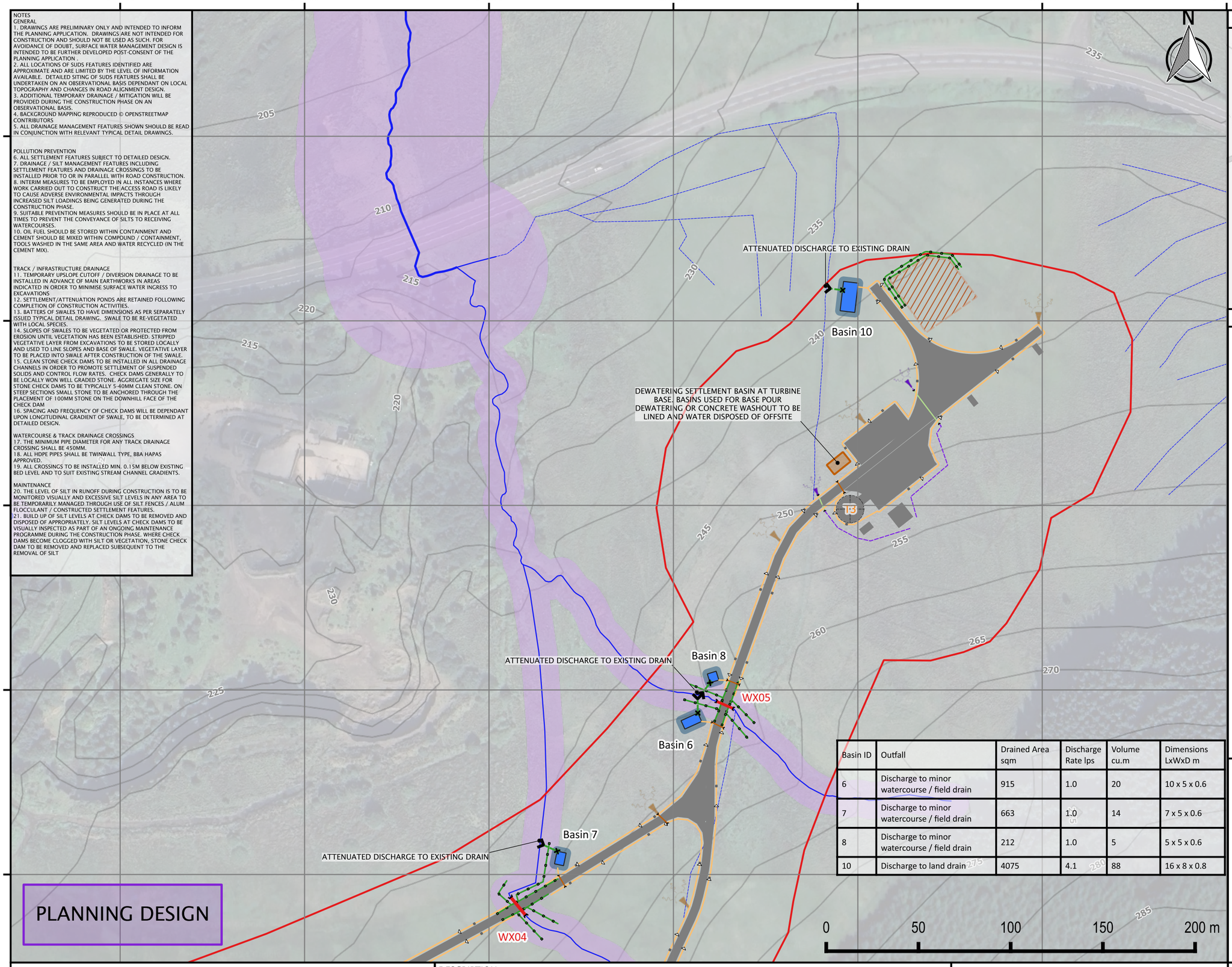
9. SUITABLE PREVENTION MEASURES SHOULD BE IN PLACE AT ALL TIMES TO PREVENT THE CONVEYANCE OF SILTS TO RECEIVING WATERCOURSES.
10. OIL FUEL SHOULD BE STORED WITHIN CONTAINMENT AND CEMENT SHOULD BE MIXED WITHIN COMPOUND / CONTAINMENT. TOOLS WASHED IN THE SAME AREA AND WATER RECYCLED (IN THE CEMENT MIX).

TRACK / INFRASTRUCTURE DRAINAGE
11. TEMPORARY UPSLOPE CUTOFF / DIVERSION DRAINAGE TO BE INSTALLED IN ADVANCE OF MAIN EARTHWORKS IN AREAS INDICATED IN ORDER TO MINIMISE SURFACE WATER INGRESS TO EXCAVATIONS
12. SETTLEMENT/ATTENUATION PONDS ARE RETAINED FOLLOWING COMPLETION OF CONSTRUCTION ACTIVITIES.
13. BATTERS OF SWALES TO HAVE DIMENSIONS AS PER SEPARATELY ISSUED TYPICAL DETAIL DRAWING. SWALE TO BE RE-VEGETATED WITH LOCAL SPECIES.
14. SLOPES OF SWALES TO BE VEGETATED OR PROTECTED FROM EROSION UNTIL VEGETATION HAS BEEN ESTABLISHED. STRIPPED VEGETATIVE LAYER FROM EXCAVATIONS TO BE STORED LOCALLY AND USED TO LINE SLOPES AND BASE OF SWALE. VEGETATIVE LAYER TO BE PLACED INTO SWALE AFTER CONSTRUCTION OF THE SWALE.
15. CLEAN STONE CHECK DAMS TO BE INSTALLED IN ALL DRAINAGE CHANNELS IN ORDER TO PROMOTE SETTLEMENT OF SUSPENDED SOLIDS AND CONTROL FLOW RATES. CHECK DAMS GENERALLY TO BE LOCALLY WON WELL GRADED STONE. AGGREGATE SIZE FOR STONE CHECK DAMS TO BE TYPICALLY 5-40MM CLEAN STONE. ON STEEP SECTIONS SMALL STONE TO BE ANCHORED THROUGH THE PLACEMENT OF 100MM STONE ON THE DOWNHILL FACE OF THE CHECK DAM
16. SPACING AND FREQUENCY OF CHECK DAMS WILL BE DEPENDANT UPON LONGITUDINAL GRADIENT OF SWALE, TO BE DETERMINED AT DETAILED DESIGN.

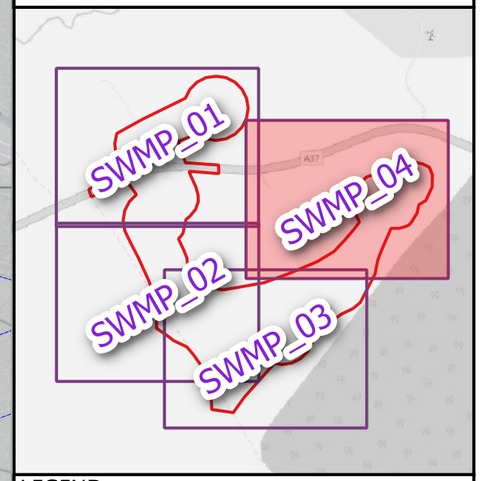
WATERCOURSE & TRACK DRAINAGE CROSSINGS
17. THE MINIMUM PIPE DIAMETER FOR ANY TRACK DRAINAGE CROSSING SHALL BE 450MM.
18. ALL HDPE PIPES SHALL BE TWINWALL TYPE, BBA HAPAS APPROVED.
19. ALL CROSSINGS TO BE INSTALLED MIN. 0.15M BELOW EXISTING BED LEVEL AND TO SUIT EXISTING STREAM CHANNEL GRADIENTS.

MAINTENANCE
20. THE LEVEL OF SILT IN RUNOFF DURING CONSTRUCTION IS TO BE MONITORED VISUALLY AND EXCESSIVE SILT LEVELS IN ANY AREA TO BE TEMPORARILY MANAGED THROUGH USE OF SILT FENCES / ALUM FLOCCULANT / CONSTRUCTED SETTLEMENT FEATURES.
21. BUILD UP OF SILT LEVELS AT CHECK DAMS TO BE REMOVED AND DISPOSED OF APPROPRIATELY. SILT LEVELS AT CHECK DAMS TO BE VISUALLY INSPECTED AS PART OF AN ONGOING MAINTENANCE PROGRAMME DURING THE CONSTRUCTION PHASE. WHERE CHECK DAMS BECOME CLOGGED WITH SILT OR VEGETATION, STONE CHECK DAM TO BE REMOVED AND REPLACED SUBSEQUENT TO THE REMOVAL OF SILT



PLANNING DESIGN

KEY PLAN



LEGEND

Proposed Development
- Planning Application Boundary
- Turbine Locations
- Consented Dunbeg South WF
- Permanent Hardstanding & tracks
- Temporary Compound
- Substation Compound

Hydrology Constraints
- Significant Watercourse
- Minor Watercourse
- Abandoned
- Other Ephemeral / Minor drainage
- Hydrological Buffers

Proposed Drainage
- Track Drainage / Check Dam
- Dirty Drainage Pipe
- Clean Cutoff Drain
- Clean Drainage Pipe
- Attenuation Basin
- Foul Drainage
- Outfall to Watercourse
- Outfall - Level Spreader
- Silt Fence
- Spoil Storage
- Drainage Breakout
- New Culvert
- Existing Culvert
- Extended Culvert

Basin ID	Outfall	Drained Area sqm	Discharge Rate lps	Volume cu.m	Dimensions LxWxD m
6	Discharge to minor watercourse / field drain	915	1.0	20	10 x 5 x 0.6
7	Discharge to minor watercourse / field drain	663	1.0	14	7 x 5 x 0.6
8	Discharge to minor watercourse / field drain	212	1.0	5	5 x 5 x 0.6
10	Discharge to land drain	4075	4.1	88	16 x 8 x 0.8

REF	WATERCOURSE CROSSING DESC.
WX04	New 0.9m dia. culvert - Class 120 PCC or equivalent
WX05	New 0.75m dia. culvert - Class 120 PCC or equivalent

POLLUTION PREVENTION GUIDANCE NOTES:

1. Suitable SUDS prevention measures should be in place at all times to prevent the conveyance of silts to receiving watercourses.

2. Temporary or permanent SuDS features should be installed BEFORE or adjacent to construction of new access road and hardstanding.

3. Clean water cutoff ditch and crossing should be planned and installed BEFORE construction. Clean water management must consider spoil deposition on the site.

4. Direct discharge of road drainage to watercourses shall not be permitted.

5. Buffer zones are to be maintained around all relevant watercourses as indicated on this drawing. No excavated material is to be stored within the buffer zone.

6. DO NOT pump water direct to watercourses.

7. DO NOT strip vegetation from existing ditches unless absolutely necessary.

8. If water pollution is identified the following steps should be adhered to:

STOP - Work in the immediate area should be stopped and the source of the pollution identified

CONTAIN - The source of the pollution should be bunded using a suitable method. Natural watercourses should be temporarily diverted around the source of pollution.

NOTIFY - The relevant authorities (Site Manager / NIEA) and Client/Developer should be notified immediately to ensure that measures can be implemented downstream to protect fisheries and other sensitive areas.

McCloy Consulting
Mossley Mill,
Lower Ground (West),
Carnmoney Road North,
Newtownabbey BT36 5QA
T: 028 9084 8694
E: info@mccloyconsulting.com
w: www.mccloyconsulting.com

DESCRIPTION
DUNBEG SOUTH EXT. WIND FARM - DRAINAGE LAYOUT SHEET 4

PROJECT / FIGURE NO.
M01616-31_SWMP_04

DRAWN BY	SCALE	REVISION	DATE
DKS	1:2000	0	31/10/2024

res

Appendix C

Correspondence

Asset Management Unit

Department for Infrastructure
An Roinn Bonneagair
Depairtment fur Infrastructure
www.infrastructure-ni.gov.uk

Andrew Snowling
McCloy Consulting
Mossley Mill
Lower Ground (West)
Carnmoney Road North
Newtownabbey
Co. Antrim
BT36 5QA

Dfl Rivers
49 Tullywiggan Road
Loughry
Cookstown
Co. Tyrone
BT80 8SG

Telephone: 028 8676 8300

Your reference:
Our reference: IN1-23-11516

4 September 2023

Dear Andrew,

Re: Wind Farm located north-east of Limavady

Thank you for your enquiry received 22/08/23 regarding the above sites. There are no watercourses within the site, designated within the terms of the Drainage (Northern Ireland) Order 1973.

There may be undesignated watercourses, within or bounding the sites, about which we are unaware. Dfl Rivers does not maintain a database of undesignated watercourses, which may be present at the sites. In this regard, you are advised to consult with Ordnance Survey, and/or undertake site inspections, etc. Within the terms of the above mentioned Order you are advised as follows:

1. If during the course of developing a site a watercourse is uncovered which was not previously evident, the Coleraine Office, 37 Castleroe Road, Coleraine, BT51 3RL, Tel 028 70 342357, must be contacted immediately in order that arrangements may be made for an investigation and direction in respect of any possible actions that may be necessary to maintain its drainage function; moreover

2. Any proposal either temporary or permanent in connection with a development that may impact on the drainage function of any watercourse within the site, now or in the future, such as release of storm water to, culverting, bridging, diverting building, adjacent to and/or over, etc. requires prior written consent from the Department. Details of such proposals, together with accompanying drawings, maps and calculations etc. must be submitted in advance of any development to the Coleraine Office at 37 Castleroe Road, Coleraine, BT51 3RL, Tel 028 70 342357. Failure to obtain such a written consent is an offence under the provisions of the above Order, which may lead to prosecution or other statutory action as provided for.

Dfl Rivers' records indicate that there is no history of flooding pertaining to your specific site.

Dfl Rivers' records show that there is floodplain encroachment of your site for the following predictive flood modelling scenarios:

- Pluvial (surface water) I200 (1 in 200-year return period, 0.5% Annual Exceedance Probability), map attached.

- Fluvial Q100 (1 in 100-year return period, 1% Annual Exceedance Probability), map attached.

Please note that the above details form the best available information currently available to Dfl Rivers. The responsibility rests with the user to seek further advice from appropriately qualified professionals, who may be able to undertake appropriate validation of the information provided. In addition, it is noteworthy that the above information does not take into account climate change, and therefore may be subject to change.

For further information you may wish to view The Strategic Flood Map (NI) — Rivers & Sea, available on the Dfl Rivers website at: - https://www.infrastructure-ni.gov.uk/topics/rivers- and-flooding/flood-maps-ni

The Department does not accept any liability for loss, injury or damage to any person or property as a result of any inaccuracy in the above information provided. In this regard you are advised to seek the services of qualified competent professional bodies to ascertain the suitability and completeness of the information regarding the location, condition of and responsibility for any buried services at this location.

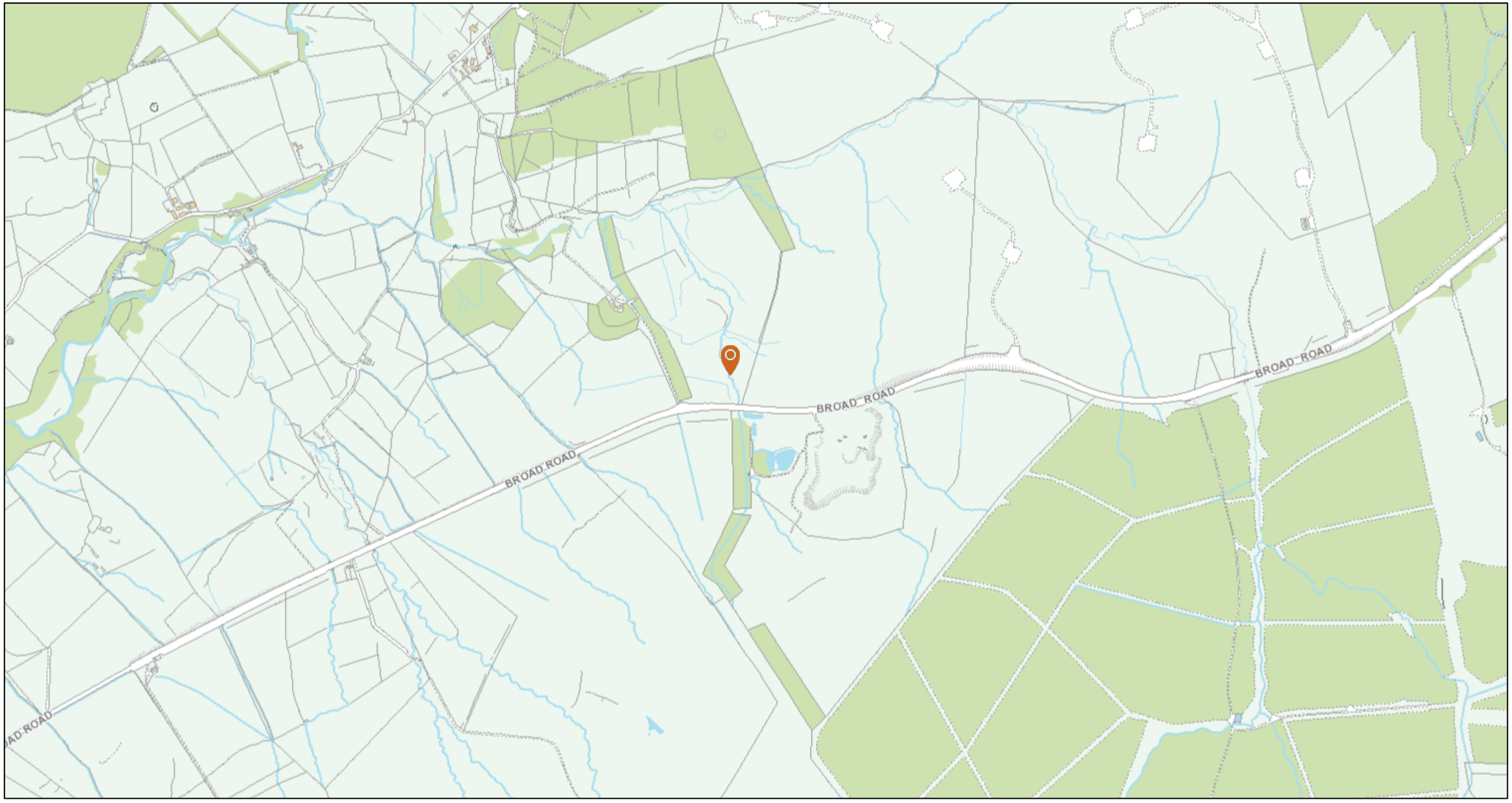
Future requests regarding the information on the Department's drainage and flood defence infrastructure should continue to be addressed to the DfI Rivers Asset Management Unit at the above address.

Yours sincerely,

Gavin Bell

Asset Management Unit

DfI Rivers Assets - IN1-23-11516



04/09/2023, 10:34:52

1:10,000

- Watercourses (Designated)
- Network Pipe
- Network Node
- Flood Defence Structures
- River Level Alert Station
- River Alert Gauging Station

0 0.13 0.25 0.5 mi

0 0.2 0.4 0.8 km

Created by : - DfI Rivers Business Support Unit

Appendix D

Drainage Calculations

Project	Dunbeg South Ext WF
Ref	M01616-31
Date	30/10/2024

Purpose

To estimate the indicative (1-hr) change in runoff rate on a site caused by the proposed development. Note that proposed / indicative runoff rates are outline only and rely on the routing equation within the Modified Rational and Wallingford methods; actual runoff rates may differ significantly dependant on the nature of the surface water drainage network proposed and should be determined using hydraulic modelling.

Existing Site	A1	A2	A3	%-Runoff	**EFFECTIVE TOTAL**	
Roof	0			90%	0	m^2
Bitmac / Paved / Hardstanding	0			50%	0	m^2
					0	m^2

Proposed Site	A1	A2	A3	%-Runoff	**EFFECTIVE TOTAL**	
Roof	0			90%	0	m^2
Bitmac / Paved / Hardstanding	32782			50%	16391	m^2
					16391	m^2

Site Details

Total Site Area	3.28	**Ha**	
SAAR	1267	**mm**	From FEH3
SAAR4170	1306	**mm**	From FEH3
UCWI	113	**mm**	
IOH124 region	I		from map ->
SOIL	5		From WRAP maps
SOIL	0.50		
DEEPSTOR	0.22		

Modified Rational Method (MRM):

	Existing		***Proposed***		
Length (m)	750	**m**	750	**m**	From Site Maps
Impermeable Area (ha)	0.000	**Ha**	1.639	**Ha**	
Max Height	276.0	**mAOD**	276.0	**mAOD**	From Survey
Min Height	192.0	**mAOD**	192.0	**mAOD**	From Survey
DeltaH	84.000		84.000		
Slope (%)	11.20		11.20		
Te (mins)	9.26		9.26		
ARF	0.000		0.982		

	Existing Site		Proposed Site	
PIMP	0.000	%	100.000	%
Percentage Runoff PR	0.50	%	83.49	%
Cv	0.00		0.83	
Cr	1.3		1.3	

Institute of Hydrology Report 124 (IoH 124) "Flood Estimation on Small Catchments" method

	Existing		***Proposed***	
Remaining Greenfield Area	3.28	**Ha**	1.64	**Ha**
% Greenfield	100.00	%	50.00	%

Existing Site - Peak (1-hr) Runoff Rates

Return Period	Permeable Runoff (IOH124) (lps)	Impermeable Runoff (MRM) (lps)	Total Runoff (lps)
1 in 2 year (1hr)	35.6	0.0	35.6
1 in 30 year (1hr)	61.7	0.0	61.7
1 in 100 year (1hr)	73.5	0.0	73.5

Proposed Site - Peak (1-hr) Runoff Rates

Return Period	Permeable Runoff (IOH124) (lps)	Impermeable Runoff (MRM) (lps)	Total Runoff (lps)
1 in 2 year (1hr)	17.8	49.5	67.3
1 in 30 year (1hr)	30.9	145.0	175.9
1 in 100 year (1hr)	36.7	187.9	224.7

Summary - Peak (1-hr) Runoff Rates

Return Period	Existing Site (lps)	Proposed Site (lps)	*Increase (lps)*	Increase (%)
1 in 2 year (1hr)	35.6	67.3	*31.7*	*89%*
1 in 30 year (1hr)	61.7	175.9	*114.1*	*185%*
1 in 100 year (1hr)	73.5	224.7	*151.2*	*206%*

By	Checked	Revision	Reason for Change	Date
IB	KS	Original		30/10/2024

CRM Stormflow Stormwater Management Software

Client:	RES
Project:	Dunbeg South Extension Wind Farm
Location:	Barr Cregg Wind Farm
Catchment:	Whole Drained Area (Gravel Tracks & Hardstands)

Catchment Details:

Buildings	0	m^2	x 95 %
Dense surfacing	32785	m^2	x 55 %
Effective Area	18031.75	m^2	

Storage Details:

Volume	705	Cu.m
Porosity	100	%
Area Increase	0	%

Rainfall Details - FEH Method:

Return Period		100	years
Climate Change Factor		20	%
c	-0.029	d1	0.4603
d2	0.48541	d3	0.33282
e	0.29305	f	2.18189

	mm	mm/h	storage (m^3)
30 min	32.6	65.3	529.791
45 min	37.3	49.7	583.790
60 min	40.9	40.9	620.631
2 hours	51.4	25.7	690.682
6 hours	73.6	12.3	619.967
24 hours	117.8	4.9	0.000

Outflow Details:

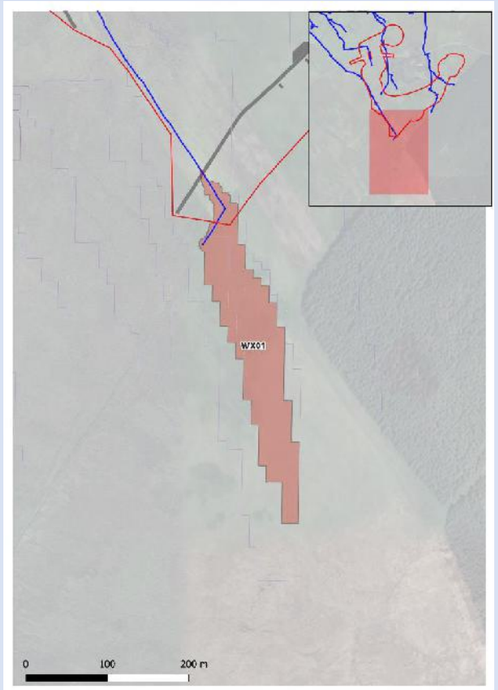
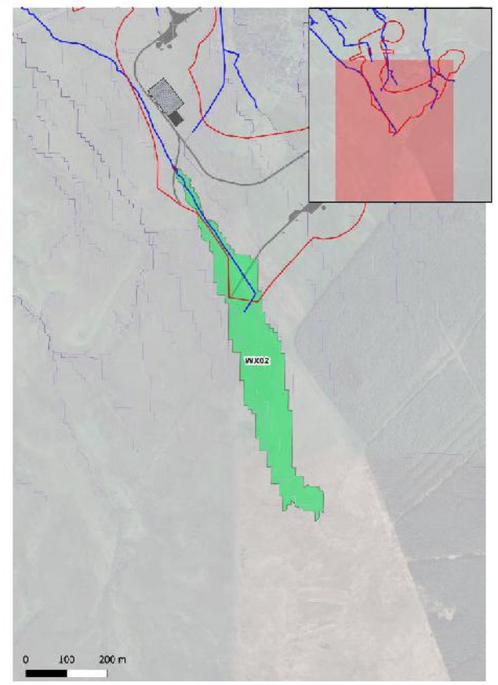
Infiltration rate	0	m/hr
Attenuation Control	Fixed Outflow	
Control Diameter	-	mm
Discharge rate	32.7	l/s

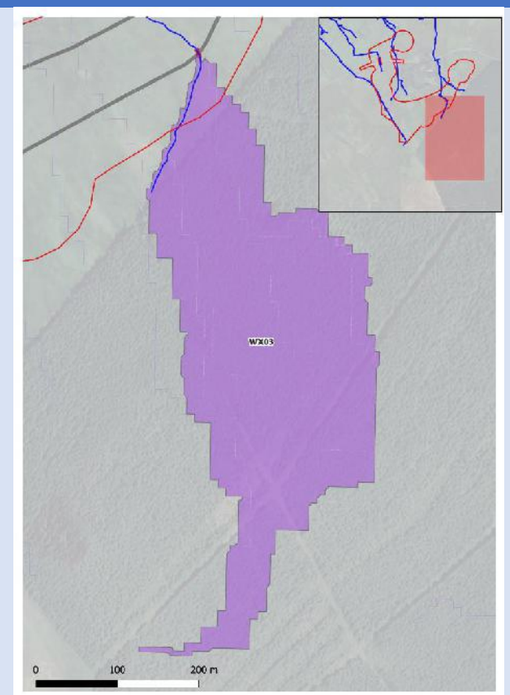
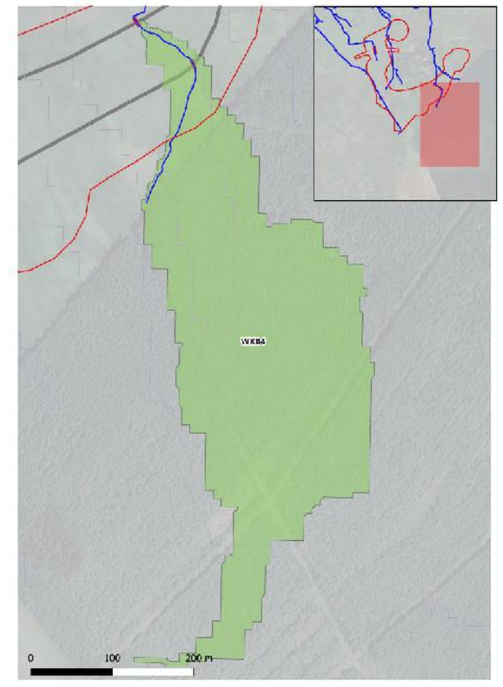
Results:

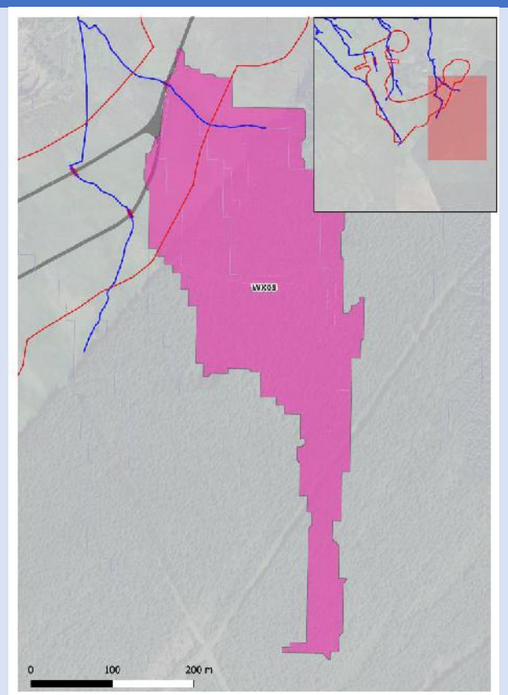
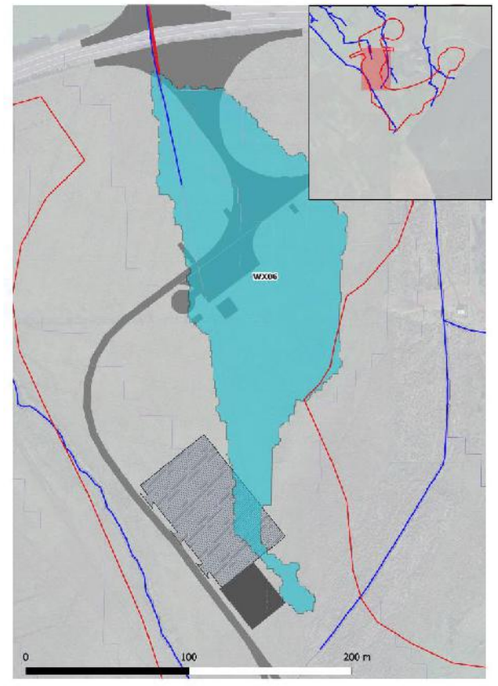
Outcome:	Pass
Critical Storm Duration	2.92 hrs
Hmax	0.999 m
Time to half empty	3 hrs

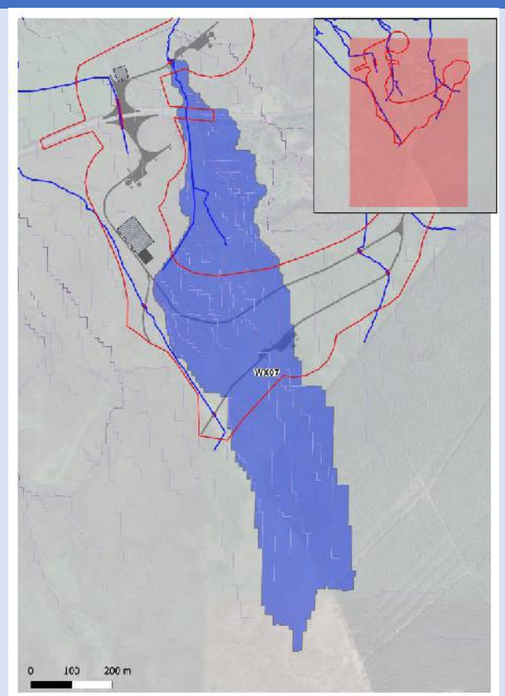
Appendix E

Watercourse Crossing Schedule

REFERENCE	EASTING	NORTHING	CATCHMENT AREA SQ KM	DESCRIPTION	PHOTOGRAPH	CATCHMENT MAP
WX01	274565	425478	0.019	UNNAMED DRAIN SUMMARY: CHARACTERISTIC OF BOG / LAND DRAIN. MORPHOLOGY: POORLY DEFINED BANKS. HEAVY VEGETATED, PEATY SUBSTRATE FISHERY POTENTIAL: NONE / NOT SIGNFICANT PROPOSAL: NEW MIN. 0.6 M DIA. CIRCULAR CULVERT (CLASS 120 CONCRETE OR EQUIVALENT). DESIGNED FOR FREE INLET CONDITIONS 1% AEP + CLIMATE CHANGE. HYDROLOGY & HYDRAULIC ASSESSMENT IN ANNEX A & B RESPECTIVELY.		
WX02	274390	425739	0.067	UNNAMED DRAIN SUMMARY: CHARACTERISTIC OF BOG / LAND DRAIN. MORPHOLOGY: VERY POORLY DEFINED / TRAMPLED BANKS. HEAVY VEGETATED, PEATY SUBSTRATE FISHERY POTENTIAL: NONE / NOT SIGNFICANT PROPOSAL: NEW MIN. 0.75 M DIA. CIRCULAR CULVERT (CLASS 120 CONCRETE OR EQUIVALENT). DESIGNED FOR FREE INLET CONDITIONS 1% AEP + CLIMATE CHANGE. HYDROLOGY & HYDRAULIC ASSESSMENT IN ANNEX A & B RESPECTIVELY.		

REFERENCE	EASTING	NORTHING	CATCHMENT AREA SQ KM	DESCRIPTION	PHOTOGRAPH	CATCHMENT MAP
WX03	274986	425833	0.107	UNNAMED DRAIN SUMMARY: CHARACTERISTIC OF NATURAL HEADWATER MORPHOLOGY: LIMITED DEFINITION / WATER FLOWING THROUGH REEDS, SOIL AND REED SUBSTRATE FISHERY POTENTIAL: NONE / NOT SIGNFICANT PROPOSAL: NEW MIN. 0.9 M DIA. CIRCULAR CULVERT (CLASS 120 CONCRETE OR EQUIVALENT). DESIGNED FOR FREE INLET CONDITIONS 1% AEP + CLIMATE CHANGE. HYDROLOGY & HYDRAULIC ASSESSMENT IN ANNEX A & B RESPECTIVELY.		
WX04	274916	425883	0.111	UNNAMED DRAIN SUMMARY: CHARACTERISTIC OF NATURAL HEADWATER MORPHOLOGY: LIMITED DEFINITION / WATER FLOWING THROUGH REEDS, SOIL AND REED SUBSTRATE FISHERY POTENTIAL: NONE / NOT SIGNFICANT PROPOSAL: NEW MIN. 0.9 M DIA. CIRCULAR CULVERT (CLASS 120 CONCRETE OR EQUIVALENT). DESIGNED FOR FREE INLET CONDITIONS 1% AEP + CLIMATE CHANGE. HYDROLOGY & HYDRAULIC ASSESSMENT IN ANNEX A & B RESPECTIVELY.		

REFERENCE	EASTING	NORTHING	CATCHMENT AREA SQ KM	DESCRIPTION	PHOTOGRAPH	CATCHMENT MAP
WX05	275028	425992	0.090	UNNAMED DRAIN SUMMARY: CHARACTERISTIC OF NATURAL HEADWATER IN WELL DEFINED VALLEY MORPHOLOGY: LIMITED DEFINITION / WATER FLOWING THROUGH REEDS, SOIL AND REED SUBSTRATE FISHERY POTENTIAL: NONE / NOT SIGNFICANT PROPOSAL: NEW MIN. 0.75 M DIA. CIRCULAR CULVERT (CLASS 120 CONCRETE OR EQUIVALENT). DESIGNED FOR FREE INLET CONDITIONS 1% AEP + CLIMATE CHANGE. HYDROLOGY & HYDRAULIC ASSESSMENT IN ANNEX A & B RESPECTIVELY.		
WX06	274327	426182	0.019	UNNAMED DRAIN @ A37 DRAINAGE CROSSING. SUMMARY: ARTIFICIAL AGRICULTURAL DRAIN MORPHOLOGY: WELL DEFINED BANKS, LIMITED FLOW OBSERVED FISHERY POTENTIAL: NONE / NOT SIGNFICANT, LIMTED BY LOW FLOW AND EXISTING CULVERT PROPOSAL: NEW EXTENSION TO EXISTING 0.75M CULVERT TO MATCH EXISTING CULVERT SIZE. NEW MANHOLE CHAMBERS TO EXISTING INLET/OUTLET AT POINT OF CONNECTION.		

REFERENCE	EASTING	NORTHING	CATCHMENT AREA SQ KM	DESCRIPTION	PHOTOGRAPH	CATCHMENT MAP
WX07	274446	426338	0.292	UNNAMED DRAIN SUMMARY: WELL DEFINED SEMI NATURAL TRIBUTARY STREAM MORPHOLOGY: VEGETATED BANKS, GRAVEL / ROCKY SUBSTRATE. CHANNEL C. 0.5M WIDE / 0.2M DEEP. FISHERY POTENTIAL: FISHERIES ASSESSMENT DETERMINED NOT SIGNIFICANT DUE TO CHANNEL SIZE PROPOSAL: NEW MIN. 1.2 M DIA. CIRCULAR CULVERT (CLASS 120 CONCRETE OR EQUIVALENT). DESIGNED FOR FREE INLET CONDITIONS 1% AEP + CLIMATE CHANGE. HYDROLOGY & HYDRAULIC ASSESSMENT IN ANNEX A & B RESPECTIVELY.		

ANNEX A – HYDROLOGY / FLOW ESTIMATON SUMMARY

Calculation Record - Flood Hydrology

Purpose

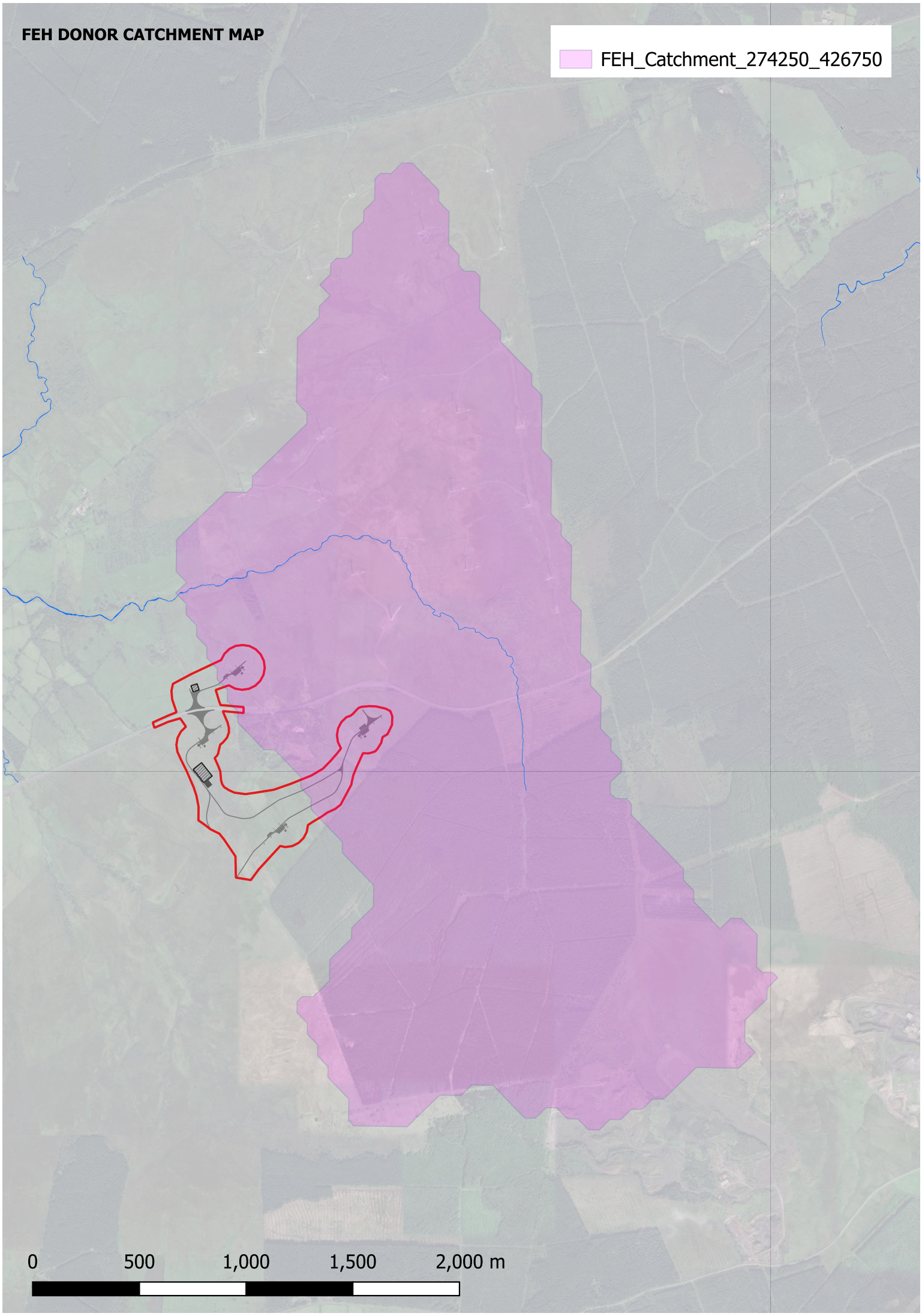
To estimate design floods at culvert locations. Culvert catchments are insufficient to be represented in FEH dataset. Approach adopts estimation of discharge at closest downstream point in FEH dataset by REFH2.3 methodology. REFH flow scaled pro-rata by area to respective culvert catchments.

Donor Catchment

Hydrological estimation point	253050_411750			
Catchment Area		6.3	sq.km	from FEH dataset
1% AEP Present Day (cumecs)		18.22	from REFH2.3	refer to separate REFH calculation output
Specific Discharge		2.89	cumecs/sq.km	

Culvert Catchment / Flow Estimation

CulvertID	Area (sq.m)	Area (sq.km)	1% AEP Present Day (cumecs)	**1% AEP Climate Change (cumecs)**
WX01	19471	0.019	0.06	**0.07**
WX02	66959	0.067	0.19	**0.23**
WX03	106872	0.107	0.31	**0.37**
WX04	111129	0.111	0.32	**0.39**
WX05	89879	0.090	0.26	**0.31**
WX06	19079	0.019	0.06	**0.07**
WX07	291904	0.292	0.84	**1.01**


FEH DONOR CATCHMENT MAP
FEH_Catchment_274250_426750
0
500
1,000
1,500
2,000 m

UK Design Flood Estimation

Generated on Wednesday, October 30, 2024 12:00:21 PM by terminal
Printed from the ReFH2 Flood Modelling software package, version 4.1.8879.22310

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH2)

Site details Checksum: 264F-ABFD

Site name: FEH_Catchment_Descriptors_274250_426750_v5_0_1

Easting: 274250

Northing: 426750

Country: England, Wales or Northern Ireland

Catchment Area (km²): 6.3

Using plot scale calculations: No

Model: 2.3

Site description: None

Model run: 100 year

Summary of results

Rainfall - FEH22 (mm):	51.53	Total runoff (ML):	201.63
Total Rainfall (mm):	46.65	Total flow (ML):	293.78
Peak Rainfall (mm):	11.60	Peak flow (m³/s):	18.22

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH22)

Name	Value	User-defined?
Duration (hh:mm:ss)	03:45:00	No
Timestep (hh:mm:ss)	00:15:00	No
SCF (Seasonal correction factor)	0.95	No
ARF (Areal reduction factor)	0.95	No
Seasonality	Summer [Winter]	Yes

Loss model parameters

Name	Value	User-defined?
Cini (mm)	114.52	No
Cmax (mm)	200.77	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	1.54	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0.31	No
BL (hr)	21.69	No
BR	0.46	No

Urbanisation parameters

Name	Value	User-defined?
Sewer capacity (m^3/s)	0	No
Exporting drained area (km^2)	0	No
Urban area (km^2)	0	No
Effective URBEXT2000	0	n/a
Impervious runoff factor	0.7	No
Imperviousness factor	0.4	No
Tp scaling factor	0.75	No
Depression storage depth (mm)	0.5	No

Appendix

Catchment descriptors

Name	Value	User-defined value used?
Area (km^2)	6.3	No
ALTBAR	254	No
ASPBAR	337	No
ASPVAR	0.33	No
BFIHOST	0.66	No
BFIHOST19	0.27	No
DPLBAR (km)	2.5	No
DPSBAR (mkm^{-1})	61.7	No
FARL	1	No
LDP	5	No
PROPWET	0.61	No
RMED1H	8.2	No
RMED1D	35	No
RMED2D	46.7	No
SAAR (mm)	1276	No
SAAR4170 (mm)	1306	No
SPRHOST	24.05	No
URBEXT2000	0	No
URBEXT1990	0	No
URBCONC	0	No
URBLOC	0	No
DDF parameter C	-0.03	No
DDF parameter D1	0.46	No
DDF parameter D2	0.47	No
DDF parameter D3	0.35	No
DDF parameter E	0.29	No
DDF parameter F	2.18	No
DDF parameter C (1km grid value)	-0.03	No
DDF parameter D1 (1km grid value)	0.47	No
DDF parameter D2 (1km grid value)	0.49	No
DDF parameter D3 (1km grid value)	0.33	No
DDF parameter E (1km grid value)	0.29	No
DDF parameter F (1km grid value)	2.17	No

ANNEX B - HYDRAULICS / CULVERT SIZING

Project	Dunbeg South Ext. Wind Farm
Ref	M01616-31
Date	30/10/2024

Purpose

To determine the adequacy of hydraulic capacity for culverts in accordance with the requirements of CIRIA C689

1.0 *Input Data:*

Culvert Ref:		WX07		
Watercourse Name		Unnamed		
Design Discharge Q		***1.01***	***m3/sec***	As per Hydrological Analysis
Design Return Period		*100+CC*	*Yrs*	As per LA requirement
Elevation of Stream Bed @ Culvert Inlet		197.7	m AOD	from 10m DTM & site obs
Elevation of Stream Bed @ Culvert Outlet		196.4	m AOD	from 10m DTM & site obs
Culvert Length		23	m	from SWMP layout
Elevation of Stream bed upstream of Culvert		198.8	m AOD	from 10m DTM & site obs
Distance upstream of Culvert		36	m	
Elevation of Stream bed downstream of Culvert		195.5	m AOD	from 10m DTM & site obs
Distance downstream of Culvert		30	m	
Elevation of Proposed Embankment Crest		199	m AOD	Est.from on 10m DTM EGL
Average channel invert width		1	m	Est from site obs
Average channel top of bank width		1.2	m	Est from site obs
Average Channel Depth to Bank		0.5	m	Est from site obs
Left Over-Bank Ground Level (Floodplain) (Culvert Inlet)		198.5	m AOD	From 10m DTM
Distance from bank		30	m	
Right Over-Bank Ground Level (Floodplain) (Culvert Inlet)		198.5	m AOD	From 10m DTM
Distance from bank		30	m	
Mannings n - Channel		0.05		From C689 Table A1.1
Mannings n - Overbanks		0.08		From C689 Table A1.1
Bedslope upstream of Culvert 1 in S1	S1	32.73	-	Calculated
Bedslope downstream of Culvert 1 in S2	S2	33.33	-	Calculated
Bedslope across Culvert 1 in S3	S3	17.69	-	Calculated
Bedslope across whole reach considered 1 in S4	S4	26.97	-	Calculated
Channel Side Slopes 1 in X	X =	0.20	-	Calculated
Upstream Left Over- Bank Slope	Y =	100.00	-	Calculated
Upstream Right Over- Bank Slope	Z =	100.00	-	Calculated

2.0 *Calculate Tailwater Depth and Level:*

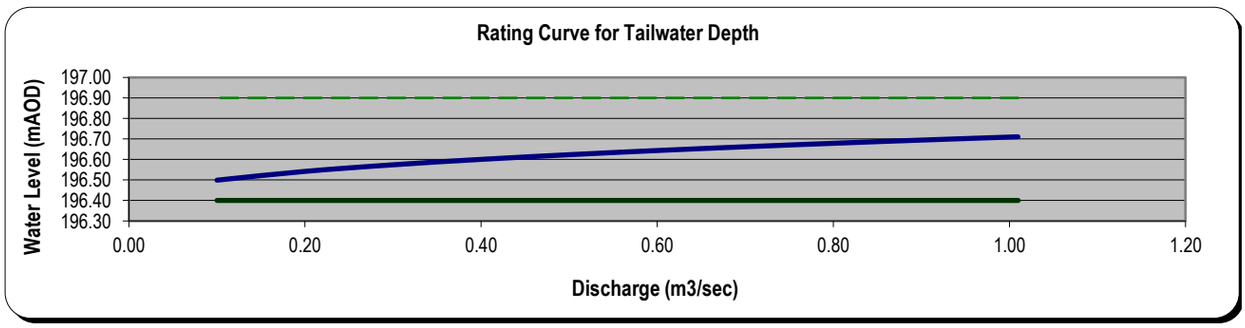
Mannings Equation:

$$Q = VA = \left(\frac{1.00}{n}\right) A R^{\frac{2}{3}} \sqrt{S} \quad [SI] \qquad R_h = \frac{A}{P}$$

Discharge Contained in Channel, Depth of Normal Flow Considered

Depth of water in channel is	y_{dc}	0.31	m	Calculated
Therefore water level at downstream extent of culvert is:	WL_t	196.71	mAOD	Calculated
	V_{dc}	1.27	m/s	Calculated

2.1 Rating Curve for Tailwater Channel Discharge



3.0 *Calculate Tailwater Elevation (Total Head) Ht:*

$$H_t = Z_{bo} + y_{dc} + \frac{V_{dc}^2}{2g}$$

Where: Z_{bo} Elevation @ Culvert Outlet
y_{dc} Water depth in downstream channel
V_{dc} Velocity in downstream channel

Tail... H_t 196.80 mAOD Calculated

4.0 *Calculate Froude No.*

Cross Sectional Area (A)		0.79	m2
Top Width (B)		4.11	m
Hydraulic mean depth (A per unit B)	d_m	0.19	m
Froude Number	Fr	0.93	*Subcritical*
Critical depth in channel	h_c	0.27	m
Critical Velocity	v_c	1.38	m/s

5.0 *Initial Design*

Initial Estimate of required culvert cross sectional area required. Analysis is based on new culvert, therefore design should allow for freeflow conditions. Applicable method is Flow Area Method

5.1 *Flow Area Method - refer to C689 Section 6.7.1*

Depth; Min. Tailwater depth	D	0.31	m	Calculated
Assume 20% Initial loss of culvert height due to Freeboard / Silt		0.39	m	Calculated
where freeboard depth is:	F	0.04	m	Calculated
Area required as per tailwater fllow calculation:	A_t	0.79	m2	Calculated
Nominal width (Area / Depth (not inc. freeboard):		2.55	m	Calculated
Therefore prelim culvert dimensions (incl freeboard + silt	D_i	*0.39*	*m*	Calculated
	B_i	*2.55*	*m*	Calculated

6.0 *Detailed Design*

6.1 *Try Culvert dimensions...*

Based on previous Initial Design

Height / Diameter	D	1.20	m	
Breadth (BLANK IF CIRCULAR)	B		m	
Number of Culverts	nr	1	n/a	
Shape		CIRCULAR		
Freeboard		0.30	m	As per CIRIA Guidance
Siltation / Depth lowered below ex. stream invert		0.10	m	Manually Entered Value

Therefore:

Upstream Pipe Invert		*197.60*	*mAOD*
Upstream Pipe Base (w/Silt)Elevation	Z_i	*197.70*	*mAOD*
Upstream Soffit Elevation		*198.80*	*mAOD*
Downstream Pipe Invert Elevation		*196.30*	*mAOD*
Downstream Pipe Base (w/ Silt) Elevation	Z_o	*196.40*	*mAOD*
Downstream Soffit Elevation		*197.50*	*mAOD*

6.2 *Calculation of Discharge Intensity*

$$q_i = \frac{1.811Q}{A_b D^{0.5}}$$

Where

Discharge	Q	1.01	m3/s
Depth / Diameter of barrell	D	1.10	m
Culvert cross section area excl. freeboard + siltation	Ab	0.86	m2
Discharge Coefficient	qi	2.02	n/a
Discharge intensity classification is:		Free Flow Inlet Control	

6.3 *Calculation of headwater depth for free flow inlet control*

Based on Table A1.3, Culvert type is Nr 20 n/a
i.e, Rectangular concrete, 90˚ headwall; 45˚ bevels

$$\frac{E_{sh}}{D} = \frac{E_{sc}}{D} + k\left[\frac{1.811Q}{A_b D^{0.5}}\right]^M - 0.5S_0 \quad \text{Eqn 6.23}$$

$$\frac{E_{sh}}{D} = k\left[\frac{1.811Q}{A_b D^{0.5}}\right]^M \quad \text{Eqn 6.25}$$

Therefore applicable CIRIA C689 equation reference: Equation 6.25

Where

Discharge	Q	1.01	m3/s	
Depth / Diameter of barrell	D	1.1	m	
Unsubmerged analysis constant	k	0.495		Table A1.3
Unsubmerged analysis constant	M	0.667		Table A1.3
Culvert cross section area excl. freeboard + siltation	Ab	0.86	m2	
Culvert Slope	So	0.06	m/m	1 in 17.69
Critical depth calculated as:	y_c	0.483	m	
Specific Energy at Critical Depth	E_{sc}	0.72	m	
Therefore Specific Energy of Headwater	E_{sh}	0.87	m	

$$\frac{Q^2 W}{gA^3} = 1$$

$$E_{sc} = \frac{3}{2} y_c$$

6.4 *Calculation of headwater elevation for inlet control*

Headwater Elevation H_{hic} determined by:

$$H_{hic} = Z_i + E_{sh} + h_s$$

Where

oss due to inlet screen	h_s	N/A	(No Screen Proposed)
ream Elevation at Inlet	Z_i	197.70	mAOD
Specific Energy of Headwater	E_{sh}	0.87	m
Therefore Headwater Elevation:	H_{hic}	198.57	mAOD

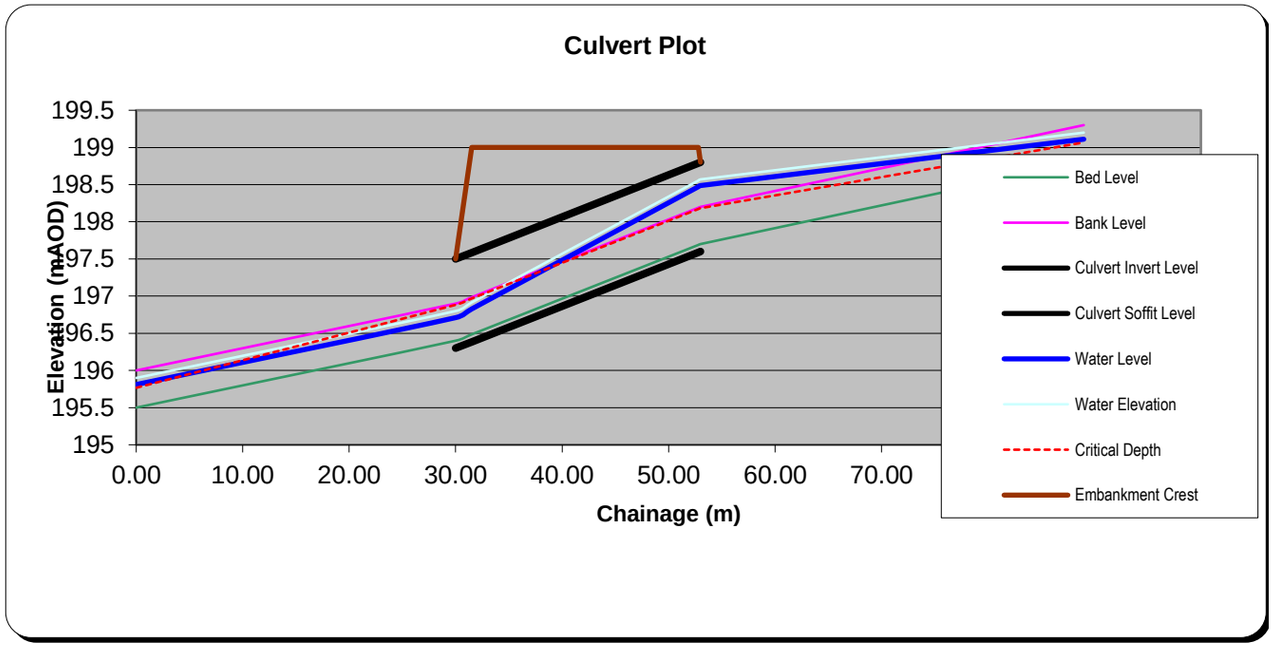
Water Level at the headwater for inlet control WL_{hic} determined by:

$$WL_{hic} = H_{hic} - \frac{V_{uc}^2}{2g}$$

Where

Headwater Elevation:	H_{hic}	198.57	mAOD
elocity in Upstream Channel	V_{uc}	1.27	m/s
Therefore Water Level at Inlet:	WL_{hic}	198.49	mAOD

6.5 *Culvert Profile*



7.0 *Summary*

	Complies	Fails	Comment
Culvert Inlet Soffit Elevation > Headwater Elevation for Inlet Cor	X		
Adequate Freeboard provided to water level?	X		

Therefore proposed culvert dimensions: **1 nr** **Diameter** **1.20 m**

By	Checked	Revision	Date
DH	DKS	Original	30/10/2024

Project	Dunbeg South Ext. Wind Farm
Ref	M01616-31
Date	30/10/2024

Purpose

To determine the adequacy of hydraulic capacity for culverts in accordance with the requirements of CIRIA C689

1.0 *Input Data:*

Culvert Ref:		WX01		
Watercourse Name		Unnamed		
Design Discharge Q		***0.07***	***m3/sec***	As per Hydrological Analysis
Design Return Period		*100+CC*	*Yrs*	As per LA requirement
Elevation of Stream Bed @ Culvert Inlet		271.8	m AOD	from 10m DTM & site obs
Elevation of Stream Bed @ Culvert Outlet		271.1	m AOD	from 10m DTM & site obs
Culvert Length		9	m	from SWMP layout
Elevation of Stream bed upstream of Culvert		274.8	m AOD	from 10m DTM & site obs
Distance upstream of Culvert		18	m	
Elevation of Stream bed downstream of Culvert		264.9	m AOD	from 10m DTM & site obs
Distance downstream of Culvert		15	m	
Elevation of Proposed Embankment Crest		275	m AOD	Est.from on 10m DTM EGL
Average channel invert width		0.4	m	Est from site obs
Average channel top of bank width		0.7	m	Est from site obs
Average Channel Depth to Bank		0.7	m	Est from site obs
Left Over-Bank Ground Level (Floodplain) (Culvert Inlet)		275	m AOD	From 10m DTM
Distance from bank		30	m	
Right Over-Bank Ground Level (Floodplain) (Culvert Inlet)		275	m AOD	From 10m DTM
Distance from bank		30	m	
Mannings n - Channel		0.04		From C689 Table A1.1
Mannings n - Overbanks		0.05		From C689 Table A1.1
Bedslope upstream of Culvert 1 in S1	S1	6.00	-	Calculated
Bedslope downstream of Culvert 1 in S2	S2	2.42	-	Calculated
Bedslope across Culvert 1 in S3	S3	12.86	-	Calculated
Bedslope across whole reach considered 1 in S4	S4	4.24	-	Calculated
Channel Side Slopes 1 in X	X =	0.21	-	Calculated
Upstream Left Over- Bank Slope	Y =	12.00	-	Calculated
Upstream Right Over- Bank Slope	Z =	12.00	-	Calculated

2.0 *Calculate Tailwater Depth and Level:*

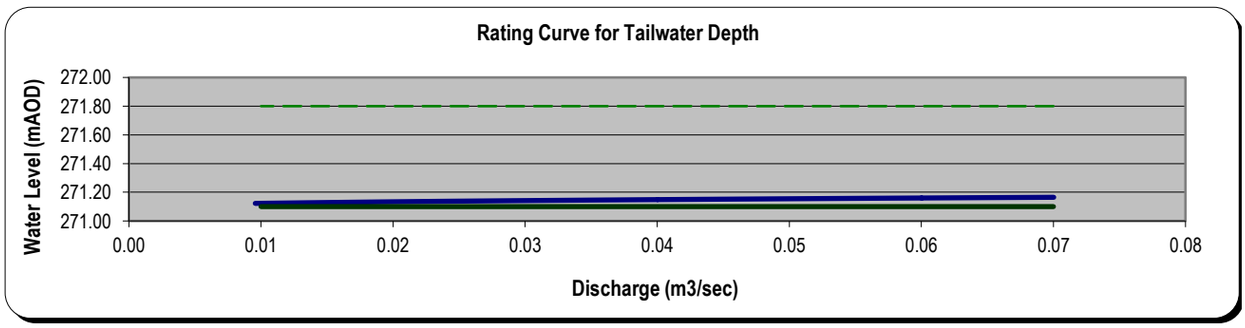
Mannings Equation:

$$Q = VA = \left(\frac{1.00}{n}\right) A R^{\frac{2}{3}} \sqrt{S} \quad [SI] \qquad R_h = \frac{A}{P}$$

Discharge Contained in Channel, Depth of Normal Flow Considered

Depth of water in channel is	y_{dc}	0.07	m	Calculated
Therefore water level at downstream extent of culvert is:	WL_t	271.17	mAOD	Calculated
	V_{dc}	1.53	m/s	Calculated

2.1 Rating Curve for Tailwater Channel Discharge



3.0 *Calculate Tailwater Elevation (Total Head) Ht:*

$$H_t = Z_{bo} + y_{dc} + \frac{V_{dc}^2}{2g}$$

Where: Z_{bo} Elevation @ Culvert Outlet
y_{dc} Water depth in downstream channel
V_{dc} Velocity in downstream channel

Tail... H_t 271.29 mAOD Calculated

4.0 *Calculate Froude No.*

Cross Sectional Area (A)		0.05	m2
Top Width (B)		1.01	m
Hydraulic mean depth (A per unit B)	d_m	0.05	m
Froude Number	Fr	2.29	*Supercritical*
Critical depth in channel	h_c	0.08	m
Critical Velocity	v_c	0.67	m/s

5.0 *Initial Design*

Initial Estimate of required culvert cross sectional area required. Analysis is based on new culvert, therefore design should allow for freeflow conditions. Applicable method is Flow Area Method

5.1 *Flow Area Method - refer to C689 Section 6.7.1*

Depth; Min. Tailwater depth	D	0.07	m	Calculated
Assume 20% Initial loss of culvert height due to Freeboard / Silt		0.08	m	Calculated
where freeboard depth is:	F	0.01	m	Calculated
Area required as per tailwater fllow calculation:	A_t	0.05	m2	Calculated
Nominal width (Area / Depth (not inc. freeboard):		0.70	m	Calculated
Therefore prelim culvert dimensions (incl freeboard + silt	D_i	*0.08*	*m*	Calculated
	B_i	*0.70*	*m*	Calculated

6.0 *Detailed Design*

6.1 *Try Culvert dimensions...*

Based on previous Initial Design

Height / Diameter	D	0.60	m	
Breadth (BLANK IF CIRCULAR)	B		m	
Number of Culverts	nr	1	n/a	
Shape		CIRCULAR		
Freeboard		0.15	m	As per CIRIA Guidance
Siltation / Depth lowered below ex. stream invert		0.15	m	As per CIRIA Guidance

Therefore:

Upstream Pipe Invert		*271.65*	*mAOD*
Upstream Pipe Base (w/Silt)Elevation	Z_i	*271.80*	*mAOD*
Upstream Soffit Elevation		*272.25*	*mAOD*
Downstream Pipe Invert Elevation		*270.95*	*mAOD*
Downstream Pipe Base (w/ Silt) Elevation	Z_o	*271.10*	*mAOD*
Downstream Soffit Elevation		*271.55*	*mAOD*

6.2 *Calculation of Discharge Intensity*

$$q_i = \frac{1.811Q}{A_b D^{0.5}}$$

Where

Discharge	Q	0.07	m3/s
Depth / Diameter of barrell	D	0.45	m
Culvert cross section area excl. freeboard + siltation	Ab	0.17	m2
Discharge Coefficient	qi	1.10	n/a
Discharge intensity classification is:		Free Flow Inlet Control	

6.3 *Calculation of headwater depth for free flow inlet control*

Based on Table A1.3, Culvert type is Nr 20 n/a
i.e, Rectangular concrete, 90˚ headwall; 45˚ bevels

$$\frac{E_{sh}}{D} = \frac{E_{sc}}{D} + k\left[\frac{1.811Q}{A_b D^{0.5}}\right]^M - 0.5S_0 \quad \text{Eqn 6.23}$$

$$\frac{E_{sh}}{D} = k\left[\frac{1.811Q}{A_b D^{0.5}}\right]^M \quad \text{Eqn 6.25}$$

Therefore applicable CIRIA C689 equation reference: Equation 6.25

Where

Discharge	Q	0.07	m3/s	
Depth / Diameter of barrell	D	0.45	m	
Unsubmerged analysis constant	k	0.495		Table A1.3
Unsubmerged analysis constant	M	0.667		Table A1.3
Culvert cross section area excl. freeboard + siltation	Ab	0.17	m2	
Culvert Slope	So	0.08	m/m	1 in 12.86
Critical depth calculated as:	y_c	0.118	m	
Specific Energy at Critical Depth	E_{sc}	0.18	m	
Therefore Specific Energy of Headwater	E_{sh}	0.24	m	

$$\frac{Q^2 W}{gA^3} = 1$$

$$E_{sc} = \frac{3}{2} y_c$$

6.4 *Calculation of headwater elevation for inlet control*

Headwater Elevation H_{hic} determined by:

$$H_{hic} = Z_i + E_{sh} + h_s$$

Where

oss due to inlet screen	h_s	N/A	(No Screen Proposed)
ream Elevation at Inlet	Z_i	271.80	mAOD
Specific Energy of Headwater	E_{sh}	0.24	m
Therefore Headwater Elevation:	H_{hic}	272.04	mAOD

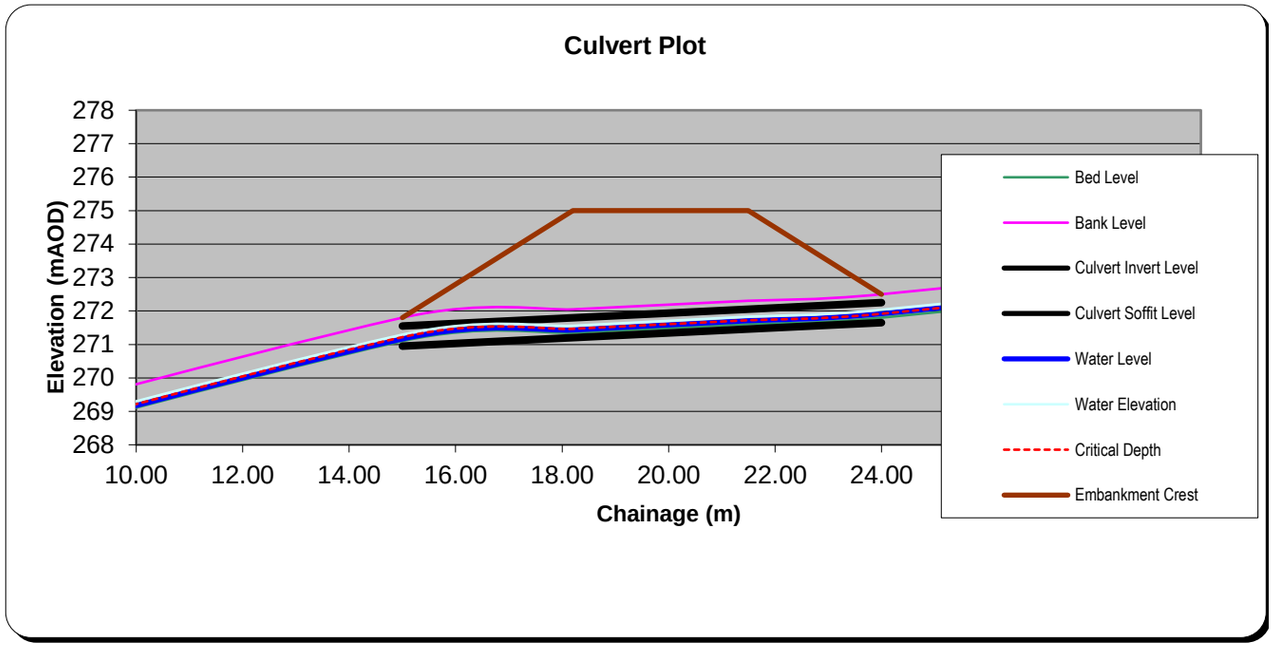
Water Level at the headwater for inlet control WL_{hic} determined by:

$$WL_{hic} = H_{hic} - \frac{V_{uc}^2}{2g}$$

Where

Headwater Elevation:	H_{hic}	272.04	mAOD
elocity in Upstream Channel	V_{uc}	1.53	m/s
Therefore Water Level at Inlet:	WL_{hic}	271.92	mAOD

6.5 *Culvert Profile*



7.0 *Summary*

	Complies	Fails	Comment
Culvert Inlet Soffit Elevation > Headwater Elevation for Inlet Cor	X		
Adequate Freeboard provided to water level?	X		

Therefore proposed culvert dimensions: **1 nr** **Diameter** **0.60 m**

By	Checked	Revision	Date
DH	DKS	Original	30/10/2024

Project	Dunbeg South Ext. Wind Farm
Ref	M01616-31
Date	30/10/2024

Purpose

To determine the adequacy of hydraulic capacity for culverts in accordance with the requirements of CIRIA C689

1.0 *Input Data:*

Culvert Ref:		WX02		
Watercourse Name		Unnamed		
Design Discharge Q		***0.23***	***m3/sec***	As per Hydrological Analysis
Design Return Period		*100+CC*	*Yrs*	As per LA requirement
Elevation of Stream Bed @ Culvert Inlet		233.9	m AOD	from 10m DTM & site obs
Elevation of Stream Bed @ Culvert Outlet		232.8	m AOD	from 10m DTM & site obs
Culvert Length		11	m	from SWMP layout
Elevation of Stream bed upstream of Culvert		234.5	m AOD	from 10m DTM & site obs
Distance upstream of Culvert		16	m	
Elevation of Stream bed downstream of Culvert		231.7	m AOD	from 10m DTM & site obs
Distance downstream of Culvert		14	m	
Elevation of Proposed Embankment Crest		235	m AOD	Est.from on 10m DTM EGL
Average channel invert width		1	m	Est from site obs
Average channel top of bank width		1.1	m	Est from site obs
Average Channel Depth to Bank		0.3	m	Est from site obs
Left Over-Bank Ground Level (Floodplain) (Culvert Inlet)		234	m AOD	From 10m DTM
Distance from bank		205	m	
Right Over-Bank Ground Level (Floodplain) (Culvert Inlet)		234.5	m AOD	From 10m DTM
Distance from bank		40	m	
Mannings n - Channel		0.04		From C689 Table A1.1
Mannings n - Overbanks		0.05		From C689 Table A1.1
Bedslope upstream of Culvert 1 in S1	S1	26.67	-	Calculated
Bedslope downstream of Culvert 1 in S2	S2	12.73	-	Calculated
Bedslope across Culvert 1 in S3	S3	10.00	-	Calculated
Bedslope across whole reach considered 1 in S4	S4	14.64	-	Calculated
Channel Side Slopes 1 in X	X =	0.17	-	Calculated
Upstream Left Over- Bank Slope	Y =	-1025.00	-	Calculated
Upstream Right Over- Bank Slope	Z =	133.33	-	Calculated

2.0 *Calculate Tailwater Depth and Level:*

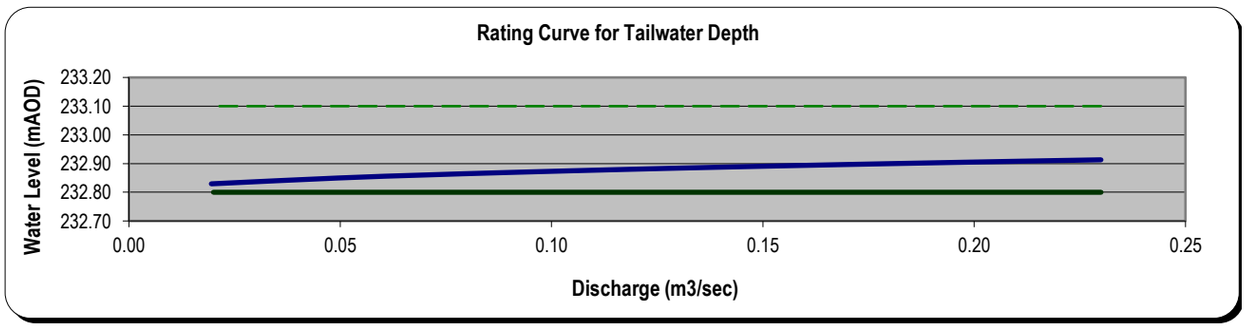
Mannings Equation:

$$Q = VA = \left(\frac{1.00}{n}\right) A R^{\frac{2}{3}} \sqrt{S} \quad [SI] \qquad R_h = \frac{A}{P}$$

Discharge Contained in Channel, Depth of Normal Flow Considered

Depth of water in channel is	y_{dc}	0.11	m	Calculated
Therefore water level at downstream extent of culvert is:	WL_t	232.91	mAOD	Calculated
	V_{dc}	1.21	m/s	Calculated

2.1 Rating Curve for Tailwater Channel Discharge



3.0 *Calculate Tailwater Elevation (Total Head) Ht:*

$$H_t = Z_{bo} + y_{dc} + \frac{V_{dc}^2}{2g}$$

Where: Z_{bo} Elevation @ Culvert Outlet
y_{dc} Water depth in downstream channel
V_{dc} Velocity in downstream channel

Tail... H_t 232.99 mAOD Calculated

4.0 *Calculate Froude No.*

Cross Sectional Area (A)		0.19	m2
Top Width (B)		2.36	m
Hydraulic mean depth (A per unit B)	d_m	0.08	m
Froude Number	Fr	1.36	*Supercritical*
Critical depth in channel	h_c	0.10	m
Critical Velocity	v_c	0.89	m/s

5.0 *Initial Design*

Initial Estimate of required culvert cross sectional area required. Analysis is based on new culvert, therefore design should allow for freeflow conditions. Applicable method is Flow Area Method

5.1 *Flow Area Method - refer to C689 Section 6.7.1*

Depth; Min. Tailwater depth	D	0.11	m	Calculated
Assume 20% Initial loss of culvert height due to Freeboard / Silt		0.14	m	Calculated
where freeboard depth is:	F	0.01	m	Calculated
Area required as per tailwater fllow calculation:	A_t	0.19	m2	Calculated
Nominal width (Area / Depth (not inc. freeboard):		1.68	m	Calculated
Therefore prelim culvert dimensions (incl freeboard + silt	D_i	*0.14*	*m*	Calculated
	B_i	*1.68*	*m*	Calculated

6.0 *Detailed Design*

6.1 *Try Culvert dimensions...*

Based on previous Initial Design

Height / Diameter	D	0.75	m	
Breadth (BLANK IF CIRCULAR)	B		m	
Number of Culverts	nr	1	n/a	
Shape		CIRCULAR		
Freeboard		0.19	m	As per CIRIA Guidance
Siltation / Depth lowered below ex. stream invert		0.10	m	Manually Entered Value

Therefore:

Upstream Pipe Invert		*233.80*	*mAOD*
Upstream Pipe Base (w/Silt)Elevation	Z_i	*233.90*	*mAOD*
Upstream Soffit Elevation		*234.55*	*mAOD*
Downstream Pipe Invert Elevation		*232.70*	*mAOD*
Downstream Pipe Base (w/ Silt) Elevation	Z_o	*232.80*	*mAOD*
Downstream Soffit Elevation		*233.45*	*mAOD*

6.2 *Calculation of Discharge Intensity*

$$q_i = \frac{1.811Q}{A_b D^{0.5}}$$

Where			
Discharge	Q	0.23	m3/s
Depth / Diameter of barrell	D	0.65	m
Culvert cross section area excl. freeboard + siltation	Ab	0.32	m2
Discharge Coefficient	qi	1.61	n/a
Discharge intensity classification is:		Free Flow Inlet Control	

6.3 *Calculation of headwater depth for free flow inlet control*

Based on Table A1.3, Culvert type is Nr 20 n/a
i.e, Rectangular concrete, 90˚ headwall; 45˚ bevels

$$\frac{E_{sh}}{D} = \frac{E_{sc}}{D} + k\left[\frac{1.811Q}{A_b D^{0.5}}\right]^M - 0.5S_0 \quad \text{Eqn 6.23}$$

$$\frac{E_{sh}}{D} = k\left[\frac{1.811Q}{A_b D^{0.5}}\right]^M \quad \text{Eqn 6.25}$$

Therefore applicable CIRIA C689 equation reference: Equation 6.25

Where				
Discharge	Q	0.23	m3/s	
Depth / Diameter of barrell	D	0.65	m	
Unsubmerged analysis constant	k	0.495		Table A1.3
Unsubmerged analysis constant	M	0.667		Table A1.3
Culvert cross section area excl. freeboard + siltation	Ab	0.32	m2	
Culvert Slope	So	0.10	m/m	1 in 10
Critical depth calculated as:	y_c	0.239	m	
Specific Energy at Critical Depth	E_{sc}	0.36	m	
Therefore Specific Energy of Headwater	E_{sh}	0.44	m	

$$\frac{Q^2 W}{gA^3} = 1$$

$$E_{sc} = \frac{3}{2} y_c$$

6.4 *Calculation of headwater elevation for inlet control*

Headwater Elevation H_{hic} determined by:

$$H_{hic} = Z_i + E_{sh} + h_s$$

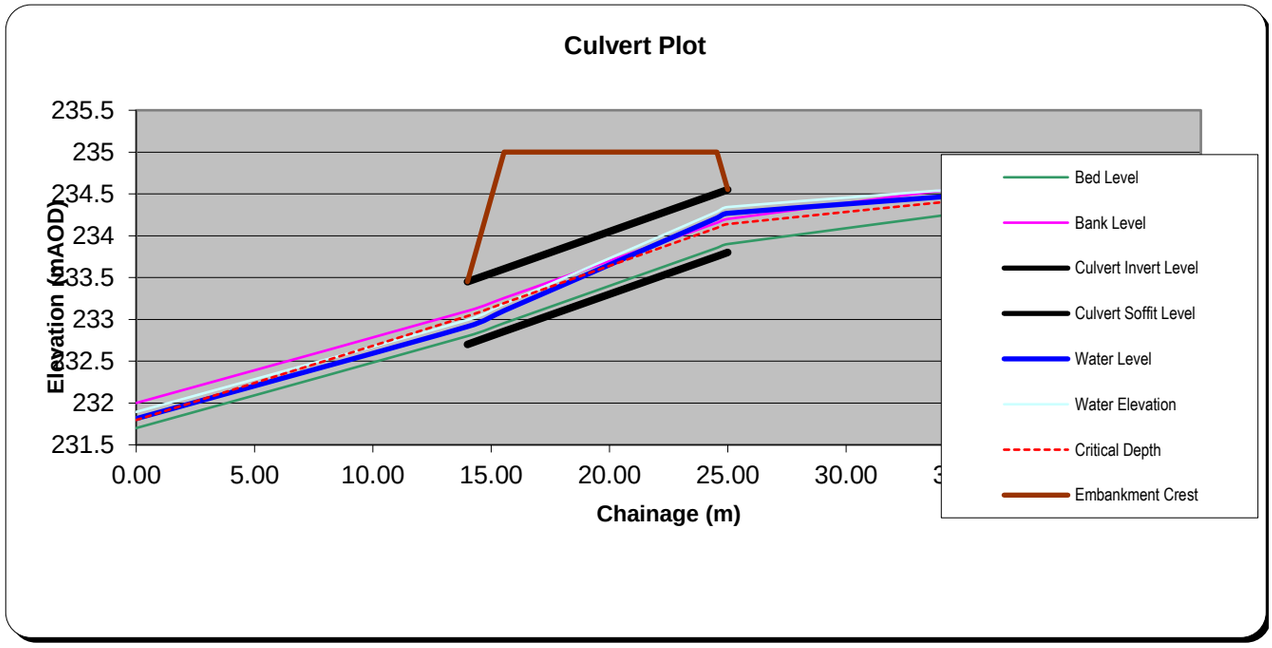
Where				
oss due to inlet screen	h_s	N/A		(No Screen Proposed)
ream Elevation at Inlet	Z_i	233.90	mAOD	
Specific Energy of Headwater	E_{sh}	0.44	m	
Therefore Headwater Elevation:	H_{hic}	234.34	mAOD	

Water Level at the headwater for inlet control WL_{hic} determined by:

$$WL_{hic} = H_{hic} - \frac{V_{uc}^2}{2g}$$

Where			
Headwater Elevation:	H_{hic}	234.34	mAOD
elocity in Upstream Channel	V_{uc}	1.21	m/s
Therefore Water Level at Inlet:	WL_{hic}	234.27	mAOD

6.5 *Culvert Profile*



7.0 *Summary*

	Complies	Fails	Comment
Culvert Inlet Soffit Elevation > Headwater Elevation for Inlet Cor	X		
Adequate Freeboard provided to water level?	X		

Therefore proposed culvert dimensions: **1 nr** **Diameter** **0.75 m**

By	Checked	Revision	Date
DH	DKS	Original	30/10/2024

Project	Dunbeg South Ext. Wind Farm
Ref	M01616-31
Date	30/10/2024

Purpose

To determine the adequacy of hydraulic capacity for culverts in accordance with the requirements of CIRIA C689

1.0 *Input Data:*

Culvert Ref:		WX03		
Watercourse Name		Unnamed		
Design Discharge Q		***0.37***	***m3/sec***	As per Hydrological Analysis
Design Return Period		*100+CC*	*Yrs*	As per LA requirement
Elevation of Stream Bed @ Culvert Inlet		265	m AOD	from 10m DTM & site obs
Elevation of Stream Bed @ Culvert Outlet		264	m AOD	from 10m DTM & site obs
Culvert Length		20	m	from SWMP layout
Elevation of Stream bed upstream of Culvert		267.3	m AOD	from 10m DTM & site obs
Distance upstream of Culvert		45	m	
Elevation of Stream bed downstream of Culvert		259.5	m AOD	from 10m DTM & site obs
Distance downstream of Culvert		40	m	
Elevation of Proposed Embankment Crest		266	m AOD	Est.from on 10m DTM EGL
Average channel invert width		0.5	m	Est from site obs
Average channel top of bank width		0.55	m	Est from site obs
Average Channel Depth to Bank		0.5	m	Est from site obs
Left Over-Bank Ground Level (Floodplain) (Culvert Inlet)		265.5	m AOD	From 10m DTM
Distance from bank		60	m	
Right Over-Bank Ground Level (Floodplain) (Culvert Inlet)		266.2	m AOD	From 10m DTM
Distance from bank		60	m	
Mannings n - Channel		0.04		From C689 Table A1.1
Mannings n - Overbanks		0.05		From C689 Table A1.1
Bedslope upstream of Culvert 1 in S1	S1	19.57	-	Calculated
Bedslope downstream of Culvert 1 in S2	S2	8.89	-	Calculated
Bedslope across Culvert 1 in S3	S3	20.00	-	Calculated
Bedslope across whole reach considered 1 in S4	S4	13.46	-	Calculated
Channel Side Slopes 1 in X	X =	0.05	-	Calculated
Upstream Left Over- Bank Slope	Y =	#DIV/0!	-	Calculated
Upstream Right Over- Bank Slope	Z =	85.71	-	Calculated

2.0 *Calculate Tailwater Depth and Level:*

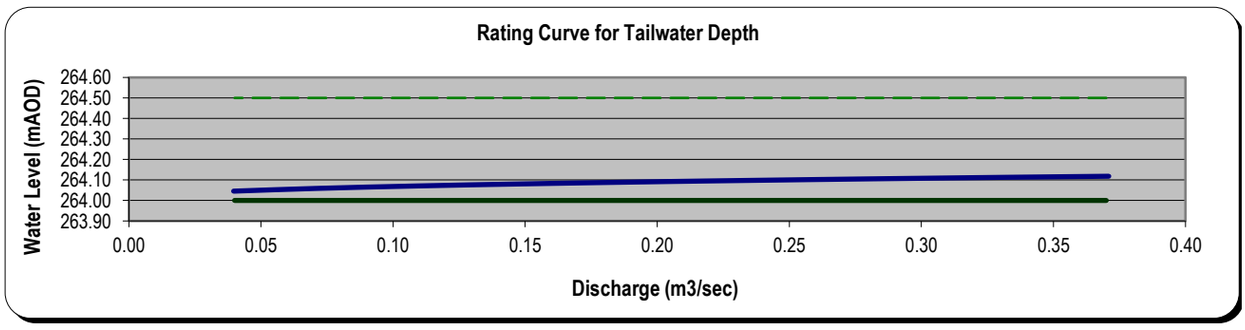
Mannings Equation:

$$Q = VA = \left(\frac{1.00}{n}\right) A R^{\frac{2}{3}} \sqrt{S} \quad [SI] \qquad R_h = \frac{A}{P}$$

Discharge Contained in Channel, Depth of Normal Flow Considered

Depth of water in channel is	y_{dc}	0.12	m	Calculated
Therefore water level at downstream extent of culvert is:	WL_t	264.12	mAOD	Calculated
	V_{dc}	1.10	m/s	Calculated

2.1 Rating Curve for Tailwater Channel Discharge



3.0 *Calculate Tailwater Elevation (Total Head) Ht:*

$$H_t = Z_{bo} + y_{dc} + \frac{V_{dc}^2}{2g}$$

Where: Z_{bo} Elevation @ Culvert Outlet
y_{dc} Water depth in downstream channel
V_{dc} Velocity in downstream channel

Tail... H_t 264.18 mAOD Calculated

4.0 *Calculate Froude No.*

Cross Sectional Area (A)		0.34	m2
Top Width (B)		5.22	m
Hydraulic mean depth (A per unit B)	d_m	0.06	m
Froude Number	Fr	1.38	*Supercritical*
Critical depth in channel	h_c	0.09	m
Critical Velocity	v_c	0.80	m/s

5.0 *Initial Design*

Initial Estimate of required culvert cross sectional area required. Analysis is based on new culvert, therefore design should allow for freeflow conditions. Applicable method is Flow Area Method

5.1 *Flow Area Method - refer to C689 Section 6.7.1*

Depth; Min. Tailwater depth	D	0.12	m	Calculated
Assume 20% Initial loss of culvert height due to Freeboard / Silt		0.15	m	Calculated
where freeboard depth is:	F	0.01	m	Calculated
Area required as per tailwater fllow calculation:	A_t	0.34	m2	Calculated
Nominal width (Area / Depth (not inc. freeboard):		2.86	m	Calculated
Therefore prelim culvert dimensions (incl freeboard + silt	D_i	*0.15*	*m*	Calculated
	B_i	*2.86*	*m*	Calculated

6.0 *Detailed Design*

6.1 *Try Culvert dimensions...*

Based on previous Initial Design

Height / Diameter	D	0.90	m	
Breadth (BLANK IF CIRCULAR)	B		m	
Number of Culverts	nr	1	n/a	
Shape		CIRCULAR		
Freeboard		0.23	m	As per CIRIA Guidance
Siltation / Depth lowered below ex. stream invert		0.00	m	Manually Entered Value

Therefore:

Upstream Pipe Invert		*265.00*	*mAOD*
Upstream Pipe Base (w/Silt)Elevation	Z_i	*265.00*	*mAOD*
Upstream Soffit Elevation		*265.90*	*mAOD*
Downstream Pipe Invert Elevation		*264.00*	*mAOD*
Downstream Pipe Base (w/ Silt) Elevation	Z_o	*264.00*	*mAOD*
Downstream Soffit Elevation		*264.90*	*mAOD*

6.2 *Calculation of Discharge Intensity*

$$q_i = \frac{1.811Q}{A_b D^{0.5}}$$

Where

Discharge	Q	0.37	m3/s
Depth / Diameter of barrell	D	0.90	m
Culvert cross section area excl. freeboard + siltation	Ab	0.51	m2
Discharge Coefficient	qi	1.38	n/a
Discharge intensity classification is:		Free Flow Inlet Control	

6.3 *Calculation of headwater depth for free flow inlet control*

Based on Table A1.3, Culvert type is Nr 20 n/a
i.e, Rectangular concrete, 90˚ headwall; 45˚ bevels

$$\frac{E_{sh}}{D} = \frac{E_{sc}}{D} + k\left[\frac{1.811Q}{A_b D^{0.5}}\right]^M - 0.5S_0 \quad \text{Eqn 6.23}$$

$$\frac{E_{sh}}{D} = k\left[\frac{1.811Q}{A_b D^{0.5}}\right]^M \quad \text{Eqn 6.25}$$

Therefore applicable CIRIA C689 equation reference: Equation 6.25

Where

Discharge	Q	0.37	m3/s	
Depth / Diameter of barrell	D	0.9	m	
Unsubmerged analysis constant	k	0.495		Table A1.3
Unsubmerged analysis constant	M	0.667		Table A1.3
Culvert cross section area excl. freeboard + siltation	Ab	0.51	m2	
Culvert Slope	So	0.05	m/m	1 in 20
Critical depth calculated as:	y_c	0.352	m	
Specific Energy at Critical Depth	E_{sc}	0.53	m	
Therefore Specific Energy of Headwater	E_{sh}	0.55	m	

$$\frac{Q^2 W}{gA^3} = 1$$

$$E_{sc} = \frac{3}{2} y_c$$

6.4 *Calculation of headwater elevation for inlet control*

Headwater Elevation H_{hic} determined by:

$$H_{hic} = Z_i + E_{sh} + h_s$$

Where

oss due to inlet screen	h_s	N/A	(No Screen Proposed)
ream Elevation at Inlet	Z_i	265.00	mAOD
Specific Energy of Headwater	E_{sh}	0.55	m
Therefore Headwater Elevation:	H_{hic}	265.55	mAOD

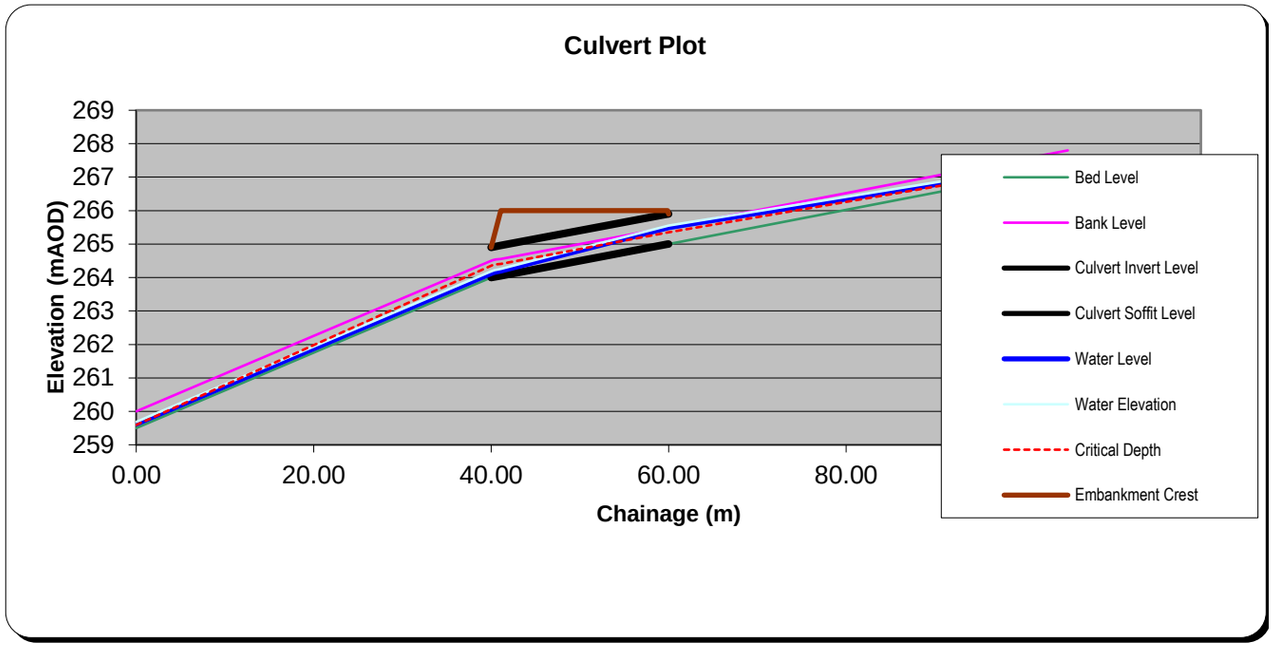
Water Level at the headwater for inlet control WL_{hic} determined by:

$$WL_{hic} = H_{hic} - \frac{V_{uc}^2}{2g}$$

Where

Headwater Elevation:	H_{hic}	265.55	mAOD
elocity in Upstream Channel	V_{uc}	1.10	m/s
Therefore Water Level at Inlet:	WL_{hic}	265.49	mAOD

6.5 *Culvert Profile*



7.0 *Summary*

	Complies	Fails	Comment
Culvert Inlet Soffit Elevation > Headwater Elevation for Inlet Cor	X		
Adequate Freeboard provided to water level?	X		

Therefore proposed culvert dimensions: **1 nr** **Diameter** **0.90 m**

By	Checked	Revision	Date
DH	DKS	Original	30/10/2024

Project	Dunbeg South Ext. Wind Farm
Ref	M01616-31
Date	30/10/2024

Purpose

To determine the adequacy of hydraulic capacity for culverts in accordance with the requirements of CIRIA C689

1.0 *Input Data:*

Culvert Ref:		WX04		
Watercourse Name		Unnamed		
Design Discharge Q		***0.39***	***m3/sec***	As per Hydrological Analysis
Design Return Period		*100+CC*	*Yrs*	As per LA requirement
Elevation of Stream Bed @ Culvert Inlet		251.2	m AOD	from 10m DTM & site obs
Elevation of Stream Bed @ Culvert Outlet		249.2	m AOD	from 10m DTM & site obs
Culvert Length		20	m	from SWMP layout
Elevation of Stream bed upstream of Culvert		252.3	m AOD	from 10m DTM & site obs
Distance upstream of Culvert		22	m	
Elevation of Stream bed downstream of Culvert		248	m AOD	from 10m DTM & site obs
Distance downstream of Culvert		20	m	
Elevation of Proposed Embankment Crest		253	m AOD	Est.from on 10m DTM EGL
Average channel invert width		0.5	m	Est from site obs
Average channel top of bank width		0.51	m	Est from site obs
Average Channel Depth to Bank		0.6	m	Est from site obs
Left Over-Bank Ground Level (Floodplain) (Culvert Inlet)		252	m AOD	From 10m DTM
Distance from bank		20	m	
Right Over-Bank Ground Level (Floodplain) (Culvert Inlet)		252	m AOD	From 10m DTM
Distance from bank		20	m	
Mannings n - Channel		0.08		From C689 Table A1.1
Mannings n - Overbanks		0.08		From C689 Table A1.1
Bedslope upstream of Culvert 1 in S1	S1	20.00	-	Calculated
Bedslope downstream of Culvert 1 in S2	S2	16.67	-	Calculated
Bedslope across Culvert 1 in S3	S3	10.00	-	Calculated
Bedslope across whole reach considered 1 in S4	S4	14.42	-	Calculated
Channel Side Slopes 1 in X	X =	0.01	-	Calculated
Upstream Left Over- Bank Slope	Y =	100.00	-	Calculated
Upstream Right Over- Bank Slope	Z =	100.00	-	Calculated

2.0 *Calculate Tailwater Depth and Level:*

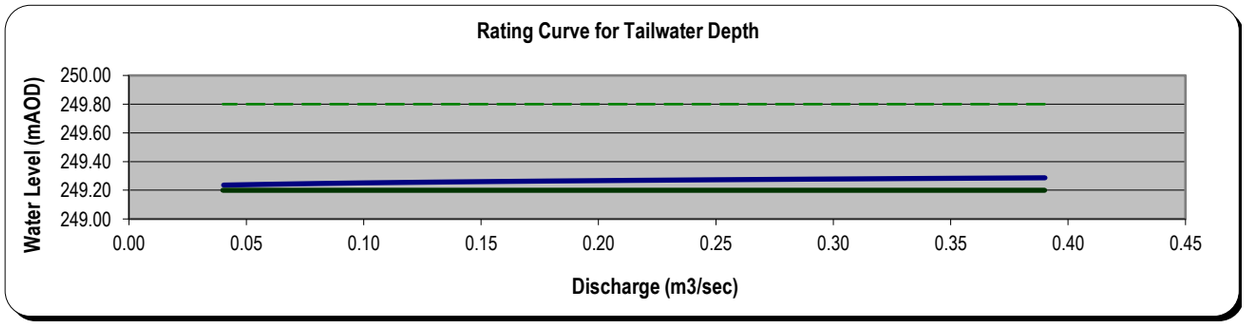
Mannings Equation:

$$Q = VA = \left(\frac{1.00}{n}\right) A R^{\frac{2}{3}} \sqrt{S} \quad [SI] \qquad R_h = \frac{A}{P}$$

Discharge Contained in Channel, Depth of Normal Flow Considered

Depth of water in channel is	y_{dc}	0.09	m	Calculated
Therefore water level at downstream extent of culvert is:	WL_t	249.29	mAOD	Calculated
	V_{dc}	0.41	m/s	Calculated

2.1 Rating Curve for Tailwater Channel Discharge



3.0 *Calculate Tailwater Elevation (Total Head) Ht:*

$$H_t = Z_{bo} + y_{dc} + \frac{V_{dc}^2}{2g}$$

Where: Z_{bo} Elevation @ Culvert Outlet
y_{dc} Water depth in downstream channel
V_{dc} Velocity in downstream channel

Tail... H_t 249.30 mAOD Calculated

4.0 *Calculate Froude No.*

Cross Sectional Area (A)		0.95	m2
Top Width (B)		21.31	m
Hydraulic mean depth (A per unit B)	d_m	0.04	m
Froude Number	Fr	0.63	*Subcritical*
Critical depth in channel	h_c	0.06	m
Critical Velocity	v_c	0.66	m/s

5.0 *Initial Design*

Initial Estimate of required culvert cross sectional area required. Analysis is based on new culvert, therefore design should allow for freeflow conditions. Applicable method is Flow Area Method

5.1 *Flow Area Method - refer to C689 Section 6.7.1*

Depth; Min. Tailwater depth	D	0.09	m	Calculated
Assume 20% Initial loss of culvert height due to Freeboard / Silt		0.11	m	Calculated
where freeboard depth is:	F	0.01	m	Calculated
Area required as per tailwater fllow calculation:	A_t	0.95	m2	Calculated
Nominal width (Area / Depth (not inc. freeboard):		10.91	m	Calculated
Therefore prelim culvert dimensions (incl freeboard + silt	D_i	*0.11*	*m*	Calculated
	B_i	*10.91*	*m*	Calculated

6.0 *Detailed Design*

6.1 *Try Culvert dimensions...*

Based on previous Initial Design

Height / Diameter	D	0.90	m	
Breadth (BLANK IF CIRCULAR)	B		m	
Number of Culverts	nr	1	n/a	
Shape		CIRCULAR		
Freeboard		0.23	m	As per CIRIA Guidance
Siltation / Depth lowered below ex. stream invert		0.00	m	Manually Entered Value

Therefore:

Upstream Pipe Invert		*251.20*	*mAOD*
Upstream Pipe Base (w/Silt)Elevation	Z_i	*251.20*	*mAOD*
Upstream Soffit Elevation		*252.10*	*mAOD*
Downstream Pipe Invert Elevation		*249.20*	*mAOD*
Downstream Pipe Base (w/ Silt) Elevation	Z_o	*249.20*	*mAOD*
Downstream Soffit Elevation		*250.10*	*mAOD*

6.2 *Calculation of Discharge Intensity*

$$q_i = \frac{1.811Q}{A_b D^{0.5}}$$

Where

Discharge	Q	0.39	m3/s
Depth / Diameter of barrell	D	0.90	m
Culvert cross section area excl. freeboard + siltation	Ab	0.51	m2
Discharge Coefficient	qi	1.46	n/a
Discharge intensity classification is:		Free Flow Inlet Control	

6.3 *Calculation of headwater depth for free flow inlet control*

Based on Table A1.3, Culvert type is Nr 20 n/a
i.e, Rectangular concrete, 90˚ headwall; 45˚ bevels

$$\frac{E_{sh}}{D} = \frac{E_{sc}}{D} + k\left[\frac{1.811Q}{A_b D^{0.5}}\right]^M - 0.5S_0 \quad \text{Eqn 6.23}$$

$$\frac{E_{sh}}{D} = k\left[\frac{1.811Q}{A_b D^{0.5}}\right]^M \quad \text{Eqn 6.25}$$

Therefore applicable CIRIA C689 equation reference: Equation 6.25

Where

Discharge	Q	0.39	m3/s	
Depth / Diameter of barrell	D	0.9	m	
Unsubmerged analysis constant	k	0.495		Table A1.3
Unsubmerged analysis constant	M	0.667		Table A1.3
Culvert cross section area excl. freeboard + siltation	Ab	0.51	m2	
Culvert Slope	So	0.10	m/m	1 in 10
Critical depth calculated as:	y_c	0.362	m	
Specific Energy at Critical Depth	E_{sc}	0.54	m	
Therefore Specific Energy of Headwater	E_{sh}	0.57	m	

$$\frac{Q^2 W}{gA^3} = 1$$

$$E_{sc} = \frac{3}{2} y_c$$

6.4 *Calculation of headwater elevation for inlet control*

Headwater Elevation H_{hic} determined by:

$$H_{hic} = Z_i + E_{sh} + h_s$$

Where

oss due to inlet screen	h_s	N/A	(No Screen Proposed)
ream Elevation at Inlet	Z_i	251.20	mAOD
Specific Energy of Headwater	E_{sh}	0.57	m
Therefore Headwater Elevation:	H_{hic}	251.77	mAOD

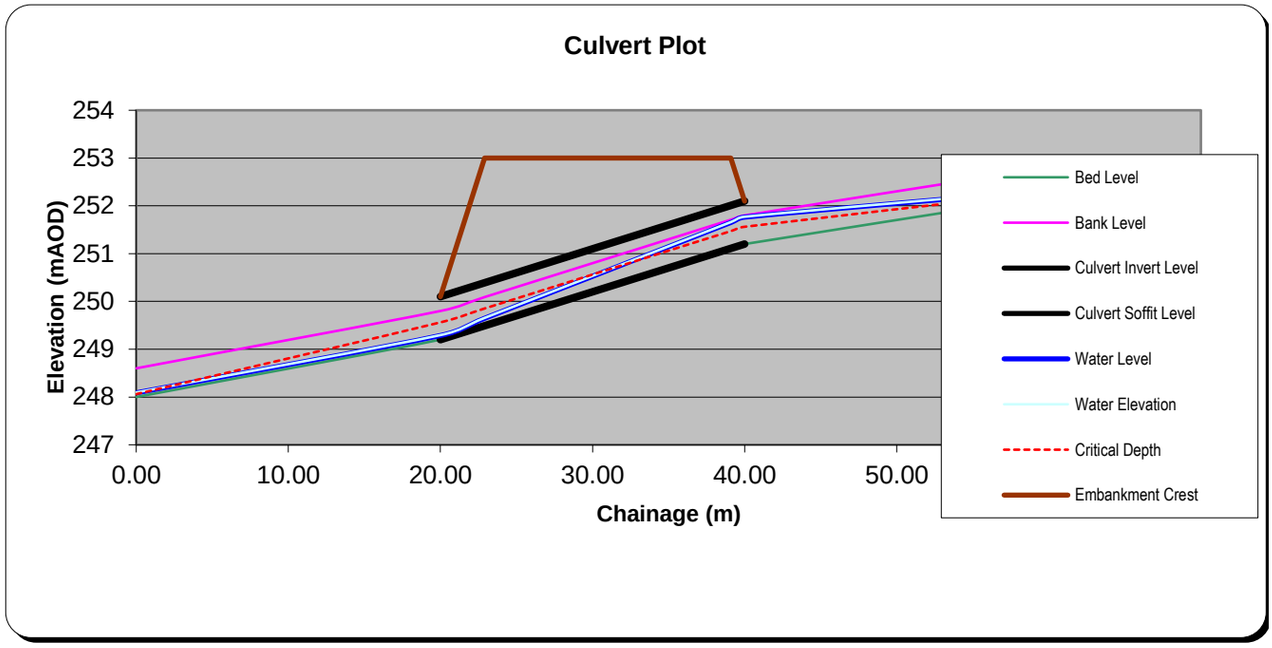
Water Level at the headwater for inlet control WL_{hic} determined by:

$$WL_{hic} = H_{hic} - \frac{V_{uc}^2}{2g}$$

Where

Headwater Elevation:	H_{hic}	251.77	mAOD
elocity in Upstream Channel	V_{uc}	0.41	m/s
Therefore Water Level at Inlet:	WL_{hic}	251.76	mAOD

6.5 *Culvert Profile*



7.0 *Summary*

	Complies	Fails	Comment
Culvert Inlet Soffit Elevation > Headwater Elevation for Inlet Cor	X		
Adequate Freeboard provided to water level?	X		

Therefore proposed culvert dimensions: **1 nr** **Diameter** **0.90 m**

By	Checked	Revision	Date
DH	DKS	Original	30/10/2024

Project	Dunbeg South Ext. Wind Farm
Ref	M01616-31
Date	30/10/2024

Purpose

To determine the adequacy of hydraulic capacity for culverts in accordance with the requirements of CIRIA C689

1.0 *Input Data:*

Culvert Ref:		WX04		
Watercourse Name		Unnamed		
Design Discharge Q		***0.31***	***m3/sec***	As per Hydrological Analysis
Design Return Period		*100+CC*	*Yrs*	As per LA requirement
Elevation of Stream Bed @ Culvert Inlet		253.1	m AOD	from 10m DTM & site obs
Elevation of Stream Bed @ Culvert Outlet		250.9	m AOD	from 10m DTM & site obs
Culvert Length		15	m	from SWMP layout
Elevation of Stream bed upstream of Culvert		254.4	m AOD	from 10m DTM & site obs
Distance upstream of Culvert		38	m	
Elevation of Stream bed downstream of Culvert		249.4	m AOD	from 10m DTM & site obs
Distance downstream of Culvert		10	m	
Elevation of Proposed Embankment Crest		254	m AOD	Est.from on 10m DTM EGL
Average channel invert width		0.5	m	Est from site obs
Average channel top of bank width		0.51	m	Est from site obs
Average Channel Depth to Bank		0.6	m	Est from site obs
Left Over-Bank Ground Level (Floodplain) (Culvert Inlet)		255	m AOD	From 10m DTM
Distance from bank		20	m	
Right Over-Bank Ground Level (Floodplain) (Culvert Inlet)		255	m AOD	From 10m DTM
Distance from bank		20	m	
Mannings n - Channel		0.08		From C689 Table A1.1
Mannings n - Overbanks		0.08		From C689 Table A1.1
Bedslope upstream of Culvert 1 in S1	S1	29.23	-	Calculated
Bedslope downstream of Culvert 1 in S2	S2	6.67	-	Calculated
Bedslope across Culvert 1 in S3	S3	6.82	-	Calculated
Bedslope across whole reach considered 1 in S4	S4	12.60	-	Calculated
Channel Side Slopes 1 in X	X =	0.01	-	Calculated
Upstream Left Over- Bank Slope	Y =	15.38	-	Calculated
Upstream Right Over- Bank Slope	Z =	15.38	-	Calculated

2.0 *Calculate Tailwater Depth and Level:*

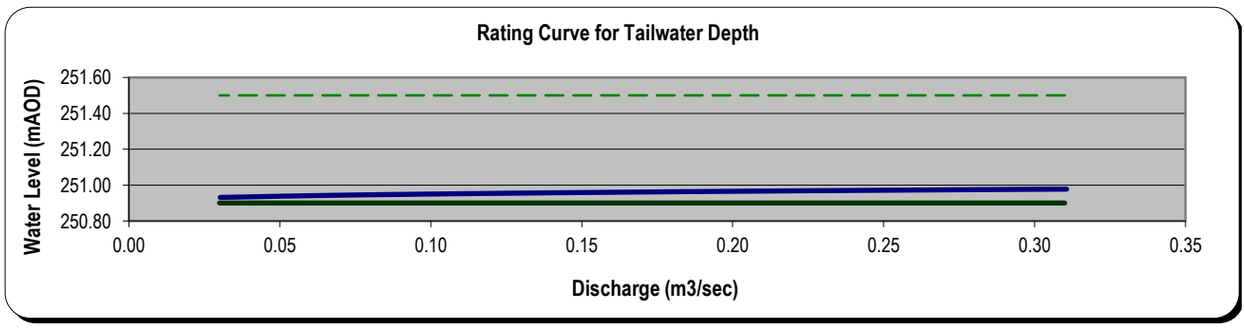
Mannings Equation:

$$Q = VA = \left(\frac{1.00}{n}\right) A R^{\frac{2}{3}} \sqrt{S} \quad [SI] \qquad R_h = \frac{A}{P}$$

Discharge Contained in Channel, Depth of Normal Flow Considered

Depth of water in channel is	y_{dc}	0.08	m	Calculated
Therefore water level at downstream extent of culvert is:	WL_t	250.98	mAOD	Calculated
	V_{dc}	0.41	m/s	Calculated

2.1 Rating Curve for Tailwater Channel Discharge



3.0 *Calculate Tailwater Elevation (Total Head) Ht:*

$$H_t = Z_{bo} + y_{dc} + \frac{V_{dc}^2}{2g}$$

Where: Z_{bo} Elevation @ Culvert Outlet
y_{dc} Water depth in downstream channel
V_{dc} Velocity in downstream channel

Tail... H_t 250.99 mAOD Calculated

4.0 *Calculate Froude No.*

Cross Sectional Area (A)		0.76	m2
Top Width (B)		19.08	m
Hydraulic mean depth (A per unit B)	d_m	0.04	m
Froude Number	Fr	0.66	*Subcritical*
Critical depth in channel	h_c	0.05	m
Critical Velocity	v_c	0.62	m/s

5.0 *Initial Design*

Initial Estimate of required culvert cross sectional area required. Analysis is based on new culvert, therefore design should allow for freeflow conditions. Applicable method is Flow Area Method

5.1 *Flow Area Method - refer to C689 Section 6.7.1*

Depth; Min. Tailwater depth	D	0.08	m	Calculated
Assume 20% Initial loss of culvert height due to Freeboard / Silt		0.10	m	Calculated
where freeboard depth is:	F	0.01	m	Calculated
Area required as per tailwater fllow calculation:	A_t	0.76	m2	Calculated
Nominal width (Area / Depth (not inc. freeboard):		9.79	m	Calculated
Therefore prelim culvert dimensions (incl freeboard + silt	D_i	*0.10*	*m*	Calculated
	B_i	*9.79*	*m*	Calculated

6.0 *Detailed Design*

6.1 *Try Culvert dimensions...*

Based on previous Initial Design

Height / Diameter	D	0.75	m	
Breadth (BLANK IF CIRCULAR)	B		m	
Number of Culverts	nr	1	n/a	
Shape		CIRCULAR		
Freeboard		0.19	m	As per CIRIA Guidance
Siltation / Depth lowered below ex. stream invert		0.00	m	Manually Entered Value

Therefore:

Upstream Pipe Invert		*253.10*	*mAOD*
Upstream Pipe Base (w/Silt)Elevation	Z_i	*253.10*	*mAOD*
Upstream Soffit Elevation		*253.85*	*mAOD*
Downstream Pipe Invert Elevation		*250.90*	*mAOD*
Downstream Pipe Base (w/ Silt) Elevation	Z_o	*250.90*	*mAOD*
Downstream Soffit Elevation		*251.65*	*mAOD*

6.2 *Calculation of Discharge Intensity*

$$q_i = \frac{1.811Q}{A_b D^{0.5}}$$

Where

Discharge	Q	0.31	m3/s
Depth / Diameter of barrell	D	0.75	m
Culvert cross section area excl. freeboard + siltation	Ab	0.36	m2
Discharge Coefficient	qi	1.83	n/a
Discharge intensity classification is:		Free Flow Inlet Control	

6.3 *Calculation of headwater depth for free flow inlet control*

Based on Table A1.3, Culvert type is Nr 20 n/a
i.e, Rectangular concrete, 90˚ headwall; 45˚ bevels

$$\frac{E_{sh}}{D} = \frac{E_{sc}}{D} + k\left[\frac{1.811Q}{A_b D^{0.5}}\right]^M - 0.5S_0 \quad \text{Eqn 6.23}$$

$$\frac{E_{sh}}{D} = k\left[\frac{1.811Q}{A_b D^{0.5}}\right]^M \quad \text{Eqn 6.25}$$

Therefore applicable CIRIA C689 equation reference: Equation 6.25

Where

Discharge	Q	0.31	m3/s	
Depth / Diameter of barrell	D	0.75	m	
Unsubmerged analysis constant	k	0.495		Table A1.3
Unsubmerged analysis constant	M	0.667		Table A1.3
Culvert cross section area excl. freeboard + siltation	Ab	0.36	m2	
Culvert Slope	So	0.15	m/m	1 in 6.82
Critical depth calculated as:	y_c	0.339	m	
Specific Energy at Critical Depth	E_{sc}	0.51	m	
Therefore Specific Energy of Headwater	E_{sh}	0.55	m	

$$\frac{Q^2 W}{gA^3} = 1$$

$$E_{sc} = \frac{3}{2} y_c$$

6.4 *Calculation of headwater elevation for inlet control*

Headwater Elevation H_{hic} determined by:

$$H_{hic} = Z_i + E_{sh} + h_s$$

Where

oss due to inlet screen	h_s	N/A	(No Screen Proposed)
ream Elevation at Inlet	Z_i	253.10	mAOD
Specific Energy of Headwater	E_{sh}	0.55	m
Therefore Headwater Elevation:	H_{hic}	253.65	mAOD

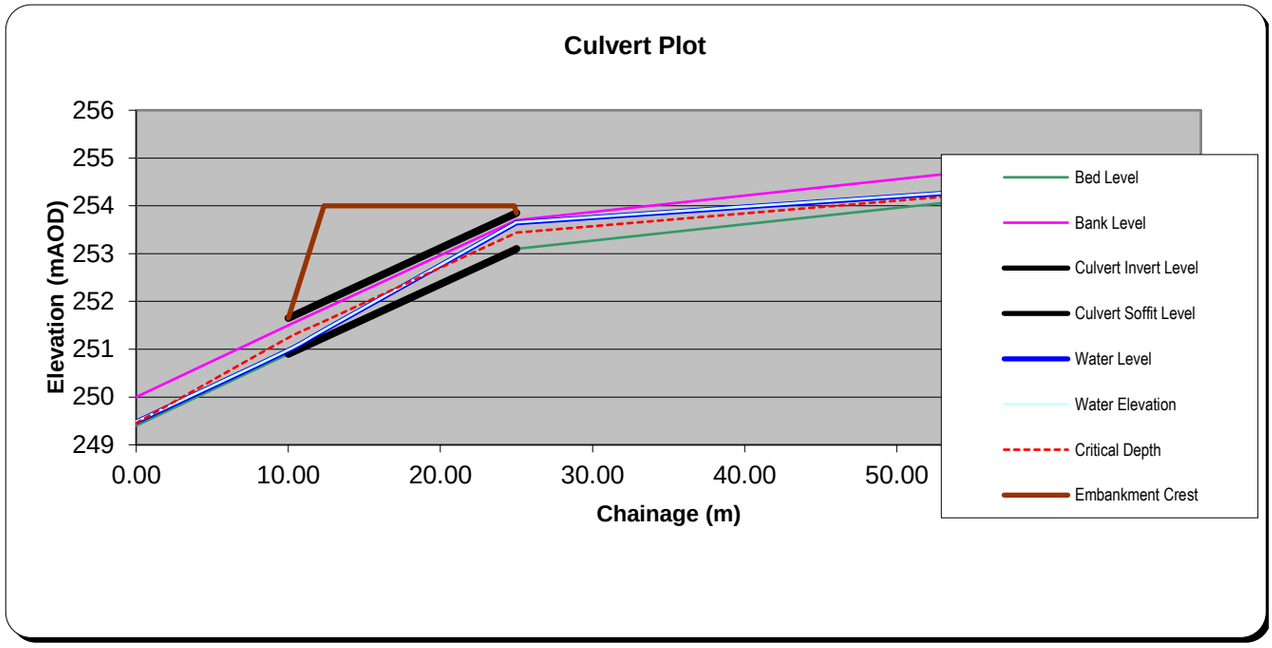
Water Level at the headwater for inlet control WL_{hic} determined by:

$$WL_{hic} = H_{hic} - \frac{V_{uc}^2}{2g}$$

Where

Headwater Elevation:	H_{hic}	253.65	mAOD
elocity in Upstream Channel	V_{uc}	0.41	m/s
Therefore Water Level at Inlet:	WL_{hic}	253.65	mAOD

6.5 *Culvert Profile*



7.0 *Summary*

	Complies	Fails	Comment
Culvert Inlet Soffit Elevation > Headwater Elevation for Inlet Cor	X		
Adequate Freeboard provided to water level?	X		

Therefore proposed culvert dimensions: **1 nr** **Diameter** **0.75 m**

By	Checked	Revision	Date
DH	DKS	Original	30/10/2024