7 Soils, Geology and Hydrogeology

7.1 Introduction

This chapter of the EIS describes the existing environment in relation to Soils, Geology and Hydrogeology in the proposed development area, predicts the relevant impacts arising from the proposed development and, where considered appropriate, mitigation measures have been specified. It is divided into the following sub-sections:

7.1 Introduction

7.2 Methodology

- *Desk Based Assessment*
- *Field Study*
- *Impact Assessment Methodology*
- *Site Contamination Assessment Methodology*

7.3 Overview of Water Requirements

- *Heat Recovery Steam Generator*
- *NOx Control*

7.4 Receiving Environment

- *Background*
- *Topography*
- *Geology and Ground Conditions*
- *Hydrogeology*
- *Hydrology*
- *Radon*
- *Geological Heritage Areas*

7.5 Impact Assessment

- *Soil and Groundwater Condition*
- *Construction Phase Impacts*
- *Operational Phase Impacts*

7.6 Mitigation

- *Pre-Construction Mitigation Requirements*
- *Mitigation of Construction Impacts*
- *Mitigation of Operational Impacts*

7.7 Residual Impacts

7.2 Methodology

7.2.1 Desk-Based Study

Geological information has been obtained for this section of the EIS from the following sources:

- Geological Survey of Ireland (GSI) Bedrock Geology 1:100,000 Map Series;
- Geological Survey of Ireland (GSI) National Draft Bedrock Aquifer Maps;
- Geological Survey of Ireland (GSI) Groundwater Protection Schemes Maps including groundwater vulnerability (Eastern Interim Vulnerability Map), aquifer category, bedrock boundaries, hydrogeological data, subsoils data, depth to bedrock data, source protection areas;
- Environmental Protection Agency (ENVision) Water Quality Maps;
- General Soil Map of Ireland, The National Soil Survey, An Foras Taluntais;
- Teagasc subsoils data, Eastern RBD Subsoil Map, (Geological Survey of Ireland);
- The Radiological Protection Institute of Ireland: Radon Map of Ireland;
- Information regarding Geological Heritage Areas received from Geological Survey of Ireland in consultation letter dated 26th May 2008;
- *The Proposed Extraction of Sand and Gravel at Derryarkin and Drumman, Co. Offaly and Co. Westmeath – An Environmental Impact Statement'*, Bord na Móna, April 2001; and
- Derrygreenagh CCGT Ground Investigation Factual Report (Glover Site Investigations Ltd, 2008); as described in Section 7.2.2 *Field Study.*

7.2.2 Field Study

A preliminary ground investigation was undertaken in April/May 2008 by Glover Site Investigations Limited (GSIL) to establish ground conditions on the site. The purpose of the ground investigation was to ascertain the soil and groundwater quality at the site and to determine the sustainable yield available from the groundwater resource. The ground investigation comprised of the following:

- 9 No. Cable percussive boreholes with rotary follow on;
- 3 No. Observation wells;
- 1 No. Pumping well;
- 11 No. Machine excavated trial pits; and
- Associated in situ and laboratory based testing of soils and groundwater.

The locations of the boreholes, observation wells, pumping wells and trial pits are indicated on Figure 7.1 *Ground Investigations.*

7.2.3 Impact Assessment Methodology

In order to assess the environmental impacts of the proposed development on the bedrock geology, drift geology and hydrogeology of the site, consideration is given to the nature of the underlying bedrock and the implications this may have on the subterranean drainage and groundwater quality. The environmental impacts due to the proposed development are described in terms of predicted impacts during the construction and operational phases of the proposed development.

The importance or sensitivity of the geological and groundwater interest of the study area was determined using the criteria set out in Table 7.1: *Geology and Groundwater Sensitivity.*

Table 7.1: Geology and Groundwater Sensitivity

Sensitivity of Geological Interest	Description
High	Areas containing geological or geomorphological features considered to be of national interest, for example, Special Areas of Conservation (SAC). Designated sites of nature conservation importance dependent on groundwater.
Medium	Areas containing geological features of designated regional importance, for example regionally important geological sites, considered worthy of protection for their educational, research, historic or aesthetic importance. Exploitation of local groundwater is not extensive and/or local areas of nature conservation known to be sensitive to groundwater impacts.
Low	Geological features not currently protected and not considered worthy of protection. Poor groundwater quality and/or very low permeabilities make exploitation of the aquifer(s) unfeasible. Changes to groundwater not expected to impact on local ecology.

The assessment of the magnitude of predicted impacts on solid and drift geology and groundwater was based on the criteria defined in Table 7.2 *Definition of Magnitude of Impacts Criteria* and the combination of sensitivity and magnitude are used to derive the impact significance as detailed in Table 7.3 *Assessment of Significance Criteria for Impacts on Geology and Groundwater.*

Table 7.2: Definition of Magnitude of Impacts Criteria

Magnitude of Impacts	Description of Degree of Impact
High	Partial (greater than 50%) or total loss of a geological site, or where there would be complete severance of a site such as to affect the value of the site. Major permanent or long term change to groundwater quality or available yield. Existing resource use is irreparably impacted upon. Changes to quality or water table level will impact upon local ecology.
Medium	Loss of part (approximately 15% - 50%) of a geological site, major severance, major effects to the setting, or disturbance such that the value of the site would be affected, but not to a major degree. Changes to the local groundwater regime are predicted to impact slightly on resource use but not rule out any existing supplies. Minor impacts on local ecology may result.
Low	Minimal effect on the geological site (up to 15%) or a medium effect on its setting, or where there would be a minor severance or disturbance such that the value of the site would not be affected. Changes to groundwater quality, levels or yields do not represent a risk to existing resource use or ecology.
Negligible	Very slight change from baseline condition. Change hardly discernible, approximating to a ‘no change’ condition.

Table 7.3: Assessment of Significance Criteria for Impacts on Geology and Groundwater.

Site Sensitivity	Magnitude of Impact			
	High	**Medium**	**Low**	**Negligible**
High	Substantial	Substantial	Moderate	Slight
Medium	Moderate	Moderate	Slight	Negligible
Low	Slight	Negligible	Negligible	Negligible

7.2.4 Site Contamination Assessment Methodology

Due to the historical nature of the proposed development site as a long standing area used for industrial purposes, an assessment was undertaken to determine the existence or otherwise of contamination at the site. Current good practice in assessment of risk requires that the findings from the site investigation are evaluated for contamination on a site-specific basis, using a risk based approach. Risk assessment involves identification of the hazards and evaluation of the risks associated with these hazards. Risk assessment requires an evaluation of a conceptual “source – pathway – receptor” linkage model and can be qualitative or quantitative.

The method used in this study to assess contamination impact is essentially qualitative. Quantifying pathway efficiency and receptor sensitivity requires detailed site specific data, which is beyond the scope of this work. In the assessment of contamination data, reference is made to a number of Assessment Criteria (AC) for different compounds. The following guidelines have been used to derive the initial assessment criteria for this site. As a conservative methodology the lowest values, for any particular analyte, from the following screening criteria have been used as the AC for the site:

- Dutch Soil Protection Act 1994, Intervention Values for Soil/Sediment and Groundwater;
- Contaminated Land Exposure Assessment (CLEA) Soil Guideline Values (Department for Environment, Food and Rural Affairs/ The Environment Agency, 2002); and
- Mott MacDonald Contamination Soil Screening Values (Mott MacDonald, 2006).

(i) Evaluation Criteria

In order to evaluate the risk posed by any contaminants in soil, leachate and groundwater, reference has been made to guidance provided in CIRIA document 552, *"Contaminated Land Risk Assessment, A Guide to Good Practice"*. The method evaluates the consequences of risks being realised due to the presence of contaminants and contamination linkages, and the probability of such risks being realised. The criteria used in this assessment to determine the level of any contamination on the site are detailed in Table 7.4 *Classification of Consequence*, Table 7.5 *Classification of Probability,* Table 7.6 *Comparison of Consequence against Probability* and Table 7.7 *Description of classified risks and likely action required.*

Table 7.4: Classification of Consequence

Classification	Definition
Severe	Short-term (acute) risk to human health likely to result in "significant harm" as defined in the Environmental Protection Act, Part IIA. Short-term risk of pollution of sensitive water resource (note: Water Resources Act contains no scope for considering significance of pollution). Catastrophic damage to buildings/property. A short-term risk to a particular ecosystem, or organism forming part of such ecosystem (note: the definitions of ecological systems within the Draft Circular on Contaminated Land, DETR, 2000)
Medium	Chronic damage to Human Health ("significant harm" as defined in DETR, 2000). Pollution of sensitive water resources (note: Water Resources Act 1991 contains no scope for considering significance of pollution). A significant change in a particular ecosystem, or organism forming part of such ecosystem. (note: the definitions of ecological systems within Draft Circular on Contaminated Land, DETR, 2000)
Mild	Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services ("significant harm" as defined in the Draft Circular on Contaminated Land, DETR, 2000). Damage to sensitive buildings/services or the environment
Minor	Harm, although not necessarily significant, which may result in a financial loss, or expenditure to resolve. Non-permanent health effects to human health (easily prevented by means such as personal protective clothing etc.). Easily repairable effects of damage to buildings, structures and services.

Table 7.5: Classification of Probability

Classification	Definition
High likelihood	There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution
Likely	There is a pollution linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
Low Likelihood	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such an event would take place, and is less likely in the shorter term.
Unlikely	There is a pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long term.

Table 7.6: Comparison of Consequence against Probability

Probability	Consequence			
	Severe	**Medium**	**Mild**	**Minor**
High Likelihood	**Very High Risk**	**High risk**	Moderate risk	Moderate Risk/low risk
Likely	**High Risk**	Moderate risk	Moderate/ low risk	Low risk
Low Likelihood	Moderate risk	Moderate risk/low risk	Low risk	Very low risk
Unlikely	Moderate/Low risk	Low risk	Very low risk	Very low risk

Table 7.7: Description of classified risks and likely action required

Risk Descriptor	Definition
Very high risk	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, OR, there is evidence that severe harm to the designated receptor is currently happening. The risk, if realised, is likely to result in substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required
High risk	Harm is likely to arise to a designated receptor from an identified hazard. The risk, if realised, is likely to result in substantial liability. Urgent investigation (if not undertaken already) is required and remedial works may be necessary in the short term and are likely in the long term.
Moderate Risk	It is possible that harm could arise to a designated receptor for an identified hazard. However, if it is either unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild. Investigation (if not already undertaken) is normally required to clarify the risk, and to determine the potential liability. Some remedial works may be required in the long term.
Low Risk	It is possible that harm could arise to a designated receptor for an identified hazard, but it is likely that this harm, if realised, would at worst be mild
Very Low Risk	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised, it is not likely to be severe.

7.3 Overview of Water Requirements

The water requirements to allow for the operation of the power plant development are primarily based on the need for water in the Heat Recovery Steam Generator (HRSG) in the CCGT unit and for NOx control during the running of the CCGT and the OCGT units on distillate fuel. Other requirements for water at the facility arise from cleaning activities, laboratory requirements and domestic water usage.

7.3.1 Heat Recovery Steam Generator

A supply of feedwater is required to generate steam in the Heat Recovery Steam Generator (HRSG). In order to avoid corrosion over the lifetime of the proposed power plant development, the feed-water must be treated prior to use. The proposed power plant will include a water treatment plant where boiler feed-water will be demineralised using either a resin based or Reverse Osmosis / Electro De-ionisation (EDI) based system. The feedwater used in the HRSG will be thermally de-aerated to remove oxygen and chemically treated to prevent corrosion of the tubes and components of the water/steam cycle. Chemical dosing for pH control essentially alters the pH of the boiler water to a pH that prevents corrosion reactions. Oxygen scavenging and de-aeration combine to remove the dissolved oxygen from the boiler water which again prohibits corrosion.

A range of specialist chemical treatment options are available for boiler feedwater. These include the use passivation chemicals for pH control and the use of oxygen scavengers.

7.3.2 NOx Control

NOx emissions to air increase significantly when distillate is used as the fuel for running a turbine. Water injection will be employed when either the OCGT or CCGT unit is running on distillate fuel. Water will be injected directly into the combustion chamber to minimise the production of NOx. The water and steam act as a heat sink in the flame zone of the combustion chamber, reducing the temperature and therefore the likelihood of thermal NO_X formation. It also has the added affect of increasing the gas turbine output due to the additional mass added by the water and steam.

7.4 Receiving Environment

7.4.1 Background

This section of the chapter outlines the baseline geology, soils and hydrogeology that exist on the site and in the vicinity of the proposed development. The information detailed below is based on the desk-based and field studies described in *Section 7.2.1 Desk Based Study and 7.2.2. Field Study.*

The proposed development site has a history of previous industrial usage and is currently occupied by a workshop, stores and office complex that supports Bord na Móna's peat harvesting activities. The complex includes workshops for mobile plant overhaul and for wagon and locomotive maintenance which are used for haulage of milled peat to the Edenderry Power Station. The remaining area consists of a mix of acid grassland and made ground in the southern and western side of the site and the only apparent area of peat is located in the northern corner of the site. The site is bounded to the west, north and east by areas of cutaway bog, where the last recorded peat harvesting extraction was in 2000/01, and farmland to the south. The proposed development occupies a total area of 25.4 ha. The site occupies an area of 22.8 ha with the main site occupying an area of 17.5 ha and the adjacent switchyard site on the western side of the R400 roadway, occupying 5.3 ha. The proposed discharge pipeline to the Yellow occupies an area of 2.6 ha.

The historical development of the site has been assessed from '*The Proposed Extraction of Sand and Gravel at Derryarkin and Drumman, Co. Offaly and Co. Westmeath – An Environmental Impact Statement*', Bord na Móna, April 2001. During the nineteenth century the Derryarkin, Derrygreenagh and Drumman bogs were a rich source of iron ore. According to the report, ore from Derrygreenagh Bog was loaded onto canal boats in Daingean, approximately 10 km south of the site.

The Derryarkin and Drumman bogs were acquired by Bord na Móna in 1952 and milled peat harvesting began in 1958 to supply the ESB peat fired Rhode Power Station, which was located approximately 4 km to the south west of the site, and the Croghan briquette factory. Both of these facilities are now closed. While some commercial peat extraction still continues within the areas, the Derryarkin and Drumman bogs are no longer in milled peat production and the area comprises of cutaway peatland. There are sand and gravel extraction sites located within these bogs. The Derryarkin extraction site lies 1.5 km to the west and the Drumman extraction site is located 2 km to the northeast.

Both the geology and soils play an important part in determining the environmental characteristics of the area in general and of the site in particular. The underlying geology has a major influence on landform and rocks provide the parent material from which soils are created. The nature of the rock helps to determine not just the nature and chemistry of the soil formed, but also the rate at which it forms. This in turn strongly affects the natural vegetation and the type of agriculture or horticulture that can be sustained.

The receiving environment of the proposed development site is described below under the following headings:

- Topography;
- Geology and Ground Conditions;
- Hydrogeology;
- Hydrology
- Radon; and
- Geological Heritage Areas

7.4.2 Topography

Topography refers to the surface features of a place or region. The proposed development site lies within an area of peatland which is designated as an area of "moderate sensitivity" in Chapter 16 *Landscape and Amenities* of the *Draft Offaly County Development Plan 2009-2015*. The area is characterised by a generally low relief and level terrain dominated by the flat featureless expanses of the peatland area. Further to this, the natural topography of the area has been modified by the historic extraction of peat from the surrounding peatlands. This extraction process has resulted in a significant drop in the level of peatland areas relative to other aspects of the landscape, such as the R400 roadway. There is a *c.* 3 m height differential between the R400 roadway and adjacent cut over bog areas. The surrounding peatlands are also characterised by a network of parallel drainage channels *c.* 15 m apart.

The proposed development site consists of a "mineral island" and is slightly elevated over the levels of the surrounding cut over peatland areas. The site for the proposed development is gently sloping from the north eastern extent of the site, from *c.* 82 metres OD (Ordnance Datum Malin Head) to *c.* 87 metres OD at the south western edge of the site. Just to the south of the proposed development site there is a further elevated area consisting of agricultural land which slopes up to a maximum height of 92 metres OD. The adjacent site on the opposite side of the R400 roadway to be used for the electrical switchyard is slightly lower than the main site area with a minimum level of *c.* 79 metres OD increasing to a level of *c.* 84 metres OD

7.4.3 Geology and Ground Conditions

Based on desk-study information, and the Geological Survey of Ireland (GSI) Bedrock and Quarternary maps show that the solid geology of the site is likely to consist of Marine Basinal Facies, known as the Lucan, or "Calp" Formation of the Visean Age (part of the Mississipian sub-period, commonly known as the Early Carboniferous sub-period). This formation usually consists of argillaceous and cherty limestone and shale. (See Figure 7.2 *Bedrock Geology*).

The drift deposits on site were assessed using data collected in the ground investigation undertaken by GSIL. There was a large variation across the site. The general stratigraphy encountered over the site was as follows:

- Made Ground;
- Peat and soft clay/silts (northern end of site) (superficial deposits);
- Glacial clay (superficial deposits);
- Completely to highly weathered limestone and karst clays; and
- Limestone ('Calp' Formation).

(i) Made Ground

Made Ground was encountered across most of the site, but prevalent to the south of the existing workshop buildings to the north of the site. The Made Ground encountered comprised of a firm to stiff, occasionally soft, slightly sandy slightly gravelly clay fill. The Made Ground encountered at the northern end of the site included much greater peat content. The Made Ground was generally overlain by topsoil to a maximum depth of 0.25 m. The original topsoil was encountered in a number of boreholes to the north west of the site to a depth of 1.40 m underlying the Made Ground. The thickness of the original topsoil ranged from 0.15 m to 0.25 m.

(ii) Superficial Deposits: Peat and Soft Clay/Silts

The ground investigation identified that the northern end of the site, and the area surrounding the site, was underlain by peat. Peat deposits are described as plastic to spongy cream to dark brown/black amorphous to fibrous slightly sandy slightly silty occasionally gravely peat with occasional to many cobbles and boulders.

Underlying the peat deposits, a soft clay/silt or clay was usually encountered. This is a common feature in peat where siltier material, often weaker than the peat itself, underlies the strata.

(iii) Superficial Deposits: Glacial Clay

Glacial clay deposits were encountered at locations across the site. The main deposits are described as firm, becoming very stiff, yellow/grey brown, slightly sandy gravelly clay.

(iv) Completely to Highly Weathered Limestone and Karst Clays

Medium to very dense dark brown to black clayey, occasionally sandy fine to coarse gravel with many cobbles and boulders was encountered across the site with proven stratum thickness of between 2 m and 22.4 m. The gravel was underlain by limestone bedrock where found.

Reduced limestone weathering was encountered to the east of the site where dense sandy gravely cobbles and boulders was present at depths from 9 m to 16.5 m below ground level. A thin layer of cobbles was also encountered from 5 m to 5.6 m below ground level near the workshops to the north of the site.

Clay deposits were encountered at the northern end of the site at depths up to 25.2 m and below ground level. As these deposits are underlying very dense gravels they have been considered separately from the glacial clays. These deposits are thought to indicate the presence of *karst* features in the site. Karst is a name given to the process of dissolution that is often found to have occurred in limestones.

(v) Limestone Bedrock

The bedrock under the site has been described as moderately strong to strong (occasionally very strong) grey fine to medium grained limestone with calcite veining and has been classified as slightly to moderately weathered rock. The limestone was encountered between 7.8 m and 24 m depth below ground level.

7.4.4 Hydrogeology

Groundwater is described as water that is stored in and moves through the pores and cracks in subsoils and bedrock. Aquifers are rocks that contain sufficient voids to store water and are permeable enough to allow water to flow through them in significant quantities. Lower Palaeozoic rocks, which underlie the study area, generally have a low permeability and are regarded as poor aquifers.

The GSI Bedrock Aquifer map classifies the aquifer to be of 'Local Importance in which bedrock is Moderately Productive only in Local Zones' (See Figure 7.3 *Aquifer Map*). The GSI define a Locally Important Aquifer as having an area of outcrop or recharge zone, of normally >1 km², with a Regionally Important Aquifer having an area of outcrop of normally >10 km².

Groundwater vulnerability as defined by the GSI is the ease with which groundwater may be contaminated by human activity related to the intrinsic geology and hydrogeological characteristics of the area. In this instance, the groundwater vulnerability is classified as being Moderate.

The result of a well search of the GSI databases (2007 dataset) indicates that the nearest recorded groundwater abstraction well is located approximately 1.3 km from the site. The approximate locations (coordinates provided by the GSI) of groundwater wells in the vicinity of the site are shown on Figure 7.4 *Water Mains and Wells within 2 km of the Proposed Development Site*.

With the exception of the borehole currently in use on the Derrygreenagh site, an analysis of the GSI Wells dataset and consultation with Offaly Co. Co., have identified that there are no other water abstractions from groundwater within 1.3 km of the site.

The nearest residences to the proposed development are those located on the Knockdrin road. This road is serviced by a water main and so water requirements arising from the residences on this road are met from this source. The proposed development site is approximately 4 km North West of the nearest Source Protection Area (See Figure 7.5 *Source Protection Area Map*).

(i) Groundwater Resource

During the ground investigation undertaken by GSIL, groundwater was encountered in all cable percussive boreholes drilled at the site. Most groundwater strikes occurred near, or within 2 m of the top of the weathered limestone. Other smaller seepages were encountered at the base of the Made Ground and at the top of the soft clay/silt (underlying peat). Most of the strikes encountered within the weathered limestone were at depths of between 6 m and 10 m below ground level. In the main test pumping well on the site, groundwater table measurements undertaken prior to the start of the pumping test showed a depth of approximately 6.5m below ground level

Following the completion of all drilling activities on-site by GSIL, a pumping test was undertaken to ascertain the sustainable yield of groundwater available in the aquifer beneath the site. This pumping test was carried out in order to determine if there was a sufficient water resource available to supply the proposed power plant development with the required quantity of water without having any negative impacts on the groundwater resource in the area. The pumping tests undertaken by GSIL identified that the pumping well had sufficient capacity to supply up to $630m^3$/day on an ongoing basis.

7.4.5 Hydrology

The site is located within the Eastern River Basin District (ERBD) and within the River Boyne catchment area. The nearest rivers to the site are the Mongagh River 0.7 km to the north of the site and the Yellow River 1.4 km to the south of the site. Both of these rivers are tributaries of the River Boyne. The Mongagh River is a tributary of the Yellow and flows into the Yellow c. 15 km downstream. The Yellow River flows into the River Boyne a further 2 km downstream. A detailed assessment of the surface water resources and potential impacts on them arising from the proposed development are discussed in Chapter 6 *Water Quality.*

7.4.6 Radon

Information obtained from the Radiological Protection Institute of Ireland (www.rpii.ie) indicates that the site is located in a High Radon Area (See Figure 7.6 *Radon Levels Map*), where greater than 20% of dwellings are predicted to have radon levels in excess of 200 Bq/m^3. The Radiological Protection Institute of Ireland has set a safe level of radon of 200 Bq/m^3 and protective measures are likely to be required where this threshold is exceeded.

7.4.7 Geological Heritage Areas

A Geological Heritage Area is one which contains geological or geomorphological features considered to be of national interest and recommended for Natural Heritage Area (NHA) designation by the GSI under the Wildlife (Amendment) Act 2000.

A consultation response letter received from the Geological Survey of Ireland (26th May 2008) has identified that there are no geological heritage sites currently on the GSI database for the area or near the area. (See Appendix 1D*: Consultation Responses*).

7.5 Impact Assessment

7.5.1 Soil and Groundwater Condition

Potential sources of contamination have been identified following the ground investigation. Elevated levels of TPH, nickel and other contaminants have been detected, in various concentrations, in soils and groundwater during the site investigation. Isolated pockets of industrial waste materials were also identified in some of the trial pits. The locations of the exploratory holes are shown on Figure 7.1 *Ground Investigations.*

A risk assessment was used to identify any risk arising from onsite contamination. Risk assessment involves identification of the hazards and evaluation of the risks associated with these hazards. Risk assessment requires an evaluation of a conceptual "source – pathway – receptor" linkage model and can be qualitative or quantitative.

Based on the available information for the site, the following potential contamination sources have been identified from an assessment of historic and current activities on or in close proximity to the site:

- **S1**: Made Ground consisting of construction related fill or imported materials (source unknown) to a shallow depth across the majority of the site area. Concentrations of metals and hydrocarbons were found above the limit of detection in samples from this material;

- **S2**: The nearby, and still operational, narrow gauge railway. Fuel storage tanks are present on site for the servicing of rail haulage and milled peat production equipment;

- **S3**: Old machinery located in various areas around the site;

- **S4**: Oil and grease from operational machinery moving around the site;

- **S5**: Off site sources. The site is surrounded on all sides by former peat extraction areas, providing a potential source of organic materials and ammoniacal nitrogen to groundwater in the vicinity of the site;

- **S6**: Structures. Existing structures on the site are to be demolished prior to the commencement of construction. These structures may contain asbestos, plus stores of other potential contaminants.

(i) Potential Contaminant Pathways

The following potential contamination pathways have been identified on the site:

- **P1**: Inhalation, ingestion and direct contact;

- **P2**: Groundwater movement through superficial deposits and the underlying aquifer;
- **P3**: Groundwater movement onto site from areas of former peat extraction;
- **P4**: Surface runoff;
- **P5**: Gas migration;
- **P6**: Root uptake.

(ii) Potential Contaminant Receptors

The following potential receptors have been identified:

- **R1**: Construction and maintenance workers;
- **R2**: Future end users;
- **R3**: Buildings and infrastructure;
- **R4**: Deep groundwater which may be extracted for the proposed power development;
- **R5**: Groundwater residing in the variably permeable superficial strata;
- **R6**: Farmland to the south of the site;
- **R7**: Peat Bogs;
- **R8**: Flora and Fauna.

Table 7.8 *Potential Pollution Linkage Pathways and Associated Risks* shows the anticipated "Source-Pathway-Receptor" linkages, with an assessment of the anticipated risks following construction.

Table 7.8: Potential Pollution Linkage Pathways and Associated Risks

Source	Principal contaminants from testing	Receptor	Potential transport pathways	Likelihood of Source- Receptor linkage	Potential Consequence	Risk Classification	Risk Management Required
S1 Made Ground **S2** Narrow Gauge Railway **S3** Disused Machinery **S4** Operational Tractors and Peat Extraction Machinery **S5** Off site Sources **S6** Structures	TPH, Nickel, (soils), TPH, Ammoniacal Nitrogen, Chromium, Copper, Iron, Nickel, Zinc, pH (groundwaters), asbestos in existing structures (assumed)	**R1** Construction and Maintenance Workers **R2** Future End Users	**P1** Human Uptake Pathways:	Likely during construction – unlikely post construction	Medium	Moderate for pre construction phase and Construction Phase Low for post construction phase.	Further investigation and remediation of the identified TPH, VOC, Nickel and industrial waste contamination will be agreed with the EPA under the terms of the existing IPPC licence. However, the results at present do not indicate significant risks to human health following construction. During construction appropriate working practices should be put in place to minimise contact with areas of contaminated soils, including but not limited to the use of PPE, dust suppression, use of machines to excavate instead of hand digging, stockpiling of contaminated soils separately from the bulk of the excavations and other measures as appropriate. These measures are set out in the following sections of this report. Following construction the site is likely to be overlain by impermeable hardstanding which will prevent human contact with the identified areas of contamination. Where areas of the site are proposed to be landscaped, further investigation may be required in order to determine the remedial requirements in these areas as directed by the EPA under the terms of the existing IPPC licence. Capping with clean topsoil, capillary break layer and basal geo-textile may be required if contamination is identified in these areas.
	TPH, Ammoniacal Nitrogen, Chromium, Copper, Iron, Nickel, Zinc, pH	**R4** Underlying Aquifer **R5** Shallow Groundwater **R6** Adjacent farmland (Off site)	**P2** Groundwater movement through superficial deposits and the underlying aquifer **P3** Groundwater migration from	Unlikely – concentrations have been decreasing throughout the monitoring and the most recent groundwater monitoring round indicated that	Medium	Low	The results of groundwater monitoring indicated marginally elevated concentrations of ammoniacal nitrogen and nickel. Concentrations of TPH were initially elevated when testing for TPH and DRO. However, analysis for TPH CWG, which removes interference from naturally occurring organic compounds, did not record concentrations of TPH above the detection limits of the laboratory. The risks to groundwater and the other identified receptors are therefore not considered significant. However, given the observed

Source	**Principal contaminants from testing**	**Receptor**	**Potential transport pathways**	**Likelihood of Source- Receptor linkage**	**Potential Consequence**	**Risk Classification**	**Risk Management Required**
		R7 Adjacent Peatbogs (Off site)	off site sources	significantly elevated contaminant concentrations were not present – monitoring is ongoing and this shall be reviewed as necessary			variation in the ongoing groundwater monitoring it is recommended that the monitoring regime is continued in order to confirm that concentrations remain within acceptable levels.
	Copper, Nickel, Zinc	**R8** Flora and Fauna	**P6** Root Uptake	Unlikely	Medium	Low	If contamination is identified in areas proposed for landscaping, treatment will be undertaken as directed by the EPA under the terms of the existing IPPC licence.
	Ground Gas, TPH, Sulphates	**R3** Buildings and Infrastructure	**P2 and P3** Groundwater Migration **P5** Migration of Volatile Vapours and Ground Gas	Likely	Medium	Moderate	The low pH associated with the peat deposits and high sulphate content of groundwaters associated with the peat may have a negative impact on below ground concrete structures. Appropriate design should be used in order to mitigate against the potential risks associated with this. Elevated concentrations of hydrocarbon in soils can potentially affect the setting of concrete. The appointed contractor should mitigate for this during the design and specification of below ground concrete structures. The results of gas monitoring did not indicate the presence of significant concentrations of ground gas. However, The site is located in an area where the radon concentration in >20% of dwellings is likely to exceed 200 Bq/m^3.

(iii) Summary of Baseline Risks

The risks in the vicinity of the proposed development associated with the baseline environmental conditions are anticipated to comprise the following:

- Contamination within the Made Ground either as a result of materials within the imported fill or due to spillages / leakages from on site processes and storage areas (See Table 7.9 *Summary of Exceedances of Human Health Criteria in Soil Samples*). In addition to the presence of nickel, areas of Total Petroleum Hydrocarbon (TPH) and Volatile Organic Compounds (VOC) contaminated soils were observed during the ground investigation and may pose a potential risk to human health during construction without appropriate mitigation. The assessment of the potential risk posed from this contamination, using the methodology described in Section 7.2.3 *Impact Assessment Methodology* results in a classification of "moderate risk" during the pre construction and construction phase. However with the implementation of risk management procedures as detailed in Table 7.8 *Potential Pollution Linkage Pathways and Associated Risks* the risk will be reduced to "low risk". Such risk management procedures include the remediation of the site where necessary as agreed with the EPA under the existing IPPC license, and the implementation of appropriate working practices to minimise contact with areas of contaminated soil. Following the construction of the development the potential risk is classified as "low risk" in terms of the risk to human health.

- Gassing ground (Radon, VOCs): The associated risk has been evaluated using the impact assessment methodology as a moderate risk . However with the implementation of risk management procedures as detailed in Table 7.8 *Potential Pollution Linkage Pathways and Associated Risks* the risk will be reduced to "low risk".

- Contaminated groundwater – ammoniacal nitrogen, iron, nickel and TPH (See Table 7.10 *Summary of Exceedances in Groundwater and Leachate Analysis*). It is considered possible that the contaminants may have been introduced to the aquifer during the drilling process used in the installation of the monitoring boreholes on the site. The contamination may have been introduced by the dragging down of Made Ground during the drilling process. The overall risk to groundwater arising from the site, evaluated by the impact assessment methodology, is categorised as low risk.

Table 7.9: Summary of Exceedances of Human Health Criteria in Soil Samples

Parameter	AC mg/kg	Number of Samples	Mean Value mg/kg	Minimum Value mg/kg	Maximum Value mg/kg	UCL_{95} if Concentration >AC	No >AC
Nickel	100 (Dutch)	13	48.7	2	180	101.2mg/kg	1/13
VOCs (dichloromethane)	3.9 (Dutch)	3	N/A*	0.8	4.5	N/A*	2/3

* Not calculated as inappropriate to do so given the limited dataset.

Table 7.10: Summary of Exceedances in Groundwater and Leachate Analysis

Parameter	IEPA Interim Guideline Value	Minimum	Maximum	No >AC	List I, List II or non list Substance	Risk Status
Ammoniacal Nitrogen	0.15mg/l	<0.2mg/l	8.3mg/l	**15/20**	II	Minor[1]
Barium	0.1mg/l	0.033mg/l	0.247mg/l	**5/21**	-	Minor
Chromium	0.03mg/l	0.003mg/l	0.036mg/l	**1/15**	II	Minor
Copper	0.03mg/l	0.001mg/l	0.144mg/l	**2/20**	II	Minor
Iron	0.2mg/l	0.018mg/l	2.6mg/l	**6/21**	-	Minor
Nickel	0.02mg/l	0.014mg/l	0.143mg/l	**10/21**	II	Minor[2]
Zinc	0.1mg/l	0.026mg/l	0.251mg/l	**4/21**	II	Minor
pH Value	≥6.5 and ≤9.5	4.32	7.75	**4/21**	II	Minor
TPH	10µg/l	<10µg/l	770µg/l	**2/20**	I	Minor

[1] Concentrations were observed to decrease throughout the monitoring period. The identified concentrations of ammoniacal nitrogen are stated by the World Health Organisation (WHO) to be below that where health effects are likely and were only marginally elevated above the assessment criteria in the 3rd round of monitoring.
[2] Concentrations were observed to decrease throughout the monitoring period, during the last round, with the exception of borehole CP 2 concentrations were all below the assessment criteria. Concentrations within CP 2 during the last round were below the UK Drinking Water Standard and are not considered indicative of significant contamination of groundwater. Subject to the ongoing groundwater monitoring continuing to show decreasing concentrations the risks have been stated as Low. Testing for TPH CWG in the 4th and final round of monitoring did not record the presence of hydrocarbon contamination. Previous elevated concentrations may have been the result of interference of natural organics in groundwaters due to the presence of overlying organic peat deposits.

(iv) Pre-Construction Consultations

Following the discovery of potential contaminants within the Made Ground during the site investigation survey, Bord na Móna has initiated a management strategy. This strategy is being carried out in consultation with the EPA, under the provisions of the existing IPPC licence, to remove any identified waste materials, including potential sources of contamination.

7.5.2 Construction Phase Impacts

The major potential construction phase impacts are set out hereunder. Mitigation measures to address these impacts are set out in *Section 7.6.1 Pre-Construction Mitigation Requirements* and *Section 7.6.2 Mitigation of Construction Impacts*

- Generation of dust. This could temporarily affect neighbouring sites and site users. It should be noted that dust suppression/minimisation will be incorporated into the Construction Environmental Management Plan given the nuisance and irritant factor which can arise from elevated dust levels in the atmosphere;

- Generation of contaminated surface water run-off. Runoff from construction sites can contain high levels of entrained sediments or other water pollutants dependent on the nature of contamination sources on the site;

- As set out previously in this chapter, levels of TPH and other contaminants have been detected in varying concentrations during the site investigation. As a consequence, and having regard to the fact that the current site activities are controlled by an Integrated Pollution Prevention Control licence, the Environmental Protection Agency has been informed of same. Any further investigations, monitoring or intrusive works to be completed will be in accordance with an agreed strategy with the Environmental Protection Agency paying due regard to the associated environmental and health and safety risks and implementing the necessary controls;

- The site is located within an area where >20% of premises are likely to exceed a radon concentration of 200 Bq/m3. The potential presence of radon is unlikely to affect the workforce as it is known to dissipate rapidly on contact with the open air. Comprehensive radon monitoring will be conducted on site during the construction phase in accordance with Radiological Protection Institute of Ireland guidelines. It is anticipated that a radon gas barrier will be required however the requirement for same in addition to any further mitigation measures will be agreed with the Radiological Protection Institute of Ireland based on the monitoring results obtained in order to prevent build-up of radon gas in enclosed areas;

- Groundwater as a result of excavations on-site as part of the construction phase, which require disposal, will be treated in advance of discharge to adjacent watercourses in agreement with the Eastern Regional Fisheries Board. Such waters will be treated appropriately (e.g. sedimentation ponds/oil interceptors) to ensure that they pose no risk of pollution to the receiving watercourses;

- Spillages / leaks of chemicals or hydrocarbons during construction can result in pollution of soil, surface and groundwaters; and

- Appropriate toilet and treatment facilities will be provided for ‘domestic nature’ sewage generated on-site during the construction stage.

7.5.3 Operational Phase Impacts

The major potential operational phase impacts are set out in this section. Mitigation measures are discussed in *Section 7.6.3 Mitigation of Operational Impacts* of this report:

(i) Predicted Water Requirements

Water for the power plant will be provided from a borehole located at the eastern side of the site. As part of the hydrogeological assessment of the site, a pumping well was drilled and tested. The pumping tests indicated that a sustainable yield, of 630 m^3/day, could be obtained from the aquifer underlying the site.

There are a number of processes in the operation of the power plant which consume water. Certain processes require water with a high level of purity, to prevent corrosion or damage in the boiler and the gas turbines. This high purity water, referred to as demineralised or ‘demin water’, is produced in the water treatment plant.

The water treatment plant takes raw water from the groundwater source and removes the constituent salts, which are then disposed of, either as a waste sludge, or in effluent which is discharged to the process wastewater tank. The estimated efficiency of the treatment plant for the proposed development is 75%, which means that 100 m^3 of raw water is required to make 75 m^3 of demin water, with the other 20 m^3 being removed as process wastewater.

The main processes that require demin water in the power plant are:

- Make up water for the water/steam cycle in the CCGT unit, to replace 'blow down' and other water losses from the system. 'Blow down' is a continuous purge of water required to maintain the correct water quality in the boiler.

- The gas turbines inject water with the fuel to abate NOx emissions, when fired on distillate. This is a very large potential demand for water, equating to about 95 m^3/h for the CCGT gas turbine and 57 m^3/h for the OCGT turbine. However, the turbines use a dry NOx suppression system when fired on gas, which consumes no water.

- There are other processes which consume a relatively minor quantity of demin water, including gas turbine cleaning, and continuous sampling for boiler water quality monitoring.

It can be taken that, while a small proportion of the demand is independent of the running profile of the power plant, the majority of this demand will only occur when the power generating units are operating.

In addition to the process demands for demin water, there is a small demand for raw water on the site, including potable water supply and supplies for cleaning and sanitation. This demand is independent of the running profile of the power plant.

The demin water consumption of the plant is therefore highly variable, depending on how the plant is dispatched, and the fuel that is used. In order to manage this variability, the plant has a large capacity of storage for demin water, amounting to 21,000 m^3, which acts as a reserve for periods of very high demin water demand. During periods when the demand for demin water is low, the reserves are replenished by the water treatment system.

In order to assess the adequacy of the demineralised water storage capacity, a number of operational scenarios for the plant were considered as detailed below.

- Scenario 1: Running of both units on natural gas with a projected annual running profile of 6,000 hours for the CCGT unit and 500 hours for the OCGT unit, which is equivalent to 16.4 hrs/day and 1.4 hrs/day on average for the respective units;

- Scenario 2: The same running profile as Scenario 1, but with the OCGT unit fired on distillate fuel. Whilst it is not possible to categorically state the daily running hours of the proposed plant as this will be dictated by the demand for electricity generation arising from Eirgrid, It is considered that this scenario represents the typical daily operational profile of the proposed power plant

- Scenario 3: The CCGT unit running on natural gas at maximum output (24 hrs/day), whilst the OCGT unit runs on distillate for a period of 6.6 hrs/day. This scenario covers the operation of the proposed power plant for short term peak potential demand, and

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- Scenario 4: Scenario, where Eirgrid directs generators to generate using their secondary fuel. The Secondary Fuelling Obligation is discussed in Section 3.7.5 (v) *Back Up Fuel* and would only be invoked in the event of a significant supply interruption to the national gas transmission system. This scenario assumes both the CCGT unit and the OCGT unit run on distillate for 24hrs/day.

The water requirements for each scenario are presented in Table 7.11 *Adequacy of Demin Water Storage Capacity under Four Operational Scenarios.* All of the first three scenarios show a significant reserve, ranging from 33 to 106 days. This reserve can allow the plant to operate un-interrupted if there is a short term interruption in the groundwater supply, or in the operation of the water treatment plant. In addition, the assessment of Scenario 4 indicates that there is sufficient demineralised water storage capacity to operate both units on distillate only for 5 days, which concurs with the periods required under the Secondary Fuelling Obligation as required by the Commission for Energy Regulation (CER).

Table 7.11: Adequacy of Demin Water Storage Capacity under Four Operational Scenarios

Scenario No.	Demin Water Requirements (m^3/day)	Demin Water Storage Capacity in Tanks (m^3)	No. of Days Storage)
Scenario 1	198	21,000	106
Scenario 2	277	21,000	76
Scenario 3	639	21,000	33
Scenario 4	3,918	21,000	5

The groundwater source on the site, and the water treatment plant, will operate independently of the water demand from the power plant, in order to maintain the necessary reserve levels of demineralised water. Demineralised water used in the plant will be taken from the storage tanks, and the reserves will be cycled to ensure that the demineralised water does not denature due to prolonged storage.

Raw water from the borehole source will be pumped to the raw water storage tank which will have a capacity of 3,500 m^3. This tank will provide approximately 3m^3/day for services, including canteen, showers, toilets and washing facilities. There is also a requirement for 500 m^3 of raw water for fire fighting purposes. The balance of the raw water storage capacity is used to feed the demineralised water production plant.

The adequacy of water supply from the borehole was assessed by considering the maximum potential demand over the course of the year, as short term variations in the supply/demand balance are buffered by the demineralised water storage on the site, as discussed above. As a worst case, the maximum possible load factor for the CCGT unit was used, equating to approximately 8,000 hours per year. It is assumed that the unit will be fired on gas, but two days running on distillate per year is included for testing of fuel changeover arrangements. In addition, it is assumed as a worst case that the OCGT unit runs on distillate for 900 hours, equivalent to an annual load factor of 10%, which is estimated as an upper limit for operating the unit on distillate alone.

The total demand from this scenario, and the supply available from the borehole, is detailed in Table 7.12 *Assessment of the Adequacy of the Water Supply from the Borehole,* below:

Table 7.12: Assessment of the Adequacy of the Water Supply from the Borehole

Water Demand Process	Demin Water Consumption	Raw Water Consumption	Raw Water Equivalent	Operating hours	Total
CCGT - gas	11 m^3/h		15 m^3/h	8,000 h/yr	120,000 m^3/yr
CCGT - Distillate	106 m^3/h		141 m^3/h	48 h/yr	6,768 m^3/yr
OCGT - Distillate	57 m^3/h		76 m^3/h	900 h/yr	68,400 m^3/yr
Other		30 m^3/day	30 m^3/day	365 day/yr	10,950 m^3/yr
Total - Maximum Annual Raw Water Demand					206,118 m^3/yr
Annual yield from borehole			630 m^3/day	365 day/yr	229,950 m^3/yr
Ratio of maximum raw water demand to supply					88%

The table shows that the borehole can meet the maximum possible annual demand for raw water from the power plant, with a reserve margin of 12%.

In conclusion there is sufficient water available from the aquifer, with a sustainable yield of 630m^3/day at the proposed development site, to supply the maximum possible demand of the proposed power plant. There is also sufficient water storage reserves held on the site to allow for the prolonged operation of the facility under different scenarios as described above, without negatively impacting on the groundwater resource under the site.

Based on the results of the site investigation and pumping test conducted on site a cone of drawdown would extend up to 300 m from the abstraction well. The cone of drawdown does not extend beyond the site boundary. It is considered that it would be unlikely that there would be any change in the effective stress beyond the cone of drawdown, therefore dewatering related settlement would be unlikely to occur beyond this point. It is anticipated that there will be no hydrogeological impact on the R400 road from water abstraction at the proposed pumping well on the site.

The impact of the drawdown on the proposed development site within 300 m of the pumping well was also assessed. By calculating the change in effective stress, as a result of the change in groundwater level, the settlement of each soil layer below the groundwater table can be estimated. It was usually found to be the case that the peat and soft clay/silt layers were above the groundwater table and therefore these deposits were not generally affected by any drawdown. The maximum predicted settlement was found to be approximately 10 mm, adjacent to the pumping well in OB1/BH04, reducing to less than a millimetre in BH02 at the south east corner of the site. The settlement at the well location, based on a 5.2 m of drawdown, was estimated to be between 15 mm and 20 mm. The cone of drawdown does not extend to the R400 roadway and it is not anticipated to impact on the road.

Abstraction of the groundwater in the limestone aquifer for use as process water in the proposed development is considered not to have a significant effect on the abstraction of groundwater from neighbouring properties. The nearest off site abstraction point is located approximately 1.3 km away. Based on the well coordinates provided by GSI, the approximate positions of these wells are shown in Figure 7.4 *Water Mains and Wells within 2 km of the Proposed Development Site.* The majority of the buildings in the vicinity of the proposed development are served by water mains and will therefore be unaffected by the proposed abstraction.

The abstraction of water from the pumping well is unlikely to have any impact on surface water resources in the area such as the Mongagh River, which is located *c.* 0.7 km north of the site, or the Yellow River, located *c.* 1.4 km to the south of the site, due to the fact these resources are significantly outside the cone of drawdown. There are no sensitive water dependent ecosystems within the predicted cone of drawdown and so it is not anticipated that there will be any significant impacts on any such resources.

(ii) Other potential impacts

- The site is in an area where levels of radon above the action level of 200 Bq/m3 may occur in buildings. It is considered that mitigation measures to prevent gas ingress will be required to be incorporated into the buildings during the design and construction in order to mitigate against the risks to operating personnel;

- The risks posed by contaminated surface water run-off are potentially high, given the vulnerability of the surrounding peat bog, which is likely to provide baseflow to the neighbouring watercourses and itself comprises a wetland area;

- The risks to groundwaters following construction and commissioning of the CCGT and OCGT units are considered to be low. Evidence of contaminated groundwaters was noted during the Glovers site investigation and is summarised in Table 7.8. *Potential Pollution Linkage Pathways and Associated Risks.* However, the proposed development will require the abstraction of significant volumes of groundwater, up to 630 m^3 per day, for use as process water, which will cause drawdown towards the abstraction well. This would mean that the potential for migration of the identified contamination would be reduced. Ongoing monitoring of the groundwater indicated that concentrations have reduced and the most recent groundwater monitoring round did not record significantly elevated concentrations of contaminants. It is considered possible that the contaminants may have arisen due to the intrusive nature of the drilling process. Any further investigations, monitoring or intrusive works to be carried out will be in accordance with an agreed strategy with the Environmental Protection Agency, paying due regard to the associated environmental and health and safety risks and implementing the necessary controls.

7.6 Mitigation Measures

7.6.1 Pre-Construction Mitigation Requirements

Variable concentrations of TPH and other contaminants were detected during the site investigation. As a consequence, and having regard to the fact that the current site activities are controlled by an Integrated Pollution Prevention Control licence, the Environmental Protection Agency has been informed of same. Any further investigations, monitoring or intrusive works to be carried out will be in accordance with an agreed strategy with the Environmental Protection Agency paying due regard to the associated environmental and health and safety risks and implementing the necessary controls. Aquifer protection measures will be employed during the piling in accordance with the current best practice: *Piling and Penetrative Ground Improvement in Land Affected by Contamination: Guidance on Pollution Prevention (Environment Agency, 2001).*

The site is located within a high radon area. Comprehensive radon monitoring will be conducted on site during the construction phase in accordance with Radiological Protection Institute of Ireland guidelines. It is anticipated that a radon gas barrier will be required however the requirement for same in addition to any further mitigation measures will be agreed with the Radiological Protection Institute of Ireland based on the monitoring results obtained to prevent build-up of radon gas in enclosed areas.

Prior to the demolition of existing structures on-site a Construction and Demolition Waste Management Plan will be developed in accordance with the Department of the Environment, Heritage and Local Government's *Guidelines on the Preparation of Waste Management Plans (WMP) for Construction and Demolition Waste Projects (DEHLG, 2006).* This plan will address all wastes to be generated during the demolition and construction phases of the project, including asbestos, or asbestos containing materials, which may be present in the structures proposed for demolition.

7.6.2 Mitigation of Construction Impacts

The environmental effects likely to arise during the construction phase of the project will be identified and managed through a Construction Environmental Management Plan (CEMP). The CEMP shall, as a minimum, address the following issues relating to effects arising from contaminated ground, as well as other more general environmental impacts:

- Water pollution will be prevented through the effective management and storage of chemicals and hydrocarbons. This will include the development of designated impervious and bunded chemical storage locations in addition to the installation of paved and ramped areas for refuelling. Such areas will be provided with a hydrocarbon interceptor for the treatment of surface waters generated at such locations;

- A comprehensive and integrated approach for water quality protection during construction will be implemented as part of the Construction Environmental Management Plan to prevent impacts to water quality in watercourses adjacent the construction site. This will incorporate such principles as silt control measures, such as sedimentation ponds, stabilisation of exposed soils which pose a risk of generation of contaminated surface water run-off and regular inspections and testing if considered necessary following consultation with the Eastern Regional Fisheries Board;

- Chemicals and hydrocarbons will not be stored within 10 metres of any surface waters or 50 metres of a borehole or well. Designated areas where chemicals or hydrocarbons are delivered, stored and dispensed will be isolated from the surface water drainage system, open ground or other porous surfaces. This will be achieved using drainage grids, gullies or kerbs in conjunction with surfaces impermeable to the products used. Potentially contaminated water and spills will be directed through an oil separator and prevented from seeping into the soil and groundwater below the site. The separator will be of an adequate size to serve the appropriate surface area catchment of the site;

- Bunds for the storage of chemicals and hydrocarbons will be lined or constructed of materials resistant to damage by the materials stored therein. In addition the capacity of such bunds will be a minimum of 110% of the volume of the largest container stored therein or 25% of the total volume, whichever is the greater. Bunds will be designed in accordance with Environmental Protection Agency guidance in relation to the storage of potentially polluting liquids (*"IPC Guidance Note on Storage and Transfer of Materials for Scheduled Activities"*, 2004) paying due regard to procedures for emptying potentially contaminated rainwater, if uncovered, orientation of fill/discharge points, valves and other risk connections within the bund structure;

- Portable toilets will be provided on site for the construction phase of the project and arrangements will be made to transport all waste generated to an appropriately licensed off site facility;

- All plant and equipment on site will be regularly maintained and inspected. Leaks will be repaired immediately prior to use of the affected item. Drip trays will be provided and used for all stationary plant. If wash down is required, a designated wash down area will be used, served by oil / water separators and isolated from the surface water drainage;

- Spill kits will be maintained near working areas. All spills / leaks will be cleaned up immediately. An emergency response plan will be put in place as part of the Construction Environmental Management Plan detailing the measures to be undertaken should pollution be identified;

- A Construction and Demolition Waste Management Plan will be developed and implemented in accordance with the Department of the Environment, Heritage and Local Government's *Guidelines on the Preparation of Waste Management Plans (WMP) for Construction and*

Demolition Waste Projects (DEHLG, 2006). The focus of this plan will be effective identification, quantification and recording of wastes generated on and removed from the construction site. The plan will also demonstrate how compliance is being achieved with all relevant national legislation for waste management and clearly identify all waste contractors utilised for the disposal, recycling or recovery of waste materials generated on-site;

- Construction activities will be carried out in accordance with the CIRIA Document C650 *Environmental Good Practice on Site, (CRIA, 2005);* and

- Using the methodology set out in *Concrete in Aggressive Ground* (BRE, 2005), and assuming mobile groundwater conditions, buried concrete will be designed for a design sulphate class of DS-2 and for an aggressive chemical environment for concrete (ACEC) class of AC-5z. This ACEC class considers the whole site, including the more acidic areas where peat is prevalent. However, due to the variable ground conditions on site, it is recommended that further tests are carried out on soils and groundwater during detailed design and in advance of commencement of construction activities to confirm this classification.

7.6.3 Mitigation of Operational Impacts

The major operational phase mitigation measures associated with the proposed development are considered to comprise the following:

- Pre-treatment of the abstracted groundwaters will be required to ensure its suitability for use as boiler / process water. Monitoring of all discharged waters will be required under the IPPC license for the development, in order to ensure that the effluent water quality is in compliance with the licence conditions;

- Storage of hydrocarbons and other hazardous or potentially polluting materials will be undertaken in accordance with best practice (See IPC Guidance Note on Storage and Transfer of Materials for Scheduled Activities, EPA, (2004)) and the conditions detailed for the IPPC licence for the site;

- An emergency response plan, setting out the procedures to be followed in the event of spillages or other pollution events, will be put in place in accordance with the requirements of the Integrated Pollution Prevention Control Licence for the site;

- Waste water, including potentially contaminated runoff, will be treated in dedicated systems to the appropriate standards, prior to discharge off site in accordance with the conditions set out in the Integrated Pollution Prevention Control Licence for the site;

- The proposed maximum abstraction of groundwater, at 630 m^3/day, is likely to cause settlement of the ground within the cone of drawdown. There is an associated risk of settlement related damage to structures on site. In order to mitigate against this potential risk all structures on the site will be designed to tolerate such settlement; and

- The maximum abstraction from the pumping well at the proposed development site will be 630m^3/day.

7.7 Residual Impacts

The mitigation strategy above recommends actions which can be taken to reduce or offset the scale, significance and duration of the known and potential impacts on soils, geological and hydrogeological resource. The purpose of this statement is to specify mitigation measures, where appropriate, to minimise the 'risk factor' to all aspects of these resources on site.

It is anticipated that with the implementation of mitigation measures detailed above neither the construction nor operational phases of the development will impact significantly on the geology, hydrology or hydrogeology of the area.

7 Soils, Geology and Hydrogeology

7.1 Introduction

This chapter of the EIS describes the existing environment in relation to Soils, Geology and Hydrogeology in the proposed development area, predicts the relevant impacts arising from the proposed development and, where considered appropriate, mitigation measures have been specified. It is divided into the following sub-sections:

7.1 Introduction

7.2 Methodology

- *Desk Based Assessment*
- *Field Study*
- *Impact Assessment Methodology*
- *Site Contamination Assessment Methodology*

7.3 Overview of Water Requirements

- *Heat Recovery Steam Generator*
- *NOx Control*

7.4 Receiving Environment

- *Background*
- *Topography*
- *Geology and Ground Conditions*
- *Hydrogeology*
- *Hydrology*
- *Radon*
- *Geological Heritage Areas*

7.5 Impact Assessment

- *Soil and Groundwater Condition*
- *Construction Phase Impacts*
- *Operational Phase Impacts*

7.6 Mitigation

- *Pre-Construction Mitigation Requirements*
- *Mitigation of Construction Impacts*
- *Mitigation of Operational Impacts*

7.7 Residual Impacts

7.2 Methodology

7.2.1 Desk-Based Study

Geological information has been obtained for this section of the EIS from the following sources:

- Geological Survey of Ireland (GSI) Bedrock Geology 1:100,000 Map Series;
- Geological Survey of Ireland (GSI) National Draft Bedrock Aquifer Maps;
- Geological Survey of Ireland (GSI) Groundwater Protection Schemes Maps including groundwater vulnerability (Eastern Interim Vulnerability Map), aquifer category, bedrock boundaries, hydrogeological data, subsoils data, depth to bedrock data, source protection areas;
- Environmental Protection Agency (ENVision) Water Quality Maps;
- General Soil Map of Ireland, The National Soil Survey, An Foras Taluntais;
- Teagasc subsoils data, Eastern RBD Subsoil Map, (Geological Survey of Ireland);
- The Radiological Protection Institute of Ireland: Radon Map of Ireland;
- Information regarding Geological Heritage Areas received from Geological Survey of Ireland in consultation letter dated 26th May 2008;
- *The Proposed Extraction of Sand and Gravel at Derryarkin and Drumman, Co. Offaly and Co. Westmeath – An Environmental Impact Statement'*, Bord na Móna, April 2001; and
- Derrygreenagh CCGT Ground Investigation Factual Report (Glover Site Investigations Ltd, 2008); as described in Section 7.2.2 *Field Study.*

7.2.2 Field Study

A preliminary ground investigation was undertaken in April/May 2008 by Glover Site Investigations Limited (GSIL) to establish ground conditions on the site. The purpose of the ground investigation was to ascertain the soil and groundwater quality at the site and to determine the sustainable yield available from the groundwater resource. The ground investigation comprised of the following:

- 9 No. Cable percussive boreholes with rotary follow on;
- 3 No. Observation wells;
- 1 No. Pumping well;
- 11 No. Machine excavated trial pits; and
- Associated in situ and laboratory based testing of soils and groundwater.

The locations of the boreholes, observation wells, pumping wells and trial pits are indicated on Figure 7.1 *Ground Investigations.*

7.2.3 Impact Assessment Methodology

In order to assess the environmental impacts of the proposed development on the bedrock geology, drift geology and hydrogeology of the site, consideration is given to the nature of the underlying bedrock and the implications this may have on the subterranean drainage and groundwater quality. The environmental impacts due to the proposed development are described in terms of predicted impacts during the construction and operational phases of the proposed development.

The importance or sensitivity of the geological and groundwater interest of the study area was determined using the criteria set out in Table 7.1: *Geology and Groundwater Sensitivity.*

Table 7.1: Geology and Groundwater Sensitivity

Sensitivity of Geological Interest	Description
High	Areas containing geological or geomorphological features considered to be of national interest, for example, Special Areas of Conservation (SAC). Designated sites of nature conservation importance dependent on groundwater.
Medium	Areas containing geological features of designated regional importance, for example regionally important geological sites, considered worthy of protection for their educational, research, historic or aesthetic importance. Exploitation of local groundwater is not extensive and/or local areas of nature conservation known to be sensitive to groundwater impacts.
Low	Geological features not currently protected and not considered worthy of protection. Poor groundwater quality and/or very low permeabilities make exploitation of the aquifer(s) unfeasible. Changes to groundwater not expected to impact on local ecology.

The assessment of the magnitude of predicted impacts on solid and drift geology and groundwater was based on the criteria defined in Table 7.2 *Definition of Magnitude of Impacts Criteria* and the combination of sensitivity and magnitude are used to derive the impact significance as detailed in Table 7.3 *Assessment of Significance Criteria for Impacts on Geology and Groundwater.*

Table 7.2: Definition of Magnitude of Impacts Criteria

Magnitude of Impacts	Description of Degree of Impact
High	Partial (greater than 50%) or total loss of a geological site, or where there would be complete severance of a site such as to affect the value of the site. Major permanent or long term change to groundwater quality or available yield. Existing resource use is irreparably impacted upon. Changes to quality or water table level will impact upon local ecology.
Medium	Loss of part (approximately 15% - 50%) of a geological site, major severance, major effects to the setting, or disturbance such that the value of the site would be affected, but not to a major degree. Changes to the local groundwater regime are predicted to impact slightly on resource use but not rule out any existing supplies. Minor impacts on local ecology may result.
Low	Minimal effect on the geological site (up to 15%) or a medium effect on its setting, or where there would be a minor severance or disturbance such that the value of the site would not be affected. Changes to groundwater quality, levels or yields do not represent a risk to existing resource use or ecology.
Negligible	Very slight change from baseline condition. Change hardly discernible, approximating to a ‘no change’ condition.

Table 7.3: Assessment of Significance Criteria for Impacts on Geology and Groundwater.

Site Sensitivity	Magnitude of Impact			
	High	**Medium**	**Low**	**Negligible**
High	Substantial	Substantial	Moderate	Slight
Medium	Moderate	Moderate	Slight	Negligible
Low	Slight	Negligible	Negligible	Negligible

7.2.4 Site Contamination Assessment Methodology

Due to the historical nature of the proposed development site as a long standing area used for industrial purposes, an assessment was undertaken to determine the existence or otherwise of contamination at the site. Current good practice in assessment of risk requires that the findings from the site investigation are evaluated for contamination on a site-specific basis, using a risk based approach. Risk assessment involves identification of the hazards and evaluation of the risks associated with these hazards. Risk assessment requires an evaluation of a conceptual “source – pathway – receptor” linkage model and can be qualitative or quantitative.

The method used in this study to assess contamination impact is essentially qualitative. Quantifying pathway efficiency and receptor sensitivity requires detailed site specific data, which is beyond the scope of this work. In the assessment of contamination data, reference is made to a number of Assessment Criteria (AC) for different compounds. The following guidelines have been used to derive the initial assessment criteria for this site. As a conservative methodology the lowest values, for any particular analyte, from the following screening criteria have been used as the AC for the site:

- Dutch Soil Protection Act 1994, Intervention Values for Soil/Sediment and Groundwater;
- Contaminated Land Exposure Assessment (CLEA) Soil Guideline Values (Department for Environment, Food and Rural Affairs/ The Environment Agency, 2002); and
- Mott MacDonald Contamination Soil Screening Values (Mott MacDonald, 2006).

(i) Evaluation Criteria

In order to evaluate the risk posed by any contaminants in soil, leachate and groundwater, reference has been made to guidance provided in CIRIA document 552, *"Contaminated Land Risk Assessment, A Guide to Good Practice"*. The method evaluates the consequences of risks being realised due to the presence of contaminants and contamination linkages, and the probability of such risks being realised. The criteria used in this assessment to determine the level of any contamination on the site are detailed in Table 7.4 *Classification of Consequence*, Table 7.5 *Classification of Probability,* Table 7.6 *Comparison of Consequence against Probability* and Table 7.7 *Description of classified risks and likely action required.*

Table 7.4: Classification of Consequence

Classification	Definition
Severe	Short-term (acute) risk to human health likely to result in "significant harm" as defined in the Environmental Protection Act, Part IIA. Short-term risk of pollution of sensitive water resource (note: Water Resources Act contains no scope for considering significance of pollution). Catastrophic damage to buildings/property. A short-term risk to a particular ecosystem, or organism forming part of such ecosystem (note: the definitions of ecological systems within the Draft Circular on Contaminated Land, DETR, 2000)
Medium	Chronic damage to Human Health ("significant harm" as defined in DETR, 2000). Pollution of sensitive water resources (note: Water Resources Act 1991 contains no scope for considering significance of pollution). A significant change in a particular ecosystem, or organism forming part of such ecosystem. (note: the definitions of ecological systems within Draft Circular on Contaminated Land, DETR, 2000)
Mild	Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services ("significant harm" as defined in the Draft Circular on Contaminated Land, DETR, 2000). Damage to sensitive buildings/services or the environment
Minor	Harm, although not necessarily significant, which may result in a financial loss, or expenditure to resolve. Non-permanent health effects to human health (easily prevented by means such as personal protective clothing etc.). Easily repairable effects of damage to buildings, structures and services.

Table 7.5: Classification of Probability

Classification	Definition
High likelihood	There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution
Likely	There is a pollution linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
Low Likelihood	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such an event would take place, and is less likely in the shorter term.
Unlikely	There is a pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long term.

Table 7.6: Comparison of Consequence against Probability

Probability	Consequence			
	Severe	**Medium**	**Mild**	**Minor**
High Likelihood	**Very High Risk**	**High risk**	Moderate risk	Moderate Risk/low risk
Likely	**High Risk**	Moderate risk	Moderate/ low risk	Low risk
Low Likelihood	Moderate risk	Moderate risk/low risk	Low risk	Very low risk
Unlikely	Moderate/Low risk	Low risk	Very low risk	Very low risk

Table 7.7: Description of classified risks and likely action required

Risk Descriptor	Definition
Very high risk	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, OR, there is evidence that severe harm to the designated receptor is currently happening. The risk, if realised, is likely to result in substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required
High risk	Harm is likely to arise to a designated receptor from an identified hazard. The risk, if realised, is likely to result in substantial liability. Urgent investigation (if not undertaken already) is required and remedial works may be necessary in the short term and are likely in the long term.
Moderate Risk	It is possible that harm could arise to a designated receptor for an identified hazard. However, if it is either unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild. Investigation (if not already undertaken) is normally required to clarify the risk, and to determine the potential liability. Some remedial works may be required in the long term.
Low Risk	It is possible that harm could arise to a designated receptor for an identified hazard, but it is likely that this harm, if realised, would at worst be mild
Very Low Risk	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised, it is not likely to be severe.

7.3 Overview of Water Requirements

The water requirements to allow for the operation of the power plant development are primarily based on the need for water in the Heat Recovery Steam Generator (HRSG) in the CCGT unit and for NOx control during the running of the CCGT and the OCGT units on distillate fuel. Other requirements for water at the facility arise from cleaning activities, laboratory requirements and domestic water usage.

7.3.1 Heat Recovery Steam Generator

A supply of feedwater is required to generate steam in the Heat Recovery Steam Generator (HRSG). In order to avoid corrosion over the lifetime of the proposed power plant development, the feed-water must be treated prior to use. The proposed power plant will include a water treatment plant where boiler feed-water will be demineralised using either a resin based or Reverse Osmosis / Electro De-ionisation (EDI) based system. The feedwater used in the HRSG will be thermally de-aerated to remove oxygen and chemically treated to prevent corrosion of the tubes and components of the water/steam cycle. Chemical dosing for pH control essentially alters the pH of the boiler water to a pH that prevents corrosion reactions. Oxygen scavenging and de-aeration combine to remove the dissolved oxygen from the boiler water which again prohibits corrosion.

A range of specialist chemical treatment options are available for boiler feedwater. These include the use passivation chemicals for pH control and the use of oxygen scavengers.

7.3.2 NOx Control

NOx emissions to air increase significantly when distillate is used as the fuel for running a turbine. Water injection will be employed when either the OCGT or CCGT unit is running on distillate fuel. Water will be injected directly into the combustion chamber to minimise the production of NOx. The water and steam act as a heat sink in the flame zone of the combustion chamber, reducing the temperature and therefore the likelihood of thermal NO_X formation. It also has the added affect of increasing the gas turbine output due to the additional mass added by the water and steam.

7.4 Receiving Environment

7.4.1 Background

This section of the chapter outlines the baseline geology, soils and hydrogeology that exist on the site and in the vicinity of the proposed development. The information detailed below is based on the desk-based and field studies described in *Section 7.2.1 Desk Based Study and 7.2.2. Field Study.*

The proposed development site has a history of previous industrial usage and is currently occupied by a workshop, stores and office complex that supports Bord na Móna's peat harvesting activities. The complex includes workshops for mobile plant overhaul and for wagon and locomotive maintenance which are used for haulage of milled peat to the Edenderry Power Station. The remaining area consists of a mix of acid grassland and made ground in the southern and western side of the site and the only apparent area of peat is located in the northern corner of the site. The site is bounded to the west, north and east by areas of cutaway bog, where the last recorded peat harvesting extraction was in 2000/01, and farmland to the south. The proposed development occupies a total area of 25.4 ha. The site occupies an area of 22.8 ha with the main site occupying an area of 17.5 ha and the adjacent switchyard site on the western side of the R400 roadway, occupying 5.3 ha. The proposed discharge pipeline to the Yellow occupies an area of 2.6 ha.

The historical development of the site has been assessed from '*The Proposed Extraction of Sand and Gravel at Derryarkin and Drumman, Co. Offaly and Co. Westmeath – An Environmental Impact Statement*', Bord na Móna, April 2001. During the nineteenth century the Derryarkin, Derrygreenagh and Drumman bogs were a rich source of iron ore. According to the report, ore from Derrygreenagh Bog was loaded onto canal boats in Daingean, approximately 10 km south of the site.

The Derryarkin and Drumman bogs were acquired by Bord na Móna in 1952 and milled peat harvesting began in 1958 to supply the ESB peat fired Rhode Power Station, which was located approximately 4 km to the south west of the site, and the Croghan briquette factory. Both of these facilities are now closed. While some commercial peat extraction still continues within the areas, the Derryarkin and Drumman bogs are no longer in milled peat production and the area comprises of cutaway peatland. There are sand and gravel extraction sites located within these bogs. The Derryarkin extraction site lies 1.5 km to the west and the Drumman extraction site is located 2 km to the northeast.

Both the geology and soils play an important part in determining the environmental characteristics of the area in general and of the site in particular. The underlying geology has a major influence on landform and rocks provide the parent material from which soils are created. The nature of the rock helps to determine not just the nature and chemistry of the soil formed, but also the rate at which it forms. This in turn strongly affects the natural vegetation and the type of agriculture or horticulture that can be sustained.

The receiving environment of the proposed development site is described below under the following headings:

- Topography;
- Geology and Ground Conditions;
- Hydrogeology;
- Hydrology
- Radon; and
- Geological Heritage Areas

7.4.2 Topography

Topography refers to the surface features of a place or region. The proposed development site lies within an area of peatland which is designated as an area of "moderate sensitivity" in Chapter 16 *Landscape and Amenities* of the *Draft Offaly County Development Plan 2009-2015*. The area is characterised by a generally low relief and level terrain dominated by the flat featureless expanses of the peatland area. Further to this, the natural topography of the area has been modified by the historic extraction of peat from the surrounding peatlands. This extraction process has resulted in a significant drop in the level of peatland areas relative to other aspects of the landscape, such as the R400 roadway. There is a *c.* 3 m height differential between the R400 roadway and adjacent cut over bog areas. The surrounding peatlands are also characterised by a network of parallel drainage channels *c.* 15 m apart.

The proposed development site consists of a "mineral island" and is slightly elevated over the levels of the surrounding cut over peatland areas. The site for the proposed development is gently sloping from the north eastern extent of the site, from *c.* 82 metres OD (Ordnance Datum Malin Head) to *c.* 87 metres OD at the south western edge of the site. Just to the south of the proposed development site there is a further elevated area consisting of agricultural land which slopes up to a maximum height of 92 metres OD. The adjacent site on the opposite side of the R400 roadway to be used for the electrical switchyard is slightly lower than the main site area with a minimum level of *c.* 79 metres OD increasing to a level of *c.* 84 metres OD

7.4.3 Geology and Ground Conditions

Based on desk-study information, and the Geological Survey of Ireland (GSI) Bedrock and Quarternary maps show that the solid geology of the site is likely to consist of Marine Basinal Facies, known as the Lucan, or "Calp" Formation of the Visean Age (part of the Mississipian sub-period, commonly known as the Early Carboniferous sub-period). This formation usually consists of argillaceous and cherty limestone and shale. (See Figure 7.2 *Bedrock Geology*).

The drift deposits on site were assessed using data collected in the ground investigation undertaken by GSIL. There was a large variation across the site. The general stratigraphy encountered over the site was as follows:

- Made Ground;
- Peat and soft clay/silts (northern end of site) (superficial deposits);
- Glacial clay (superficial deposits);
- Completely to highly weathered limestone and karst clays; and
- Limestone ('Calp' Formation).

(i) Made Ground

Made Ground was encountered across most of the site, but prevalent to the south of the existing workshop buildings to the north of the site. The Made Ground encountered comprised of a firm to stiff, occasionally soft, slightly sandy slightly gravelly clay fill. The Made Ground encountered at the northern end of the site included much greater peat content. The Made Ground was generally overlain by topsoil to a maximum depth of 0.25 m. The original topsoil was encountered in a number of boreholes to the north west of the site to a depth of 1.40 m underlying the Made Ground. The thickness of the original topsoil ranged from 0.15 m to 0.25 m.

(ii) Superficial Deposits: Peat and Soft Clay/Silts

The ground investigation identified that the northern end of the site, and the area surrounding the site, was underlain by peat. Peat deposits are described as plastic to spongy cream to dark brown/black amorphous to fibrous slightly sandy slightly silty occasionally gravely peat with occasional to many cobbles and boulders.

Underlying the peat deposits, a soft clay/silt or clay was usually encountered. This is a common feature in peat where siltier material, often weaker than the peat itself, underlies the strata.

(iii) Superficial Deposits: Glacial Clay

Glacial clay deposits were encountered at locations across the site. The main deposits are described as firm, becoming very stiff, yellow/grey brown, slightly sandy gravelly clay.

(iv) Completely to Highly Weathered Limestone and Karst Clays

Medium to very dense dark brown to black clayey, occasionally sandy fine to coarse gravel with many cobbles and boulders was encountered across the site with proven stratum thickness of between 2 m and 22.4 m. The gravel was underlain by limestone bedrock where found.

Reduced limestone weathering was encountered to the east of the site where dense sandy gravely cobbles and boulders was present at depths from 9 m to 16.5 m below ground level. A thin layer of cobbles was also encountered from 5 m to 5.6 m below ground level near the workshops to the north of the site.

Clay deposits were encountered at the northern end of the site at depths up to 25.2 m and below ground level. As these deposits are underlying very dense gravels they have been considered separately from the glacial clays. These deposits are thought to indicate the presence of *karst* features in the site. Karst is a name given to the process of dissolution that is often found to have occurred in limestones.

(v) Limestone Bedrock

The bedrock under the site has been described as moderately strong to strong (occasionally very strong) grey fine to medium grained limestone with calcite veining and has been classified as slightly to moderately weathered rock. The limestone was encountered between 7.8 m and 24 m depth below ground level.

7.4.4 Hydrogeology

Groundwater is described as water that is stored in and moves through the pores and cracks in subsoils and bedrock. Aquifers are rocks that contain sufficient voids to store water and are permeable enough to allow water to flow through them in significant quantities. Lower Palaeozoic rocks, which underlie the study area, generally have a low permeability and are regarded as poor aquifers.

The GSI Bedrock Aquifer map classifies the aquifer to be of ‘Local Importance in which bedrock is Moderately Productive only in Local Zones’ (See Figure 7.3 *Aquifer Map*). The GSI define a Locally Important Aquifer as having an area of outcrop or recharge zone, of normally >1 km², with a Regionally Important Aquifer having an area of outcrop of normally >10 km².

Groundwater vulnerability as defined by the GSI is the ease with which groundwater may be contaminated by human activity related to the intrinsic geology and hydrogeological characteristics of the area. In this instance, the groundwater vulnerability is classified as being Moderate.

The result of a well search of the GSI databases (2007 dataset) indicates that the nearest recorded groundwater abstraction well is located approximately 1.3 km from the site. The approximate locations (coordinates provided by the GSI) of groundwater wells in the vicinity of the site are shown on Figure 7.4 *Water Mains and Wells within 2 km of the Proposed Development Site*.

With the exception of the borehole currently in use on the Derrygreenagh site, an analysis of the GSI Wells dataset and consultation with Offaly Co. Co., have identified that there are no other water abstractions from groundwater within 1.3 km of the site.

The nearest residences to the proposed development are those located on the Knockdrin road. This road is serviced by a water main and so water requirements arising from the residences on this road are met from this source. The proposed development site is approximately 4 km North West of the nearest Source Protection Area (See Figure 7.5 *Source Protection Area Map*).

(i) Groundwater Resource

During the ground investigation undertaken by GSIL, groundwater was encountered in all cable percussive boreholes drilled at the site. Most groundwater strikes occurred near, or within 2 m of the top of the weathered limestone. Other smaller seepages were encountered at the base of the Made Ground and at the top of the soft clay/silt (underlying peat). Most of the strikes encountered within the weathered limestone were at depths of between 6 m and 10 m below ground level. In the main test pumping well on the site, groundwater table measurements undertaken prior to the start of the pumping test showed a depth of approximately 6.5m below ground level

Following the completion of all drilling activities on-site by GSIL, a pumping test was undertaken to ascertain the sustainable yield of groundwater available in the aquifer beneath the site. This pumping test was carried out in order to determine if there was a sufficient water resource available to supply the proposed power plant development with the required quantity of water without having any negative impacts on the groundwater resource in the area. The pumping tests undertaken by GSIL identified that the pumping well had sufficient capacity to supply up to $630m^3$/day on an ongoing basis.

7.4.5 Hydrology

The site is located within the Eastern River Basin District (ERBD) and within the River Boyne catchment area. The nearest rivers to the site are the Mongagh River 0.7 km to the north of the site and the Yellow River 1.4 km to the south of the site. Both of these rivers are tributaries of the River Boyne. The Mongagh River is a tributary of the Yellow and flows into the Yellow c. 15 km downstream. The Yellow River flows into the River Boyne a further 2 km downstream. A detailed assessment of the surface water resources and potential impacts on them arising from the proposed development are discussed in Chapter 6 *Water Quality.*

7.4.6 Radon

Information obtained from the Radiological Protection Institute of Ireland (www.rpii.ie) indicates that the site is located in a High Radon Area (See Figure 7.6 *Radon Levels Map*), where greater than 20% of dwellings are predicted to have radon levels in excess of 200 Bq/m^3. The Radiological Protection Institute of Ireland has set a safe level of radon of 200 Bq/m^3 and protective measures are likely to be required where this threshold is exceeded.

7.4.7 Geological Heritage Areas

A Geological Heritage Area is one which contains geological or geomorphological features considered to be of national interest and recommended for Natural Heritage Area (NHA) designation by the GSI under the Wildlife (Amendment) Act 2000.

A consultation response letter received from the Geological Survey of Ireland (26th May 2008) has identified that there are no geological heritage sites currently on the GSI database for the area or near the area. (See Appendix 1D*: Consultation Responses*).

7.5 Impact Assessment

7.5.1 Soil and Groundwater Condition

Potential sources of contamination have been identified following the ground investigation. Elevated levels of TPH, nickel and other contaminants have been detected, in various concentrations, in soils and groundwater during the site investigation. Isolated pockets of industrial waste materials were also identified in some of the trial pits. The locations of the exploratory holes are shown on Figure 7.1 *Ground Investigations.*

A risk assessment was used to identify any risk arising from onsite contamination. Risk assessment involves identification of the hazards and evaluation of the risks associated with these hazards. Risk assessment requires an evaluation of a conceptual "source – pathway – receptor" linkage model and can be qualitative or quantitative.

Based on the available information for the site, the following potential contamination sources have been identified from an assessment of historic and current activities on or in close proximity to the site:

- **S1**: Made Ground consisting of construction related fill or imported materials (source unknown) to a shallow depth across the majority of the site area. Concentrations of metals and hydrocarbons were found above the limit of detection in samples from this material;

- **S2**: The nearby, and still operational, narrow gauge railway. Fuel storage tanks are present on site for the servicing of rail haulage and milled peat production equipment;

- **S3**: Old machinery located in various areas around the site;

- **S4**: Oil and grease from operational machinery moving around the site;

- **S5**: Off site sources. The site is surrounded on all sides by former peat extraction areas, providing a potential source of organic materials and ammoniacal nitrogen to groundwater in the vicinity of the site;

- **S6**: Structures. Existing structures on the site are to be demolished prior to the commencement of construction. These structures may contain asbestos, plus stores of other potential contaminants.

(i) Potential Contaminant Pathways

The following potential contamination pathways have been identified on the site:

- **P1**: Inhalation, ingestion and direct contact;

- **P2**: Groundwater movement through superficial deposits and the underlying aquifer;
- **P3**: Groundwater movement onto site from areas of former peat extraction;
- **P4**: Surface runoff;
- **P5**: Gas migration;
- **P6**: Root uptake.

(ii) Potential Contaminant Receptors

The following potential receptors have been identified:

- **R1**: Construction and maintenance workers;
- **R2**: Future end users;
- **R3**: Buildings and infrastructure;
- **R4**: Deep groundwater which may be extracted for the proposed power development;
- **R5**: Groundwater residing in the variably permeable superficial strata;
- **R6**: Farmland to the south of the site;
- **R7**: Peat Bogs;
- **R8**: Flora and Fauna.

Table 7.8 *Potential Pollution Linkage Pathways and Associated Risks* shows the anticipated "Source-Pathway-Receptor" linkages, with an assessment of the anticipated risks following construction.

Table 7.8: Potential Pollution Linkage Pathways and Associated Risks

Source	Principal contaminants from testing	Receptor	Potential transport pathways	Likelihood of Source- Receptor linkage	Potential Consequence	Risk Classification	Risk Management Required
S1 Made Ground **S2** Narrow Gauge Railway **S3** Disused Machinery **S4** Operational Tractors and Peat Extraction Machinery **S5** Off site Sources **S6** Structures	TPH, Nickel, (soils), TPH, Ammoniacal Nitrogen, Chromium, Copper, Iron, Nickel, Zinc, pH (groundwaters), asbestos in existing structures (assumed)	**R1** Construction and Maintenance Workers **R2** Future End Users	**P1** Human Uptake Pathways:	Likely during construction – unlikely post construction	Medium	Moderate for pre construction phase and Construction Phase Low for post construction phase.	Further investigation and remediation of the identified TPH, VOC, Nickel and industrial waste contamination will be agreed with the EPA under the terms of the existing IPPC licence. However, the results at present do not indicate significant risks to human health following construction. During construction appropriate working practices should be put in place to minimise contact with areas of contaminated soils, including but not limited to the use of PPE, dust suppression, use of machines to excavate instead of hand digging, stockpiling of contaminated soils separately from the bulk of the excavations and other measures as appropriate. These measures are set out in the following sections of this report. Following construction the site is likely to be overlain by impermeable hardstanding which will prevent human contact with the identified areas of contamination. Where areas of the site are proposed to be landscaped, further investigation may be required in order to determine the remedial requirements in these areas as directed by the EPA under the terms of the existing IPPC licence. Capping with clean topsoil, capillary break layer and basal geo-textile may be required if contamination is identified in these areas.
	TPH, Ammoniacal Nitrogen, Chromium, Copper, Iron, Nickel, Zinc, pH	**R4** Underlying Aquifer **R5** Shallow Groundwater **R6** Adjacent farmland (Off site)	**P2** Groundwater movement through superficial deposits and the underlying aquifer **P3** Groundwater migration from	Unlikely – concentrations have been decreasing throughout the monitoring and the most recent groundwater monitoring round indicated that	Medium	Low	The results of groundwater monitoring indicated marginally elevated concentrations of ammoniacal nitrogen and nickel. Concentrations of TPH were initially elevated when testing for TPH and DRO. However, analysis for TPH CWG, which removes interference from naturally occurring organic compounds, did not record concentrations of TPH above the detection limits of the laboratory. The risks to groundwater and the other identified receptors are therefore not considered significant. However, given the observed

Source	Principal contaminants from testing	Receptor	Potential transport pathways	Likelihood of Source- Receptor linkage	Potential Consequence	Risk Classification	Risk Management Required
		R7 Adjacent Peatbogs (Off site)	off site sources	significantly elevated contaminant concentrations were not present – monitoring is ongoing and this shall be reviewed as necessary			variation in the ongoing groundwater monitoring it is recommended that the monitoring regime is continued in order to confirm that concentrations remain within acceptable levels.
	Copper, Nickel, Zinc	**R8** Flora and Fauna	**P6** Root Uptake	Unlikely	Medium	Low	If contamination is identified in areas proposed for landscaping, treatment will be undertaken as directed by the EPA under the terms of the existing IPPC licence.
	Ground Gas, TPH, Sulphates	**R3** Buildings and Infrastructure	**P2 and P3** Groundwater Migration **P5** Migration of Volatile Vapours and Ground Gas	Likely	Medium	Moderate	The low pH associated with the peat deposits and high sulphate content of groundwaters associated with the peat may have a negative impact on below ground concrete structures. Appropriate design should be used in order to mitigate against the potential risks associated with this. Elevated concentrations of hydrocarbon in soils can potentially affect the setting of concrete. The appointed contractor should mitigate for this during the design and specification of below ground concrete structures. The results of gas monitoring did not indicate the presence of significant concentrations of ground gas. However, The site is located in an area where the radon concentration in >20% of dwellings is likely to exceed 200 Bq/m^3.

(iii) Summary of Baseline Risks

The risks in the vicinity of the proposed development associated with the baseline environmental conditions are anticipated to comprise the following:

- Contamination within the Made Ground either as a result of materials within the imported fill or due to spillages / leakages from on site processes and storage areas (See Table 7.9 *Summary of Exceedances of Human Health Criteria in Soil Samples*). In addition to the presence of nickel, areas of Total Petroleum Hydrocarbon (TPH) and Volatile Organic Compounds (VOC) contaminated soils were observed during the ground investigation and may pose a potential risk to human health during construction without appropriate mitigation. The assessment of the potential risk posed from this contamination, using the methodology described in Section 7.2.3 *Impact Assessment Methodology* results in a classification of "moderate risk" during the pre construction and construction phase. However with the implementation of risk management procedures as detailed in Table 7.8 *Potential Pollution Linkage Pathways and Associated Risks* the risk will be reduced to "low risk". Such risk management procedures include the remediation of the site where necessary as agreed with the EPA under the existing IPPC license, and the implementation of appropriate working practices to minimise contact with areas of contaminated soil. Following the construction of the development the potential risk is classified as "low risk" in terms of the risk to human health.

- Gassing ground (Radon, VOCs): The associated risk has been evaluated using the impact assessment methodology as a moderate risk . However with the implementation of risk management procedures as detailed in Table 7.8 *Potential Pollution Linkage Pathways and Associated Risks* the risk will be reduced to "low risk".

- Contaminated groundwater – ammoniacal nitrogen, iron, nickel and TPH (See Table 7.10 *Summary of Exceedances in Groundwater and Leachate Analysis*). It is considered possible that the contaminants may have been introduced to the aquifer during the drilling process used in the installation of the monitoring boreholes on the site. The contamination may have been introduced by the dragging down of Made Ground during the drilling process. The overall risk to groundwater arising from the site, evaluated by the impact assessment methodology, is categorised as low risk.

Table 7.9: Summary of Exceedances of Human Health Criteria in Soil Samples

Parameter	AC mg/kg	Number of Samples	Mean Value mg/kg	Minimum Value mg/kg	Maximum Value mg/kg	UCL_{95} if Concentration >AC	No >AC
Nickel	100 (Dutch)	13	48.7	2	180	101.2mg/kg	1/13
VOCs (dichloromethane)	3.9 (Dutch)	3	N/A*	0.8	4.5	N/A*	2/3

* Not calculated as inappropriate to do so given the limited dataset.

Table 7.10: Summary of Exceedances in Groundwater and Leachate Analysis

Parameter	IEPA Interim Guideline Value	Minimum	Maximum	No >AC	List I, List II or non list Substance	Risk Status
Ammoniacal Nitrogen	0.15mg/l	<0.2mg/l	8.3mg/l	**15/20**	II	Minor[1]
Barium	0.1mg/l	0.033mg/l	0.247mg/l	**5/21**	-	Minor
Chromium	0.03mg/l	0.003mg/l	0.036mg/l	**1/15**	II	Minor
Copper	0.03mg/l	0.001mg/l	0.144mg/l	**2/20**	II	Minor
Iron	0.2mg/l	0.018mg/l	2.6mg/l	**6/21**	-	Minor
Nickel	0.02mg/l	0.014mg/l	0.143mg/l	**10/21**	II	Minor[2]
Zinc	0.1mg/l	0.026mg/l	0.251mg/l	**4/21**	II	Minor
pH Value	≥6.5 and ≤9.5	4.32	7.75	**4/21**	II	Minor
TPH	10µg/l	<10µg/l	770µg/l	**2/20**	I	Minor

[1] Concentrations were observed to decrease throughout the monitoring period. The identified concentrations of ammoniacal nitrogen are stated by the World Health Organisation (WHO) to be below that where health effects are likely and were only marginally elevated above the assessment criteria in the 3rd round of monitoring.
[2] Concentrations were observed to decrease throughout the monitoring period, during the last round, with the exception of borehole CP 2 concentrations were all below the assessment criteria. Concentrations within CP 2 during the last round were below the UK Drinking Water Standard and are not considered indicative of significant contamination of groundwater. Subject to the ongoing groundwater monitoring continuing to show decreasing concentrations the risks have been stated as Low. Testing for TPH CWG in the 4th and final round of monitoring did not record the presence of hydrocarbon contamination. Previous elevated concentrations may have been the result of interference of natural organics in groundwaters due to the presence of overlying organic peat deposits.

(iv) Pre-Construction Consultations

Following the discovery of potential contaminants within the Made Ground during the site investigation survey, Bord na Móna has initiated a management strategy. This strategy is being carried out in consultation with the EPA, under the provisions of the existing IPPC licence, to remove any identified waste materials, including potential sources of contamination.

7.5.2 Construction Phase Impacts

The major potential construction phase impacts are set out hereunder. Mitigation measures to address these impacts are set out in *Section 7.6.1 Pre-Construction Mitigation Requirements* and *Section 7.6.2 Mitigation of Construction Impacts*

- Generation of dust. This could temporarily affect neighbouring sites and site users. It should be noted that dust suppression/minimisation will be incorporated into the Construction Environmental Management Plan given the nuisance and irritant factor which can arise from elevated dust levels in the atmosphere;

- Generation of contaminated surface water run-off. Runoff from construction sites can contain high levels of entrained sediments or other water pollutants dependent on the nature of contamination sources on the site;

- As set out previously in this chapter, levels of TPH and other contaminants have been detected in varying concentrations during the site investigation. As a consequence, and having regard to the fact that the current site activities are controlled by an Integrated Pollution Prevention Control licence, the Environmental Protection Agency has been informed of same. Any further investigations, monitoring or intrusive works to be completed will be in accordance with an agreed strategy with the Environmental Protection Agency paying due regard to the associated environmental and health and safety risks and implementing the necessary controls;

- The site is located within an area where >20% of premises are likely to exceed a radon concentration of 200 Bq/m3. The potential presence of radon is unlikely to affect the workforce as it is known to dissipate rapidly on contact with the open air. Comprehensive radon monitoring will be conducted on site during the construction phase in accordance with Radiological Protection Institute of Ireland guidelines. It is anticipated that a radon gas barrier will be required however the requirement for same in addition to any further mitigation measures will be agreed with the Radiological Protection Institute of Ireland based on the monitoring results obtained in order to prevent build-up of radon gas in enclosed areas;

- Groundwater as a result of excavations on-site as part of the construction phase, which require disposal, will be treated in advance of discharge to adjacent watercourses in agreement with the Eastern Regional Fisheries Board. Such waters will be treated appropriately (e.g. sedimentation ponds/oil interceptors) to ensure that they pose no risk of pollution to the receiving watercourses;

- Spillages / leaks of chemicals or hydrocarbons during construction can result in pollution of soil, surface and groundwaters; and

- Appropriate toilet and treatment facilities will be provided for 'domestic nature' sewage generated on-site during the construction stage.

7.5.3 Operational Phase Impacts

The major potential operational phase impacts are set out in this section. Mitigation measures are discussed in *Section 7.6.3 Mitigation of Operational Impacts* of this report:

(i) Predicted Water Requirements

Water for the power plant will be provided from a borehole located at the eastern side of the site. As part of the hydrogeological assessment of the site, a pumping well was drilled and tested. The pumping tests indicated that a sustainable yield, of 630 m^3/day, could be obtained from the aquifer underlying the site.

There are a number of processes in the operation of the power plant which consume water. Certain processes require water with a high level of purity, to prevent corrosion or damage in the boiler and the gas turbines. This high purity water, referred to as demineralised or 'demin water', is produced in the water treatment plant.

The water treatment plant takes raw water from the groundwater source and removes the constituent salts, which are then disposed of, either as a waste sludge, or in effluent which is discharged to the process wastewater tank. The estimated efficiency of the treatment plant for the proposed development is 75%, which means that 100 m^3 of raw water is required to make 75 m^3 of demin water, with the other 20 m^3 being removed as process wastewater.

The main processes that require demin water in the power plant are:

- Make up water for the water/steam cycle in the CCGT unit, to replace 'blow down' and other water losses from the system. 'Blow down' is a continuous purge of water required to maintain the correct water quality in the boiler.

- The gas turbines inject water with the fuel to abate NOx emissions, when fired on distillate. This is a very large potential demand for water, equating to about 95 m^3/h for the CCGT gas turbine and 57 m^3/h for the OCGT turbine. However, the turbines use a dry NOx suppression system when fired on gas, which consumes no water.

- There are other processes which consume a relatively minor quantity of demin water, including gas turbine cleaning, and continuous sampling for boiler water quality monitoring.

It can be taken that, while a small proportion of the demand is independent of the running profile of the power plant, the majority of this demand will only occur when the power generating units are operating.

In addition to the process demands for demin water, there is a small demand for raw water on the site, including potable water supply and supplies for cleaning and sanitation. This demand is independent of the running profile of the power plant.

The demin water consumption of the plant is therefore highly variable, depending on how the plant is dispatched, and the fuel that is used. In order to manage this variability, the plant has a large capacity of storage for demin water, amounting to 21,000 m^3, which acts as a reserve for periods of very high demin water demand. During periods when the demand for demin water is low, the reserves are replenished by the water treatment system.

In order to assess the adequacy of the demineralised water storage capacity, a number of operational scenarios for the plant were considered as detailed below.

- Scenario 1: Running of both units on natural gas with a projected annual running profile of 6,000 hours for the CCGT unit and 500 hours for the OCGT unit, which is equivalent to 16.4 hrs/day and 1.4 hrs/day on average for the respective units;

- Scenario 2: The same running profile as Scenario 1, but with the OCGT unit fired on distillate fuel. Whilst it is not possible to categorically state the daily running hours of the proposed plant as this will be dictated by the demand for electricity generation arising from Eirgrid, It is considered that this scenario represents the typical daily operational profile of the proposed power plant

- Scenario 3: The CCGT unit running on natural gas at maximum output (24 hrs/day), whilst the OCGT unit runs on distillate for a period of 6.6 hrs/day. This scenario covers the operation of the proposed power plant for short term peak potential demand, and

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- Scenario 4: Scenario, where Eirgrid directs generators to generate using their secondary fuel. The Secondary Fuelling Obligation is discussed in Section 3.7.5 (v) *Back Up Fuel* and would only be invoked in the event of a significant supply interruption to the national gas transmission system. This scenario assumes both the CCGT unit and the OCGT unit run on distillate for 24hrs/day.

The water requirements for each scenario are presented in Table 7.11 *Adequacy of Demin Water Storage Capacity under Four Operational Scenarios.* All of the first three scenarios show a significant reserve, ranging from 33 to 106 days. This reserve can allow the plant to operate un-interrupted if there is a short term interruption in the groundwater supply, or in the operation of the water treatment plant. In addition, the assessment of Scenario 4 indicates that there is sufficient demineralised water storage capacity to operate both units on distillate only for 5 days, which concurs with the periods required under the Secondary Fuelling Obligation as required by the Commission for Energy Regulation (CER).

Table 7.11: Adequacy of Demin Water Storage Capacity under Four Operational Scenarios

Scenario No.	Demin Water Requirements (m^3/day)	Demin Water Storage Capacity in Tanks (m^3)	No. of Days Storage)
Scenario 1	198	21,000	106
Scenario 2	277	21,000	76
Scenario 3	639	21,000	33
Scenario 4	3,918	21,000	5

The groundwater source on the site, and the water treatment plant, will operate independently of the water demand from the power plant, in order to maintain the necessary reserve levels of demineralised water. Demineralised water used in the plant will be taken from the storage tanks, and the reserves will be cycled to ensure that the demineralised water does not denature due to prolonged storage.

Raw water from the borehole source will be pumped to the raw water storage tank which will have a capacity of 3,500 m^3. This tank will provide approximately 3m^3/day for services, including canteen, showers, toilets and washing facilities. There is also a requirement for 500 m^3 of raw water for fire fighting purposes. The balance of the raw water storage capacity is used to feed the demineralised water production plant.

The adequacy of water supply from the borehole was assessed by considering the maximum potential demand over the course of the year, as short term variations in the supply/demand balance are buffered by the demineralised water storage on the site, as discussed above. As a worst case, the maximum possible load factor for the CCGT unit was used, equating to approximately 8,000 hours per year. It is assumed that the unit will be fired on gas, but two days running on distillate per year is included for testing of fuel changeover arrangements. In addition, it is assumed as a worst case that the OCGT unit runs on distillate for 900 hours, equivalent to an annual load factor of 10%, which is estimated as an upper limit for operating the unit on distillate alone.

The total demand from this scenario, and the supply available from the borehole, is detailed in Table 7.12 *Assessment of the Adequacy of the Water Supply from the Borehole,* below:

Table 7.12: Assessment of the Adequacy of the Water Supply from the Borehole

Water Demand Process	Demin Water Consumption	Raw Water Consumption	Raw Water Equivalent	Operating hours	Total
CCGT - gas	11 m^3/h		15 m^3/h	8,000 h/yr	120,000 m^3/yr
CCGT - Distillate	106 m^3/h		141 m^3/h	48 h/yr	6,768 m^3/yr
OCGT - Distillate	57 m^3/h		76 m^3/h	900 h/yr	68,400 m^3/yr
Other		30 m^3/day	30 m^3/day	365 day/yr	10,950 m^3/yr
Total - Maximum Annual Raw Water Demand					206,118 m^3/yr
Annual yield from borehole			630 m^3/day	365 day/yr	229,950 m^3/yr
Ratio of maximum raw water demand to supply					88%

The table shows that the borehole can meet the maximum possible annual demand for raw water from the power plant, with a reserve margin of 12%.

In conclusion there is sufficient water available from the aquifer, with a sustainable yield of 630m^3/day at the proposed development site, to supply the maximum possible demand of the proposed power plant. There is also sufficient water storage reserves held on the site to allow for the prolonged operation of the facility under different scenarios as described above, without negatively impacting on the groundwater resource under the site.

Based on the results of the site investigation and pumping test conducted on site a cone of drawdown would extend up to 300 m from the abstraction well. The cone of drawdown does not extend beyond the site boundary. It is considered that it would be unlikely that there would be any change in the effective stress beyond the cone of drawdown, therefore dewatering related settlement would be unlikely to occur beyond this point. It is anticipated that there will be no hydrogeological impact on the R400 road from water abstraction at the proposed pumping well on the site.

The impact of the drawdown on the proposed development site within 300 m of the pumping well was also assessed. By calculating the change in effective stress, as a result of the change in groundwater level, the settlement of each soil layer below the groundwater table can be estimated. It was usually found to be the case that the peat and soft clay/silt layers were above the groundwater table and therefore these deposits were not generally affected by any drawdown. The maximum predicted settlement was found to be approximately 10 mm, adjacent to the pumping well in OB1/BH04, reducing to less than a millimetre in BH02 at the south east corner of the site. The settlement at the well location, based on a 5.2 m of drawdown, was estimated to be between 15 mm and 20 mm. The cone of drawdown does not extend to the R400 roadway and it is not anticipated to impact on the road.

Abstraction of the groundwater in the limestone aquifer for use as process water in the proposed development is considered not to have a significant effect on the abstraction of groundwater from neighbouring properties. The nearest off site abstraction point is located approximately 1.3 km away. Based on the well coordinates provided by GSI, the approximate positions of these wells are shown in Figure 7.4 *Water Mains and Wells within 2 km of the Proposed Development Site.* The majority of the buildings in the vicinity of the proposed development are served by water mains and will therefore be unaffected by the proposed abstraction.

The abstraction of water from the pumping well is unlikely to have any impact on surface water resources in the area such as the Mongagh River, which is located *c.* 0.7 km north of the site, or the Yellow River, located *c.* 1.4 km to the south of the site, due to the fact these resources are significantly outside the cone of drawdown. There are no sensitive water dependent ecosystems within the predicted cone of drawdown and so it is not anticipated that there will be any significant impacts on any such resources.

(ii) Other potential impacts

- The site is in an area where levels of radon above the action level of 200 Bq/m3 may occur in buildings. It is considered that mitigation measures to prevent gas ingress will be required to be incorporated into the buildings during the design and construction in order to mitigate against the risks to operating personnel;

- The risks posed by contaminated surface water run-off are potentially high, given the vulnerability of the surrounding peat bog, which is likely to provide baseflow to the neighbouring watercourses and itself comprises a wetland area;

- The risks to groundwaters following construction and commissioning of the CCGT and OCGT units are considered to be low. Evidence of contaminated groundwaters was noted during the Glovers site investigation and is summarised in Table 7.8. *Potential Pollution Linkage Pathways and Associated Risks.* However, the proposed development will require the abstraction of significant volumes of groundwater, up to 630 m^3 per day, for use as process water, which will cause drawdown towards the abstraction well. This would mean that the potential for migration of the identified contamination would be reduced. Ongoing monitoring of the groundwater indicated that concentrations have reduced and the most recent groundwater monitoring round did not record significantly elevated concentrations of contaminants. It is considered possible that the contaminants may have arisen due to the intrusive nature of the drilling process. Any further investigations, monitoring or intrusive works to be carried out will be in accordance with an agreed strategy with the Environmental Protection Agency, paying due regard to the associated environmental and health and safety risks and implementing the necessary controls.

7.6 Mitigation Measures

7.6.1 Pre-Construction Mitigation Requirements

Variable concentrations of TPH and other contaminants were detected during the site investigation. As a consequence, and having regard to the fact that the current site activities are controlled by an Integrated Pollution Prevention Control licence, the Environmental Protection Agency has been informed of same. Any further investigations, monitoring or intrusive works to be carried out will be in accordance with an agreed strategy with the Environmental Protection Agency paying due regard to the associated environmental and health and safety risks and implementing the necessary controls. Aquifer protection measures will be employed during the piling in accordance with the current best practice: *Piling and Penetrative Ground Improvement in Land Affected by Contamination: Guidance on Pollution Prevention (Environment Agency, 2001).*

The site is located within a high radon area. Comprehensive radon monitoring will be conducted on site during the construction phase in accordance with Radiological Protection Institute of Ireland guidelines. It is anticipated that a radon gas barrier will be required however the requirement for same in addition to any further mitigation measures will be agreed with the Radiological Protection Institute of Ireland based on the monitoring results obtained to prevent build-up of radon gas in enclosed areas.

Prior to the demolition of existing structures on-site a Construction and Demolition Waste Management Plan will be developed in accordance with the Department of the Environment, Heritage and Local Government's *Guidelines on the Preparation of Waste Management Plans (WMP) for Construction and Demolition Waste Projects (DEHLG, 2006).* This plan will address all wastes to be generated during the demolition and construction phases of the project, including asbestos, or asbestos containing materials, which may be present in the structures proposed for demolition.

7.6.2 Mitigation of Construction Impacts

The environmental effects likely to arise during the construction phase of the project will be identified and managed through a Construction Environmental Management Plan (CEMP). The CEMP shall, as a minimum, address the following issues relating to effects arising from contaminated ground, as well as other more general environmental impacts:

- Water pollution will be prevented through the effective management and storage of chemicals and hydrocarbons. This will include the development of designated impervious and bunded chemical storage locations in addition to the installation of paved and ramped areas for refuelling. Such areas will be provided with a hydrocarbon interceptor for the treatment of surface waters generated at such locations;

- A comprehensive and integrated approach for water quality protection during construction will be implemented as part of the Construction Environmental Management Plan to prevent impacts to water quality in watercourses adjacent the construction site. This will incorporate such principles as silt control measures, such as sedimentation ponds, stabilisation of exposed soils which pose a risk of generation of contaminated surface water run-off and regular inspections and testing if considered necessary following consultation with the Eastern Regional Fisheries Board;

- Chemicals and hydrocarbons will not be stored within 10 metres of any surface waters or 50 metres of a borehole or well. Designated areas where chemicals or hydrocarbons are delivered, stored and dispensed will be isolated from the surface water drainage system, open ground or other porous surfaces. This will be achieved using drainage grids, gullies or kerbs in conjunction with surfaces impermeable to the products used. Potentially contaminated water and spills will be directed through an oil separator and prevented from seeping into the soil and groundwater below the site. The separator will be of an adequate size to serve the appropriate surface area catchment of the site;

- Bunds for the storage of chemicals and hydrocarbons will be lined or constructed of materials resistant to damage by the materials stored therein. In addition the capacity of such bunds will be a minimum of 110% of the volume of the largest container stored therein or 25% of the total volume, whichever is the greater. Bunds will be designed in accordance with Environmental Protection Agency guidance in relation to the storage of potentially polluting liquids (*"IPC Guidance Note on Storage and Transfer of Materials for Scheduled Activities"*, 2004) paying due regard to procedures for emptying potentially contaminated rainwater, if uncovered, orientation of fill/discharge points, valves and other risk connections within the bund structure;

- Portable toilets will be provided on site for the construction phase of the project and arrangements will be made to transport all waste generated to an appropriately licensed off site facility;

- All plant and equipment on site will be regularly maintained and inspected. Leaks will be repaired immediately prior to use of the affected item. Drip trays will be provided and used for all stationary plant. If wash down is required, a designated wash down area will be used, served by oil / water separators and isolated from the surface water drainage;

- Spill kits will be maintained near working areas. All spills / leaks will be cleaned up immediately. An emergency response plan will be put in place as part of the Construction Environmental Management Plan detailing the measures to be undertaken should pollution be identified;

- A Construction and Demolition Waste Management Plan will be developed and implemented in accordance with the Department of the Environment, Heritage and Local Government's *Guidelines on the Preparation of Waste Management Plans (WMP) for Construction and*

Demolition Waste Projects (DEHLG, 2006). The focus of this plan will be effective identification, quantification and recording of wastes generated on and removed from the construction site. The plan will also demonstrate how compliance is being achieved with all relevant national legislation for waste management and clearly identify all waste contractors utilised for the disposal, recycling or recovery of waste materials generated on-site;

- Construction activities will be carried out in accordance with the CIRIA Document C650 *Environmental Good Practice on Site, (CRIA, 2005);* and

- Using the methodology set out in *Concrete in Aggressive Ground* (BRE, 2005), and assuming mobile groundwater conditions, buried concrete will be designed for a design sulphate class of DS-2 and for an aggressive chemical environment for concrete (ACEC) class of AC-5z. This ACEC class considers the whole site, including the more acidic areas where peat is prevalent. However, due to the variable ground conditions on site, it is recommended that further tests are carried out on soils and groundwater during detailed design and in advance of commencement of construction activities to confirm this classification.

7.6.3 Mitigation of Operational Impacts

The major operational phase mitigation measures associated with the proposed development are considered to comprise the following:

- Pre-treatment of the abstracted groundwaters will be required to ensure its suitability for use as boiler / process water. Monitoring of all discharged waters will be required under the IPPC license for the development, in order to ensure that the effluent water quality is in compliance with the licence conditions;

- Storage of hydrocarbons and other hazardous or potentially polluting materials will be undertaken in accordance with best practice (See IPC Guidance Note on Storage and Transfer of Materials for Scheduled Activities, EPA, (2004)) and the conditions detailed for the IPPC licence for the site;

- An emergency response plan, setting out the procedures to be followed in the event of spillages or other pollution events, will be put in place in accordance with the requirements of the Integrated Pollution Prevention Control Licence for the site;

- Waste water, including potentially contaminated runoff, will be treated in dedicated systems to the appropriate standards, prior to discharge off site in accordance with the conditions set out in the Integrated Pollution Prevention Control Licence for the site;

- The proposed maximum abstraction of groundwater, at 630 m^3/day, is likely to cause settlement of the ground within the cone of drawdown. There is an associated risk of settlement related damage to structures on site. In order to mitigate against this potential risk all structures on the site will be designed to tolerate such settlement; and

- The maximum abstraction from the pumping well at the proposed development site will be 630m^3/day.

7.7 Residual Impacts

The mitigation strategy above recommends actions which can be taken to reduce or offset the scale, significance and duration of the known and potential impacts on soils, geological and hydrogeological resource. The purpose of this statement is to specify mitigation measures, where appropriate, to minimise the ‘risk factor’ to all aspects of these resources on site.

It is anticipated that with the implementation of mitigation measures detailed above neither the construction nor operational phases of the development will impact significantly on the geology, hydrology or hydrogeology of the area.