9. HYDROLOGY AND HYDROGEOLOGY

9.1 Introduction

CDM Smith Ireland Ltd was engaged by MKO Ireland (MKO) to assess the potential likely and significant hydrological and hydrogeological effects of the Proposed Development on the receiving water environment. The assessment is based on:

- Publicly available data and information relevant to baseline hydrological and hydrogeological conditions.
- Site-specific baseline data generated from site investigations listed in Section 9.2.2.
- Requirements for preparation of this Chapter, per relevant legislation and guidance listed in Sections 9.1.4 and 9.1.5).

The Proposed Development site location was shown in **Figure 1-1b** and the Proposed Development layout was presented in **Figure 4-1a** and **Figure 4-1b**. The site is situated within Sheskin Forest, approximately 20 kilometres west of Crossmolina and approximately 7 km northeast of Bangor Erris in Co. Mayo. The site is accessible via the N59 National Secondary and the L52926 local road in the townland of Shranakilly.

As described in Chapter 4, encompasses new and upgraded existing roadways, wind turbines, an electrical substation, a meteorological mast, grid connection cables, borrow pits, peat and spoil placement areas, and temporary construction compounds. To accommodate the Proposed Development, tree-felling and establishment of a drainage management system are also part of the planned works.

The Proposed Development area covers 1,189 hectares (ha), or 11.89 km^2. However, the proposed permanent development footprint is 24.22 ha, or 0.244 km^2.

9.1.1 Statement of Authority

This Chapter 9 was prepared by Henning Moe of CDM Smith Ireland Ltd. He is a registered professional geologist (P. Geo.) with the Institute of Geologists of Ireland and has more than 30 years of practical experience. He has worked on several projects for EPA related to the implementation of the European Union Water Framework Directive (WFD). This included working with EPA's Catchment Science and Management Unit to prepare guidance on Investigative Assessments of rural catchments involving a wide range of environmental pressures and mitigation measures, including those associated with peat- and forestry-related activity. Henning has also worked with both the National Parks and Wildlife Service (NPWS) and the Pesticide Control and Forestry Services of the Department of Agriculture, Food and Marine (DAFM). With MKO, he assisted the review of potential impacts of planned improvement works along the Kiltiernan-Ballinderreen Flood Mitigation Scheme on Natura 2000 sites (specifically, fens), and for Kerry County Council, he reviewed flood risk downstream of a proposed major quarry development based on a discharge of 25,000 m^3/d. For Irish Water, Henning peer-reviewed the hydrology and hydrogeology chapters of the EIAR for the Shannon Pipeline project which traverses more than 25 km of peatland. For Bord na Móna, he is leading the preparation of the Soils, Geology and Hydrogeology, and Water, chapters for a proposed expanded landfill development within Timahoe Bog.

Henning was supported by Dr Jon Hunt which contributed technically to the planning stage drainage plan. Jon has 20 years of experience which has included mapping upland and peat terrains through his geological research (e.g., mapping 34 km^2 at 1:10,560 scale in upland areas of the west of Ireland), and managing flood risk assessments of housing developments using modelling techniques and mitigation measures to alleviate potential downstream risks and impacts.

Technical review was provided by Ruairi O'Carroll BE MEng Sc CEng MIEI, a chartered engineer with over 20 years of experience in the management and delivery of environmental and engineering projects. Ruairi has prepared feasibility studies, preliminary reports and assessment studies for a range of water and environmental projects, and has extensive expertise in the preparation of tender documents, procurement and contract management.

9.1.2 Objectives

The objectives of this Chapter 9 are to:

- Present the methodology that was applied to assess potential and likely significant effects of the Proposed Development;
- Describe the hydrological and hydrogeological settings and baseline conditions of the Proposed Development area;
- Identify likely significant effects of the Proposed Development on surface water and groundwater resources, and the associated receiving environment during construction, operational and decommissioning phases of the Proposed Development;
- Identify and describe suitable and proposed mitigation measures that will be implemented to avoid, reduce or offset significant negative effects;
- Assess likely significant residual effects;
- Assess cumulative effects of the Proposed Development after mitigation measures are implemented, in associated with other relevant developments that are identified in the area.

9.1.3 Scope and Consultation

As described in Chapter 2, scoping was undertaken during the preparation of this EIAR. Scoping responses are included in **Appendix 2-1**. Inputs from consultees have informed the preparation of content in this Chapter 9. Key matters that were raised in respect of hydrology and hydrogeology are summarised in **Table 9-1**.

Table 9-1 Summary of Hydrological and Hydrogeological Matters Raised by Consultees

Consultee	Matters Raised	Addressed in Chapter Section
Development Application Unit Department of Housing, Local Government and Heritage (DHLGH)	In summary, DHLGH requested the following to be addressed: • The EIAR must demonstrate that the proposed wind farm development will not pose any threat to surface waters and associated species (e.g. Salmon). • The impacts of tree felling on wildlife, habitats and surface waters (e.g. water quality) should be assessed fully, including the risk of phosphate mobilisation from peat soils as a result of tree clearance and ground disturbance. • The likely impacts of grid connection, particularly for birds, sensitive habitats and surface waters, should be given due consideration at the EIA stage. • Recommendations for the preparation of a Construction Management Plan were also provided.	Section 9.4; Chapter 6 of the EIAR Chapter 6 of the EIAR Section 9.4.2 Section 9.4.2.4; Appendix 9-4 Appendix 4-1, Appendix 4-3
Inland Fisheries Ireland (IFI) - Shannon Region & Western Region	In summary, IFI requested the following to be addressed: • Water quality • Surface water hydrology • Sediment transport	Chapter 9 in its entirety

Geological Survey Ireland (GSI)	GSI provided background information and a list of our publicly available datasets to be considered.	Chapter 8 of the EIAR Section 9.3.8
Irish Peatland Conservation Council (IPCC)	In summary, IPCC requested the following to be addressed: › Account for nitrogen within pre-planning coupled with a nitrogen monitoring agenda which could highlight possible pathways of nutrient enrichment. › Ensure that the proposed development will not adversely impact on the water quality. › Assess the cumulative effects of windfarms, afforestation, peat extraction, drainage, overgrazing on the environment - specifically including the designated sites - and also assess the implications of impacts on annexed species and biodiversity.	Sections 9.3.7, 9.3.13 Sections 9.4.2 through 9.4.4 Section 9.4.5; Section 9.4.3.4, Appendix 9-4; Chapter 6 of the EIAR
Mayo County Council (MCC)	MCC requested information on slopes, soil type, bedrock, depth to bedrock, depth to groundwater and depth to be peat to be presented. MCC also requested information related to: › Forestry proposals, notably clear-felling and afforestation plans. › Existing drainage onsite. › Details of overall site management relative to water courses, with regard to the Water Framework Directive and any relevant River Basin Management Plan, including impact on downstream water body status. Moreover, MCC requested information, as follows: › The hydrological context of the site. › Baseline water quality conditions prior to works commencing onsite. › Delineation of subcatchments for each turbine, including slope and drainage. › Location and flow direction of all streams and drains. › Details of how water crossings will be designed and constructed to reduce impacts to the receiving environment. › A cumulative impact assessment which shows and has regard to other wind farms in the area, quarries, flood relief works, cutover bogs, substations, grid connections. › A Construction Environmental Management Plan.	Chapter 8 Appendix 4-2; Appendix 8-1 Sections 9.3.1, 9.3.8 Chapter 4 Sections 9.3.2, 9.3.7 Section 9.4.3.2, 9.4.3.4 Appendix 4-1; Appendix 4-4; Appendix 9-3, Appendix 9-4 Sections 9.3.2, 9.3.5, 9.3.6 Section 9.3.7 Section 9.3.12 Appendix A of Appendix 4-4 Chapter 4; Appendix 4-1 Section 9.4.2.2, 9.4.2.3, 9.4.2.4 Section 9.4.5 Appendix 4-3

9.1.4 Relevant Legislation

This Chapter 9 was prepared in accordance with the legislation itemised in Chapter 1 (Introduction) and the following guidance documents:

- Environmental Protection Agency (2022). Guidelines on the Information to be Contained in Environmental Impact Assessment Report
- Institute of Geologists Ireland (2013): Guidelines for Preparation of Soils, Geology & Hydrogeology Chapters in Environmental Impact Statements.

- National Roads Authority (2009): Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes.
- Inland Fisheries Ireland (2016): Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters.
- Scottish Natural Heritage (2010): Good Practice During Wind Farm Construction.
- 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).
- CIRIA 2006: Control of Water Pollution from Construction Sites - Guidance for Consultants and Contractors (CIRIA C532, 2006).

9.2 Assessment Methodology

9.2.1 Desk Study

A desk study of the Proposed Development site and potential receiving environment was completed which involved collecting relevant data and information from publicly available sources, namely:

- OPW Flood Risk Information, including the CFRAM Flood Risk Assessment mapping (www.floodinfo.ie).
- Environmental Protection Agency (EPA) 'Water' web viewer and databases related to implementation of the Water Framework Directive (WFD) - https://gis-stg.epa.ie/EPAMaps/Water and www.catchments.ie
- EPA and Office of Public Works (NPWS) stream gauging station data.
- Geological Survey of Ireland (GSI) map coverages available on their web viewer.
- EPA and Teagasc soils maps.
- Historical aerial imagery and mid-19th century 6-inch and 25-inch sheets from Ordnance Survey Ireland.
- National Parks and Wildlife Services Public Map Viewer (www.npws.ie).
- Met Eireann rainfall and evapotranspiration data and maps.

Publicly available reports (e.g. from GSI) and journal (research) articles were also used, and are referenced throughout this Chapter 9.

9.2.2 Baseline Monitoring and Site Investigations

Data and findings from site investigations were also used for the description of baseline conditions, specifically:

- Trial pits were excavated by Irish Drilling Ltd (IDL) under the supervision of Fehily Timoney (FT) in November 2021 (IDL, 2022).
- Water level measurements in peat and surface water sampling was undertaken by Tobin Consulting Engineers (TCE) between August 2020 and August 2021 (TCE, 2021).
- Peat probing as part of a geotechnical and peat stability assessment was undertaken by FT between March 2021 and May 2022 (FT, 2022).
- A walkover survey was conducted by CDM Smith in July 2021, with a focus on the existing site drainage.

Related data and findings are presented in subsequent sections.

9.2.3 Assessment Methodology

Using the information from the desk study and site investigations, the importance and environmental sensitivity of the receiving environment was judged by the criteria presented in **Table 9-2** (hydrology) and **Table 9-3** (hydrogeology).

Table 9-2 Estimation of Importance of Hydrology Attributes (NRA, 2009)

Importance	Criteria	Example
Extremely High	Attribute has a high quality or value on an international scale	River, wetland or surface water body ecosystem protected by EU legislation e.g. 'European sites' designated under the Habitats Regulations or 'Salmonid waters' designated pursuant to the European Communities (Quality of Salmonid Waters) Regulations, 1988.

Very High	Attribute has a high quality or value on a regional or national scale	River, wetland or surface water body ecosystem protected by national legislation – NHA status. Regionally important potable water source supplying >2500 homes. Quality Class A (Biotic Index Q4, Q5). Flood plain protecting more than 50 residential or commercial properties from flooding. Nationally important amenity site for wide range of leisure activities.
High	Attribute has a high quality or value on a local scale	Salmon fishery. Locally important potable water source supplying >1000 homes. Quality Class B (Biotic Index Q3-4). Flood plain protecting between 5 and 50 residential or commercial properties from flooding. Locally important amenity site for wide range of leisure activities.
Medium	Attribute has a medium quality or value on a local scale	Coarse fishery. Local potable water source supplying >50 homes. Quality Class C (Biotic Index Q3, Q2-3). Flood plain protecting between 1 and 5 residential or commercial properties from flooding.
Low	Attribute has a low quality or value on a local scale	Locally important amenity site for small range of leisure activities. Local potable water source supplying <50 homes. Quality Class D (Biotic Index Q2, Q1). Flood plain protecting 1 residential or commercial property from flooding. Amenity site used by small numbers of local people.

Table 9-3 Estimation of Importance of Hydrogeological Attributes (NRA, 2009)

Importance	Criteria	Examples
Extremely High	Attribute has a high quality or value on an international scale	Groundwater supports river, wetland or surface water body ecosystem protected by EU legislation e.g. SAC or SPA status.
Very High	Attribute has a high quality or value on a regional or national scale	Regionally Important Aquifer with multiple wellfields. Groundwater supports river, wetland or surface water body ecosystem protected by national legislation – NHA status. Regionally important potable water source supplying >2500 homes. Inner source protection area for regionally important water source.
High	Attribute has a high quality or value on a local scale	Regionally Important Aquifer. Groundwater provides large proportion of baseflow to local rivers. Locally important potable water source supplying >1000 homes. Outer source protection area for regionally important water source.

		Inner source protection area for locally important water source.
Medium	Attribute has a medium quality or value on a local scale	Locally Important Aquifer. Potable water source supplying >50 homes. Outer source protection area for locally important water source.
Low	Attribute has a low quality or value on a local scale	Poor Bedrock Aquifer. Potable water source supplying <50 homes.

The assessment of likely significant effects in this chapter uses the effects classification terminology of EPA (2022), as presented in **Table 9-4**. Descriptors of effects include quality (negative, positive or neutral), significance, probability/likelihood, duration and/or frequency, and type.

Table 9-4 Effect Classification Terminology (EPA, 2022)

Impact Characteristic	Term	Description
Quality	Positive	A change which improves the quality of the environment
	Neutral	No effects or effects that are imperceptible, within normal bounds of variation or within the margin of forecasting error.
	Negative	A change which reduces the quality of the environment.
Significance	Imperceptible	An effect capable of measurement but without significant consequences.
	Not significant	An effect which causes noticeable changes in the character of the environment but without significant consequences
	Slight	An effect which causes noticeable changes in the character of the environment without affecting its sensitivities
	Moderate	An effect that alters the character of the environment in a manner consistent with existing and emerging baseline trends
	Significant	An effect, which by its character, magnitude, duration or intensity alters a sensitive aspect of the environment
	Very significant	An effect which, by its character, magnitude, duration or intensity significantly alters most of a sensitive aspect of the environment
	Profound	An effect which obliterates sensitive characteristics
Extent and Context	Extent	Describe the size of the area, number of sites and the proportion of a population affected by an effect
	Context	Describe whether the extent, duration, or frequency will conform or contrast with established (baseline) conditions
Probability	Likely	Effects that can reasonably be expected to occur because of the planned project if all mitigation measures are properly implemented
	Unlikely	Effects that can reasonably be expected not to occur because of the planned project if all mitigation measures are properly implemented
Duration and Frequency	Momentary	Effects lasting from seconds to minutes
	Brief	Effects lasting less than one day
	Temporary	Effects lasting less than one year
	Short-term	Effects lasting 1-7 years
	Medium-term	Effects lasting 7-15 years
	Long-term	Effects lasting 15-60 years
	Permanent	Effects lasting over 60 years
	Reversible	Effects that can be undone, for example through

		remediation or restoration
	Frequency	Describe how often the effect will occur (once, rarely, occasionally, frequently, constantly – or hourly, daily, weekly, monthly, annually)
Types	Indirect	Effect on the environment, which are not a direct result of the project, often produced away from the project site or because of a complex pathway
	Cumulative	The addition of many minor or insignificant effects, including effects of other projects, to create larger, more significant effects.
	'Do Nothing'	The environment as it would be in the future should the subject project not be carried out
	'Worst Case'	The effects arising from a project in the case where mitigation measures substantially fail
	Indeterminable	When the full consequences of a change in the environment cannot be described.
	Irreversible	When the character, distinctiveness, diversity or reproductive capacity of an environment is permanently lost
	Residual	The degree of environmental change that will occur after the proposed mitigation measures have taken effect
	Synergistic	Where the resultant effect is of greater significance than the sum of its constituents

In addition, the two impact characteristics proximity and probability are described for each effect considered, and these are defined in **Table 9-5**.

Table 9-5 Additional Impact Characteristics Considered

Impact Characteristic	Degree/Nature	Description
Proximity	Direct	An impact which occurs within the area of the proposed project, as a direct result of the proposed project.
	Indirect	An impact which is caused by the interaction of effects, or by off-site developments.
Probability	Low	A low likelihood of occurrence of the impact.
	Medium	A medium likelihood of occurrence of the impact.
	High	A high likelihood of occurrence of the impact.

9.3 Existing Environment

9.3.1 Physiographic Setting and Topography

The Proposed Development site is situated in a forested upland blanket bog setting on the southeast facing slopes of Slieve Fyagh. Topographic elevation within the Proposed Development site boundary ranges from approximately 290 mOD to approximately 105 mOD and topographic slope ranges from <2 to approximately 8 degrees. Detailed slope descriptions of planned turbine locations are provided in **Appendix 8-1**.

Land uses within the Proposed Development site are predominantly dense commercial forestry and recently felled scrubland.

9.3.2 Regional and Local Drainage

The Proposed Development site is situated in a headwater subcatchment of the Owenmore River which drains to Tullaghan Bay (**Figure 9-1**). The Owenmore River catchment[1] encompasses a total area of approximately 300 km^2 and incorporates streams that drain south through the Oweninny River sub-catchment and north from the Nephin Beg range.

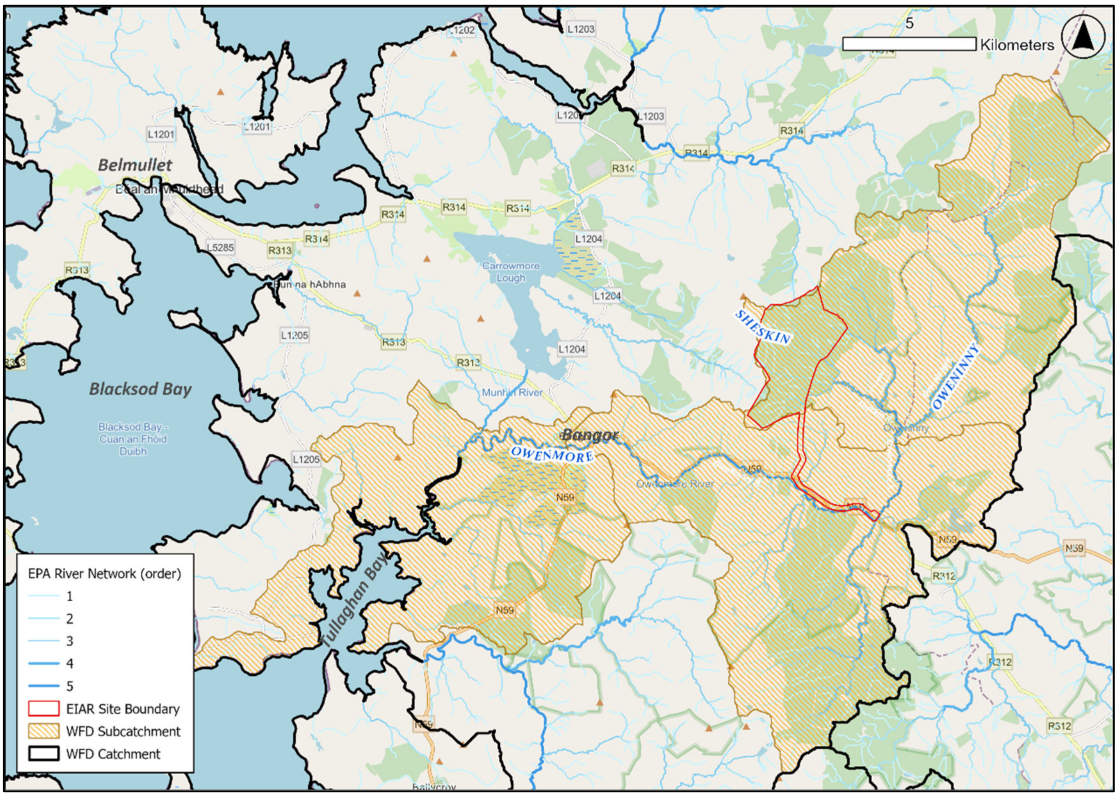

Figure 9-1 Regional Drainage of the Owenmore River Catchment

The headwaters that encompass the Proposed Development site are shown in **Figure 9-2**. They are:

- Sheskin River, which drains the southern part of Sheskin forest.
- An unnamed stream, which drains the northern part of Sheskin forest.
- Local streams that drain southeast to the Owenmore River

The Sheskin River and unnamed stream subcatchments cover an area of approximately 31.4 km^2 which is approximately 13% of the total Owenmore River catchment.

As depicted in **Figure 9-2**, both Sheskin River and the unnamed stream originate at higher elevation within Sheskin Forest, being fed by runoff and originating as a series of bog seeps/springs. Several small tributaries merge progressively as they flow eastward. The seeps and springs at higher elevation appear as 'rises' on the 6-inch sheets from OSI which show the original, natural drainage pattern of the site in the mid-19th Century.

The Sheskin River and unnamed stream merge on lower ground to the east of the Proposed Development site. From their point of merger, the streams flow combined as the Sheskin River before merging with the Oweninny River in the townland of Shranakilly. South of this confluence point, the Oweninny River becomes the Owenmore River. An important EPA water quality monitoring station

[1] Defined by WFD subcatchments Owenmore(Mayo)_SC_010, Owenmore(Mayo)_SC_020 and Owenmore(Mayo)_SC_030

(labelled 'RS33S030150' in **Figure 9-2**) is located on the Sheskin River just upstream of the confluence (See Section 9.3.7 for details).

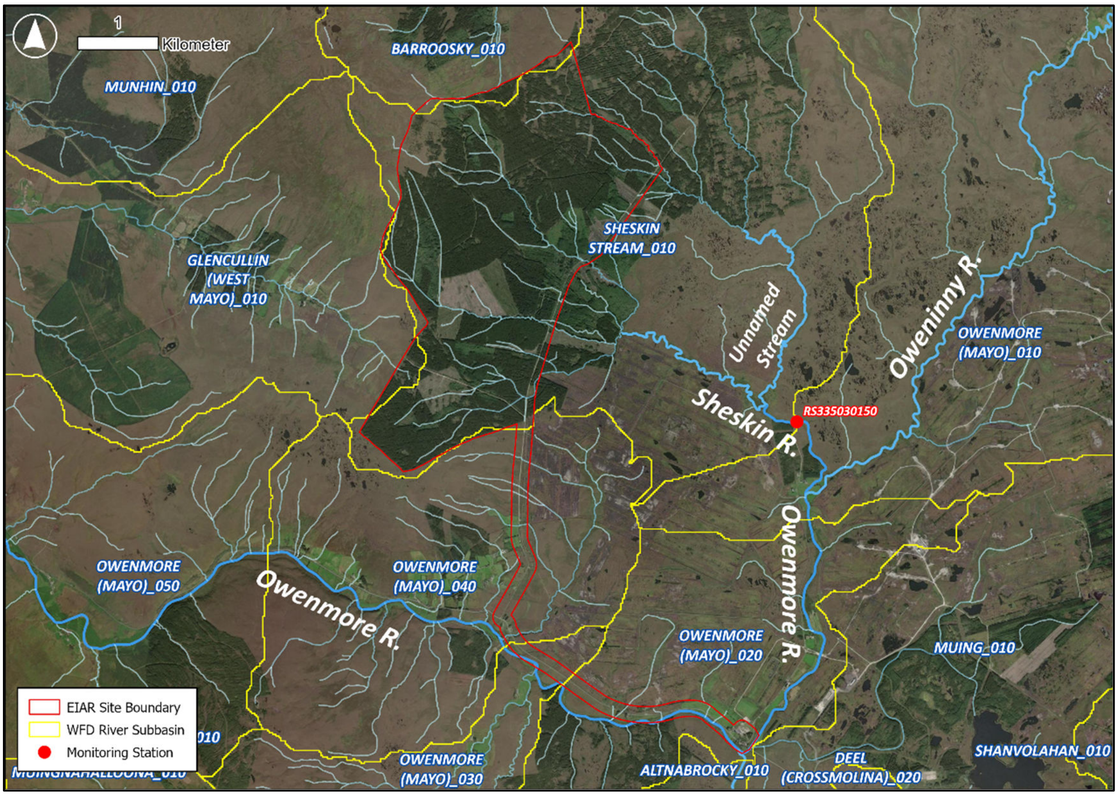

Figure 9-2 Local Drainage and WFD River Sub-basins

The Owenmore River subsequently turns sharply to the west at Bellacorick (by the N59 National Primary Road), from where it subsequently flows west through Bangor Erris and discharges to sea in Tullaghan Bay. The distance of flow from Sheskin Forest to sea via the Owenmore River is approximately 30 km.

The grid connection route of the Proposed Development also crosses the subcatchment of a series of local streams which drain south from the southern boundary of Sheskin forest. These unnamed tributaries flow directly into Owenmore River in the townland of Tawnaghmore.

9.3.3 Site Drainage

The Proposed Development site in Sheskin Forest is extensively drained as part of the ongoing forestry operations. Types of drains observed were 'mound' drains, ploughed drains, and interceptors drains. The drains serve to lead runoff from plantations to local streams. During the walkover surveys, the majority of interceptor drains were heavily vegetated, yet transmitted flow. Silt traps were also observed.

The drains tend to be linear and run in parallel with variable spacing. They follow the orientations of plantations and often run at oblique angles to roads and topographic contours.

Interceptor drains were observed upgradient and downgradient of both forestry plantations and existing access roads. Based on observation, they are mostly shallow (<1 m deep) but cut into peat and/or the underlying subsoils.

9.3.4 Potential Receptor Environments

The potential receptors associated with the Proposed Development are:

- The headwater streams in and south of Sheskin Forest.
- The Sheskin and Owenmore Rivers downstream of the Sheskin Forest.
- Groundwater beneath the Proposed Development site.

In context of EPA's coding of water bodies for Water Framework Directive (WFD) implementation and reporting purposes, the relevant receptor surface water bodies are part of the 'Owenmore(Mayo)_SC_010' subcatchment, specifically the following water bodies (shown in **Figure 9-2**):

- Sheskin Stream_010 (code IE_WE_33S030150)
- Owenmore(Mayo)_010 (code IE_WE_33O040050)
- Owenmore(Mayo)_020 (code IE_WE_33O040200), downstream.
- Owenmore(Mayo)_040 (code IE_WE_33O040270), which is associated with the grid connection route.

The relevant groundwater bodies which underlie the Proposed Development site are:

- Belmullet (code IE_WE_G_0057)
- Bangor (code IE_WE_G_0052)

9.3.5 Water Balance Components

Natural drainage and streamflows are influenced by rainfall, runoff and recharge. Runoff, which is influenced by rainfall events and the physical attributes of subcatchments, influences the drainage design of the Proposed Development. To estimate runoff, both long-term annual average and return period characteristics must be defined.

9.3.5.1 Long Term Annual Average Rainfall, Runoff and Recharge

The nearest synoptic weather station with long-term rainfall and evaporation data is Belmullet. This station is near sea level and approximately 27 km west of the site. The mean annual rainfall for the 30-year period 1981-2010 is 1,248 mm, and as presented in **Table 9-6**, the wettest month historically is October.

Table 9-6 Mean Monthly Rainfall, Belmullet Synoptic Weather Station, 1981-2010

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean monthly total	134.0	97.1	99.2	72.0	70.4	72.1	79.0	101.9	101.8	145.9	134.0	137.4
Greatest daily total	44.7	31.3	25.6	25.9	42.2	38.9	33.2	49.5	62.6	79.6	43.0	41.7
Mean no. days with >= 5.0mm	10.0	7.0	7.0	4.0	4.0	4.0	5.0	6.0	6.0	10.0	10.0	9.0

The Proposed Development site is situated at a higher elevation than the synoptic weather station at Belmullet, at approximately 250 mOD. This means that rainfall in the catchment of the Sheskin River will be slightly higher than at Belmullet. Following a rule of thumb of 100 mm of rainfall per 100 m increase elevation, the mean annual rainfall in Sheskin Forest is expected to be in excess of 1,500 mm.

Based on EPA's Qube model of river flows in ungauged catchments in Ireland (available from EPA's 'Water' web viewer[2], the long-term annual average rainfall (AAR) within the Proposed Development site is approximately 1,536 mm/year. Potential evapotranspiration (PET) is approximately 480 mm/year. Using these figures, effective rainfall (ER), which represents the rainwater that is available for runoff and groundwater recharge, is approximately:

ER = AAR – PET = 1,536 – 480 = 1,056 mm/year

Based on the national groundwater recharge map prepared by GSI, 10% or less of ER is recharged to the bedrock aquifer. For an ER of 1,056 mm/year and a recharge coefficient of 10%, groundwater recharge would be 106 mm/year. This value is close to the recharge 'cap' of 100 mm/year which GSI assigns to 'poorly productive bedrock aquifer' and which underlies the site (Chapter 8). Poorly productive bedrock does not have the physical characteristics and capacity to accept all of the available, infiltrating water. Hence, the excess recharge is 'rejected.' This enhances flow via shallow pathways, including runoff.

Accordingly, it is inferred that long term average groundwater recharge to bedrock is approximately 100 mm/year at the site, and the remainder of water, 956 mm/yr, is available as runoff and shallow groundwater flow through subsoils. This implies that the runoff potential approaches 90% of effective rainfall.

The hydrology of the Proposed Development site is, therefore, characterised by high runoff rates and low groundwater recharge rates (to bedrock). Water logged peat will enhance lateral runoff of rainwater to streams.

9.3.5.2 Baseline Assessment of Runoff

Long-term average runoff volumes were calculated further for the Proposed Development site by considering:

- The estimated long-term average annual rainfall at the site (1,536 mm/yr).
- Applying a further escalation factor of 1.1 to account for higher rainfall due to climate change.
- Evapotranspiration, to estimate the effective rainfall.
- Applying a 90% runoff coefficient to the effective rainfall value.
- Multiplying the resulting depth of water to the Proposed Development site to obtain an average runoff volume.

The calculation is presented in **Table 9-7**.

Table 9-7 Estimated Long-term Average Annual Runoff

Item	Value	Comment
Long-term average annual rainfall	1,536 mm/yr	Sourced from EPA's Qube model
Escalated rainfall	1,690 mm/yr	Accounts for climate change in future, with a net increase in rainfall totals
Mean annual evapotranspiration	480 mm/yr	From Met Eireann national map of Potential evapotranspiration
Effective rainfall	1,690-480 mm/yr = 1,210 mm/yr	Effective rainfall = available recharge
Runoff coefficient	90%	10% is groundwater recharge
Baseline runoff depth	1,220 mm/yr × 90% = 1,089 mm/yr	
Proposed Development site area	11.89 km^2	Excluding the grid connection route[1]

[2] https://gis-stg.epa.ie/EPAMaps/Water

Long-term average annual runoff	11.89 km^2 × 1,098 mm/yr = 13,055,220 m^3/yr, or 35,768 m^3/d, or 0.414 m^3/s.	

Note:
[1]the grid connection route covers a narrow linear path which is on lower elevation and slope, and does not materially affect the overall estimation of runoff.

9.3.5.3 Streamflow

Runoff contributes to streamflow and estimates of streamflow were obtained from EPA's Qube model for naturalized streamflow in ungauged catchments.[3] The Proposed Development site is covered by the two Qube model subcatchments that are shown as the lighter shaded green areas across Sheskin Forest (deep green area) in **Figure 9-3**, as extracted from EPA's 'Water' web viewer. The two subcatchments cover areas of 13.58 and 8.97 km^2, respectively, for a total combined area of 22.55 km^2.

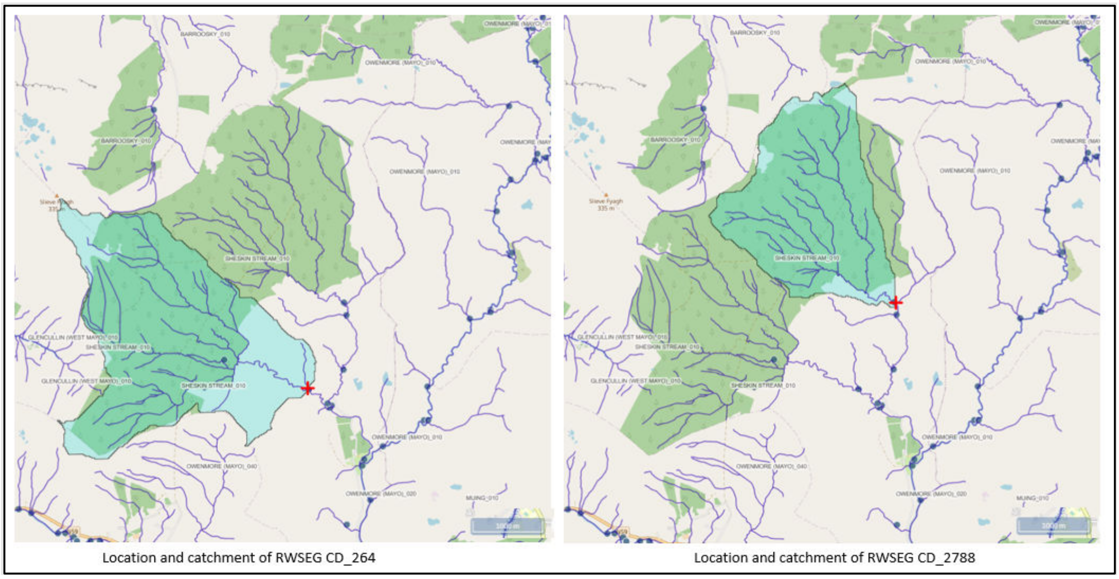

Figure 9-3 Locations and Catchments of Qube Model Nodes 33_264 (red cross, left) and CD 33_2788 (red cross, right)

The model-derived flow percentiles for the two subcatchments are presented in **Figure 9-4**. Flood flow conditions are represented towards the left side of the graph while low flow conditions are represented towards the right. As an example, a flow percentile of 10 in **Figure 9-4** represents the flow that is exceeded 10% of the time (at Qube model nodes 'CD 33_264' and 'CD 33_2788', indicated by the red crosses in **Figure 9-3**).

[3] https://www.epa.ie/our-services/monitoring--assessment/freshwater--marine/rivers/water-level-and-flow-data/

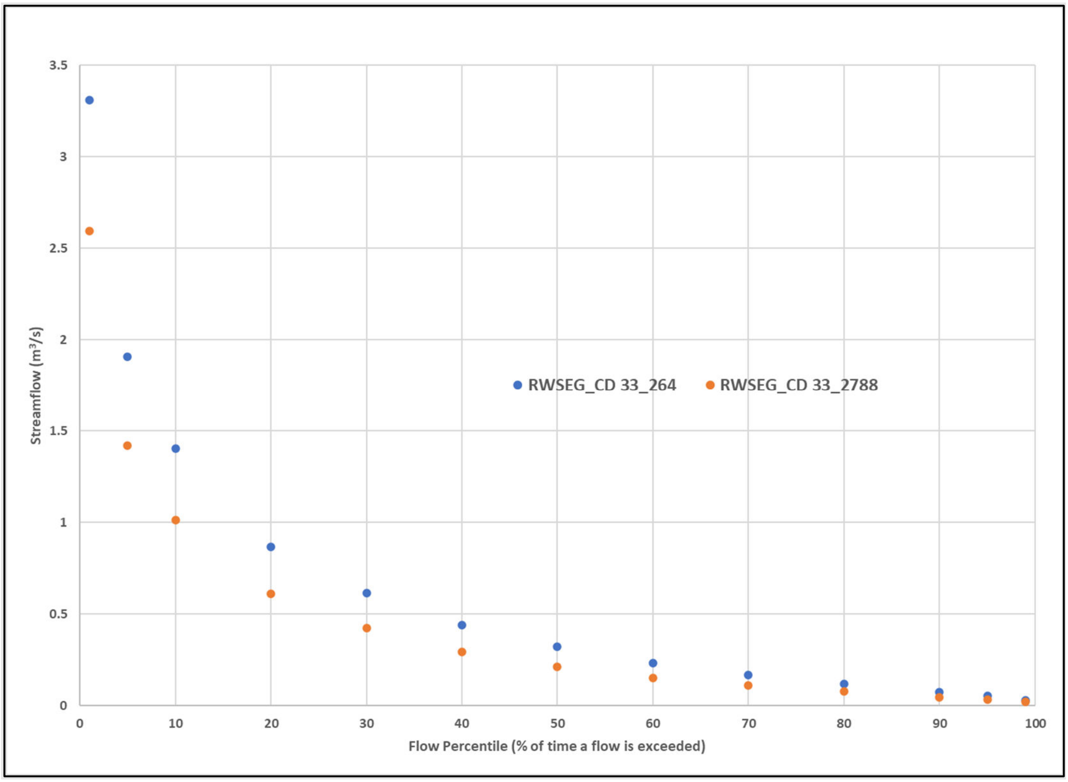

Figure 9-4 Model-estimated Flow Percentiles for the Two Main Streams Exiting Sheskin Forest

Based on **Figure 9-4**:

- Peak estimated streamflows, represented by the 1-percentile flow, is 2.59 and 3.31 m^3/s, respectively in the two subcatchments, for a sum of 5.90 m^3/s.
- Mean estimated streamflows, which is approximated by the 30-percentile flow (LAWPRO/EPA, 2022), are 0.423 and 0.614 m^3/s, respectively, for a sum of 1.037 m^3/s.
- Low-flow conditions, which are generally defined by the estimated 95-percentile flows, are 0.035 and 0.053 m^3/s, respectively, for a sum of 0.088 m^3/s.

Based on the runoff coefficient of 90%, an estimated 0.933 m^3/s (i.e., 90% of the 1.037 m^3/s total mean flow) is inferred to represent mean annual runoff from the Proposed Development site. The remaining 10% is contributed by groundwater baseflow.

The proportion of the model-derived mean flow value that originates within the area of the proposed permanent development footprint (11.89 km^2) would be 1.037 $m^3/s \times (11.89/22.55) = 0.55$ m^3/s, or 47,242 m^3/d.

The Qube modeled flows in **Figure 9-4** cover a wide range of values. This is characteristic of 'flashy' catchments, in which both runoff and streamflow respond quickly to rainfall events. In such catchments, both individual storm events and antecedent (particularly wet) hydrological conditions can significantly influence runoff rates.

The flashy nature of the catchment is reflected in the river stage of the Owenmore River near Bangor Erris, shown in **Figure 9-5**, with rapidly rising and falling water levels. Although river flow data for the Bangor gauging station are not available, other gauging stations in northwest Co. Mayo and outside of the catchment of the Proposed Development area show similar hydrological behaviour.

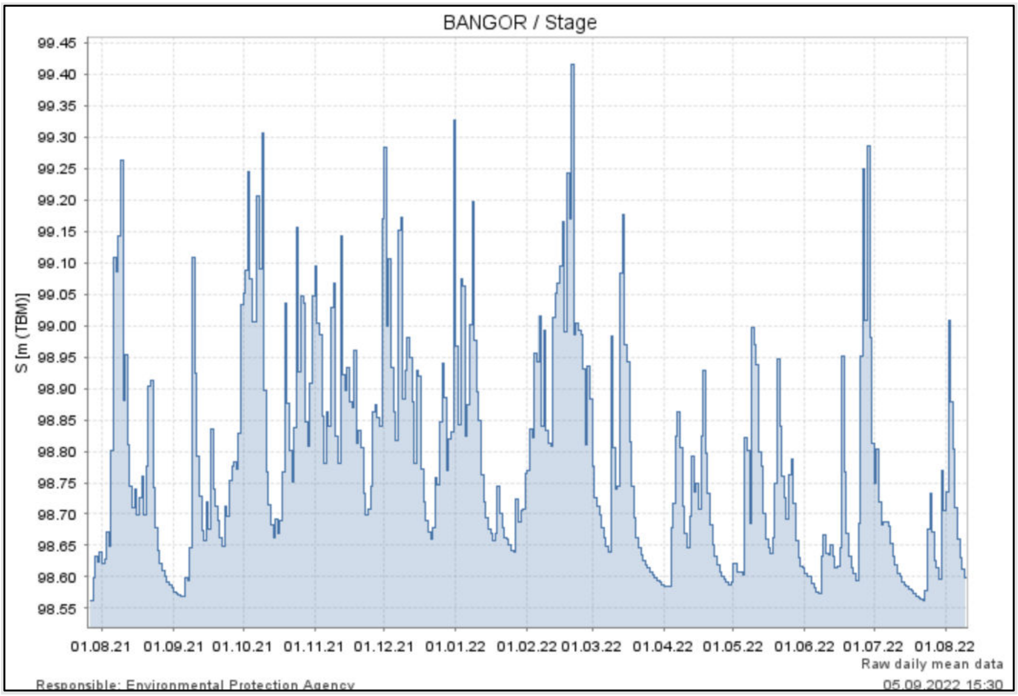

Figure 9-5 Owenmore River Stage at Bangor Gauging Station, January 2021 to January 2022

Adjusted for the respective subcatchment areas in **Figure 9-3** (8.97 and 13.58 km^2, respectively), the mean streamflow values from **Figure 9-4** produce similar specific runoff values for each subcatchment of 0.047 and 0.045 m^3/s/km^2, respectively.

9.3.5.4 Rainfall Return Periods

Table 9-8 below presents return period rainfall depths for the Proposed Development site, specifically at Irish Grid coordinate 93929E 327473N. The data were sourced from Met Eireann and provide rainfall depths for a range of storm durations and return periods. These values were sourced to compute design runoff rates in **Appendix 9-3**, but **Table 9-8** is also relevant to the understanding of scale of recorded flood events in the area, as described below.

Table 9-8 Rainfall Return Periods for Irish Grid Location 93828E, 327473N (Source: Met Eireann)

Duration	Interval		Years													
	6 Months	1 Year	2	3	4	5	10	20	30	50	75	100	150	200	250	500
5 mins	3.0	4.2	4.8	5.8	6.4	6.9	8.6	10.4	11.7	13.4	14.9	16.1	17.9	19.3	20.5	n/a
10 mins	4.1	5.8	6.7	8.0	8.9	9.6	11.9	14.5	16.2	18.6	20.8	22.4	25.0	26.9	28.6	n/a
15 mins	4.9	6.8	7.9	9.5	10.5	11.3	14.0	17.1	19.1	21.9	24.4	26.4	29.4	31.7	33.6	n/a
30 mins	6.4	8.9	10.2	12.2	13.5	14.5	17.8	21.5	23.9	27.3	30.3	32.6	36.2	38.9	41.2	n/a
1 hours	8.5	11.6	13.3	15.7	17.3	18.5	22.6	27.0	29.9	34.0	37.6	40.3	44.5	47.7	50.4	n/a
2 hours	11.2	15.2	17.2	20.2	22.2	23.7	28.6	34.0	37.5	42.3	46.6	49.8	54.8	58.6	61.7	n/a
3 hours	13.2	17.7	20.0	23.4	25.6	27.4	32.9	38.9	42.8	48.1	52.8	56.4	61.9	66.0	69.5	n/a
4 hours	14.9	19.8	22.3	26.0	28.4	30.3	36.3	42.8	47.0	52.7	57.8	61.6	67.5	71.9	75.6	n/a
6 hours	17.5	23.1	26.0	30.1	32.9	35.0	41.6	48.9	53.6	60.0	65.5	69.8	76.2	81.1	85.1	n/a
9 hours	20.6	27.0	30.2	34.9	38.0	40.4	47.8	55.9	61.1	68.2	74.3	79.0	86.0	91.4	95.8	n/a
12 hours	23.1	30.1	33.7	38.8	42.2	44.7	52.8	61.5	67.1	74.7	81.3	86.2	93.8	99.5	104.2	n/a
18 hours	27.2	35.2	39.2	45.0	48.7	51.6	60.6	70.3	76.5	84.9	92.2	97.6	105.9	112.2	117.3	n/a
24 hours	30.6	39.3	43.7	49.9	54.0	57.2	66.9	77.4	84.0	93.0	100.8	106.6	115.4	122.1	127.6	146.0
2 days	40.4	50.6	55.7	62.9	67.5	71.0	81.8	93.2	100.4	110.1	118.3	124.5	133.7	140.6	146.3	165.2
3 days	49.0	60.5	66.1	74.1	79.2	83.0	94.8	107.1	114.8	125.1	133.8	140.3	150.0	157.3	163.2	182.9
4 days	56.9	69.5	75.7	84.3	89.8	93.9	106.6	119.7	127.9	138.7	147.9	154.8	165.0	172.6	178.7	199.1
6 days	71.6	86.2	93.3	103.1	109.3	113.9	128.1	142.7	151.7	163.6	173.6	181.1	192.1	200.3	206.9	228.7
8 days	85.4	101.7	109.6	120.5	127.3	132.4	147.9	163.7	173.5	186.3	197.1	205.1	216.8	225.6	232.6	255.7
10 days	98.6	116.6	125.1	136.9	144.4	149.9	166.6	183.6	194.0	207.7	219.1	227.6	240.0	249.2	256.6	280.9
12 days	111.4	130.9	140.1	152.8	160.8	166.7	184.5	202.5	213.5	228.0	240.1	249.0	262.0	271.7	279.4	304.8
16 days	136.4	158.6	169.1	183.3	192.3	198.8	218.6	238.6	250.7	266.6	279.8	289.5	303.7	314.1	322.5	349.8
20 days	160.8	185.5	197.0	212.7	222.5	229.7	251.3	273.0	286.1	303.2	317.4	327.8	343.0	354.2	363.1	392.2
25 days	190.8	218.3	231.1	248.5	259.2	267.2	290.8	314.4	328.7	347.2	362.5	373.7	390.0	402.0	411.5	442.6

9.3.6 Summary of Flood Risk Assessment

A flood risk assessment of the Proposed Development site is presented in **Appendix 9-1**. OPW's flood risk maps (https://www.floodinfo.ie/map/floodmaps/) and OSI's historical 6-inch sheets and 25-inch basemaps were consulted to identify if any part of the Proposed Development site may be at risk of fluvial flooding.

Summarised in **Figure 9-6**, the National Indicative Fluvial flood risk map shows a "*medium probability*" of fluvial flooding downstream and outside of the Proposed Development site. Based on the accompanying text to the flood risk map, the "*Medium probability"* extent of flooding is a *"modelled extent of land that might be flooded by rivers (fluvial flooding) during a theoretical or 'design' flood event with an estimated probability of occurrence, rather than information for actual floods that have occurred in the past.*" In this instance, the probably of occurrence is 100:1, *i.e.*, a 100-year return period event, noting that it does not account for possible effects of climate change.

Historical OSI 6- or 25-inch sheets for the Proposed Development site do not identify any lands that are "*liable to flood*". GSI's groundwater flooding probability maps also do not indicate a groundwater flood risk within or downgradient of the site.

All Proposed Development infrastructure is located outside and above the mapped 1,000-year flood level and, therefore, all infrastructure is located in Flood Zone C (Low Risk).

There are no recorded recurring flood events on Sheskin River specifically within or immediately downstream of Sheskin Forest (**Figure 9-6**). The nearest mapped flood event is on the Owenmore River at a location near Bangor Erris. At this location, OPW's flood incident reporting[4] describes the river overflowing its banks on 12 July 1997 after 49.5 mm of rain had fallen in Bangor Erris over just a 2-hour period. Based on **Table 9-8**, this would equate to a 100-year rainfall event. The same reporting also refers to "*small landslides*" along the river.

[4] https://www.floodinfo.ie/map/pf_addinfo_report/2438/

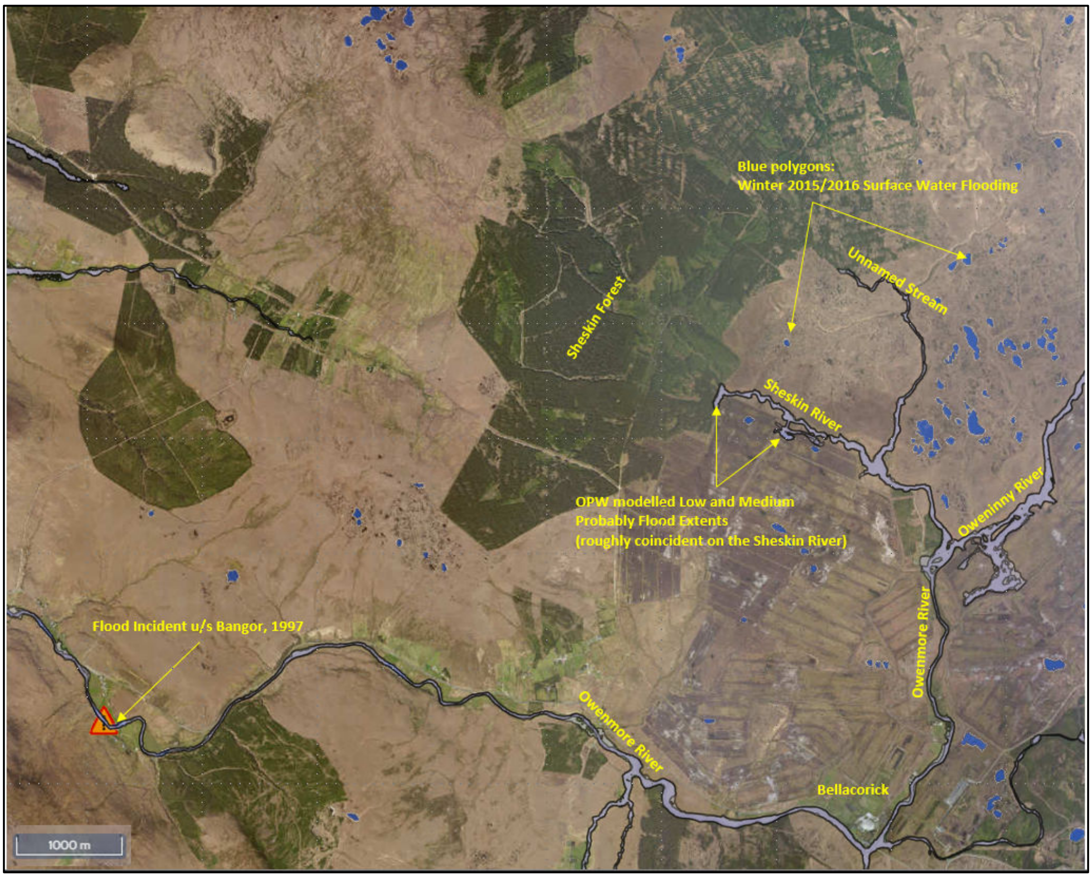

Figure 9-6 Extent of "Medium Probability" Flood Risk

9.3.7 Surface Water Quality

Surface water sampling was conducted by Tobin Consulting Engineers (TCE) in December 2020 and April, July, and August 2021. Sample locations are reproduced in **Figure 9-7**, and include:

- The Sheskin River downstream of the Proposed Development site, labelled as "Sheskin".
- The Owenmore River after the confluence with the Oweninny River, labelled as "Oweninny".
- The unnamed stream south of Sheskin forest, labelled as "701".
- Individual tributaries of Sheskin River within the Proposed Development site, e.g., "704" and "705".

The available data for "Sheskin", "Oweninny" and "701" are presented **Table 9-9**, reflecting the main streams associated with the site. The available data for tributary locations are presented in **Table 9-10**. The data from the referenced sampling events do not indicate any significant water quality issues.

- Suspended solids concentrations were less than 25mg/l in all analysed samples, which is the threshold value cited in the European Communities (Quality of Salmonid Waters) Regulations (S.I. No. 293 of 1988).
- One single detection of orthophosphate at 0.064 mg/l (as PO4) was recorded at location "701" (value in bold in **Table 9-9**) which exceeded the annual average (AA) environmental quality standard (EQS) and 95-percentile EQS for both "High" and "Good" chemical status in the surface water regulations (S.I. No. 77 of 2019), but as an individual detection, not an AA or 95-percentile concentration.
- Ammonium as NH_4 was reported at 0.19 mg/l in one sample at location "702" (value in bold in **Table 9-9**). Converted to NH_3-N, this is equivalent to 0.179 mg/L, which exceeds both the

AA-EQS and 95-percentile EQS for ammonia (as NH_3) for both “High” and “Good” chemical status in the surface water regulations. However, this was a single value, not an AA or 95-percentile value.

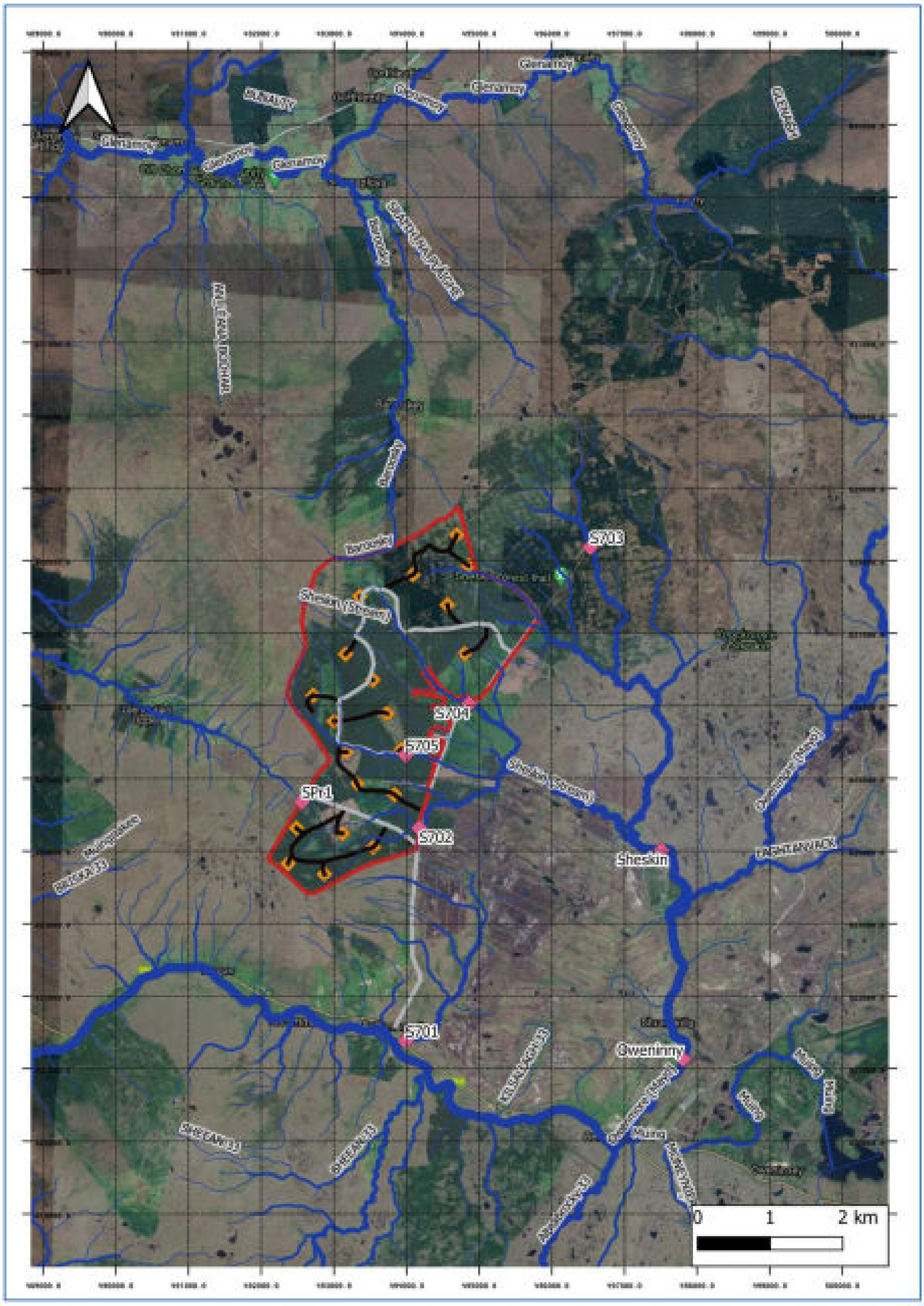

Figure 9-7 Surface Water Sampling Locations For This EIAR (Source: TCE 2021)

Table 9-9 Surface Water Sample Results, Main Streams (Source: TEC, 2021)

		701				Sheskin				Oweninny			
Parameter	**Units**	**Dec-20**	**Apr-21**	**Jul-21**	**Aug-21**	**Dec-20**	**Apr-21**	**Jul-21**	**Aug-21**	**Dec-20**	**Apr-21**	**Jul-21**	**Aug-21**
pH	pH units	7.7	8.1	8.1	7.8	7.7	*ns*	7.8	*ns*	7.9	7.9	7.8	8
Suspended Solids	mg/l	10	<5	11	<5	<5	*ns*	7	*ns*	12	<5	18	<5
Turbidity	NTU	*na*	*na*	17	*na*	*na*	*ns*	10	*ns*	*na*	*na*	20	*na*
Ammonium (NH_4)	mg/l	<0.05	<0.03	<0.05	<0.03	<0.05	*ns*	<0.05	*ns*	<0.05	<0.03	<0.05	<0.03
Nitrate	mg/l	<0.5	*na*	<0.5	*na*	<0.5	*ns*	1.6	*ns*	<0.5	*na*	0.61	*na*
Nitrite	mg/l	*na*	<0.01	*na*	*na*	*na*	*ns*	*na*	*ns*	*na*	<0.01	*na*	*na*
Phosphorus (Total)	mg/l	0.021	<0.1	0.029	<0.1	<0.02	*ns*	0.021	*ns*	<0.02	<0.1	0.021	<0.1
Orthophosphate (as PO_4)	mg/l	**0.064**	*na*	*na*	<0.02	<0.05	*ns*	*na*	*ns*	<0.05	*na*	*na*	<0.02
Dissolved Organic Carbon	mg/l	19	*na*	*na*	*na*	16	*ns*	*na*	*ns*	17	*na*	*na*	*na*
Specific Electrical Conductivity	µS/cm	*na*	132	150	142	na	*ns*	140	*ns*	*na*	134	200	151
Chloride	mg/l	21	26	21	22.5	16	*ns*	19	*ns*	17	24.9	22	19.7
Chemical Oxygen Demand	mg-O_2/l	*na*	33	<10	*na*	*na*	*ns*	54	*ns*	*na*	32	37	*na*
Note: na = not analysed/reported; ns = not sampled													

Table 9-10 Surface Water Sample Results, Tributaries of Sheskin River (Source: TEC, 2021)

		702				703				704				705			
Parameter	**Units**	**Dec-20**	**Apr-21**	**Jul-21**	**Aug-21**	**Dec-20**	**Apr-21**	**Jul-21**	**Aug-21**	**Dec-20**	**Apr-21**	**Jul-21**	**Aug-21**	**Dec-20**	**Apr-21**	**Jul-21**	**Aug-21**
pH	pH units	*ns*	8	8	7.8	7.8	*ns*	7.9	*ns*	*ns*	*ns*	7.7	*ns*	7.6	*ns*	7.7	*ns*
Suspended Solids	mg/l	*ns*	<5	<5	<5	<5	*ns*	<5	*ns*	*ns*	*ns*	14	*ns*	<5	*ns*	6	*ns*
Turbidity	NTU	*ns*	*na*	2.7	*na*	*na*	*ns*	6	*ns*	*ns*	*ns*	21	*ns*	*na*	*ns*	9	*ns*
Ammonium (NH_4)	mg/l	*ns*	<0.03	**0.19**	<0.03	<0.05	*ns*	<0.05	*ns*	*ns*	*ns*	<0.05	*ns*	<0.05	*ns*	<0.05	*ns*
Nitrate	mg/l	*ns*	*na*	15	*na*	<0.5	*ns*	<0.5	*ns*	*ns*	*ns*	<0.5	*ns*	<0.5	*ns*	<0.5	*ns*
Nitrite	mg/l	*ns*	<0.01	*na*	*na*	*na*	*ns*		*ns*	*ns*	*ns*	*na*	*ns*	*na*	*ns*	*na*	*ns*
Phosphorus (Total)	mg/l	*ns*	<0.1	0.031	<0.1	<0.02	*ns*	0.5	*ns*	*ns*	*ns*	0.32	*ns*	<0.02	*ns*	0.25	*ns*
Orthophosphate (as PO_4)	mg/l	*ns*	*na*	*na*	<0.02	<0.05	*ns*	*na*	*ns*	*ns*	*ns*	*na*	*ns*	<0.05	*ns*	*na*	*ns*
Dissolved Organic Carbon	mg/l	*ns*	*na*	*na*	*na*	16	*ns*	*na*	*ns*	*ns*	*ns*	*na*	*ns*	23	*ns*	*na*	*ns*
Specific Electrical Conductivity	µS/cm	*ns*	107	120	140	*na*	*ns*	120	*ns*	*ns*	*ns*	96	*ns*	*na*	*ns*	130	*ns*
Chloride	mg/l	*ns*	28.3	31	20.7	17	*ns*	16	*ns*	*ns*	*ns*	17	*ns*	22	*ns*	18	*ns*
Chemical Oxygen Demand	mg-O_2/l	*ns*	47	<10	*na*	*na*	*ns*	14	*ns*	*ns*	*ns*	23	*ns*	*na*	*ns*	16	*ns*
Note: na = not analysed/reported; ns = not sampled																	

A more detailed and longer-term dataset of water quality of the Sheskin River is available from EPA for a WFD sampling station (RS33S030150) which is labelled on **Figure 9-2** and located close to "Sheskin" in **Figure 9-7**. EPA has monitored this location for WFD reporting purposes since 2007, and the data are summarised in **Table 9-11**. The water quality at this location represents both of the subcatchments that drain from the Proposed Development site.

Table 9-11 Summary of EPA Water Quality Data, WFD Monitoring Location RS33S030150, 2007-2022

Parameter	Unit	Min.	Max.	No. Samples	No. Detections	Mean	AA-EQS[2] (mg/l)
Total Ammonia (NH_3-N)	mg/l	<0.2	0.05	58	10	0.015	≤0.040
Nitrate (as N)	mg/l	<0.2	0.63	32	1	Nc[2]	--
Nitrite[3] (as N)	mg/l	<0.005-<4	14	67	1	Nc[2]	--
Total Oxidised Nitrogen (as N)	mg/l	<0.2	0.62	68	1	Nc[2]	--
Orthophosphate (as P)	mg/l	<0.01	0.085	68	16	0.0086	≤0.025
pH	--	5	8.2	68	68	6.93	--
Alkalinity (as $CaCO_3$)	mg/l	<8	90	68	49	26.5	--
True Colour	Hazen or mg/l Pt co	49	436	68	68	187.2	--
Total Hardness (as $CaCO_3$)	mg/l	17	98	68	59	39.8	--
Chloride	mg/l	14.3	47.1	68	60	24.2	--
Electrical Conductivity	µS/cm	66	270	68	68	140	--
BOD_5	mg/l	<1	4.1	68	33	0.9	≤1.3
Notes: [1]Annual average EQS for nutrients for WFD High Status classification							
[2] Not calculated for nitrogen compounds due to a large number of non-detects							
[3]Wide range of limits of detection							

The water at EPA sampling station RS33S030150 (**Figure 9-2**) is characterised by low nutrient concentrations, low alkalinity and total hardness, low salinity, and generally low biological oxygen demand (BOD_5). Moreover, the mean concentrations for total ammonia, orthophosphate (ORP), and BOD_5 are all below respective AA-EQSs for "High" chemical status. WFD status of water bodies in and around the Proposed Development site are described further in **Appendix 9-4**.

Details of detections for total ammonia and true colour, which are two relevant parameters of concern in peat settings, are plotted in **Figure 9-8** and **Figure 9-9**, respectively.

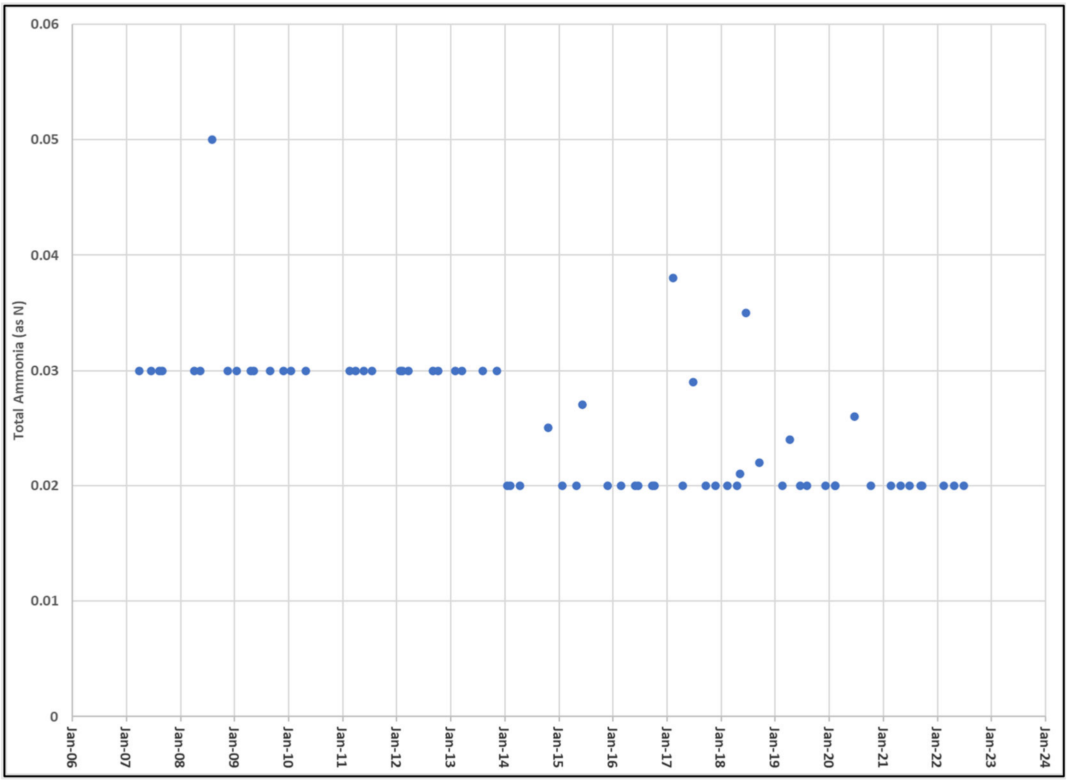

Figure 9-8 Total Ammonia Concentrations, Sheskin River, 2007-2022

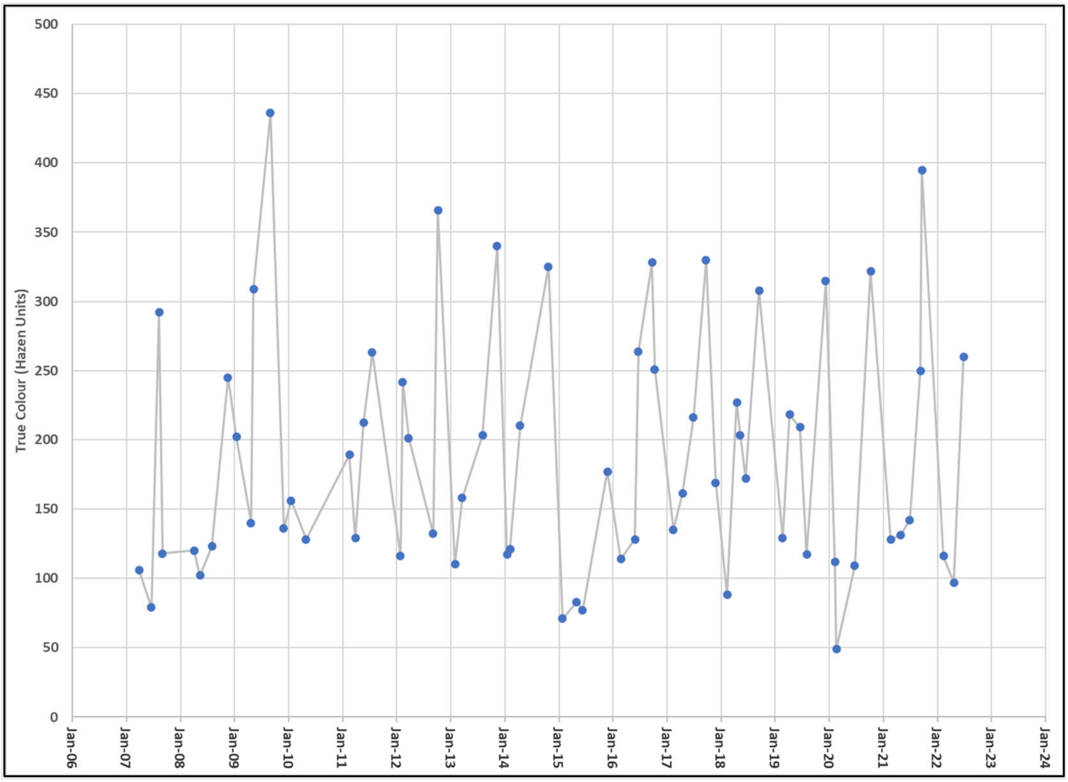

Figure 9-9 True Colour Concentrations, Sheskin River, 2007-2022

Total ammonia concentrations are generally below their reported limits of detection (LOD), which is either <0.03 or <0.02 mg/l in the period of record. There are relatively few detections and the majority of detections are noted in summer. The maximum recorded value was single detection of 0.05 mg/l in 2008.

True colour, as a proxy of fine suspended matter, ranged between 49 and 436 mg/l over the period of record, with seasonal maximum values generally occurring in autumn. There is no EQS for true colour, but elevated concentrations reflect releases of organic matter (dissolved organic carbon) from humic matter such as peat.

Plots of two other relevant parameters, pH and orthophosphate, are shown in **Figure 9-10** and **9-11** (next page) respectively. pH values range from 5 to 8.2, with summer maxima. Orthophosphate is generally below the LOD (0.01 or 0.012 mg/L-P for most samples), with few, sporadic (scattered) detections over the period record.

In addition to the WFD water quality monitoring, EPA conducts biological monitoring through macroinvertebrate 'kick-sampling' at the same fixed water quality sampling locations on the Sheskin River. The resulting 'Q rating' is consistently high (4 to 5), implying favourable High status biological conditions.

9.3.8 Hydrogeology

Based on GSI's bedrock mapping, the Proposed Development site is underlain by sandstones and siltstones of the Downpatrick Formation (**Figure 8-2**). This is bounded to the north by sandstones and siltstones of the Minnaun Sandstone Formation. The two sandstone formations are faulted against each other. Faulting trends northeast-southwest. There are no apparent surface manifestations of the faults and it is not inferred that faults or bedrock geology influence the site's drainage patterns.

As shown in **Figure 9-12**, the Downpatrick Formation is hydrogeologically considered by GSI as a 'Pl' bedrock aquifer, which is a "*poorly productive bedrock aquifer which is generally unproductive except for local zones*". In poorly productive bedrock aquifers, the term 'local zones' usually refers to geological faults.

The Minnaun Sandstone Formation to the north is classified as an 'Lm' aquifer, which per GSI's classification system is "*locally important*" and "*generally moderately productive*".

In both cases, groundwater flow in bedrock is expected to be via fractures, with flow directions that mimic topography. In poorly productive bedrock settings, groundwater flow cells tend to be localised, a few hundreds of metres only. Hence, groundwater flow is expected to discharge locally to the many small streams. Runoff will be the dominant water (and pollutant) transport mechanism.

The bedrock is overlain by natural subsoils. According to GSI mapping, ground is covered by blanket peat and fen peat across the Proposed Development site (**Figure 8-1**). Small pockets of underlying glacial till (derived from bedrock beneath) are exposed along streams that cut through the peat, thereby exposing subsoils along streambeds.

As described in Chapter 8, trial pits were excavated which confirmed the presence of till beneath the peat. The till is described as "*granular*" and "*cohesive*" (Chapter 8), comprising "*silty sands and gravels and/or slightly gravelly sandy silt with cobbles and boulders*" (IDL, 2022).

Recorded peat thicknesses across the Proposed Development site range from 0.2 to 5.7 m, with an average peat depth of 2.1m. Of 960 no. peat probes and measurements along tracks, 53% of recorded peat depths were less than 2.0m and 83% were less than 3.0 m (FT, 2022). As noted in Chapter 8, the peat thickness at each infrastructure component location ranged from 0.6 to 3.0 m. One peat pipe was recorded at a location in the southwest, by a spring near the boundary with the Carrowmore Lake Complex SAC.

The trial pits at infrastructure component locations reached depths of approximately 4 metres below ground level (mbgl). The minimum depth to bedrock recorded was 0.9 m but most of the trial pits did not encounter bedrock.

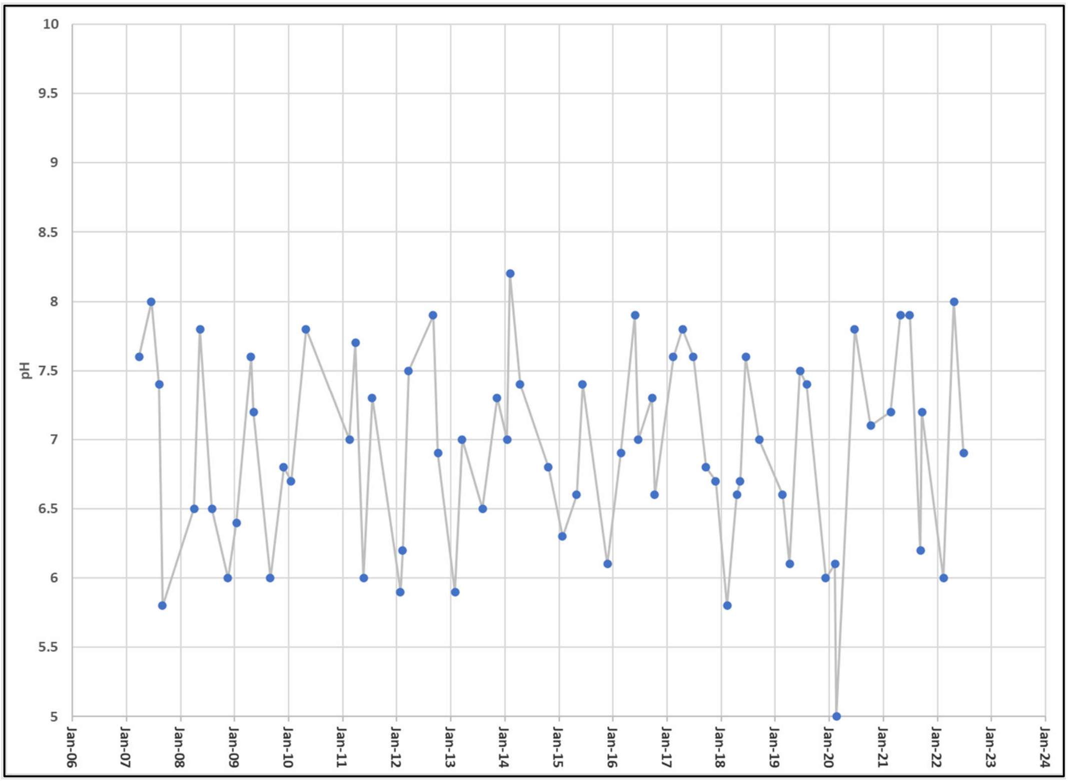

Figure 9-10 pH Values, Sheskin River, 2007-2022

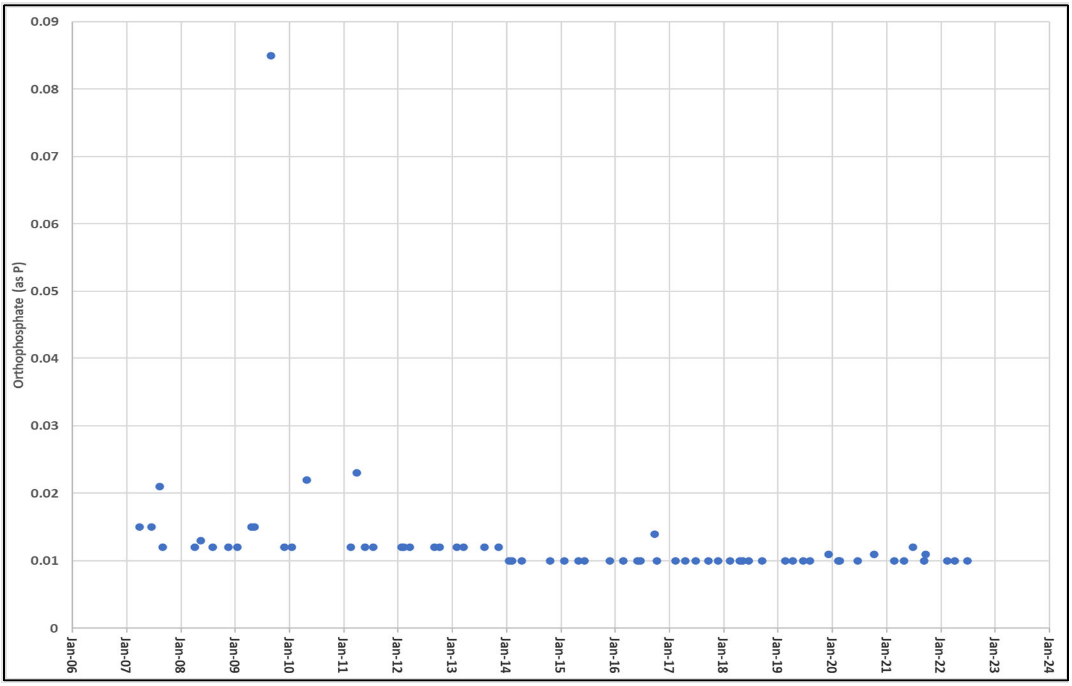

Figure 9-11 ORP Concentrations, Sheskin River, 2007-2022

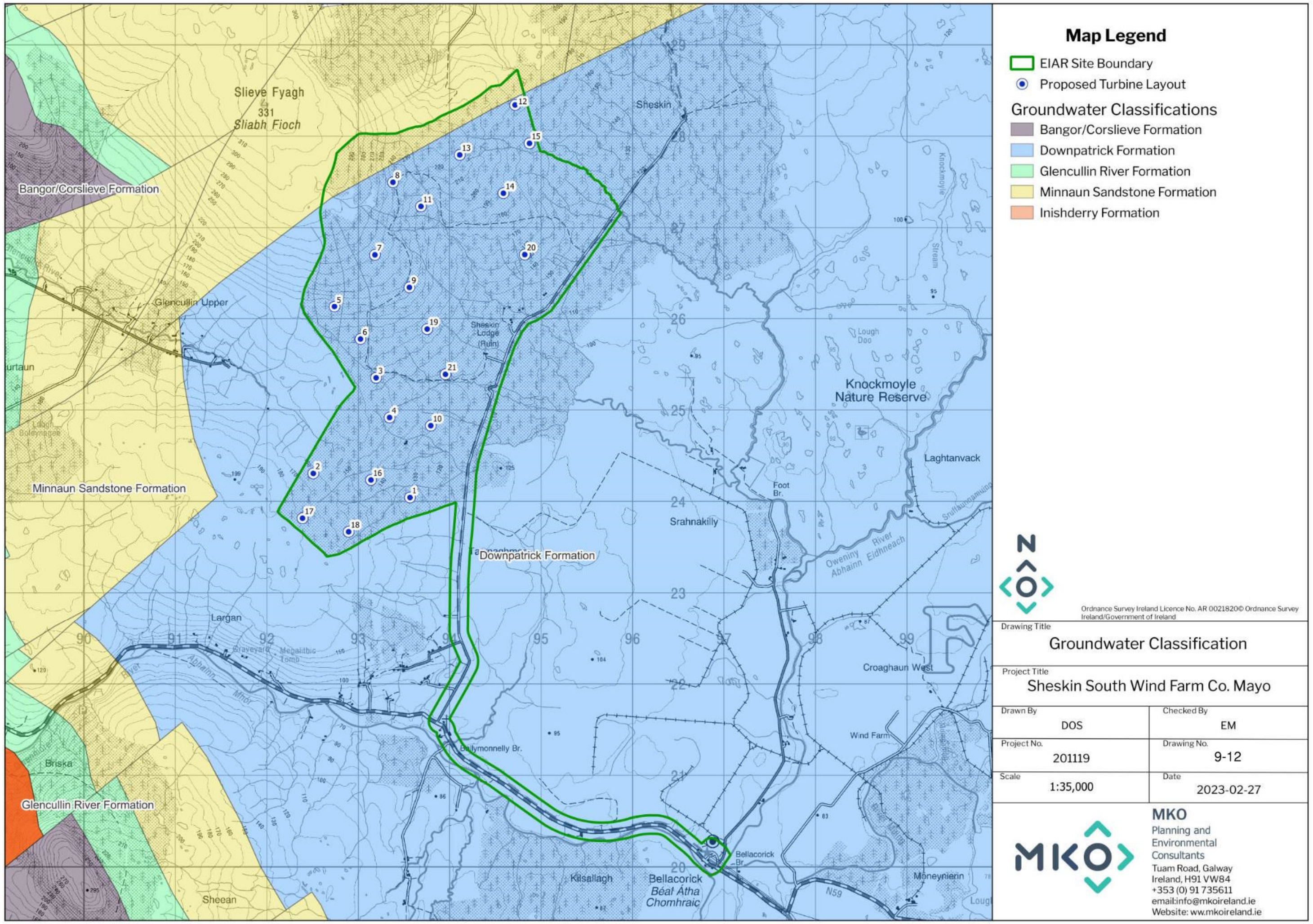

Figure 9-12 Bedrock Aquifer Classification Map

Trials pits also recorded "*ingress of water*" below peat in subsoils at depths between 0.5 and 3.1 mbgl, which is likely associated with more permeable lenses within the subsoils, possibly near the contacts between the peat and till. Several of the trial pits could not be kept open – notably, sidewalls collapsed "*due to ingress of water*" (IDL, 2022). This means that sub-peat groundwater movement takes place, likely locally via thin sand and gravel lenses or channels within the till.

Conceptually, the shallow groundwater in bedrock is hydraulically connected with groundwater in subsoils, which includes movement of groundwater via the 'transition zone' at the top of rock (Moe *et al.* 2010).

Baseline monitoring of water levels in 16 no. peat piezometers across the Proposed Development site between August 2020 and August 2021 recorded depths to water that ranged from 0.1 to 1.0 mbgl (**Figure 9-13**). Water level fluctuations ranged between <0.1 and 0.6 m (TCE, 2021). Responses were broadly similar, with the lowest water levels in August and highest water levels in January through March. In **Figure 9-13**, the secondary y-axis on the right is daily rainfall in mm.

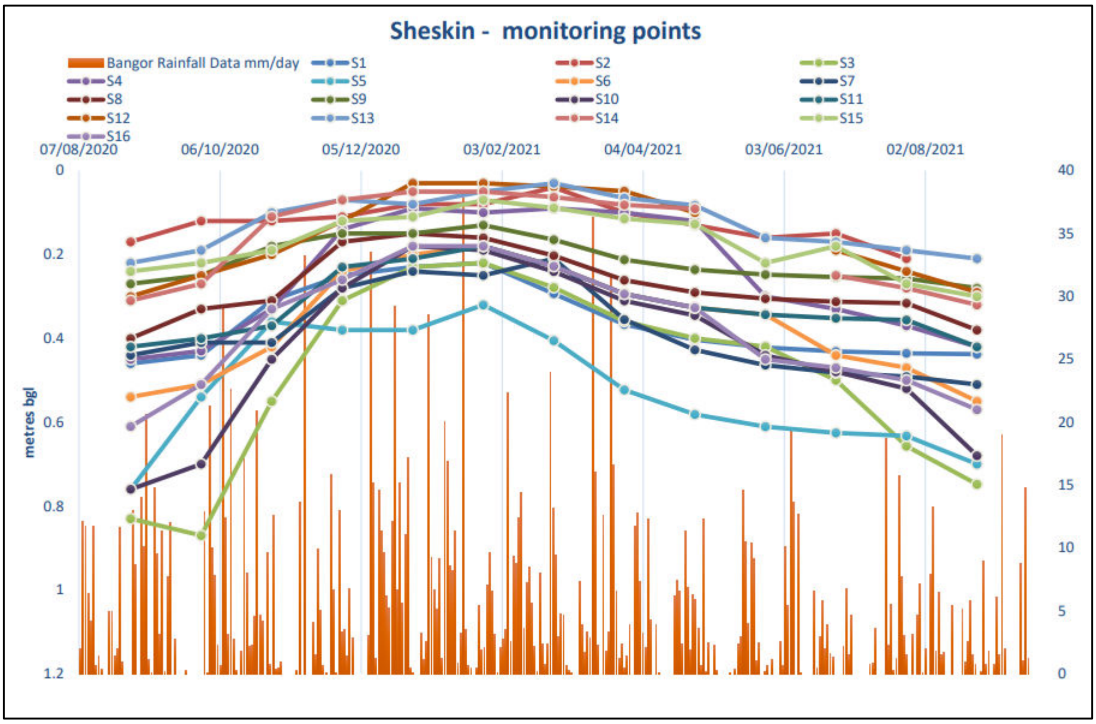

Figure 9-13 Water Level Fluctuations in Peat Piezometers, Proposed Development Site, August 2020-August 2021 (Source: TCE, 2021)

Water levels in peat piezometers that were installed along the cable grid route show similar behaviour as shown in **Figure 9-14** (the y-axis is mbgl. Some of the water levels in both sets of piezometers are relatively deep in summer months, potentially below the 'acrotelm' (active peat layer).

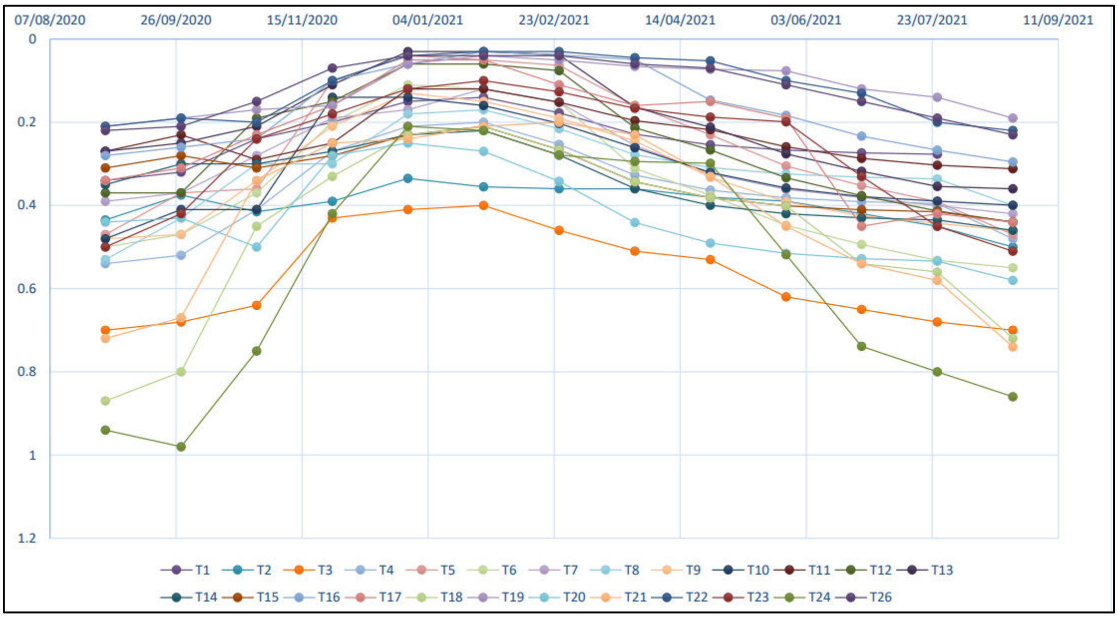

Figure 9-14 Water Level Fluctuations in Peat Piezometers, Proposed Development Site, August 2020-August 2021 (Source: TCE, 2021)

9.3.8.1 Groundwater Vulnerability

Groundwater vulnerability within the site is predominantly mapped by GSI as "High" (**Figure 9-15**). Subsoil permeability is indicated as "Moderate" which means the vulnerability category assumes or is further based on depths to bedrock between 3 and 10 m (DELG/EPA/GSI, 1999). Depth to bedrock greater than 3 m is mostly supported by the site specific information from the trial pits referenced above.

Along one of the tributaries of Sheskin River, groundwater vulnerability is mapped as 'Extreme'. This is where peat and till have been cut through by the stream and bedrock is closed to surface or exposed along the streambed.

On the lower (eastern) slopes of the site and the offsite areas to the east, groundwater vulnerability is mapped as Moderate and Low, which is linked to greater subsoil thicknesses and/or lower permeability characteristics.

9.3.9 Public and Private Water Supply

There are no surface water or groundwater abstractions used for public water supply purposes directly within or hydrologically downgradient of the Proposed Development area. The nearest source of public water supply is Carrowmore Lough, approximately 7 km to the west of Sheskin Forest. This serves approximately 3,900 people in Bangor Erris, Belmullet, and surrounding areas. It also provides treated drinking water to three public group water schemes (LAWPRO, 2020).

Carrowmore Lough receives surface water from rivers/streams that drain from the northern and western slopes of Slieve Fynagh. As such, Carrowmore Lough is not connected or influenced by the Proposed Development site and is, therefore, not at risk of pollution from the Proposed Development.

There are private dwellings, farms and commercial enterprises within the broader Owenmore River catchment. These have access to public water supply but it cannot be ruled out that they also have private supply wells (or 'boreholes'). The nearest dwellings are south of the site, along the N59 and at Shranakilly, near the confluence of the Sheskin and Oweninny Rivers and west of the site in the townland of Glencullin Upper.

As described previously, groundwater flow is localized, with short flow paths to nearby streams. As such, it is considered implausible that any private wells can be affected by site activity. That said, groundwater can function as localized, shallow pathways to nearby small streams within the Proposed Development site during the construction phase.

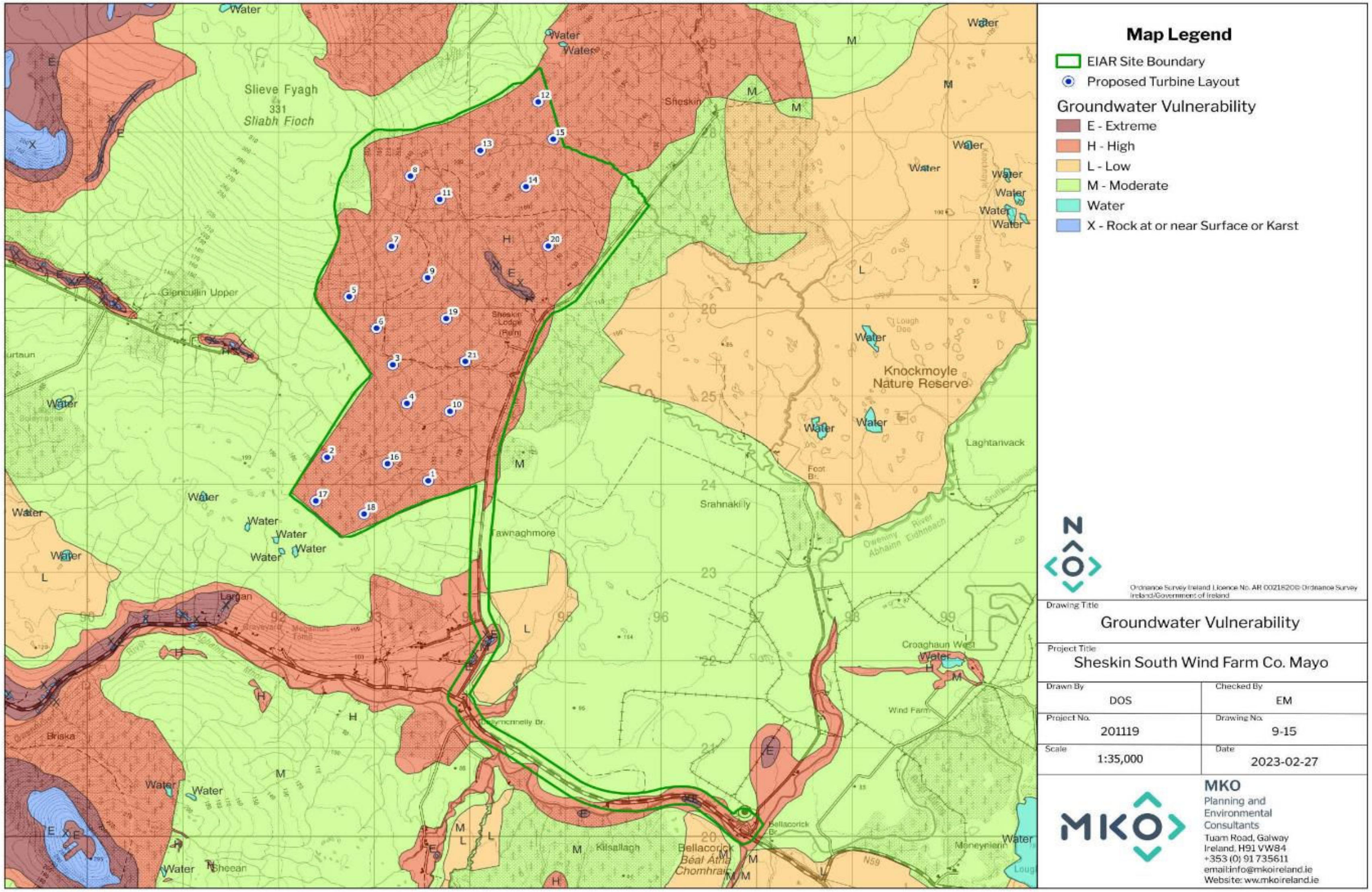

Figure 9-15 Groundwater Vulnerability Map

9.3.10 Designated Sites and Protected Areas

The potential for the Proposed Development to impact on designated sites and habitats was considered, comprising:

- Special Areas of Conservation (SACs) and Special Protection Areas for Birds (SPAs), which are designated under the EU Habitats Directive and EU Birds Directive, respectively. SACs and SPAs are collectively referred to as 'European Sites'.
- Natural Heritage Areas (NHAs), which are designated under Section 18 the Wildlife (Amendment) Act 2000.
- Proposed Natural Heritage Areas (pNHAs), which are designated on a non-statutory basis in 1995 but have not since been statutorily proposed or designated.

The source-pathway-receptor model of environmental risk assessment served to guide the determination about which sites may be affected by the Proposed Development. Mainly, to be affected, the designated sites have to be judged to be hydrologically or hydrogeologically linked to the Proposed Development via surface water or groundwater pathways. As well, the designated sites must have qualifying interest (designation features) which are water-dependent. The latter was checked from 'site synopsis' reports prepared by the National Parks and Wildlife Service (NPWS), published on their website (www.npws.ie).

Designated sites which are deemed to be potentially connected with the Proposed Development site hydrologically or hydrogeologically are shown in **Figure 9-16** and summarised in **Table 9-12**. They are:

- Slieve Fyagh Bog Complex SAC
- Carrowmore Lake Complex SAC
- Glenamoy Bog Complex SAC
- Bellacorick Bog Complex SAC
- Owenduff/Nephin SAC/SPA

The Broadhaven Bay SAC is also hydrologically linked to the Proposed Development site via the Owenmore River, but the SAC is considered too distant (>30 km) to be at risk of effect.

Neither the Sheskin or Owenmore Rivers are protected areas. They are not designated bathing waters, drinking water protected areas, or designated freshwater pearl, salmonid or nutrient sensitive waters. The rivers are, however, recognised as being important for fish spawning and recreational fishing (including salmonid species), as described in Chapter 6 of this EIAR.

9.3.11 Receptor Importance and Sensitivity

Based on the baseline characterisation, the principal environmental receptors associated with the Proposed Development site are the local streams and Sheskin River that drain from Sheskin Forest to Owenmore River. This includes the local streams that are crossed by the grid connection route.

Neither the local streams nor Sheskin River and its headwater tributaries are designated salmonid rivers, nutrient sensitive water bodies, or within a freshwater pearl mussel catchment. They are also not used for drinking water supply and are no upstream of a designated drinking water protected area.

The local streams and Sheskin River with its tributaries are, however, designated WFD 'High Status' water bodies, and are classified as being at 'High' status for the latest WFD reporting period (2016-2021).

For this reason, the importance and sensitivity of the receptor surface water environment is considered to be "Very High" (from **Table 9-2**). Maintaining the 'High' status classification in 'High' status objective water bodies is a WFD priority (DHLGH, 2021),

Groundwater provides minor baseflow to streams and is a minor water balance component overall. However, groundwater is part of the environmental supporting conditions of the peat within the Proposed Development site. For this reason, the importance of the groundwater receiving environment is considered to be "Medium" (from **Table 9-3**).

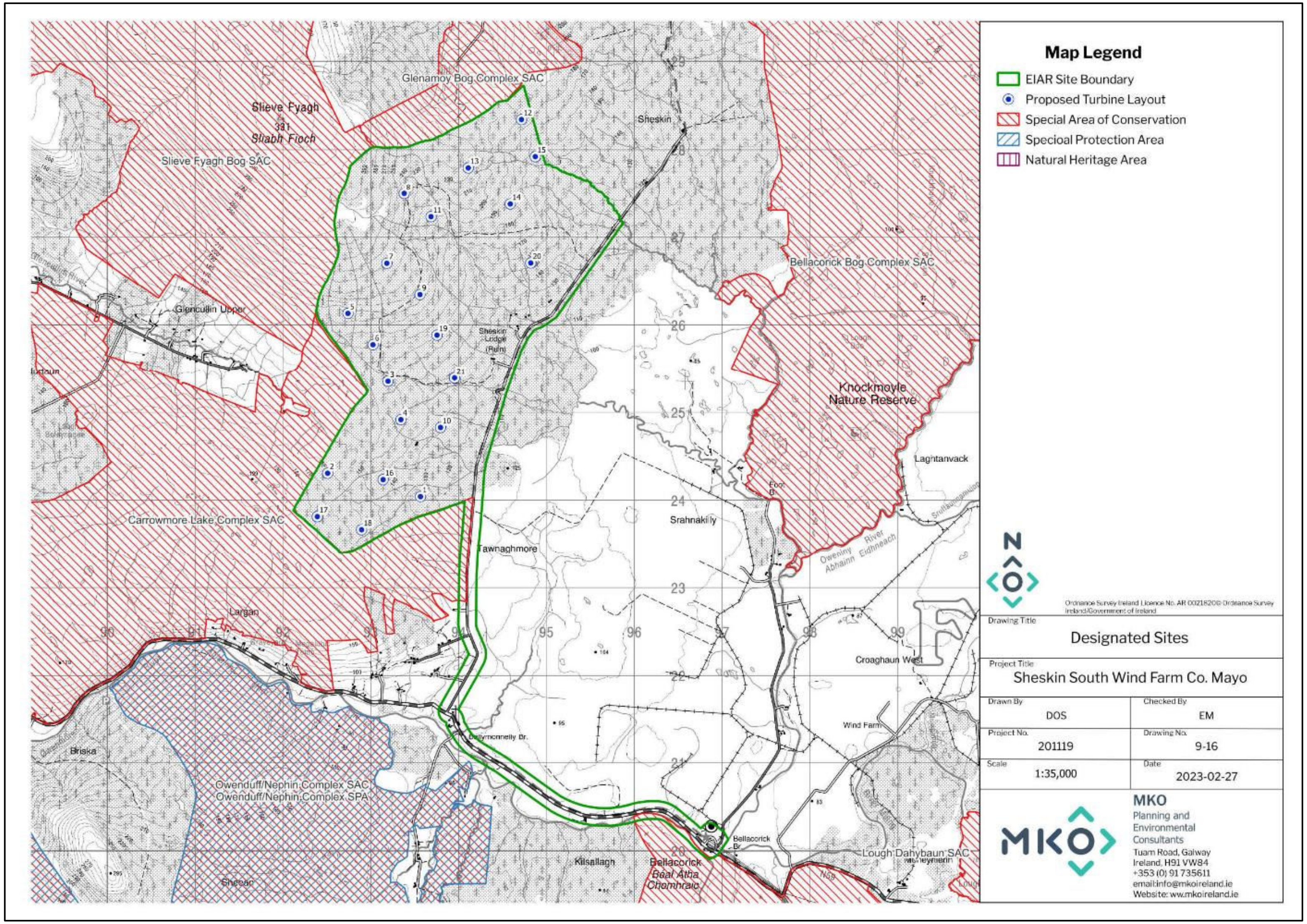

Figure 9-16 Locations of Designated Sites

Table 9-12 Designated Sites – Assessment of Likely Influence

Designated Site	Distance from Site Boundary	Likely Zone of Impact Determination
Special Areas of Conservation (SAC)		
Carrowmore Lake Complex SAC [000476]	0 km (adjacent, upslope)	The designated site is located approximately 200m away from the nearest proposed works. There will be no direct effects as the footprint of the Proposed Development is outside the designated site and there are no pathways or surface water linkages in a downstream direction of any works. Due to the proximity of the SAC to the grid connection route, there is potential for water pollution and hence there is potential of deterioration of qualifying interest (QI) habitats and supporting habitats for QI species within this SAC during the construction phase. From a hydrological and hydrogeological perspective, there is a potential for indirect effects on water and water-related habitats from proposed drainage. For this reason, further assessment is required.
Slieve Fyagh Bog SAC [000542]	0 km (adjacent, upslope)	The designated site is located approximately 250m away from the nearest proposed works. There will be no direct effects as the footprint of the Proposed Development is outside the designated site and there are no pathways or surface water linkages in a downstream direction of any works. From a hydrological and hydrogeological perspective, there is potential for effects on water and water-related habitats from proposed drainage. For this reason, further assessment is required.
Glenamoy Bog Complex SAC [000500]	0 km (adjacent, upslope)	The designated site is located approximately 300m away from the nearest proposed works. There will be no direct effects as the footprint of the Proposed Development is outside the designated site and there are no pathways or surface water linkages in a downstream direction of any works. From a hydrological and hydrogeological perspective, there is a potential for indirect effects on water and water-related habitats from proposed drainage. For this reason, further assessment is required.
Bellacorick Bog Complex SAC [001922]	~2 km (east)	There will be no direct effects as the footprint of the Proposed Development is outside the designated site. There is potential for water pollution of the Owenmore River which forms the western border of the SAC. However, there is no potential for water pollution within the SAC given the distance from the site. There are other wind farms in place within the SAC. For this reason, further assessment is required (cumulative effects).
Owenduff/Nephin Complex SAC [000534]	South of Owenmore River	There will be no direct effects as the footprint of the Proposed Development is outside the designated site. There is potential for water pollution of the Owenmore River which forms the northern border of the SAC. However, there is no potential for water pollution within the SAC given the hydraulic separation and distance from the site. Nevertheless, because of the proximity of the SAC to the grid connection route on the north side of Owenmore River, further assessment is required.

Designated Site	Distance from Site Boundary	Likely Zone of Impact Determination
Broadhaven Bay SAC [000472]	13.6 km (straight-line, west)	There will be no direct effects as the footprint of the Proposed Development is outside the designated site. There is only indirect and very remote hydrological connectivity via the Owenmore River and Tullaghan Bay (an estuary). For this reason, further assessment is not required.
Special Protection Area (SPA)		
Owenduff/Nephin Complex SPA [004098]	South of Owenmore River	There will be no direct effects as the footprint of the Proposed Development is outside the designated site. There is potential for water pollution of the Owenmore River which forms the northern border of the SPA. However, there is no potential for water pollution within the SAC given the hydraulic separation and distance from the site. Nevertheless, because of the proximity of the SPA to the grid connection route on the north side of Owenmore River, further assessment is required.
Blacksod Bay/ Broadhaven SPA [004037]	13.6 km (straight-line, west)	There will be no direct effects as the footprint of the Proposed Development is outside the designated site. The designated site is indirectly hydrologically linked in the downstream direction, but because of the distance involved (more than 30 km), there is an unlikely potential for effects to occur. Any pollutants will be diluted to such an extent that impact will not be perceptible. For this reason, further assessment is not required.

9.3.12 Drainage Planning

To accommodate the Proposed Development, and to serve as a basis for the assessment of likely significant effects, the drainage system that will need to be constructed within the Proposed Development site was planned as presented below and described and shown in **Appendix 4-1** and **Appendix A of Appendix 4-4**.

In short, new drains and swales will be constructed and existing drains will be upgraded and adapted to the needs of the Proposed Development. Interceptor drains will capture greenfield runoff from areas that are upslope of new and existing infrastructure. This water will be discharged in a controlled manner from multiple locations at greenfield runoff rates before diffusely flow across ground and entering streams. Buffered outfalls will also promote percolation of discharge waters across vegetation. The interceptor drains will be integrated as much as possible with existing drains that currently serve the forestry operations.

Interceptor swales will be established downslope of access roads and other infrastructure components to capture 'dirty water' associated with construction activity. This water will be directed to settlement ponds before being discharged in a controlled manner before diffusely entering streams. The swales will remain in place during all subsequent phases of the Proposed Development and will capture runoff from access roads and hardstanding.

The proposed drainage system layout is presented in **Appendix A of Appendix 4-4**. Calculations of runoff rates and pond area requirements are presented in **Appendix 9-3**. Layout and locations of drains, swales, and ponds are dictated by the combined consideration of:

- Topography, making sure the drainage network always transmits water in the downslope direction, even across shallow gradient areas.
- Physical space, between existing or planned features.
- Avoidance of situations where discharges from one drain or pond could be entrained by another in the downslope direction.

Topography in some areas in subtle (e.g. around turbine T3), and it is anticipated that some engineering judgement of final placement/alignment of culverts, swales and settlement ponds will be necessary during construction based on detailed surveying.

A total of seven new culverts at stream crossing will be installed to accommodate the necessary drainage, which is mainly determined by the layout of infrastructure and topography.

To estimate greenfield runoff rates, the Proposed Development site was divided into subcatchments that drain to roads and infrastructure components. Subcatchments were drawn from development layouts and were guided by detailed Lidar survey data (1-m contour intervals). Roads were divided into logical segments guided by their orientations relative to topographic contours and natural streams. The delineated subcatchments are presented in **Figure 9-17**.

Based on calculations (**Appendix 9-3**), settlement ponds will be constructed to sizes that range between <3×5 m and 3×10 m, and will be approximately 1 m deep.

The proposed drainage management approach is detailed in **Appendix 4-4**. Infrastructure, including drains and settlement ponds, will be constructed at least 50 m away from streams, where possible, in order to minimize the potential for effects (e.g., sedimentation and morphological changes) to streams. The layout of the planned infrastructure, water courses and 50 m buffer are shown on the planning-level design drawings in **Appendix A of Appendix 4-4**.

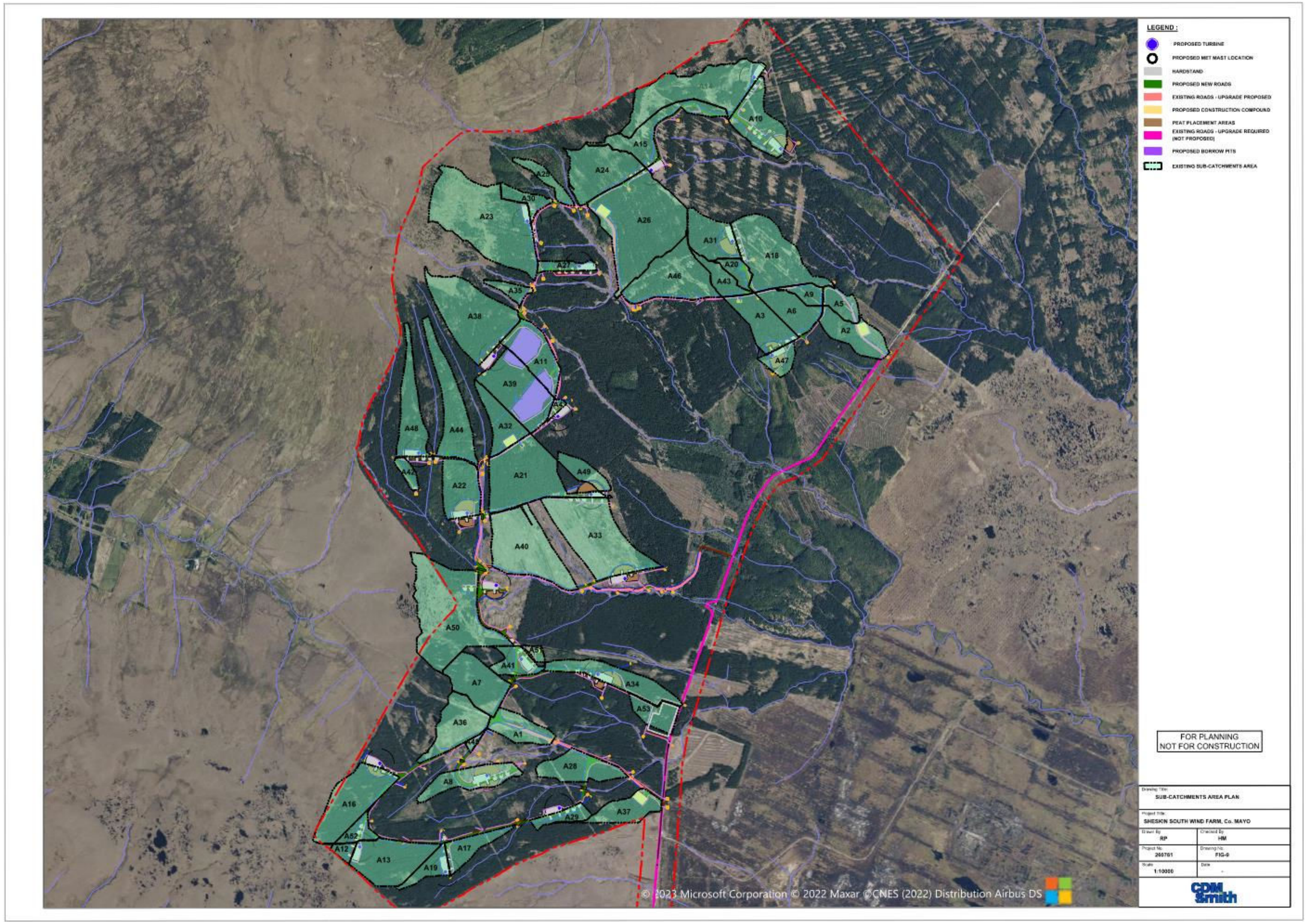

Figure 9-17
Subcatchments Used To Calculate Greenfield Runoff

Direct discharges to water courses will not take place. There are, however, locations constrained by physical space where some discharges will have to be within a few metres of water courses. In such instances, additional attenuation ponds and double silt fencing will be applied as additional measures, the details of which will be judged practically in the field. During construction, new drains will also be integrated with existing drains as much as possible to reduce the scale of earthworks and maintain current runoff patterns in Sheskin Forest.

Check dams will be incorporated along interceptor drains and swales to attenuate the flow and energy associated with storm events, thereby reducing scour and erosion and promoting the settling of sediments. Depending on slope, check dams will be incorporated every 50 m or less.

The proposed Construction and Environmental Management Plan (CEMP) in **Appendix 4-3** also incorporates measures related to drainage management. Runoff management is furthermore detailed in the Surface Water Management Plan in **Appendix 4-4**.

9.3.13 Proposed Monitoring

During the construction phase, a field monitoring campaign will be undertaken in local streams where construction activity takes place. This involves a) visual checks of drains, settlement ponds and streams, and b) daily measurements of field parameters temperature, pH, specific electrical conductivity (SEC), alkalinity and turbidity. The field measurements will be taken once a day, upstream and downstream of the construction activity. The field campaign will begin two weeks prior to activity starts and will cease up to four weeks after activity is completed, unless observations dictate that measurements should continue. 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.

If visible impact occurs, works will be suspended at the discretion of the supervising engineer, in which case the problem will be identified and corrective action taken before recommencing works.

In addition, surface water samples will be taken to monitor for effects and any shifts in baseline conditions over the longer term and potential cumulative effects that may arise from other developments (Section 9.4.5). The following sampling is proposed:

- Samples will be collected from three tributaries of Sheskin River flow east out of Sheskin Forest before merging as the Sheskin River. This is necessary to be able to sample upgradient of infrastructure related to the Oweninny Phase 2 (OP2) wind farm (Section 9..4.5) and differentiate any effects between the two developments.
- Samples will be collected on Sheskin River near or at the EPA monitoring station referenced in Section 9.3.7. This is necessary to continue the baseline monitoring of the Sheskin River subcatchment as a whole and to be able to detect and describe the potential cumulative effects (if any) of OP2 operations on Sheskin River. OP2 extends the full length of Sheskin River east of Sheskin Forest.

The samples will be collected on a monthly schedule during construction and decommissioning, and on a quarterly schedule during the operational phase.

The monthly samples will be analysed for general physico-chemical parameters, nutrients, dissolved organic carbons, and true colour. The quarterly samples will be analysed for the same, but will also include dissolved metals and a suite of oil and fuel-related constituents.

The monthly sampling will be accompanied by field measurements of water temperature, pH, SEC, alkalinity and turbidity.

The broader purpose of the proposed monitoring is to quantity baseline conditions and track how this might evolve under changing climate and subcatchment conditions. The baseline monitoring will commence three months prior to commencement of the construction phase.

The data will be periodically (quarterly) reviewed to assess whether changes (trends) to water quality and cumulative effects are occurring.

9.4 Likely Significant Effects and Associated Mitigation Measures

9.4.1 'Do-Nothing Scenario'

If the Proposed Development were not to proceed, the commercial forestry operations will continue, involving coniferous plantation and tree-felling operations.

In this scenario, the existing surface water drainage will continue to function in the manner currently observed and experienced, which means that the WFD 'High' status objective will likely be maintained, which is a WFD environmental objective. Because there will be no changes to forestry operations or drainage, there will be no further or additional effects from current operations.

If there are new coniferous plantations, or re-ploughing to facilitate afforestation is planned, then reviews of the existing drainage systems will be required before activity commences in order to protect water courses from chemical and sediment loads, and from potential physical damage to water courses. The same applies before tree-felling operations commence, to assure that adequate protective measures are in place for the planned activity.

9.4.2 Construction Phase - Likely Significant Effects and Mitigation Measures

The likely significant effects of the Proposed Development and mitigation measures that were considered during the approximate 2-year construction phase (Chapter 2) relate to:

- Clearfelling of coniferous plantations
- Earthworks
- Culvert installations
- Cable works installations
- Hydraulic effects of drainage
- Water quality effects of drainage
- Pumping from open pits
- Accidental spills or leaks
- Release of cement-based products
- Wastewater management
- Turbine delivery route
- Public and private water supplies
- WFD water body status
- Designated sites

Mitigation measures consider specific actions which are designed to avoid, prevent or lessen potential effects – *i.e.,* mitigation by avoidance and mitigation by design.

9.4.2.1 Clear-Felling of Coniferous Plantation

A total of 117 ha of forest will be felled to accommodate the Proposed Development. The duration of the felling activity is less than six months. Tree felling is subject to a Felling Licence application to the Forest Service, in accordance with the Forestry Act 2014 and the Forestry Regulations 2017 (SI No. 191/2017) and as per the Forest Service's policy on granting felling licenses for wind farm developments.

Clear-felling involves the use of machinery. The activity results in physical disturbance of residual peat and subsoil. The disturbance is from vehicle tracking and skidding, forwarding extraction methods, and damage to existing tracks and timber/brush in stacking areas.

The related activity can release sediments, organic matter (including dissolved organic carbon) and nutrients into drains.

As described in Section 4.8.1, the activity is part of preparatory groundworks and will be conducted in stages over a planned duration of 10 months.

Pathways: Runoff, drains.

Receptors: Local streams and the Sheskin and Owenmore Rivers downstream.

Pre-Mitigation Potential Effects: Without mitigation, potential effects will be indirect, negative, moderate, temporary, reversible, and of high probability.

Proposed Mitigation Measures: Best practice methods will be incorporated into the forestry management. These are set out below and will be in accordance with:

- DAFM (2019): Standards for Felling and Reforestation.
- Coillte (2009): Forest Operations and Water Protection Guidelines.
- Coillte (2009): Methodology for Clear Felling Harvesting Operations; Forest Service (Draft).
- Forest Service of the Department of Agriculture, Food & the Marine (2008): 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.

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. Minimum buffer zone widths recommended in the Forest Service (2000) guidance document "Forestry and Water Quality Guidelines" are shown in **Table 9-13**.

Table 9-13 Recommended buffer zone widths adjacent to aquatic zones

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

Mitigation by Design: Mitigation measures will be implemented wherever clear-felling is planned. The objective will be to mitigate the risk of mobilising suspended solids and nutrients into drains and surface water courses, as follows:

Small felling areas (<25ha), sequencing of felling to avoid intense felling in one subcatchment

- Limiting felling areas and sequencing the felling to avoid intense felling in one subcatchment.

- Machine combinations (*i.e.* handheld or mechanical) will be chosen which are most suitable for ground conditions and which will minimise soils disturbance.
- Sediment/Silt traps will be strategically placed downslope within forestry drains near streams before ground preparation. The purpose is to slow water flow, increase residence time, and allow settling of silt. No direct discharge of such ditches to water courses will occur.
- Crossing of streams away from bridges and culverts will not be permitted. Checking and maintenance of roads and culverts will be on-going throughout felling activity. No tracking of vehicles through watercourses will occur. Existing interceptor drains will also not be disturbed.
- Clay, soil and silts will be removed from roads during wet periods and dust will be suppressed during dry spells.
- Main drains that accommodate the discharge from collector drains will include rock armour, as required, where there are steep gradients.
- On steep slopes and where felling inside the 50 metre buffer is required, it will be necessary to install double or triple sediment traps. All drainage channels will taper out before entering the buffer zone. This ensures that discharged water fans out over the buffer zone before entering the aquatic zone, with sediment filtered out by ground vegetation within the 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. Machine access will be maintained to enable the accumulated sediment to be excavated. Sediment will be carefully disposed of in dedicated disposal areas.
- Correct drain alignment, spacing and depth will ensure that erosion and sediment build-up are minimized and controlled.
- Brash management/removal.
- Brash mats will be used to support vehicles on soft ground, reducing soil erosion and avoiding the formation of rutted areas. Brash mat renewal will take place when they become heavily used and worn. Provision will 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, extraction will be suspended during periods of high rainfall.
- Timber will be stacked in dry areas and outside a 50 metre buffer. Straw bales and check dams will be emplaced on the downgradient side of timber storage/processing sites.
- Works will not be conducted during significant rainfall events (see Section 9.4.2.2) in order to minimise entrainment of exposed sediment in surface water run-off.
- Branches, logs or debris will not be allowed to build up in aquatic zones. All such material will be removed when tree-felling operations have been completed.

Drain Inspection and Maintenance: The following items will be conducted 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 (*i.e.,* hot spot areas).
- Inspections of plant and machinery will be conducted prior to any works to assure all are in good condition.
- Inspection of drainage ditches and outfalls. During pre-felling inspections, the main drainage ditches will be identified. The pre-felling inspection will be conducted during rainfall events.
- Following tree felling, all main drains will 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.
- 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: Surface water monitoring will be conducted as presented in Section 9.3.13. Field and sampling monitoring will be conducted upstream and downstream of the felling activity. Visual observation will be relied on to shut down activity if necessary, in order to fix or upgrade any components of mitigation which may be failing or underperform. Daily surface water monitoring forms will be used at every works site. These will kept on site for record and inspection.

Residual Effects: The proven forestry best practice measures proposed above will break the pathway between sources and receptors. Residual effects will be indirect, negative, slight, temporary, and of low probability.

Significance of Effects: With implementation of the proposed mitigation measures, likely significant effects on surface water receptors will not occur.

9.4.2.2 Earthworks

The construction phase involves earthworks in the form of excavation, movement, staging, and reinstatement of excavated materials. The scale of earthworks and the means and methods of conducting earthworks were presented in Chapter 4. Within the Proposed Development site, which encompasses 1,189 hectares (11.89 km^2), the proposed permanent development footprint is 24.22 hectares (0.24 km^2), or 2% of the total area.

The main risks associated with earthworks are direct releases/discharges of sediment load to surface water courses. Releases of sediments to surface water courses increases suspended sediment and organic matter loads. In a peat environment, such releases can affect water quality, water clarity, morphology, and aquatic habitats in the downstream direction. Clogging of streambed substrate is a morphological effect.

Compared to tree-felling, the scale of earthworks during the construction phase are considerably greater. This means that the potential magnitude of likely effects are also greater.

Pathways: Drainage, runoff, surface water discharge routes.

Receptors: Local streams and the Sheskin and Owenmore Rivers downstream.

Pre-Mitigation Potential Effects: Without mitigation, potential effects will be indirect, negative, significant, short-term, reversible, and of high probability.

Mitigation by Avoidance: Works areas will be kept at least 50 m from water courses to the extent possible. The proposed setback distance/buffer will serve to avoid:

- Direct physical damage to watercourses and associated releases of sediment.
- Direct entry of suspended sediments from earthworks into watercourses.
- Direct entry of suspended sediments from the drainage system into watercourses, which is achieved in part by ending drain discharges outside the buffer and allowing percolation across the vegetation within the buffer.

Risks and effects of earthworks are made greater during storm events. Hence, earthworks will not be conducted during significant storm events. The works programme for the entire construction stage of the development will take account of weather forecasts, notably predicted rainfall. Large excavations and movements of soil/subsoil or vegetation stripping will be scaled back or suspended if heavy rain is forecast. Threshold rainfall values will serve to guide decisions to suspend works, visually and/or judged from weather forecasting, by either of the following:

- High-intensity rainfall events, >10 mm/hr.
- Heavy frontal rainfall lasting most of the day, >25 mm in a 24-hour period.
- More than half the monthly average rainfall over 7 days.

The checking and communication of weather forecasts are part of the CEMP. Prior to suspending works for climatic reasons, the following control measures will be completed:

- Open excavations will be secured.
- Temporary or emergency drainage will be provided to prevent back-up of surface runoff in work areas.
- Working for up to 12 hours after heavy rainfall events will be avoided to ensure drainage systems are not overloaded. Decisions are subject to visual inspection and judgement by the resident (supervising) engineer. The intent and objective is to control erosion, avoid collapses of embankments, and limit the mobilisation and transport of sediments.

Mitigation by Design: Key mitigation by design measures that will be implemented comprise source controls, in-line controls and treatment systems, as follows:

- Source control measures cover working areas, staging areas and stockpiles. Methods that will be employed are diversion drains, flume pipes, sand bags, oyster bags filled with gravel, and filter fabrics. Flexibility to adapt methods will be required based on location-specific conditions, as judged by supervising engineers from visual inspection.
- In-Line controls involve settling of suspended sediments and particulate organic matter with the use of silt fences, straw bales, sand or oyster bags, weirs, baffles, and check dams. Flow limiters and sump pumping systems may be employed where needs arise in order to maintain the hydraulic functioning of the existing drain system.
- Treatment systems involve sediment traps and temporary sumps/attenuation ponds.

Moreover, clay, soil and silts will be removed from access roads during wet periods and dust will be suppressed during dry spells.

If discharge water fails to be of a high quality during regular inspection, then a filtration treatment system such as a “Siltbuster” or equivalent will be used to filter discharge water before release to water courses. This applies for the entire construction phase.

For discharges near water courses, within the 50 m buffer, and including discharges of greenfield runoff, double silt fences will be employed. These will be inspected and maintained, and remain in place throughout the entire construction phase.

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 outfall from the silt bag. Sedimats will be secured to the ground surface using stakes/pegs. Sedimats will extend the full width of the outfall to ensure all water passes through this additional treatment measure. Level spreaders will be designed for each outfall.

Management of Runoff from Peat and Spoil Placement Areas: Excavated peat and spoil will be used for landscaping, spread within the proposed peat placement areas around certain turbines and used to reinstate the 2 no. borrow pits. A Peat and Spoil Management Plan is presented in **Appendix 4-2**.

During the initial placement of peat and spoil, silt fences, straw bales and biodegradable matting will be used to control runoff from reinstatement areas. ‘Siltbuster’ treatment trains will be employed if previous treatment is not to a high quality, a stated above.

Drainage from peat placement areas will ultimately be routed to swales and settlement ponds with storage and settlement designed for a 6-hour duration, 1 in 10 year storm event. Peat and spoil placement areas will be vegetated to reduce sediment entrainment in runoff, which will further help to reduce risks of sediment mobilisation.

Field Inspection: An inspection and maintenance plan for the construction drainage system will be prepared in advance of commencement of works. Regular inspections of installed drainage systems will be undertaken, especially after heavy rainfall, to check for damage and blockages, and ensure there is no escape or 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 conducted on a daily basis.

Surface Water Quality Monitoring: Monitoring will be performed as described in Section 9.3.13 and 9.4.2.1.

Residual Effects: Proven and effective measures to mitigate the risk of releases of sediment have been proposed which will break the pathway between potential sources and receptors. Hence, residual effects will be indirect, negative, not significant, short-term, and of low probability.

Moreover, residual effects will be monitored for and corrective action can be taken. Slight changes in current baseline conditions are expected during the construction phase but these are not sufficient to change the character or sensitivity of the receiving waters, and not sufficient to affect the 'High' status classification of the Sheskin water body (**Appendix 9-4**).

Significance of Effects: For the reason outlined above, likely significant effects on surface water quality will not occur.

9.4.2.3 Culverts at Stream Crossings

Culverting is necessary where new access roads will cross streams and where existing stream crossings need upgrades. Based on the planned layout (**Appendix A of Appendix 4-4**), there will be:

- 7 no. new culverted stream crossings
- 9. no. existing stream crossing upgrades

The works require use and movement of machinery and equipment which can result in physical disturbance of streambanks and streambeds, hence sediment mobilisation and both water quality and morphological effects.

Pathway: Runoff and streams

Receptor: Local streams and the Sheskin and Owenmore Rivers downstream.

Pre-Mitigation Potential Effects: Without mitigation, potential effects will be direct, negative, moderate, short-term, reversible, and of high probability.

Mitigation Measures by Avoidance: Machinery and personnel are kept out of the river directly. Direct in-stream works will be avoided.

Mitigation Measures by Design: All works will be conducted in accordance with the CEMP which incorporates the best practice IFI "Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters" (IFI, 2016). Related activity incorporates many of the same measures that are presented in Section 9.4.2.2 (earthworks). Moreover:

- All stream crossings will be bottomless-box or clear span culverts. Existing banks will remain undisturbed.

- Based on IFI (2016), the relevant work period is July to September inclusive, *i.e.,* the relatively drier summer period. Any deviation that may be temporarily necessary will be done in discussion with the IFI.
- During near-stream construction works, double-row silt fences will be emplaced immediately downgradient of work areas for the duration of activity.
- All new 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.

Underground cabling routes within the Proposed Development site (e.g. from turbines) will follow an existing access road or a road proposed for upgrade, and cables will pass within the structure of the road and associated culverts.

Residual Effects: With the proposed mitigation measures, residual effects will be direct, negative, not significant, short-term, and of low probability.

Significance of Effects: For the reasons outlined above, likely significant effects on surface water courses will not occur.

9.4.2.4 Grid Connection Installation

As described in Chapter 4, the grid connection route passes south from Sheskin Forest along an existing roadway to the N59 National Primary Road, from where the route turns east and connects to grid at Bellacorick. Cables will be installed below ground in dug trenches except for two bridge crossings where trenchless technology by horizontal drilling will accommodate the crossing. Horizontal drilling involves the application of a drill rig. This is a heavy plant and requires secure and safe footing for operations, hence preparatory earthworks, including use of basecourse or mats. The risks of effects are the same as those described in Sections 9.4.2.2, 9.4.2.3, and 9.4.2.8.

With respect to the cable crossings, in-stream works will be avoided by directional drilling beneath water courses. 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 will be implemented in full, as follows:

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

The duration of the activity is approximately 3 months.

Pathways: Runoff.

Receptors: Local streams and Sheskin and Owenmore Rivers downstream.

Pre-Mitigation Potential Effects: Without mitigation, potential effects will be direct, negative, slight, temporary, reversible and of medium probability.

Mitigation by Design: Applicable mitigation measures for dug trenches (which involves earthworks) are those described in Section 9.4.2.2 and 9.4.2.3. Where trenches are dug with excavators, spoil will be kept adjacent to the trenches and filled in immediately upon of installation of cables. Cable works will proceed in sections or segments to avoid trenches remaining open over protracted periods of time.

Where cables will cross streams in horizontally drilled boreholes, mitigation measures for earthworks and culverting also apply, per Sections 9.4.2.2 and 9.4.2.3.

Residual Effects: With mitigation measures, the residual effects are direct, negative, not significant, temporary, and unlikely.

Significance of Effects: For the reasons outlined above, likely significant effects on surface water quality will not occur.

9.4.2.5 Hydraulic Effects of Drainage

The shallow interceptor drains that are planned upslope of infrastructure components, including access roads, are designed to capture greenfield runoff. While drainage patterns within Sheskin Forest will be modified, the water balance of the natural drainage system to Sheskin River is maintained.

The main risks associated with the construction of interceptor drains are a) sediment mobilisation to water courses, and b) the potential for draining peat. The latter involves hydraulic effects (see below) and can contribute to water quality effects (addressed in Section 9.4.2.6.

Draining of peat lowers water levels in the peat. This can result in subsidence/slumping of the peat surface in the hydraulically affected area(s) and a loss or changes to vegetation types/communities in the affected area(s).

The hydraulic effect of drainage propagates away from drains, in the upslope directions especially. There is no simple rule of thumb that can be applied to estimate how far the effect may extend. This is because bog science is location-specific. Bog hydrology is also dynamic and transient, responding to changes in event-based, seasonal, and longer-term climatic conditions. Researchers like Rezanezhad *et. al.* (2016), Holden (2009), and Ramchunder *et al.* (2009) also highlight the influence of drain depths, peat depths, relative slopes, the potential interference with other nearby drains, as well as peat stratigraphy, permeability, and structure.

In the UK and Irish scientific literature, there are empirically based examples of drainage effects, although these tend to be associated with deep and purposeful draining of peat for 'land improvement', turf-cutting or larger exploration purposes. Nevertheless, based on monitoring data from Derrycolumb, Co. Longford, Gill (2020) reported that "*water levels on the high bog adjacent to a 1.5m high facebank (with drain along production side) are not significantly influenced by the facebank and associated drainage beyond c. 40m distance*". Gill (2020) concluded that a "*zone of influence distance of 60 m would be a conservative buffer*". For deep perimeter bog drains at the same site, Gill (2020) reported that a "*conservative buffer*" of 100 m would apply.

Price *et al.* (2003) reviewed evidence on the "e*fficacy of drainage*" and referred to studies where water tables in peat were lowered to distances "*up to 50m from the ditch in fibrous peat*", but shorter distances in decomposed fen peat.

Based on monitoring at Clara Bog in Co. Offaly, Regan et al. (2019) estimated that the hydraulic effect of bog margin drainage extended up to 900 m into the bog, as evidenced by land subsidence. They cautioned that the sensitivity of a bog system to environmental change such as drainage will vary depending on the connectivity of the bog to the regional hydrological regime. A similar observation was made by Siegel and Glaser, (2006). In the case of Clara Bog, observations were based on a 28-year record of monitoring the bog is underlain by highly permeable glacial deposits.

The upland blanket bogs at and around the Proposed Development site are characterised by:

- Peat that is underlain by glacial till (silt/clay with sand and gravel) and poorly productive bedrock, which limits rainfall-recharge of the groundwater system and flow.
- Shallow depths to bedrock.

- High and frequent rainfall.

From this, it is considered that the peat is rainfall-dependent more so than groundwater-dependent, even though hydrogeology is part of the mechanism that limits recharge helps to maintain saturation of peat.

To advance the discussion pragmatically for the purposes of the EIAR, a distance of 100 m was used to guide the further discussion of potential effects, which would primarily occur during the operational phase (Section 9.4.3.2). This is because bog hydrology is dynamic and transient, and potential effects at distance will take time to be established - likely longer than the 2-year construction phase. For this reason, the discussion of hydraulic effects has greater relevance during the subsequent phases of the Proposed Development.

In contrast to potential effects of linear interception drains, the smaller excavations that will serve the construction of other infrastructure components (e.g. foundations of turbines) will involve temporary sump pumping, which is addressed in Section 9.4.2.7.

Pathways: Peat, drains.

Receptors: Peat.

Pre-Mitigation Potential Effects: Potential effects are indirect, negative, not significant, short-term, reversible and of medium probability.

Mitigation Measures by Design: Development footprints have been reduced to a minimum and interceptor drains will be shallow which serves to reduce the relative risk of drainage effects. The drainage system will be integrated with the existing drainage network in the forest to the maximum extent possible. All construction works will be supervised.

Monitoring: A network of up to 20 no. piezometers will be installed for monitoring of water levels in peat along the SAC boundaries, upslope of facilities that are closest to the SACs (e.g., turbines T2 and T17). The standpipes will be measured manually on a monthly interval and a select set of 6 no. standpipes along the SACs will be equipped with automatic data loggers for continuous water level measurement. The data will be periodically (quarterly) reviewed to assess whether effects are detected.

Residual Effects: Given the time span of construction (2 years), residual effects from the construction phase will be indirect, negative, not significant, short-term, and of low probability.

Significance of Effects: For the reasons outlined above, likely significant hydrological or hydrogeological effects, beyond those already experienced in Sheskin Forest, are not expected to occur.

9.4.2.6 Water Quality Effects of Drainage

Drainage water can carry suspended matter, dissolved organic matter, and nutrients. If peat is excessively drained, drainage water can also affect the pH of surface water. Hence, local streams in the forest can experience shifts in baseline conditions even if this is unlikely to affect the larger Sheskin and Owenmore Rivers downstream.

Specific water quality issues relate to water clarity, colour, pH and nutrient concentrations. Sedimentation of suspended matter can affect streambed substrate, which is also a stream morphology issue. All items can affect aquatic habitat and biota.

Water quality deterioration has the potential to affect the WFD status classification of related surface water bodies, not in the construction phase but in the operational phase. This is described in Section 9.4.2.13 and in **Appendix 9-4**.

Pathway: Drains.

Receptor: Local streams and Sheskin and Owenmore Rivers.

Pre-Mitigation Potential Effects: Without mitigation, potential effects will be indirect, negative, slight, temporary, and of medium probability.

Mitigation by Design: Potential effects from construction works will be mitigated by drainage controls (e.g. Sections 9.4.2.1 through 9.4.2.3) which are established as part of drainage management. Further descriptions are presented in drainage-related **Appendices 4-1** and **4-4**, as well as Section 9.3.12.

Monitoring: Streams will be extensively monitored as described in Section 9.3.13.

Residual Effects: With the planned drainage system, residual effects will be indirect, negative, not significant, temporary, and of low probability.

Significance of Effects: For the reasons outlined above, changes to current baseline conditions may be measurable but likely significant effects will not occur.

9.4.2.7 Pumping from Open Pits

Open excavations for foundations and the Borrow Pit will have to be temporarily pumped to keep the excavations free of water. Excavation depths will range from <5 mbgl at turbine locations to approximately 11 mbgl at the two Borrow Pits. The depth of peat at the Borrow Pit sites is less than 1 m (**Appendix 4-2**).

Water will enter directly from rainfall and via subsurface seepage when the groundwater table is intersected. In bedrock, groundwater may ingress from fractures and a 'transition zone' that may be present at the contact between subsoils and bedrock. The quantities to be pumped will be small given the generally low-permeability characteristics of both the till and bedrock groundwater flow system.

The pumping from excavations will only be needed for short periods of time. For most components, the time frame is measured in days to weeks. However, the Borrow Pit excavation will be excavated and constructed over an approximately 10 month period, in four stages, as described in **Appendix 4-2**.

The pumped water, which contains suspended solids, will be pumped to the nearest swale and led to the associated settlement pond which has been established in the first stage of construction. The pond will serve to settle out sediments prior to discharge to the nearest water course.

The excavation-related water will be discharged periodically, on as-needed basis. It is not a continuous process, and quantities pumped will vary from location to location.

Given the geology of the Proposed Development site, the quantities that will be pumped and managed are expected to be less than 10 m^3/hr (0.0026 m^3/s, or 2.6 l/s). Pumping can be flexibly adapted (expanded) to accommodate higher pumping needs.

Discharges from sump pumping can affect the water quality of water courses, especially with regard to suspended sediments.

Pre-Mitigation Potential Effects: Without mitigation, potential effects will be indirect, negative, not significant, temporary, reversible, and medium probability. Hydrogeologically, from a quantitative perspective, pumping effects are direct, neutral, imperceptible, temporary and unlikely.

Mitigation by Avoidance: An upslope interceptor drain will be established upslope of the excavation area to prevent greenfield runoff into the excavations. Berms can also be used, as necessary.

Mitigation by Design: The water pumped by sump pumps will pass through silt bags before being discharged into the swale. As the water pass through the silt bags, the majority of sediment and organic matter is retained by geotextile fabric. The silt bags will be used with natural vegetation filters or sedimats. The sedimats will be secured to the ground surface using stakes/pegs. They will extend to the full width of the outfall to ensure that all water passes through this treatment measure. Level spreaders will be installed for each outfall.

The footprints of excavations for infrastructure foundation works and hardstanding have been planned to be as small as practicable. Excavations will be backfilled after completion of installations, which will serve to restore water levels and drainage patterns, hence reduce the temporary drainage effects.

Residual Effects: As outlined in the CEMP, the methods above are standard practice methods which serve to reduce suspended matter loads from discharges. In this manner, the sediment load is managed and residual effects will be indirect, negative, not significant, temporary, and of low probability. Hydrogeologically, from a quantitative perspective, residual pumping effects are direct, neutral, imperceptible, temporary and unlikely.

Significance of Effects: For the reasons outlined above, likely significant effects will not occur.

9.4.2.8 Accidental Spills, Leaks or Other Releases

Accidental spillage of fuels or chemicals represent a pollution risk to both groundwater and surface water, as well as aquatic habitats and biota.

Pathways: Runoff, drains, streams, groundwater.

Receptors: Groundwater, local streams and Sheskin and Owenmore Rivers downstream.

Pre-Mitigation Potential Effects: Without mitigation, potential effects are direct and indirect, negative, imperceptible to profound, brief to long-term, reversible and of low probability.

Small spills and leaks may cause effects that are imperceptible. Large or continuous spills and leaks can potentially damage the habitats and living organisms in the receiving water.

Hence, effects can be brief to long-term, depending on the nature and scale of the spills or leaks. Potential effects can be mitigated.

Mitigation Measures by Design: The prevention of, and responses to, accidental spills and leaks of fuel and other chemicals are covered by the CEMP and SWMP. The following mitigation measures will be implemented:

- Trained personnel will conduct onsite refuelling only.
- Onsite refuelling of machinery will be done by mobile double-skinned fuel bowsers.
- Drip trays and fuel absorbent mats will be available and used during all refuelling operations
- A permit for the fuel system will be put in place.
- Fuels stored onsite will be minimised. Fuel storage areas will be bunded to contain 110%v of the fuel storage volume for the time period of the construction. Rainwater will not be allowed to accumulate within the bund, and will thus be fitted with a storm drainage system and appropriate oil interceptor.
- The plant used during construction will be regularly inspected for leaks and fitness for purpose.
- Spill kits will be available to deal with and accidental spillage in and outside the re-fuelling area.

Residual Effects: With mitigation, residual effects will be indirect, negative, imperceptible, short-term, and unlikely.

Proven, routine, and effective measures to mitigate the risk of releases of fuels and chemicals are proposed which will break the link between potential sources and receptors.

Significance of Effects: For the reasons outlined above, likely significant effects on surface water or groundwater quality will not occur.

9.4.2.9 Release of Cement-based Products

Entry of cement-based products into drains or surface water within the Proposed Development site represents a risk to the aquatic environment at and downstream of the release.

Concrete and other cement-based products are alkaline and can be corrosive. They generate fine, highly alkaline silt (pH 11.5) that can physically damage fish. 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 ± 0.5 of a pH unit.

Batching of wet concrete onsite is not proposed. Washing out of transport and placement machinery are the activities most likely to generate a risk of cement-based pollution.

Releases of cement-based products are obvious when they happen and can be stopped. They also involve small volumes (individually). Risks are increased with repeated poor practice.

Pathways: Drains, streams.

Receptors: Peat and streams.

Pre-Mitigation Effects: Pre-mitigation effects on peat are covered in Chapter 8. Pre-mitigation effects on surface waters can be direct and indirect (depending on how and where releases occur), and are negative, slight, temporary to short term, and of low probability.

Mitigation Measures by Avoidance:

- Concrete will be delivered in sealed concrete delivery trucks. Batching of wet-cement products will not occur on site.
- Ready-mixed supply of wet concrete products and emplacement of pre-cast elements will take place.
- Pre-cast elements for culverts and concrete works will be used.
- Concrete trucks will not be washed out on site but will be directed back to their batching plant for washout.

Mitigation Measures by Design:

- 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 washout ponds.
- Where temporary lined impermeable containment areas are used, such containment areas are built using straw bales and lined with an impermeable membrane. These are covered when not in use to prevent rainwater collecting.
- Pour sites of cement will be kept free of standing water, and plastic covers will be ready in case of sudden rainfall events.

Concrete deliveries are often conducted outside of normal working hours in order to limit traffic effects on roads. Concrete pouring for turbine foundations is normally complete in a single day per turbine.

Risks of pollution will be further reduced as follows:

- Concrete will not be transported around the site in open trailers or dumpers so as to avoid spillage while in transport.
- All concrete used in the construction of turbine bases will be pumped directly into the shuttered formwork from the delivery truck. If this is not practical, the concrete will be pumped from the delivery truck into a hydraulic concrete pump or into the bucket of an excavator, which will transfer the concrete locally to the location where it is needed.
- Arrangements for concrete deliveries to the site will be discussed with suppliers before work starts, confirming routes, prohibiting on-site washout and discussing emergency procedures.
- Clearly visible signage will be placed in prominent locations close to concrete pour areas specifically stating washout of concrete lorries is not permitted on the site.
- Weather forecasting will be used to assist in planning large concrete pours and large pours will be avoided where prolonged periods of heavy rain is forecast..
- Concrete pumps and machine buckets from slewing over watercourses will be restricted while placing concrete.
- Excavations will be sufficiently dewatered before concreting begins and dewatering will continue while concrete sets.
- Covers will be available for freshly placed concrete to avoid the surface washing away in heavy rain.
- Any potential, small surplus of concrete will be disposed of after completion of a pour in suitable locations away from any watercourse or sensitive habitats.

Residual Effects: Residual effects on peat are covered in Chapter 8. With mitigation, residual effects on surface water quality will be indirect, negative, imperceptible, short-term, and unlikely.

Proven, routine, and effective measures to mitigate the risk of releases of cement-based products are in place which will break the link between potential sources and receptors.

Significance of Effects: For the reasons outlined above, likely significant effects on surface water or groundwater quality will not occur.

9.4.2.10 Wastewater Management

During the construction phase of the Proposed Development, staff welfare facilities will be provided at each of 4 no. construction compounds. Port-a-loos will be used. These will be collected regularly and brought offsite in fully enclosed tanks for disposal by authorised means (permitted wastewater collector) to a wastewater treatment plant.

Pathways: Runoff, drains.

Receptors: Local streams and Sheshkin River downstream, groundwater.

Pre-mitigation Potential Effects: Potential effects are direct and indirect, negative, not significant, short-term, reversible, and of low probability.

Mitigation Measures by Avoidance: Wastewater will not be treated or disposed of onsite.

Residual Effects: Use of sealed storage tanks and offsite disposal breaks the link between the source and potential receptors. With the planned management measures, residual effects will be indirect, neutral, imperceptible, short-term, and unlikely.

Significance of Effects: For the reasons outlined above, likely significant effects on surface water or groundwater quality from wastewater will not occur.

9.4.2.11 Turbine Delivery Route Accommodation Works

As described in Chapter 4, accommodation works will be required covering an area of 1,500 m^2 at the junction of the N59 and L52926, and the intersection of the N17 and N5, comprising construction of widened junctions to facilitate the delivery of turbine components and other abnormal loads. Overnight, turbine blade storage area will also be required along the L52926 local road. The storage area will measure approximately 200 metres in length and will be 5 metres wide.

The activity involves earthworks, which was described in Section 9.4.2.2, and carries risk of accidental spills and leaks, which was described in Section 9.4.2.8.

Pathway: Runoff.

Receptor: Surface water (including Owenmore River).

Pre-Mitigation Potential Effects: Without mitigation, potential effects are direct, negative, moderate, temporary, and of medium probability.

Mitigation Measures by Design: Mitigation measures in relation to earthworks are presented in Section 9.4.2.2. Mitigation measures in relation to accidental spills, leaks or other releases are described in Section 9.4.2.8.

Residual Effects: With mitigation, residual effects are indirect, negative, not significant, temporary, and of low probability.

Significance of Effects: For the reasons outlined above, likely significant effects on nearby surface waters will not occur.

9.4.2.12 Public or Private Water Supply

The site is not hydrologically linked to any sources of public water supply. Hence, the risk of affecting public water supplies are absent. The only risk is posed by private wells, at single dwellings and farms downgradient of the Proposed Development site. The nearest dwellings/farms are more 1.3km from the nearest proposed turbine location. Groundwater flow in the poorly productive bedrock aquifer is localized, with shorth flow paths (hundreds of metres) to local streams.

Pathway: Groundwater.

Receptor: Groundwater and private wells downgradient of site

Pre-Mitigation Potential Effects: Indirect, negative, imperceptible, permanent, unlikely (high probability).

Proposed Mitigation Measures: By following the best practice measures outlined for other potential effects (e.g. accidental spills and leaks, wastewater management) risks to private wells are eliminated.

Residual Effects: With mitigation, residual effects are indirect, neutral, imperceptible, permanent, and unlikely (high probability).

Significance of Effects: For the reasons outlined above, likely significant effects on public or private water supplies will not occur.

9.4.2.13 WFD Water Body Status

A WFD compliance assessment is presented in **Appendix 9-4**. The Proposed Development site is hydraulically connected with the Sheskin_010 and the Owenmore(Mayo)_040 river subbasins (Section 9.3.2). These both have 'High" status objectives assigned by EPA, and maintaining 'High' status is a priority for WFD implementation in Ireland (DHLGH, 2021).

Per the latest WFD status classification period (2016-2021), both water bodies met their WFD 'High' status objectives. As described in **Appendix 9-4** also, the underlying bedrock aquifers also met their WFD 'Good' status objective.

The Proposed Development has the potential to affect surface water quality, and effects can be translated further downstream. However, the duration of the construction phase is approximately 2 years. WFD status updates are determined and reported by EPA every 6 years. Accordingly, risks to WFD status are more relevant for the operational phase (Section 9.4.3.8).

Pathways: Runoff, drains, other discharges (e.g. spills and leaks).

Receptors: Local streams and Sheskin and Owenmore Rivers downstream, groundwater.

Pre-Mitigation Potential Effects: Without mitigation, potential effects on WFD status of the named river subbasins are indirect, negative, imperceptible, short-term, and unlikely (high probability). The same applies for the underlying groundwater bodies.

Mitigation by Design: Mitigation measures are necessary and proposed to break potential source-receptor linkages and allow for attenuation. The means and methods of achieving the necessary levels of protection are proven and established based on existing guidance and practical experiences from other comparable sites.

Relevant mitigation measures are all of those described in the preceding sections for the construction phase. The Contractor will be legally required to adhere to the CEMP. Extensive monitoring will be undertaken to monitor water quality (Section 9.3.13) in order to identify potential effects and take corrective action, as necessary.

Residual Effects: With mitigation, residual effects are indirect, negative, imperceptible, short-term, and unlikely (high probability). The same applies for the underlying groundwater bodies.

Significance of Effects: For the reasons outlined above, likely significant effects on WFD status of the named river subbasins will not occur in the construction period. The same applies for the underlying groundwater bodies.

9.4.2.14 Designated Sites

An assessment on potential effects on designated sites is included with **Appendix 9-4**. As presented in Chapter 6, there are three SACs that directly border the Proposed Development site:

- Slieve Fyagh Bog Complex SAC
- Carrowmore Lake Complex SAC
- Glenamoy Bog Complex SAC

The Slieve Fyagh Bog Complex SAC is hydrologically and hydrogeologically upgradient of the Proposed Development site. Drainage from the SAC enters Sheskin Forest near turbine T3.

The Glenamoy Bog Complex SAC is located across a topographic divide and is hydrologically and hydrogeologically separated from the Proposed Development site.

The positions of the Slieve Fyagh Bog Complex SAC and Glenamoy Bog Complex upgradient and in a separate subcatchment from the Proposed Development, respectively, means that they cannot be hydrologically or hydrogeologically affected during construction.

The Carrowmore Lake Complex SAC borders the Proposed Development site around the southern part of Sheskin Forest. Water drains west, south and southeast from the SAC (**Figure 9-2**). The water courses that drain west and south are in different subcatchments from the Proposed Development. The water that drains to the southeast forms headwater streams that cross the grid connection route which is downgradient of the SAC. While there is a potential to affect the water quality of these streams during construction of the grid connection route, the streams cannot be affected upstream within the SAC boundary.

In theory, construction dust could blow onto each SAC, but mitigation measures will be put in place for dust suppression purposes. The nearest distance from an SAC boundary to planned infrastructure are:

- Slieve Fyagh Bog SAC – 230m (access track to turbine T5 and met mast, southeast of SAC).
- The Carrowmore Lake Complex SAC – 25m (hardstanding for turbine T2, east of SAC).
- The Glenamoy Bog Complex SAC – 195m (access track to turbine T12, southeast of SAC).

There are two SACs/SPAs that are indirectly linked to the Proposed Development site via the Owenmore River, *i.e.,* in the downstream direction:

- Bellacorick Bog Complex SAC
- Owenduff/Nephin SAC/SPA

As explained in **Appendix 9-4,** potential effects on either are considered highly unlikely as both of the SACs/SPA are on the opposite sides of the Owenmore River from the Proposed Development site, and as such their water dependencies are related to hydrological and hydrogeological conditions which are isolated from the Proposed Development site.

Pathway: Local streams and Sheskin and Owenmore Rivers downstream.

Receptor: Water-dependent habitats of SACs/SPAs bordering the Proposed Development site and along floodplains of the Owenmore River downstream.

Pre-Mitigation Potential Effects: Based on proximity to the grid connection route, potential effects to Carrowmore Lake SAC are indirect, negative, not significant, short-term, and low probability.

Mitigation Measures by Design: Mitigation measures described in Sections 9.4.2 generally will serve to mitigate potential effects on named SACs/SPA. Mitigation measures in Sections 9.4.2.1 through 9.4.2.4, and 9.4.2.8, specifically will serve to protect the Carrowmore Lake Complex SAC.

Residual Effects: With mitigation measures, residual effects will be indirect, negative, imperceptible, short-term, and unlikely.

Significance of Effects: For the reasons outlined above, likely significant effects on the designated sites will not occur.

9.4.3 Operational Phase - Likely Significant Effects and Mitigation Measures

The likely significant effects of the Proposed Development and mitigation measures that were considered during the 35-year operational phase (Chapter 4) relate to:

- Maintenance works.

- Hydraulic effects of drainage.
- Water quality effects of drainage – general.
- Water quality effects of drainage – designated sites.
- Compaction of access roads and hardstanding.
- Water well installation and pumping.
- Wastewater management.
- WFD water body status.

Mitigation measures consider specific actions which are designed to avoid, prevent or lessen potential effects – *i.e.,* mitigation by avoidance and mitigation by design.

9.4.3.1 Maintenance Works

During the operational phase, maintenance works of access roads, structures, and drainage system components (e.g. settlement ponds) will be undertaken regularly per the SMWP. Maintenance is a repeated activity which includes cleaning and removal of accumulated sediments, in addition checks and replacements necessary for the electro-mechanical installations.

For the drainage system, potential will be related to sedimentation and damage to water courses. However, risks are much reduced compared to the construction activity as the scale works are less.

Accidental spills and leaks can also occur. Oil used in transformers at the substation and within each turbine, and storage of oils in tanks at the substation, could leak during the operational phase and impact on streams and groundwater. Risk can be managed by following the mitigation measures presented in Section 9.4.2.8. The substation transformer and oil storage tanks will be in a concrete bund capable of holding 110% of the stored oil volume. Turbine transformers are located within the turbines, so any leaks would be contained within the turbine structure.

Pathway: Runoff and drains, surface water, and groundwater (for accidental spills and leaks).

Receptor: Local streams and Sheskin and Owenmore Rivers, and groundwater (for accidental spills and leaks).

Pre-Mitigation Potential Effects: Potential effects will be those that would occur without the SWMP, in which case the potential effects will be indirect, negative, slight, long-term, and of medium probability.

Mitigation by Design: Maintenance works will be subject to control measures contained in Section 3.2.3 of the SWMP (**Appendix 4-4**).

Monitoring: Monitoring will be performed as described in Section 9.3.13.

Residual Effects: With mitigation measures, residual effects will be indirect, negative, not significant, long-term, and of low probability.

Significance of Effects: For the reasons outlined above, likely significant effects from maintenance works will not occur.

9.4.3.2 Hydraulic Effects on Designated Sites

The assessment in Section 9.4.2.3 is particularly relevant to the SACs that border the Proposed Development site in the upslope directions, namely:

- Slieve Fyagh Bog SAC
- Carrowmore Lake Complex SAC
- Glenamoy Bog Complex SAC

Each SAC has active blanket bog among their qualifying interests, and being upslope of planned drainage, there is a potential they could become affected if the peat within the Proposed Development site is excessively drained. For this reason, the topic received closer consideration. As stated in Section 9.4.2.5, the effects would be longer-term and are more relevant to the operational phase (and beyond).

The Slieve Fyagh SAC is partially within the same surface water catchment as Sheskin River. The other two SACs are in different subcatchments, across topographic divides. Nonetheless, the blanket bog is contiguous across the divide.

The nearest distance from respective SAC boundaries to planned drainage features (considering relative directions of drainage) are:

- Slieve Fyagh Bog SAC – 230 m (access track to turbine T5 and met mast).
- Carrowmore Lake Complex SAC – 25m (hardstanding for turbine T2).
- Glenamoy Bog Complex SAC – 195m (access track to turbine T12).

The areas where planned infrastructure is within or approaches the 100 m distance criterion proposed in Section 9.4.2.3, in the upslope direction, are:

- Turbines T2 and T17 in the southwestern portion of the site (Carrowmore Lake SAC)
- Turbines T3 and T5/met mast (Slieve Fyagh Bog SAC)
- Turbine T12 (Glenamoy Bog Complex SAC).

Given the layout of the Proposed Development (Chapter 4), it is principally the interceptor drains between turbines T2 and T17, between T3/T4 and T5/met mast, and between T13 and T12, that would pose a hydraulic risk to the named SACs.

Taking the drain that will run along and upslope of the access track between turbines T2 and T17 as an example (see **Figure 8-1**), this covers a distance of approximately 500 metres. The section runs sub-parallel to the Carrowmore Lake SAC boundary and is roughly perpendicular to the expected slope and expected hydraulic gradient to the southeast. Both T2 and T17 are close to the SAC boundary, and assuming a hydraulic effect of drainage translates 100 m into the SAC, the area within the SAC that would be hydraulically influenced (further assuming the effect translates in the bog across the topographic divide) becomes:

$$100 \text{ m} \times 500 \text{ m (length)} = 50{,}000 \text{ m}^2\text{, or 5 ha.}$$

This equates to 0.14 % of the total SAC area (3,648 ha; NPWS, 2017).

Although effects along SAC boundaries can theoretically add up, the probability of significant hydraulic effects extending into the SACs is low. This is because the blanket bogs are significantly 'wet' (high and frequent rainfall in the upland setting), the planned drains are shallow, and the weight of evidence from literature indicates that hydraulic effects will not be significant.

Pathways: Peat and shallow groundwater

Receptors: Peat

Pre-Mitigation Potential Effects: Indirect, negative, not significant, long-term, and of low probability.

Mitigation Measures by Design: Development footprints have been reduced to a minimum which mains drainage is also reduced to the extent possible. Maintaining shallow drains as proposed reduces the scope and likelihood of drainage effects. The drainage system will be integrated with the existing network in the forest.

Monitoring: The monitoring of the proposed piezometers in Section 9.4.2.5 will continue through the operational and decommissioning phases

Residual Effects: Indirect, negative, imperceptible, long-term, and of low probability.

Any effects that may be detected in the piezometers will have to be assessed, specifically whether they could be caused by other factors. Any residual effects from the operational phase would involve small areas as indicated above, and are reversible through hydraulic measures should they occur.

Significance of Effects: For the reasons outlined above, likely significant hydrological or hydrogeological effects on the SACs will not occur.

9.4.3.3 Water Quality Effects - General

Water quality risks during the operational phase are much reduced compared to the construction phase. Maintenance activity is the main item that can affect water quality, at times when the drainage system undergoes periodic cleaning and/or replacement of installations. The interceptor drains capture greenfield runoff which may contain suspended and dissolved organic matter, which attenuates in the downstream direction.

Specific water quality issues relate to sedimentation, water clarity, pH and nutrient concentrations. Sedimentation is a stream morphology issue. All items can affect aquatic habitat and biota.

Extensive monitoring is proposed for the operational phase, to identify and track water quality (Section 9.3.13).

Pathway: Runoff, drains

Receptor: Local streams and Sheskin and Owenmore Rivers downstream

Pre-Mitigation Potential Effects: Without mitigation (e.g., maintenance), potential effects will be indirect, negative, slight, long-term, and of low probability.

Mitigation Measures by Design: During the operational phase, potential effects will be mitigated by implementation of the SWMP and maintenance works (Section 9.4.3.1).

Monitoring: Streams will be monitored as described in Section 9.3.13.

Residual Effects: With mitigation, residual effects are expected to be indirect, negative, not significant, long-term, and of low probability.

It is possible that current baseline conditions will evolve during the 35-year operational phase, and it will be important to monitor water quality regularly to be able to assess whether these derive from the Proposed Development or other climatic or cumulative effects (Section 9.4.5).

Significance of Effects: For the reasons outlines above, and with the extensive mitigation and monitoring measures that are proposed, likely significant effects on the surface water receptor environment are not expected to occur.

9.4.3.4 Water Quality Effects – Designated Sites

Without mitigation measures, activities in Sheskin Forest can affect the water quality and morphology of local streams and Sheskin River. Effects can also reach the Owenmore River downstream.

Near its confluence with Sheskin River and north of Bellacorick, the Owenmore River borders the Bellacorick Bog Complex SAC. Hence, the Proposed Development is hydrologically, albeit indirectly, linked to the Bellacorick Bog Complex SAC. A potential effect of the Proposed Development on the SAC is, however, considered highly unlikely. This is because the SAC is on the eastern flood plain of Owenmore River and the SAC is dependent on surface water and groundwater inflows from the north and east.

The Owenmore River also borders the Bellacorick Bog Complex SAC at Bellacorick, this time on the south side of the river. This part of the SAC receives inflows from the south, and the SAC at this location is considered to be outside of any possible influence of Sheskin River.

By extension, the Owenmore River borders the Owenduff/Nephin Complex SAC/SPA further downstream, several kms west of Bellacorick. The SAC/SPA also drains from the south, and for the same reason, the SAC/SPA is considered to be outside of any possible influence of Sheskin River.

With regard to the grid connection route, this follows an existing roadway south from Sheshkin Forest which passes east of the Carrowmore Lake Complex SAC. Several small tributaries drain south from the SAC to the Owenmore River (approximately 4 km downstream from Bellacorick). The tributaries are part of the Owenmore (Mayo)_040 water body.

The construction of the grid connection route involves earthworks (trenching, ducting and filling) and stream crossings using existing bridges and trenchless technology (horizontal drilling). The SAC is hydrologically upstream of the route, and for this reason, there will be no deterioration of water quality or WFD status of water bodies within the SAC.

The Slieve Fyagh Bog SAC and Glenamoy Bog Complex SAC referred to in Section 5.1 are upslope and/or in separate subcatchments from the Proposed Development. For this reason, there will be no deterioration of water quality within respective SACs.

Pathway: Local streams and Sheskin and Owenmore Rivers downstream.

Receptor: Water-dependent habitats of SACs/SPAs bordering the Proposed Development site and along floodplains of the Owenmore River downstream.

Pre-Mitigation Potential Effects: Based on proximity to the grid connection route, potential effects to Carrowmore Lake SAC are indirect, negative, not significant, short-term, and low probability. For the other SACs/SPA, potential effects are Indirect, negative, imperceptible, long-term, unlikely (high probability).

Mitigation Measures by Design: Mitigation measures described in Sections 9.4.4 generally will serve to mitigate potential effects on SACs/SPA, although water quality effects are not likely given their geographic positions relative to the Proposed Development site.

Residual Effects: With mitigation measures, residual effects will be indirect, negative, imperceptible, long-term, and unlikely (high probability).

Significance of Effects: For the reasons outlined above, likely significant effects on the designated sites will not occur.

9.4.3.5 Compaction of Access Track and Hardstanding

Access roads and hardstanding (e.g., turbine spaces) will reduce the permeability of the ground across respective areas. Over time, these may become compacted further, which in theory can increase runoff from such areas.

The total footprint of access roads and hardstanding for turbines is 237,761 m^2. In **Appendix 9-3**, the runoff from these areas was calculated to be 0.321 m^3/s for a 1 in 10 year storm event, using a runoff coefficient of 0.7. Accounting for compaction in the future (which reduces ground permeability), by adjusting the runoff coefficient to 0.8, runoff volumes will increase by 0.0045 m^3/s to 0.366 m^3/s. To settle out particles of 10 µm (**Appendix 9-3**), this increases the associated settlement pond area requirements by 193 m^2 in total, which does not pose a practical challenge across the Proposed Development site.

Pathways: Drainage.

Receptors: Local streams and Sheskin River downstream

Pre-Mitigation Potential Effects: Without maintenance, potential effects will be indirect, negative, slight, long-term, and of medium probability.

Proposed Mitigation by Design: The operational phase drainage system (**Appendix 4-4**) will be functioning and maintained (Section 9.4.3.1).

Residual Effects: With maintenance, residual effects will be indirect, negative, imperceptible, long-term, and of low probability.

Significance of Effects: For the reasons outlined above, likely significant effects from surface compaction will not occur.

9.4.3.6 Water Well Installation and Pumping

As described in Chapter 4, staff welfare facilities will be provided at control buildings during the operational phase. There will be a small water requirement for welfare facilities, but not for potable use. It is proposed to harvest rainwater from roofs or, alternatively, install a well adjacent to the electrical substation in accordance with the Institute of Geologists Ireland (IGI) "*Guide for Drilling Wells for Private Water Supplies*" (IGI, 2007).

The well would be flush to the ground and covered with a standard manhole. A pump house is not required as an in-well pump will direct water to a water tank within the roof space of the control building. Bottled water will be supplied for drinking, if required.

The volumes of groundwater that would be pumped are small, <5 m^3/d. The pumping would be intermittent. The hydraulic influence of pumping would be localised and would not result in any significant reduction in groundwater levels, peat water levels, or natural groundwater baseflow to streams.

Pathways: Groundwater.

Receptors: Groundwater, peat, and local streams.

Pre-Mitigation Potential Effects: Direct, negative, imperceptible, long-term, and of low probability.

Mitigation Measures: Rainwater harvesting to reduce the need for groundwater pumping further.

Residual Effects: Direct, neutral, imperceptible, long-term, and of low probability.

Significance of Effects: For the reasons outlined above, likely significant effects will not occur from low-volume well pumping.

9.4.3.7 Wastewater Management

Toilet facilities will be installed with a low-flush cistern and low-flow wash basin. It is not proposed to treat wastewater on site. Wastewater from the staff welfare facilities in the control building will be managed by means of a sealed storage tank, with all wastewater being transported offsite by permitted waste collector to wastewater treatment plants.

Pathways: Runoff, drains.

Receptors: Local streams and Sheshkin River downstream, groundwater.

Pre-mitigation Potential Effects: Indirect, negative, imperceptible, long-term, reversible, and unlikely.

Mitigation Measures by Avoidance: Wastewater will not be treated or disposed of onsite.

Mitigation Measures by Design: The proposed wastewater storage tank will be fitted with an automated alarm system that will provide sufficient notice that the tank requires emptying. Full details of the proposed tank alarm system will be submitted to the Planning Authority in advance of any works commencing on-site. Only waste collectors holding valid waste collection permits under the Waste Management (Collection Permit) Regulations, 2007 (as amended), will be employed to transport wastewater away from the site.

Residual Effects: Use of sealed storage tanks and offsite disposal breaks the link between the source and potential receptors. Hence, residual effects will be indirect, neutral, imperceptible, long-term, and unlikely.

Significance of Effects: For the reasons outlined above, likely significant effects on surface water or groundwater quality from wastewater management will not occur.

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

9.4.3.8 WFD Water Body Status

During the operational phase, risks of water quality effects are much reduced compared to the construction. Maintenance activity is the main item that can affect water quality.

In the operational phase, the functional drainage management system and all necessary mitigation measures are in place to limit the entry of potential pollutants, especially sediment and suspended and dissolved organic matter, to local streams.

In the context of WFD status, all of the water quality parameters which can affect the biological quality elements of rivers are addressed by the mitigation measures. Parameters like pH and ammonia, which can be influenced by drainage from peat, will undergo attenuation in the downstream direction by a) mixing/dilution with the greenfield runoff, b) further mixing/dilution in the streams, and c) in-stream transformation mechanisms (e.g. nitrification) that will take place in the downstream direction.

It is worth noting that 'High' and 'Good' status have been maintained in site-related surface and groundwater bodies, respectively, over three successive river basin management cycles. This means that existing forestry operations and land uses in and around Sheskin Forest have not affected WFD status objectives.

Nevertheless, a comprehensive monitoring programme is necessary and proposed to be able to identify and track any potential effects that may arise, especially in context of climate change and possible other future developments (Section 9.4.5).

Pathway: Runoff, drains

Receptor: Local streams and Sheskin and Owenmore Rivers downstream

Pre-Mitigation Potential Effects: Without mitigation potential effects are indirect, negative, slight, long-term, and of low probability.

Mitigation Measures by Design: During the operational phase, potential effects will be mitigated by implementation of the SWMP and maintenance works (Section 9.4.3.1).

Monitoring: Streams will be monitored as described in Section 9.3.13.

Residual Effects: Based on the Proposed Development alone, mitigation measures are in place to address identified risks, and residual effects will be indirect, negative, not significant, long-term, and of low probability.

Significance of Effects: For the reasons outlines above, and with the extensive mitigation and monitoring measures that are proposed, no likely significant effects on WFD status of surface water and groundwater bodies are expected to occur during the operational phase.

9.4.4 Decommissioning Phase - Likely Significant Effects and Mitigation Measures

The potential effects associated with decommissioning of the proposed development will be similar to those associated with construction but of a reduced magnitude.

Decommissioning works are described in Chapter 4. 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 operations, by rehabilitating constructed areas such as turbine bases and hardstanding. This will be done by re-establishing vegetation, thereby reducing runoff and sediment loads.

Roadways will be kept and maintained following decommissioning of the wind farm infrastructure, as these will be used by ongoing forestry works and for recreational purposes.

The electrical cabling connecting the Proposed Development site infrastructure to the substations will be removed, while ducting will remain in-situ rather than excavating and removing it, as this is considered to have less of a potential environmental effect, in terms of soil disturbance, and thus on the possibility of the generation of suspended sediment.

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 offsite along their original delivery route. The disassembly and removal of the turbines will not have an effect on the hydrological/hydrogeological environment at the Proposed Development site.

Other effects 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 effects will be avoided by leaving elements of the proposed development in place where appropriate. 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. With these measures, no significant effects on the hydrological and hydrogeological environment will occur during the decommissioning stage of the Proposed Development.

9.4.5 Cumulative Effects

Developments within 20 km of the site boundary that were considered for cumulative effects are presented in Figure 2-3 and Figure 13-16. They are:

- ABO Sheskin (8 no. turbines) – consented
- Bellacorick (21 no. turbines) – operational
- Oweninny Phase 1 (29 no. turbines) - operational
- Oweninny Phase 2 (32 no. turbines) – under construction
- Oweninny Phase 3 (18 no. turbines) – pre-planning
- Bunnahowen (3 no. turbines) – operational
- Glenora (22 no. turbines) – pre-planning

In addition, there are plans for a hydrogen plant just northeast of the Bellacorick substation[5], and in proximity with the terminus of the grid connection route for the Proposed Development.

Of these, and from the hydrological and hydrogeological perspectives, only ABO Sheskin and Oweninny Phase 2 are relevant to the cumulative effects assessment. Both are located within the subcatchment of the Sheskin_010 water body. Specifically:

- ABO Sheskin is situated immediately north of the Proposed Development site. The ABO Sheskin site is drained by the “unnamed stream” referred to in Section 9.3.2.
- Oweninny Phase 2 (OP2) borders Sheskin River in the ‘Oweninny cutaway bog’ site on lower ground to the east of the Proposed Development, extending south to the N59 National Primary Road.

The Oweninny Phase 1, Oweninny Phase 3, and Bellacorick wind farm developments are only relevant in so far that they can influence the Oweninny and Owenmore Rivers, but not Sheskin River since they are located in separate subcatchments from Sheskin River.

ABO Sheskin and APO2 can influence the Sheskin River, in different ways. ABO Sheskin is situated in an upland setting and carries the same risks and potential effects that are described in the current Chapter 9. OP2 is operational. It resides within a bog which was exploited by Bord Na Mόna (BNM) and has been subject of a bog rehabilitation programme between 2001 and 2012 (BES, 2013; ESBI, 2015).

Accordingly, Sheskin River will be under conflicting influences of added pressures from ABO Sheskin and bog restoration activity in the APO2 operational area.

Based on these observations, there is potential for cumulative effects on Sheskin River in combination with ABO Sheskin (mainly) and OP2. There are no potential cumulative effects on the groundwater environment.

Cumulative effects are defined by measurable water quality deterioration of the Sheskin and Owenmore Rivers in the longer term, mainly from sediment transport and sedimentation, but potentially also from nutrients, dissolved organic matter, water clarity, and pH.

[5] https://www.eplanning.ie/MayoCC/AppFileRefDetails/22502/0

With the specified mitigation measures for the Proposed Development and with similar measures implemented for ABO Sheskin, the likely cumulative effects on the Sheskin and Owenmore Rivers will, however, not be significant.

To be able to detect and distinguish potential effects of the Proposed Development on Sheskin River from both ABO Sheskin and OP2, additional monitoring stations are necessary as follows:

- One monitoring station on the "unnamed stream" before it merges with Sheskin River. This will serve to monitor effects from ABO Sheskin.
- Three monitoring stations on three tributaries Sheskin River that flow out from Sheskin Forest. This is necessary to be able to sample upgradient of OP2 infrastructure and differentiate the effects of the Proposed Development from OP2.
- To continue the monitoring near the EPA monitoring station referenced in Section 9.3.7 to be able to monitor the cumulative effect of OP2 (if any) on Sheskin River.

This is acknowledged in Section 9.3.13. To understand any effects that may arise from the totality of developments within the Owenmore River catchments, more detailed spatial sampling is necessary along the Oweninny and Owenmore Rivers. However, in context of the Proposed Development, the itemised items above are sufficient to parse the contribution from the Sheskin River subcatchment.

With regard to the hydrogen plant referred to above, this is situated adjacent to the Owenmore River downstream of the confluence point with Sheskin River. Construction and operations at the plant can affect the water quality of Owenmore River below the plant location, and as such it does not interact hydrologically or hydrogeologically with the Proposed Development. The end points of the grid connection routes from both developments will be roughly at the same location near the former Bellacorick power station, but associate construction works do not cause any significant hydrological or hydrogeological cumulative effects.