4 SOILS, GEOLOGY & HYDROGEOLOGY

This section of the EIS addresses soils, geology and hydrogeology in the existing environment, identifies potential impacts of the proposed development, and outlines measures to mitigate potential impacts. It also addresses the potential for instability of peat on the site resulting from the construction of the proposed development.

4.1 Soils, Geology & Hydrogeology Assessment Methodology

This report was prepared having regard to the publication 'Geology in Environmental Impact Statements' by the Institute of Geologists of Ireland'[10]. It was prepared using available published literature and following a walkover survey of the site. Intrusive site investigations were also carried out as part of this assessment to assess the nature of the overburden geology.

The literature reviewed included:

- Groundwater Protection Scheme for County Offaly[11]
- Geology of Galway-Offaly[12]
- Bedrock Geological Maps[13]
- Soil Map of Ireland[14]
- Proposed Derrygreenagh Power Plant EIS[15]

Following the compilation of site investigation data and published information on the existing environment, the details of the proposed development were reviewed to identify potential impacts on geology and hydrogeology. Where potential impacts have been identified, mitigation measures have been proposed to minimise the magnitude and consequence of the impacts.

4.2 Existing Soils and Geology

The existing geology is described in terms of the bedrock geology, overburden geology and hydrogeology. The overburden geology of the site was determined by means of preliminary site investigations undertaken in December 2009 by FTC. This work included trial pit excavations and hand-held probes, as follows:

- 24 trial pit excavations to a maximum depth of 4.0 m
- 115 in-situ hand-held probes to a maximum depth of 2.3 m

Information sources include the records of the Geological Survey of Ireland (GSI), both published and online records.

A copy of the trial pit logs and probe test results are included in Appendix 7 of this document. The site has been previously harvested by Bord na Móna PLC. The trial pits and probes encountered peat covering the entire site with an average thickness of 1.3 m. The maximum depth of peat encountered was 3.0 m, overlying predominantly silty sandy gravel or occasionally sandy gravelly silt. The trial pits were excavated to a maximum depth of 4.0 m and possible bedrock was encountered at only one location during the investigations, in the extreme north east of the site. Peat probes were also undertaken on the site at the locations shown in Figure 4-1 which also shows the locations of the trial pit excavations and the distribution of peat thickness across the site. The depth of peat generally increases from north west to south east.

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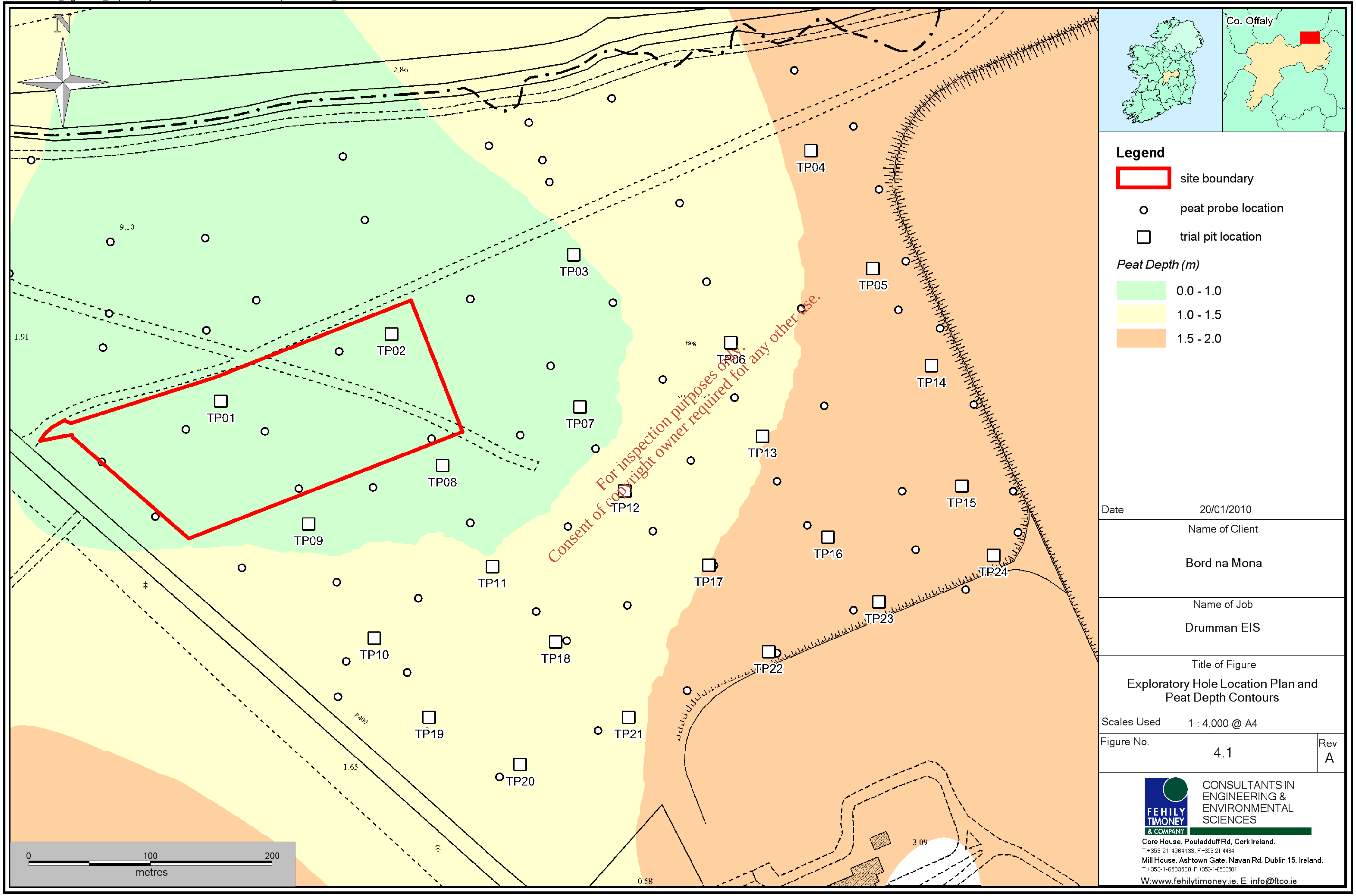
[10] Geology in Environmental Impact Statements – a Guide. Institute of Geologists of Ireland. 2002
[11] Geological Survey of Ireland (GSI, 2009) website http://gsigis1.dcmnronline.ie/imf/imf.jsp?site=Groundwater)
[12] Geology of Galway-Offaly. S. Gatley, I. Somerville, J.H. Morris, A.G. Sleeman and G. Emo. Geological Survey of Ireland. 2005.
[13] Bedrock Geological Maps of The Carboniferous of Central Ireland, 1:100,000 - Sheets 15 & 16. Geological Survey of Ireland. 1992.
[14] General Soil Map of Ireland. National Soil Survey - Second Edition 1980
[15] Proposed Power Plant at Derrygreenagh, Co. Offaly. Environmental Impact Statement. Mott MacDonald Pettit. February 2009. www.derrygreenagpower.ie

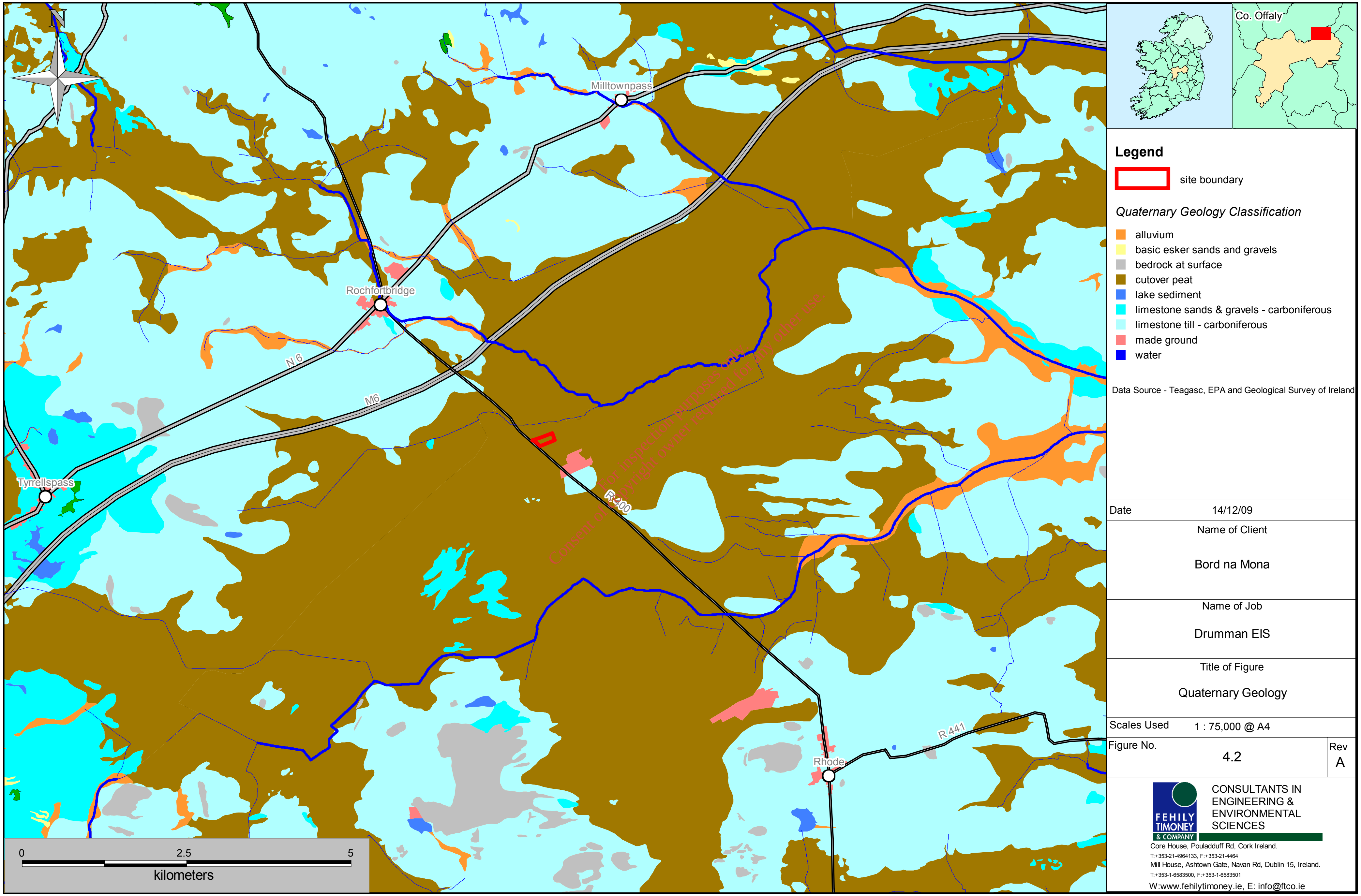
4.2.1 Overburden Geology

The main soil associations in northern Offaly belong to the 'Flat to Undulating Lowland' broad physiographic division. The main Quaternary sediments identified in this area of Offaly are cutover basin peat deposits. A summary of the main Quaternary deposits is shown in Figure 4-2.

LW09-660-04_Figure 4.1_Exploratory Hole Location Plan and Peat Depth Contours_Rev A

Mapping Reproduced Under Licence from the Ordnance Survey Ireland Licence No. EN 0001209 © Government of Ireland





Date	14/12/09
Name of Client	Bord na Mona
Name of Job	Drumman EIS
Title of Figure	Quaternary Geology
Scales Used	1 : 75,000 @ A4
Figure No.	4.2
Rev	A

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The 'General Soil Map of Ireland' is the reference source for description of the soil of the area which shows that the site is covered by basin peat deposits (also known as fens). Fens are bogs which have formed from vegetation which is fed by nutrient rich waters. They often form in the midlands and have an average depth of about 2.2 m. They are often an early stage of raised bogs which can grow on top of the fens.

Fieldwork confirmed the presence of peat at all areas of the site to depths of up to 3 m. The average depth of peat encountered was about 1.3 m, possibly as a result of peat harvesting over the site. The peat encountered within the trial pits typically comprised brown, wet, and cohesive to fibrous peat.

Immediately underlying the peat layer is generally grey silty, sandy, cobbly gravel, which grades in places to soft, sandy, gravelly silt, particularly towards the north east part of the site. This granular soil has a thickness of at least 3 m over the majority of the site.

4.2.2 Bedrock Geology

Figure 4-3 shows the bedrock geology of the site and surrounding area. The GSI published maps for Galway-Offaly (Sheet 15) and Kildare-Wicklow (Sheet 16) are the reference sources for the description of the bedrock geology of the region. Possible limestone bedrock was met at a depth of 3.2 m within the extreme north east corner of the site (trial pit TP23). The 1:100,000 scale bedrock geology maps show that Lower Carboniferous (Upper Dinantian) rock underlies the site. The rock comprises Lucan Formation dark impure (muddy) limestone and shale usually referred to as 'Calp'.

4.2.3 Structural Geology

Structurally, the Drumman area lies within a relatively undeformed area. Although the surrounding area is crossed by a number of north east to south west or North West to south east faults, none are shown to cross the site itself. The geological maps for the area show that the underlying bedrock is likely to dip at a shallow angle (up to 20°) to the east.

4.3 Existing Hydrogeology

The hydrogeological characteristics of the region are strongly influenced by the underlying rock type. The Lucan Formation underlying the site is part of the 'Carboniferous Limestone lowlands' which represents one of the six main hydrogeological units within the Offaly-Galway region. The GSI aquifer classification for the region is shown in Figure 4-4. The GSI classifies the Lucan Formation as a 'Locally Important Aquifer (LI) which is considered to be moderately productive only in localised zones.

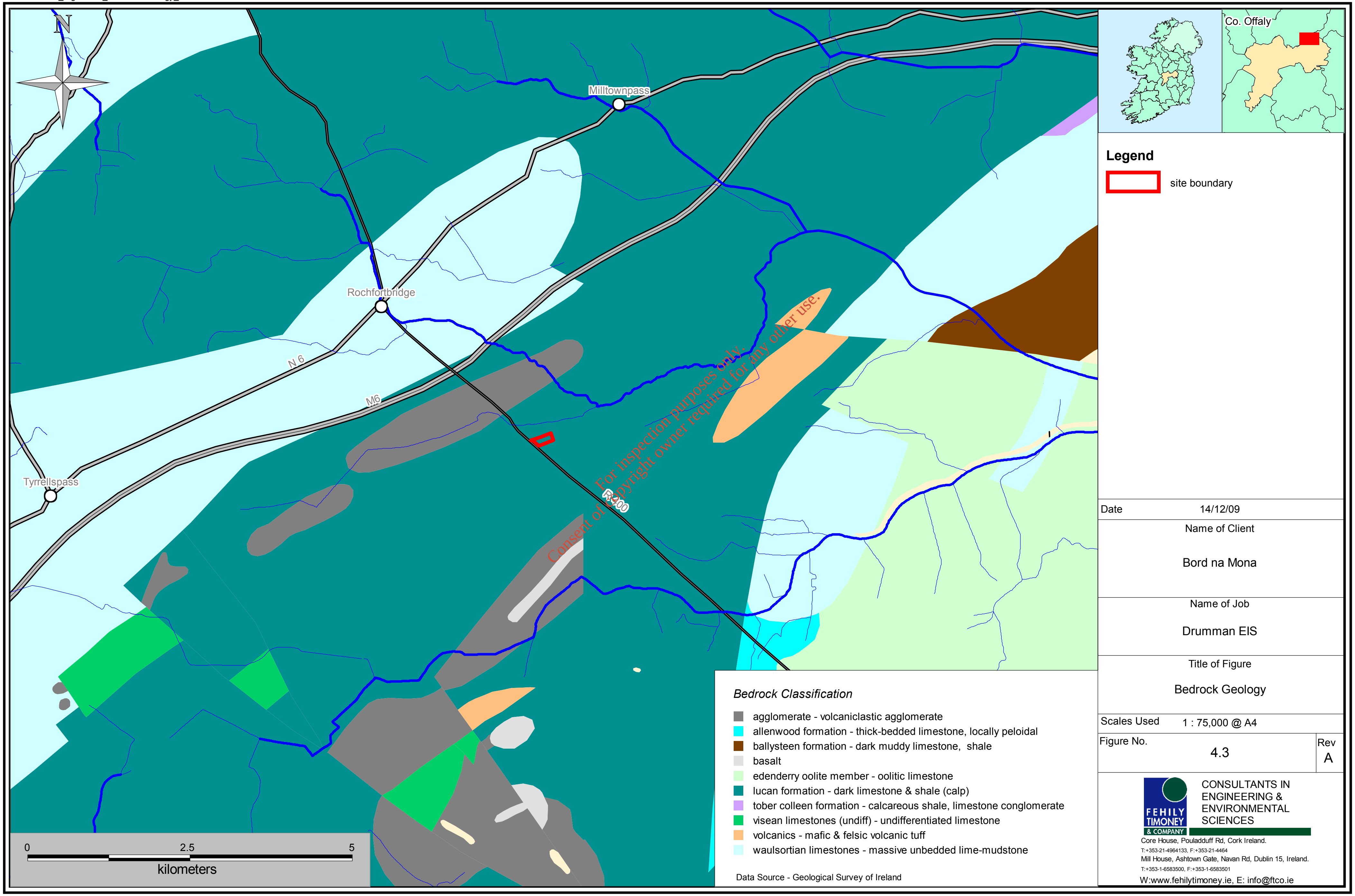
Groundwater storage and movement is limited within these rocks due to the muddy nature of the limestone and the shale interbeds which limits the overall primary permeability. Groundwater is likely to flow predominantly through faults and fractures within the upper few metres of fractured rock and also near faults. Although karst features are uncommon, they are present within the Lucan limestone in Co. Galway where turloughs and sinkholes are recorded.

Groundwater development within the Lucan Formation is often not particularly successful with low yields and problems with iron and manganese, and sometimes hydrogen sulphide. Good yields will generally only be obtained within fault zones and/or dolomitisation at depth. Although the upper, more permeable layer might provide sustainable enough supplies for larger wells, it will often be poorer quality than the water within the deeper permeable horizons.

The bedrock in this area is covered by Quaternary sediments of variable thickness, structure and composition. The low permeability material (clay and till) protects the underlying bedrock aquifers while the high permeability material (sand and gravel) allow recharge of the aquifers and may themselves also form aquifers where they are sufficiently thick.

The silts within parts of the site area are probably intermediate between these extremes. Acting as aquicludes, they will restrict movement of water to the bedrock, but are unlikely to be of sufficient permeability to form aquifers themselves although the interbedded gravels may locally be used as water supplies.

Groundwater vulnerability, as defined by the GSI, is the term used to represent the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater could be contaminated by human activities.


N
Milltownpass
Rochfortbridge
Tyrrellspass
N 6
M6
R400
Co. Offaly
0
2.5
5
kilometers
Legend
site boundary
Bedrock Classification
agglomerate - volcaniclastic agglomerate
allenwood formation - thick-bedded limestone, locally peloidal
ballysteen formation - dark muddy limestone, shale
basalt
edenderry oolite member - oolitic limestone
lucan formation - dark limestone & shale (calp)
tober colleen formation - calcareous shale, limestone conglomerate
visean limestones (undiff) - undifferentiated limestone
volcanics - mafic & felsic volcanic tuff
waulsortian limestones - massive unbedded lime-mudstone
Data Source - Geological Survey of Ireland
Date 14/12/09
Name of Client
Bord na Mona
Name of Job
Drumman EIS
Title of Figure
Bedrock Geology
Scales Used 1 : 75,000 @ A4
Figure No. 4.3
Rev A
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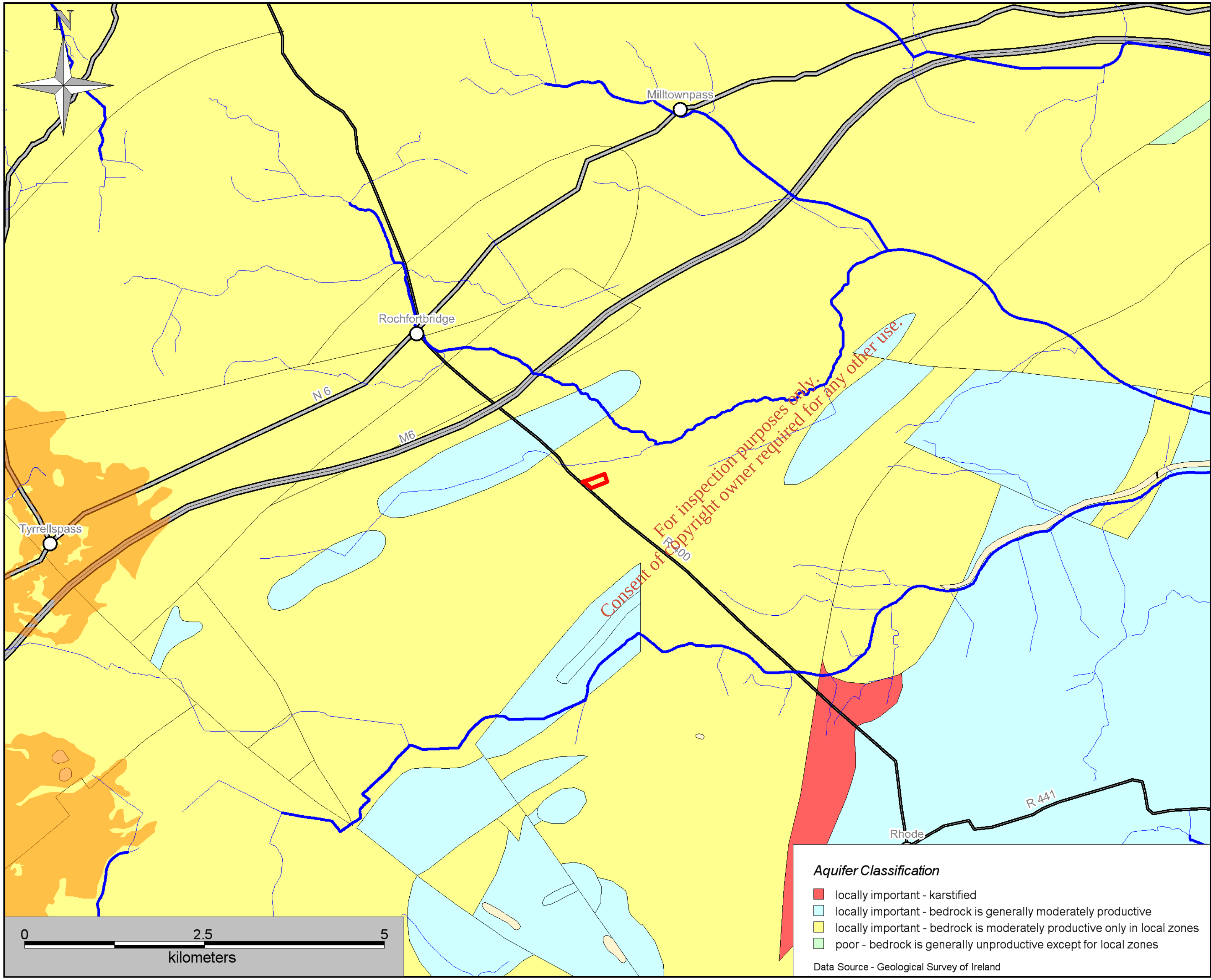
LW09-660-04_Figure 4.4_Aquifer Classification_Rev A



Date	14/12/09
Name of Client	Bord na Mona
Name of Job	Drumman EIS
Title of Figure	Aquifer Classification
Scales Used	1 : 75,000 @ A4
Figure No.	4.4
Rev	A

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The vulnerability of an aquifer to contamination is influenced by the leaching characteristics of the topsoil, the permeability and thickness of the subsoil, the presence of an unsaturated zone, the type of aquifer, and the amount and form of recharge (the hydrologic process where water moves downward from surface water to groundwater). Groundwater vulnerability is determined mainly according to the thickness and permeability of the subsoil that underlies the topsoil, as these properties strongly influence the travel times and attenuation processes of contaminants that could be released into the subsurface from below the topsoil (as in the case of contaminants from landfills, septic tank systems and underground storage tanks). The type of recharge is also considered where indirect recharge can occur through swallow holes or sinking streams.

The GSI distribution of vulnerability for the site area is shown in Figure 4-5. Groundwater vulnerability is classified as being 'moderate' for the site based on the information available on the overburden.

The GSI methodology for assessing groundwater protection is outlined in the publication 'Groundwater Protection Schemes'. The methodology proposes a matrix, which relates vulnerability, source and resource such that a particular site is given a response rating to specific activities.

The assessed vulnerability for the Drumman site is shown in Table 4-1 below. The table illustrates the standard ratings of vulnerability used by the GSI, with the existing site conditions highlighted based on the findings of the site investigations.

Table 4-1 Groundwater Vulnerability at Drumman

Vulnerability Rating	Hydrogeological Conditions		
	Subsoil Permeability (Type) and Thickness		
	High Permeability[1]	Moderate Permeability[2]	Low Permeability[3]
Extreme (E)	0 - 3.0 m	0 - 3.0 m	0 - 3.0 m
High (H)	**> 3.0 m**	**3.0 -10.0 m**	3.0 - 5.0 m
Moderate (M)	N/A	>10.0 m	5.0 - 10.0 m
Low (L)	N/A	N/A	>10 m

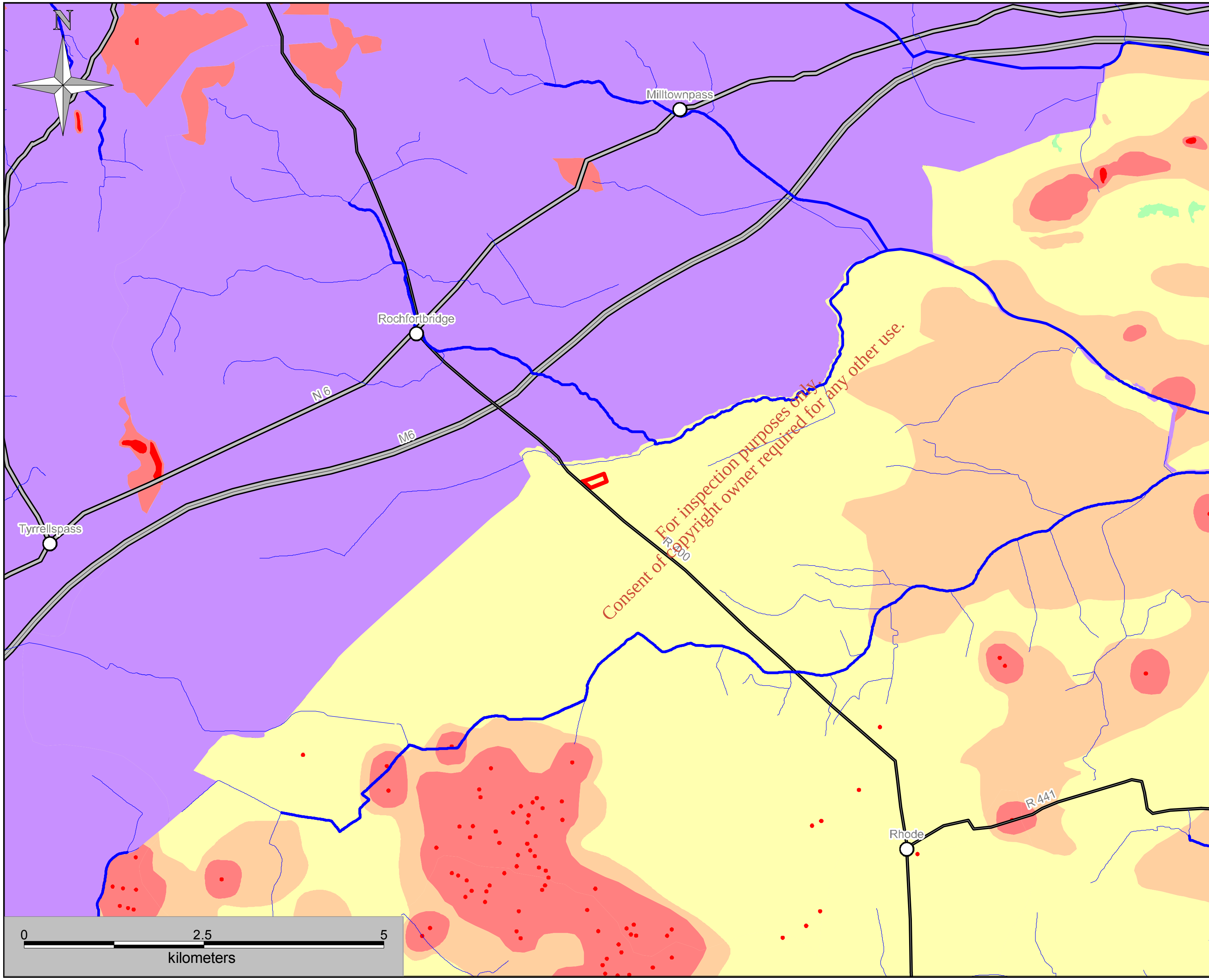
Notes:
1. sand/gravel
2. sandy soil
3. clayey subsoil, clay, peat
4. N/A = Not Applicable
5. precise permeability values & overburden depths cannot be given at present

Based on the findings from the trial pit excavations and probes, the assessed vulnerability for the site is high, based on the thickness and permeability of the strata estimated from the fieldwork. The resource protection zone associated with the aquifer class and vulnerability is therefore classified as LI/H (Locally Important aquifer with High vulnerability).

Groundwater observations within the trial pit excavations showed that groundwater was generally observed at the base of the peat layer at a typical depth of 1 m to 2 m below ground level. There are no rivers or lakes within the boundary of the site. The topography of the site is mostly flat lying or sloping gently to the west. The site is drained via a series of parallel man-made ditches which run parallel to the site boundaries in a north east to south west direction, although many of the ditches appear to be redundant, resulting in poor drainage and surface ponding. Regional drainage is generally to the south towards the Phillpstown River and tributaries of the Cushina River; however local drainage is towards the Mongagh River which runs along the north western boundary of the site. It is expected that local groundwater gradients will be very low but generally flowing towards the Mongagh River to the North West.

The GSI website records no groundwater well locations within 2 km of the site, as shown on the Figure 4.6. The figure shows that there are at least ten wells located within 5 km of the site, However it is should be noted that the EIS compiled by Mott MacDonald for the proposed Derrygreenagh Power Plant records additional groundwater wells including one well at the adjacent works, one well approximately 2km north of the site and two wells approximately 2km southwest of the site.

A source protection zone is shown to the southwest of Rhode, some 7 km south of the site. This is a public water supply which is supplied by the underlying carboniferous limestone. The source protection zones are also shown in Figure 4.6.



Legend

site boundary

Groundwater Vulnerability

- extreme (rock near surface or karst)
- extreme
- high to low (interim study only)
- high
- moderate
- low

Data Source - Geological Survey of Ireland

Date	14/12/09
Name of Client	Bord na Mona
Name of Job	Drumman EIS
Title of Figure	Groundwater Vulnerabilty
Scales Used	1 : 75,000 @ A4
Figure No.	4.5
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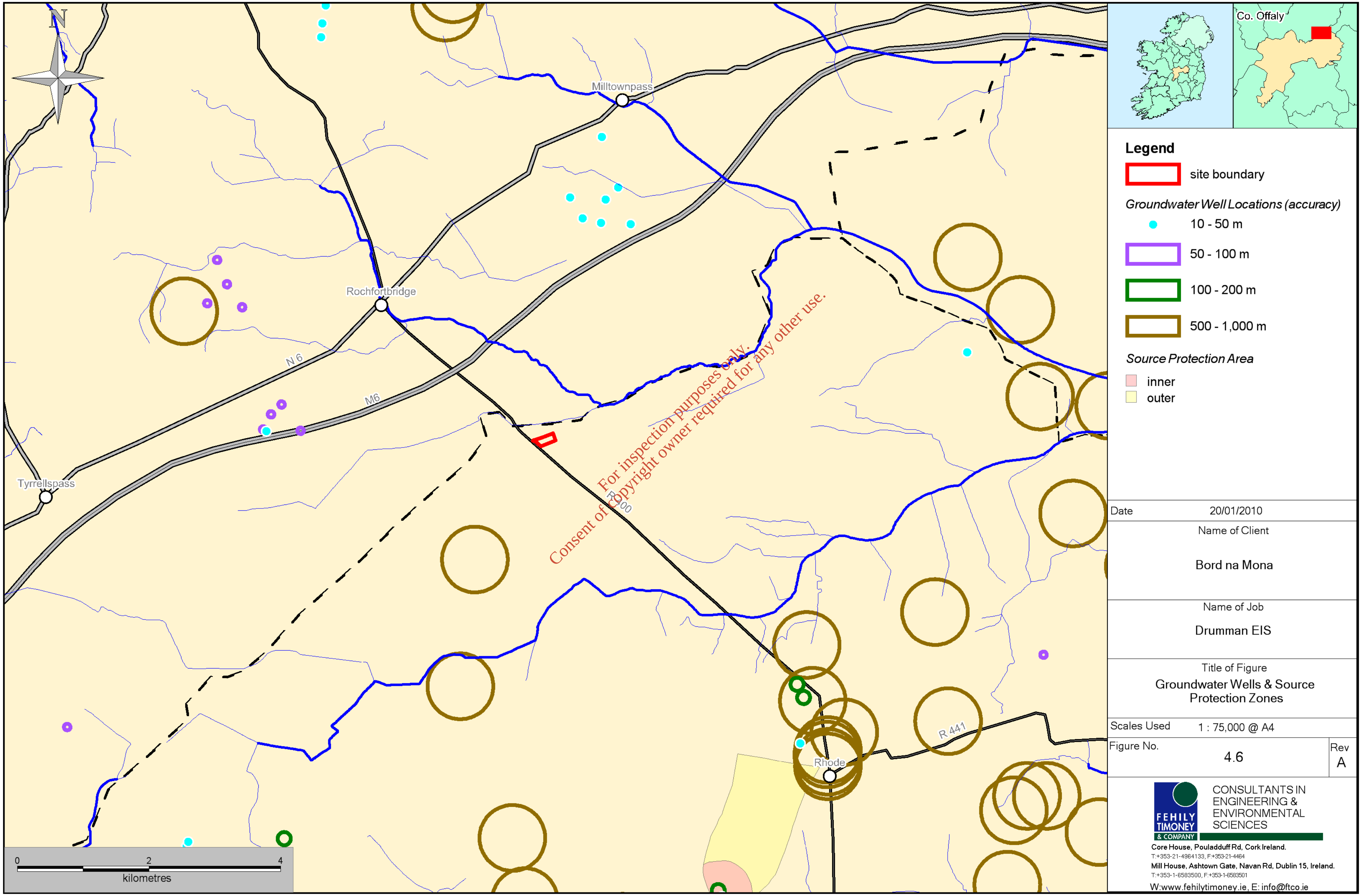

Legend

site boundary

Groundwater Well Locations (accuracy)

- 10 - 50 m
- 50 - 100 m
- 100 - 200 m
- 500 - 1,000 m

Source Protection Area

- inner
- outer

Date	20/01/2010
Name of Client	Bord na Mona
Name of Job	Drumman EIS
Title of Figure	Groundwater Wells & Source Protection Zones
Scales Used	1 : 75,000 @ A4
Figure No.	4.6
Rev	A

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4.4 Existing Peat Stability

In order to provide information to assess the peat stability of the site, a site walkover, including peat probing and trial pit excavations, was carried out during December 2009. The site walkover, fieldwork and desk study provided the following information which was used to assess the existing peat stability on the site:

- Fieldwork confirmed the presence of peat over virtually all areas of the site with a maximum peat depth of 3.0 m and an average peat depth of 1.3m.
- The main access to the site is from the south west of the site.
- A gravel track runs along the north western side of the site.
- The vegetation cover across the site generally consists of sparse wetland cutover bog vegetation (grasses, heather and small shrubs).
- Immature trees also cover some parts of the site.
- A number of (largely redundant) manmade drainage channels also exist across the site, running generally in an east-west direction.
- The site is generally flat lying, with altitudes of between c.75 mOD over the northern part of the site rising up to around c.79 mOD over the southern part of the site.
- The fieldwork and walkover revealed no slope stability concerns or issues on the site.

A review of the above factors has been undertaken by FTC. The review concluded that there are currently no peat stability issues or concerns on the site.

4.5 Potential Impacts on Soils, Geology and Hydrogeology

The proposed works require the construction of buildings, car parking, access roads and associated infrastructure in areas where the generalised geology consists of basin peat (fen bog) overlying gravelly, silty soils and limestone bedrock. Existing drainage characteristics vary, but generally consist of some standing surface water intercepted by manmade drainage channels, most of which are now redundant. The potential impacts on the soils, geology and hydrogeology are assessed below.

4.5.1 Impact Assessment Methodology

The following elements were examined to determine the potential impacts on the soils and geology aspects of the proposed development at Drumman:

- evaluation of the risks and potential impacts of the proposed development
- assessment of stability issues, in the context of the existing environment and the proposed development

The following on-site activities have been identified as the causes of potential risks to the geology, hydrogeology & peat stability on the site:

- excavations
- access roads/car park construction
- foundation construction
- drainage
- peat excavation/reuse

4.5.2 Potential Impact of Excavation and Construction

Excavation of peat over the entire development area will be required during construction. The average depth of peat covering the development area is approximately 0.65 m; hence a total peat excavation volume of approximately 17,500 m^3 will be required. Following removal of the peat, the site levels will be raised above the existing ground levels by importing granular fill from the nearby quarries. The final site level will be determined during the detailed design phase.

The importation of granular fill will require excavation of granular fill from local quarries or borrow pits, and other products in the form of concrete or other construction related products. This will have a permanent impact on the source quarries or borrow pits.

It is possible that deep piled foundations may be required at some locations which would involve less soil excavation. While the impact of piles on near-surface soils would be less, any impact would extend to a greater depth. Given the scale of the development relative to the size of the site, this is anticipated to have a minor, permanent impact. In addition, bored piles, if utilised, would also require disposal of soil and possibly some bedrock.

The construction of roads and foundations also imposes hydrological impacts in the form of modifying the natural seepage from upslope of the road, thus depriving the downslope soil of its natural supply of water, leading to drying of the soil surface. Due to the flat-lying nature of the Drumman site, and the drainage design proposed, these effects will be minimal.

The potential environmental impact of the use of peat berms is primarily related to the risk of oxidisation of the peat and the release of sediment into surface waters. The estimated volume of peat excavated from the development area will be about 17,500 m^3. It is proposed to construct a landscaped berm of maximum height 1 m over an area of approximately 18,900 m^2 (adopting 1:4 side slopes). The potential hydrological impacts are discussed further in the hydrology chapter of this document, and mitigated through appropriate drainage techniques.

Soil compaction can occur due to movement of construction and maintenance traffic. This will occur especially within areas of peat bog which are highly compressible. This could lead to an increase in runoff and subsequently to an increase in flooding and erosion. Rapid loading of the peat can also result in the generation of very high pore pressures which can result in peat failure.

Removal of peat and subsoils can also result in exposure of the underlying rock to sources of contamination. Chemical pollution could occur as a result of spillage or leakage of chemicals, runoff from vehicle washing facilities, unset concrete, storage of fuels or refuelling activities etc. Chemical pollutants can enter groundwater supplies and have implications for damage to ecology and local water supplies.

4.5.3 Potential Impact on Hydrogeology

Parts of the site have been drained by manmade drainage channels on the site. The formation of new site roads and drains will involve removal of linear areas of the peat and blocking or removal of existing drains.

The excavation of peat and subsoils is a permanent impact that, without mitigation, could alter the existing hydrogeological balance of the site. Shallow foundations are likely to be used for the buildings after removal of peat and any soft mineral soils. Removal of this cover will expose the underlying soils to erosion and may result in sediment run-off. Groundwater drawdown will occur as a result of pumping which may be required during construction. However, levels will be allowed to rise to current levels after construction is complete.

Some drawdown could also occur adjacent to the sidewalls of the internal haul road (typically within 5 m); however much less significant drawdowns will occur away from the track drainage. Although this is a permanent impact for permanent roads, it is considered to be relatively minor as the depth of peat excavation is low (typically less than 1.5 m).

Excavation below the water table could be required where pad or strip foundations are constructed. In this case, temporary dewatering or lowering of the water table could be required in the form of sheet piling, sump pumping, or possibly well pointing in extreme cases. This will be a temporary and relatively minor impact on hydrogeology, which will result in drawdown of the water table around the foundations and to a horizontal distance of typically 10 – 20 m depending on the depth of the excavation and the permeability of the surrounding soils. Pumping may also result in sediment release into drains and watercourses. After excavation, the water table adjacent to the excavations will return to its former level, although piled foundations extending below the water table will have some effect on the wider aquifer flow patterns within the overburden. The magnitude of this impact will depend on the size and density distribution of the piles installed. Given the moderately high permeability of the overburden, the effect is considered to be a minor, permanent impact.

Where dewatering of the site is required for excavations, this could also have a potential impact on nearby groundwater wells and could, without mitigation, result in sedimentation or potential contamination of the groundwater.

Should piled foundations be required, the impact on the hydrogeological regime is likely to be reduced, particularly with regard to water table drawdown and flow patterns. However, the piles are likely to extend to a greater depth than would pad foundations. This could have an impact on aquifers within both overburden and bedrock. There is the possibility that piling could create a preferential vertical pathway for movement of water or contaminants down to the underlying aquifer. This effect would be greatest where piles extend through low permeability strata and into a confined bedrock aquifer, however it appears that the strata underlying the peat is largely granular in nature and hence this impact would be reduced.

4.5.4 Potential Impact on Peat Stability

Excavation and removal of peat in association with other construction activities and external factors (e.g. heavy rainfall) can give rise to peat instability. The stockpiling of material on peat, creating loadings in excess of the bearing capacity of the in-situ peat has been shown to influence peat failure and consequently trigger peat slides. The dewatering of excavations with inappropriate disposal of excess water can also lead to erosion or undercutting of slopes or saturation and weakening of materials. Vibrations caused by construction traffic or excavation activities near deep peat deposits in addition to the unsupported excavation of roads through areas of saturated and weak peat can trigger peat failure.

The potential impact of the works on existing slopes and the potential for peat failure has been considered. Due to the relatively flat and low-lying nature of the topography, and the moderately thin cover of peat on the site, the risk of instability and slope failure at the site is considered to be low.

The factors that have been shown to influence failure of slopes include:

- interference with site drainage, resulting in changes in the hydrological regime of the peat/subsoil, with subsequent weakening of the affected material
- stockpiling of material on peat, creating loadings in exceedence of bearing capacities
- dewatering of excavations with inappropriate disposal of excess water leading to erosion or undercutting of slopes, or saturation and weakening of materials
- unsupported excavation of roads through areas of saturated and weak peat thereby removing support for the upslope material
- triggering events (vibrations) caused by construction traffic or excavation activities near deep peat deposits
- any combination of the above

These factors will be mitigated through judicious design and implementation of best practice during the design, construction and monitoring process.

The foundations will be predominantly located in areas of thin peat cover with access along existing roads, or new roads excavated through the peat and founded on the underlying soil. Construction of the foundations at these locations is considered feasible with a low risk of peat failure. An assessment of the potential risks is presented in Table 4.2.

Table 4-2 Peat Failure Risk Rating at Drumman

Factor	Existing Risk	Reason
Historical incidence of bog burst in Offaly	Medium	Peat flows or slips have been recorded at seven locations within Offaly including ones at Edenderry (date unknown) and Daingean (1975).
Historical incidence of bog burst on site	Low	No recorded failures on site.

Factor	Existing Risk	Reason
Rainfall	Low	Rainfall is relatively low at the site (approximately 800 to 900 mm per annum based on Met Eireann figures for Birr and Mullingar, which are likely to be similar to the site)
Hydrology	Low	Peat failures are sometimes associated with oversaturated peat, particularly where this peat crosses a break in slope. The peat at the Drumman site was found to be saturated but does not cross any slopes.
Elevation	Low	Studies have shown that site elevation (probably as a corollary of rainfall) is an important control on slope failures (Pellicer, 2006), with most slides in the north west of Ireland initiating above 200 mOD. The Drumman site is situated below 90 mOD.
Man-made drainage	Low to medium	Existing man-made drainage channels are present across the site and could therefore have an impact on slope stability.
Peat depth	Low to medium	Peat failures can occur at various depths of undrained peat. Peat depths encountered across the site are generally less than 2 m.
Slope	Low	Slope is important, but failures can initiate on slopes as low as 2°. Breaks in slope appear to cause instabilities, since they provide a pathway for release of water at the base of the peat layer. The Drumman site has low slopes (average less than 1°) and lacks any significant slope breaks.
Land-use	Low	The current land use is a matrix of scrub, immature trees with open bog. Stockpiling of soils on the in-situ peat or the creation of extensive breaks in the slope were not evident on site walkover.

It is judged from the above assessment of risk that the overall risk of peat failure at the site is low.

4.6 Mitigation Measures for Soils, Geology and Hydrogeology

Mitigation measures in relation to the potential impacts on soils, geology and hydrogeology are addressed below in terms of:

- Excavations and construction
- Hydrogeology
- Peat stability
- Best practice for design, construction and monitoring

4.6.1 Mitigation Measures for Excavations and Construction

Mitigation measures in respect of peat, subsoil and bedrock excavation and construction are addressed below.

One of the primary mitigation measures employed at the preliminary design stage has been the minimisation of volumes of peat and other soil excavation and lengths of road construction. Development will take place within the south west part of the available site where peat depths are generally thinner, which will reduce the amount of peat to be excavated and removed.

The peat thickness at the proposed foundation locations and along access roads will be typically less than 1 m. Newly constructed roads will continue from areas of the site where existing roads have been constructed through areas of thin peat cover, with drainage being provided as appropriate. Excavation will precede the construction work with the peat being replaced with granular fill where required. Peat excavated during the work will be re-used on-site within landscaped berms in areas of minimal peat cover, specifically to the south and east of the development area.

To minimise the transportation of granular fill for access track construction, it is proposed to re-use excavated sand and gravel from within the adjacent sand and gravel quarries. To minimise the volume of imported aggregate, site-won aggregate will be re-used wherever possible.

If piles are required, precast driven piles would be preferred in granular strata and these tend to increase the density of the strata adjacent to the piles and hence would be unlikely to result in the creation of preferential pathways. In addition, using driven piles would also reduce the amount of soil requiring disposal when compared with CFA piles, bored piles or conventional pad foundations.

To minimise the potential impact of groundwater contamination due to a fuel leak or spill, fuel interceptor traps will be incorporated into the drainage system within vulnerable areas. Further details are given in the Section 5 of this EIS.

4.6.2 Mitigation Measures for Hydrogeology

The potential impact to the hydrogeology of the site caused by drawdown of the water table adjacent to roads has been minimised during preliminary design due to the choice of the construction area close to the existing access road. This will minimise the length of new road construction. The new access road and development footprint will be raised above the current ground level, hence the new drainage will not extend any deeper than current site drainage.

The potential impacts due to dewatering or pumping from foundation excavations has again been mitigated by the choice of construction area within an area of thinner peat cover. Depending on the time of year of construction, it may be possible to excavate into the gravel with minimum disruption to the water table and with a minimum of pumping or dewatering. Should significant dewatering be required, water will be pumped into a siltation pond prior to discharge to site drains in order to prevent siltation of drains and watercourses.

In the unlikely event that piled foundations will be required during construction, the impact on the hydrogeological regime will be minimised by minimising the number of piles required. However, the piles are likely to be reduced, particularly with regard to water table drawdown and flow patterns. However, the piles are likely to extend to a greater depth than would pad foundations. This could have an impact on aquifers within both overburden and bedrock. There is the possibility that piling could create a preferential vertical pathway for movement of water or contaminants down to the underlying aquifer. This effect would be greatest where piles extend through low permeability strata and into a confined bedrock aquifer, however it appears that the strata underlying the peat is largely granular in nature and hence this impact would be reduced.

4.6.3 Mitigation Measures for Peat Stability

As discussed previously, the risk assessment for slope failure on the site is considered to be low and therefore no additional mitigation measures for slope failure are deemed necessary further to the best practice guidelines given below.

Provided that the best practice measures outlined above are adhered to, the site is of **low residual risk** from peat slides. It is noted that the majority of these measures have already been implemented during the preliminary design process. The remaining measures will be implemented during the construction process.

The risks associated with berm construction will be mitigated by the following measures:

- minimising the use of berms by:
  - minimising overall peat excavation due to choice of development location
  - giving precedence to peat landscaping and back-fill at other locations on site

- the placing of harvested vegetative peat layers on the berms where available: this will provide resistance against rainfall events, and will minimise sediment and nutrient release until natural re-vegetation is established as discussed above
- restricting the use of berms to gradients not exceeding 2° - it is noted that the site gradients are typically less than 1°
- berms will not be located adjacent to slopes
- placing of berms will not interfere with site drainage
- re-seeding of berms with an appropriate wild seed mix or covering with topsoil and grass seed or covering with a vegetated blanket in the event of failure of natural re-vegetation.

Natural re-vegetation is the preferred method of recovery for the peat berms. However, where required (for example, where adequate quantities of vegetated peat are not available or natural re-vegetation processes are found to be insufficient), the reinstated peat can be secured using vegetation blankets such as Greenfix Embankment Mat, Geojute or similar approved product. An appropriately pre-seeded CoirMesh may also be suitable, if required. This provides both erosion control and an improved soil micro climate to assist natural re-vegetation.

4.6.4 Best Practice for Design, Construction and Monitoring

In order to provide additional mitigation measures, best practice in the detailed design and construction will be implemented as outlined below:

Design Best Practice

Despite being located in a low-lying area where risks of peat slides are low, best practice will be followed in all aspects of design. Detailed design best practice will include the following:

- The works will be designed and checked by a suitably qualified and experienced geotechnical engineer and hydrologist
- The designers will carry out a design risk assessment to evaluate risk levels for the construction, operation and maintenance of the works. Identified risks will be minimised by the application of principles of avoidance, prevention and protection. Information on residual risks will be recorded and relayed to appropriate parties
- Details of all appropriate assumptions, relating to methods and sequencing of work, will be provided to the contractor
- The designers will provide the contractor with a Preliminary Health and Safety Plan in accordance with health and safety regulations
- No amendments to the designed works will be carried out without the prior approval of the designers.

Construction Best Practice

The following measures will be implemented during construction:

- Excavation will be carried out from access roads where possible. Only low ground pressure machinery will operate directly on areas of deep peat (> 2 m)
- Drainage will be constructed in parallel with road construction
- Excavations will not proceed until the relevant drainage elements are complete
- Where necessary, drainage will be constructed in advance of road construction, using bog mats and/or shuttering; including drainage swales, settlement ponds, etc
- Excavation works associated with the construction phase of the development will be monitored by suitably qualified and experienced geotechnical personnel
- The programming of the works will be such that earthworks/excavations are not scheduled to be carried out during severe weather conditions. Where such weather is forecast, suitable measures will be taken to secure the works
- All temporary cuts/excavations will be carried out such that they are stable or adequately supported. Gravel fill will be used to provide additional support to drains where appropriate. Unstable temporary cuts/excavations will not be left unsupported. Where appropriate and necessary, temporary cuts and excavations will be protected against the ingress of water or erosion

- Temporary works will be such that they do not adversely interfere with existing drainage channels/regimes
- Plant, materials and spoil will be stored in appropriate locations, and will not be positioned or trafficked in a manner that would surcharge existing or newly formed slopes
- Prior to construction, a site specific environmental management plan for construction will be prepared. This will provide for the checking of equipment, materials storage and transfer areas, and drainage structures and their attenuation ability, on a regular basis. The plan will be compiled in consultation with the relevant statutory bodies.

Construction Monitoring Programme Best Practice

An appropriate monitoring programme will be put in place prior to construction. This will involve the following:

- The works will be monitored by a suitably experienced geotechnical engineer. Detailed geotechnical site investigations will be carried out to assist in the determination of the appropriate soil parameters in advance of construction.
- Visual inspections will take place on a weekly basis and during periods of high precipitation. These will entail examination of water-logging, channelling and new excavations.
- An assessment of the short-term stability of all excavations in peat will be carried out by an experienced geotechnical engineer during construction.
- Ground movement, if present or anticipated, will be monitored using topographic surveying and inclinometers.
- The works will be monitored to ensure that the assumptions made at the design stage are in line with actual conditions encountered. Where conditions on site differ from the conditions assumed in the design, the works will be altered as required.
- Appropriate contingency plans and reporting procedures will be put in place to deal with any landslip events that occur.
- Post-construction, a maintenance and monitoring regime will be implemented over the lifetime of the site. Such a regime will include the periodic inspection and maintenance of slopes, access roads and drainage provisions.

4.7 Conclusions for Soils, Geology & Hydrogeology

The following generalised conclusions can be drawn, in relation to soils, geology and hydrogeology:

- The site geology typically consists of shallow peat deposit (0 to 3 m) overlying deposits of silt, sand and gravel, overlying limestone bedrock at depth
- The site has a high water table and overlies a locally important aquifer of high vulnerability
- The site is located 5 km north of a source protection area
- Drainage of the area is poor, with largely redundant shallow manmade drains leading to off-site rivers
- The site is generally flat-lying with very low slope gradients

The potential impacts on the geology and hydrogeology of the site are considered to be minor and mainly short-term due to access road construction, foundation construction, excavations, drainage and dewatering measures. Although some long term impacts are likely to occur due to removal of soils and localised lowering of the water table and disruption of flow regimes, these are expected to be relatively insignificant given the scale of the development.

The available information indicates that the proposed development at Drumman is of low risk with regard to slope stability.

Detailed mitigation measures have been provided with regard to the design, construction, and maintenance of the proposed development which lead to a low residual impact in terms of soils, geology and hydrogeology.

5 HYDROLOGY & WATER QUALITY

This section addresses hydrology, water quality and surface water runoff in the existing environment, identifies potential impacts of the proposed development and outlines measures to avoid, reduce and mitigate potential impacts. Residual impacts that cannot be avoided are also identified and discussed.

5.1 Hydrological Assessment Methodology

Further to consultation with the OPW (refer to Appendix 1), a flood risk assessment was prepared in accordance with the guidelines produced by the Department of Environment, Heritage and Local Government (DoEHLG) – 'The Planning System and Flood Risk Management - Guidelines for Planning Authorities', November 2009.

The flood risk assessment takes account of the potential cumulative effect on the receiving waters of the proposed materials recycling & waste transfer facility together with the proposed power generation plant at the adjacent Derrygreenagh site. The drainage from the M6 motorway was also examined as part of the cumulative assessment, to determine the extent to which the drainage discharge from this new road contributed to the Mongagh river catchment.

A surface water management plan was prepared for the construction and operational phases for the proposed materials recycling & waste transfer facility at Drumman. The surface water management infrastructure was informed by the flood risk assessment and that the drainage systems proposed will be sized at detailed design stage. A consultation letter was sent to the National Parks and Wildlife Service (NPWS) and the Eastern Regional Fisheries Board (ERFB) as part of the EIA consultation process. The ERFB, as part of consultation in relation to the proposed adjacent power plant development at Derrygreenagh, has indicated the potential of the Mongagh River as a salmonid habitat.

All activities that could impact on surface water quality are assessed in the surface water management plan. The flood risk assessment (included in Appendix 8) provides the background, informing the surface water management plan on the methods of drainage required to mitigate any potential flood risk from the proposed development.

The assessment of peat stability and ground conditions presented in Section 4 informs the suitability of the drainage design and the siting of the infrastructure to be provided for settlement of suspended solids and attenuation of flows.

The following guidelines and documents were also considered in the development of this report:

- Greater Dublin Strategic Drainage Study (GDSDS): Technical documents of Regional Drainage Policies, March 2005
- CIRIA Environmental good practice on site
- BPGCS005, oil storage guidelines
- CIRIA Control of water pollution from linear construction sites. Technical guidance (C648)
- CIRIA Control of water pollution from construction sites. Guidance for consultants and contractors (C532)
- CIRIA Sustainable construction procurement. A guide to delivering environmentally responsible projects (C571)
- Proposed Power Plant at Derrygreenagh, Co. Offaly EIS, Mott McDonald Pettit
- Kinnegad to Athlone Dual Carriageway EIS, Riada Consult[16]
- UK Pollution Prevention Guidelines (PPG):
  - PPG1: General guide to the prevention of water pollution
  - PPG2: Above ground oil storage tanks
  - PPG4: The disposal of sewage where no mains drainage is available
  - PPG5: Works in, near or liable to affect watercourses
  - PPG6: Working at construction and demolition sites
  - PPG8: Safe storage and disposal of used oil
  - PPG21: Pollution incident response planning

[16] Available from: http://www.wccprojectoffice.ie/new/database/downloads/N6_eis_text.pdf

- o PPG26: Dealing with spillages on highways
- o Measures to avoid, reduce and mitigate any potential impacts from the proposed development are presented.

5.2 Existing Surface Water Hydrology & Water Quality

5.2.1 Existing Drainage

The Mongagh River bounds the site to the north at a distance of approximately 200m from the proposed site boundary. The Mongagh River flows in an easterly direction joining the Yellow River to the south of Castlejordon. The Yellow River continues in an easterly direction, flowing into the River Boyne to the north of Grange. The River Boyne flows in a north easterly direction passing through the towns of Trim, Navan and Drogheda before flowing out to the sea at Baltray. The River Boyne is in Hydrometric Area HA07, which is situated in the Eastern River Basin District (ERBD)

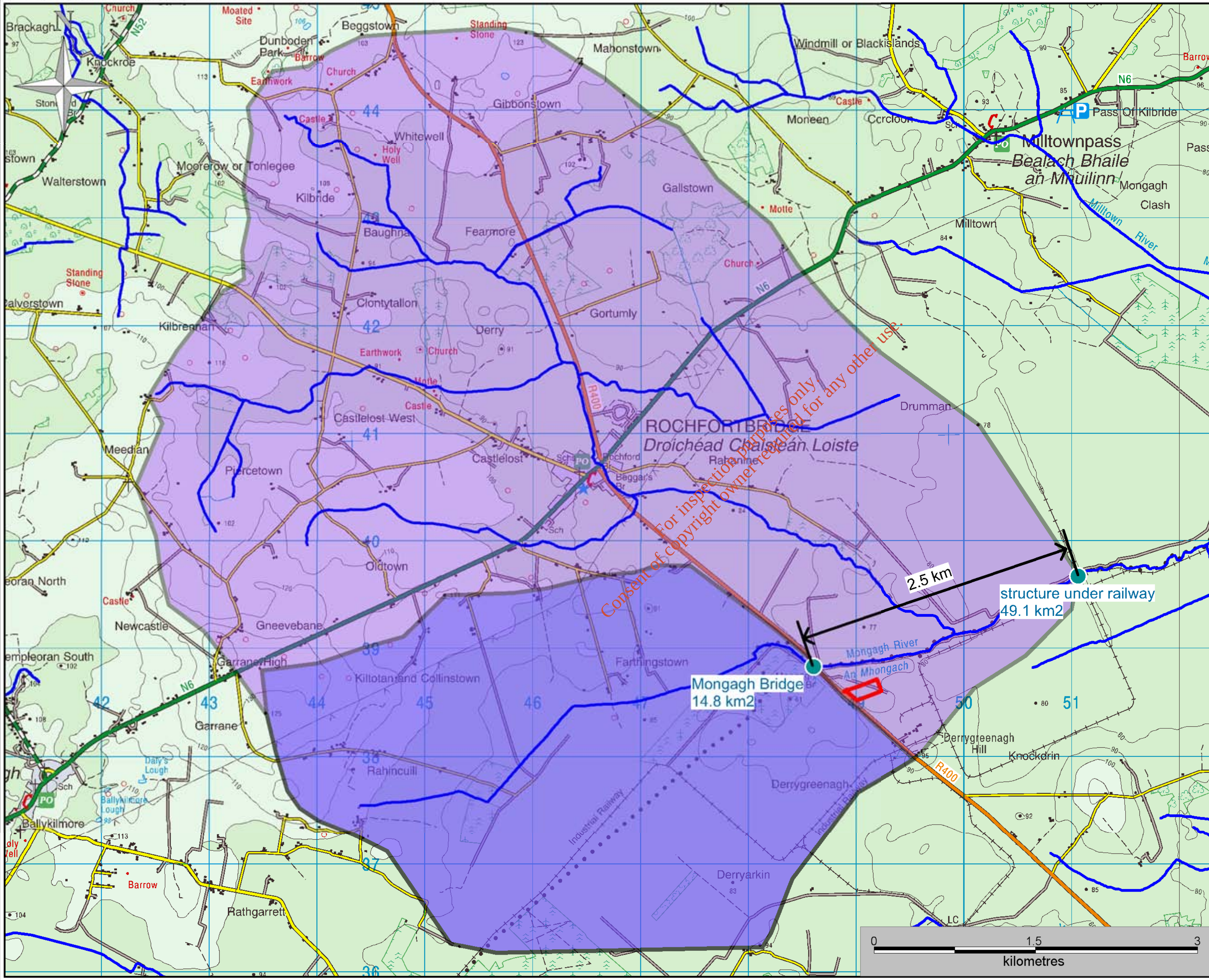
There are no protected sites, proposed Natural Heritage Areas (pNHAs), Special Areas of Conservation (SACs) or Special Protection Areas (SPAs) in the vicinity of the site. The nearest protected sites are shown in Figure 6-1 of Section 6 where they are discussed in greater detail.

The proposed development site is situated in an area of cutaway bog which is part of the Derrygreenagh group of bogs. The site is relatively flat and low-lying with existing levels on the site varying from c.77.0 mOD to 79.0 mOD. The site drains in a north easterly direction towards the Mongagh River, as shown in Figure 5-2.

There are a number of drainage ditches at the site remaining from the peat extraction activity which are now generally redundant, as shown in Figure 5-1.

Figure 5-1 Example of Existing Drainage Ditch

The average annual rainfall over a 30 year period is 931 mm (refer to Section 3.4) at Mullingar synoptic station which can be taken as indicative for the proposed site.



Legend

- site boundary

Catchments

- Mongagh Bridge
- structure under railway
- hydrological structure
- river / stream

Date	26/01/2010
Name of Client	Bord na Mona
Name of Job	Drumman EIS
Title of Figure	Mongagh Catchment Map
Scales Used	1 : 50,000 @ A4
Figure No.	5.2
Rev	A

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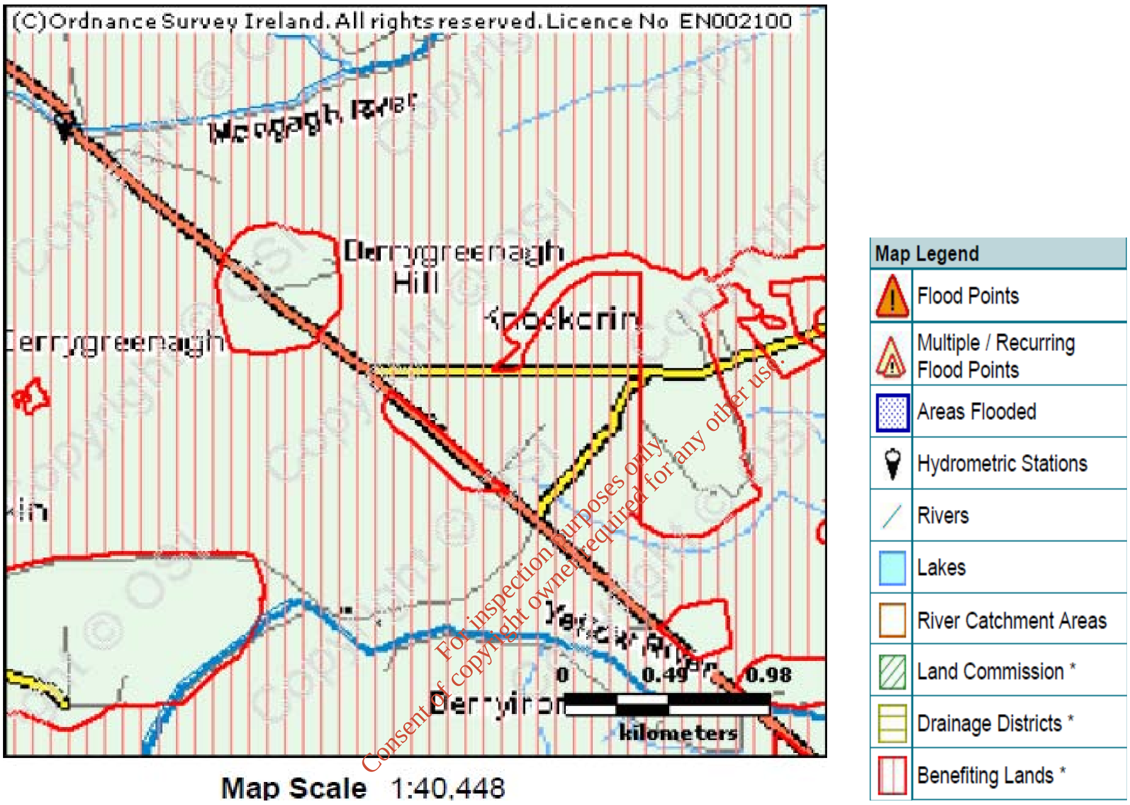
5.2.2 Flooding in the existing environment

The national flood hazard mapping website[17] does not indicate any history of flooding within 2.5 km of the proposed site to be developed at Drumman. This is illustrated in Figure 5-3 below. The lands in the vicinity of the site are identified by the OPW as benefitting lands i.e. lands that might benefit from the implementation of Arterial (Major) Drainage Schemes (under the Arterial Drainage Act 1945) and indicating areas of land subject to flooding or poor drainage. There are no incidents of flooding recorded in the vicinity of the site.

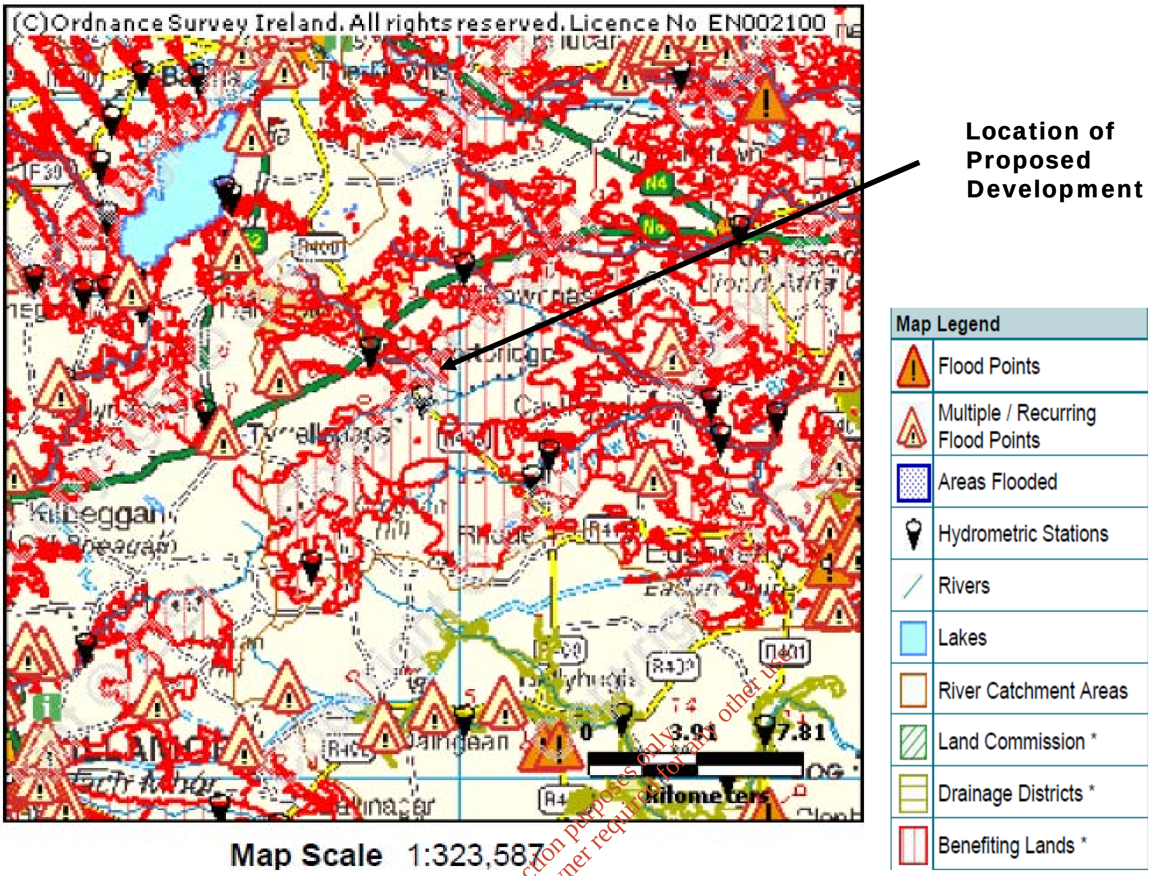
Figure 5-3 Floodmap report with 2.5 km of the site



The nearest incident of flooding recorded is at a distance of 18 km downstream in the River Boyne at Ballybogin Bridge, as shown in Figure 5-4 below. The River Boyne is crossed by the regional road R401 at this location. Downstream of the bridge, at Ballycowan, flooding has been reported in the floodplain of the River Boyne.

[17] www.floodhazardmapping.ie

Figure 5-4 Floodmap report within 20 km of the site



The incidence of flooding recorded at Ballyboggan Bridge and Ballycowan further downstream are at such a distance from the proposed site to be developed that it is not considered that the site would either be impacted by this flooding nor would it contribute to any significant increase in flooding at this location.

There is currently no catchment flood risk management plan (CFRMP) available for the River Boyne. Flood risk mapping is therefore currently not available for the River Boyne.

5.2.3 Existing Surface Water Quality

Water Framework Directive

The Water Framework Directive (2000/60/EC) was established by the European Community in 2000. This Directive was transposed into Irish legislation in December 2003 as the European Communities (Water Policy) Regulations 2003, (S.I. No 722 of 2003). The overriding purpose of the Water Framework Directive is to achieve at least ‘good status’ in all European waters by 2015 and ensure that no further deterioration occurs in these waters. European waters are classified as groundwaters, rivers, lakes, transitional and coastal waters. The Water Framework Directive has been implemented in Ireland by dividing the island of Ireland into eight river basin districts. The proposed facility is located in the Eastern River Basin District (ERBD).

The ERBD is home to approximately 40% of Ireland’s population, comprising a land area of approximately 6,500 km^2 and includes Dublin City and the towns which form the Greater Dublin Area and its commuter belt. The Eastern River Basin District incorporates all or part of twelve local authority areas: Dublin City, Offaly, Westmeath, Meath, Kildare, Wicklow, Cavan, Dun Laoghaire-Rathdown, Fingal, South Dublin and small portions of Wexford and Louth.

There are 356 river water bodies in the ERBD comprising of the river catchments of the Boyne, the Liffey, the Avoca/Varty and the Nanny/Devlin. The facility is located close to the Mongagh River, which is a tributary of the River Boyne. The waterbodies within the ERBD are divided into 'water management units' (WMU). The Mongagh River is incorporated into the WMU entitled 'Boyne Upper WMU' via the water body 'YellowTRIB_Castlejordan'.

A baseline risk assessment was completed of the water bodies within each River Basin District in 2005. Four types of pressures, created by human activities, were identified which can cause deterioration of water quality if not managed properly. These are:

- sewage and other effluents discharged to waters from point sources, e.g. outfall from treatment plant
- discharges arising from diffuse or dispersed activities on land
- abstractions from waters
- structural alterations to water bodies

Risk assessment procedures were developed to analyse the impact of these pressures on water bodies in the district. Four categories of risk were created to assess how sensitive the water bodies are from the pressures above.

- *Not at Risk:* Sufficient information is available to determine that the impact of the pressures on the water body is such that the water body is likely to achieve good status. In some cases monitoring data is available to confirm the good quality status of the water body. Measures must be considered here to ensure deterioration from good status does not occur. Approximately 2.3% of the catchment area of the ERBD falls under this category

- *Probably Not at Risk*: Sufficient information is not available at present to determine whether the water body is at risk of failing to meet good status. However, based on existing available data, it is probable that the water body will be found to be not at risk when further information becomes available. Approximately 23.6% of the catchment area of the ERBD falls under this category

- *Probably at Risk:* Sufficient information is not available at present to determine whether the water body is at risk of failing to meet good status. However, based on existing available data it is probable that the water body will be found to be at risk when further information becomes available. Approximately 25.5% of the catchment area of the ERBD falls under this category

- *At Risk*: Sufficient information is available to determine that the impact of pressures on the water body is such that the water body is unlikely to achieve good quality status unless measures are taken to reduce the impact, thereby improving the water quality. Approximately 48.6% of the catchment area of the ERBD falls under this category

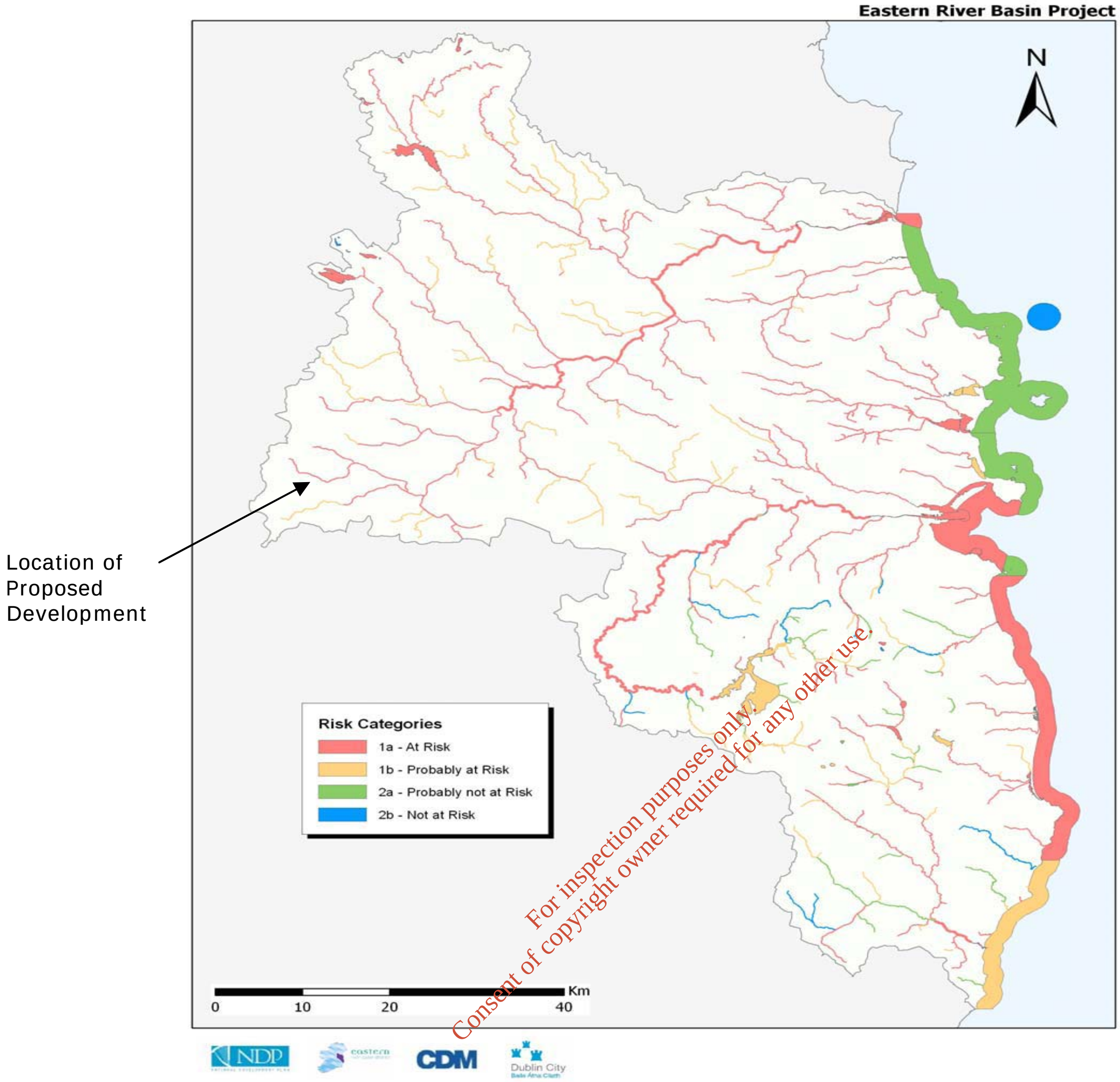
The results of this assessment indicate that the Mongagh River is 'at risk' of not achieving good status by 2015. The ERBD *River Basin Management Plan 2009-2015* currently classifies the 'YellowTRIB_Castlejordan' waterbody as having 'Poor Status' and the overall objective of the ERBD is to 'restore' the status of the river.

Article 4 of the Water Framework Directive permits extensions to the deadline of achieving 'good status' by 2015 under certain circumstances. The ERBD *River Basin Management Plan 2009-2015* lists the waterbodies which have an alternative target date for achieving 'good status'.

The Boyne Upper WMU is included in this list and is not expected to achieve "good status" until 2027 for the following reason:

- *Due to peatlands: naturally occurring ammonia. Diffuse agricultural and wastewater point source pollution. Extrapolated sub-catchments – need more data*

Figure 5-5 ERBD - River Water Bodies Risk Assessment Result (Source www.erbd.ie)



Biological Water Quality of Receiving Waters

The Q Index scheme was developed to determine the status of organic pollution in Irish rivers by assessing the occurrence of macroinvertebrate taxa of varying sensitivity to pollution. For the purposes of the scheme, macroinvertebrate taxa have been divided into five groups of varying sensitivity to pollution, as presented in Table 5-1.

Table 5-1 Macroinvertebrate Groups & Sensitivity to Pollution

Macroinvertebrate Group	Sensitivity to Pollution
Group A	Sensitive
Group B	Less sensitive
Group C	Tolerant
Group D	Very tolerant
Group E	Most tolerant

The composition of the macroinvertebrate community is assessed according to these groups and this is then used to derive a Q Index. The EPA scheme of Biotic Indices or Quality (Q) Values and their relationship to water quality are set out in Table 5-2 below.

Table 5-2 Biotic (Q) Indices

Q Value	Community Diversity	Water Quality	Condition[a]
Q5	High	Good	Satisfactory
Q4	Reduced	Fair	Satisfactory
Q3	Much reduced	Doubtful	Unsatisfactory
Q2	Low	Poor	Unsatisfactory
Q1	Very low	Bad	Unsatisfactory

[a] 'condition' refers to the likelihood of interference with beneficial or potential beneficial uses.

Intermediate indices Q1-2, 2-3, 3-4 and 4-5 are also used to denote transitional conditions. The scheme mainly reflects the effects of biodegradable organic wastes (deoxygenation and eutrophication).

Where a toxic effect is apparent or suspected the suffix '0' is added to the biotic index (e.g. Q 1/0, 2/0 or 3/0). Attention is sometimes drawn to siltation or atypical effects by appending an asterix to the biotic index. The scheme can be simplified as shown by the classification set out in Table 5-3.

Table 5-3: Intermediate Biotic (Q) Indices

Biotic Index	Quality Status	Quality Class
Q5, 4-5, 4	Unpolluted	Class A
Q3-4	Slightly polluted	Class B
Q3, 2-3	Moderately polluted	Class C
Q2, 1-2,1	Seriously polluted	Class D

Class A waters are those in which problems relating to existing or potential uses are unlikely to arise. They are therefore regarded as being in a satisfactory condition. Classes B, C and D are to a lesser or greater extent unsatisfactory in this regard. For example, the main characteristic of Classes B and C waters is eutrophication, which could interfere with the amenity, abstraction for water supply, or fisheries.

The closest EPA monitoring station to the proposed facility on the Mongagh River is at Baltinoran Bridge (07C040100) some 4 km downstream of the proposed facility location. Table 5-4 below outlines the Q Values measured at Baltinoran Bridge. There is no EPA monitoring stations on the Mongagh River upstream of the proposed facility although there are two other stations on the Rochfortbridge Stream and Castlejordan River (07C040060 & 07R040300), all downstream of the proposed development.

Table 5-4 Biological Quality Ratings (Q Values) (Source: www.epa.ie)

Sampling Stations		Q Values						
No.	**Location**	**1981**	**1985**	**1990**	**1994**	**1997**	**2000**	**2003**
0100	Baltinoran Br	4-5	3-4	4	3-4	3-4	4	3

Table 5-4 shows that in 2003 the water quality at Baltinoran Bridge can be described as moderately polluted (Q3). According to the EPA Water Quality Monitoring Report (2003), sewage from Rochfortbridge is suspected as the most likely cause of the moderate pollution of the river at Baltinoran Bridge in 2003.

Physio-Chemical Water Quality

The EPA does not have any chemical monitoring data for the Mongagh River and it should be noted that one of the reasons provided by the ERBD for exempting the river from achieving 'good status' in 2015 was due to lack of data.

Surface water sampling on the Mongagh River was therefore undertaken by FTC personnel on the 17th November 2009. Grab samples were taken from the Mongagh River upstream and downstream of the proposed facility at locations shown in Figure 3-3. The samples were sent to Alcontrol Laboratories for analysis. The results of the water quality monitoring of the Mongagh River is shown in Table 5-5.

Table 5-5 Surface Water Monitoring Results

Parameter	Unit	SW1 (Upstream)	SW2 (Downstream)
BOD	mg/l O	1.12	1.37
Phosphate (ortho as PO4)	mg/l	<0.0800	<0.0800
Ammoniacal Nitrogen as N	mg/l as N	0.456	0.33
Dissolved Oxygen	mg/l	6.4	6.8
Temperature	°C	9.2	9.3
pH	pH units	7.82	7.6
COD	mg/l O	40.6	47.4
Nitrite	mg/l	0.098	0.105
Nitrate	mg/l	11.4	9.12
Total Organic Carbon	mg/l	17.9	19.9
Sulphate (soluble)	mg/l	64.5	74.9
Conductivity (at 20 deg.C)	mS/cm	0.664	0.661
Chloride	mg/l	16.9	14.7
Total Alkalinity Filtered as CaCO3	mg/l	317	301
Total Oxidised Nitrogen as N	mg/l	2.6	2.09
Mercury Dissolved	µg/l	<0.0100	<0.0100
Calcium Dissolved	mg/l	158	189
Sodium Dissolved	mg/l	8.94	10.8
Magnesium Dissolved	mg/l	8.17	9.04
Potassium Dissolved	mg/l	4.03	2.92
Iron Dissolved	mg/l	<0.0190	0.231
Cadmium Dissolved	µg/l	<0.220	<0.220
Chromium Dissolved	µg/l	6.63	6.95
Copper Dissolved	µg/l	2.88	2.6
Lead Dissolved	µg/l	<0.400	<0.400
Manganese Dissolved	µg/l	122	156
Nickel Dissolved	µg/l	8.36	6.83
Zinc Dissolved	µg/l	17.3	5.87
Total coliform	No./100ml	804	510
Faecal coliforms	No./100ml	108	55

Table 5-6 compares the background measured water quality in the Mongagh River to the environmental quality standards outlined in Table 9 of the European Communities Environmental Objectives (Surface Waters) Regulations 2009 (SI No. 272 of 2009) assuming 'good status'.

Table 5-6 Background versus 'Good Status' Water Quality

Parameter	Unit	SW1 (Upstream)	'Good Status' 95%ile
BOD	mg/l O	1.12	2.6
OrthoPhosphate	mg/l P	<0.026	0.075
Total Ammonia	mg/l N	0.554	0.14

As can be seen from the table above, concentrations of BOD and Orthophosphate in the Mongagh River upstream of the proposed facility are well below the 95%ile environmental quality standard for a river with 'good status'. The background concentrations of these parameters are also below the mean quality standards for a river of 'good status' (BOD 1.5 mg/l and Orthophosphate 0.035 mg/l P).

Table 5-6 shows that the background ammonia concentration in the river is quite high. The ERBD *River Basin Management Plan 2009-2015* states that this ammonia is naturally occurring due to the peatlands in the area.

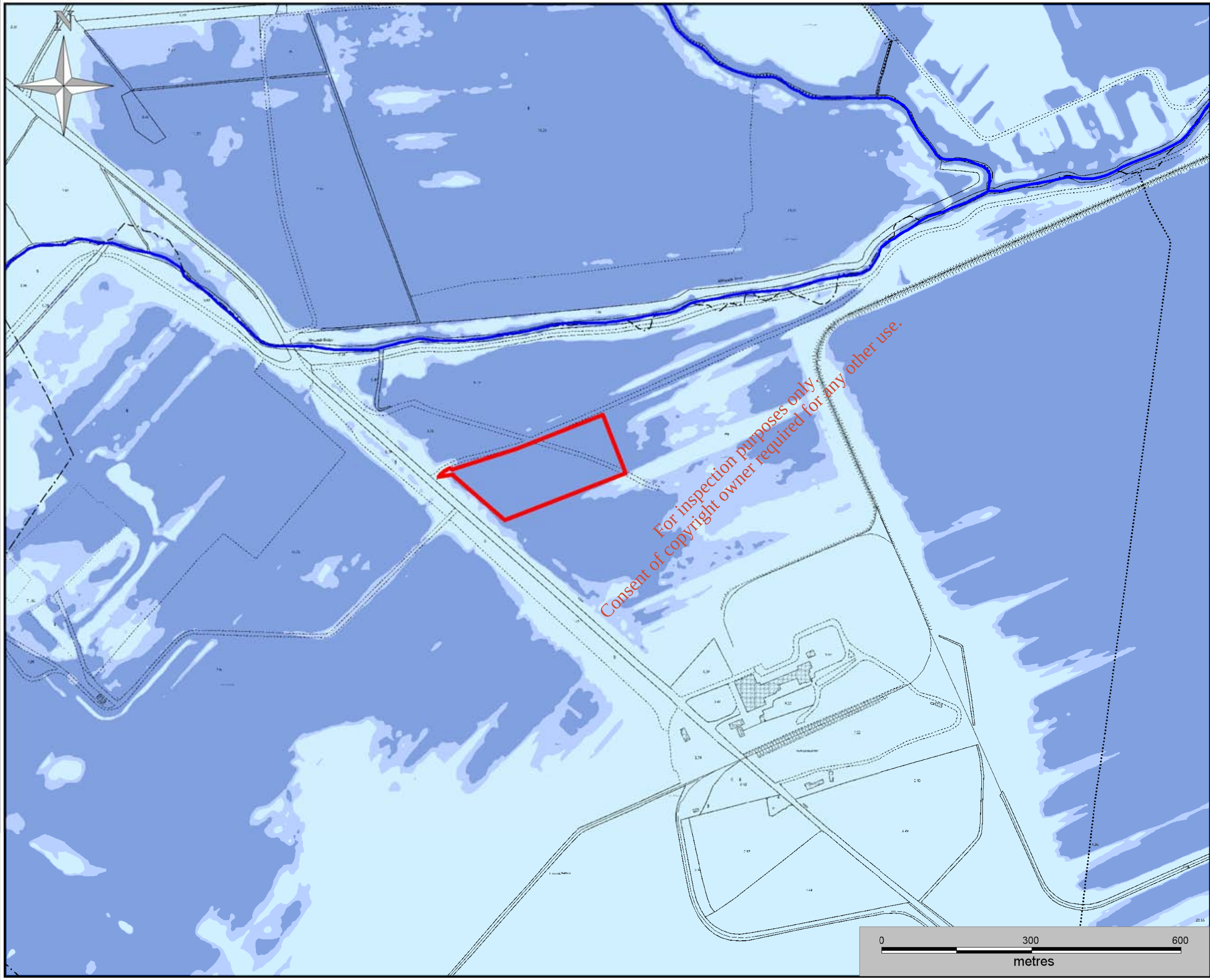
5.3 Flood Risk Assessment

The flood risk assessment, included in Appendix 8, examines the flood levels that could be expected in severe storm events in the Mongagh catchment i.e. in a 1 in 100 year flood event and a 1 in 1000 year flood event. The assessment took account of an increase in flows of 20 % to allow for climate change. A flood zone map was prepared for the flood risk assessment in the vicinity of the site indicating the flood zones as described in the Planning System and Flood Risk Management Guidelines (refer to Figure 5-6).

Lidar survey data and a preliminary site topographical survey were used to determine the levels across the site. It was found that the site is within Flood Zone A and the site would be inundated in a 1 in 100 year event. The flood level determined for this event was 77.95 m OD. The flood level will impact on the design of the proposed buildings and overall site layout in terms of the general site level and building finished floor levels.

As part of the flood risk assessment, two structures were examined on the Mongagh River:

- Structure 1 - Mongagh Bridge and
- Structure 2 – a box culvert 2.5 km downstream of Structure 1 under an old bog railway



Legend

- site boundary
- river / stream

Flood Zones

- A
- B
- C

Date	26/01/2010
Name of Client	Bord na Mona
Name of Job	Drumman EIS
Title of Figure	Flood Zone Map
Scales Used	1 : 10,000 @ A4
Figure No.	5.6
Rev	A

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Figure 5-7 Structure 1, Mongagh Bridge (upstream view) – 3000mm culvert

Figure 5-8 Structure 2, 2.5 km downstream, upstream view -3300 mm box culvert

Further views of these structures are presented in the Flood Risk Assessment Report (Appendix 8).

Structure 1 is a culvert measuring c. 3000 mm diameter. The catchment of the Mongagh River at this point was estimated, as shown in Figure 5-2 and flows for 1 in 100 year and 1 in 1000 year events were determined. These flows were modelled in the structure using Culvert Master Software (by Haestad) to determine the expected flood level from these events.

Structure 2 is a box culvert with dimensions c. 3300 mm wide x 3300 mm high. The catchment is increased considerably at the location of this structure as a tributary of the Mongagh River joins the river upstream of the structure. The flow for a 1 in 100 year event was determined and modelled in this structure using Culvert Master Software to determine the expected flood level from this event.

As the proposed development is downstream of the Mongagh Bridge the estimated rise in the flood level was determined by adding the predicted unattenuated flows from the development to the flows entering the downstream structure. The impact of the assessment on Structure 2 was that;

- existing flows in a 1 in 100 year flood event would surcharge by 110 mm above the soffit of the structure
- the river level would rise by an estimated 20 mm as a result of the proposed development for this event. This would occur if the flows from the development were not attenuated.

A summary of the results for the 1 in 100 year event in the model in the downstream structure follows in Table 5-7.

Table 5-7 Summary of Flows and Flood Levels Determined for 1 in 100 year event

Structure	1 in 100 year flow + Climate Change allowance	1 in 100 year flood level	1 in 100 year flow due to proposed development	1 in 100 year flood level including proposed development	Estimated increase in flood level due to development
	M^3/s	M	M^3/s	M	M
Structure 2	31.484	76.70	0.32	76.72	0.02

The increased flow due to the development amounts to 1% and this could have the effect of increasing the river flows by 20 mm. The calculations assume a confined channel and in reality there is some floodplain available along the river banks, therefore the 20 mm estimated is a maximum rise as a result of the development. Although this increase is considered to be of low significance, it is proposed to attenuate the flows running off the site to greenfield rates as it was determined that flooding would occur at the downstream structure in a 1 in 100 year flood event for existing flows.

5.4 Proposed Development

The site layout is presented in Figure 2.4 and the main site elements consist of the waste reception and processing building, the bale storage building, administration building, weighbridge facilities, skip and trailer storage areas and truck and staff parking at the entrance to the site. Marshalling areas to the front and rear of the waste reception and processing building allow for the movement of vehicles throughout the site and to access different areas of the building. The footprint of the waste reception and processing building is 6,810 m^2, the bale storage building 978 m^2 and the administration building 430 m^2. It is proposed to harvest the rainwater from the roof of the waste reception and processing building. Effluent treatment will be provided for the washdown from the waste reception and processing building and from the administration building. The area within the boundary of the site is 3.22 ha. Where possible, areas will be landscaped and permeable and it is estimated that 85 % of the proposed site will consist of impermeable surfaces. This will amount to c. 2.75 ha of impermeable surfaces.

5.5 Potential Hydrological Impacts

5.5.1 Potential Hydrological Impact from the proposed development

The principle hydrological impact from the proposed development is an increase in run-off. It has been established that the increase in flow as a result of the proposed development is approximately 1 % and is determined to be of low significance. A secondary hydrological impact for consideration is a decrease in water quality in the receiving waters. The impacts due to the elements of the proposed development are set out in Table 5-8.

Table 5-8 Potential Hydrological Impacts from the proposed development

Description of Areas	Potential Impact	Construction Phase	Operational Phase	Decommissioning
Administration Bldg	Increase in run-off	low	low	low
	Increase in suspended solids	medium	low	medium
Staff parking Area	Increase in run-off	low	low	low
	Increase in suspended solids	medium	low	medium
Weighbridge Area	Increase in run-off	low	low	low
	Increase in suspended solids	medium	low	medium
	Increase in hydrocarbons in run-off	low	medium	low
Truck parking Areas	Increase in run-off	low	low	low
	Increase in suspended solids	medium	low	medium
	Increase in hydrocarbons in run-off	low	medium	low
Access roads	Increase in run-off	low	low	low
	Increase in suspended solids	medium	low	medium
	Increase in hydrocarbons in run-off	low	medium	low
	Increase in pollution due to accidental spills	medium	medium	medium
Materials Reception & Processing Building	Increase in run-off	low	low	low
	Increase in suspended solids	medium	low	medium
Marshalling Areas	Increase in run-off	low	low	low
	Increase in suspended solids	medium	low	medium
	Hydrocarbons in run-off	low	medium	low
	Pollution due to accidental spills	medium	medium	medium

Table 5-8 indicates that elements of the proposed development have the potential to cause a hydrological impact on the receiving environment. Mitigation measures are proposed in the following sections to reduce and eliminate these impacts.

5.5.2 Potential Cumulative Hydrological Impacts from other developments in the area

Cumulative hydrological impacts as a result of other developments in the vicinity of the proposed site location were examined as part of the flood risk assessment. The neighbouring developments considered were:

- the proposed power plant at the adjacent Derrygreenagh Works site
- the Derryarkin Sand and Gravel development
- the M6 motorway within the catchment of the Mongagh River considered for this study

Proposed Power Plant

Proposals for the attenuation of surface water from the proposed power plant have been submitted as part of the planning application process currently ongoing. It is proposed to fully attenuate the flows for a 1 in 100 year storm event in accordance with GDSDS Guidelines prior to discharge to the Mongagh River via a pipeline and open drain. All oils and other chemicals will be bunded. Foul and process waters will receive separate treatment. Mitigation methods will be implemented for the reduction of suspended solids during the construction period.

Derryarkin Sand and Gravel

Surface water management at the Derryarkin Sand and Gravel site is via a large surface water lagoon which provides for a reduction in suspended solids and attenuation of the surface water generated onsite. There are no direct discharges to watercourses from this site.

M6 Motorway

In terms of the surface water management employed along M6 motorway, the environmental impact statement produced in relation to that development identifies the means by which surface water is managed along the route.

It states: '*it has been decided in the case of the N6 to allow surface run-off in most cases from the carriageway to side drains constructed parallel to and at either side of the road. On this case, water will infiltrate into the overburden along with dissolved contaminants, much of which would be expected to absorb to soil….if these are made sufficiently wide they will increase the hydraulic retention within the system'.*

In addition, it is identified that the surface water drains will be *'widened at 5 key outlets to form linear wetlands with shallow standing water and be planted with reeds and other common aquatic plants in order to facilitate contaminant entrainment and adsorption.'*

One of the key outfalls identified for the development of a wetland is the Milltownpass Stream which flows to the Mongagh River. The Miltown Pass Stream joins the Mongagh River approximately 3 km downstream of the Drumman location.

The impact of the unattenuated run-off from the above neighbouring developments, together with the proposed development at Drumman is assessed in the flood risk assessment report. This assessment was undertaken to determine the impact of a failure in the attenuation facilities in each of the developments. It was concluded that only the cumulative impact from the proposed Derrygreenagh Power Station and the proposed MRF at Drumman could be considered. The M6 motorway drains to filter drains which detain the flows entering the receiving watercourses and there are no direct discharges from the Derryarkin Sand and Gravel site. In the worst case scenario, a model of the cumulative impact of unattenuated drainage from the developments at the proposed Derrygreenagh power station and the proposed Drumman facility resulted in a flood level rise in the structure 2.5 km downstream of Mongagh Bridge of 70 mm over the existing flood level. This is considered to be of low significance as the model does not take into account the available flood plain along the banks of the Mongagh River.

5.5.3 Potential Impacts on Water Quality due to discharge of treated effluent during operations

Section 5.6 describes the surface water drainage system of the proposed facility. Wastewater will be produced on site from the welfare facilities (e.g. toilets, showers, canteen) and from washdown within the waste reception and processing building.

The wastewater will be treated on site in a proprietary wastewater treatment plant (Puraflo) and discharged to the Mongagh River. It is proposed that the effluent receive secondary treatment to a standard of 20:30 (BOD mg/l: Suspended Solids mg/l) as per 'BS6297 The Code of Practice for the Design and Installation of Small Sewage Treatment Works and Cesspools'.

It is assumed that, once operational, there will be approximately 30 - 35 no. staff working at the facility. The wastewater loading was calculated using the 'EPA Wastewater Treatment Manual, Treatment Systems for Small Communities, Business, Leisure Centres and Hotels' for an industrial office and/or factory with canteen:

- Flow - 60 l/day per person
- BOD – 30 g/day per person

The individual areas of the waste reception and processing building will be washed down at different intervals depending on the level of contamination of the waste being sorted within the areas. For the purposes of sizing the onsite WWTP, the maximum flow from the building will occur when all three areas are washed down on the same day. It is assumed that it will take approximately 2 hours to wash down the building with a standard hose with a flow rate of 1 l/s. The maximum flow to the onsite wastewater treatment plant and subsequently discharging to the Mongagh River is therefore estimated as 9,000 l/day.

The assimilative capacity of a river determines the maximum discharge that can be tolerated by the river without deteriorating the quality of the river water. To estimate the assimilative capacity of a freshwater river, to determine if the receiving waters can absorb the wastewater discharge, the following formula18 is used:

$$\textbf{Assimilative capacity [kg/day]} = (C_{max} - C_{back}) \times F \times 86.4$$

Where

C_{max} = maximum permissible concentration [mg/l] based on legislative standards and design guides
C_{back} = background (upstream) concentration [mg/l]
F = the flow in the receiving waters [m^3/s]
86.4 = conversion factor.

Calculations were done to determine the impact of the discharge of the treated effluent on the receiving waters if the wastewater treatment plant was designed for a throughput flow of 9,000 l/day and was operating at full capacity. These calculations were done using the mass balance equation. This calculates the predicted concentration of a parameter in the stream downstream of the outfall, based on the concentration of the parameter in the effluent and in the river upstream of the outfall. These calculations were limited to assessing the impact of the treated effluent on the river with respect to three parameters: Biochemical Oxygen Demand (BOD), Orthophosphate and Ammonia.

The flow in the river was obtained from the register of hydrometric stations maintained by the EPA on their website. This register provides hydrometric data from gauging stations located on rivers and streams throughout the country. An active gauging station exists just upstream of the proposed development on the Mongagh River. Details from the gauging station are provided in Table 5-9 below.

[18] National Urban Waste Water Study, Volume 2, Part A, Methodology, *5. Assimilative Capacity of Receiving Waters.*

Table 5-9 Flow in the Mongagh River

Station Number	Station name	River	Catchment Area (km²)	95 Percentile Flow (m³/s)	Dry Weather Flow (m³/s)
07028	Derrygreenagh	Mongagh	15	0.03	0.015

BOD

The BOD assimilative capacity was calculated on the basis that the maximum BOD concentration in the river is limited to 2.6 mg/l as described previously and the 95 percentile flow. The effluent BOD was taken to be 20 mg/l at the outfall.

The followings figures were calculated:

Background BOD Concentration	=	*1.12 mg/l*
BOD Assimilative Capacity of Receiving Waters	=	*3.84 kg/day*
BOD Load Discharged from the plant	=	*0.18 kg/day*
% of A.C. consumed	=	*4.68%*
Estimated Downstream BOD concentration	=	*1.19 mg/l*
% increase in BOD in receiving waters	=	*5.8%*

Therefore, in terms of BOD, the assimilative capacity of the receiving waters is sufficient to cater for the proposed discharge and the impact is not significant with a BOD increase of 5.8%. The estimated downstream concentration of BOD (1.19 mg/l) is below the allowable 95 percentile concentration for a river waterbody with 'good status' (2.6 mg/l). It is also below the allowable mean concentration for a river of 'good status' (1.5 mg/l).

Orthophosphate

The Orthophosphate (OP) assimilative capacity was calculated on the basis that the maximum OP concentration in the river is limited to 0.075 mg/l as described previously and the 95 percentile flow. The effluent OP was taken to be 2 mg/l at the outfall.

The followings figures were calculated:

Background OP Concentration	=	*0.026 mg/l P*
OP Assimilative Capacity of Receiving Waters	=	*0.13 kg/day*
OP Load Discharged from the plant	=	*0.018 kg/day*
% of A.C. consumed	=	*14.17%*
Downstream OP concentration	=	*0.033 mg/l*
% increase in OP in receiving waters	=	*26.3%*

In terms of OP, the assimilative capacity of the receiving waters is sufficient to cater for the proposed discharge and the estimated downstream concentration of OP (0.033 mg/l) is below the allowable 95 percentile concentration for a river waterbody with 'good status' (0.075 mg/l). It is also below the allowable mean concentration for a river of 'good status' (0.035 mg/l).

Ammonia

The background concentration of Ammonia in the Mongagh River is higher than the allowable 95 percentile concentration in a river waterbody with 'good status' as discussed previously; therefore the assimilative capacity of the river could not be assessed.

Mass Balance calculations have been carried out to establish the impact of the effluent on the ammonia concentration in the receiving waters. These figures can be summarised as follows:

95%ile Flow in Receiving Waters	=	*30 l/s*
Estimated Discharge Volume (at outfall)	=	*0.1 l/s*
Background Ammonia Concentration	=	*0.554 mg/l*
Ammonia Concentration in Effluent	=	*2 mg/l*
Estimated Downstream Ammonia concentration	=	*0.559 mg/l*
% increase in Ammonia due to Effluent	=	*0.9%*

The ammonia concentration in the receiving waters will be increased from 0.554 mg/l to 0.559 mg/l. This equates to a 0.9% increase in ammonia concentrations at 95 percentile flow. This is an insignificant increase and no appreciable impact will be caused by the effluent on the receiving waters with respect to ammonia.

Analysis

The above calculations conclude that the assimilative capacity of the receiving waters with respect to BOD and Orthophosphate is adequate to cater for the proposed discharge. The receiving waters have been found to contain elevated levels of naturally occurring ammonia.

However, given the flows in the river and the associated dilution available, the proposed discharge will have a negligible effect on these concentrations.

On the basis of the assimilative capacity calculations outlined, it is concluded that the proposed discharge from the development at Drumman will have a negligible impact on the quality of the Mongagh River.

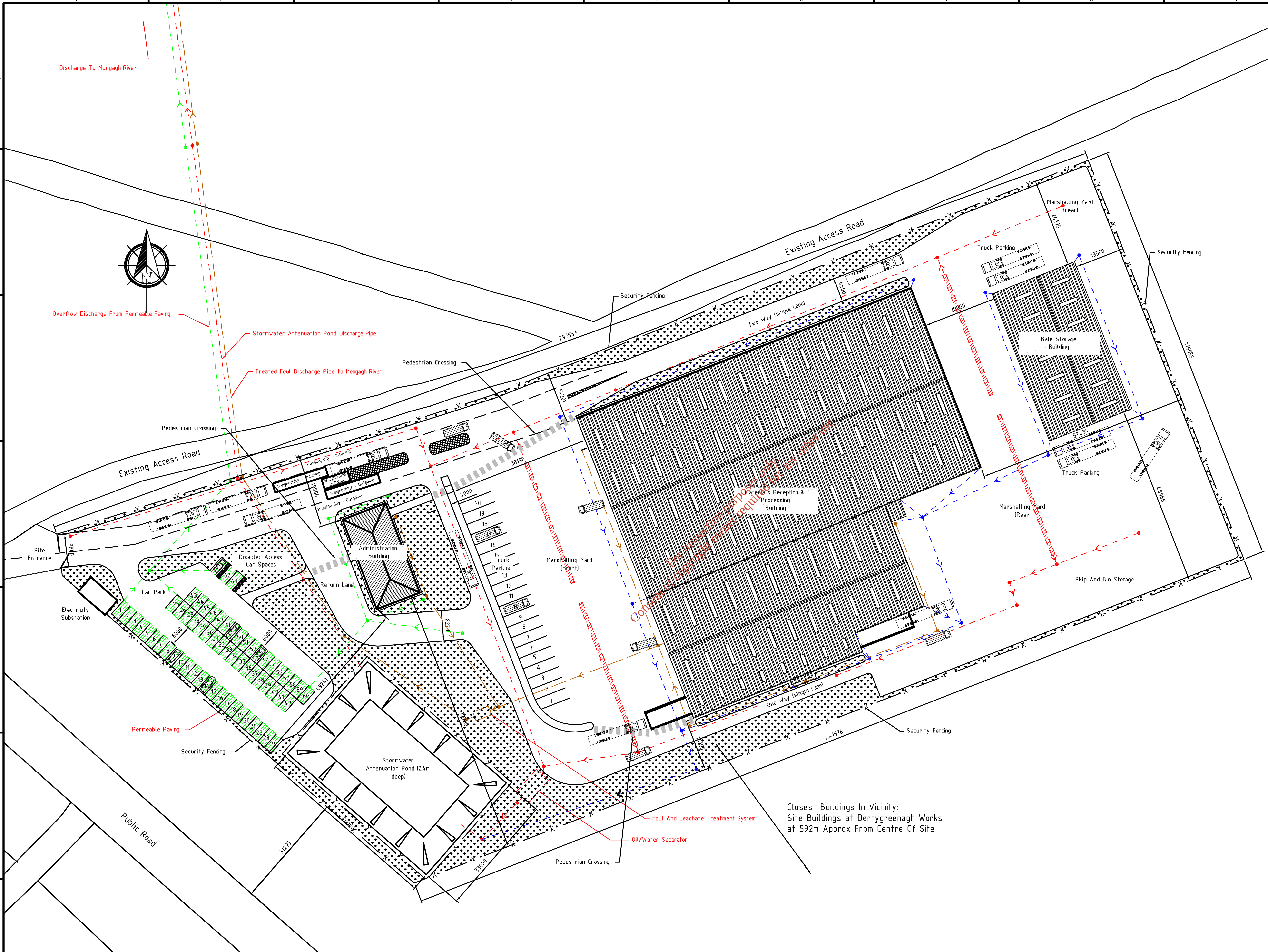
5.6 Proposed Surface Water Management

The management of surface water at the proposed facility was informed by the flood risk assessment report (refer to Appendix 8). Management of surface waters will be provided through attenuation of the surface water run-off from the site. The surface water management system will be designed to reduce the potential impacts of the proposed development on the receiving environment, as outlined in Table 5-8.

It is proposed to install an attenuation pond as a first element of construction of the proposed development. The attenuation pond will provide for the full attenuation of a 1 in 100 year event at the site in accordance with the Greater Dublin Strategic Drainage Study (GDSDS) guidelines.

The preliminary design calculations for the attenuation pond are included in Appendix 8. The live volume required for attenuation of the surface water run-off from the site for a 1 in 100 year storm event is 1407 m^3. During detailed design, hydrological design assumptions will be reassessed and verified in the event of any alteration to site layout or design.

The attenuation pond will be located to the southerly corner of the site. The proposed drainage layout is shown in Figure 5-9.



SURFACE WATER AND FOUL COLLECTION SYSTEMS LAYOUT PLAN

Scale 1:1000

NOT FOR CONSTRUCTION UNLESS SPECIFICALLY STATED OTHERWISE

Do not scale. Use figured dimensions only. If in doubt - Ask!

LEGEND

Surface Water From Roads And Hardstandings

Surface Water From Building Roofs

Surface Water From Permeable Paving

Foul And Leachate Collection And Treatment

Rev.	Drawn	Chk'd	App'd	Rev Origin / Date	Description
A				Cork 25.02.10	ISSUE FOR EIS

Revision History A

Name of Client

Bord na Mona PLC

Name of Job

Drumman Project

Title of Drawing

Proposed Surfacewater and Foul Collection Systems Layout Plan

Scales Used 1:1000

This Drawing was printed to A3

Dwg. No. LW09-660-04-Figure 5.9

Rev. A

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ORIGINAL DRAWING SIZE A1 - (841 x 594)

During consultation with Offaly County Council, it was recommended that permeable paving be considered in the design of the surface water system on site. This would allow for some recharge into the groundwater on site. The most suitable area to provide permeable paving is the staff car park. The potential for infiltration at this location will be examined at detail design stage using the recommended method in BRE 365. If infiltration tests prove to be inadequate at this location, then gullies will be provided in the staff car park and the drainage connected into the main drainage system as shown in the drainage layout.

The roof water from the Administration Building and the Waste Reception and Processing Building will be connected into the drainage system as shown on the layout drawing. Rainwater harvesting is also proposed for the materials reception and processing Building. The design of the rainwater harvesting system will be confirmed during detailed design. In any event, the surface water drainage pipework will be designed to take the full flow from the roofs of all buildings.

The access roads, the truck parking areas and the marshalling areas will all pass via hydrocarbon interceptors and silt traps before discharging to the attenuation pond.

The ERFB will be consulted prior to the construction of the discharge pipe from the attenuation pond. The discharge pipe will be laid in accordance with the ERFB guidance document 'Protection of Fisheries Habitat during Construction and Development Works at River Sites'.

The attenuation pond will be fenced off with lockable gates and warning signs and lifebuoys provided.

5.7 Mitigation Measures

5.7.1 Mitigation Measures during construction

The mitigation measures proposed during the construction phase are outlined as follows and include measures to prevent runoff, erosion from vulnerable areas and consequent sediment release into the nearby watercourses receiving flow from the proposed development site. These measures are described in more detail below.

- The ground preparation for the development will initially require the excavation of the peat layer throughout the site. This peat layer will be formed into landscaped peat berms throughout the site. The gravel layer below the peat layer will be infilled with good quality stone. During the period of ground preparation, this could lead to an increase in silt-laden run-off draining off site. Silt fencing will be provided to protect existing drains and the river bank to the north of the site, see Appendix 8 for details of silt fencing.

- The attenuation pond and discharge pipe will be installed in advance of construction. The attenuation pond will also provide for sediment removal.

- Construction activities will be located away from watercourses as far as possible. The contractor will ensure that trafficking on site is kept to a minimum and the routes of haul roads are kept away from watercourses as far as possible. Where haul roads pass close to watercourses, silt fencing will be used to protect the streams. Wheel washing facilities will be provided at the site entrance draining to silt traps. Additional silt fencing will be kept on site in case of an emergency break out of silt laden run-off.

- The contractor shall ensure that erosion control and attenuation facilities, namely sediment/silt-traps and ponds are regularly maintained during the construction phase. The contractor shall ensure that all personnel working on site are trained in pollution incident control response. During the construction period, it is envisaged that a facility to shut off the outfall from the attenuation pond during an emergency will be provided. This will mitigate any accidental spillage on site impacting on the watercourse and the size of the ponds (designed for a 1 in 100 year return flood event) will allow sufficient time to arrange for cleaning up the relevant pollutant in the attenuation pond. In addition, appropriate signage will be placed on site outlining the spillage response procedure and a contingency plan to contain silt. A regular review of weather forecasts of heavy rainfall is required and the contractor is required to prepare a contingency plan for before and after such events.

- Standing water in the excavations will contain an increased concentration of suspended solids as a result of the disturbance to the underlying soils below the peat. The excavations will be pumped into temporary settlement basins which will be lined and which will drain to the attenuation pond.

- The contractor will carry out visual examinations of watercourses receiving flows from the proposed development during the construction phase and regular water samples will be taken.

- Any diesel or fuel oils stored on site will be bunded to 110 % of the capacity of the storage tank. Design and installation of fuel tanks to be in accordance with best practice guidelines BPGCS005, oil storage guidelines. Refuelling of plant during construction will be carried out on a designated concrete pad, away from watercourses, draining to an oil interceptor. Drip trays and spill kits will be kept available on site. Only emergency breakdown maintenance will be carried out on site. Appropriate containment facilities will be provided to ensure that any spills from the vehicle are contained and removed off site.

- Portaloos will be used to provide toilet facilities for site personnel. Sanitary waste will be removed from site via a licenced waste disposal contractor.

- If wet concrete operations are required within or adjacent to watercourses, a suitable risk assessment should be completed prior to works being carried out.

5.7.2 Mitigation Measures during operation

When operational, the development will have a negligible effect on surface water quality due to sedimentation as there will be no further disturbance of soils post construction. During the operational phase, small quantities of oil will be used in operations. There is potential for oil spills, but they are not likely to be significant, should they occur. A full retention petrol interceptor will be provided to remove hydrocarbons from the run-off coming from any areas at risk, see the proposed drainage layout in Figure 5-9.

The foul water emanating from the proposed development will be subject to secondary treatment in a proprietary onsite wastewater treatment plant prior to discharge to the Mongagh River. The flow from the WWTP will be sampled regularly in accordance with the requirements of the facility waste licence to ensure the plant is operating to the required standard.

The maintenance of the drainage system will include for the activities associated with keeping the system operating effectively. The operator will have the responsibility for maintaining the drainage system. The maintenance regime will include:

- inspecting manholes for any blockages
- inspecting outfalls to watercourses
- inspecting the ponds and testing the water quality at the outfalls as per licence requirements

Maintenance shall be in accordance with CIRIA C697 SuDS and Maintenance Manual and the WWTP maintenance manual. Weekly inspections will be required during the construction phase with periodic assessment as required during the operational phase.

5.8 Residual Hydrological Impacts

The potential hydrological impacts are examined again in Table 5-10 to establish if any residual impacts remain following mitigation.

Table 5-10 Residual Hydrological Impacts

Description of Areas	Potential impact	Construction Phase	Operational Phase	Decommissioning
Administration Bldg	Increase in run-off	low	low	low
	Increase in suspended solids	low	low	low
Staff parking Area	Increase in run-off	low	low	low
	Increase in suspended solids	low	low	low
Weighbridge Area	Increase in run-off	low	low	low
	Increase in suspended solids	low	low	low
	Increase in hydrocarbons in run-off	low	low	low
Truck parking Area	Increase in run-off	low	low	low
	Increase in suspended solids	low	low	low
	Increase in hydrocarbons in run-off	low	low	low
Access roads	Increase in run-off	low	low	low
	Increase in suspended solids	low	low	low
	Increase in hydrocarbons in run-off	low	low	low
	Increase in pollution due to accidental spills	low	low	low
Materials Reception and Processing Building	Increase in run-off	low	low	low
	Increase in suspended solids	low	low	low
Marshalling Areas	Increase in run-off	low	low	low
	Increase in suspended solids	low	low	low
	Increase in hydrocarbons in run-off	low	low	low
	Increase in pollution due to accidental spills	low	low	low
WWTP	Compromise the quality of receiving water	low	low	low

Table 5-10 indicates that all potential hydrological impacts have been addressed with the mitigation measures proposed. The degree of confidence in mitigation measures preventing a significant release of silt into the neighbouring watercourses lies in the adoption of all of the mitigation measures outlined previously.

The adoption of these mitigation measures will ensure that any potential impacts on the receiving environment will be insignificant

5.9 Conclusion on Hydrology & Water Quality

The surface water hydrology impacts of the proposed materials recycling & waste transfer facility development at Drumman affect both the surface water runoff and the existing water quality of the receiving waters of the River Mongagh. During construction, there is potential for an increase in the sediment load to the watercourse during works for the excavation of peat and ground infill and preparation for roads/site-tracks, buildings and hard-standing areas. The impact on hydrology and water quality during construction will be mitigated by the use of silt fencing initially and then an appropriately sized attenuation/settlement pond and additional mitigation measures. Management of surface water runoff from the project will include attenuation of the increased surface water runoff and settling of suspended solids. This will be achieved by directing all runoff from the site through the attenuation/settlement pond. Permeable paving may be considered for the staff car park if ground conditions are deemed suitable. A proprietary wastewater treatment plant will treat washdown water and administration building foulwater to an appropriate standard prior to discharge to the Mongagh River.

A flood risk assessment was carried out for the proposed development at Drumman, Co. Offaly. Existing structures on the Mongagh River were assessed for their capacity to take the 1 in 100 year flood. It was found that in the existing situation the structure downstream of the development would surcharge for this flood event. A marginal increase in surcharge would occur as a result of the increased run-off from the development for the same event. The combined increase in run-off from an adjacent development would also only amount to a marginal increase in surcharge at the structure.

The flood risk assessment found that, without any mitigation measures, the proposed development would not result in a significant increase in flood risk in the downstream receptors. However, attenuation of the surface water run-off from the site is recommended as an extreme event would cause surcharge through the downstream structure in the existing pre-development situation. An attenuation pond is proposed as part of the drainage infrastructure for the proposed development.

The proposed drainage layout was informed by the results of the flood risk assessment. The drainage layout therefore incorporates mitigation measures for the attenuation of surface water flows from the development to greenfield (pre-development) rates. A high degree of confidence in the success of this method of mitigation can be expected, provided the pond is installed correctly and maintained regularly.

The design of the mitigation measures as detailed in the proposed drainage layout will be adopted to minimise any residual flood risk downstream of the site.

The civil contractor shall have responsibility for ensuring that all the mitigation and maintenance measures included in the proposed drainage layout and detailed in the surface water management plan to be prepared prior to construction are put in place. Water quality monitoring will also be the responsibility of both the contractor and the developer.

The contractor will prepare an emergency plan which will include the requirement for the shutting off of the outfall from the pond during the construction period when very heavy rain is forecasted.

The pond will be installed in advance of the rest of the development infrastructure. All silt fencing as required will be installed in advance of the works. The residual significance rating of the effect of the development on the receiving watercourses after mitigation is indicated in Table 5-10. The residual significance is considered to be low.

6 FLORA & FAUNA

6.1 Introduction

An ecological assessment of the proposed facility was carried out by Fehily Timoney and Company (FTC). FTC carried out a variety of ecological surveys at the site, including habitat, botanical and mammal surveys in January 2010, using standard ecological survey techniques (*e.g.* Lawrence & Brown, 1973; Clark, 1988; Institute of Environmental Assessment, 1995; Smal, 1995; Sargent & Morris, 2003; Bang & Dahlstrom, 2004; JNCC, 2004; The Heritage Council, 2005; Sutherland, 2006). The survey area comprised the wider Drumman site of approximately 21 ha. Within this area lies the development site boundary where the development of the materials recycling facility will occur. The development site boundary occupies approximately 3.2 ha.

The purpose of the ecological assessment was:

- to undertake a desktop study of available ecological data for the site and surrounding area, including a review of designated sites within 10 km of the site
- to undertake ecological field surveys of the site and surrounding land
- to evaluate the ecological significance of the site
- to assess the potential impact(s) of the proposed development on the ecology of the site and surrounding areas
- to recommend mitigation measures to reduce the potential negative impact(s) of the proposed development on the ecology of the site and surrounding land.

The following sections presents the methodology and results of the surveys carried out by FTC and provides an assessment of the potential impact(s) of the proposed development and any mitigating measures required to reduce any potential negative impacts.

6.2 Ecological Assessment Methodology

The ecological investigation for this EIS comprised of a number of dedicated surveys which are described below. It should be noted that the timing of this ecological assessment was sub-optimal for some aspects, the botanical survey in particular, and as a result some species may have been under-recorded. A bat survey was not carried out at the site as it was considered to be too early in the season for bats to be on the wing. However, a visual assessment was made on the potential of the site to provide roosting and foraging opportunities.

An overall ecological evaluation of the site and an impact significance assessment was undertaken using the NRA (2006) guidelines (see Appendix 9).

6.2.1 Designated Sites

A desktop study was carried out to identify designated sites such as Natural Heritage Areas (NHAs), Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) located within 10 km of the proposed development site. FTC holds an archive of GIS data that includes the location and extent of designated conservation areas. These were plotted on an OSi background map using MapInfo Professional (v 9.0.2) GIS application. Designated sites identified by this aspect of the study are outlined in Section 6.3.1 and illustrated in Figure 6.1.

6.2.2 Habitats, Botanical & Water Quality

Dominant habitats within the wider Drumman site were classified according to Fossitt (2000). This involved undertaking a field survey of the site and adjacent area. A botanical survey was also carried out in each of the dominant habitats found at the site, with plants recorded to species level. Any rare or protected species of flora were noted. Rare or protected species are listed on the Flora Protection Order (1999), The Irish Red Data Book (Curtis & McGough, 1988) and also under Annex II of the EU Habitats Directive.

Handheld GPS units (Garmin) and maps were used by fieldworkers to establish positions on-site as necessary. Aerial photographs of the area were also reviewed to confirm the extent and boundaries of the habitat types present on site.

A plant species list for the 10 km grid square N53 in which the site occurs was generated from the National Biodiversity Network website http://data.nbn.org.uk. This list was then used to determine what rare or protected plants (as listed on the Flora Protection Order (1999) and The Irish Red Data Book (Curtis & McGough, 1988)) have been previously recorded in grid square N53. A desktop review was also undertaken of National Park & Wildlife Service (NPWS) historical records of protected flora species occurring in the vicinity of the wider Drumman site.

A desktop review of water quality data collected by the Environmental Protection Agency (EPA) for the site and surrounding area was undertaken. More details on the hydrology of the area are available in Section 5 – Hydrology & Water Quality.

Habitats, botanical species and a review of the water quality status of rivers on/or in the vicinity of the proposed development site are outlined in Section 6.3.2.

6.2.3 Fauna Survey

Bird Survey

A formal bird survey was not undertaken. Instead a site walkover was carried, covering all of the representative habitats present on site. The bird species encountered were noted and an assessment as to the suitability of the habitats present on site for birds was undertaken.

The conservation status of each bird species recorded by this study was assessed. 'Birds of Conservation Concern in Ireland' (BoCCI) are classified into three separate lists; *Red-listed* species are of high conservation concern, *Amber-listed* species are of medium conservation concern and *Green-listed* species are considered to be of no conservation concern (see Lynas *et al.* 2007). To date two BoCCI lists have been published with the current list by Lynas *et al.* (2007) superceding the former by Newton *et al.* (1999). The conservation status of the bird species found by this study was also assessed by reviewing if species recorded at the site are listed on Annex I on the EU Birds Directive (79/409/EEC). These species are afforded additional protection through the designation of Special Protection Areas (SPAs) throughout EU countries.

Mammal Survey

The wider Drumman site was surveyed for mammals on the 19th January, 2010. The mammal survey consisted of a site walkover, with features such as field boundaries and access tracks being closely searched for signs of mammals. Any tracks or signs (including droppings, resting places, burrows and setts) of mammals occurring within or in the vicinity of the site were recorded using field notes and/or handheld GPS units (Garmin). In addition, any direct sightings of mammals made during the walkover (or during other site surveys) were recorded.

Signs such as dwellings, feeding traces, tracks or droppings indicate the presence of mammals on site, and occasional direct observations were made. The methods used to identify the presence of mammals in the survey area followed international best practice (Lawrence & Brown, 1973; Clark, 1988; Smal, 1995; Sargent & Morris, 2003; Bang & Dahlstrom, 2004; JNCC, 2004).

The results of the mammal survey work are provided in Section 6.3.3.

Other Fauna

The presence of any other species (*e.g.* butterflies, reptiles or amphibians) encountered during the site walkover was also recorded. Again, an assessment was also made as to the suitability of the habitats present on site for other fauna. These fauna are outlined in Section 6.3.3.