7.0 WATER

7.1 INTRODUCTION

7.1.1 Background

Hydro-Environmental Services (HES) was engaged by Jennings O'Donovan & Partners Ltd to undertake an assessment of the potential impacts of the proposed wind farm at Yellow River, Co. Offaly on water aspects (hydrology and hydrogeology) of the receiving environment.

The primary objectives of the assessment include:

- Produce a baseline study of the existing water environment (surface and groundwater) in the area of the proposed wind farm development;
- Identify likely positive and negative impacts of the proposed development on surface and groundwater during construction and operational phases of the development; and,
- Identify mitigation measures to avoid, remediate or reduce significant negative impacts.

7.1.2 Relevant Legislation

The EIS is carried out in accordance with the follow legislation:

- S.I. No. 349 of 1989: European Communities (Environmental Impact Assessment) Regulations, and subsequent Amendments (S.I. No. 84 of 1995, S.I. No. 352 of 1998, S.I. No. 93 of 1999, S.I. No. 450 of 2000 and S.I. No. 538 of 2001), S.I. No. 30 of 2000, the Planning and Development Act, and S.I. 600 of 2001 Planning and Development Regulations and subsequent Amendments. These instruments implement EU Directive 85/373/EEC and subsequent amendments, on the assessment of the effects of certain public and private projects on the environment;
- S.I. No. 600 of 2001 Planning and Development Regulations, 2001;

- S.I. No. 94 of 1997 European Communities (Natural Habitats) Regulations, resulting from EU Directives 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (the Habitats Directive) and 79/409/EEC on the conservation of wild birds (the Birds Directive);

- S.I. No. 293 of 1988 Quality of Salmon Water Regulations, resulting from EU Directive 78/659/EEC on the Quality of Fresh Waters Needing Protection or Improvement in order to Support Fish Life;

- S.I. No. 272 of 2009 European Communities Environmental Objectives (Surface Waters) Regulations 2009 and S.I. No. 722 of 2003 European Communities (Water Policy) Regulations which implement EU Water Framework Directive (2000/60/EC) and provide for implementation of 'daughter' Groundwater Directive (2006/118/EC). Since 2000 water management in the EU has been directed by the Water Framework Directive (WDF). The key objectives of the WFD are that all water bodies in member states achieve (or retain) at least 'good' status by 2015. Water bodies comprise both surface and groundwater bodies, and the achievement of 'Good' status for these depends also on the achievement of 'good' status by dependent ecosystems. Phases of characterisation, risk assessment, monitoring and the design of programmes of measures to achieve the objectives of the WFD have either been completed or are ongoing. In 2015 it will fully replace a number of existing water related directives, which are successively being repealed, while implementation of other Directives (such as the Habitats Directive 92/43/EEC) will form part of the achievement of implementation of the objectives of the WFD;

- S.I. No. 41 of 1999 Protection of Groundwater Regulations, resulting from EU Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances (the Groundwater Directive);

- S.I. No. 249 of 1989 Quality of Surface Water Intended for Abstraction (Drinking Water), resulting from EU Directive 75/440/EEC concerning the quality required of surface water intended for the abstraction of drinking water in the Member States (repealed by 2000/60/EC in 2007);

- S.I. No. 439 of 2000 Quality of Water intended for Human Consumption Regulations and S.I. No. 278 of 2007 European Communities (Drinking Water No. 2) Regulations, arising from EU Directive 98/83/EC on the quality of water intended for human consumption (the Drinking Water Directive) and WFD 2000/60/EC (the Water Framework Directive);

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

- S.I. No. 9 of 2010 European Communities Environmental Objectives (Groundwater) Regulations 2010: and,

- European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009.

7.1.3 Relevant Guidance

The water assessment of the EIS is carried out in accordance with guidance contained in the following:

- Environmental Protection Agency (2003): Advise Notes on Current Practice (in the preparation on Environmental Impact Statements);

- Environmental Protection Agency (2002): Guidelines on the Information to be Contained in Environmental Impact Statements;

- Institute of Geologists Ireland (2002): Geology in Environmental Impact Statements – A Guide;

- National Roads Authority (2005): Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes;

- Offaly County Council - County Development Plan 2009 – 2015;

- Wind Farm Development Guidelines for Planning Authorities (September, 1996);

- Forestry Commission (2004): Forests and Water Guidelines, Fourth Edition. Publ. Forestry Commission, Edinburgh; and,

- Coillte (2009): Forest Operations & Water Protection Guidelines.

7.2 METHODOLOGY

7.2.1 Desk Study

A desk study of the site and the surrounding area was completed in advance of undertaking the walkover survey. This involved collecting all relevant geological, hydrological, hydrogeological and meteorological data for the area. This included consultation with the following:

- Environmental Protection Agency database (www.epa.ie);

- Geological Survey of Ireland - National Draft Bedrock Aquifer map;

- Geological Survey of Ireland - Groundwater Database (www.gsi.ie);

- The Department of Communications Marine and Natural Resources - Exploration and Mining Division website (www.minex.ie);

- Met Eireann Meteorological Databases (www.met.ie);

- National Parks & Wildlife Services Public Map Viewer (www.npws.ie);

- Water Framework Directive "WaterMaps" Map Viewer (www.wfdireland.ie);

- Bedrock Geology 1:100,000 Scale Map Series, Sheet 15 (Galway - Offaly). Geological Survey of Ireland (GSI, 1996);

- Geological Survey of Ireland – Athboy & Trim Groundwater Bodies - Initial Characterisation Reports - Draft (2004);

- OPW Indicative Flood Maps (www.flooding.ie); and,

- CFRAM – Catchment Flood Risk Assessment and Management – Preliminary Flood Risk Assessment maps (www.cfram.ie).

7.2.2 Consultation

A number of public and private bodies were consulted in relation to the proposed development and the EIA process. Water (hydrology & hydrogeology) related responses are summarised in Table 7.1.

Body Name	**Key Water Related Points in Response**
Department, Agriculture, Food & Fisheries	The potential impacts of tree felling operations and mitigation to prevent impact on surface waters.
Geological Survey of Ireland	Potential impacts on the warm spring at Toberdaly (E251700, N231700) arsing from the proposed development are to be assessed.
Inland Fisheries Ireland	Fish stocks would be protected from the negative effects of in-stream works associated with this project (turbines, buildings, cabling, roads, etc) and that adequate buffer zones are set around watercourses. IFI Guidance Document "Guidelines *Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites"* must be adhered to.

Table 7.1: Summary of Water Related Consultation Responses.

7.2.3 Site Investigations & Surveys

Hydrological baseline monitoring and sampling was undertaken by HES on 11th and 12th October 2012 and on 9th May 2013. Investigations to address the Water Section of the EIS included the following:

- Walkover surveys and hydrological mapping of the site and the surrounding area were undertaken by HES whereby water flow directions and drainage patterns were recorded;

- Field hydrochemistry measurements (electrical conductivity, pH, dissolved oxygen and temperature) were taken at a number of locations to determine the origin of surface water flows;

- Field hydrochemistry measurements to determine potential groundwater and surface water interactions; and,

- 4 no. surface water samples were taken by HES to determine the baseline water quality of the primary surface waters downstream of the site.

7.2.4 Impact Assessment Methodology

Please refer to Chapter 1 of the EIS for details on the impact assessment methodology (EPA, 2002 & 2003). In addition to the above methodology the sensitivity of the water environment receptors were assessed on completion of the desk study and baseline study. Levels of sensitivity which are defined in Table 7.2 are then used to assess the potential effect that the proposed development may have on them.

Sensitivity of Receptor:

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

Table 7.2: Receptor Sensitivity Criteria (Adapted from www.sepa.org.uk).

7.3 RECEIVING ENVIRONMENT

7.3.1 General Site description

The proposed wind farm development, which comprises 32 no. turbines (and related ancillary infrastructure) over multiple landholdings, is located on lands to the northwest, north and northeast of Rhode, Co. Offaly. The dispersed sections of the site are described below. Refer to Figure 7.1 for their locations.

Proposed turbines T1 to T7 are located on an area of extensively drained and improved grassland approximately 4km to the northwest of Rhode. The proposed development area, which has an elevation range of between 83 and 93mOD, is predominately flat with the exception of some small hills on the south of the landholding. An unnamed tributary stream of the Yellow River flows in an easterly direction through the centre of the landholding. An area of intact bog exists on the eastern side of the landholding in the vicinity of proposed turbine T7.

Proposed turbines T8 to T12 are located in an area of cutaway raised bog which exists approximately 2.5km to the northwest of Rhode village. A small section of intact raised bog still exists on the south of the landholding. The topography of the landholding is relatively flat (with the exception of the transition from the cutaway bog into the raised bog i.e. bank face) and has an elevation range of between 80 and 83mOD. The Yellow River flows in an easterly direction through the northern section of the landholding.

Proposed turbines T13 to T15 are located on area of grassland comprising poorly draining soils which is situated approximately 1km to the northeast of Rhode village. The landholding, with an elevation of between 80 and 90mOD, slopes gently to the northwest in the direction of the Yellow River which runs approximately 1km to the north of the landholding boundary.

Proposed turbines T16 to T23 are located on poorly draining grassland to the north and south of the Yellow River, approximately 2.5km to the west of Castlejordan. The land on either side of the Yellow River has an elevation range of between 70 and 80m OD with a gentle slope towards the Yellow River channel.

Proposed turbines T24 – T32 are located in an area grassland and forestry which mainly slopes in a northerly and westerly direction towards the Castlejordan River. The southern section of the landholding slopes south towards the Yellow River. The western side of the landholding borders on an area of cutaway peat. The central section of the landholding is covered by dense deciduous and conifer plantations while the northern section of the landholding is open grassland.

7.3.2 Water Balance

Long term rainfall and evaporation data was sourced from Met Éireann. The 30 year annual average rainfall (AAR) recorded at Rhode immediately to the south of the proposed wind farm development and at Derrygreenagh (i.e. Bord na Mona site), 4km to the west of the proposed development, are presented in Table 7.3.

Station		X-Coord		Y-Coord		Ht (MAOD)		Opened		Closed		
Rhode		253600		233600		*94*		1944		1985		
Jan	***Feb***	***Mar***	***Apr***	***May***	***Jun***	***July***	***Aug***	***Sept***	***Oct***	***Nov***	***Dec***	
87	62	66	56	64	63	59	78	78	87	80	88	**868**
Derrygreenagh		249300		238200		90		1955		N/A		
Jan	***Feb***	***Mar***	***Apr***	***May***	***Jun***	***July***	***Aug***	***Sept***	***Oct***	***Nov***	***Dec***	
88	62	67	57	65	62	58	79	80	86	82	89	**875**
										Average		**872**

Table 7.3m: Local Average Long Term Rainfall Data (mm).

The closest synoptic station where the average potential evapotranspiration (PE) is recorded is at Mullingar, approximately 50km north of the proposed development. The long term average PE for this station is 448mm/yr. This value is used as a best estimate of the site PE. Actual Evaporation (AE) at the site is estimated as 425mm/yr (which is 0.95 × PE).

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

Effective rainfall (ER) = AAR – AE

= 872mm/yr – 425mm/yr

ER = 447mm/yr

Based on recharge coefficient estimates from the GSI (***Appendix L*** (7.1)), an overall estimate of 20% recharge is taken for each of the landholding as an overall average. This value is for "*Moderate permeability subsoil overlain by poorly drained (gley) soil*" with a "Moderate" vulnerability rating. The lowest value in the available range was chosen to reflect the relatively high drainage density in the region which reflects poor recharge. Therefore, annual recharge and runoff rates for the sites are estimated to be 89mm/yr and 358mm/yr respectively.

7.3.3 Local & Regional Hydrology

Regionally the proposed development is located in the Yellow River and the Casltejordan River surface water catchments which are sub-catchments of the River

Boyne surface water catchment within Hydrometric Area (HA) 07 of the Eastern River Basin District. The River Boyne flows in a northerly direction approximately 2km downstream of the confluence of the Yellow River and the Castlejordan River (i.e. approximately 5km downstream of the eastern extremity of the proposed development). Proposed turbines T1 to T25 are located in the Yellow River surface water catchment while proposed turbines T26 to T32 are located in the Casltejordan River surface water catchment. A regional hydrology map is shown as Figure 7.1.

7.3.4 Site Drainage

As presented in Section 7.3.1 above the proposed development is clustered in into five main separate landholding areas. The drainage associated with each of these areas is discussed below.

Turbine Location T1 to T7

T1 to T7 are to be located in an area that is characterised by heavily drained improved grassland. Drains DA-1, DA-2 and DA-3, which are the primary collector drains in the vicinity of the proposed turbine locations, drain towards a tributary of the Yellow River which flows in a north-easterly direction to the southeast of the turbine locations. Drains DA-1 to DA-3 are deep drains which have intercepted the sand and gravel deposits (and the groundwater table) which underlie the peat in this area. Site observations indicate that much of the surface runoff which enters the drains percolates into the underlying saturated sand and gravel deposits as it was noted in May 2012 that drainage water contained within DA-1 had disappeared beneath the base of the drain prior to its outfall at the tributary of the Yellow River. A site drainage map for this area is shown as Figure 7.2.

Turbine Location T8 to T12

Proposed turbine locations T8 to T12 are located in an area of cutaway peat / improved grassland which lies adjacent to the Yellow River. The primary drainage feature (with the exception of the Yellow River) is a peat face bank drain DB-1 which flows in a south-easterly direction close to the cutaway peat bank face. Drain DB-1 enters the Yellow River approximately 200m to the south of proposed turbine T11. The south-eastern end of the peat bank face (i.e. in the vicinity of T10) drains predominately by concentrated overland flow towards drain DB-2 which enters the

Yellow River on the south-eastern corner of the landholding. The Yellow River flood plain extends onto areas of this landholding. Flooding and flood zones are dealt with in Section 7.3.5 below. A site drainage map for this area is shown as Figure 7.3.

Turbine Location T13 to T15

The predominant drainage features in the vicinity of proposed turbines T13 to T15 are streams SC-1 and SC-2 which are tributaries of the Yellow River. The Yellow River flows approximately 1.2km to the north of the landholding. Localised land drains in the vicinity of the proposed turbine locations drain into SC-1 and SC-2 prior to two streams converging to the north of the landholding. A site drainage map for this area is shown as Figure 7.4.

Turbine Location T16 to T23

Proposed turbines T16 to T23 are located on grassland to the north (T20-T24) and south (T16-T19) of the main Yellow River channel. The area is drained by three unnamed streams (i.e. SD-1, SD-2 & SD-3) which are tributaries of the Yellow River. The landholding area, which has a large network of deep land drains (i.e. field boundary drains), drain towards the Yellow River channel from the north and south. The land drains are generally associated with field boundaries. A site drainage map for this area is shown as Figure 7.5.

Turbine Location T24 to T32

Turbines T27 and T30 to T32 drain via a network of drains to the Castlejordan River which flows in an easterly direction to the north of the landholding. The major drains draining the northern section of the landholding include drains DE-1 and DE-2. Turbines T26, T28 and T29 drain (i.e. DE-3 & DE-4) in a southerly direction towards an unnamed tributary stream of the Castlejordan River. Turbines T24 and T25 drain in a southerly direction via a network of forestry and land drains (i.e. DE-5) towards the Yellow River. A site drainage map for this area is shown as Figure 7.6.

7.3.5 Flood Risk Identification & Assessment

CFRAM Preliminary Flood Risk Assessment (PFRA) maps (www.cfram.ie) and the OPW's indicative river and coastal flood mapping (www.flooding.ie) were consulted to identify potential areas of the proposed development that maybe at risk of flooding.

The PFRA mapping shows the extents of the indicative 100-year flood zone which relates to fluvial (i.e. river) and pluvial (i.e. rainfall) flood events. As part of the wind farm layout design all proposed turbine locations were cited outside of the fluvial indicative 100-year flood zone as shown in Figures 7.7 to 7.9. However, there is a potential for flooding near some of the proposed access roads as some sections are located within the 100-year flood zone (i.e. between T8 – T11, T9 – T12, met mast and T18-T19). Access roads and the met mast would be considered Less Vulnerable developments are referred to in The Planning System and Flood risk Management – Guidelines for Planning Authorities (DEHLG, 2009). Also, these structures themselves will not enhance downstream flooding as they will not occupy floodplain space/flood storage volume.

In addition the OPW's indicative flood mapping was also consulted and shows no recorded flooding in the vicinity of the proposed development; however these maps are more generalised and would not have the same flood zone details as the PFRA mapping which were the main source used in terms of flood risk assessment.

7.3.6 Surface Water Quality

EPA Q-rating data is available for the Yellow River immediately downstream of proposed turbine landholding area T1 to T9 and immediately upstream of the confluence with the Castlejordan River. A Q-rating of Good and Moderate has been assigned for these locations respectively.

EPA Q-rating data is available for the Castlejordan River upstream of the proposed development at Rochfortbridge and upstream of the confluence with the Yellow River (i.e. downstream of the development). A Q-rating of Poor and Good has been assigned for these locations respectively. The Boyne River downstream of the proposed development has been assigned a Q-Rating of Good.

Field hydrochemistry measurements of unstable parameters, electrical conductivity (µS/cm), pH (pH units) and temperature (°C) were taken at various locations in surface watercourses at the proposed development area on 11th and 12th October 2012 and 9th May 2013. The hydrochemical field measurements and the locations are listed in Table 7.5.

Electrical conductivity values for the site surface waters ranged between 250µS/cm and 700µS/cm with the higher value representative of drains that intercept the saturated gravel deposits. pH values which were all slightly basic ranged from 7.6 to 8.3. This is consistent with the fact that all catchments are dominated by mineral subsoils which is underlain by limestone bedrock. Temperature readings were normal for the time of year visited (October 2012 & May 2013).

Location ID	Easting	Northing	Conductivity (µS/cm)	pH	Temp °C
FP1	247336	237073	567	8.3	9.2
FP2	246996	236181	638	8	8.9
FP3	247275	236356	663	8	8.9
FP4	248006	236493	647	8	9.1
FP5	254100	235310	250	7.8	9.3
FP6	253740	235350	230	7.8	9.2
FP7	251844	235956	360	7.9	8.9
FP8	256760	238470	563	7.7	8.8
FP9	254833	282480	700	7.6	9.1
FP10	254690	241070	400	8	8.9

Table 7.5: Summary of Surface Water Chemistry Measurements.

Water samples were taken from surface waters downstream of the proposed development on 12th October 2012 at locations SW1, SW2, SW3 and SW4. The sampling points are shown on Figures 7.2 to 7.6. Samples were stored in a cool environment and transported to City Analysts Ltd (Dublin: 01-6136003) where they were analysed for a list of parameters as shown in Tables 7.6 & 7.7 below. Results of analysis are show alongside relevant surface water regulations. For comparison Environmental Objectives Surface Water Regulations (S.I. 272 of 2009) are shown in Table 7.8. Certificates of analysis are shown in **Appendix L** (7.2).

PARAMETER	UNITS	EC DIRECTIVES				SAMPLE ID	
		75/440/EEC	78/659/EEC		98/83/EC		
			Salmonid	Cyprinid		SW1	SW2
Total Suspended Solids		50 (A1)	≤ 25 (O)	≤ 25 (O)		13	88
Ammonia N						0.08	0.05
Total Nitrogen						<10	<10
Nitrite (NO_2)		0.05	≤ 0.01	≤ 0.03	0.5	0.16	0.1
Ortho Phosphate (P)		0.03				<0.025	0.049
Nitrate (NO_3)		25 (A1) 50 (A2 & A3)			50	9.57	<8.9
Phosphorus (unfiltered)		400 (A1) 700 (A2)				0.13	0.36
Chloride		250			250	13.28	<10
BOD		5 (A1)	≤ 3	≤ 6		2	5

Table 7.6: Analytical Results of Surface Water Samples.

PARAMETER	JNITS	EC DIRECTIVES				SAMPLE ID	
		75/440/EEC	78/659/EEC		98/83/EC		
			almonid	Cyprinid		SW3	SW4
Total Suspended Solids		50 (A1)	≤ 25 (O)	≤ 25 (O)		32	10
Ammonia N						0.22	0.37
Total Nitrogen						<10	<10
Nitrite (NO_2)		0.05	≤ 0.01	≤ 0.03	0.5	0.1	0.13
Ortho Phosphate (P)		0.03				0.04	0.047
Nitrate (NO_3)		25 (A1) 50 (A2 & A3)			50	14.62	12.8
Phosphorus (unfiltered)		400 (A1) 700 (A2)				0.25	0.16
Chloride		250			250	11.02	
BOD		5 (A1)	≤ 3	≤ 6		3	3

Table 7.7: Analytical Results of Surface Water Samples.

BOD	High status ≤ 1.3 (mean) Good status ≤ 1.5 mean
Ammonia-N	High status ≤ 0.04 (mean) Good status ≤0.065 (mean)
Ortho-phosphate	High status ≤0.025 (mean) Good status ≤0.035 (mean)

* Environmental Objectives Surface Water Regulations (S.I. 272 of 2009).

Table 7.8: Chemical Conditions Supporting Biological Elements*.

In comparison to the Environmental Objectives Surface Water Regulations (S.I. 272 of 2009), all results for ammonia-N exceeded the "Good Status" threshold with the exception of SW2.

For ortho-phosphate all results exceed the "Good Status" threshold with the exception of SW1 which was in the "High Status" threshold. For BOD all results exceeded the "Good Status" threshold.

Suspended solids results were between 10 and 88mg/l. All samples with the exception of SW2 (88mg/l) were below the surface water regulation (75/440/EEC) values of 50mg/l. The heavy rainfall at the time of sampling may have attributed to the exceedence in SW2.

7.3.7 Hydrogeology

The GSI bedrock map of the area (**www.gsi.ie**) shows that the majority of the western landholding areas are underlain by the Dinantian Upper Impure Limestone, while the eastern landholding areas are predominately underlain by the Dinantian Pure bedded Limestone. Intrusions of basalt and other volcanic rocks are also mapped in the area. A bedrock aquifer map is shown as Figure 7.10.

Based on the GSI mapping (**www.gsi.ie**) the Dinantian upper impure limestone are classified as a Locally Important Aquifer LI (bedrock which is moderately productive only in locals zones) while the Dinantian Pure bedded Limestone are classified as a Locally Important Aquifer Lm (bedrock which is moderately productive).

The bedrock in both aquifer types is described as been highly heterogeneous and the depth to which major groundwater flows are encountered varies even over short distances. In general in a locally important aquifer such as this the majority of groundwater flow is expected to occur in an upper broken and weathered zone, which is considered to be about 3m thick. Additional flows are commonly found in the upper 10m where groundwater flows along fracture networks. Occasionally deeper isolated groundwater flows are found in cavities which may have been layers or pure limestone solutionally enlarged by karstification.

Deposits of poorly sorted sand and gavels were noted to underlie the peat in landholding areas T1 to T7 and T8 to T12. The land drains in both landholding areas were noted to intercept the sand and gravel deposits and a groundwater level of 1.5m below ground was noted on the day of the survey (Refer to Plate A). The sand and gravels are fully exposed in an existing open sand and gravel pit to the southeast of turbine location T6. The sand and gravel deposits are estimated to have a moderate to high permeability which may have implications for construction dewatering in terms of turbine base construction (This is discussed further in the Impact and Mitigation Section below).

The remainder of the proposed turbine locations are located in poorly draining agricultural land and high water tables (<1m) are expected in many areas.

Plate A: Existing exposed sand and gravel deposits beneath peat

7.3.8 Groundwater Vulnerability

The vulnerability of the aquifers underlying the study area is rated between "Low" and "Extreme" by the GSI (www.gsi.ie). The groundwater vulnerability rating in the area of the western landholdings (i.e. turbines T1 – T12) is generally mapped as "Low" and this is due to the coverage of peat in this area. The remainder of the landholdings are located in areas mapped as "Moderate" vulnerability with the more elevated areas having an "Extreme" vulnerability rating.

Trial pits TP1 and TP2 were undertaken by Whitefords Ltd in landholding A and D respectively. Both trial pits encountered sand deposits exceeding 3m in depth. Based on GSI groundwater vulnerability mapping criteria these locations would be rated as "High" vulnerability. The total depth to bedrock is unknown.

However, due to the nature of wind farm developments, being near surface construction activities, impacts on groundwater are generally negligible and surface water is generally the main sensitive receptor assessed during impact assessments. Also, the fact that there are no proposed on-site borrow pits is positive in terms of potential impacts on groundwater, as borrow pits generally pose a greater risk to groundwater and adjacent water supplies due to their general greater depth of excavation.

7.3.9 Groundwater Hydrochemistry

Sampling of groundwater was not undertaken at the site as part of the assessment. Such sampling would not normally be completed as surface water is the main receptor for wind farm developments. Based on groundwater quality data from elsewhere in the country, the expected groundwater type within the Dinantian Limestone would be Calcium Bicarbonate (Ca-HCO3) type. EPA water quality data for Toberdaly spring which is used as a public supply source is shown in Table 7.9 below (Refer to Section 7.3.14 below for details of source).

Parameter	Unit	29/11/2012
Total Coliforms	cfu	<1
Faecal Coliforms	cfu	<1
pH_Laboratory	pH units	7
Conductivity	µS/cm	614
Alkalinity	mg/l	280
Total Hardness	mg/l	320
Colour	Hazen	5
Turbidity	NTU	<0.5
Ammonium	mg/l	<0.026
Nitrite as NO_2	mg/l	<0.002
Nitrate as NO_3	mg/l	15.54
Nitrate as N	mg/l	3.51
Total Phosphorus	mg/l	0.021
Ortho-phosphate	mg/l	0.020
Total Organic Carbon	mg/l	1.5
Chloride	mg/l	15
Fluoride	mg/l	0.17
Sulphate	mg/l	16
Sodium	mg/l	8.1
Potassium	mg/l	1.7
Magnesium	mg/l	15.9
Calcium	mg/l	98
Iron	µg/l	<10
Manganese	µg/l	1

Table 7.9: Water Quality Data for Toberdaly Spring

7.3.10 Water Framework Directive Water Body Status & Objectives

The Eastern River Basin District (ERBD) Management Plan was adopted by all local authorities in the ERBD prior to 30th of April 2010, as stipulated in the European Communities (Water Policy) Regulations 2003 (S.I. 722 of 2003 as amended). The ERBD Management Plan (2009 – 2015) objectives, which will be integrated into the design of the proposed wind farm development, include the following:

- Prevent deterioration and maintain a high status where it already exists;
- Protect, enhance and restore all waters with aim to achieve at least good status by 2015;
- Ensure waters in protected areas meet requirements; and,
- Progressively reduce chemical pollution.

Section 4.2.3 of the ERBD Management Plan States:

"*Alternative objectives can also be set in cases where certain developments may cause a failure to achieve good status or to maintain high status. This is subject to the developments being of overriding public interest and/or there being overriding benefits to human health and safety. Alternative options for delivering these benefits must be considered and all practicable steps must be taken to mitigate adverse impact on the water body"*

Our understanding of these objectives is that surface waters, regardless of whether they have 'Poor' or 'High' status, should be treated the same in terms of the level of protection and mitigation measures employed, *i.e.* there should be no negative change in status at all.

Strict mitigation measures in relation to maintaining a high quality of surface water runoff from the development and groundwater protection will ensure that the status of both surface water and groundwater bodies in the vicinity of the site will be at least maintained (see below for WFD water body status and objectives) regardless of their existing status.

7.3.11 Groundwater Body Status

Local Groundwater Body and Surface water Body status reports are available for download from **www.wfdireland.ie.**

The Athboy (GWB: IE_EA_G_001) and Trim Groundwater Bodies (GWB: IE_EA_G_002) which underlie the proposed wind farm site are assigned 'Good

Status'[23] (**www.wfdireland.ie**), this applies to both quantitative status and chemical status. The overall risk rating for both groundwater bodies is 2a – Not at Risk. The western landholding areas (*i.e.* turbines T1 – T12 and T25 – T32) are within the Athboy GWB while the eastern landholding areas are within the Trim GWB.

7.3.12 Surface Water Body Status

Based on WFD mapping, the proposed development lies within the Castlejordan (IE_EA_07_1025), the Yellow River Upper (IE_EA_07_332) and the Yellow River Lower (IE_EA_07_1026) surface water bodies. The downstream water body to the development is the Boyne (IE_EA_07_235). Refer to Figure 7.1.

A summary of the water body status, risk result and protection objective for the surface water body is shown in Table 7.10 below.

Water Body	Macro-invertebrate Status	Overall Ecological Status	Overall Status	Overall Risk Result	Overall Objective
Castlejordan	Poor	Poor	Poor	At Risk (1a)	Restore_2027
Yellow Upper	Good	Good	Good	At Risk (1a)	Protect
Yellow Lower	Moderate	Moderate	Moderate	At Risk (1a)	Restore_2015
Boyne Upper	Good	Good	Good	At Risk (1a)	Protect

Table 7.10: Summary WFD Information for Surface Water Bodies.

7.3.13 Designated Sites

Designated sites include proposed National Heritage Areas (pNHAs), National Heritage Areas (NHA), candidate Special Areas of Conservation (cSACs) and Special Protection Areas (SPAs).

The proposed development site is not located within or adjacent to any designated site. The closest downstream (i.e. approximately 17km) designated site is the River Boyne and Blackwater SAC.

7.3.14 Water Resources

Toberdaly spring which is used as a public supply source is located approximately 2km to the southwest of Rhode town. The GSI Groundwater Protection Zone (ZOC)

[23] 'Status' means the condition of the water in the waterbody. It is defined by its chemical status and its ecological status, whichever is worse. Waters are ranked in one of 5 classes: High, Good, Moderate, Poor and Bad (WFD, 2010).

for this spring is shown on Figure 7.10. None of the proposed development or any of its ancillary activities lie within the ZOC to the spring. There can be no impact on this water source as a result of the proposed wind farm development.

A search of the Geological Survey of Ireland (GSI) well database (**www.gsi.ie**) only indicated 2 no. private wells within the vicinity of the site (refer to Figure 7.10). These wells are located more than 1km from the landholding boundary and are situated outside the groundwater catchment to the site. As the GSI well database is not exhaustive in terms of the locations of all wells in the area (as the database relies on the submission of data by drillers and the public etc) to be conservative it is assumed that every private dwelling in the vicinity of the proposed development has a groundwater supply well/spring associated with it (this is very unlikely to be the case). Shown on Figures 7.2 to 7.6 are the locations of private dwellings within close proximity to the landholding areas. A private well impact assessment is undertaken for each of the dwellings as shown below.

The assessment assumes that the groundwater flow direction in the aquifer underlying the site mimics topography whereby flow paths will be from topographic high points to lower elevated discharge areas at the streams and rivers. Therefore, if no dwellings are located in the groundwater flow path between the proposed development areas (*i.e.* turbine location) and the discharge zone (*i.e.* stream/river) there can be no impact on any potential wells associated with dwellings.

Turbine Location T1 to T7

Six private dwellings are located to the southeast of proposed turbines T1 to T7 (LH-A). The inferred groundwater flow direction in the vicinity of the turbine locations is southeast towards the tributary stream of the Yellow River which acts as the discharge zone (Refer to Figure 7.2). Likewise the inferred groundwater flow direction in the vicinity of the dwellings is northwest towards the stream. Therefore, no dwellings are located in the groundwater flow path between the proposed turbine locations and the discharge zone stream and therefore there can be no impact on any potential wells associated with houses in this area.

Turbine Locations T8 to T12

Three private dwellings are located to the northeast of Landholding B (T8 to T12). The inferred groundwater flow direction in the vicinity of the proposed turbine locations is north and south towards the Yellow River channel (Refer to Figure 7.3). The houses to the northeast of the landholding are not within the groundwater flow path of any of the proposed turbine locations and therefore there can be no impact on any potential wells associated with houses in this area.

Turbine Locations T13 to T15

There are a large number of private dwellings located to the east and west of proposed turbine locations T13 to T15 (Refer to Figure 7.4). The inferred groundwater flow direction in the vicinity of the proposed turbine locations is north towards the main Yellow River channel. Shallow groundwater flow may discharge into streams SC1 and SC2 which flows to the west of the proposed turbine locations. The houses to the east and west of the proposed turbine locations are not within the groundwater flow path and therefore there can be no impact on any potential wells associated with houses in this area.

Turbine Location T16 to T23

There are a large number of private dwellings located to the north and south of proposed turbine locations T16 to T23 (Refer to Figure 7.5). The inferred groundwater flow direction in the vicinity of the proposed turbine locations is north and south towards the main Yellow River channel. There are no private dwellings located in the groundwater flow path between the proposed turbine locations and the Yellow River channel and therefore there can be no impact on any potential wells associated with houses in this area.

Turbine Location T24 to T32

The inferred groundwater flow direction in the vicinity of the proposed turbine locations T27, T30 to T32 is in a northerly direction towards the main Castlejordan River channel (Refer to Figure 7.6). There are no private dwellings located in the groundwater flow path between the proposed turbine locations and the Castlejordan River channel and therefore there can be no impact on any potential wells. The inferred groundwater flow direction in the vicinity of the proposed turbine locations T24 to T26, T28 and T29 is in a southerly direction towards a tributary stream of the Yellow River. There are no private dwellings located in the flow path between the proposed turbine locations and this stream and therefore there can be no impact on any potential wells associated with houses in this area.

7.3.15 Receptor Sensitivity

Due to the nature of wind farm developments, being near surface construction activities, impacts on groundwater are generally negligible and surface water is generally the main sensitive receptor assessed during impact assessments. The primary risk to groundwater at the site would be from hydrocarbon spillage, leakages at storage areas, and from domestic wastewater discharge. These are common potential impacts to all construction sites (such as road works and industrial sites). These potential contamination sources are to be carefully managed at the site during the construction and operational phases of the development and mitigation measures are proposed within the EIS to deal with these potential minor impacts. Also, the fact that there are no proposed on-site borrow pits is a positive thing in terms of potential impacts on groundwater as borrow pits generally pose the greatest risk to groundwater and adjacent water supplies if not managed properly.

Groundwater at the site can be classed as sensitive (refer to Table 7.2 for sensitivity criteria) because most of the underlying aquifers are classified as been Locally Important. The low permeability peat and poorly draining soils which overlying much of the site will provide some protection, however, where excavations occur the underlying sand and gravels (*i.e.* T1 to T12) will be made increasingly vulnerable to contamination.

The moderate runoff coefficient at the site makes surface water bodies such as streams and rivers more vulnerable to pollution than groundwater bodies at this site. Runoff from development sites drains into the headwaters of the Yellow River and the Castlejordan River. However, due to the flat topography of the landholdings, control and attenuation of runoff will be easily achieved. All natural water bodies draining the site can be classified as very sensitive.

Mitigation measures will ensure that surface runoff from the developed areas of the site will be of high quality and therefore there will be no impact on the quality of downstream surface water bodies. Any introduced drainage works at the site will mimic the existing hydrological regime thereby avoiding changes to flow volumes leaving the site.

Hydrological constraints mapping for the development areas is shown on Figures 7.2 – 7.6 and Figures 7.7 and 7.9 (*i.e.* flood zone mapping). The map shows that all proposed development areas are generally away from areas on the site that have been determined to be hydrologically sensitive (*i.e.* Yellow River, Castlejordan River and their tributaries). The large setback distance from sensitive hydrological features means they will not be impacted on by excavations/drains etc. It also allows adequate room for the proposed drainage mitigation measures (discussed below) to be properly installed up-gradient of primary drainage features. This will allow attenuation of surface runoff to be more effective.

7.4 POTENTIAL IMPACTS OF THE DEVELOPMENT

7.4.1 Development Description

The proposed development comprises 32 no. turbines (excavation diameter 18m, depth 2m), temporary construction compound, substation/control building, 18,275m of new access track, 5,916m of existing track upgrade, 1 no. meteorological mast and 9 no. stream/river crossings. The development will also require the felling of 10.4ha of forestry.

7.4.2 Do Nothing Scenario

If the wind farm development does not proceed, the proposed development sites will remain solely as poorly draining agricultural land. In areas where conifer forestry plantations are present, deforestation and reforestation will continue to occur into the future.

7.4.3 Worst Case Scenario

Contamination of surface water streams during the construction and operational phases, which in turn could affect the ecology and quality of the downstream water bodies such as the Yellow River and Castlejordan River. Also, potentially localised groundwater contamination may occur. However, measures will be put in place to prevent this from happening.

7.5 LIKELY IMPACTS AND MITIGATION MEASURES

The likely impacts of the proposed development and mitigation measures that will be put in place to eliminate or reduce them are shown in Table 7.10.

7.5.1 Background on Proposed Runoff Control and Drainage Design

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

CONSTRUCTION PHASE IMPACTS & MITIGATION MEASURES
1. ***CLEAR FELLING OF CONIFEROUS PLANTATION & WATER QUALITY IMPACTS***
Approximately 10.4ha of existing plantation forestry will be felled to allow for development of the proposed wind farm infrastructure. Provision of the construction area at each turbine location will require approximately 1.5 hectares for turbines T1, T25, T26 & T27 and part of T2 (6.77ha in total for turbine hardstanding & assembly areas). The estimated loss of forestry due to access roads is approximately 3.63ha based on the requirement for approximately 2,425 metres of new access road. This gives a total area for tree felling as a result of the development of approximately 10.4ha, with 2.77ha being located in Landholding A and 7.63ha being located in Landholding E.
The total area of tree felling required for the proposed development represents approximately only 3.7% of the total forested area which is 275ha. The locations of

the areas to be felled are shown in Figures 7.2 and 7.6.

Potential impacts during tree felling occurs mainly from:

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

In their consultation response the Department of Agriculture highlighted the potential impacts of the proposed tree felling on the aquatic environment and stated that mitigation measures and monitoring need to be addressed adequately in the EIS;

Pathways *- Drainage and surface water discharge routes.*

Receptors - Surface waters and associated dependent ecosystems.

Potential Impacts - Direct, negative, moderate, short term, high probability impact on water quality.

Proposed Mitigation Measures:

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

- Forestry Commission (2004) Forests and Water Guidelines, Fourth Edition. Publ. Forestry Commission, Edinburgh;
- Coillte (2009) Forest Operations & Water Protection Guidelines; and,
- Coillte (2009) Methodology for Clear Felling Harvesting Operations.

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

- Machine combinations will be chosen which are most suitable for ground conditions at the time of felling, and which will minimise soils disturbance;
- Use of buffer zones for aquatic zones (see Table 7.11 below);
- Checking and maintenance of roads and culverts will be on-going through any felling operation. No tracking of vehicle through watercourses will occur, as vehicles will use road infrastructure and watercourse crossing points. Where possible, existing drains will not be disturbed during felling works;
- Mound drains which drain from the areas to be felled towards main drains (*i.e.* DA-2, DA-3, DE-2, DE-4 & DE-5) will be blocked, and temporary silt traps will be constructed. Drains and sediment traps should be installed during ground preparation. Collector drains will be excavated at an acute angle to the contour (0.3%-3% gradient), to minimise flow velocities. Main drains to take the discharge from collector drains must be provided with water drops and rock armour where there are steep gradients, and should avoid being placed at right angles to the contour;
- Sediment traps will be sited outside of buffer zones and have no direct outflow into the aquatic zone. Machine access will be maintained to enable the accumulated sediment to be excavated. Sediment will be carefully disposed of away from all aquatic zones. Where possible, all new silt traps will be constructed on even ground and not on sloping ground;
- In areas particularly sensitive to erosion, it may be necessary to install double or triple sediment traps.
- All drainage channels will taper out before entering the aquatic buffer zone. This ensures that discharged water gently fans out over the buffer zone before entering the aquatic zone, with sediment filtered out from the flow by ground vegetation within the zone. On erodable soils silt traps will be installed at the end of the drainage channels to the outside of the buffer zone;
- Drains and silt traps will be maintained throughout all felling works, ensuring that they are clear of sediment build-up and are not severely eroded. Correct drain alignment, spacing and depth will ensure that erosion and sediment build-up are minimised and controlled;
- Brash mats will be used (with further advise from the ecologist) to support vehicles on soft ground, reducing peat and mineral soils erosion and avoiding

the formation of rutted areas, in which surface water ponding can occur. Brash mat renewal should take place when they become heavily used and worn. Provision should be made for brash mats along all off-road routes, to protect the soil from compaction and rutting. Where there is risk of severe erosion occurring, extraction should be suspended during periods of high rainfall;

- Timber should be stacked in dry areas, and outside a local 50m stream buffer zone. Straw bales and check dams to be emplaced on the down gradient side of timber storage/processing sites;
- Works should be carried out during periods of no, or low rainfall, in order to minimise entrainment of exposed sediment in surface water run-off;
- Checking and maintenance of roads and culverts will be on-going through the felling operation;
- Do not refuel or maintain machinery within 50m of an aquatic zone. Dedicated refuelling areas will be used during the felling works;
- Do not allow branches, logs or debris to build up in aquatic zones. All such material will be removed when harvesting operations have been completed, but avoid removing natural debris deflectors.

<u>Mitigation Measures as recommended in (Coillte, 2009):</u>

Buffer zones:

There is a requirement in the Forest Service Best Code of Practice and in the FSC Certification Standard for the installation of buffer zones adjacent to aquatic zones at planting stage. Minimum buffer zone widths are shown in Table 7.11

Table 7.11: Forest Service Best Code of Practice Buffer Zone Widths

Average slope leading to the aquatic zone		Buffer zone width on either side of the aquatic zone	Buffer zone width for highly erodable soils
Moderate	(0 – 8.50)	10 m	15 m
Steep	(8.5 – 16.70)	15 m	20 m
Very steep	(>16.70)	20 m	25 m

All proposed tree felling areas are located significantly more than 25m from a primary water course (Refer to Figures 7.2 & 7.6). 10m is the minimum distance recommended by Forest Service Best Code of Practice for moderate sloped ground, which would apply in this area. There are no natural streams in the vicinity of the proposed felling areas. All watercourses present in the area are manmade drainage channels associated with forestry plantations. Nevertheless mitigation measures to prevent impact on more ecologically sensitive downstream water bodies are discussed below.

Silt Traps:

Silt traps will be strategically placed down-gradient within mound drains or collector drains as required. The main purpose of the silt traps and drain blocking is to slow water flow, increase residence time and allow settling of silt in a controlled manner. This also allows nutrient bearing water to have more contact with mineral soil and thus more nutrients are retained and do not runoff. Silt traps are particularly effective in the removal of mineral silt and less so in the case of organic (from peat or decayed vegetation) or colloidal silt (gleys, clays) where it can take a lot longer for sedimentation to occur. Mineral silt poses the largest threat to watercourses in its potential to settle on a streambed and damage fish spawning areas.

In cases where mineral subsoils are present beneath the peat subsoil additional mitigation by way of use of specialist treatment systems such as Siltbuster systems with two-stage chemical dosing to aid settlement can be employed.

Drain Inspection and Maintenance:

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

1. 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;
2. Inspection of all areas reported as having unusual conditions;
3. Inspection of main drainage ditches and outfalls. During pre-felling inspection the main drainage ditches shall be identified. Ideally the pre-felling inspection shall be carried out during rainfall;
4. Following tree felling all main drains shall be inspected to ensure that they are functioning;
5. 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;

6. Culverts on drains exiting the site must be unblocked; and,
7. All silt removed from drains, culverts and silt traps must 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

Water Sampling:

1. Sampling will be done before, during (if the operation is conducted over a protracted time) & after the felling activity. The 'before' sampling should be conducted within 4 weeks of the felling activity, preferably in medium to high water flow conditions;
2. The 'after' sampling should comprise as many samplings as necessary to demonstrate that water quality has returned to pre-activity status (*i.e.* where an impact has been shown).

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

- Avoid man-made drains & watercourses without all-year flow;
- Select sampling points upstream and downstream of the forest activity;
- It is advantageous if the upstream location is outside/above the forest in order to evaluate the impact of land-uses other than forestry; and,
- Where possible, three downstream locations should be selected: one immediately below the forest activity, the second at exit from the forest, and the third some distance from the second (this allows demonstration of no impact through dilution effect or contamination by other land-uses where impact increases at third downstream location relative to second downstream location).
- At a minimum sampling should be undertaken at the surface water sampling locations used in this EIS investigation (*i.e.* SW1, SW2, SW3 & SW4). Additional sampling points in main drains upstream and downstream of felling areas will be added where required (*i.e.* DA-2, DA-3, DE-2, DE-4 & DE-5).

Residual Impact - Direct, negative, slight, short term, low probability impact.

2. EARTHWORKS (REMOVAL OF VEGETATION COVER, EXCAVATIONS AND STOCK PILING) RESULTING IN SUSPENDED

SOLIDS ENTRAINMENT IN SURFACE WATERS.

Construction phase activities including access road, turbine base construction, drainage installation and cable trenching will require earthworks resulting in removal of vegetation cover and excavation of peat and mineral subsoil where present. Potential sources of sediment laden water include:

- Drainage and seepage water resulting from road and turbine base excavation;
- Stockpiled excavated material providing a point source of exposed sediment;
- Construction of access road culverts resulting in entrainment of sediment from the excavations during construction; and,
- Erosion of sediment from emplaced site drainage channels.

These activities can result in the release of suspended solids to surface watercourses and could result in an increase in the suspended sediment load, resulting in increased turbidity which in turn could affect the water quality and fish stocks in the downstream Yellow River and Castlejordan River.

Pathways - Drainage and surface water discharge routes.
Receptors - Down-gradient rivers and dependant ecosystems

Potential Impacts - Direct, negative, significant, short term, highprobability impact.

Proposed Mitigation Measures:

Mitigation by avoidance:

The key mitigation measure during the construction phase is the avoidance of sensitive aquatic areas. A 50m wide watercourse buffer zone will be in place during the construction phase where possible. From Figures 7.2 to 7.6 it can be seen that all of the proposed development areas are generally away from the primary water bodies in the area which include the Yellow River and the Castlejordan River. The large setback distance from sensitive hydrological features means that adequate room is maintained for the proposed drainage mitigation measures (discussed below) to be properly installed and operate effectively.

Exceptions to this self imposed 50m buffer include stream/river crossings or where existing roads adjacent to streams require upgrade. Stream/river crossings and near stream construction work in dealt with in Impact Section 9 below.

The proposed buffer zone will:

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

Excavations have the potential to release sediment into surface waters, however excavations may encounter mineral subsoils (where present) and therefore there is a higher risk from this activity. It is proposed that the following design mitigation measures will be installed prior to excavations taking place.

Mitigation by Design:

- Interceptor drains will be installed up-gradient of works areas to collect surface runoff, in order to minimise the amount of runoff reaching areas where suspended sediment could become entrained. It will then be directed to areas where it can be re-distributed over the ground as overland flow;
- Swales will be used to intercept and collect runoff from works areas of the site, likely to have entrained suspended sediment, and channel it to stilling ponds for sediment settling;
- Check dams will be installed at regular intervals along interceptor drains and swales in order to reduce flow velocities and therefore minimise erosion within the system during storm rainfall events;
- Stilling ponds, emplaced as pairs in series, will buffer volumes of runoff discharging from the drainage system during periods of high rainfall, by retaining water until the storm hydrograph has receded, thus reducing the hydraulic loading to watercourses. Stilling ponds will be designed to retain the volume associated with a 1 in 100 year 6 hour return period. Stilling ponds are designed to reduce the flow velocity of discharge water; and,
- Vegetation filters, that is areas of existing vegetation, accepting drainage water issuing from level spreaders as overland flow, will remove any suspended sediment from water channelled via interceptor drains.

Cable Trenching:

The design of the cable trench alignment will avoid the creation of preferential flow paths. The following shall apply to the construction of the cable trenches at the site:

- To minimise impacts from disturbance, cables will be laid in small trenches alongside the access roads as far as possible;
- Where feasible trenches will be excavated during dry periods and any spoil will be immediately removed and stored in the repository;
- Excavation of cable trenching will be carried out over short distances, with frequent backfilling of trenches in order to minimise opportunity for the ingress of water;
- Temporary silt traps will be placed in longer trench runs and on steeper ground;
- Swale slopes are to be correctly reinstated post infilling of the cable trench; and,
- There will be no cable trenching laid under natural streams.

Water Treatment Train:

If the discharge water from construction areas fails to be of a high quality then a filtration treatment system (such as a 'siltbuster' unit (http://www.siltbuster.com/sheets/RCW.pdf) or similar equivalent treatment train (sequence of water treatment processes) will be used to filter and treat all surface discharge water collected in the dirty water drainage system. This will apply for all of the construction phase.

All concrete wash down at the site should be completed in a dedicated RCW concrete wash unit This unit catches the solid concrete and filters and holds wash liquid for pH adjustment and further solids separation. The residual liquids and solids can be disposed of off-site at an appropriate waste facility.

Silt fences:

Silt fences will be emplaced within forestry drains down-gradient of all construction areas. Silt fences are effective at removing heavy settleable solids. This will act to prevent entry to water courses of sand and gravel sized sediment, released from excavation of mineral sub-soils of glacial and glacio-fluvial origin, and entrained in surface water runoff. Inspection and maintenance of these of these structures during construction phase is critical to their functioning to stated purpose. They will remain in place throughout the entire construction phase.

Pre-emptive Site Drainage Management:

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

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

General Forecasts: Available on a national, regional and county level from the Met Eireann website (**www.met.ie/forecasts**). These provide general information on weather patterns including rainfall, wind speed and direction but do not provide any quantitative rainfall estimates;

MeteoAlarm: Alerts to the possible occurrence of severe weather for the next 2 days. Less useful than general forecasts as only available on a provincial scale;

3 hour Rainfall Maps: Forecast quantitative rainfall amounts for the next 3 hours but does not account for possible heavy localised events;

Rainfall Radar Images: Images covering the entire country are freely available from the Met Eireann website (**www.met.ie/latest/rainfall_radar.asp**). The images are a composite of radar data from Shannon and Dublin airports and give a picture of current rainfall extent and intensity. Images show a quantitative measure of recent rainfall. A 3 hour record is given and is updated every 15 minutes. Radar images are not predictive; and,

Consultancy Service: Met Eireann provide a 24 hour telephone consultancy service. The forecaster will provide interpretation of weather data and give the best available forecast for the area of interest.

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

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

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

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

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

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

Residual Impact - Negative, imperceptible, short term, medium probability impact.

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

Any excess build up of silt levels at dams, the settlement pond, or any other drainage features that may decrease the effectiveness of the drainage feature, will be removed.

During the construction phase field testing and laboratory analysis of a range of parameters with relevant regulatory limits and EQSs should be undertaken for each watercourse (*i.e.* at SW1, SW2, SW3 & SW4 sample locations), and specifically following heavy rainfall events (*i.e.* weekly, monthly and event based). The will be done in consultation with the Fisheries Board.

3. IMPACTS ON THE RIVER BOYNE & BLACKWATER SAC

The River Boyne and Blackwater SAC exist approximately 17km downstream of the

proposed wind farm development. Significant hydrological or water quality impacts on the Yellow River and the Castlejordan River (which are both tributaries) could potentially have an impact on the water quality flowing towards the SAC.
Pathway - Surface water drainage network. **Receptor** – The River Boyne / Blackwater SAC and related habitats. **Potential** **Impact - In**direct, negative, moderate, short term, low probability impact on the SAC.
<u>Impact Assessment:</u> The proposed mitigation measures which will include buffer zones and drainage control measures (*i.e.* interceptor drains, swales, temporary stilling ponds) will ensure that the quality of runoff from proposed development areas will be very high. As stated in Impact Section 2 above, there could potentially be an "*imperceptible, short term, low probability impact*" on local streams and rivers but this would be very localised and over a very short time period (*i.e.* hours). Therefore, direct, or indirect impacts on the River Boyne / Blackwater SAC, which exists 17km downstream of the proposed development will not occur.
<u>Residual Impact –</u> No impact
4. POTENTIAL RELEASE OF HYDROCARBONS DURING CONSTRUCTION AND STORAGE Accidental spillage during refuelling of construction plant with petroleum hydrocarbons is a significant pollution risk to groundwater, surface water and associated ecosystems, and to terrestrial ecology. The accumulation of small spills of fuels and lubricants during routine plant use can also be a pollution risk. Hydrocarbon has a high toxicity to humans, and all flora and fauna, including fish, and is persistent in the environment. It is also a nutrient supply for adapted micro-organisms, which can rapidly deplete dissolved oxygen in waters, resulting in death of aquatic organisms.
Pathway – Groundwater flow paths and site drainage network. **Receptor** – Groundwater, surface water & water supplies (if present). **Potential** **Impact -** Direct, negative, significant, temporary, medium probability impact to surface water quality. Direct, negative, significant, temporary, medium probability impact to local

groundwater quality.
<u>Proposed Mitigation Measures:</u> Mitigation measures proposed to avoid release of hydrocarbons at the site are as follows: 1. Minimal refuelling or maintenance of construction vehicles or plant will take place on site. Off-site refuelling should occur at a controlled fuelling station. 2. On site re-fuelling will take place at a specific designated re-fuelling area. This re-fuelling area will be bunded appropriately for the fuel usage volume for the time period of the construction and fitted with an appropriate oil interceptor. 3. Fuels stored on site should be minimised. This storage area will be bunded appropriately for the fuel storage volume for the time period of the construction and fitted with a storm drainage system and an appropriate oil interceptor. 4. The electrical control building should be bunded appropriately to the volume of oils likely to be stored, and to prevent leakage of any associated chemicals and to groundwater or surface water. The bunded area will be fitted with a storm drainage system and an appropriate oil interceptor. 5. The plant used should be regularly inspected for leaks and fitness for purpose; and, 6. An emergency plan for the construction phase to deal with accidental spillages will be contained within Environmental Management Plan. Spill kits will be available to deal with and accidental spillage in and outside the re-fuelling area.
Residual Impact - Direct, negative, imperceptible, short term, low probability impact.
5. GROUNDWATER & SURFACE WATER CONTAMINATION FROM WASTEWATER DISPOSAL Release of effluent from domestic wastewater treatment systems have the potential to impact on groundwater and surface waters if site conditions are not suitable for an on-site percolation unit.
Pathway – Groundwater flow paths and site drainage network. **Receptor** – Down-gradient well supplies and surface water. **Potential Impact -** Direct, negative, significant, temporary, low probability impact to surface water quality. Direct, negative, slight, temporary, low probability impact to local groundwater.
<u>Proposed Mitigation Measures:</u>

1. A self contained port-a-loo with an integrated waste holding tank will be used, maintained by the providing contractor, and removed from site on completion of the construction works.
2. Water supply for the site office and other sanitation will be brought to site and removed after use from the site to be discharged at a suitable off-site treatment location; and,
3. No water will be sourced on the site, or discharged from the site.

Residual Impact – No impact

6. RELEASE OF CEMENT BASED PRODUCTS

Concrete and other cement-based products are highly alkaline and corrosive and can have significant negative impacts on water quality. They generate very fine, highly alkaline silt (pH 11.5) that can physically damage fish by burning their skin and blocking their gills. A pH range of ≥ 6 ≤ 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. Entry of cement based products into the site drainage system, into surface water runoff, and hence to surface watercourses or directly into watercourses represents a risk to the aquatic environment. Peat ecosystems are dependent on low pH hydrochemistry. They are extremely sensitive to introduction of high pH alkaline waters into the system. Batching of wet concrete on site and wash out of transport and placement machinery are the activities most likely to generate a risk of cement based pollution.

Pathway – site drainage network.

Receptor – Surface water and peat water hydrochemistry and water dependant ecosystems (*i.e.* the on-site wetland).

Potential Impact - Direct, negative, moderate, short term, medium probability impact to surface water.

Proposed Mitigation Measures:

The following mitigation measures are proposed:

1) No batching of wet-cement products will occur on site. Ready-mixed supply of wet concrete products and where possible, emplacement of pre-cast elements, will take place.
2) Where possible pre-cast elements for culverts and concrete works will be used.
3) No washing out of any plant used in concrete transport or concreting

operations will be allowed on-site.

4) Where concrete is delivered on site, only the chute need be cleaned, using the smallest volume of water possible. 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 is to be tanked and removed from the site to a suitable, non-polluting, discharge location.
5) Use weather forecasting to plan dry days for pouring concrete.
6) Ensure pour site is free of standing water and plastic covers will be ready in case of sudden rainfall event.
7) The 50m wide river buffer zone which will be emplace for the duration of the construction phase. No construction activity will occur within the buffer zone with the exception of river crossings and road upgrade works.

The buffer zone will:

- Prevent any cement based products accidentally entrained in the construction phase drainage system entering directly into watercourses, achieved in part by ending drain discharge outside the 50m buffer zone and allowing percolation across the vegetation of the buffer zone;
- Provide a buffer against accidental direct pollution of surface waters by any pollutants, or by pollutants entrained in surface water runoff.

Residual Impact - Negative, direct, imperceptible, short term, moderate probability impact.

7 IMPACTS ON PEATLAND HYDROLOGY

Proposed turbines T9 are located in an area of cutaway raised bog. The bog is undesignated, however potential impacts on the local peat hydrology could occur as result of the following:

- Construction and operational phase lowering of peat water levels in the vicinity of roads, turbines and other development infrastructure due to emplaced artificial drainage and excavations;
- Road emplacements, depending on design, can act as drains or barriers to flow, resulting in lowered water levels;
- Changes to peat water flow directions due to emplacement of roads, drains and other infrastructure;
- Construction and operational phase re-distribution of natural and additional surface water run-off, resulting in changes to the natural distribution of drainage; and,
- Change in hydrochemistry due to materials used to construct roads and turbine

bases and hardstands,

Pathway – Drainage and excavations

Receptor – Peatland hydrology;

Potential Impact - Direct, adverse, moderate, high probability impact on peatland hydrology.

Impact Assessment:

Proposed turbine T9 is located in an area of cutaway raised bog (*i.e.* close to the peat cutting face) and therefore the potential to further impact on the peatland hydrology (which has already been impacted on to some extent) of the section of bog in question is low. There are a number of existing significant drains in the area and therefore the proposed wind farm infrastructure will only have a very subdued impact on the peat hydrology (*i.e.* water levels) immediately adjacent to the proposed turbines and access roads.

Residual Impact: Direct, adverse, negligible, high probability impact on peatland hydrology.

8 PHYSICAL CHANGES TO SURFACE WATERCOURSES AND DRAINAGE PATTERNS.

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

A total of nine bridge crossings will be required over the Yellow River (including its tributaries) to allow for the proposed wind farm access road infrastructure. The remainder of the crossings are over local field drains with generally little or no flow. The locations of all crossings are shown in Figures 7.2 to 7.6.

Pathway: Surface water discharge routes.

Receptor: River morphology and associated dependant ecosystems.

Potential Impact: Direct, negative, slight, short term to permanent, high probability impact.

<u>Impact Assessment & Mitigation</u>

The proposed stream crossings over the Yellow River will be clear spanning and the existing banks will remain undisturbed. No in-stream works are proposed and therefore there will be no impact on the Yellow River at the proposed crossing

locations. Any guidance / mitigation measures proposed by the OPW or the Inland Fisheries Ireland will be incorporated into the design of the proposed crossings. As a further precaution near stream construction work will only be carried out during the period permitted by Inland Fisheries Ireland for in-stream works according to the Eastern Regional Fisheries Board (2004) guidance document "*Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites"*, that is, May to September inclusive. This time period coincides with the period of lowest expected rainfall, and therefore minimum runoff rates. This will minimise the risk of entrainment of suspended sediment in surface water runoff, and transport via this pathway to surface watercourses. During the near stream construction work double row silt fences will be emplaced immediately down-gradient of the construction area for the duration of the construction phase. There will be no batching or storage of cement allowed in the vicinity of the crossing construction areas. All river/stream crossings will require a Section 50 application (Arterial Drainage Act, 1945). The river/stream crossings will be designed in accordance with OPW guidelines/requirements on applying for a Section 50 consent.
Residual Impact: Direct, negligible, short term, low probability impact.
9 EXCAVATION DEWATERING & IMPACTS ON SURFACE WATER QUALITY & GROUND WATER LEVELS Excavation seepage will likely occur in turbine base excavations and can potentially result in a localised flow of groundwater into the excavation. This can create additional volumes of water to be treated by the runoff management system. The proposed turbine base excavations will be dug to approximately 2 metres below ground level (mbgl) and therefore may intercept the saturated gravels (estimated to be moderate/high permeability from field observations) that underlie the peat deposits in places. Groundwater inflows may require management and treatment to reduce suspended sediments. Excavation dewatering has also the potential to impact on water levels in the vicinity of the excavation and adjacent well supplies.
Pathway: Surface water discharge routes. **Receptor:** Drainage routes and overland flow.

Potential Impact: Direct, negative, moderate, short term, high probability impact on surface water quality

Direct, negative, slight, short term, high probability impact on local groundwater levels.

Impact assessment

The presence of saturated gravels with a high water table (<1.5m) beneath the peat deposits in the western areas (*i.e.* turbines T1 to T12) will mean that dewatering of turbine base excavation will likely be required. In addition, the remainder of the proposed turbine locations are generally located on poorly draining land where the water table is likely to be shallow (*i.e.* <1m). Management of groundwater inflows and subsequent treatment prior to discharge into the drainage network will be required as follows:

Design and Control Measures to deal with excavation seepages include:

- Appropriate interceptor drainage, to prevent upslope surface runoff from entering excavations will be put in place;
- If required, pumping of excavation seepage will prevent build up of seepage water in the excavation;
- The interceptor drainage will be discharged to the site constructed drainage system or onto natural vegetated surfaces and not directly to surface waters;
- The pumped water volumes will be discharged via volume and sediment attenuation ponds adjacent to excavation areas, or via specialist treatment systems if required;
- Attenuation/Stilling ponds will be located on the inlet and outlet sides of the open drain. These ponds will be robust enough to allow for frequent cleaning.
- There will be no direct discharge to surface watercourses, and therefore no risk of hydraulic loading or contamination; and,
- Daily monitoring of excavations by a suitably qualified person should occur during the construction phase. If high levels of seepage inflow occur, excavation work should immediately be stopped and a geotechnical assessment undertaken.

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

In terms of impacts on local groundwater levels, a slight lowering (<0.3m) of groundwater levels in close proximity (<20m) of the excavation may occur. The proposed turbine base excavation depth is 2m in total and on average 0.5m of this will comprise low permeability peat. Therefore, the excavation depth into the saturated gravels will only be in the order of 1.5m. Dewatering an excavation of such shallow depth in saturated gravels will have minimal surrounding impacts on groundwater levels. Also, the dewatering will only be a temporary requirement (*i.e.* days) while the base is being constructed.

The potential impact on local well supplies is addressed in Section 7.3.14 and Potential Impact no. 11 below.

Residual Impact: Direct, negligible, short term, low probability impact on local surface water bodies.

10 IMPACTS ON LOCAL/PUBLIC GROUNDWATER (WELL) SUPPLIES

Excavation dewatering, storage and handling of fuels etc have the potential to impact on groundwater supplies down-gradient of development areas.

Toberdaly spring which is used as a public supply source is located approximately 2km to the southwest of Rhode town. The GSI Groundwater Protection Zone (ZOC) for this spring is shown on Figure 7.10. None of the proposed development or any of its ancillary activities lie within the ZOC to the spring. There can be no impact on this water source as a result of the proposed wind farm development.

In terms of local well supplies the assessment undertaken in Section 7.3.14 assumes that the groundwater flow direction in the aquifer underlying the site mimics topography whereby flow paths will be from topographic high points to lower elevated discharge areas at the streams and rivers. Therefore, if no dwellings are located in the groundwater flow path between the proposed development areas (*i.e.* turbine location) and the discharge zone (*i.e.* stream/river) there can be no impact on any potential wells associated with the dwellings. The assessment identified no dwellings in the groundwater flow path down-gradient of the main development areas (*i.e.* proposed turbine locations) and therefore impacts on groundwater supplies is not expected.

Residual Impact: No impact

Table 7.11: Potential Impacts and Proposed Mitigation Measures

7.6 REFERENCES

Environmental Protection Agency (2003): *Advise Notes on Current Practice (in the preparation on Environmental Impact Statements)*.

Environmental Protection Agency (2002): *Guidelines on the Information to be Contained in Environmental Impact Statements*.

Forest Services (2004): Forestry Schemes Manual.

Institute of Geologists Ireland (2002): *Geology in Environmental Impact Statements – A Guide*.

National Roads Authority (2005): *Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes*.

Wind Farm Development Guidelines for Planning Authorities (September, 1996).