

Appendix 10

Hydrology, Geology and Hydrogeological Assessment

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A10.1 WATERCOURSE CROSSING ASSESSMENT

Introduction

A10.1.1 This appendix fulfils the requirements for a Watercourse Crossings Assessment at Y Bryn Wind Farm (the proposed development) as part of Chapter 10 of the Environmental Statement (ES). The purpose of this document is to provide the relevant information associated with the watercourse crossings required as part of the proposed development and to assist in the identification of regulatory licensing requirements. It is recommended that all the watercourse crossings are designed to maintain hydrology as well as, where necessary, allowing the free passage of mammals and aquatic species.

Regulatory Legislation

- A10.1.2 All watercourses within the proposed development are classed as ordinary watercourses, which are defined as a watercourse that is not a main river, and includes rivers, streams, drains and ditches, and passages through which water flows.
- A10.1.3 Under the requirements of the Land Drainage Act 1991, as amended by the Flood and Water Management Act 2010, all structures, including culverts, will require an Ordinary Watercourse Consent.
- A10.1.4 The information presented in this document is only intended to act as a guide. The actual design, construction and/or improvements to the crossings during construction will be the responsibility of the appointed contractor. Application for an Ordinary Watercourse Consent will also be made to the Lead Local Flood Authority (LLFA), likely to be Neath Port Talbot County Borough Council prior to construction.
- A10.1.5 This document relates to watercourses that have been identified from the 1:10,000, 1:25,000 and 1:50,000 scale OS mapping. Additional crossings will be required where the access track crosses anthropogenic features such as forestry drains and furrows. As these are minor features where no flow was observed during any site inspection, these would be culverted with the use of appropriately sized circular culverts.

There are at least a minimum of 60 existing road drainage culverts associated with the existing access track. As part of the detailed design these will all require condition assessment and consideration for being replaced as required as a result of poor condition and/or being undersized. These crossings are not considered in this Appendix however the importance of correctly assessing these are understood, The Local Authority will be consulted with the hope that these culverts can be agreed under bulk application post consent.

Limitations of Report

A10.1.6 This report should be considered live, and as such, changes will be made should new information come to light. Natural Power has endeavoured to identify the watercourse crossings required as part of the construction associated with the proposed development. However, it is possible additional watercourse crossings, which do not feature on either the Ordnance Survey (OS) mapping or were not encountered during the site visit will be identified within the proposed

development area. Should the construction process identify additional crossings then these should be surveyed, and due consideration given to the legislation above to ensure compliance.

Methodology

Desk Study

A10.1.7 The desk study consisted of a review of the information regarding the proposed development, principally involving an examination of the track layout and the identification of watercourses which will require crossings, including those marked on the 1:10,000 and 1:25,000 scale OS maps.

Site Visit

- A10.1.8 Following the desk study, a survey of the identified crossings was undertaken to obtain information specific to each watercourse. Photographs and detailed field notes were taken, reporting the dimensions of the watercourse channel and flood channel (where apparent), the type of substrate and the crossing type.
- A10.1.9 Watercourse surveys were undertaken in November and December 2021 and April 2022. The surveying was undertaken below cloud level with regular rain showers.
- A10.1.10 A plan indicating the site boundary and survey points is illustrated in Figure 10.1 of the ES – Hydrology Overview in Volume 2 of the ES.

Water Crossing Selection Criteria

- A10.1.11 The design process adopted for each watercourse crossing is complex, taking account of a range of design criteria and constraints to develop the most appropriate crossing for each watercourse. The primary technical standards driving the design of culverts are Design Manual for Roads and Bridges (DMRB) HA107/04 Design of Outfall and Culvert Details (2004) and the Construction Industry Research and Information Association (CIRIA) Culvert design and operation guide (C689) (2010). However, in addition to these technical standards, there are other site-specific drivers that influence the culvert design which include: flood risk; maintenance requirements; ecological considerations; and geomorphological considerations; among others.
- A10.1.12 The design process for each watercourse crossing is iterative, such that the final design meets the fundamental design standard; which is that the proposed development remains free from flooding during the design flood event whilst maintaining adequate freeboard (typically 600 mm) and flood risk is not compromised elsewhere.

Watercourse Crossing Assessment Summary

A10.1.13 Thirteen watercourse crossings are identified for the proposed access tracks for Y Bryn Wind Farm and are summarised in Table A10.1. As previously indicated, the installation of new and upgrade of the existing crossings will be subject to an Ordinary Watercourse Consent under the requirements of the Land Drainage Act 1991, as amended by the Flood and Water Management Act 2010.

Table A10.1: Summary of watercourse crossing types

ID	Easting	Northing	Type	Proposed Crossing Type
WX1	278788	187757	Existing	Circular Culvert
WX2	279674	188596	Existing	Circular Culvert
WX3	279821	188758	Existing	Circular Culvert
WX4	281396	189361	Existing	Circular Culvert
WX5	281480	189267	Existing	Circular Culvert
WX6	282325	189025	Existing	Circular Culvert
WX7	282739	189822	Existing	Circular Culvert
WX8	282582	190547	Existing	Circular Culvert
WX9	282540	190541	Existing	Circular Culvert
WX10	282946	190704	Existing	Circular Culvert
WX11	282977	190771	Existing	Circular Culvert
WX12	283594	191535	Existing	Circular Culvert
WX13	283686	193024	New	Circular Culvert

Source: Natural Power

A10.1.14 The location of the watercourse crossings in relation to the proposed infrastructure is provided in Figure 10.1 Hydrology Overview. More detailed information on the watercourse crossings is provided in later in this appendix and includes photographs and hydromorphological information associated with each crossing.

Rationale and Design

A10.1.15 The design of the proposed track layout has been optimised as far as possible to make use of existing tracks, to reduce the total area of land take (by minimising required earthworks) and to minimise the number of watercourse crossings, whilst accommodating other environmental or engineering related constraints. At each watercourse crossing location, consideration has been given to the nature and size of the crossing, fluvial scour and environmental requirements.

A10.1.16 Post consent following the completion of detailed site investigation and micro-siting, a revised version of this assessment should be produced to estimate peak flows in the watercourses for which flows need to be accommodated to ensure that any potential risk to flooding is minimised. These estimated peak flows will help inform the detailed design considerations required for each of the identified crossing locations. An indication of the required sizing for crossing dimensions would also be provided.

A10.1.17 In designing the watercourse crossings, industry good practice will be applied, ensuring that various conditions will be considered during the works, and which are summarised below:

- All watercourses, over which the access road crosses, will be routed through circular culverts, bottomless arch culverts or under bridges appropriately sized and designed not to impede the flow of water. Safe passage for wildlife, such as fish, water voles, otters etc. will also be considered in the design through increased capacity of culvert or separate mammal crossing (pipe);

- When constructing culverts, the appointed contractor takes care to ensure that the construction does not pose a permanent obstruction to migrating species of fish, or riparian mammals;
- Culvert design will be engineered to ensure that the invert can be sunk into the bed of the watercourse allowing riverine substrate to stabilise on the floor of the culvert;
- Watercourse crossing designed to convey a minimum of 1 in 100 years plus climate change return period flood events, and individually sized and designed to suit the specific requirements and constraints of its location; and
- All watercourse crossings to include splash boards and run-off diversion measures to prevent any direct siltation of watercourses.

A10.1.18 Erosion protection will be implemented at the outfall of all culverts. Where required, the type of erosion protection would depend on a number of factors including:

- Flow;
- Velocity;
- Channel bed material;
- Vegetation;
- The effects/consequences of erosion; and
- Types of erosion protection including:
 - Geotextile bank reinforcement;
 - Vegetation solution;
 - Dumped stone;
 - Laid stone (Rip-rap or equivalent); and
 - Concrete block systems.

A10.1.19 The appointed construction contractor will adhere to the following principles for culvert design and construction:

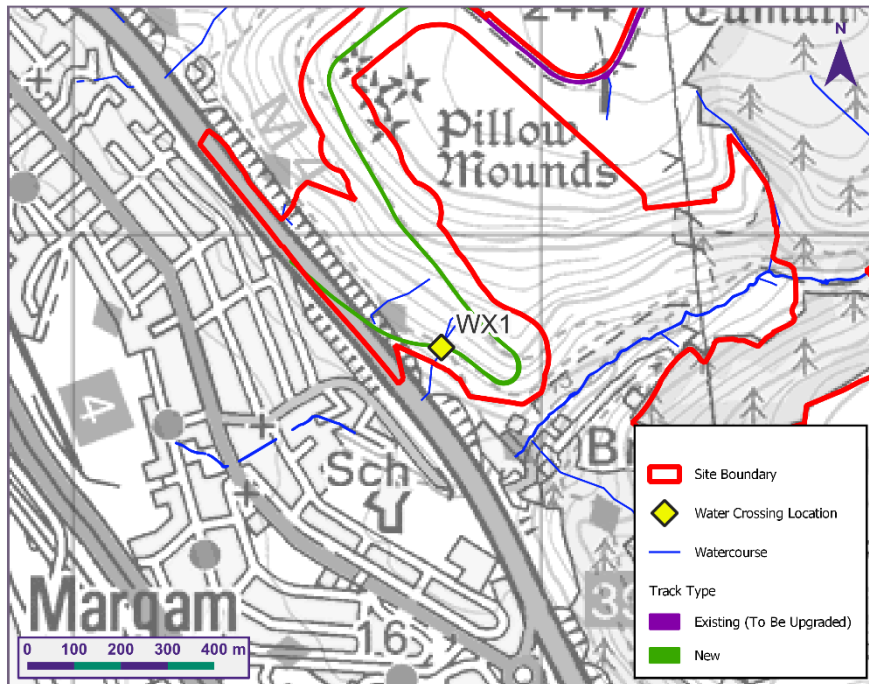
- Where appropriate, the natural low flow depths are maintained through culvert base;
- The culvert base should be buried below the natural bed level to allow for a naturalised culvert bed to be maintained during scour associated with high flow events;
- The culvert should be at least the same width as the natural active channel width, with consideration to low flows and channel migration;
- Culvert alignment should match alignment of the watercourse i.e., in a parallel direction to flow;
- The slope of the culvert base should be similar to that of the bed of the watercourse;
- The culvert must not present a barrier by creating a step or hydraulic drop at the culvert inlet or outlet;
- The culvert must be designed not to exacerbate or create flooding;
- A natural stone headwall should be provided upstream and downstream to protect the road embankment where necessary;

- Culverts should not be constructed under high flow conditions; and
- A mammal tunnel should be provided where considered appropriate by the Environmental Clerk of Works (ECoW), so that no restriction is related to established animal movement routes.

Detailed Crossing Assessment

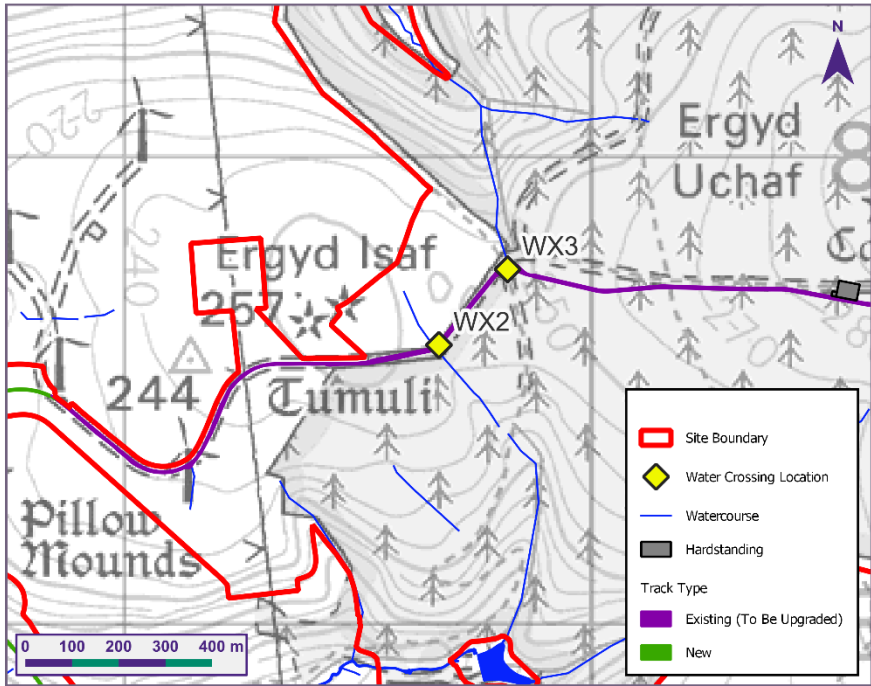
A10.1.20 Tables A10.2 to A10.14 provide information on the new and existing watercourse crossings outlined in Table A10.1.

Table A10.2: Crossing WX1

WX1 (281396, 189361)		
Crossing Location	Crossing Description	
	- Existing Crossing: Yes - Crossing Type (existing): Circular Culvert - Crossing Material (existing): Plastic - Crossing Condition (existing): Average - Channel Type: Incised - Gradient: Moderate - Valley form: Shallow vee - Bank condition: Stable - Bed material: Fine sand/silt, Coarse gravel, Boulders - Riparian corridor: Heavily Vegetated (e.g., gorse, bramble), Agricultural Grazing - Flow condition: Slow Culvert Dimensions (m): 0.45 Water width (m): 0.5 Water depth (m): 0.05-0.1 Bankfull width (m): 1 Bankfull height (m): 0.5 Note: Plastic culvert on upstream of track is at least half full of silt. Heavily vegetated upstream with brambles, gorse and willow. Sparse gorse, bramble, nettles and bracken on downstream side of track.	
Crossing Photographs		
Upstream	Across	Downstream
		

Source: Natural Power

Table A10.3: Crossing WX2

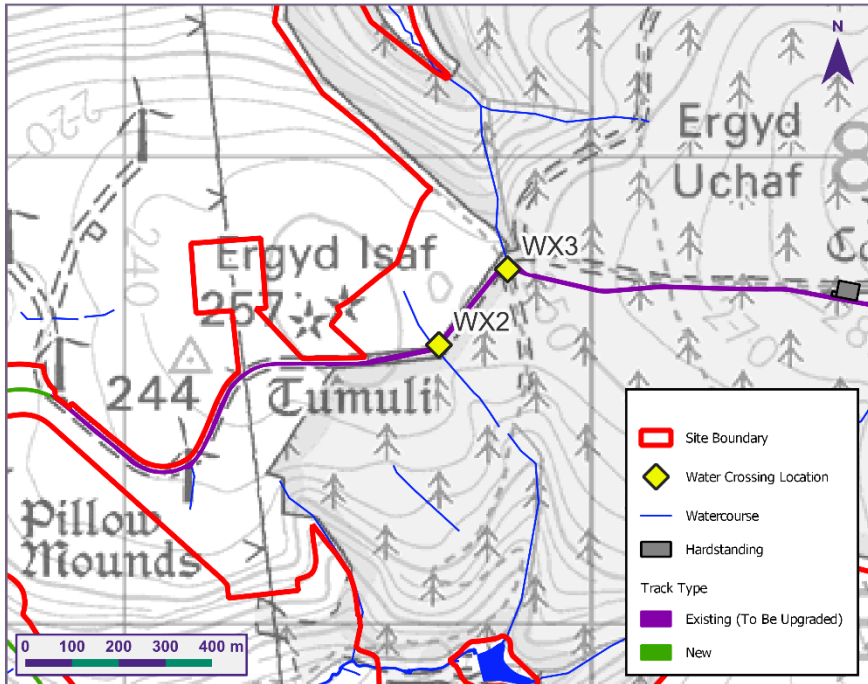
WX2 (279674, 188596)		
Crossing Location	Crossing Description	
	- Existing Crossing: Yes - Crossing Type (existing): Circular Culvert - Crossing Material (existing): Plastic - Crossing Condition (existing): Excellent - Channel Type: Poorly defined - Gradient: Gentle - Valley form: Shallow vee - Bank condition: Stable - Bed material: Vegetation, Soil, Peat - Riparian corridor: Heavily Vegetated (e.g., gorse, bramble), Agricultural Grazing, Productive Forestry - Flow condition: Dry Culvert Dimensions (m): 0.62 Water width (m): 0.3 Water depth (m): 0 Bankfull width (m): 4.0 Bankfull height (m): 0.5 Note: Up to 6 m wide upstream in field, likely braided and more of a marsh than a channel. More defined channel downstream.	

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Crossing Photographs		
Upstream	Across	Downstream
		

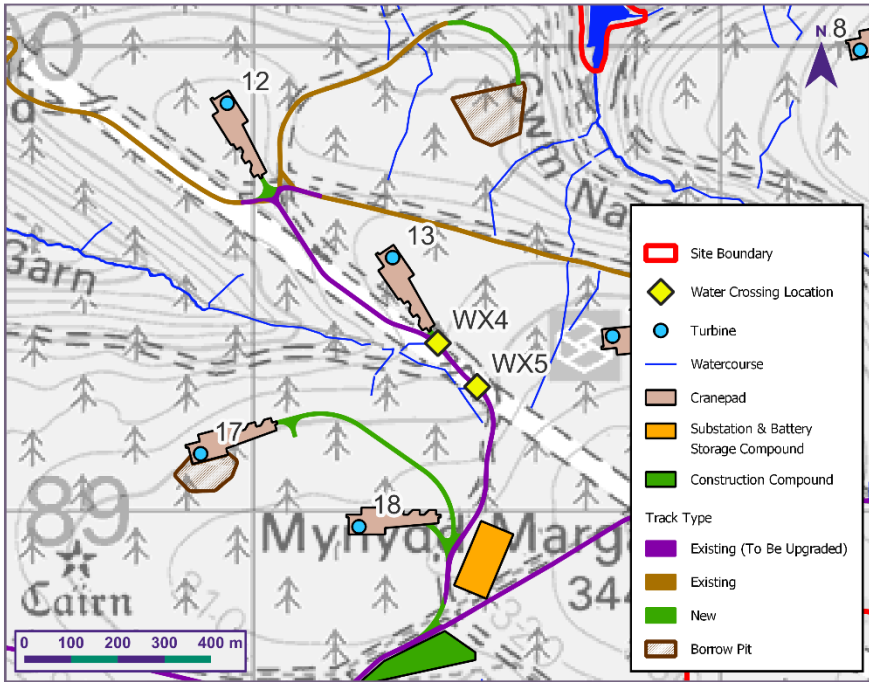
Source: Natural Power

Table A10.4: Crossing WX3

WX3 (279821, 188758)		
Crossing Location	Crossing Description	
 © Crown Copyright 2023. All rights reserved. Ordnance Survey Licence 0100031673.	- Existing Crossing: Yes - Crossing Type (existing): Circular Culvert - Crossing Material (existing): Plastic - Crossing Condition (existing): Good - Channel Type: Incised - Gradient: Moderate - Valley form: Deep vee, Shallow vee - Bank condition: Stable - Bed material: Vegetation, Fine sand/silt - Riparian corridor: Heavily Vegetated (e.g., gorse, bramble), Agricultural Grazing, Productive Forestry - Flow condition: Stagnant Culvert Dimensions (m): 0.8 Water width (m): 1.0 Water depth (m): 0 Bankfull width (m): 2.0 Bankfull height (m): 0.5 Note: very close to watershed. Too heavily vegetated by brambles for accurate channel measurements.	
Crossing Photographs		
Upstream	Across	Downstream
		

Source: Natural Power

Table A10.5: Crossing WX4

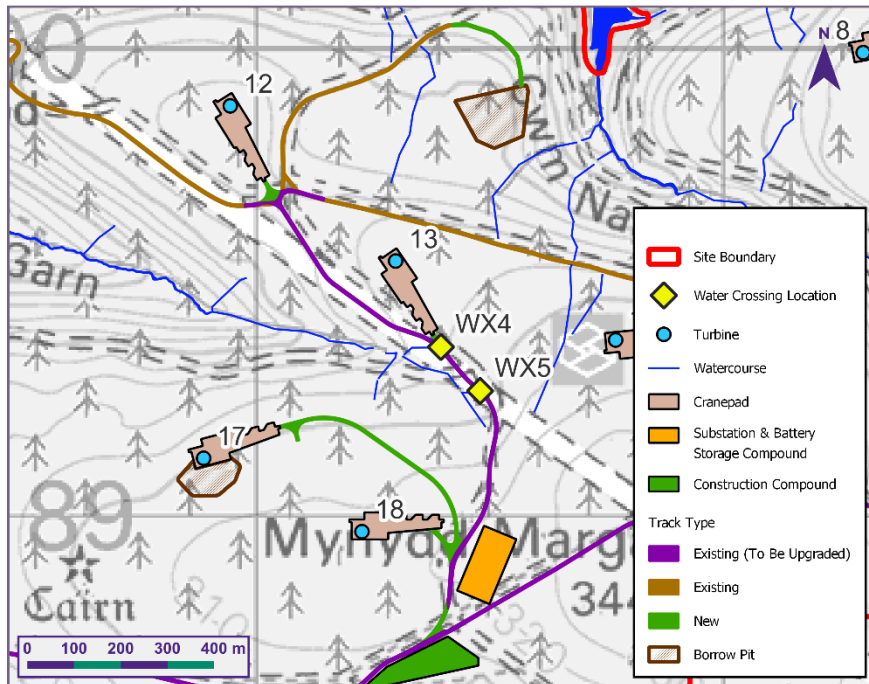
WX4 (281396, 189361)		
Crossing Location	Crossing Description	
	- Existing Crossing: Yes - Crossing Type (existing): Circular Culvert - Crossing Material (existing): Concrete - Crossing Condition (existing): Good - Channel Type: Incised - Gradient: Gentle - Valley form: No obvious valley sides - Bank condition: Stable - Bed material: Fine sand/silt, Coarse gravel, Boulders - Riparian corridor: Heavily Vegetated (e.g., gorse, bramble), Productive Forestry, Natural Woodland - Flow condition: Slow Culvert Dimensions (m): 0.4 Water width (m): 0.2 - 0.4 Water depth (m): 0.05 Bankfull width (m): 2.0 Bankfull height (m): 1.2 Note: Upper reaches of watercourse, lots of brambles and vegetation around watercourse at crossing. Existing crossing in good condition in such that there appears to be no restriction to flow and or obvious degradation to the structure.	

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Crossing Photographs		
Upstream	Across	Downstream
		

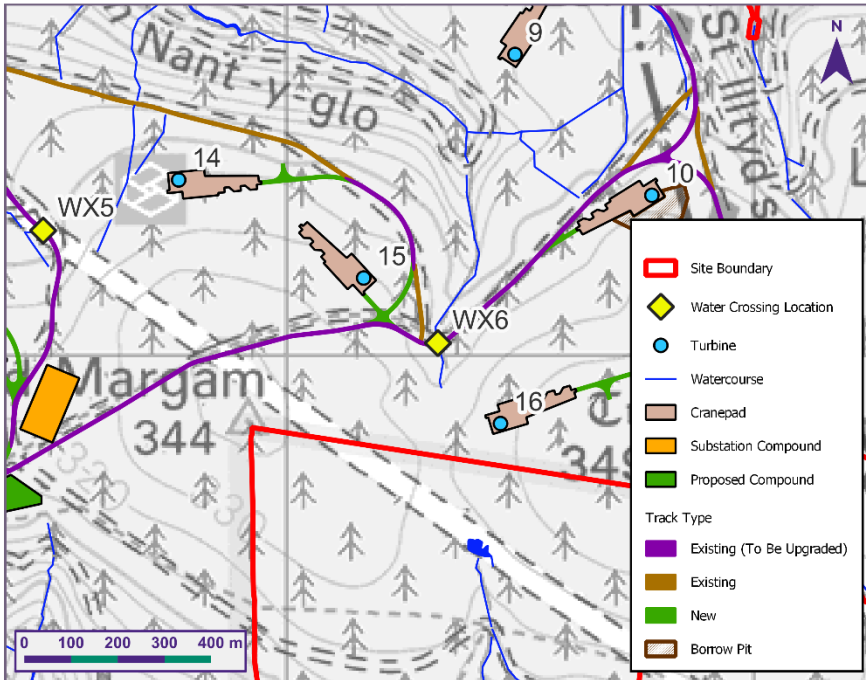
Source: Natural Power

Table A10.6: Crossing WX5

WX5 (281480, 189267)		
Crossing Location	Crossing Description	
	• Existing Crossing: Yes • Crossing Type (existing): Circular Culvert • Crossing Material (existing): Concrete • Crossing Condition (existing): Good • Channel Type: Artificial drainage channel • Gradient: Gentle • Valley form: No obvious valley sides • Bank condition: Stable • Bed material: Vegetation • Riparian corridor: Productive Forestry, Moorland, Heavily Vegetated (e.g., gorse, bramble) • Flow condition: Stagnant • Culvert Dimensions (m): 0.4 m • Water width (m): N/A • Water depth (m): N/A • Bankfull width (m): N/A • Bankfull height (m): N/A Note: This does not exist as a natural water crossing with the watercourse starting downstream of the track. Presumably to allow the upstream catchment to drain now there is a track in place an artificial roadside ditch and culvert have been put in place. Road is in very good condition and wide.	
Crossing Photographs		
Upstream	Across	Downstream
		

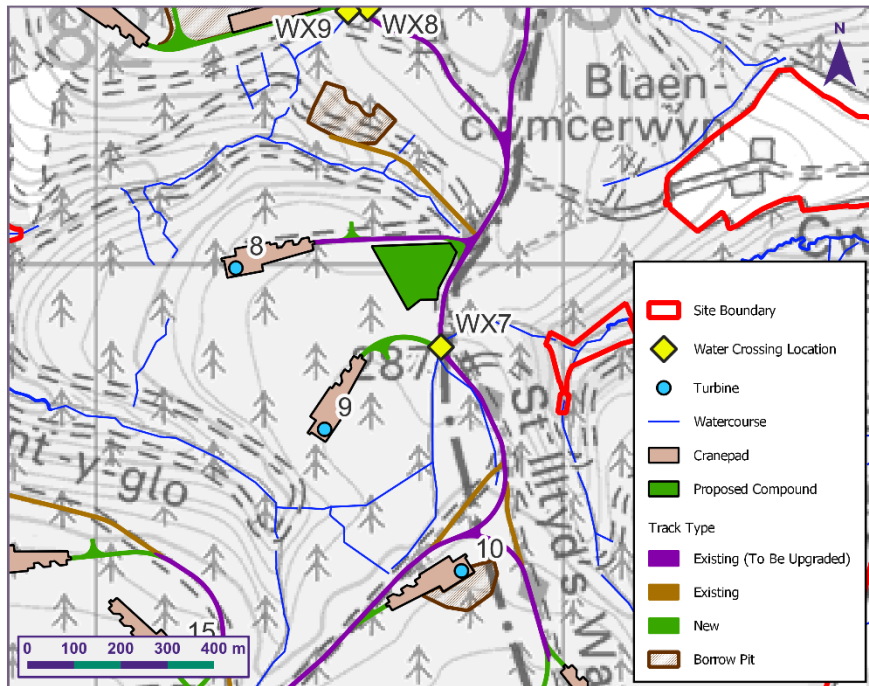
Source: Natural Power

Table A10.7: Crossing WX6

WX6 (282325, 189025)		
Crossing Location	Crossing Description	
 © Crown Copyright 2023. All rights reserved. Ordnance Survey Licence 0100031673.	• Existing Crossing: Yes • Crossing Type (existing): Circular Culvert • Crossing Material (existing): Concrete • Crossing Condition (existing): Good • Channel Type: Incised • Gradient: Moderate • Valley form: Shallow vee, Asymmetrical • Bank condition: Stable • Bed material: Fine sand/silt, Coarse gravel, Boulders • Riparian corridor: Heavily Vegetated (e.g., gorse, bramble), Productive Forestry, Natural Woodland • Flow condition: Moderate • Culvert Dimensions (m): 0.9 m • Water width (m): 0.3 - 0.8 • Water depth (m): 0.05 - 0.1 • Bankfull width (m): 4.0 • Bankfull height (m): 1.0 - 1.5 • Flooded Bankfull width (m): 4.0 Note: Existing wide crossing in what appears to be good condition. Channel deeper and narrower upstream of crossing.	
Crossing Photographs		
Upstream	Across	Downstream
		

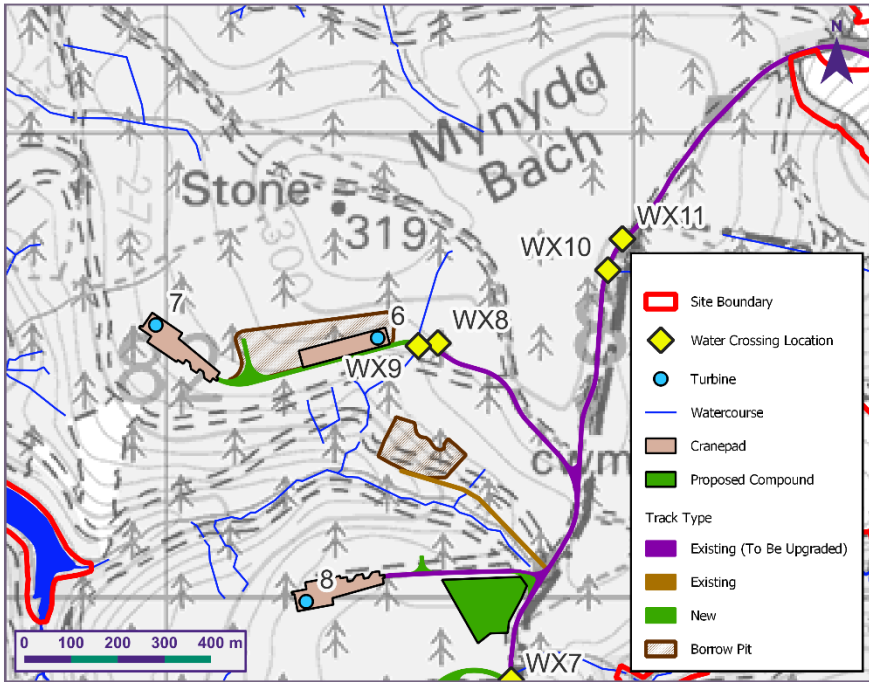
Source: Natural Power

Table A10.8: Crossing WX7

WX7 (282739, 189822)		
Crossing Location	Crossing Description	
 © Crown Copyright 2023. All rights reserved. Ordnance Survey Licence 0100031673.	- Existing Crossing: Yes - Crossing Type (existing): Circular Culvert - Crossing Material (existing): Concrete - Crossing Condition (existing): Good - Channel Type: Incised - Gradient: Moderate - Valley form: Shallow vee - Bank condition: Stable - Bed material: Fine sand/silt, Coarse gravel, Boulders - Riparian corridor: Natural Woodland, Productive Forestry - Flow condition: Moderate - Culvert Dimensions (m): 0.9 m - Water width (m): 1.5 - 2.0 - Water depth (m): 0.05 - 0.4 - Bankfull width (m): 2.2 - Bankfull height (m): 1.0 Note: Although not so close to the break in slope, this crossing is similar to WX7 near the edge of the plateau. Older concrete culvert but in good condition with well-maintained wide road in place. Old, engineered dam to slow flow before culvert entrance.	
Crossing Photographs		
Upstream	Across	Downstream
		

Source: Natural Power

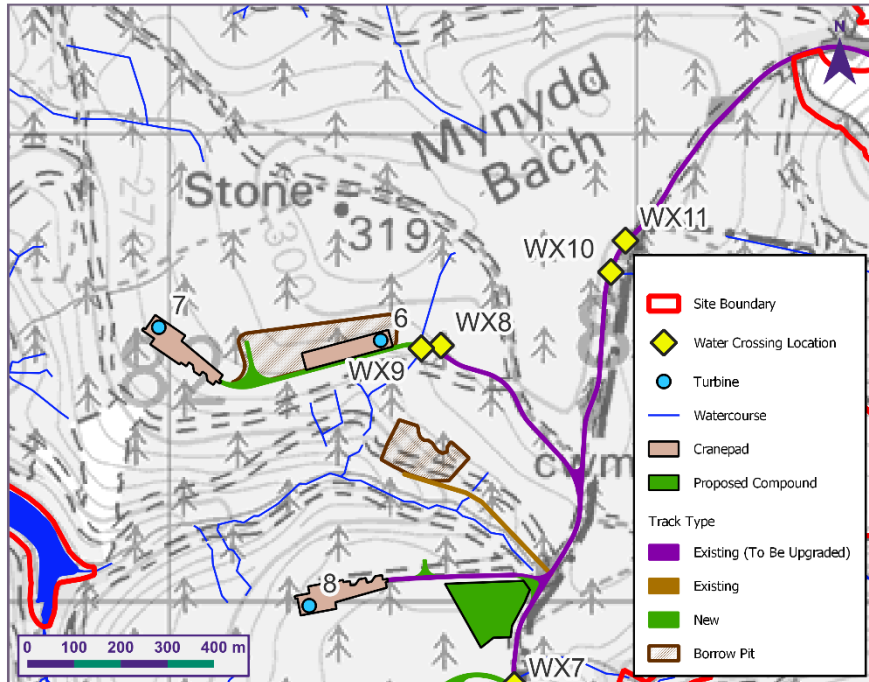
Table A10.9: Crossing WX8

WX8 (282582, 190547)		
Crossing Location	Crossing Description	
	• Existing Crossing: Yes • Crossing Type (existing): Circular Culvert • Crossing Material (existing): Plastic • Crossing Condition (existing): Good • Channel Type: Incised • Gradient: Moderate • Valley form: Shallow vee • Bank condition: Stable • Bed material: Fine sand/silt, Coarse gravel, Boulders • Riparian corridor: Productive Forestry • Flow condition: Moderate	
	• Culvert Dimensions (m): 0.6 • Water width (m): 0.3 - 2.7 • Water depth (m): 0.05 - 0.2 • Bankfull width (m): 1.4 - 4.0 • Bankfull height (m): 1.0 - 1.7 Note: Water crossing in good condition in place with evidence of recent upgrading and engineering (old, discarded culverts, unvegetated verges). Wide road in good condition. Larger channel widths and depths are from dug out pool area at entrance to culvert. Generally, 0.05 m depth, 0.4 m width. Note that WX9 is an almost identical crossing, ~30 m west.	

Crossing Photographs		
Upstream	Across	Downstream
		

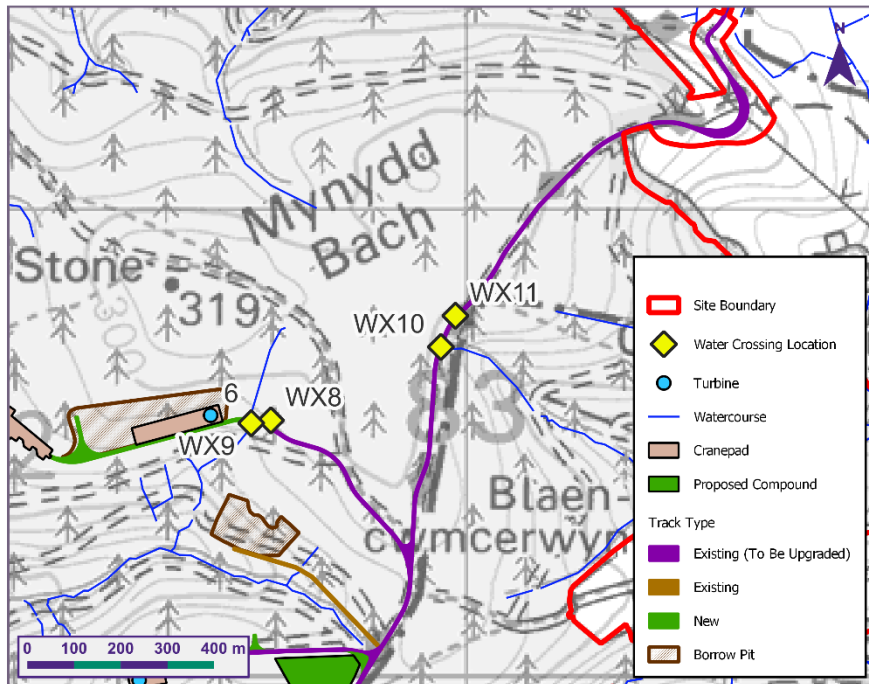
Source: Natural Power

Table A10.10: Crossing WX9

WX9 (282540, 190541)		
Crossing Location	Crossing Description	
	• Existing Crossing: Yes • Crossing Type (existing): Circular Culvert • Crossing Material (existing): Plastic • Crossing Condition (existing): Good • Channel Type: Incised • Gradient: Moderate • Valley form: Shallow vee • Bank condition: Stable • Bed material: Fine sand/silt, Coarse gravel, Boulders • Riparian corridor: Productive Forestry • Flow condition: Moderate • Culvert Dimensions (m): 0.6 m • Water width (m): 0.3 - 2.7 • Water depth (m): 0.05 - 0.45 • Bankfull width (m): 1.4 - 4.0 • Bankfull height (m): 1.0 - 1.7 Note: Water crossing in good condition in place with evidence of recent upgrading and engineering (old, discarded culverts, unvegetated verges). Wide road in good condition. Larger channel widths and depths are from dug out pool area at entrance to culvert. Generally, 0.05 m depth, 0.4 m width. Note that WX8 is an almost identical crossing, ~30 m east.	
Crossing Photographs		
Upstream	Across	Downstream
		

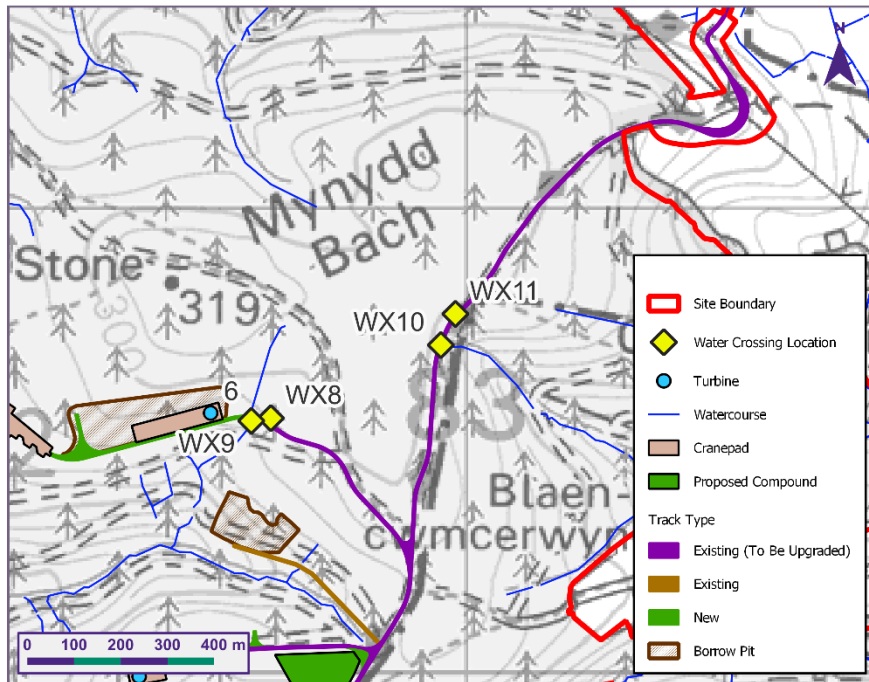
Source: Natural Power

Table A10.11: Crossing WX10

WX10 (282946, 190704)				
Crossing Location	Crossing Description			
	• Existing Crossing: Yes • Crossing Type (existing): Circular Culvert • Crossing Material (existing): Plastic • Crossing Condition (existing): Good • Channel Type: Incised • Gradient: Gentle • Valley form: No obvious valley sides (upstream), Deep vee (downstream), Gorge (downstream) • Bank condition: Stable • Bed material: Fine sand/silt, Coarse gravel, Boulders • Riparian corridor: Natural Woodland, Productive Forestry • Flow condition: Slow			
• Culvert Dimensions (m): 0.45 • Water width (m): 0.3 - 0.8 • Water depth (m): 0.15 • Bankfull width (m): 1.7 • Bankfull height (m): 1.0 Note: Wide track in good condition at existing crossing. Crossing sits at the edge of the sedimentary plateau, so is very flat upstream, and within 3 m downstream drops into a very steep sided vee valley or gorge. Note that WX11 is a very similar crossing, ~50 m north.				
Crossing Photographs				
Upstream	Across	Downstream		
				

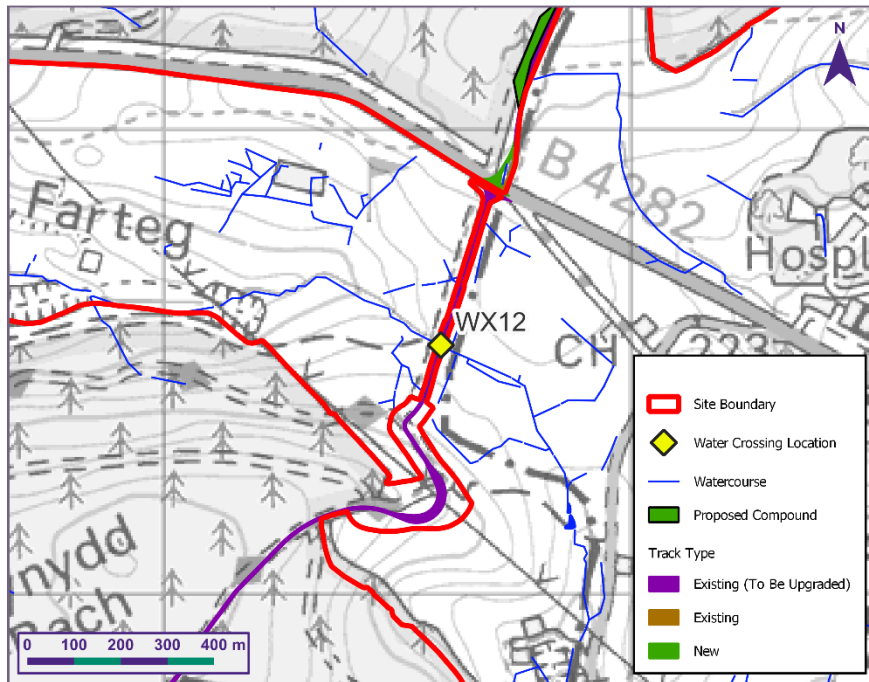
Source: Natural Power

Table A10.12: Crossing WX11

WX11 (282977, 190771)		
Crossing Location	Crossing Description	
 © Crown Copyright 2023. All rights reserved. Ordnance Survey Licence 0100031673.	- Existing Crossing: Yes - Crossing Type (existing): Circular Culvert - Crossing Material (existing): Plastic - Crossing Condition (existing): Good - Channel Type: Incised - Gradient: Gentle - Valley form: No obvious valley sides (upstream), Deep vee (downstream), Gorge (downstream) - Bank condition: Stable - Bed material: Fine sand/silt, Coarse gravel, Boulders - Riparian corridor: Natural Woodland, Productive Forestry - Flow condition: Slow - Culvert Dimensions (m): 0.45 - Water width (m): 0.3 - 0.8 - Water depth (m): 0.15 - Bankfull width (m): 1.7 - Bankfull height (m): 1.0 Note: Wide track in good condition at existing crossing. Crossing sits at the edge of the sedimentary plateau, so is very flat upstream, and within 3 m downstream drops into a very steep sided vee valley or gorge. Note that WX10 is a very similar crossing, ~50 m south.	
Crossing Photographs		
Upstream	Across	Downstream
		

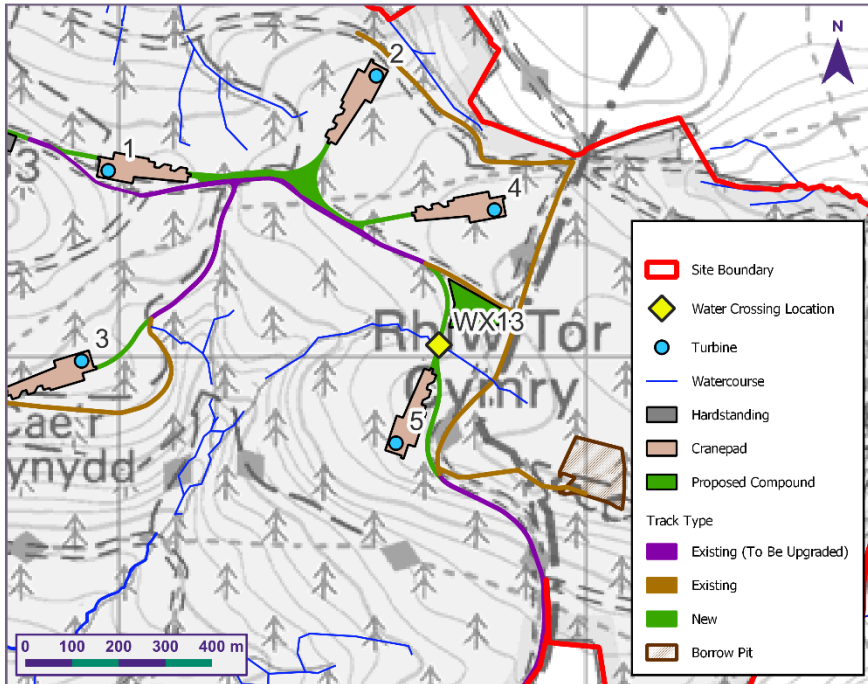
Source: Natural Power

Table A10.13: Crossing WX12

WX12 (283595, 191540)		
Crossing Location	Crossing Description	
 © Crown Copyright 2023. All rights reserved. Ordnance Survey Licence 0100031673.	• Existing Crossing: Yes • Crossing Type (existing): Circular Culvert • Crossing Material (existing): Concrete • Crossing Condition (existing): Good • Channel Type: Incised • Gradient: Moderate • Valley form: Deep vee • Bank condition: Stable • Bed material: Boulders, Coarse gravel, Fine sand/silt • Riparian corridor: Moorland, Heavily Vegetated (e.g., gorse, bramble), Other • Flow condition: Moderate • Culvert Dimensions (m): 0.5 • Water width (m): 0.4 • Water depth (m): 0.05 • Bankfull width (m): 1.7 • Bankfull height (m): 0.7 • Notes: On golf course. Less incised upstream of culvert	
Crossing Photographs		
Upstream	Across	Downstream
		

Source Natural Power

Table A10.14: Crossing WX13

WX13 (283686, 193024)		
Crossing Location	Crossing Description	
	• Existing Crossing: No • Channel Type: Incised • Gradient: Moderate • Valley form: Shallow vee • Bank condition: Stable • Bed material: Rounded pebbles, Coarse gravel, Fine sand/silt • Riparian corridor: Heavily Vegetated (e.g., gorse, bramble), Productive Forestry • Flow condition: Moderate • Water width (m): 0.7 • Water depth (m): 0.15 • Bankfull width (m): 0.7 • Bankfull height (m): 0.7 • Notes: None • Proposed Crossing Type: Circular Culvert	
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Crossing Photographs		
Upstream	Across	Downstream
		

Source: Natural Power