10. WATER

10.1 Introduction

10.1.1 Background and Objectives

Hydro-Environmental Services (HES) was engaged by MKO Ireland to carry out an assessment of the potential impacts of the proposed Lyrenacarriga Wind Farm Project (i.e. 17 no. turbines and associated access roads and infrastructure including borrow pits and compounds, met mast, 110 kV substation, grid connection loop-in, turbine delivery route works, collector cabling, and replacement planting lands) on water aspects (hydrology and hydrogeology and water natural resources) of the receiving environment. A full description of the proposed development is provided in Chapter 4 of this Environmental Impact Assessment Report (EIAR).

The proposed wind farm site is located approximately 5 km southeast of Tallow, Co. Waterford and approximately 9 km northwest of Youghal, Co. Cork (11 no. turbines are located in Co. Waterford and 6 no. in Co. Cork). The study area with regard to the Proposed Development site is the Blackwater River catchment which is shown as Plate 10-1 below.

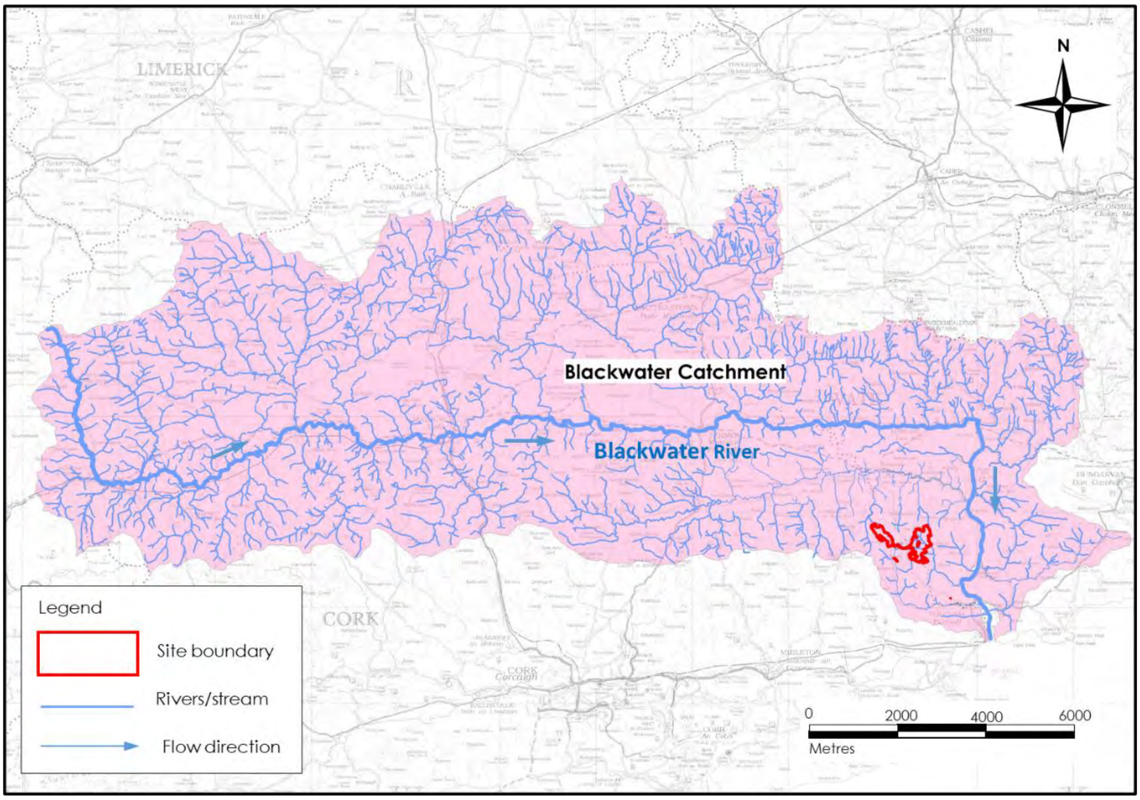


Plate 10-1 Water Chapter Study Area

The objectives of the assessment are to:

- Produce a baseline study of the existing water environment (surface water and groundwater natural resources) in the area of the proposed project;
- Identify likely significant effects of the Proposed Development on surface water and groundwater natural resources during construction, operational and decommissioning phases of the project;
- Identify mitigation measures to avoid, reduce or offset significant negative effects;
- Assess significant residual effects; and

- Assess cumulative effects of the proposed project and other local developments (as described in Chapter 2: Section 2.7 of this EIAR)

The replanting lands are located in County Sligo. The baseline environment, potential direct and indirect impacts of replanting lands on the water environment has been assessed in Section 7 of Appendix 4-3: Assessment of Forestry Replacement Lands. The replanting lands are assessed cumulatively in Section 10.5.6 of this chapter.

10.1.2 Statement of Authority

Hydro-Environmental Services (HES) are a specialist hydrological, hydrogeological and environmental practice which delivers a range of water and environmental management consultancy services to the private and public sectors across Ireland and Northern Ireland. HES was established in 2005, and our office is located in Dungarvan, County Waterford.

HES' core areas of expertise and experience include upland hydrology and wind farm drainage design. They routinely complete impact assessments for hydrology and hydrogeology for a large variety of project types.

This chapter of the EIAR was prepared by Michael Gill and David Broderick.

Michael Gill (P. Geo., B.A.I., MSc, Dip. Geol., MIEI) is an Environmental Engineer with over 18 years' environmental consultancy experience in Ireland. Michael has completed numerous hydrological and hydrogeological impact assessments of wind farms in Ireland. He has also managed EIAR assessments for infrastructure projects and private residential and commercial developments. In addition, he has substantial experience in wastewater engineering and site suitability assessments, contaminated land investigation and assessment, wetland hydrology/hydrogeology, water resource assessments, surface water drainage design and SUDs design, and surface water/groundwater interactions. For example, Michael has worked on the EIS/EIARs for Slievecallan Wind Farm, Cahermurphy Wind Farm, and Carrownagowan Wind Farm, and over 100 other wind farm related projects across the country.

David Broderick (BSc, H. Dip Env Eng, MSc) is a hydrogeologist with over 13 years' experience in both the public and private sectors. Having spent two years working in the Geological Survey of Ireland working mainly on groundwater and source protection studies David moved into the private sector. David has a strong background in groundwater resource assessment and hydrogeological/hydrological investigations in relation to developments such as quarries and wind farms. David has completed numerous geology and water sections for input into EIARs for a range of commercial developments. David has worked on the EIS/EIARs for Slievecallan Wind Farm, Cahermurphy Wind Farm, and Oweninny Wind Farm, and over 60 other wind farm related projects across the country.

Michael and David have completed over 120 wind farm related projects across Ireland and Northern Ireland over the past 10 years.

10.1.3 Scoping and Consultation

The scope for this chapter of the EIAR has also been informed by consultation with statutory consultees, bodies with environmental responsibility and other interested parties. This consultation process is described in Section 2.6 in Chapter 2 of this EIAR. As summary of the responses are shown in Table 10-1 below.

Table 10-1 Summary of Scoping Responses

Consultee	Summary Response	Addressed in Section of Chapter 10
Cork County Council (Ecological comments)	› Ensure undeveloped buffers will be maintained on all watercourses within the site boundary; and, › Provide for appropriate attenuation and control of surface water generating from the site.	10.3.16, 10.4.2 & 10.2.2.2
Waterford County Council (Heritage Officer)	› Impacts from forestry clearance to River Blackwater catchment on both hydrology and qualifying habitats and species of the SAC.	10.5.2.1 & 10.5.2.9
Inland Fisheries Ireland (IFI)	› No physical interference with stream channels prior to consultation with IFI; › Management of cement compounds; › Prevention of silt deposition in watercourses; › Mitigation to deal with increased runoff from hardstand areas; › Clear span bridges to be used at watercourse crossings and culvert pipes are not recommended; and, › Best practice measures with respect the use and handling of oils and fuels.	10.5.2.2, 10.5.2.5, 10.5.2.7, 10.5.2.8
Irish Water	› With regard the public water supply abstractions on the Glendine River and the Tourig River. Impacts on the contributing catchments in terms of water abstraction and water quality need to be carefully assessed.	10.3.8 & 10.5.2.10
OPW	› The proposed development works will need to adhere to Section 47 and 50 of the Arterial Drainage Act 1945 and The Flood Risk Planning Guidelines for Planning Authorities (November 2009).	10.5.2.8

10.1.4 Relevant Legislation

The EIAR is prepared in accordance with the requirements of European Union Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment (the 'EIA Directive') as amended by Directive 2014/52/EU. Regard has also been taken of the requirements of the following legislation (where Relevant):

- *Planning and Development Act 2000 (as amended);*
- *Planning and Development Regulations, 2001 (as amended);*
- *S.I. No 296 of 2018: European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018 which transposes the provisions of the EIA Directive as amended by the Directive 2014/52/EU into Irish Law;*
- *S.I. No. 94 of 1997: European Communities (Natural Habitats) Regulations, resulting from EU Directives 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (the Habitats Directive) and 2009/147/EC on the conservation of wild birds (the Birds Directive);*
- *S.I. No. 293 of 1988: Quality of Salmon Water Regulations;*
- *S.I. No. 272 of 2009: European Communities Environmental Objectives (Surface Waters) Regulations 2009 and S.I. No. 722 of 2003 European Communities (Water Policy) Regulations which implement EU Water Framework Directive (2000/60/EC) and provide for implementation of 'daughter' Groundwater Directive (2006/118/EC). Since 2000 water management in the EU has been directed by the Water Framework Directive (WFD). The key objectives of the WFD are that all water bodies in member states achieve (or retain) at least 'good' status by 2015. Water bodies comprise both surface and groundwater bodies, and the achievement of 'good' status for these depends also on the achievement of 'good' status by dependent ecosystems. Phases of characterisation, risk assessment, monitoring and the design of programmes of measures to achieve the objectives of the WFD have either been completed or are ongoing. In 2015 it replaced a number of existing water related directives, which are successively being repealed, while implementation of other Directives (such as the Habitats Directive 92/43/EEC) will form part of the achievement of implementation of the objectives of the WFD;*
- *S.I. No. 41 of 1999: Protection of Groundwater Regulations, resulting from EU Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances (the Groundwater Directive);*
- *S.I. No. 294 of 1989: Quality of Surface Water Intended for Abstraction (Drinking Water), resulting from EU Directive 74/440/EEC concerning the quality required of surface water intended for the abstraction of drinking water in the Member States (repealed by 2000/60/EC in 2007);*
- *S.I. No. 439 of 2000: European Communities (Drinking Water) Regulations and S.I. No. 278 of 2007 European Communities (Drinking Water No. 2) Regulations, arising from EU Directive 98/83/EC on the quality of water intended for human consumption (the Drinking Water Directive) and WFD 2000/60/EC (the Water Framework Directive);*
- *S.I. No. 9 of 2010: European Communities Environmental Objectives (Groundwater) Regulations 2010; and,*
- *S.I. No. 296 of 2009: European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009.*

10.1.5 Relevant Guidance

The Water Section of the EIAR is carried out in accordance with guidance contained in the following:

- *Environmental Protection Agency (2017): Draft Guidelines on the Information to be Contained in Environmental Impact Assessment Reports;*
- *Environmental Protection Agency (September 2015): Draft - Advice Notes on Current Practice (in the preparation of Environmental Impact Statements);*
- *Environmental Protection Agency (September 2015): Draft – Revised Guidelines on the Information to be Contained in Environmental Impact Statements;*
- *Environmental Protection Agency (2003): Advice Notes on Current Practice (in the preparation of Environmental Impact Statements);*

- *Environmental Protection Agency (2006): Environmental Management in the Extractive Industry;*
- *European Commission (2017): Environmental Impact Assessment of Projects – Guidance on the Preparation of the Environmental Impact Assessment Report;*
- *Institute of Geologists Ireland (2013): Guidelines for Preparation of Soils, Geology & Hydrogeology Chapters in Environmental Impact Statements;*
- *National Roads Authority (2008): Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes;*
- *Forestry Commission (2004): Forests and Water Guidelines, Fourth Edition. Publ. Forestry Commission, Edinburgh;*
- *Coillte (2009): Forest Operations & Water Protection Guidelines;*
- *Forest Services (Draft) Forestry and Freshwater Pearl Mussel Requirements – Site Assessment and Mitigation Measures;*
- *Forest Service (2000): Forestry and Water Quality Guidelines. Forest Service, DAF, Johnstown Castle Estate, Co. Wexford;*
- *COFORD (2004): Forest Road Manual – Guidelines for the Design, Construction and Management of Forest Roads;*
- *Inland Fisheries Ireland (2016): Guidelines on Protection of Fisheries during Construction Works in and Adjacent to Watercourses;*
- *Good Practice During Wind Farm Construction (Scottish Natural Heritage, 2010);*
- *PPG1 - General Guide to Prevention of Pollution (UK Guidance Note);*
- *PPG5 – Works or Maintenance in or Near Watercourses (UK Guidance Note);*
- *CIRIA (Construction Industry Research and Information Association) 2006: Guidance on 'Control of Water Pollution from Linear Construction Projects' (CIRIA Report No. C648, 2006); and,*
- *CIRIA 2006: Control of Water Pollution from Construction Sites - Guidance for Consultants and Contractors. CIRIA C532. London, 2006.*

10.2 Methodology

10.2.1 Desk Study and Preliminary Hydrological Assessment

A desk study of the Proposed Development site and study area was completed in advance of undertaking the walkover survey, field mapping and site investigations. This involved collecting all relevant geological, hydrological, hydrogeological and meteorological information for the Proposed Development site and study area. This included consultation of the following:

- Environmental Protection Agency database (www.epa.ie);
- Geological Survey of Ireland - Groundwater Database (www.gsi.ie);
- Met Eireann Meteorological Databases (www.met.ie);
- National Parks & Wildlife Services Public Map Viewer (www.npws.ie);
- Water Framework Directive Map Viewer (www.catchments.ie);
- Bedrock Geology 1:100,000 Scale Map Series, Sheet 22 (Geology of East Cork - Waterford). Geological Survey of Ireland (GSI, 1995);
- Geological Survey of Ireland (2004) –Groundwater Body Initial Characterization Reports;
- OPW Flood Hazard Maps (www.floodinfo.ie);
- Environmental Protection Agency – "Hydro-tool" Map Viewer (www.epa.ie);
- CFRAM Preliminary Flood Risk Assessment (PFRA) maps (www.cfram.ie); and,
- Department of Environment, Community and Local Government on-line mapping viewer (www.myplan.ie).

10.2.2 Site Investigations

Detailed drainage mapping, constraints mapping and hydrological baseline monitoring was undertaken by HES on 30th and 31st August 2018 with further surveys completed in January, February and September 2019 and trial pitting undertaken in May 2020.

In summary, site investigations to address the water section of the EIAR included the following:

- Walkover surveys and hydrological mapping of the Proposed Development site and the study area were undertaken whereby water flow directions and drainage patterns were recorded;
- Field hydrochemistry measurements (electrical conductivity, pH, dissolved oxygen and temperature) were taken to determine the origin and nature of surface water flows;
- Surface water sampling (3 no. rounds) was undertaken to determine the baseline water quality of the primary surface waters originating from the site;
- Surface water flow monitoring (5 no. rounds) was completed in the primary streams passing through the Proposed Development site;
- A total of 27 no. trial pits were undertaken by HES across the site to assess soil/subsoil lithology and depth to bedrock; and,
- Site visits, surveys and surface water sampling (4 no. rounds) of downstream Public Water Supply (PWS) surface water abstractions relating to the Youghal PWS and Tallow PWS.

10.2.3 Impact Assessment Methodology

Please refer to Chapter 1 of the EIAR for details on the impact assessment methodology (EPA, 2002, 2003, 2015 and 2017). In addition to the above methodology, the sensitivity of the water environment receptors was assessed on completion of the desk study and baseline study. Levels of sensitivity which are defined in Table 10-2 are then used to assess the potential effect that the proposed project may have on them.

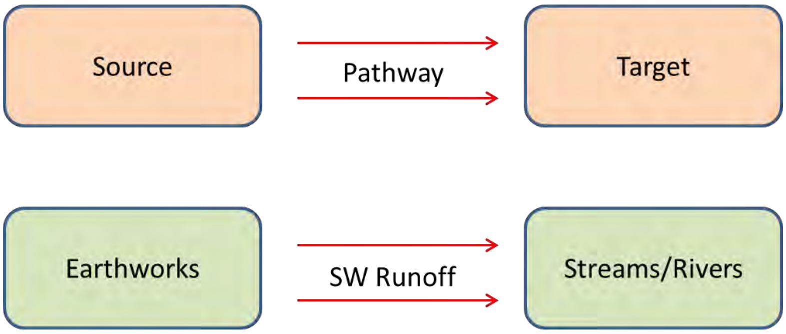
Table 10-2 Receptor Sensitivity Criteria (Adapted from www.sepa.org.uk)

Sensitivity of Receptor	
Not sensitive	Receptor is of low environmental importance (e.g. surface water quality classified by EPA as A3 waters or seriously polluted), fish sporadically present or restricted). Heavily engineered or artificially modified and may dry up during summer months. Environmental equilibrium is stable and is resilient to changes which are considerably greater than natural fluctuations, without detriment to its present character. No abstractions for public or private water supplies. GSI groundwater vulnerability “Low” – “Medium” classification and “Poor” aquifer importance.
Sensitive	Receptor is of medium environmental importance or of regional value. Surface water quality classified by EPA as A2. Salmonid species may be present and may be locally important for fisheries. Abstractions for private water supplies. Environmental equilibrium copes well with all natural fluctuations but cannot absorb some changes greater than this without altering part of its present character. GSI groundwater vulnerability “High” classification and “Locally” important aquifer.
Very sensitive	Receptor is of high environmental importance or of national or international value i.e. NHA or SAC. Surface water quality classified by EPA as A1 and salmonid spawning grounds present. Abstractions for public drinking water supply. GSI

Sensitivity of Receptor	
	groundwater vulnerability “Extreme” classification and “Regionally” important aquifer

10.2.4 Overview of Impact Assessment Process

The conventional source-pathway-target model (see below, top) was applied to assess potential impacts on downstream environmental receptors (see below, bottom as an example) as a result of the proposed wind farm development.



Where potential impacts are identified, the classification of impacts in the assessment follows the descriptors provided in the Glossary of Impacts contained in the following guidance documents produced by the Environmental Protection Agency (EPA):

- Draft Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (EPA, 2017); and,
- Advice Notes For Preparing Environmental Impact Statements DRAFT (EPA, 2015).

The description process clearly and consistently identifies the key aspects of any potential impact source, namely its character, magnitude, duration, likelihood and whether it is of a direct or indirect nature.

In order to provide an understanding of the stepwise impact assessment process applied below (Section 10.5), we have firstly presented below a summary guide that defines the steps (1 to 7) taken in each element of the impact assessment process. The guide also provides definitions and descriptions of the assessment process and shows how the source-pathway-target model and the EPA impact descriptors are combined.

Using this defined approach, this impact assessment process is then applied to all wind farm project construction and operation and decommissioning activities which have the potential to generate a source of significant adverse impact on the geological and hydrological/ hydrogeological (including water quality) environments.

Step 1	Identification and Description of Potential Impact Source This section presents and describes the activity that brings about the potential impact or the potential source of pollution. The significance of effects is briefly described.	
Step 2	Pathway / Mechanism:	The route by which a potential source of impact can transfer or migrate to an identified receptor. In terms of this type of development, surface water and groundwater flows are the primary pathways, or for example, excavation or soil erosion are physical mechanisms by which a potential impact is generated.
Step 3	Receptor:	A receptor is a part of the natural environment which could potentially be impacted upon, e.g. human health, plant / animal species, aquatic habitats, soils/geology, water resources, water sources. The potential impact can only arise as a result of a source and pathway being present.
Step 4	Pre-mitigation Impact:	Impact descriptors which describe the magnitude, likelihood, duration and direct or indirect nature of the potential impact before mitigation is put in place.
Step 5	Proposed Mitigation Measures:	Control measures that will be put in place to prevent or reduce all identified significant adverse impacts. In relation to this type of development, these measures are generally provided in two types: (1) mitigation by avoidance, and (2) mitigation by engineering design.
Step 6	Post Mitigation Residual Impact:	Impact descriptors which describe the magnitude, likelihood, duration and direct or indirect nature of the potential impacts after mitigation is put in place.
Step 7	Significance of Effects:	Describes the likely significant post mitigation effects of the identified potential impact source on the receiving environment.

10.2.5 Limitations and Difficulties Encountered

No limitations or difficulties were encountered during the preparation of the Water Chapter of the EIAR.

10.3 Receiving Environment

10.3.1 General Site Description

The Proposed Development site consists of two separate clusters of turbines. The turbine clusters are referred to herein as the western and eastern clusters.

The eastern cluster (11 no. turbines) is located in Co. Waterford while the western cluster (6 no. turbines) is located in Co. Cork.

The two clusters will be connected via a 3.3km underground collector cable connection which will mainly cross grassland and also short multiple sections of public road (0.6km) that run between the two clusters.

The western cluster, which has an area of approximately 206ha, is located approximately 5 km south of Tallow, between the R627 and R634 regional roads. The northern half of the western cluster is largely coniferous forestry while the southern half is agricultural grassland. It is proposed that 6 no. turbines will be located in the western cluster (3 no. in forestry and 3 no. in grassland area). The forestry is accessible via a network of existing forest tracks. Ground elevation ranges from approximately 203m OD at the topographic peak of Kilcalfmountain north of the western cluster to ~130 m OD near the south of the western cluster, with the overall slope (gentle to moderate) to the south – southeast.

The eastern cluster, which has an area of approximately 518ha, is located ~1.7km to the southwest of the western cluster (~6.5km to the southeast of Tallow) and comprises mainly coniferous forestry with areas of grassland in the central and south-eastern parts of the eastern cluster. The eastern cluster is located immediately east of the R634 and has a ground elevation range between 200 m OD at the south of the cluster, and 120 m OD along the eastern boundary with the overall ground slope (gentle to moderate) to the east. It is proposed that 11 no. turbines will be located in the eastern cluster (7 no. in forestry and 4 no. in grassland).

The grid connection will be made to the existing 110 kV Overhead Line (OHL) which passes through the eastern cluster at the location of the proposed 110 kV substation via a loop in connection. The western cluster will be connected to the 110 kV substation via the underground collector cable as described above.

Turbine delivery route works required along the route from Youghal (see Section 4.4.2 of EIAR) to the Proposed Development site include temporary road widening at Lombard's crossroads on the R634, new section of access road on private land (300m) at Breeda Bridge (1.3km southwest of the western cluster) as well as temporary removal of some street signs and temporary levelling of the centre island of some roundabouts. These works are assessed as part of the EIAR.

10.3.2 Water Balance

Long term Annual Average Rainfall (AAR) and evaporation data was sourced from Met Éireann. The 30-year annual average rainfall (1981 - 2010) recorded at Youghal (Glendine - E206400, N83900), approximately 2 kilometres southeast of the eastern cluster, are presented in Table 10-3. This is the most appropriate station to use with respect distance and elevation.

Table 10-3 Local Average long-term Rainfall Data (mm)

Station		X-Coord		Y-Coord		Elevation (mOD)		Opened		Closed		
Glendine W.W		206400		83900		107		1964		N/A		
Jan	Feb	Mar	Apr	My	Jun	July	Aug	Sept	Oct	Nov	Dec	Total
126.2	89.8	99.6	79.3	80.6	85.9	81.3	99.8	99	137.3	118.3	124.6	1221.7

The closest synoptic[1] station where the average potential evapotranspiration (PE) is recorded is at Cork Airport, approximately 40 kilometres southwest of the Proposed Development site. The long-term average PE for this station is 513mm/yr. This value is used as a best estimate of the site PE. Actual Evaporation (AE) at the site is estimated as 488mm/year (which is 0.95 × PE).

The effective rainfall (ER) represents the water available for runoff and groundwater recharge. The ER for the site is calculated as follows:

Effective rainfall (ER) = AAR – AE

= 1,222mm/yr – 488mm/yr

ER = 734mm/yr

Based on recharge coefficient estimates from the GSI (www.gsi.ie), an estimate of 60% recharge is taken for the Proposed Development site as an overall average. This value is for *"moderate permeability subsoil overlain by well-drained soil"*. Smaller localised areas where poorly draining grey soils are present may have slightly lower recharge rates (22.5%), while areas with bedrock outcrop/subcrop will have higher values (85%), but the recharge coefficient value of 60% is assumed to fairly reflect the majority of the site as an overall average.

The recharge coefficient of 60% was used to calculate values for key hydrological properties. Therefore, annual recharge and runoff rates for the site are estimated to be 440mm/year and 294mm/year respectively.

Table 10-4 below presents return period rainfall depths for the area of the Proposed Development site. These data are taken from https://www.met.ie/climate/services/rainfall-return-periods and they provide rainfall depths for various storm durations and sample return periods (1-year, 50-year, 100-year). These extreme rainfall depths will be the basis of the Proposed Development drainage hydraulic design as described further below.

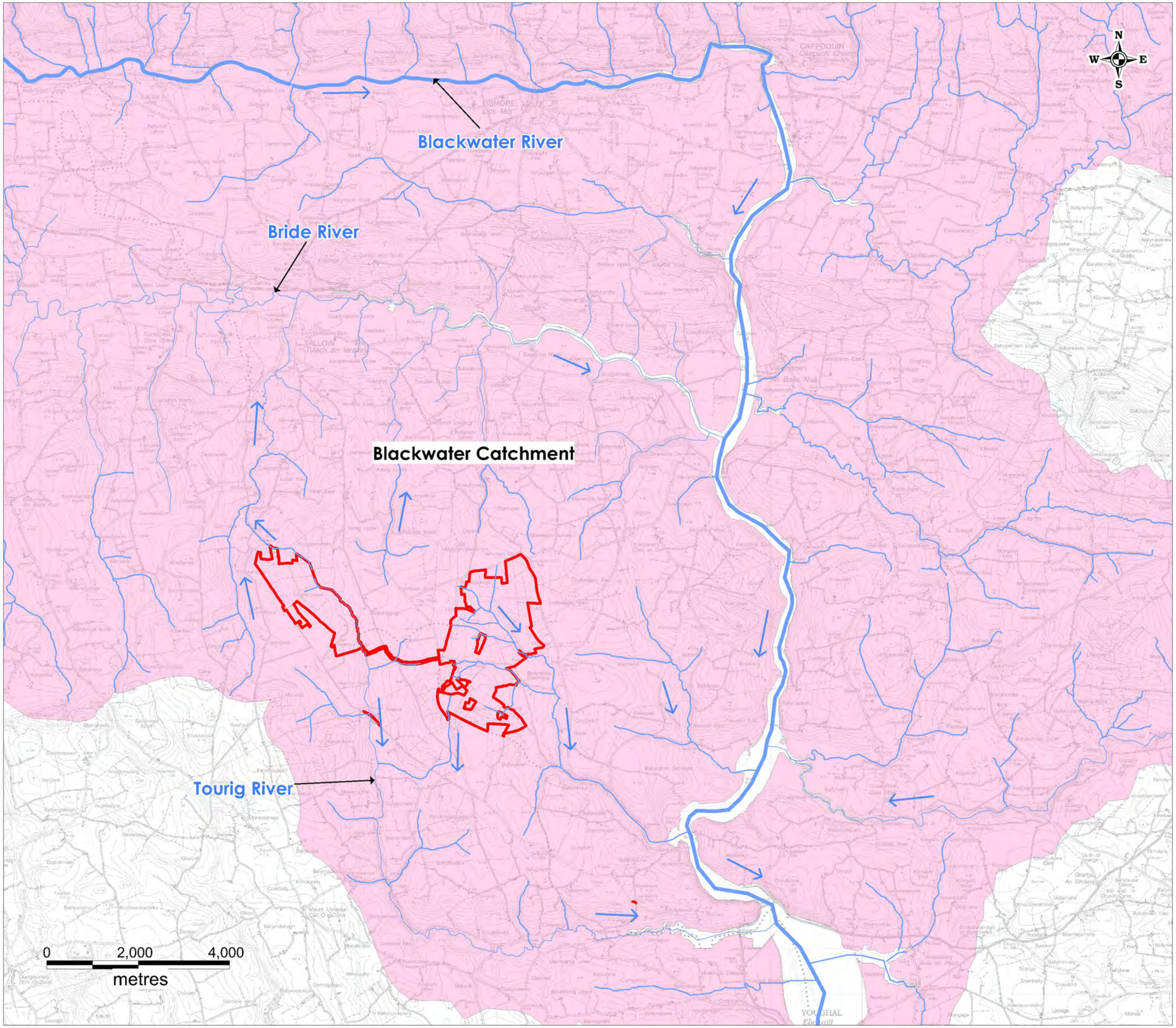
Table 10-4 Return Period Rainfall Depths for the Lyrenacarriga site

Duration	10-year Return Period	50-Year Return Period	100-Year Return Period
15 min	11	15.3	17.5
1 hour	20	27.7	31.7
6 hour	43.2	59.9	68.6
12 hour	58.1	80.6	92.4
24 hour	78.3	108.6	124.4
48 hour	94.4	127.6	144.6

10.3.3 Regional and Local Hydrology

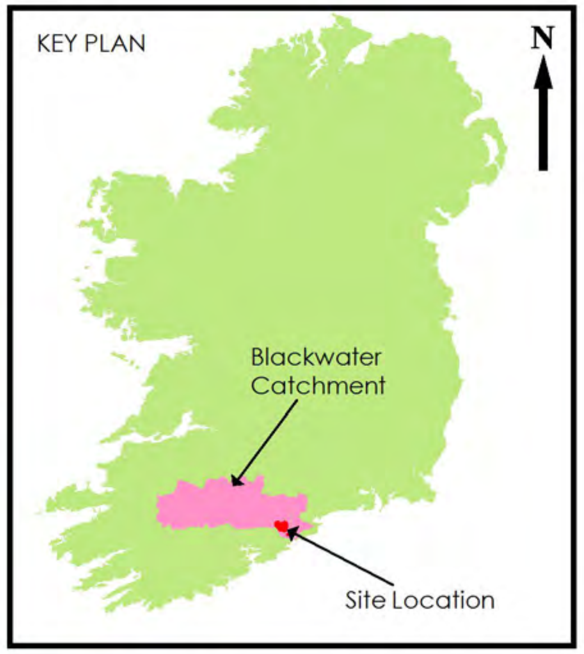
On a regional scale, the Proposed Development site is located in the River Blackwater surface water catchment within Hydrometric Area 18 of the South Western International River Basin District (SWIRBD). The River Blackwater, which is transitional (i.e. estuarine) at this location, flows in a southerly direction approximately 5km to the east of the eastern cluster at its closet point. A regional hydrology map is shown as **Figure 10-1**.

[1] *Meteorological station at which observations are made for synoptic meteorology and at the standard synoptic hours of 00:00, 06:00, 12:00, and 18:00.*



Legend

- Site Boundary
- Blackwater Catchment
- Watercourse
- Flow Direction



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Client: Innogy Renewables	
Job: Lyrenacarriga WF, Co. Waterford/Co. Cork	
Title: Regional Hydrology Map	
Figure No: 10-1	
Drawing No: P1453-0-1220-A3-1001-0A	
Sheet Size: A3	Project No: P1453-0
Scale: 1:80,000	Drawn By: GD
Date: 02/12/2020	Checked By: MG

In terms of local hydrology, the northern part of the western cluster and the north-eastern tip of the eastern cluster (~20% of the overall site) are located in the River Bride surface water sub-catchment (Bride(Waterford)_SC0_30). The River Bride flows in an easterly direction approximately 4km to the north of the western cluster and is a major tributary to the River Blackwater.

In terms of proposed wind farm infrastructure, there is 1 no. turbine (T12) and 1 no. borrow pit from the western cluster located in the River Bride sub-catchment. The western cluster drains to the River Bride via the Glenaboy River (Glenaboy_010) and Kilbeg Stream with all the aforementioned proposed infrastructure being located in the Glenaboy River catchment. There is no proposed development in the Kilbeg Stream catchment.

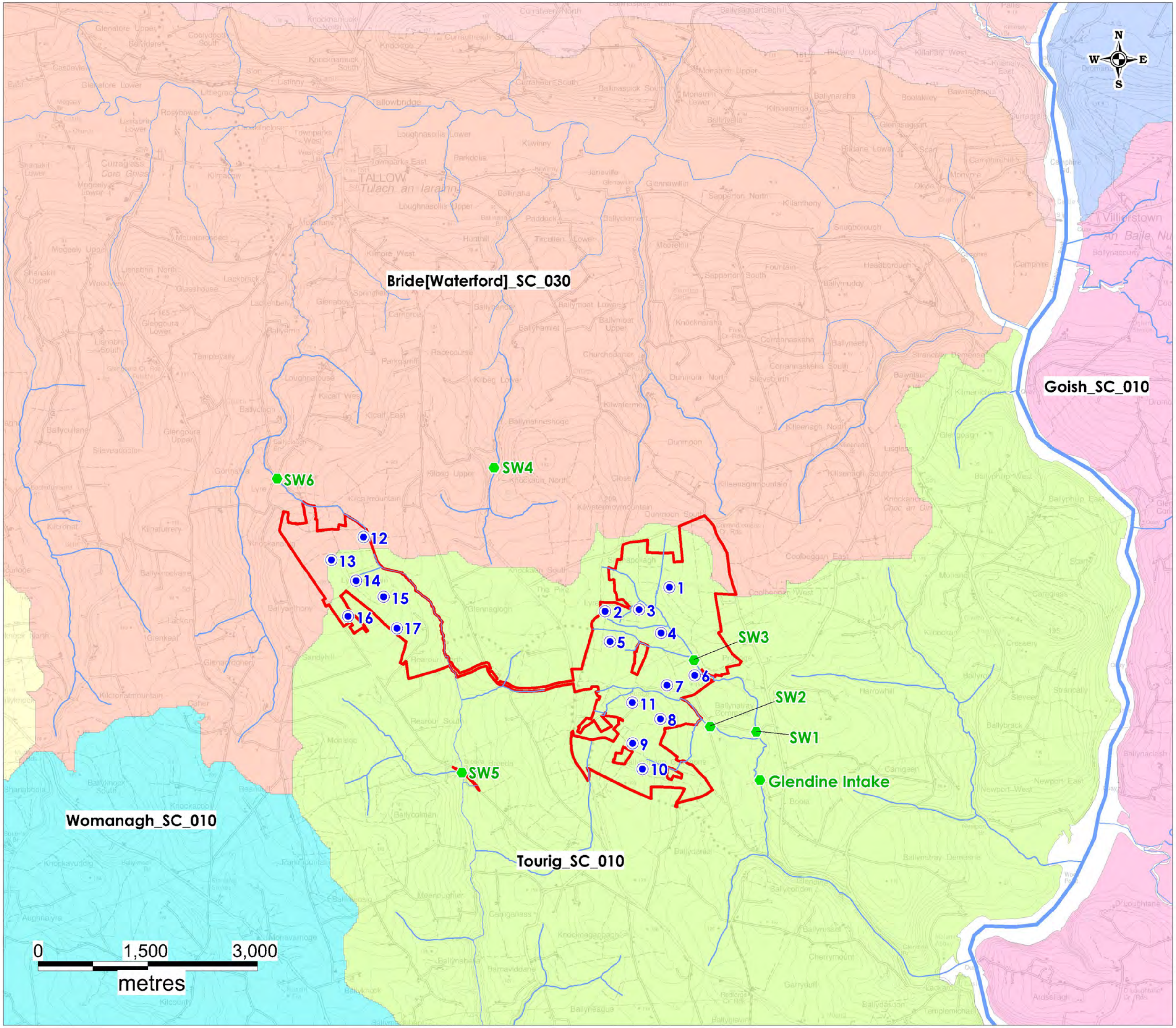
There is no proposed wind farm infrastructure from the eastern cluster located in the River Bride catchment.

The remainder of western and eastern cluster are located in the Tourig River and Glendine River surface water sub-catchments respectively (collectively these catchments are referred to as the Tourig_SC_010). The turbine delivery works at Lombards Crossroads and Breeda Bridge are within the Tourig River catchment.

A summary of the local hydrology with respect the proposed wind farm infrastructure is shown in Table 10-5. A local hydrology map is shown as **Figure 10-2.**

Table 10-5 Summary of Sub-catchments & Proposed Infrastructure

Regional Catchment	Sub-catchment	Main Development Infrastructure	Primary Drainage Features
River Blackwater	Tourig River (Tourig_010)	5 no. turbines, 1 no. borrow pit, 1 no. temporary compound and the collector cable (3.3km). Turbine delivery route works at Breeda Bridge and Lombards Crossroads	Tourig River
	Bride River (Bride(Waterford)_SC_030	1 no. turbine and 1 no. borrow pit	Glenaboy River
	Glendine River (Glendine(Blackwater)_010	11 no. turbines, 1 no. borrow pit, 1 no. temporary construction compound, 110 kV substation and the OHL grid connection loop-in	Glendine River



Legend

- Site Boundary
- Proposed Turbine Layout
- Watercourse
- SW Monitoring Location

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Client: Innogy Renewables

Job: Lyrenacarriga WF, Co. Waterford/Co. Cork

Title: Local Hydrology Map

Figure No: 10-2

Drawing No: P1453-0-1220-A3-1002-0A

Sheet Size: A3	Project No: P1453-0
Scale: 1:50,000	Drawn By: GD
Date: 02/12/2020	Checked By: MG

10.3.4 Local and Site Drainage

A site drainage map is shown as **Figure 10-3.**

The eastern cluster is drained by a relatively dense network of mainly first and second order streams, many of which are headwater streams of the Glendine River. One headwater stream emerges from the west and also from the south of the eastern cluster which flow towards the Tourig River. Most of the headwater streams of Glendine River (within the eastern cluster) emerge close to the northern and western boundaries and flow the full distance through the cluster landholding in a general south-easterly direction. The headwater streams of the Glendine River converge into two main stream channels before leaving the eastern cluster landholding area at its south-eastern corner. The streams then merge approximately 300m downstream of the eastern cluster landholding boundary to form the upper reach of the Glendine River.

Due to the slightly more elevated nature of the western cluster and the steeper sloping topography, the natural stream density is relatively low compared to the eastern cluster area. Two main headwater streams emerge from the western cluster. The stream emerging from the northwest of the cluster is a headwater stream of the Glenaboy River (Bride catchment) and the stream emerging from the east is a headwater stream of the Tourig River. The north-eastern section of the western cluster slopes towards the Kilbeg Stream which emerges approximately 0.5km to the east of the western cluster.

In addition, within both cluster landholding areas there are numerous manmade drains that are in place predominately to drain the forestry plantations. The current internal forestry drainage pattern is influenced by the topography, soil type, layout of the forest plantation and by the existing road network. The forest plantations are generally drained by a network of mound drains which typically run perpendicular to the topographic contours of the site and feed into collector drains, which discharge to interceptor drains down-gradient of the plantation.

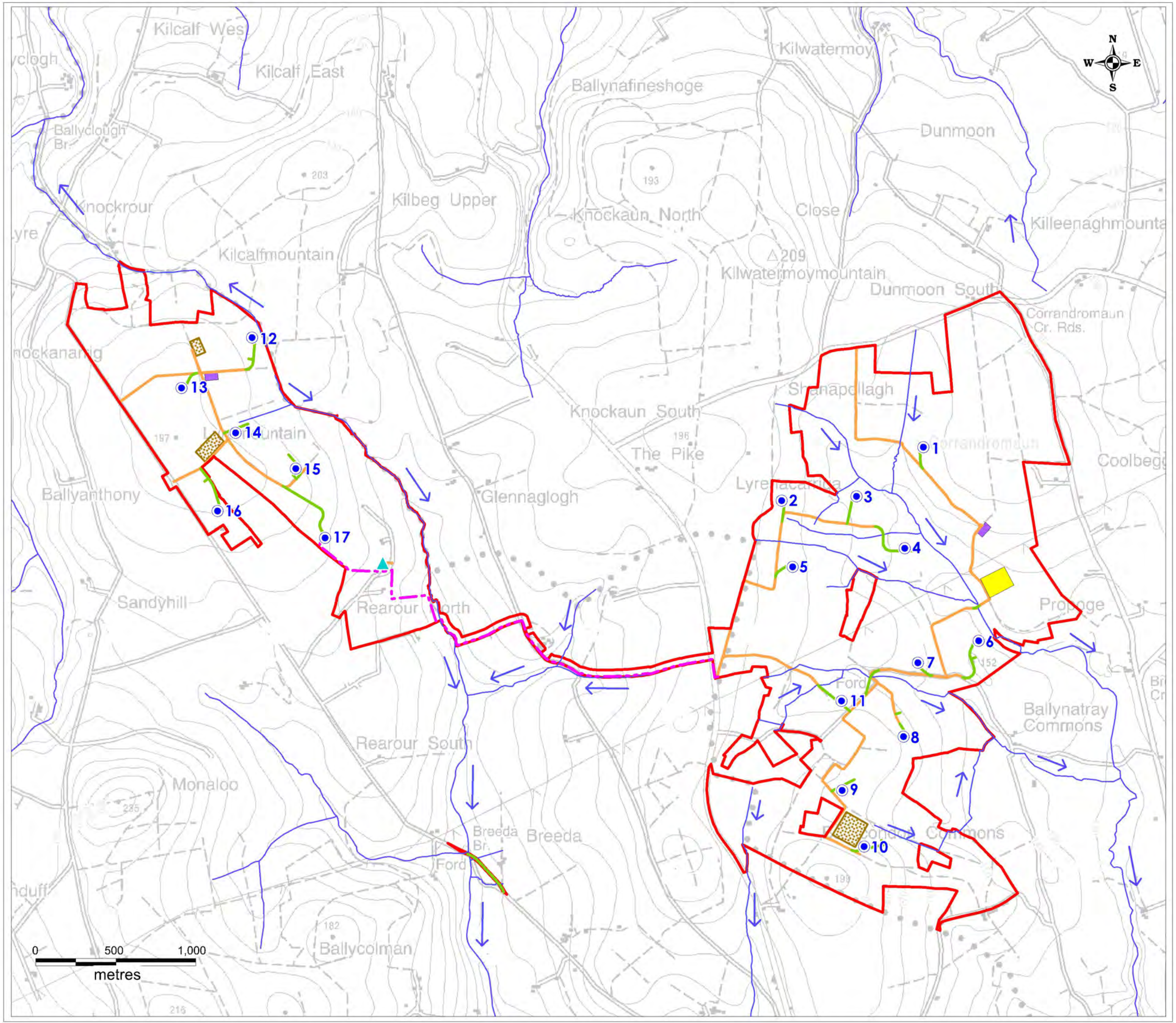
Mound drains and ploughed ribbon drains are generally spaced approximately every ~15m and ~2m respectively. As illustrated in **Plate 10-2**, interceptor drains are generally located up-gradient (cut-off drains) and down-gradient of forestry plantations. Interceptor drains are also located up-gradient of forestry access roads. Culverts are generally located at stream crossings and at low points under access roads which drain runoff onto down-gradient forest plantations. A schematic of a typical standard forestry drainage network and one which is representative of the site drainage network is shown as **Plate 10-2.**

The forestry drains are the primary drainage routes towards the natural streams on the development site, but the flows in these drains are generally very low with the smaller one being dry most of the year. The integration of the existing main drains with the proposed wind farm drainage is a key component of the drainage design which is discussed further in Section 10.4.1 and Section 10.5.2.2 below.

The proposed temporary haul route access road (300m) at Breeda Bridge crosses a field herringbone drainage network which ultimately drains into the Touring River which is located approximately 200m downstream (west) of the proposed works.

Monitoring of stream discharge in the main streams passing through the site was undertaken on 5 no. occasions at 6 no. monitoring locations (SW1 – SW6) between September 2018 and February 2019 and these data are presented in Table 10-6 below.

The locations of the monitoring points are shown on **Figure 10-2 above**. Surface water flow monitoring was also undertaken further downstream on the Glendine River and Tourig River where there are surface water abstractions (off-takes) for the Youghal Public Water Supply (refer to Section 10.3.7 below for details on public water supply surface water abstractions).



Legend

- Site Boundary
- Proposed Turbine Layout
- Proposed Cable Route
- Proposed Met Mast
- Proposed Substation
- Proposed Construction Compound
- Proposed Borrow Pit
- Existing Road Proposed to be Upgraded
- Proposed New Road
- Flow Direction
- Watercourse

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Client: Innogy Renewables	
Job: Lyrenacarriga WF, Co. Waterford/Co. Cork	
Title: Site Drainage Map	
Figure No: 10-3	
Drawing No: P1453-0-1220-A3-1003-0A	
Sheet Size: A3	Project No: P1453-0
Scale: 1:22,500	Drawn By: GD
Date: 02/12/2020	Checked By: MG

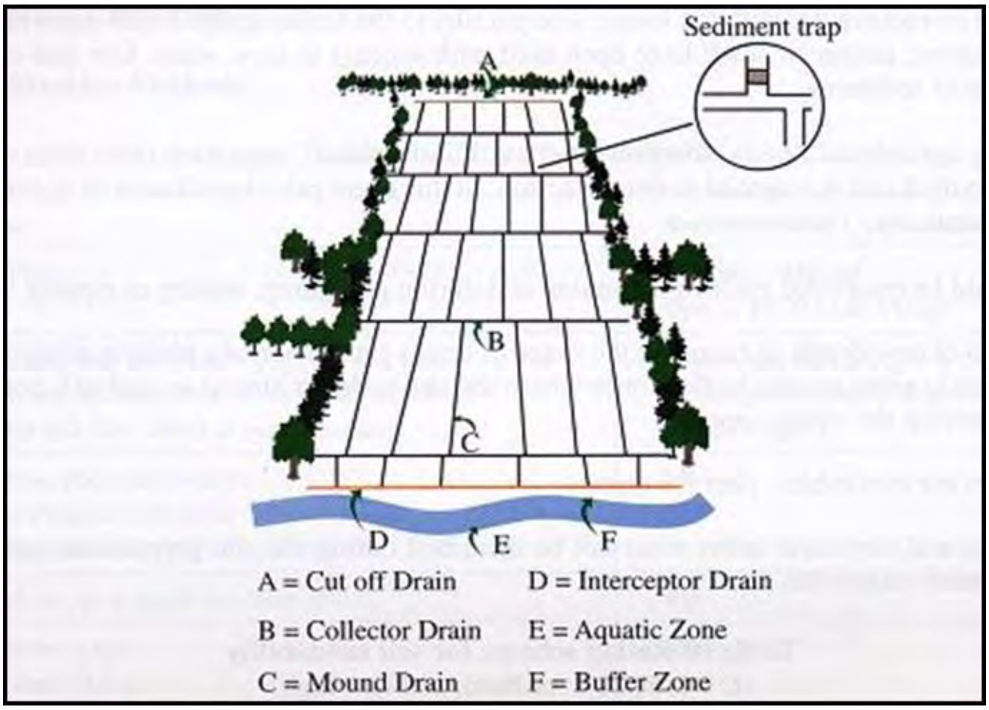


Plate 10-2 Standard Forestry Drainage (Forestry Schemes Manual, Forest Service, August 2004)

Table 10-6: Surface Water Flow Monitoring Data

Location	17/09/2018	17/10/2018	06/11/2018	30/01/2019	05/02/2019
	Flow (l/sec)	Flow (l/sec)	Flow (l/sec)	Flow (l/sec)	Flow (l/sec)
SW1	15	45	200	120	210
SW2	5	10	150	100	180
SW3	10	40	200	130	220
SW4	12	70	75	25	110
SW5	30	40	200	200	500
SW6	Dry	Dry	15	10	20
Glendine Gravity Intake	-	-	-	500	550
Tourig Intake	-	-	-	450	800

Flow Duration Curves (upper and lower confidence) for the Tourig River and Glendine River are shown as **Plate 10-3** below.

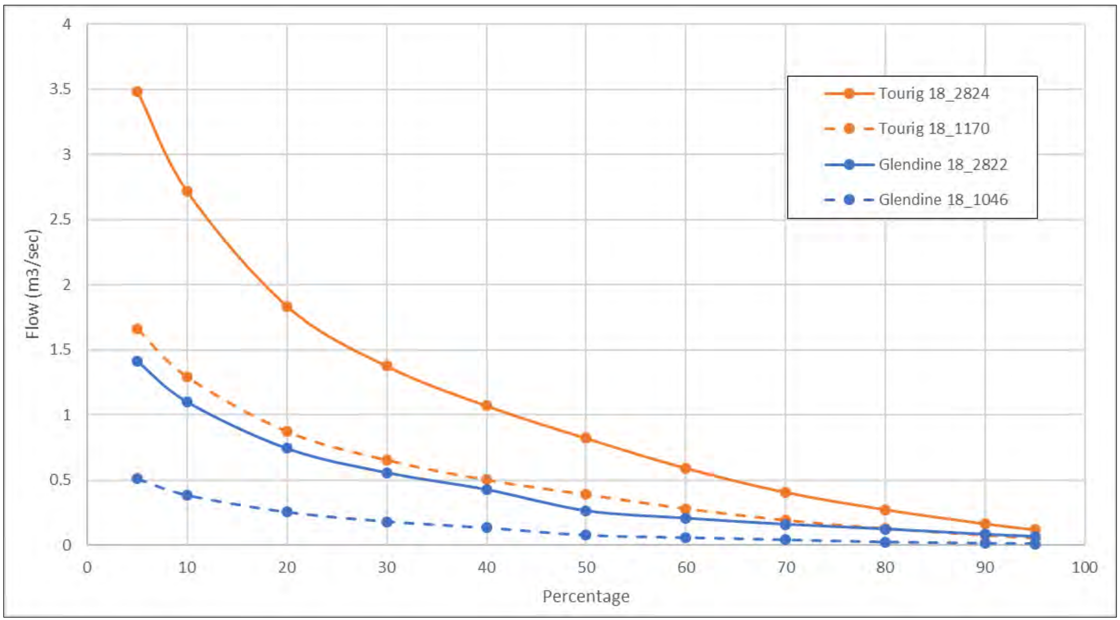


Plate 10-3 Flow Duration Curves (upper and lower confidence) for the Tourig River and Glendine River

10.3.5 Baseline Assessment of Development Site Runoff

The following water balance assessment gives an indication of the highest monthly average volume of surface water runoff expected. The calculations are carried out for the month with the highest average recorded rainfall versus evapotranspiration, for the current baseline site conditions, in terms of subsoil and bedrock exposure (Table 10-7). It represents, therefore, the average wettest monthly scenario in terms of volumes of surface water runoff from the Proposed Development site pre-development. The surface water runoff co-efficient for the site is estimated to be only 40%, based on the moderate permeability of the underlying subsoils.

Table 10-7 Water Balance and Baseline Runoff Estimates for Wettest Month (October)

Water Balance Component	Depth (m)
Average October Rainfall (R)	0.137
Average October Potential Evapotranspiration (PE)	0.02
Average October Actual Evapotranspiration (AE = PE x 0.95)	0.019
Effective Rainfall October (ER = R - AE)	0.118
Recharge co-efficient (60% of ER)	0.071
Runoff (40% of ER)	0.047

As outlined in Section 10.5.2.2 below a 1 in 100-year 6-hour return period will be used for drainage design purposes and not the average values reviewed in this section.

The highest long-term average monthly rainfall recorded at Glendine over the period 1981 – 2010 occurred in the month of October, at 137mm. The average monthly evapotranspiration for the synoptic station at Cork Airport over the same period in October was 20mm. The calculation is carried out for the Proposed Development site area. The balance indicates that a conservative estimate of surface water runoff for the site during the highest rainfall month is 344,510m^3/month, which equates to an average of 11,113m^3/day, as outlined in Table 10-8.

Table 10-8 Baseline Runoff for the Proposed Development Site

Approx. Area (ha)	Baseline Runoff per month (m^3)	Baseline Runoff per day (m^3)
733	344,510	11,113

10.3.6 Summary Flood Risk Assessment

This section is a summary of the flood risk assessment (FRA) undertaken for the Proposed Development. The full FRA report is attached **Appendix 10-1**.

OPW's flood hazard mapping (www.floodmaps.ie), CFRAM Preliminary Flood Risk Assessment (PFRA) maps (www.cfram.ie), Department of Environment, Community and Local Government on-line planning mapping (www.myplan.ie) and historical mapping (i.e. 6" & 25" base maps) were consulted to identify those areas as being at risk of flooding.

No recurring flood incidents within the Proposed Development site boundary or immediately downstream were identified from OPW's flood hazard mapping. The closest mapped recurring flood events are located on the Bride River at Tallow Bridge and on the Glendine River just upstream of where it merges with the Blackwater River.

Where complete the CFRAM Study OPW Flood Risk Assessment Maps are now the primary reference for flood risk planning in Ireland and supersede the PFRAM maps. There is no CFRAM mapping available for the area of the Proposed Development site and therefore the PFRA mapping has been reviewed. The PFRA mapping is shown in the attached FRA report.

The PFRA mapped 100-year fluvial flood zones within the Proposed Development site are typically constrained by topography and confined to land in close proximity of mapped watercourses. The proposed turbine locations, compounds, substation or borrow pits are not within any PFRA mapped fluvial flood zone as these infrastructure elements are located at least 75m from a watercourse.

Proposed wind farm infrastructure located within a mapped fluvial flood zone is limited to 2 no. existing watercourse crossing locations in the eastern cluster (these existing crossings will be upgraded as part of the proposed development).

Small localised areas of pluvial flooding are mapped within the site within areas of low relief and/or relatively poorly draining soils/subsoils. The mapped pluvial flood zones do not affect any of the proposed wind farm infrastructure.

There is no text on local available historical 6" or 25" mapping for the proposed site that identify areas that are "prone to flooding" or benefitting lands (lands benefiting from the OPW Arterial Drainage Scheme).

Detailed walkovers and monitoring of the Proposed Development footprint were undertaken monthly between September 2018 and May 2020, specifically the areas identified from the PFRA mapping (discussed above) and there were no obvious signs or anecdotal evidence of flooding noted at any Proposed Development locations. Due to the elevated location and sloping nature of the majority of the Proposed Development areas no significant flooding issues are anticipated.

It is a key mitigation of the proposed wind farm development to preserve and protect all existing watercourses by ensuring all surface water runoff is treated (water quality control) and attenuated (water quantity control) prior to diffuse discharge at pre-existing Greenfield rates. As such the mechanism by which downstream flooding is prevented and controlled is through avoidance by design. These proposed drainage attenuation measures are described in the impact assessment section below.

10.3.7 Surface Water Abstractions

There are two public surface water supplies downstream of the Proposed Development site, the Tallow Public Water Supply (3100PUB1096) and the Youghal Public Water Supply (0500PUB2510).

HES are very familiar with the Tallow supply as they have carried out site audits on the scheme and have also worked on a groundwater supplementation project for Irish Water at the nearby Tallow reservoir. A site visit to the Glendine and Tourig abstractions along with the Boola Water Treatment Plant was undertaken in January 2019 in the company of Ken O'Keefe (engineer) from Cork County Council.

Further details on the protection of water supplies are provided below in Section 10.3.16 Receptor Sensitivity, and in Section 4.6 of Chapter 4, which presents the proposed site drainage design.

10.3.7.1 Tallow Public Water Supply

The Tallow PWS (3100PUB1096) has a surface water abstraction point on the Kilbeg Stream which is located approximately 1km to the northeast of the western landholding. The scheme also has three production wells (discussed below in Section 10.3.15) which are used to supplement the overall demand of the scheme which is approximately 240 – 280m^3/day. During the summer period the groundwater / surface water proportion is typically 50:50. During winter the proportion is typically 85:15. The surface water abstraction point is located approximately 2km downstream of the western cluster (the eastern cluster is not in the Kilbeg Stream surface water catchment).

Approximately 82ha of the western cluster landholding (of the total 206 ha) is located within the Kilbeg Stream surface water catchment however, there is no proposed wind farm infrastructure located in the Kilbeg Stream catchment and therefore there is no potential for the development to impact on this existing surface water abstraction source.

10.3.7.2 Youghal Public Water Supply

The Youghal PWS (0500PUB2510) has 2 no. surface water abstraction points on the Glendine River (located approximately 0.6 and 2.5km to the southeast of the eastern cluster) and 1 no. surface water abstraction point on the Tourig River (approximately 4.5km to the southeast of the eastern cluster. Raw water from the 3 no. abstraction locations is piped to the Boola Water Treatment Plant (WTP) which is located in Co. Waterford, approximately 2.5km to the southeast of the eastern cluster.

The abstraction points on the Glendine River are referred to as the Glendine Gravity Intake and the Glendine Pumped Intake. The Glendine Gravity Intake is 2km upstream of the Glendine Pumped Intake with the downstream distance from eastern cluster being 1 and 3km respectively. The majority of the eastern cluster landholding (518 ha) which includes 11 no. turbines, substation, compound and 1 no. borrow pit is located in the Glendine River catchment upstream of the existing surface water abstraction locations.

No part of the western cluster landholding is located in the Glendine River catchment. The Tourig River abstraction point is located approximately 11km downstream of the western cluster. Approximately 159ha of the western cluster landholding (of the total 206 ha) is located within the Tourig River surface water catchment which includes 5 no. turbines, 1 no. borrow pit, 1 no. compound and the collector cable. Water from the Tourig abstraction location is pumped to the Boola Water Treatment Plant.

All of Youghal PWS demand (approximately 110m^3/hr) comes from the Boola Water Treatment Plant and the proportion form each of the abstraction points is as follows - Glendine Gravity Intake (59%), Glendine Pumped Intake (18%) and Tourig River (23%).

Water treatment at the Tallow and the Youghal PWS schemes comprises a mixture of coagulation, pH adjustment, Alum dosing, clarifiers and sand filters, with the final water receiving chloride and fluoride dosing.

Both schemes are very sensitive to changes in surface water turbidity and requires manual adjustment based on testing of raw water inflows. Surface water sampling at the abstractions locations was undertaken as part of the EIAR assessment and this is described below.

The locations of the abstraction/offtake points and the surface water catchments of the Glendine River, Tourig River and Kilbeg Stream are shown on **Figure 10-2** above.

10.3.8 Surface Water Hydrochemistry

Q-rating data for EPA monitoring points on the Glenaboy river are available for two locations downstream of the western cluster, at Ballyclogh bridge and an unnamed bridge, approximately 0.75km and 1km northwest of the cluster landholding. Most recent data (2018) show that the river has a Q-4 rating (Good Status) at both Ballyclogh Bridge and the downstream unnamed bridge.

Most recent data (2018) for the Tourig River (downstream of the western cluster) shows that it achieved a Q-4 rating (Good Status) at a monitoring point approximately 4 km south of the cluster.

Most recent data (2018) for River Glendine are available for a monitoring point at Ballycondon approximately 1.5 km southeast of the eastern cluster and the latest Q rating is Q4 (Good Status).

Field hydrochemistry measurements of unstable parameters (electrical conductivity - µS/cm, pH, and temperature - ^{0}C) and turbidity (NTU) were undertaken at 6 no. designated monitoring locations (SW1 – SW6) downstream of the proposed development site between 17th September 2018 and 4th June 2020. Monitoring was also completed at the Youghal PWS Glendine gravity intake and the Tourig intake. The field hydrochemistry results are listed in Table 10-9 and Table 10-10 below.

Electrical conductivity (EC) values for surface waters draining the Proposed Development site area ranged between 120 and 224µS/cm with an overall average of ~170µS/cm. pH ranged between 6.6 and 7.8, with dissolved oxygen saturation ranging between 78 and 107%. The field hydrochemistry values/ranges for pH and electrical conductivity are typical for a catchment which comprises non-calcareous subsoils (i.e. sandstone tills) and bedrock (i.e. mudstone and sandstone). The dissolved oxygen levels would be normal for a Good Status and exceed the required dissolved lower limit of 80% (Surface Water Regulations S.I. No. 272 of 2009).

Turbidity values ranged between 0.39 and 31.2NTU with an average of 9.27NTU. There was a notable increase in turbidity from sampling round R2 and R3 in the downstream windfarm monitoring locations which is likely related to increased rainfall during October and November.

The turbidity levels at the Glendine and Tourig abstractions ranged between 0.72 and 12.3.

Table 10-9 Field Hydrochemistry Results (Rounds 1 – 3)

Location	EC (µS/cm)			pH			Dissolved Oxygen (%)			Turbidity (NTU)		
	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3
SW1	198	162	131	7.4	6.99	7.06	92	89.1	84.1	1.03	0.89	31.2
SW2	213	181	151	7.8	7.49	6.82	98	90.7	88.5	4.43	2.15	17.8
SW3	177	160	131	7.6	7.23	6.63	78	80	82.8	2.63	19.7	18.9
SW4	205	188	169	7.6	7.44	7.28	106.9	90.5	87.4	0.89	0.98	15.2
SW5	220	177	194	7.4	7.54	7.18	95	92.6	85.5	0.39	3.49	144
SW6	N/A	N/A	147	Dry	Dry	7.46	Dry	Dry	89.7	Dry	Dry	Dry

R1 (Round 1) – 17/09/2018, R2 (Round 2) – 17/10/2018, R3 (Round 3) – 06/11/2018

Table 10-10 Field Hydrochemistry Results Rounds 4 - 6)

Location	EC (µS/cm)			pH			Dissolved Oxygen (%)			Turbidity (NTU)		
	R4	R5	R6	R4	R5	R6	R4	R5	R6	R4	R5	R6
SW1			81.2			7.7			9.93			0.58
SW2	133.4	120.6	160	7.67	7.1	8.3	96.3	96.3	10.3	10.1	9.4	1.83
SW3			134.3			8.3			10.2			1.36
SW4	-	-		-	-		-	-		-	-	
SW5	162.4	154.1	148	7.5	7.1	8.4	95.8	94.2	10.2	8.2	5.22	1.82
SW6			135.1			8.6			10.4			1.96
Glendine Gravity Intake	155	126.5	144.7	7.4	7.3	8.1	96	94.8	10.6	8.7	9.08	0.72
Tourig Intake	224.4	198.3	213.5	7.8	7.6	8.2	99.5	98.2	11.1	10.8	12.3	4.32

R4 (Round 4) – 30/01/2019, R5 (Round 5) – 05/02/2019, R6 (Round 6) – 04/06/2020

Surface water sampling was completed at the downstream monitoring locations SW1 – SW5 on 19th September and 17th October 2018. The watercourse at SW6 was dry during the monitoring period and therefore no sample was taken there. A further round of sampling was completed on 4th June 2020, with the exclusion of SW4 due to a revised turbine/infrastructure layout. The laboratory results are shown in Table 10-11, Table 10-12 and Table 10-13 below.

Surface water sampling was also completed at the Glendine gravity intake and the Tourig intake (which supply the Youghal PWS) between 8th and 31st January 2019 (3 rounds), with a further round conducted on 4th June 2020 and these results are shown in Table 10-14 below. Laboratory reports are shown as **Appendix 10-2**.

Results are discussed separately below for the Proposed Development site downstream monitoring locations (SW1 – SW6) and the Youghal PWS intake locations.

Table 10-11 Analytical Results of Surface Water Samples (Round 1 – 19/09/2018)

Parameter	EQS	Sample ID					
		SW1	SW2	SW3	SW4	SW5	SW6
Total Suspended Solids (mg/L)	25(+)	<5	<5	<5	<5	<5	N/A
Ammonia N (mg/L)	Good Status: ≤0.065 High Status ≤ 0.04(*)	0.03	0.03	0.04	0.02	0.03	N/A
Nitrite NO2 (mg/L)	-	<0.05	<0.05	<0.05	<0.05	<0.05	N/A
Ortho-Phosphate – P (mg/L)	Good Status ≤ 0.035 to High Status: ≤0.025(*)	0.02	0.03	<0.02	0.04	0.03	N/A
Nitrate - NO3 (mg/L)	-	14.5	8.5	5	8.2	11.8	N/A
Nitrogen (mg/L)	-	3.9	2.6	3.4	6.9	5.6	N/A
Phosphorus (mg/L)	-	<0.10	<0.10	<0.10	<0.10	<0.10	N/A
Chloride (mg/L)	-	19.6	19.6	20.6	20.6	20.1	N/A
BOD	Good Status: ≤ 1.5 High Status: ≤ 1.3(*)	2	2	2	2	2	N/A

(+) S.I. No. 293 of 1988: Quality of Salmon Water Regulations.

(*) S.I. No. 272 of 2009: European Communities Environmental Objectives (Surface Waters) Regulations 2009.

Table 10-12 Analytical Results of Surface Water Samples (Round 2 – 17/10/2018)

Parameter	EQS	Sample ID					
		SW1	SW2	SW3	SW4	SW5	SW6
Total Suspended Solids (mg/L)	25$^{(+)}$	<5	<5	44	16	<5	N/A
Ammonia (mg/L)	Good Status: ≤0.065 High Status ≤ 0.04(*)	0.03	<0.02	<0.02	<0.02	<0.02	N/A
Nitrite NO2 (mg/L)	-	<0.05	0.05	<0.05	<0.05	<0.05	N/A
Ortho-Phosphate – P (mg/L)	Good Status ≤ 0.035 to High Status: ≤0.025(*)	<0.02	0.02	0.04	<0.02	<0.02	N/A
Nitrate - NO3 (mg/L)	-	9.2	10.2	<5.0	10	13	N/A
Nitrogen (mg/L)	-	1.8	2.8	2.4	4.4	3.4	N/A
Phosphorus (mg/L)	-	<0.10	0.19	0.15	0.13	<0.10	N/A
Chloride (mg/L)	-	19.6	21.5	21.6	19.9	18.8	N/A
BOD	Good Status: ≤ 1.5 High Status: ≤ 1.3(*)	<2	<2	<2	<2	<2	N/A

Table 10-13 Analytical Results of Surface Water Samples (Round 3 - 04/06/2020)

Parameter	EQS	Sample ID					
		SW1	SW2	SW3	SW4	SW5	SW6
Total Suspended Solids (mg/L)	25(+)	<5	<5	<5	-	<5	9
Ammonia (mg/L)	Good Status: ≤0.065 High Status ≤ 0.04(*)	<0.02	0.07	0.03	-	0.03	<0.02
Nitrite NO2 (mg/L)	-	<0.05	<0.05	<0.05	-	<0.05	<0.05
Ortho-Phosphate – P (mg/L)	Good Status ≤ 0.035 to High Status: ≤0.025(*)	0.01	0.02	0.01	-	0.02	0.02
Nitrate - NO3 (mg/L)	-	12	5.1	6.9	-	13.9	13.4
Nitrogen (mg/L)	-	3.1	1.9	1.1	-	3.3	4.6
Phosphorus (mg/L)	-	<0.10	<0.10	<0.10	-	<0.10	<0.10
Chloride (mg/L)	-	-	-	-	-	-	-
BOD	Good Status: ≤ 1.5 High Status: ≤ 1.3(*)	<1	<1	<1	-	2	2

Table 10-14 Analytical Results of Surface Water Samples taken at the Youghal PWS Intakes

Parameter	EQS	Sample ID							
		Glendine Intake R1	Glendine Intake R2	Glendine Intake R3	Glendine Intake R4	Tourig Intake R1	Tourig Intake R2	Tourig Intake R3	Tourig Intake R4
Total Suspended Solids (mg/L)	25(+)	<5	<5	<5	<5	<5	<5	<5	7
Ammonia (mg/L)	Good Status: ≤0.065 High Status ≤ 0.04(*)	0.04	0.03	0.03	0.02	0.03	0.17	0.02	<0.02
Nitrite NO2 (mg/L)	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ortho-Phosphate – P (mg/L)	Good Status ≤ 0.035 to High Status: ≤0.025*	<0.02	<0.02	<0.02	0.01	0.02	0.03	0.02	0.01
Nitrate - NO3 (mg/L)	-	12.6	11	8.5	12.5	31.7	29	18.7	19.5
Nitrogen (mg/L)	-	3.1	5.7	2.0	3.1	11.5	8.2	4.5	4.5
Phosphorus (mg/L)	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.11	<0.10
Chloride (mg/L)	-	19.7	19.7	19.2	-	21.3	24.8	21.1	-
BOD	Good Status: ≤ 1.5 High Status: ≤ 1.3*	2	<2	3	<1	<2	<2	2	<1

R1 (Round 1) – 08/01/2019, R2 (Round 2) – 24/01/2019, R3 (Round 3) – 31/01/2019, R4 (Round 4) – 04/06/2020

Wind Farm Development Site Downstream Monitoring Locations

Total suspended solids (TSS) at all sampling locations during Round 1 and Round 3 of sampling were reported as <5mg/L. TSS values were similar in Round 2 except for SW3 and SW4 where a TSS values of 44 and 16mg/L were reported. There was only 1 no. exceedance of S.I. No. 293 of 1988 (Quality of Salmon Water Regulations) threshold values of 25mg/L and this was SW3 in Round 2.

Ammonia levels in all 3 no. sampling rounds were relatively low (0.02 – 0.04mg/L) and were generally close to the water quality threshold value for Salmonid waters (S.I 293 of 1988) of <0.02mg/L, however 5 no. the total 10 no. samples (R1 & R2) exceeded the 0.02mg/L threshold, with the highest exceedance of 0.07 mg/L at SW2 during Round 3.

Nitrite values during all sampling rounds was below the laboratory detection limit of <0.05mg/L. Nitrate values ranged between <5 and 14.5mg/L.

Ortho-phosphate was relatively low during sampling with a range of <0.02 and 0.04mg/L and BOD was reported as 2mg/L or less.

In comparison to the Environmental Objectives Surface Water Regulations (S.I. 272 of 2009), all results for ammonia N were within the "High Status" threshold of ≤0.04 mg/l, apart from SW2 during Round 3 (0.07 mg/L).

All results for ortho-phosphate were below the "Good Status" threshold apart from SW4 in Round 1 and SW3 in Round 2 where 0.04mg/L was reported in both cases. 11 no. the total 15 no. samples were also below the "High Status" threshold of 0.025mg/L.

BOD was below or at the detection limit of 2 mg/l for all samples, which exceeds of both the "Good status" and "High status" threshold values.

Youghal PWS Surface Water Intake Locations

The Glendine gravity intake and the Tourig intake were sampled on four occasions as part of this assessment. TSS were <5mg/L in all 4 no. sampling rounds from the Glendine Intake and in 3 of 4 no. rounds at Tourig, with a value of 7 mg/L reported during the fourth round (04/06/2020).

Ammonia was low in all samples with the exception of the Tourig Round 2 sample where 0.17mg/L was reported.

Nitrate, which ranged between 8.5 and 31.7mg/L (average 18.5mg/L), is slightly higher than the further upstream windfarm monitoring locations (SW1-SW6) and this is likely due to an increase in agricultural land coverage and farmyards with downstream distance. Nitrite levels were all below 0.05mg/L which is the same as the upstream windfarm site monitoring locations.

The range in ortho-phosphate levels was <0.02 and 0.03mg/L which is similar to the upstream windfarm site monitoring locations and similarly BOD values ranged between <1 and 3mg/L.

10.3.9 Hydrogeology

The Old Red Sandstones (ORS) which underlie the Proposed Development site are classified by the GSI (www.gsi.ie) as a Locally Important Aquifer - Bedrock which is moderately productive only in local zones local zones (LI).

In terms of local Groundwater Bodies (GWBs), the Proposed Development site is located in the Glenville GWB (GWB: IE_SW_G_037).

The ORS rocks have no intergranular permeability. Groundwater flow occurs in faults and joints which vary in presence and frequency. Most groundwater flow probably occurs in an upper shallow weathered zone. Below this in the deeper zones water-bearing fractures and fissures are less frequent and less well connected. The water table is generally within 10 m of the surface. Groundwater in this GWB is generally unconfined. Local groundwater flow is towards the rivers and streams, and flow paths will not usually exceed a few hundred metres (200-300m) in length.

Local groundwater flow directions will mimic topography, whereby flowpaths will be from topographic high points to lower elevated discharge areas at local streams (GSI, 2004).

Baseflow contribution to streams tends to be low, particularly in summer as the groundwater regime cannot sustain significant summer baseflows due to low storativity within the aquifer.

No groundwater inflows of any significant were encountered during the trial pit investigation (refer to 9.3.2 of the Land and Soils Chapter – Chapter 9).

10.3.10 Groundwater Vulnerability

The GSI mapped vulnerability rating of the aquifer within the Proposed Development site ranges between "High vulnerability" to "Extreme vulnerability (X)" and this reflects the varying depth and permeability of the local subsoils. The majority of the western cluster is mapped as "High vulnerability" and with the presence of moderate permeability subsoils. During the trial pit investigation varying depths (0.85 to 2.2mbgl) of Devonian derived glacial tills were encountered at the western cluster which would indicate a predominant Extreme vulnerability rating.

The northern half of the eastern cluster is mapped as "High vulnerability" with the southern area mapped as "Moderate vulnerability" and given that moderate permeability subsoils are mapped on the south of the cluster too, this would suggest subsoils are deeper (potentially up to 10m) on the south of the site. 3 no. of the 11 turbines in the eastern cluster are mapped in an area of "Moderate vulnerability" and the rest are located in "High vulnerability" mapped areas.

Based on the trial pit investigation, subsoils are generally thicker across the eastern cluster of the wind farm compared with the western cluster.

However, due to the relatively low permeability nature of the Old Red Sandstone underlying the Proposed Development site, groundwater flow paths are likely to be short, with recharge emerging close by at seeps and surface streams. This means there is a low potential for groundwater dispersion and movement within the aquifer, making surface water bodies such as streams more vulnerable than groundwater at this site.

10.3.11 Groundwater Hydrochemistry

There is no groundwater quality data for the Proposed Development site and groundwater sampling would generally not be undertaken for this type of development in terms of EIAR reporting as groundwater quality impacts would not be anticipated.

The Old Red Sandstone formations largely contain calcium bicarbonate type water (Working Group on Groundwater, 2004). This indicates that these groundwaters largely contain the more readily dissolved ions such as calcium and bicarbonate. Conductivities in these units are relatively low ranging from 125 to 600µS/cm, with an average of 300µS/cm. Iron (Fe) and manganese (Mn) commonly occur in groundwater derived from sandstone and shale formations, due to the dissolution of Fe and Mn from the sandstone/shale where reducing conditions occur.

10.3.12 Groundwater Body Status

Local Groundwater Body (GWB) status information are available (www.catchments.ie).

The Glenville GWB (GWB: IE_SW_G_037) underlies the Proposed Development site. It is assigned 'Good Status', which is defined based on the quantitative status and chemical status of the GWB.

10.3.13 WFD River Water Quality Status and Risk

River water quality and risk result date are available from (www.catchments.ie).

The Bride River, Tourig River and Glendine River have been assigned a "Good Status" (2013-2018) while the Glenaboy River has been assigned a "Moderate Status". The is no WFD status for the Kilbeg Stream.

The Lower Blackwater Estuary has been assigned a "Moderate Status".

In terms of risk the Bride River, Tourig River and Glendine River are assigned "Not At Risk" while the Kilbeg Stream has been assigned "At Risk".

10.3.14 Designated Sites and Habitats

Designated sites include National Heritage Areas (NHAs), Proposed National Heritage Areas (pNHAs) Special Areas of Conservation (SACs), candidate Special Areas of Conservation (cSAC) and Special Protection Areas (SPAs). The Proposed Development site is not located within any designated conservation-site. Designated sites in proximity to the proposed development site are shown in **Figure 10-4**.

The Proposed Development site drains to the Blackwater River which is a designated SAC (Blackwater River SAC – Site code: 002170), proposed NHA (Blackwater River and Estuary - Site code: 000072) and SPA (Blackwater Estuary SPA – Site code:004028).

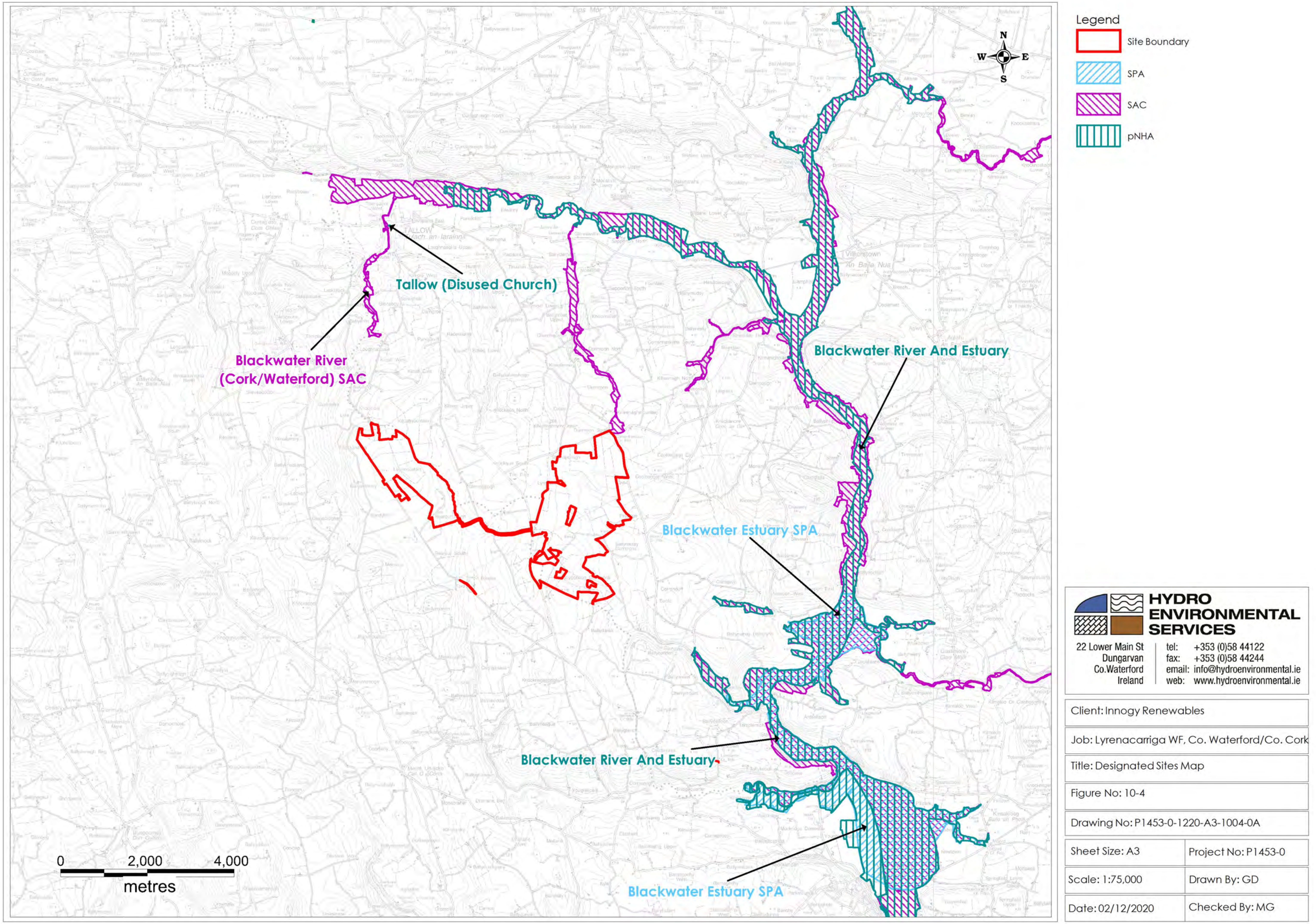
This SAC includes the downstream section of the Glenaboy River near Tallow and also the River Bride.

The Blackwater River SAC/pNHA continues south towards Youghal. The western cluster of the site which is within the Tourig River subcatchment ultimately drain towards the lower sections of the River Blackwater SAC.

10.3.15 Groundwater Supplies

There are no mapped groundwater source protection areas for either public water supplies or group water schemes (National Federation Group Water Schemes registered) in the area of the Proposed Development.

Groundwater abstractions for the Tallow Public Water Supply (3100PUB1096) are located to the north of the Proposed Development. The Tallow scheme has three bored production wells which are used to supplement a surface water abstraction/off-take (discussed above). Two of the wells are located within the same compound as the surface water off-take which is situated 1km to the northwest of the western cluster and 1 no. well is located at the Tallow reservoir site which is located approximately 2.5km to the northwest of the western cluster. The locations of the public supply wells are shown on **Figure 10-5**.



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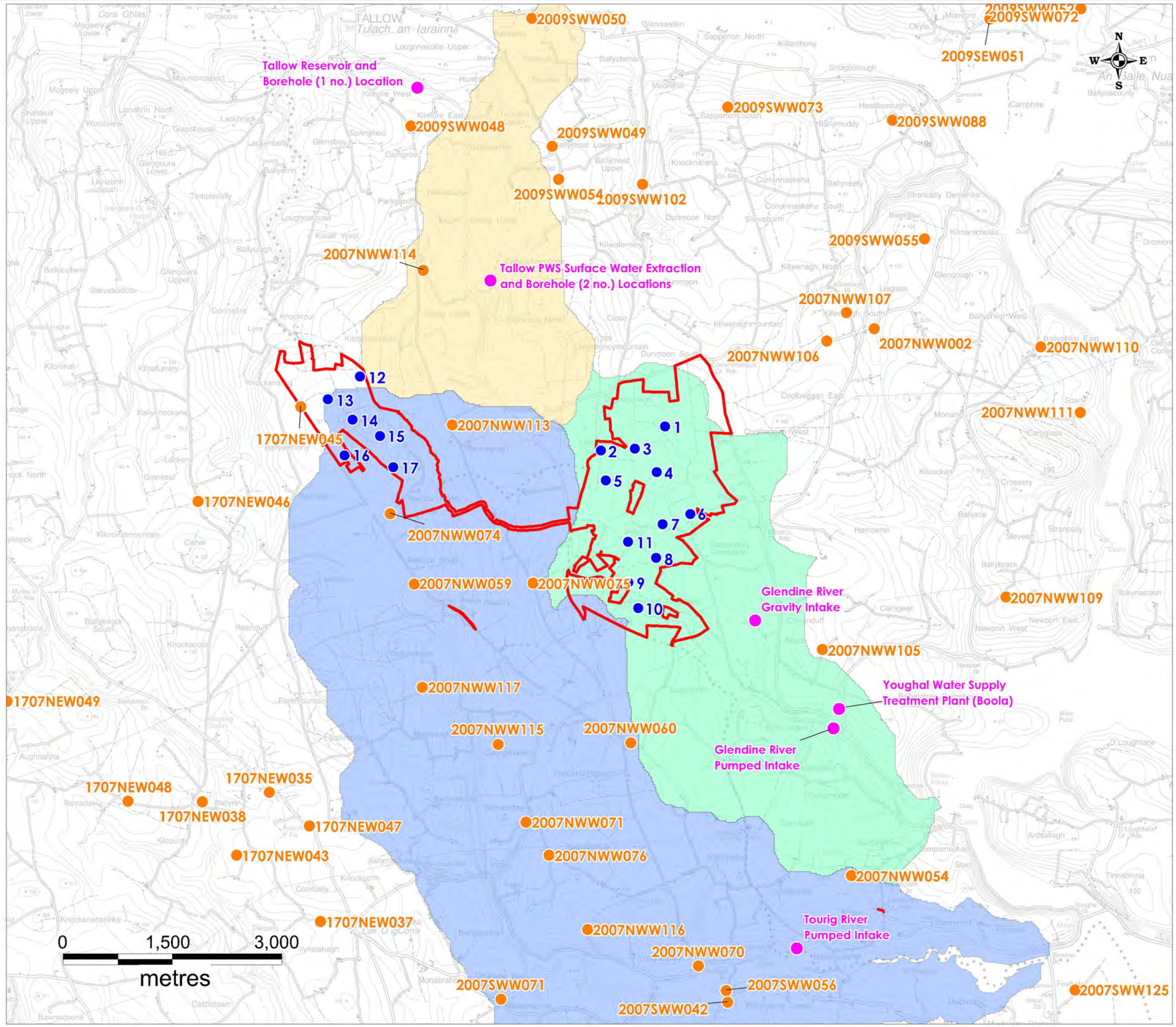
Client: Innogy Renewables	
Job: Lyrenacarriga WF, Co. Waterford/Co. Cork	
Title: Designated Sites Map	
Figure No: 10-4	
Drawing No: P1453-0-1220-A3-1004-0A	
Sheet Size: A3	Project No: P1453-0
Scale: 1:75,000	Drawn By: GD
Date: 02/12/2020	Checked By: MG



Legend

- Site Boundary
- Proposed Turbine Layout
- GSI Mapped Wells (<50m accuracy)
- The Glendine River Catchment
- The Kilbeg Stream Catchment
- SW Abstraction Point

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Client: Innogy Renewables	
Job: Lyrenacarriga WF, Co. Waterford/Co. Cork	
Title: Local Water Supplies Map	
Figure No: 10-5	
Drawing No: P1453-0-1220-A3-1005-0A	
Sheet Size: A3	Project No: P1453-0
Scale: 1:30,000	Drawn By: GD
Date: 02/12/2020	Checked By: MG

The estimated groundwater zone of contribution (ZOC) to these wells covers the elevated ground to the west of the surface water offtake compound and the lands to the southwest of the Tallow reservoir site. There is no proposed wind farm development in the ZOC of these Tallow PWS wells.

Private well locations (accuracy of <50m only) were reviewed using GSI well database (www.gsi.ie) and only 2 no. wells are mapped within 1km of the Proposed Development site (refer to **Figure 10-5**). The GSI reference for these wells, both of which are agricultural/domestic use, is 2007NWW114 and 2007NWW113. Both wells are located at least 1km from the closest proposed wind farm infrastructure with no development proposed upslope/upgradient of either well location.

GSI mapped wells with accuracy greater than 50m were not assessed due to the poor information/accuracy regarding their location. To overcome the poor accuracy problem of other GSI mapped wells (>50m accuracy) it is conservatively assumed (for the purpose of assessment only) that every private dwelling in the area (shown on **Figure 10-5**) has a well supply and this impact assessment approach is described further below. (Please note wells may or may not exist at each property, but our conservative rationale here is that it is better to assume a well may exist at each downgradient property and assess the potential impacts from the proposed development on such assumed wells, rather than make no assessment and find out later that groundwater wells do actually exist).

The private well assessment undertaken assumes the groundwater flow direction underlying the site mimics topography, whereby flow paths will be from topographic high points (i.e. top of hill) to lower elevated discharge areas at local streams/rivers. This is consistent with groundwater body conceptual model as reported by the GSI (2004).

Using this conceptual model of groundwater flow, dwellings that are potentially located down-gradient of the footprint of the Proposed Development are identified and an impact assessment for these actual and potential well locations is undertaken if required.

Based on the above approach no private dwelling houses were identified to be located down-gradient (i.e. downslope) of the proposed wind farm infrastructure (and, in particular, turbine and borrow pit locations where deep excavations are required) and therefore there is no potential to impact on groundwater supplies. This assessment was focused on the turbine locations and borrow pits as this is where the deepest excavations will be required. All excavations required for roads, compounds, substation, met mast and cabling will be relatively shallow (~1.2m) and therefore have no potential to impact on groundwater supplies.

10.3.16 Receptor Sensitivity

Due to the nature of wind farm developments, being near surface construction activities, impacts on groundwater are generally negligible and surface water is generally the main sensitive receptor assessed during impact assessments. The primary risk to groundwater at the site would be from cementitious materials, hydrocarbon spillage and leakages. These are common potential impacts on all construction sites (such as road works and industrial sites). All potential contamination sources will be carefully managed at the site during the construction, operational and decommissioning phases of the development and mitigation measures are proposed below to deal with these potential minor impacts.

Based on criteria set out in **Table 10-1**, groundwater at the site can be classed as Sensitive to pollution because the bedrock is classified as a Locally Important aquifer. However, due to the localised nature of groundwater flow in the area of the site, any contaminants which may be accidently released on-site are more likely to travel to nearby streams within surface runoff. Also due to the shallow nature of the construction works and the localised nature of groundwater flow, domestic water supply wells are not considered to be sensitive to impact.

Surface waters such as the Glendine River, Tourig River, Glenaboy River and River Bride can be considered Very Sensitive to potential contamination due to their fisheries potential, the presence of public drinking water supply abstractions (i.e. Youghal PWS schemes) and finally because all the above watercourses flow into Blackwater River SAC.

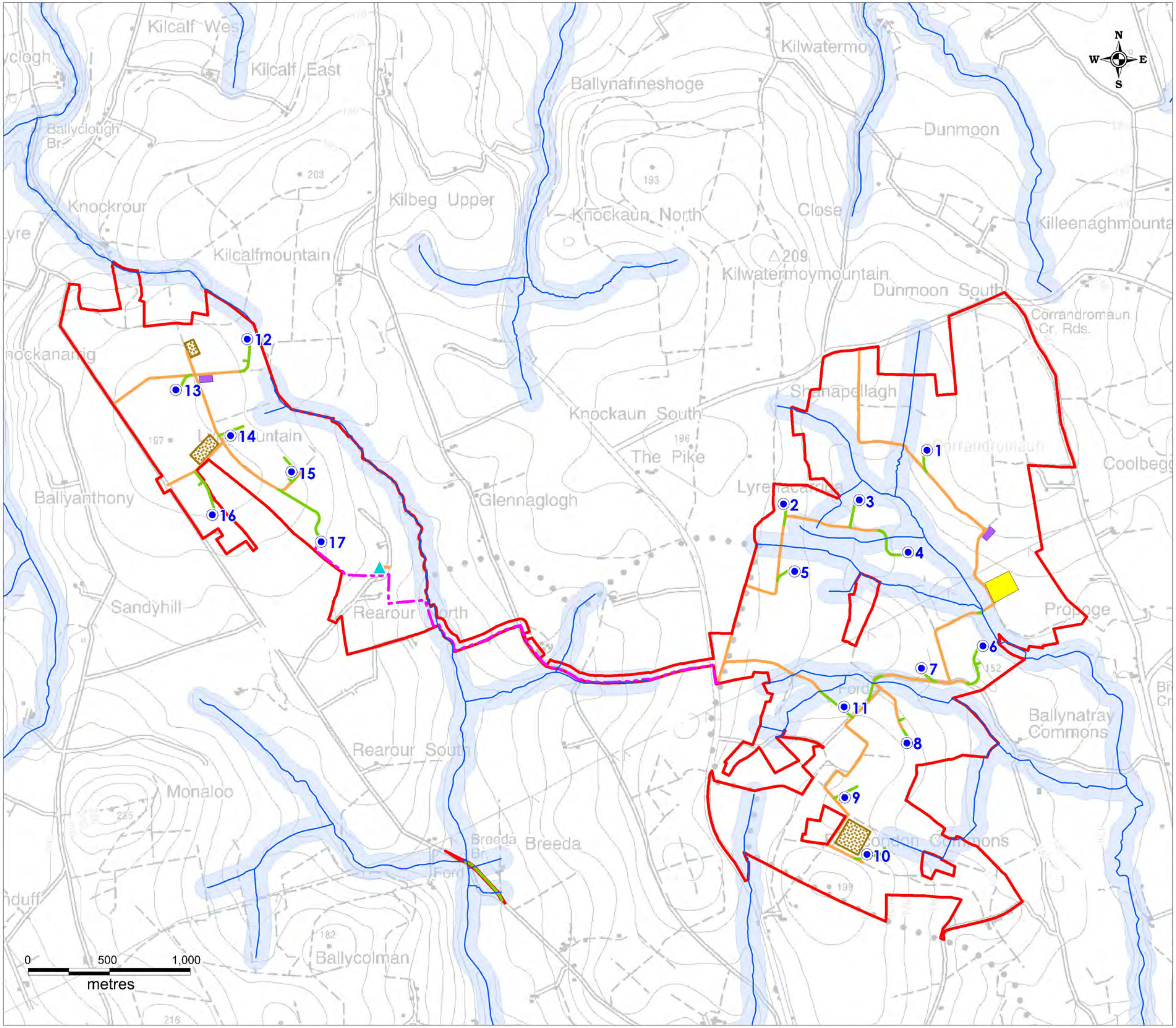
The Youghal PWS scheme surface water abstractions are very sensitive to changes in surface water turbidity as manual adjustments are required based on testing of raw water inflows to the treatment plant at Boola.

The designated sites that are hydraulically connected (surface water flow paths only) to the proposed wind farm development site includes the Blackwater River and Estuary NHA and the Blackwater River SAC. These designated sites can be considered Very Sensitive in terms of potential impacts (see Chapter 6 of the EIAR).

Comprehensive surface water mitigation and controls are outlined below to ensure protection of all downstream receiving waters. Mitigation measures will ensure that surface runoff from the developed areas of the site will be of a high quality. The lack of peat at the site (foundations will be excavated in tills and bedrock), means settlement of mineral soil suspended solids in construction runoff will be done effectively Any introduced drainage works at the site will mimic the existing hydrological regime thereby avoiding changes to flow volumes leaving the site. These drainage management controls are outlined in detail below.

A hydrological constraints map for the site is shown as **Figure 10-6**. A self-imposed 75m buffer from the main streams was applied during the constraints mapping and will be maintained during the construction phase. As standard practice, a 50m buffer would normally be used for this purpose, but due to the high sensitivity of the downstream public surface water abstractions and designated sites (SACs), the separation distance between sensitive watercourses (stream/rivers) at the site and infrastructure such as turbines, borrow pits, met mast, and substation is increased by 50%.

Apart from the new watercourse crossings and upgrade of existing watercourse crossings (and associated sections of existing forestry tracks) which are described in Section 10.5.2 below, all other areas of the Proposed Development infrastructure are away from areas on the site that have been determined to be hydrologically sensitive. The very large setback distance of more than 75m (50% greater than what is typically used) from sensitive hydrological features, coupled with good practice work methodology and robust site-specific drainage means they will not be impacted by excavations/drains etc. It also allows adequate room for the proposed drainage mitigation measures (discussed below) to be installed up-gradient of primary drainage features within each sub-catchment. This will allow attenuation and treatment of surface runoff to be more effective before it reaches local watercourses.



Legend

- Site Boundary
- Proposed Turbine Layout
- Proposed Cable Route
- Proposed Met Mast
- Proposed Substation
- Proposed Construction Compound
- Proposed Borrow Pit
- Existing Road Proposed to be Upgraded
- Proposed New Road
- Watercourse
- 75m River Buffer

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Client: Innogy Renewables	
Job: Lyrenacarriga WF, Co. Waterford/Co. Cork	
Title: Hydro-Constraints Map	
Figure No: 10-6	
Drawing No: P1453-0-1220-A3-1006-0A	
Sheet Size: A3	Project No: P1453-0
Scale: 1:22,500	Drawn By: GD
Date: 02/12/2020	Checked By: MG

10.4 Characteristics of the Proposed Development

10.4.1 Development Interaction with the Existing Forestry Drainage Network

In relation to hydrological constraints, a self-imposed conservative buffer zone of 75m has been put in place for on-site streams/rivers. Manmade forestry drains at the site are not considered a hydrological constraint and therefore no buffering of forestry drains has been undertaken.

The general design approach to wind farm layouts in existing forestry is to utilize and integrate with the existing forestry infrastructure where possible whether it be existing access roads or the existing forestry drainage network. Utilising the existing infrastructure means that there will be less of a requirement for new construction/excavations which have the potential to impact on downstream watercourses in terms of suspended solid input in runoff (unless managed appropriately). The existing forestry drains have no major ecological or hydrological value and can be readily integrated into the proposed wind farm drainage scheme using the methods outlined below (Sections 10.5.2.2 and 9.5.3.1).

The drainage design drawings are presented in Appendix 4-6 of this EIAR.

10.4.2 Proposed Drainage Management

Runoff control and drainage management are key elements in terms of mitigation against impacts on surface water bodies. Two distinct methods will be employed to manage drainage water within the Proposed Development. The first method involves 'keeping clean water clean' by avoiding disturbance to natural drainage features, minimising any works in or around artificial drainage features, and diverting clean surface water flow around excavations, construction areas and temporary storage areas. The second method involves collecting any drainage waters from works areas within the site that might carry silt or sediment, and nutrients, to route them towards stilling ponds prior to controlled diffuse release over vegetated surfaces. There will be no direct discharges to surface waters. During the construction phase all runoff from works areas (i.e. dirty water) will be attenuated and treated to a high quality prior to being released.

A schematic of the proposed site drainage management is shown as **Plate 10-4** below. A detailed drainage plan showing the layout of the proposed drainage design elements as shown in **Plate 10-4** is attached in Appendix 4-6 of this EIAR.

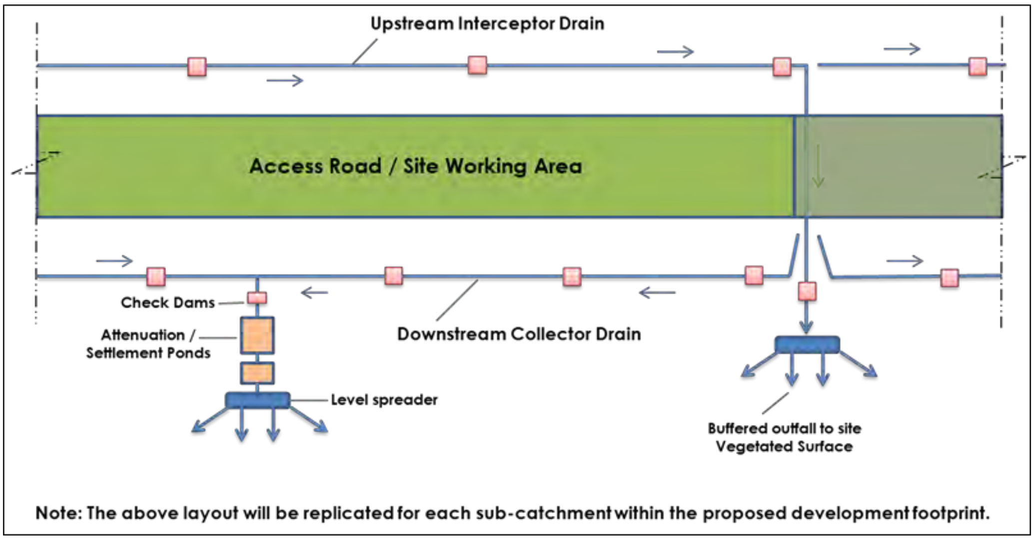


Plate 10-4 Schematic of Proposed Site Drainage Management

10.5 Likely and Significant Effects and Mitigation Measures

The potential effects of the Proposed Development and mitigation measures that will be put in place to eliminate or reduce them are set out below.

10.5.1 Do Nothing Scenario

Current land use practices will continue. In particular commercial deforestation and reforestation will continue at the site. Surface water drainage carried out in areas of forestry will continue to function and may be extended in some areas.

The do-nothing scenario would also not contribute to renewable energy targets as set by the state.

10.5.2 Construction Phase – Likely Effects and Mitigation Measures

10.5.2.1 Clear Felling of Coniferous Plantation

A total of 45.6 hectares of forestry will have to be permanently felled within and around the footprint of the Proposed Development. The temporary felling area amounts to 5.4ha.

The tree felling activities required as part of the Proposed Development will be the subject of a Felling Licence application to the Forest Service, in accordance with the Forestry Act 2014 and the Forestry Regulations 2017 (SI 191/2017) and as per the Forest Service's policy on granting felling licenses for wind farm developments.

Pathways: Drainage and surface water discharge routes.

Receptors: Surface waters and associated dependant ecosystems.

Potential Impacts: Direct, negative, moderate, short term, high probability effect.

Potential effects during tree felling occurs mainly from:

- Exposure of soil and subsoils due to vehicle tracking, and skidding or forwarding extraction methods resulting in a source of suspended sediment which can become entrained in surface water runoff and enter surface water courses;
- Entrainment of suspended sediment in watercourses due to vehicle tracking through watercourses;
- Damage to roads resulting in a source of suspended sediment which can become entrained in surface water runoff and enter surface water courses;
- Release of sediment attached to timber in stacking areas; and,
- Nutrient release.

Pathways: Drainage and surface water discharge routes.

Receptors: Surface waters (Blackwater River, Glendine River, Tourig River, Glenaboy River and Bride River) and associated dependant ecosystems.

Pre-Mitigation Potential Impact: Indirect, negative, moderate, temporary, likely effect.

Proposed Mitigation Measures:

Best practice methods related to water incorporated into the forestry management and mitigation measures have been derived from:

- Forestry Commission (2004): Forests and Water Guidelines, Fourth Edition. Publ. Forestry Commission, Edinburgh;
- Coillte (2009): Forest Operations and Water Protection Guidelines;
- Coillte (2009): Methodology for Clear Felling Harvesting Operations;
- Forest Service (Draft): Forestry and Freshwater Pearl Mussel Requirements – Site Assessment and Mitigation Measures; and,
- Forest Service (2000): Forestry and Water Quality Guidelines. Forest Service, DAF, Johnstown Castle Estate, Co. Wexford.

Mitigation by Avoidance:

There is a requirement in the Forest Service Code of Practice and in the FSC Certification Standard for the installation of buffer zones adjacent to aquatic zones at planting stage. Minimum buffer zone widths recommended in the Forest Service (2000) guidance document "Forestry and Water Quality Guidelines" are shown in Table 10-15.

Table 10-15 : Minimum Buffer Zone Widths (Forest Service, 2000)

Average slope leading to the aquatic zone		Buffer zone width on either side of the aquatic zone	Buffer zone width for highly erodible soils
Moderate	(0 – 15%)	10 m	15 m
Steep	(15 – 30%)	15 m	20 m
Very steep	(>30%)	20 m	25 m

During the wind turbine construction phase a self-imposed conservative buffer zone of 75 metres will be maintained for all streams where possible. These buffer zones are shown on **Figure 10-6**. With the exception of existing road/crossing upgrades and proposed stream crossings, the proposed tree felling areas are generally located outside of imposed buffer zones.

Only 2.9ha of the total proposed tree felling area (45.6 ha) will be required inside the 75-metre buffer zone. Additional mitigation (detailed below) will be carried where tree felling is required inside the buffer zones.

The large distance between the majority of the proposed felling areas and sensitive aquatic zones means that potential poor-quality runoff from felling areas can be adequately managed and attenuated prior to even reaching the aquatic buffer zone and primary drainage routes. Where tree felling is required in the vicinity of streams, the following additional mitigation measures will be employed.

Mitigation by Design:

Mitigation measures which will reduce the risk of entrainment of suspended solids and nutrient release in surface watercourses comprise best practice methods which are set out as follows:

- Machine combinations (i.e. handheld or mechanical) will be chosen which are most suitable for ground conditions and which will minimise soils disturbance;
- Checking and maintenance of roads and culverts will be on-going through any felling operation. No tracking of vehicles through watercourses will occur, as vehicles will use road infrastructure and existing watercourse crossing points. Where possible, existing drains will not be disturbed during felling works;

- Removing clay, soil, silts from roads during wet periods and dust suppression during dry spells;
- Ditches which drain from the proposed area to be felled towards existing surface watercourses will be blocked, and temporary silt traps will be constructed. No direct discharge of such ditches to watercourses will occur. Drains and sediment traps will be installed during ground preparation. Collector drains will be excavated at an acute angle to the contour (~0.3%-3% gradient), to minimise flow velocities. Main drains to take the discharge from collector drains will include water drops and rock armour, as required, where there are steep gradients, and should avoid being placed at right angles to the contour;
- Sediment traps will be sited in drains downstream of felling areas. Machine access will be maintained to enable the accumulated sediment to be excavated. Sediment will be carefully disposed of in the disposal areas. Where possible, all new silt traps will be constructed on even ground and not on sloping ground;
- In areas particularly sensitive to erosion or where felling inside the 75 metre buffer is required, it will be necessary to install double or triple sediment traps;
- All drainage channels will taper out before entering the 75m buffer zone. This ensures that discharged water gently fans out over the buffer zone before entering the aquatic zone, with sediment filtered out from the flow by ground vegetation within the zone. On erodible soils, silt traps will be installed at the end of the drainage channels, to the outside of the buffer zone;
- Drains and silt traps will be maintained throughout all felling works, ensuring that they are clear of sediment build-up and are not severely eroded. Correct drain alignment, spacing and depth will ensure that erosion and sediment build-up are minimized and controlled;
- Brash mats will be used to support vehicles on soft ground, reducing mineral soils erosion and avoiding the formation of rutted areas, in which surface water ponding can occur. Brash mat renewal should take place when they become heavily used and worn. Provision should be made for brash mats along all off-road routes, to protect the soil from compaction and rutting. Where there is risk of severe erosion occurring, extraction should be suspended during periods of high rainfall;
- Timber will be stacked in dry areas, and outside a local 75 metre watercourse buffer. Straw bales and check dams to be emplaced on the down gradient side of timber storage/processing sites;
- Works will be carried out during periods of no, or low rainfall, in order to minimise entrainment of exposed sediment in surface water run-off;
- Checking and maintenance of roads and culverts will be on-going through the felling operation;
- Refuelling or maintenance of machinery will not occur within 100m of a watercourse. Mobile bowser, spill kits, qualified personnel will be used where refuelling is required;
- A permit to refuel system will be adopted:
- Branches, logs or debris will not be allowed to build up in aquatic zones. All such material will be removed when harvesting operations have been completed, but care will be taken to avoid removing natural debris deflectors;
- Crossing of streams will not be permitted;
- Trees will be cut manually from along streams and using machinery to extract whole tree; and
- Travel only perpendicular to and away from stream.

Silt Traps:

Silt traps will be strategically placed down-gradient within forestry drains near streams. The main purpose of the silt traps and drain blocking is to slow water flow, increase residence time, and allow settling of silt in a controlled manner.

Drain Inspection and Maintenance:

The following items shall be carried out during pre-felling inspections and after:

- Communication with tree felling operatives in advance to determine whether any areas have been reported where there is unusual water logging or bogging of machines;
- Plant machinery inspections to be carried out prior to any works to assure all are in condition;
- Inspection of all areas reported as having unusual ground conditions;
- Inspection of main drainage ditches and outfalls. During pre-felling inspections the main drainage ditches shall be identified. Ideally the pre-felling inspection shall be carried out during rainfall;
- Following tree felling all main drains shall be inspected to ensure that they are functioning;
- Extraction tracks nears drains need to be broken up and diversion channels created to ensure that water in the tracks spreads out over the adjoining ground;
- Culverts on drains exiting the site will be unblocked; and,
- All accumulated silt will be removed from drains and culverts, and silt traps, and this removed material will be deposited away from watercourses to ensure that it will not be carried back into the trap or stream during subsequent rainfall.

Surface Water Quality Monitoring:

Sampling will be completed before, during (if the operation is conducted over a protracted time) and after the felling activity. The 'before' sampling should be conducted within 4 weeks of the felling activity commencing, preferably in medium to high water flow conditions. The "during" sampling will be undertaken once a week or after rainfall events. The 'after' sampling will comprise as many samplings as necessary to demonstrate that water quality has returned to pre-activity status (i.e. where an impact has been shown).

Criteria for the selection of water sampling points include the following:

- Avoid man-made ditches and drains, or watercourses that do not have year round flows, i.e. avoid ephemeral ditches, drains or watercourses;
- Select sampling points upstream and downstream of the forestry activities;
- It is advantageous if the upstream location is outside/above the forest in order to evaluate the impact of land-uses other than forestry;
- Where possible, downstream locations should be selected: one immediately below the forestry activity, the second at exit from the forest, and the third some distance from the second (this allows demonstration of no impact through dilution effect or contamination by other land-uses where impact increases at third downstream location relative to second downstream location); and,
- The above sampling strategy will be undertaken for all on-site sub-catchments streams where tree felling is proposed.

Also, daily surface water monitoring forms will also be utilised at every works site near any watercourse. These will be taken daily and kept on site for record and inspection.

Residual Impact: The potential for the release of suspended solids to watercourse receptors during tree felling is a risk to water quality and the aquatic quality of the receptor. Proven forestry best practice measures to mitigate the risk of releases of sediment have been proposed above and will break the pathway between the potential sources and the receptor. The residual effect is considered to be - Negative, imperceptible, indirect, temporary, low probability effect on downstream water quality and aquatic habitats.

Significance of Effects: For the reasons outlined above, no significant effects on the surface water quality will occur.

10.5.2.2 Earthworks (Removal of Vegetation Cover, Excavations and Stock Piling) Resulting in Suspended Solids Entrainment in Surface Water

Construction phase activities that will require earthworks resulting in removal of vegetation cover and excavation of soil and mineral subsoil are detailed in Chapter 4 the Description of the Proposed Development. Potential sources of sediment laden water include:

- Drainage and seepage water resulting from infrastructure excavation;
- Stockpiled excavated material providing a point source of exposed sediment;
- Construction of the collector cable trench resulting in entrainment of sediment from the excavations during construction; and,
- Erosion of sediment from emplaced site drainage channels.

These activities can result in the release of suspended solids to surface watercourses and could result in an increase in the suspended sediment load, resulting in increased turbidity which in turn could affect the water quality and fish stocks of downstream water bodies. Potential impacts are significant if not mitigated against.

Pathways: Drainage and surface water discharge routes.

Receptors: Down-gradient rivers (Blackwater River, Glendine River, Tourig River, Glenaboy River and Bride River) and dependant ecosystems.

Pre-Mitigation Potential Impact: Indirect, negative, significant, temporary, likely impact.

Mitigation by Avoidance:

The key mitigation measure during the construction phase is the avoidance of sensitive aquatic areas where possible. From **Figure 10-6** it can be seen that all of the key areas of the Proposed Development are actually significantly away from the delineated buffer zones with the exception of existing road upgrades new roads proposed stream crossings and existing stream crossings requiring upgrading. Additional control measures, which are outlined further on in this section, will be undertaken at these locations. See Section 10.5.2.8 below for watercourse crossing details.

The large setback distance from sensitive hydrological features means that adequate room is maintained for the proposed drainage mitigation measures (discussed below) to be properly installed and operated effectively. The proposed buffer zone will:

- Avoid physical damage to watercourses, and associated release of sediment;
- Avoid excavations within close proximity to surface water courses;
- Avoid the entry of suspended sediment from earthworks into watercourses; and,
- Avoid the entry of suspended sediment from the construction phase drainage system into watercourses, achieved in part by ending drain discharge outside the buffer zone and allowing percolation across the vegetation of the buffer zone.

Mitigation by Design:

- Source controls:
  - Interceptor drains, vee-drains, diversion drains, flume pipes, erosion and velocity control measures such as use of sand bags, oyster bags filled with gravel, filter fabrics, and other similar/equivalent or appropriate systems.

- Small working areas, covering stockpiles, weathering off stockpiles, cessation of works in certain areas or other similar/equivalent or appropriate measures.
  - In-Line controls:
- Interceptor drains, vee-drains, oversized swales, erosion and velocity control measures such as check dams, sand bags, oyster bags, straw bales, flow limiters, weirs, baffles, silt bags, silt fences, sedimats, filter fabrics, and collection sumps, temporary sumps/attenuation lagoons, sediment traps, pumping systems, settlement ponds, temporary pumping chambers, or other similar/equivalent or appropriate systems.
  - Treatment systems:
- Temporary sumps and attenuation ponds, temporary storage lagoons, sediment traps, and settlement ponds, and proprietary settlement systems such as Siltbuster, and/or other similar/equivalent or appropriate systems.

It should be noted for this site that an extensive network of forestry and roadside drains already exists, and these will be integrated and enhanced as required and used within the wind farm development drainage system. The integration of the existing forestry drainage network and the proposed wind farm network is relatively simple. The key elements being the upgrading and improvements to water treatment elements, such as in line controls and treatment systems, including silt traps, stilling ponds and buffered outfalls.

The main elements of interaction with existing drains will be as follows:

- Apart from interceptor drains, which will convey clean runoff water to the downstream drainage system, there will be no direct discharge (without treatment for sediment reduction, and attenuation for flow management) of runoff from the proposed wind farm drainage into the existing site drainage network. This will reduce the potential for any increased risk of downstream flooding or sediment transport/erosion;
- Silt traps will be placed in the existing drains upstream of any streams where construction works / tree felling is taking place, and these will be diverted into proposed interceptor drains, or culverted under/across the works area;
- Runoff from individual turbine hardstanding areas will be not discharged into the existing drain network but discharged locally at each turbine location through stilling ponds and buffered outfalls onto vegetated surfaces;
- Buffered outfalls which will be numerous over the site will promote percolation of drainage waters across vegetation and close to the point at which the additional runoff is generated, rather than direct discharge to the existing drains of the site; and,
- Drains running parallel to the existing roads requiring widening will be upgraded, widening will be targeted to the opposite side of the road. Velocity reducing and silt control measures such as check dams, sand bags, oyster bags, straw bales, flow limiters, weirs, baffles, silt fences will be used during the upgrade construction works. Regular buffered outfalls will also be added to these drains to protect downstream surface waters.

Water Treatment Train:

A final line of defence will be provided by a water treatment train such as a “Siltbuster”. If the discharge water from construction areas fails to be of a high quality during regular inspections, then a filtration treatment system (such as a ‘Siltbuster’ or similar equivalent treatment train (sequence of water treatment processes)) will be used to filter and treat all surface discharge water collected in the dirty water drainage system. This will apply for all of the construction phase. As there is no requirement to construct on peat only mineral subsoils, water treatment trains will be very effective in remove suspended solids from surface water drainage.

Silt Fences:

Silt fences will be emplaced within drains down-gradient of all construction areas. Silt fences are effective at removing heavy settleable solids such as those present in the subsoils/sandstone tills that overlie the site. This will act to prevent entry to water courses of sand and gravel sized sediment, released from excavation of mineral sub-soils of glacial and glacio-fluvial origin, and entrained in surface water runoff. Inspection and maintenance of these structures during the construction phase is critical to their functioning to stated purpose. They will remain in place throughout the entire construction phase. Double silt fences will be placed within drains down-gradient of all construction areas inside the hydrological buffer zones.

Silt Bags:

Silt bags will be used where small to medium volumes of water need to be pumped from excavations. As water is pumped through the bag, the majority of the sediment is retained by the geotextile fabric allowing filtered water to pass through. Silt bags will be used with natural vegetation filters or sedimats, Sediment entrapment mats, consisting of coir or jute matting, will be placed at the silt bag location to provide further treatment of the water outfall from the silt bag. Sedimats will be secured to the ground surface using stakes/pegs. The sedimat will extend to the full width of the outfall to ensure all water passes through this additional treatment measure.

Pre-emptive Site Drainage Management

The works programme for the entire construction stage of the development will also take account of weather forecasts, and predicted rainfall in particular. Large excavations and movements of soil/subsoil or vegetation stripping will be suspended or scaled back if heavy rain is forecast. The extent to which works will be scaled back or suspended will relate directly to the amount of rainfall forecast.

The following forecasting systems are available and will be used on a daily basis at the site to direct proposed construction activities:

- General Forecasts: Available on a national, regional and county level from the Met Eireann website (www.met.ie/forecasts). These provide general information on weather patterns including rainfall, wind speed and direction but do not provide any quantitative rainfall estimates;
- MeteoAlarm: Alerts to the possible occurrence of severe weather for the next 2 days. Less useful than general forecasts as only available on a provincial scale;
- 3-hour Rainfall Maps: Forecast quantitative rainfall amounts for the next 3 hours but does not account for possible heavy localised events;
- Rainfall Radar Images: Images covering the entire country are freely available from the Met Eireann website (www.met.ie/latest/rainfall_radar.asp). The images are a composite of radar data from Shannon and Dublin airports and give a picture of current rainfall extent and intensity. Images show a quantitative measure of recent rainfall. A 3-hour record is given and is updated every 15 minutes. Radar images are not predictive; and,
- Consultancy Service: Met Eireann provide a 24-hour telephone consultancy service. The forecaster will provide interpretation of weather data and give the best available forecast for the area of interest.

Using the safe threshold rainfall values will allow work to be safely controlled (from a water quality perspective) in the event of forecasting of an impending high rainfall intensity event.

Works will be suspended if forecasting suggests either of the following is likely to occur:

- >10 mm/hr (i.e. high intensity local rainfall events);
- >25 mm in a 24-hour period (heavy frontal rainfall lasting most of the day); or,
- >half monthly average rainfall in any 7 days.

Prior to works being suspended the following control measures should be completed:

- Secure all open excavations;
- Provide temporary or emergency drainage to prevent back-up of surface runoff; and,
- Avoid working during heavy rainfall and for up to 24 hours after heavy events to ensure drainage systems are not overloaded.

Management of Runoff from Spoil Reinstatement Areas:

It is proposed that excavated soil/subsoil (spoil) will be used for landscaping throughout the site and any excess spoil will be used to reinstate the 3 no. proposed borrow pits. All the proposed borrow pits are located outside the 75m stream buffer zone (refer to **Figure 10-6**).

During the initial placement of soil and subsoil, silt fences, straw bales and biodegradable matting will be used to control surface water runoff from the reinstatement areas. 'Siltbuster' treatment trains will be employed if previous treatment as listed above is not to a high quality.

Drainage from peat reinstatement areas will ultimately be routed to an oversized swale and a number of stilling ponds and a 'Siltbuster' with appropriate storage and settlement designed for a 1 in 100 year 6 hour return period before being discharged to the on-site drains.

Soil/subsoil reinstatement areas will be sealed with a digger bucket and vegetated as soon as possible to reduce sediment entrainment in runoff. Once re-vegetated and stabilised soil/subsoil reinstatement areas will no longer be a potential source of silt laden runoff.

Timing of Site Construction Works:

Construction of the site drainage system will only be carried out during periods of low rainfall, and therefore minimum runoff rates. This will minimise the risk of entrainment of suspended sediment in surface water runoff, and transport via this pathway to surface watercourses. Construction of the drainage system during this period will also ensure that attenuation features associated with the drainage system will be in place and operational for all subsequent construction works.

Monitoring:

An inspection and maintenance plan for the on-site construction drainage system will be prepared in advance of commencement of any works. Regular inspections of all installed drainage systems will be undertaken, especially after heavy rainfall, to check for blockages, and ensure there is no build-up of standing water in parts of the systems where it is not intended. Inspections will also be undertaken after tree felling.

Any excess build-up of silt levels at dams, the settlement pond, or any other drainage features that may decrease the effectiveness of the drainage feature, will be removed. Checks will be carried out on a daily basis.

During the construction phase field testing and laboratory analysis of a range of parameters with relevant regulatory limits and EQSs will be undertaken for each primary watercourse, and specifically following heavy rainfall events (as per the CEMP is included in Appendix 4-4 of this EIAR).

Residual Impact: The potential for the release of suspended solids to watercourse receptors is a risk to water quality and the aquatic quality of the receptor. Proven and effective measures to mitigate the risk of releases of sediment have been proposed above and will break the pathway between the potential sources and the receptor. The residual effect will be - Negative, imperceptible, indirect, short term, unlikely impact on down gradient rivers, water quality, and dependant ecosystems.

Significance of Effects: For the reasons outlined above, no significant effects on the surface water quality will occur.

10.5.2.3 Potential Impacts on Groundwater Levels During Turbine Base Excavation Works & from Proposed Borrow Pits

Dewatering of borrow pits (as required) and other deep excavations (i.e. turbine bases) have the potential to impact on local groundwater levels. However, groundwater level impacts are not anticipated to be significant due to the local hydrogeological regime and the proposed borrow pit excavation method as outlined below.

No groundwater level impacts are predicted from the construction of the collector cabling trench, access roads, substation, compound or met mast due to the shallow nature of the excavation (i.e. 0 - ~1.2m).

Pathway: Groundwater flowpaths

Receptor: Groundwater levels.

Pre-Mitigation Potential Impact: Direct, negligible, slight, short term, unlikely effect.

Impact Assessment:

The proposed borrow pits (3 no.) are located in bedrock (ORS) which is generally unproductive in terms of groundwater flow. No groundwater dewatering will be required as rock excavation will progress in a horizontal manner into the side of outcropping bedrock.

The topographical and hydrogeological setting of the proposed borrow pits locations means no significant groundwater dewatering will be required during the works to the borrow pits during the construction phase. Moreover, direct rainfall and surface water runoff will be the main inflows that will require water volume and water quality management. For the avoidance of doubt, we would generally define dewatering as a requirement to temporarily drawdown the local groundwater table by means of over pumping, e.g. as would be required for the operation of a bedrock quarry in a valley floor. We consider that this example is very different in scale and operation from the proposed operation of a temporary shallow borrow pit on the side of a hill. In order to explain this thoroughly we will outline our reasoning in a series of bullet points as follows:

- Firstly, the borrow pit areas are located on the side of local hills where the ground elevations are between 170 and 190m OD and therefore are rock outcrops;
- These elevations are above the elevations of the local valleys and streams;
- The proposed borrow pits will be between approximately 8 – 10m below ground level which is notable. However, in the context of the topographical/elevated setting of the borrow pits, this depth range is relatively shallow;
- The local bedrock comprises sandstone/ORS and is known to be generally unproductive. This means that groundwater flows will be relatively minor;
- The flow paths (i.e. the distance from the point of recharge to the point of discharge) in this type of geology is short, localised, and will also be relatively shallow;
- No regional groundwater flow regime, i.e. large volumes of groundwater flow, will be encountered at these elevations;
- Therefore shallow groundwater inflows will largely be fed by recent rainfall, and possibly by limited groundwater seepage form localised shallow bedrock;
- The sloping nature of the ground on the hills where the borrow pits are proposed along with the coverage of soil means groundwater recharge is going to be very low;
- As such the shallow groundwater flow system will be small in comparison to the expected surface water flows from the bog surface;

- This means that there will be a preference for high surface water runoff as opposed to groundwater recharge and flow; and,
- Hence, we consider that the management of surface water will form the largest proportion of water to be managed and treated.

Environmental management guidelines from the EPA quarry 2006 guidance document – *"Environmental Management in the Extractive Industry"* in relation to groundwater issues will be implemented during the construction phase.

Residual Impact: Due to large separation distances and height difference between proposed development works and local stream and rivers, and the relatively shallow nature of the proposed borrow pit works, and also the prevailing hydrogeology of the Proposed Development site the potential for water level drawdown impacts at receptor locations is considered negligible. The residual effect will be – Negative, imperceptible, direct, short term, unlikely impact on groundwater levels.

Significance of Effects: For the reasons outlined above, no significant effects on groundwater levels will occur.

10.5.2.4 Excavation Dewatering and Potential Impacts on Surface Water Quality

Some minor groundwater/surface water seepages will likely occur in turbine base excavations, the borrow pits and sections of the collector cable and internal cabling trenches, and this will create additional volumes of water to be treated by the runoff management system. Inflows will likely require management and treatment to reduce suspended sediments. No contaminated land was noted at the site and therefore pollution issues are not anticipated.

Pathway: Overland flow and site drainage network.

Receptor: Down-gradient surface water bodies (Blackwater River, Glendine River, Tourig River, Glenaboy River and Bride River).

Pre-Mitigation Potential Impact: Indirect, negative, significant, temporary, unlikely impact to surface water quality.

Proposed Mitigation Measures:

Management of groundwater seepages and subsequent treatment prior to discharge into the drainage network will be undertaken as follows:

- Appropriate interceptor drainage, to prevent upslope surface runoff from entering excavations will be put in place;
- If required, pumping of excavation inflows will prevent build-up of water in the excavation;
- The interceptor drainage will be discharged to the site constructed drainage system or onto natural vegetated surfaces and not directly to surface waters;
- The pumped water volumes will be discharged via volume and sediment attenuation ponds adjacent to excavation areas, or via specialist treatment systems such as a Siltbuster unit;
- There will be no direct discharge to surface watercourses, and therefore no risk of hydraulic loading or contamination will occur;
- Daily monitoring of excavations by a suitably qualified person will occur during the construction phase. If high levels of seepage inflow occur, excavation work should immediately be stopped and a geotechnical assessment undertaken; and,

- A mobile 'Siltbuster' or similar equivalent specialist treatment system will be available on-site for emergencies in order to treat sediment polluted waters from settlement ponds or excavations should they occur. Siltbusters are mobile silt traps that can remove fine particles from water using a proven technology and hydraulic design in a rugged unit. The mobile units are specifically designed for use on construction-sites. They will be used as a final line of defence if needed.

Residual Impact: The potential for the release of suspended solids to watercourse receptors is a risk to water quality and the aquatic quality of the receptor. Proven and effective measures to mitigate the risk of releases of sediment have been proposed above and will break the pathway between the potential sources and the receptor. The residual effect will be – Negative, imperceptible, indirect, short term, unlikely impact on local surface water quality.

Significance of the Effects: For the reasons outlined above, no significant effects on the surface water quality will occur.

10.5.2.5 Potential Release of Hydrocarbons during Construction and Storage

Accidental spillage during refuelling of construction plant with petroleum hydrocarbons is a significant pollution risk to groundwater, surface water and associated ecosystems, and to terrestrial ecology. The accumulation of small spills of fuels and lubricants during routine plant use can also be a pollution risk. Hydrocarbon has a high toxicity to humans, and all flora and fauna, including fish, and is persistent in the environment. It is also a nutrient supply for adapted micro-organisms, which can rapidly deplete dissolved oxygen in waters, resulting in death of aquatic organisms.

Pathway: Groundwater flowpaths and site drainage network.

Receptor: Groundwater and surface water (Blackwater River, Glendine River, Tourig River, Glenaboy River and Bride River).

Pre-Mitigation Potential Impact:

Indirect, negative, slight, short term, likely impact to local groundwater quality.

Indirect, negative, significant, short term, unlikely impact to surface water quality.

Proposed Mitigation Measures:

Mitigation measures proposed to avoid release of hydrocarbons at the site are as follows:

- On site re-fuelling of machinery will be carried out using a mobile double skinned fuel bowser. The fuel bowser, a double-axel custom-built refuelling trailer will be re-filled off site, and will be towed around the site by a 4x4 jeep to where machinery is located. The 4x4 jeep will also carry fuel absorbent material and pads in the event of any accidental spillages. The fuel bowser will be parked on a level area in the construction compound when not in use and only designated trained and competent operatives will be authorised to refuel plant on site. Mobile measures such as drip trays and fuel absorbent mats will be used during all refuelling operations;
- Onsite refuelling will be carried out by trained personnel only;
- A permit to fuel system will be put in place;
- Fuels stored on site will be minimised. Fuel storage areas if required will be bunded appropriately for the fuel storage volume for the time period of the construction and fitted with a storm drainage system and an appropriate oil interceptor;

- The plant used during construction will be regularly inspected for leaks and fitness for purpose; and,
- An emergency plan for the construction phase to deal with accidental spillages is included within the CEMP (Appendix 4-4 of this EIAR). Spill kits will be available to deal with and accidental spillage in and outside the re-fuelling area.

Residual Impact: The potential for the release of hydrocarbons to groundwater and watercourse receptors is a risk to surface water and groundwater quality, and also the aquatic quality of the surface water receptors. Proven and effective measures to mitigate the risk of releases of hydrocarbons have been proposed above and will break the pathway between the potential source and each receptor. The residual effect will be - Negative, imperceptible, indirect, short term, unlikely impact to local groundwater quality. Negative, imperceptible, indirect, short term, unlikely impact to surface water quality.

Significance of Effects: For the reasons outlined above, no significant effects on surface water or groundwater quality will occur.

10.5.2.6 Groundwater and Surface Water Contamination from Wastewater Disposal

Release of effluent from domestic wastewater treatment systems has the potential to impact on groundwater and surface waters if site conditions are not suitable for an on-site percolation unit.

Pathway: Groundwater flowpaths and site drainage network.

Receptor: Down-gradient well supplies, groundwater quality and surface water quality (Blackwater River, Glendine River, Tourig River, Glenaboy River and Bride River).

Pre mitigation Impact:

Indirect, negative, significant, temporary, unlikely impact to surface water quality.

Indirect, negative, slight, temporary, unlikely impact to local groundwater.

Proposed Mitigation Measures:

- It is proposed to manage wastewater from the staff welfare facilities in the control buildings/substation by means of a sealed storage tank, with all wastewater being tankered off site by permitted waste collector to wastewater treatment plants. It is not proposed to treat wastewater on-site.

Residual Impact: No residual impact.

Significance of Effects: No significant effects on surface water or groundwater quality will occur.

10.5.2.7 Release of Cement-Based Products

Concrete and other cement-based products are highly alkaline and corrosive and can have significant negative impacts on water quality. They generate very fine, highly alkaline silt (pH 11.5) that can physically damage fish by burning their skin and blocking their gills. A pH range of $\geq 6 \leq 9$ is set in S.I. No. 293 of 1988 Quality of Salmonid Water Regulations, with artificial variations not in excess of $\pm$ 0.5 of a pH unit. Entry of cement-based products into the site drainage system, into surface water runoff, and hence to surface watercourses or directly into watercourses represents a risk to the aquatic environment. Peat ecosystems are dependent on low pH hydrochemistry. They are extremely sensitive to introduction of high pH alkaline waters into the system. Batching of wet concrete on site and washing out of transport and placement machinery are the activities most likely to generate a risk of cement-based pollution.

Pathway: Site drainage network.

Receptor: Surface water and peat water hydrochemistry.

Pre-Mitigation Impact: Indirect, negative, moderate, short term, likely impact to surface waters (Blackwater River, Glendine River, Tourig River, Glenaboy River and Bride River).

Proposed Mitigation Measures:

- No batching of wet-cement products will occur on site. Ready-mixed supply of wet concrete products and where possible, emplacement of pre-cast elements, will take place.
- Where possible pre-cast elements for culverts and concrete works will be used.
- Where concrete is delivered on site, only the chute will be cleaned, using the smallest volume of water practicable. No discharge of cement contaminated waters to the construction phase drainage system or directly to any artificial drain or watercourse will be allowed. Chute cleaning water will be undertaken at lined cement washout ponds.
- The pour site will be kept free of standing water and plastic covers will be ready in case of sudden rainfall event.

Residual Impact: The potential for the release of cement-based products or cement truck wash water to groundwater and watercourse receptors is a risk to surface water and groundwater quality, and also the aquatic quality of the surface water receptors. Proven and effective measures to mitigate the risk of releases of cement-based products or cement truck wash water have been proposed above and will break the pathway between the potential source and each receptor. The residual effect will be - Negative, imperceptible, indirect, short term, unlikely impact to surface water quality.

Significance of the Effect: For the reasons outlined above, no significant effects on surface water quality will occur.

10.5.2.8 Morphological Changes to Surface Water Courses & Drainage Patterns

Diversion, culverting and bridge crossing of surface watercourses can result in morphological changes, changes to drainage patterns and alteration of aquatic habitats. Construction of structures over water courses has the potential to significantly interfere with water quality and flows during the construction phase.

It is proposed that 2 no. new stream crossing and 6 no. existing stream crossing upgrades will be required to facilitate the wind farm development. An additional 1 no. new crossing and 2 no. existing crossing upgrades will be required at the proposed new access road on the turbine delivery route (please see Section 4.3.2.2 in Chapter 4 for further detail on these locations).

There is a total of 2 no. watercourse crossings along the collector cable route, 1 no. existing culvert crossing and 1 no. open channel stream/watercourse crossing.

Pathway: Site drainage network.

Receptor: Surface water flows (Blackwater River, Glendine River, Tourig River, Glenaboy River and Bride River).

Pre-Mitigation Potential Impact: Negative, direct, slight, long term, likely impact.

Proposed Mitigation Measures:

- All proposed new stream crossings will be bottomless or clear span culverts and the existing banks will remain undisturbed. No in-stream excavation works are proposed and therefore there will be no direct impact on the stream at the proposed crossing location;
- Where the proposed underground cabling route follows an existing road or road proposed for upgrade, the cable will pass over or below the culvert within the access road;
- All guidance / mitigation measures proposed by the OPW or the Inland Fisheries Ireland[2] (IFI) is incorporated into the design of the proposed crossings;
- As a further precaution, near stream construction work, will only be carried out during the period permitted by Inland Fisheries Ireland for in-stream works according to the Eastern Regional Fisheries Board (2004) guidance document "Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites", i.e., May to September inclusive. This time period coincides with the period of lowest expected rainfall, and therefore minimum runoff rates. This will minimise the risk of entrainment of suspended sediment in surface water runoff, and transport via this pathway to surface watercourses (any deviation from this will be done in discussion with the IFI);
- During the near stream construction work double row silt fences will be emplaced immediately down-gradient of the construction area for the duration of the construction phase. There will be no batching or storage of cement allowed in the vicinity of the crossing construction areas; and,
- All new river/stream crossings will require a Section 50 application (Arterial Drainage Act, 1945). The river/stream crossings will be designed in accordance with OPW guidelines/requirements on applying for a Section 50 consent.

With respect to the collector cable watercourse crossings, 3 possible construction crossing methods are proposed that will avoid in-stream works and these include:

- Method 1 - Where no crossing culvert currently exists, the cable will pass over the watercourse on a new bottomless box culvert or pre-cast concrete slab in a standard trefoil arrangement;
- Method 2 - Where the required depth above the culvert to accommodate the standard trench is achieved in the road, the cabling will pass below the road surface; and,
- Method 3 - Where the required depth above the culvert to accommodate the standard trench cannot be achieved in the road, the cabling will pass over the culvert in a flatbed formation.
- Method 4 - In the event that none of the above methods are appropriate, directional drilling will be utilised. Mitigation Measures relating to the use of a mixture of a natural, inert and fully biodegradable drilling fluid such as Clear Bore™ and water for directional drilling include:

    - The area around the Clear Bore™ batching, pumping and recycling plants shall be bunded using terram and sandbags in order to contain any spillages;
    - One or more lines of silt fences shall be placed between the works area and adjacent rivers and streams on both banks;
    - Accidental spillage of fluids shall be cleaned up immediately and transported off site for disposal at a licensed facility; and,

[2] *Inland Fisheries Ireland (2016): Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters*

- Adequately sized skips will be used for temporary storage of drilling arisings during directional drilling works. This will ensure containment of drilling arisings and drilling flush.

Residual Impact: With the application of the best practice mitigation outlined above, the residual effect will be - Negative, imperceptible, direct, long term, unlikely impact on stream flows, stream morphology and surface water quality.

Significance of Effects: For the reasons outlined above, no significant effects on stream morphology or stream water quality will occur at crossing locations.

10.5.2.9 Potential Hydrological Impacts on Downstream Designated Sites

The closest NHA to the site is the Blackwater River and Estuary (Sitecode: 000072). This is situated ~4.3km north of the western cluster, just north of Tallow, Co. Waterford.

The closest SAC to the site is the Blackwater River SAC (Sitecode: 002170) the boundary of which is located within 10 metres of the proposed development site boundary (tributary of the Blackwater). This SAC includes the downstream section of the Glenaboy river near Tallow and also the River Bride. Both the Glenaboy River and Tourin River also drain into the Blackwater River SAC where the downstream distance is approximately 5km and 13km respectively.

Pathway: Surface water flowpaths.

Receptor: Down-gradient water quality and designated sites.

Pre-Mitigation Potential Impact: Indirect, negative, imperceptible, short term, likely impact.

Impact Assessment & Proposed Mitigation Measures:

Mitigation measures for surface water quality protection are summarised again below:

The proposed mitigation measures, which include 75m buffer zones and drainage control measures (i.e. interceptor drains, swales, stilling ponds), will ensure that the quality of runoff from the Proposed Development area will be very high. As stated in Impact Section 10.5.2.2 above, there could potentially be an “imperceptible, short term, likely impact” on local streams and rivers but this would be very localised (i.e. within the Proposed Development site) and over a very short time period (i.e. hours). Therefore, significant direct, or indirect impacts on the Blackwater River and Estuary NHA or Blackwater River SAC will not occur.

Residual Impact: No impacts.

Significance of Effects: No significant impacts on designated sites are anticipated.

10.5.2.10 Surface Water Quality Impacts on the Youghal Public Water Supply Abstractions

The Youghal PWS has 2 no. surface water abstraction points on the Glendine River and 1 no. surface water abstraction point on the Tourig River. These 3 no. off-takes supply 100% of the water to the Youghal PWS.

The abstraction points on the Glendine River are referred to as the Glendine Gravity Intake and the Glendine Pumped Intake. The Glendine Gravity Intake is 2km upstream of the Glendine Pumped

Intake with the downstream distance from eastern landholding being 1 and 3km respectively. The Tourig River abstraction point is located approximately 11km downstream of the western cluster.

The sensitivity of the off-takes to surface water quality fluctuations (mainly turbidity) means effects of the proposed wind farm could be significant if adequate drainage mitigation and pollution prevention measures are not put in place.

As discussed above, the Proposed Development site does not include the Kilbeg Stream catchment and therefore there can be no impacts on the Tallow PWS surface water abstraction.

Pathway: Site drainage network.

Receptor: Youghal PWS Abstractions

Pre-Mitigation Impact:

Indirect, negative, slight, temporary, likely impact.

Impact Assessment & Proposed Mitigation Measures:

The design team were at all times aware that public water supply abstractions existed in the downstream watercourses, and as such all proposed mitigation and drainage design proposals were designed towards providing a "best in class" drainage management proposal for the Proposed Development considering the significant catchment sensitivities, particularly the eastern cluster which is only 1km upstream of the Glendine gravity offtake.

During the layout optimisation process, all surface waters at the site were classified as Very Sensitive (the criteria for this are presented in **Table 10.1** of the EIAR). Very sensitive surface waters are receptors of high environmental importance such as designated sites (i.e. NHA or SAC) or a public drinking water supply source. The surface waters at the proposed development were given the highest possible sensitivity rating.

With respect of the constraints mapping, the use of a 75m watercourse buffer is 50% wider than the standard 50m buffer that would normally be used in wind farm layout design. For a site where surface water rates are only moderate (compared to high rates in peatland sites), the 75m buffer would be considered conservative. The 50m buffer has been effectively employed on numerous wind farm sites across the country and therefore the additional protection offered by the increased buffer at the Proposed Development is significant.

As stated previously in the chapter, a comprehensive surface water management plan and drainage plan has been prepared for the Proposed Development and this will ensure that surface water runoff from the developed areas of the site will be of a high quality and will therefore not impact on the quality of downstream rivers.

Detailed drainage management design and pollution prevention measures proposed during the construction phase are presented above in Sections 10.5.2 above, and 10.5.3 below (operational stage). These proposals are "best in class" and in line with current best practice approaches for surface water quality protection on wind farm and forestry sites.

To emphasise the high level of attenuation and treatment that will be put in place during the construction phase, a process flow diagram for the following elements of the Proposed Development is provided:

- Borrow Pits
- Turbine bases
- Access Roads

An illustration of the various levels of controls proposed for borrow pit discharges is shown as **Plate 10-5**.

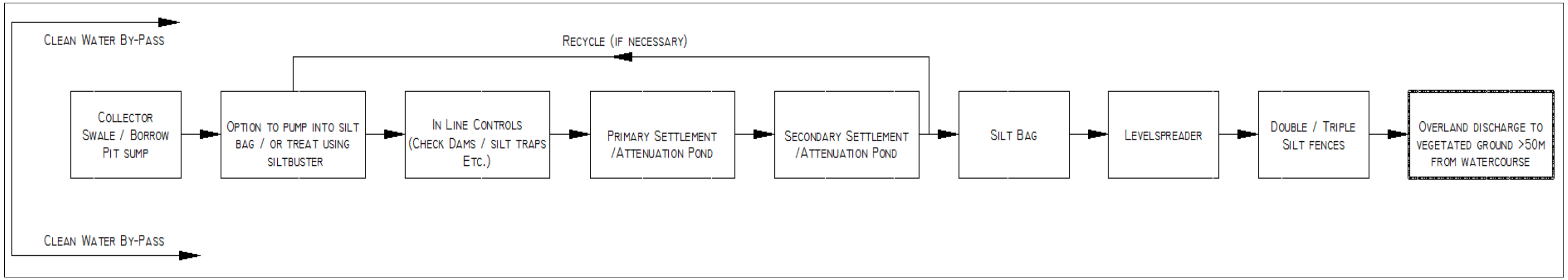


Plate 10-5 Water Treatment Train for Borrow Pits.

An illustration of the various levels of controls proposed for turbine base discharges is shown as **Plate 10-6**.

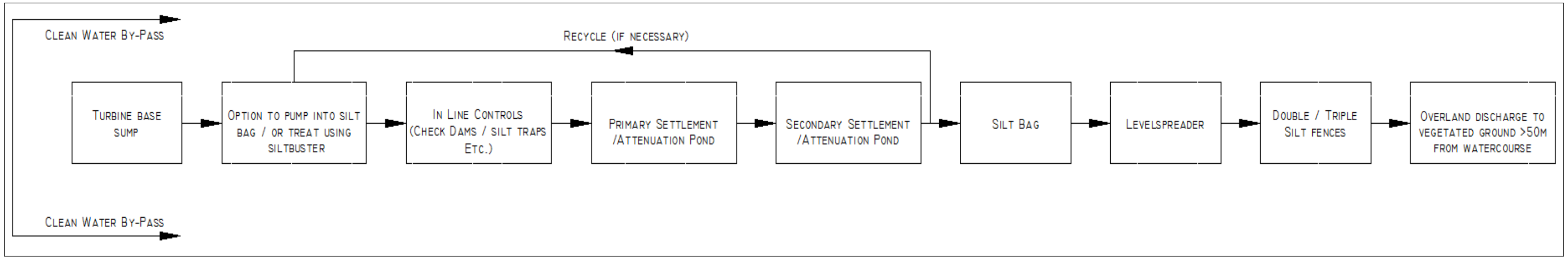


Plate 10-6 Water Treatment Train for Turbine Bases.

An illustration of the various levels of controls proposed for access roads is shown as **Plate 10-7**.

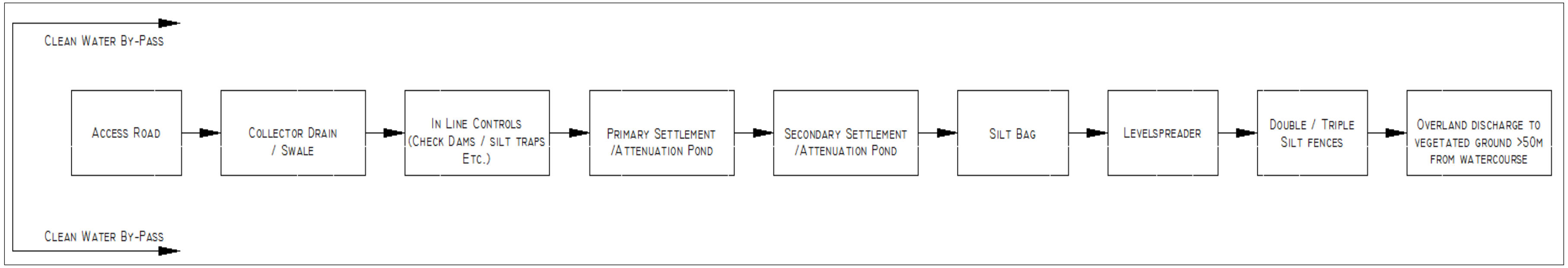


Plate 10-7 Water Treatment Train for Access Roads.

The process flow diagrams demonstrate that while settlement ponds form an important element of the drainage proposals for the site, they are not sand alone but occur as part of a treatment train of systems that will be applied in series to ensure protection of downstream watercourses. The treatment of site runoff occurs before and also continues after the settlement ponds, with the "after" treatment also utilising natural elements of the site such as the existing vegetated ground. Therefore, the final "polished" discharge effluent quality will not be achieved until the discharge passes through the last element of the treatment series train which is the vegetated ground upslope of the local watercourse (i.e. compliance point). This is illustrated in the drainage design drawings in Appendix 4-6 of this EIAR.

A final line of defence can be provided by a water treatment train such as a "Siltbuster" if required. If the discharge water from construction areas fails to be of a high quality then a filtration treatment system (such as a 'Siltbuster' or similar equivalent treatment train (sequence of water treatment processes) will be used to filter and treat all surface discharge water collected in the dirty water drainage system. This will apply forall of the construction phase

Daily inspections will be undertaken to assess the effectiveness of the water treatment trains and this will include a visual assessment of water quality and also portable probes for field hydrochemistry monitoring (turbidity, pH, electrical conductivity etc) will be used by the ECoW (Ecological Clerk of Works – see the CEMP in Appendix 4-4 for further details) to make on the spot checks. Corrective measures will be carried out as appropriate (i.e. silt build-up removal or replacement/upgrade works) in the event treatment is ineffective.

Residual Impact: The potential for the release of suspended solids to watercourse receptors is a risk to water quality and the aquatic quality of the receptor. Proven and effective measures to mitigate the risk of releases of sediment have been proposed above and will break the pathway between the potential sources and the receptor. The residual effect will be - Negative, imperceptible, indirect, short term, unlikely impact on down gradient rivers, water quality, and dependant ecosystems.

Significance of Effects: For the reasons outlined above, no significant effects will occur on the Youghal Public Water Supply Abstraction.

10.5.2.11 Turbine Delivery Route Works

Earthworks are required for the turbine delivery route (TDR) works. These include road widening, a new 300m stretch of access road on agricultural land and temporary levelling of the centre island of some roundabouts. These accommodation works are described in Section 4.4.3 of this EIAR.

Pathway: Surface water flowpaths.

Receptor: Down-gradient water quality (Blackwater River, Glendine River, Tourig River, Glenaboy River and Bride River) and designated sites.

Pre-Mitigation Potential Impact: Indirect, negative, slight, short term, likely impact.

Proposed Mitigation Measures:

- Silt traps will be temporarily be placed in all drains intercepted by the works prior to works commencing
- Silt fence perimeters will be placed downslope of the works before excavations begin
- At the Breeda Bridge proposed access road temporary drains (interceptor and collector drains) and settlement ponds will be put in place to deal with surface water runoff.

Residual Impact: The potential for the release of suspended solids to watercourse receptors is a risk to water quality and the aquatic quality of the receptor. Proven and effective measures to mitigate the risk of releases of sediment have been proposed above and will break the pathway between the potential sources and the receptor. The residual effect will be - Negative, imperceptible, indirect, short term, unlikely impact on down gradient rivers, water quality, and dependant ecosystems.

Significance of Effects: For the reasons outlined above, no significant effects will occur on surface waters.

10.5.3 Operational Phase – Likely Impacts and Mitigation Measures

10.5.3.1 Progressive Replacement of Natural Surface with Lower Permeability Surfaces

The potential for increased surface water runoff is the primary potential impact during the operational phase of the Proposed Development.

Progressive replacement of the vegetated surface with impermeable surfaces will decrease the permeability of the ground within the wind farm site footprint (i.e. turbine bases, hardstandings, substation and, to a lesser extent, the new access roads). This will result in an increase in the proportion of surface water runoff reaching the surface water drainage network as outlined in Table 10-16 below.

The emplacement of the proposed permanent development footprint, as described in Chapter 4 of the EIAR, (assuming emplacement of impermeable materials as a worst-case scenario) could result in an average total site increase in surface water runoff of approximately 16,543m^3/month (Table 10-16). This represents a potential increase of approximately 4.8 % in the average daily/monthly volume of runoff from the site area in comparison to the baseline pre-development site runoff conditions.

This is a small increase in average runoff and results from a relatively small area of the overall Proposed Development site being developed. Specifically, the proposed permanent development footprint is approximately 23.3 ha, representing approximately 3% of the total development site of 733 ha. Of the proposed wind farm footprint, approximately 6.4 ha are already in place in the form of existing roads.

Also, this calculation assumes that all hardstanding areas including roads will be impermeable which is considered to be a worst case scenario and is unlikely to be the case. The increase in runoff from most of the development catchment will therefore be negligible and this is before mitigation measures are put in place. Therefore, there will be no risk of exacerbated flooding down-gradient of the site.

Table 10-16: Baseline Site Runoff V Development Runoff

Baseline Runoff/month (m^3)	Baseline Runoff/day (m^3)	Permanent Footprint Area (m^2)	Footprint Area 100% Runoff (m$_3$) (m^3)	Footprint Area 40% Runoff (m^3)	Net Increase/month (m^3)	Net Increase/day (m^3)	% Increase from Baseline Conditions (m^3)
344,510	11,113	233,000	27,494	10,951	16,543	534	4.8

Pathway: Site drainage network.

Receptor: Surface waters (Blackwater River, Glendine River, Tourig River, Glenaboy River and Bride River) and dependant ecosystems.

Pre-Mitigation Potential Impact: Negative, slight, indirect, permanent, moderate probability effect on all downstream surface water bodies.

Proposed Mitigation by Design:

The operational phase drainage system of the Proposed Development will be installed and constructed in conjunction with the road and hardstanding construction work as described below and as shown on the Drainage drawings submitted with this planning application:

- Interceptor drains will be installed up-gradient of all proposed infrastructure to collect clean surface runoff, in order to minimise the amount of runoff reaching areas where suspended sediment could become entrained. It will then be directed to areas where it can be re-distributed over the ground by means of a level spreader;
- Swales/collector road side (dirty water) drains will be used to collect runoff from access roads and turbine hardstanding areas of the site, likely to have entrained suspended sediment, and channel it to settlement ponds for sediment settling;
- On steep sections of access road transverse drains ('grips') will be constructed in the surface layer of the road to divert any runoff off the road into swales/road side drains;
- Check dams will be used along sections of access road drains to intercept silts at source. Check dams will be constructed from a 4/40mm non-friable crushed rock;
- Settlement ponds, emplaced downstream of road swale sections and at turbine locations, will buffer volumes of runoff discharging from the drainage system during periods of high rainfall, by retaining water until the storm hydrograph has receded, thus reducing the hydraulic loading to watercourses; and,
- Settlement ponds will be designed in consideration of the greenfield runoff rate.

Residual Impact: Direct, negative, neutral, long term, likely impact.Proven and effective measures to attenuate runoff and mitigate the risk of flooding will be employed. The residual effect will be - Neutral, indirect, long term, likely effect on down gradient streams/rivers.

Significance of Effects: No significant effects on downstream flood risk will occur during the operational phase of the Proposed Development.

10.5.3.2 Runoff Resulting in Suspended Solids Entrainment in Surface Waters

During the operational phase, the potential for silt-laden runoff is much reduced compared to the construction phase. In addition, all permanent drainage controls will be in place and the disturbance of ground and excavation works will be complete. Some minor maintenance works may be completed, such as maintenance of site entrances, internal roads and hardstand areas. These works would be of a very minor scale and would be very infrequent. Potential sources of sediment laden water would only arise from surface water runoff from small areas where new material is added during maintenance works

These minor activities could, however, result in the release of suspended solids to surface water and could result in an increase in the suspended sediment load, resulting in increased turbidity which in turn could affect the water quality and fish stocks of downstream water bodies. Potential effects could be significant if not mitigated against.

During such maintenance works there is a small risk associated with release of hydrocarbons from site vehicles, although it is not envisaged that any significant refuelling works will be undertaken on site during the operational phase.

Pathways: Drainage and surface water discharge routes.

Receptors: Down-gradient rivers and associated dependent ecosystems.

Pre-Mitigation Potential Impact: Negative, slight, indirect, temporary, low probability effect.

Proposed Mitigation Measures:

Mitigation measures for sediment control are the same as those outlined in Sections 10.5.2.2 and 10.5.3.1

Mitigation measures for control of hydrocarbons during maintenance works will be the same as those outlined in Section 10.5.2.5.

Residual Effects: With the implementation of the proposed wind farm drainage measures as outlined above, and based on the post-mitigation assessment of runoff, we consider that residual effect are - Negative, imperceptible, indirect, temporary, low probability effect on downstream water quality.

Significance of Effects: For the reasons outlined above, no significant effects on the surface water quality are anticipated.

10.5.4 Decommissioning Phase - Likely Significant Effects and Mitigation Measures

The potential impacts associated with decommissioning of the proposed development will be similar to those associated with construction but of a reduced magnitude, due to the reduced scale of the proposed decommissioning works in comparison to construction phase works. A description of the decommissioning works is contained in Chapter 4 of this EIAR.

During decommissioning, it will be possible to reverse or at least reduce some of the potential effects caused during construction, and to a lesser extent operation, by rehabilitating constructed areas such as turbine bases and hard standing areas. This will be done by covering with vegetation to encourage vegetation growth and reduce run-off and sedimentation.

The Proposed Development site roadways will be kept and maintained following decommissioning of the wind farm infrastructure, as these will be utilised by ongoing forestry works and by local farmers.

The electrical cabling connecting the Proposed Development site infrastructure to the on-site substation will be removed, while the ducting itself will remain in-situ rather than excavating and removing it, as this is considered to have less of a potential environmental impact, in terms of soil exposure, and thus on the possibility of the generation of suspended sediment which could enter nearby watercourses.

The turbines will be removed by disassembling them in a reverse order to their erection. This will be completed using the same model cranes as used in their construction. They will then be transported off-site along their original delivery route. The disassembly and removal of the turbines will not have an impact on the hydrological/hydrogeological environment at the Proposed Development site.

Other impacts such as possible soil compaction and contamination by fuel leaks will remain but will be of reduced magnitude than the construction phase because of the smaller scale of the works and reduced volumes on-site.

As noted in the Scottish Natural Heritage report (SNH) Research and Guidance on Restoration and Decommissioning of Onshore Wind Farms (SNH, 2013) reinstatement proposals for a wind farm are made approximately 30 years in advance, so within the lifespan of the wind farm, technological advances and preferred approaches to reinstatement are likely to change. According to the SNH guidance, it is, therefore:

> *"best practice not to limit options too far in advance of actual decommissioning but to maintain informed flexibility until close to the end-of-life of the wind farm".*

Some of the impacts will be avoided by leaving elements of the proposed development in place where appropriate. The EirGrid section of the substation will be retained by EirGrid as a permanent part of the national grid. The turbine bases will be rehabilitated by covering with local topsoil/peat in order to regenerate vegetation which will reduce runoff and sedimentation effects. Mitigation measures to avoid contamination by accidental fuel leakage and compaction of soil by on-site plant will be implemented as per the construction phase mitigation measures.

No significant effects on the hydrological and hydrogeological environment will occur during the decommissioning stage of the proposed development.

10.5.5 Risk of Major Accidents and Disasters

None, as indicated above the risk of flooding at the wind farm site is determined to be negligible/none.

10.5.6 Cumulative Impacts

In terms of the potential impacts of the Proposed Development on downstream surface water bodies, the biggest risk is during the construction phase as this is the phase when earthworks and excavations will be undertaken at the sites.

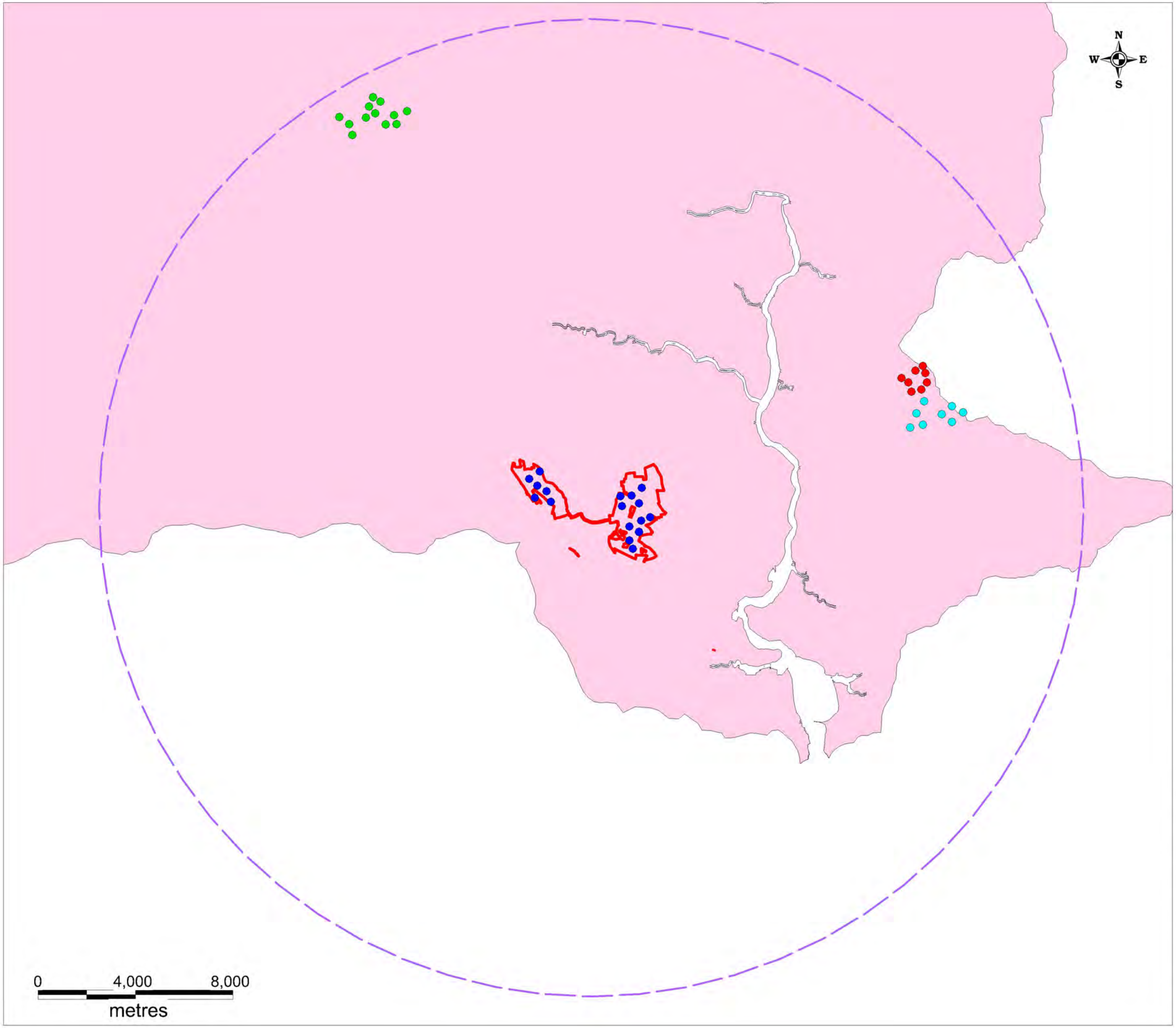
In terms of operational phase hydrological effects, the total number of turbines that could potentially be operating within the Blackwater River Catchment inside a 20km radius is 43 no. (inclusive of the 17 no. from the Proposed Development) – see **Figure 10-7**. The total catchment area of the Blackwater River within a 20km radius of the Proposed Development site is approximately 900km^2 and therefore this equates to 1 turbine for approximately every 21km^2 which would not be considered high density. Therefore, effects on catchment hydrology such as increased runoff would not be expected.

In addition operational phase drainage mitigation measures will ensure the risk to surface waters during this period is negligible to none.

The construction timeframe of the non-wind farm related developments is also unknown but due to the small footprint area of these developments, cumulative impacts on the Blackwater River catchment are not expected.

With regard to non-wind farm related forestry activities and the potential for cumulative impacts, all scheduled tree felling or replanting will be planned around the Proposed Development construction phase in order to prevent hydrological cumulative impacts. No scheduled tree felling will occur in the same local catchment where wind farm construction is taking place.

The replanting lands are located in county Sligo and in a different water catchment and therefore are not likely to contribute to potential cumulative impacts with the proposed wind farm development. The potential direct, indirect and cumulative impacts of replanting lands on water has been assessed in the Section 7 of Appendix 4-3 Assessment of Forestry Replacement Lands.



Legend

- Site Boundary
- Proposed Turbine Layout
- Barranafaddock WF (Constructed)
- Knocknamona_WF (Not constructed)
- Woodhouse WF (Constructed)
- 20km buffer from Lyrenacarriga WF
- Blackwater Catchment

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Client: Innogy Renewables	
Job: Lyrenacarriga WF, Co. Waterford/Co. Cork	
Title: Cumulative Impact Map	
Figure No: 10-7	
Drawing No: P1453-0-1220-A3-1007-0A	
Sheet Size: A3	Project No: P1453-0
Scale: 1:150,000	Drawn By: GD
Date: 02/12/2020	Checked By: MG

Table 10-17 Other Developments Assessed for Hydrological Cumulative Impacts within 20km radius of Site

Regional Catchment	Wind Energy Developments	Total Turbine No.	Turbine No. in Blackwater Catchment
Blackwater River	Knocknamona WF (Permitted)	8	6
	Woodhouse WF (Constructed)	8	8
	Barranafaddock WF (Constructed)	12	12
Total		28	26

10.5.7 Summary

During each phase of the Proposed Project (construction and operation / maintenance and decommissioning) a number of activities will take place on the site of the proposed wind farm, some of which will have the potential to significantly affect the hydrological regime or water quality at the site or its vicinity. These significant potential impacts generally arise from sediment input from runoff and other pollutants such as hydrocarbons and cement-based compounds, with the former having the most potential for impact.

Surface water drainage measures, pollution control and other preventative measures have been incorporated into the project design to minimise significant adverse impacts on water quality and avoid impact on downstream designated sites. A self-imposed 75m stream buffer was used during the layout of the proposed development, thereby avoiding sensitive hydrological features and also protecting sensitive downstream receptors such the Youghal PWS and the Blackwater River SAC.

The surface water drainage plan will be the principal means of significantly reducing sediment runoff arising from construction activities and to control runoff rates. The key surface water control measure is that there will be no direct discharge of wind farm runoff into local watercourses. This will be achieved by avoidance methods (i.e. stream buffers) and design methods (i.e. surface water drainage plan).

Preventative measures also include fuel and concrete management and a waste management plan which will be incorporated into the Construction and Environmental Management Plan (Refer to Appendix 4-4).

Overall the Proposed Development presents no significant impacts to surface water and groundwater quality provided the proposed mitigation measures are implemented.

No significant cumulative impacts on any of the regional surface water catchment or groundwater bodies will occur from the Proposed Development including the associated grid connection and other wind farm developments.