11.0 SOILS AND GEOLOGY

11.1 Introduction

This Chapter of the EIS considers the potential and likely significant soils and geology effects of the proposed alterations to the permitted development. The purpose of this chapter is to identify and describe any likely significant soils and geology effects as a result of the proposed alterations in the context of the permitted development.

11.2 Methodology

The assessment methodology is based on the document produced by the Institute of Geologists of Ireland, "Geology in Environmental Impact Statements – a guide", September 2002. This document outlines the likely impacts and potential mitigation measures for geological issues by topic, although no importance criteria are given by which the impact can be graded.

Information from a number of sources was collated in preparation of this Chapter and are outlined below:

- Ordnance Survey of Ireland, Discovery Series,
- Ordnance Survey of Ireland online historical maps and aerial photographs,
- Ordnance Survey of Ireland online Environmental Report,
- Geological Society of Ireland, Geology of Cork (1:100,000) Sheet 25,
- Geological Society of Ireland online Groundwater Database, Aquifer Classification, Aquifer Vulnerability, Teagasc Soil Classification,
- National Parks and Wildlife Service online database,
- Environmental Protection Agency online mapping,
- National Maritime College, Ringaskiddy, Co. Cork. Site Investigation Contract Interpretive Report No. 179116. Geotech Specialists Limited,
- Implementation of Port of Cork Strategic Development Plan, Ringaskiddy, Co. Cork. Site Investigation. Report No. 05-653. Glover Site Investigations Limited 2006,
- Site Investigation for a Proposed Development at the National Maritime College, Cork. Interpretive Report. Site Investigations Limited (Contract No. 4900) 2009,
- Marine Energy Research Centre, Ringaskiddy. Preliminary Site Investigation Factual report. No. P11038. PGL Priority Geotechnical August 2011.
- Ringaskiddy Port Redevelopment Site Investigation Report - PGL Priority Geotechnical 2015.
- OSI Environmental Report - Reference No. 19651241
- New Maintenance and Office Building Preliminary Risk Assessment Report (See EIS Volume III – Appendix 11.1).

A glossary of terms used to explain the quality and significance of impacts used in this assessment are outlined below:

- Positive Impact – a change which improves the quality of the environment.
- No Change Impact – a change which does not affect the quality of the environment.
- Negative Impact – a change which reduces the quality of the environment.
- Slight Impact – an impact which causes noticeable changes in the character of the environment without affecting its sensitivities.
- Moderate Impact – an impact that alters the character of the environment in a manner that is consistent with existing and emerging trends.
- Substantial Impact – an impact which, by its character, magnitude, duration or intensity alters a sensitive aspect of the environment.

11.3 Baseline Conditions

11.3.1 Regional Geology

The geology of County Cork presents a simplistic geological structure (Figure 11.1 - EIS Volume II). The surface geology is controlled throughout by folds in the rock sequence, with the axis considered to run approximately from east to west. These folds were created during the Variscan Orogeny (a period

of mountain-building caused by continental collision) between approximately 390 and 310 million years ago.

The ridges which are evident across southern Cork comprise of Devonian age (roughly 415 to 360 million years ago) sandstones and mudstones. However, the valleys are considered to consist of much softer limestones from the Carboniferous period (roughly 360 to 300 million years ago) which have been eroded into u-shaped valleys by ancient rivers and glaciers.

Geologically recent Quaternary sediments cover many of the rocks, particularly in the valleys and are mostly of glacial origin, ranging from approximately 1.6 million years to the present day. These sediments have been deposited either directly from glacier ice during an Ice Age, or by glacial meltwater flowing from the ice. The sediments may be up to 100m thick in deep-cut valleys and are considered to represent a major resource in the Cork area, through sands and gravels which they are predominantly composed, of groundwater, and also of geothermal energy. Two buried valleys in the Cork Syncline can be classed as high yield regional aquifers.

11.3.2 Local Geology

The proposed alterations are located north of the "*Ringaskiddy Anticline*" – which is described as a small wedge of older sandstones and mudstones, known as the "*Kinsale Formation*" which have been thrust upwards by faulting. The site is underlain by the Waulsortian Mudbank which comprises pale grey massive Limestones (Figure 11.2 - EIS Volume II).

The geological map indicates that there are a number of geological faults which occur around the site (see Figure 11.3 - EIS Volume II). However, these faults are not currently active and the previous intrusive ground investigations undertaken for the permitted development at the site, confirm that these faults do not represent a threat to the stability of the site.

An area immediately south of the site is designated as a Geological Heritage Site by the Geological Survey of Ireland (Ringaskiddy, Golden Rock) due to the presence of exposed Limestone bedrock at the surface.

11.3.4 Soils

'Brown Podzolic' is the principal soil type in County Cork, which is a soil highly suited to agricultural use and in particular for pasture. When sufficiently supplemented with lime and fertiliser, it is possible for this type of soil to sustain 185 livestock units per 100ha. This soil is generally well drained and has good moisture holding capacity. The lime-deficient Acid Brown Earth that is mainly found to the north of the County but also present at Ringaskiddy, is also free draining with good moisture holding capacity. The soil originates from glacial drift of sandstone-limestone mix, and is generally of good structure. Although the soil is of relatively low nutrient status, it is considered to respond well to additives and is a desirable soil for both tillage and pasture lands.

A significant proportion of the Ringaskiddy Harbour has been constructed on reclaimed land. Therefore the site is underlain by fill material (Made Ground). Information provided by Port of Cork indicated that fill material for Ringaskiddy East was pumped ashore from Curlane Bank whilst Ringaskiddy West was filled with sands recovered from Spit Bank.

11.3.5 Hydrogeology

Eighty percent of Cork County Council's drinking water is provided from surface water resources, with approximately 94% of South Cork's total water supply originating from rivers and lakes *(Cork City WMP, 2004-2009)*. However, in contrast to this, North Cork is highly dependent on groundwater supplies.

Groundwater is water found below the surface of the earth, often occurring in natural reservoirs in permeable rock layers. Bedrock formations or sand and gravel deposits which yield significant quantities of water are called aquifers. The type of rock affects the volume and chemistry of the water. The dominant sandstone and limestone rock types around Cork are classified as aquifers but vary significantly in productivity. Figure 11.4 (EIS Volume II) represents the aquifer classification within the

area. It is apparent that the majority of the site has not been classified by GSI as it comprises reclaimed land. The land to the south of the site is classified as; a Locally Important Karstified aquifer (Lk) and also as a Locally Important aquifer (Li) which is only productive in local zones. The majority of the site has not been assigned a Groundwater Vulnerability rating by the GSI. The area to the south of the site is classified as having an Extreme vulnerability ('E'). There are currently no potable groundwater abstraction wells within a 1km radius of the site.

11.3.6 Surface Water Hydrology

Ringaskiddy is located within Cork Harbour which represents the closest surface water body to the site of the proposed alterations. The River Lee flows into Cork Harbour approximately 1.5km north of the site where it is classified as Transitional water (not fully saline and not fully freshwater). Under the Water Framework Directive, Cork Harbour is classified as being of Moderate status (2007-2009) and is at risk of not achieving good status by 2015. The River Lee where it enters Cork Harbour is classified as being of Good status (2007-2009), however it is also at risk of not maintaining its Good status by 2015.

Cork Harbour is designated as a Special Protection Area (SPA) (refer to Chapter 15), and as an important Shellfish area (refer to Chapter 13).

11.3.7 Previous Ground Investigations

A number of site investigations have been carried out in the area surrounding the site of the proposed alterations.

National Maritime College – Geotech Specialists Ltd, 1999
During May and June 1999, Geotech Specialists Ltd carried out a geotechnical site investigation on a site for the proposed National Maritime College. The investigation comprised 8 No. boreholes advanced via cable percussive boring techniques with follow on rotary percussive methods.

Ground conditions encountered during the investigation comprised Topsoil and Hydraulic Fill (medium dense silty Sand) overlying Glacial Clay (firm to stiff sandy gravelly Clay) or Gravel above Bedrock. Bedrock was encountered in one location only at a depth of 5.2m below ground level. No description of the rock is provided and the report assumes from the published geology that the rock is likely to be sandstone.

Marine Energy Research Centre – PGL Priority Geotechnical 2011
During May 2010, PGL Priority Geotechnical carried out a site investigation on a site for a proposed University College Cork marine research centre. The investigation comprised 2 No. cable percussion boreholes, 6 No. rotary cored boreholes and 9 No. trial pits.

The site was characterised by glacial deposits of slightly sandy gravelly Clay/Silt, slightly sandy slightly gravelly organic Silt, clayey/silty very gravelly Sand and very clayey/silty very gravelly Sand and silty sandy Gravel to depths of 10m below existing ground level.

Limestone bedrock was encountered at four test locations at depths of; 5.6m, 6.5m, 8.7m and 10.0m below ground level where it was described as moderately strong to very strong.

Groundwater was encountered at shallow depths within the Sand and Gravel deposits and at greater depth upon encountering the Limestone bedrock.

A limited number of sub-soil samples were analysed for metal, Hydrocarbon and Polycyclic Aromatic Hydrocarbon (PAH) contaminants. The laboratory results indicated that contaminant levels were low overall.

Port of Cork Strategic Development Study – Glover Site Investigations Ltd 2006
During November 2005 and again during March 2006, two phases of intrusive site investigation were completed by Glover Site Investigations Ltd. The site investigations were carried out within Cork Harbour in the area immediately adjacent to Ringaskiddy Pier (Oyster Bank) and also in the area adjacent to the existing Deepwater Berth (DWB). One borehole (RPSBH18) was advanced on land

within the current site area. The investigation made provision for the advancement of 17 No. boreholes by means of a Dando 2000 shell and auger drilling rig using light cable percussion techniques. These boreholes were drilled from a jack-up platform, manoeuvred around the site by tugboat.

The site investigation also made provision for eleven vibrocores, driven to practical refusal using a seabed vibrocore unit lowered to the seabed over the side of a workboat. These vibrocores were undertaken between 2st February 2006 and 2nd March 2006. During this time 4 No. cone penetration tests (CPTs) were completed by Lankelma from the jack-up platform using the shell and auger drilling rig to lower the facilitating casing and CPT rods to the required depth.

Twenty one (21 No.) grab samples were taken from the service boat at locations determined using GPS. Sediment contamination testing parameters and detection limits were recommended by the Marine Institute and the samples were sent to the Environment Agency (UK) for contamination analysis.

The general progression identified by the ground investigation was as follows:

- Uncompacted organic silt with occasional layers of sand, clay or shells (marine silt)
- Firm brown and grey brown very gravely sandy clay with some cobbles and boulders (glacial till)
- Very weak grey highly weathered fine-grained carboniferous limestone
- Moderately strong grey fine-grained carboniferous limestone

In some areas the cores contained mostly oyster shells (70%) in a matrix of uncompacted silt.

The borehole advanced on land within the site area encountered Made Ground to a depth of 4.6m which was underlain by Sand to the borehole completion depth of 10m. The Made Ground comprised; Limestone quarry fill underlain by Loose to medium dense grey slightly silty fine to medium Sand with occasional shells. The Sand was described as; medium dense grey slightly silty fine to medium Sand with occasional shells.

Extensive testing of sea bed sediments for chemical quality was carried out within the Oyster Bank and at the area adjacent to the existing ferry terminal at Ringaskiddy. Testing was also carried out in the area of Paddy's Point.

The sediment sampling results demonstrated that the sediments were not contaminated and would be therefore suitable for re-use where appropriate, or for disposal at sea where not suitable as engineering fill material.

Permitted Ringaskiddy Port Redevelopment - PGL Priority Geotechnical 2015
A number of boreholes were advanced across the Ringaskiddy site as part of a ground investigation for the permitted Ringaskiddy Port Redevelopment. A number of Trial Pits and boreholes were advanced in close proximity to the study site. The logs for these test locations are included within the New Maintenance and Office Building Preliminary Risk Assessment Report (See EIS Volume III – Appendix 11.1).

In summary, the ground conditions within the study area consist of Made Ground comprising gravelly Sand and Gravel which is underlain by deposits of Sand. Further south of the study area, deposits of Silt are present underneath Gravel deposits.

11.4 Impact Assessment

The following section assesses the potential impacts on soils, geology and hydrogeology for the construction and operational phases of the proposed alterations to the permitted development. Typically impacts occurring during the construction phase of a development result in short term exposure.

11.4.1 Construction Impacts

11.4.1.1 Soils and Geology

It is anticipated that earthworks will be required during the construction of the development for the proposed alterations. It will be necessary to utilise a piled foundation solution to construct the combi-walls required for the new quay wall extension. The combi-wall will comprise tubular steel piles installed at intervals with traditional steel sheet piles filling the space in-between. The tubular piles will be drilled and installed or grouted into the bedrock.

The new mooring dolphins will require piling. The three proposed mooring dolphins will comprise concrete pile caps on steel tubular piles and will be similar in scale and massing to the existing dolphins. Each dolphin will require 8 tubular steel piles with a diameter of 914 mm. Concrete pile caps will be approximately 7m x 7m x 2 m deep.

Dredging works will be carried out to -13.4m Chart Datum maximum adjacent to the altered Berth 1 to provide sufficient water depths for vessels. Bed conditions comprise uncompacted silts overlying Gravel, Clay and Limestone bedrock. Dredging will be required in all materials including bedrock.

The soft overlying silt material is unsuitable for use in the works and therefore this will be removed, either by backhoe or trailing suction hopper dredger, and disposed of at a sea disposal site. The quantity involved is in the order of 15,000m^3. The disposal of the dredged material will require application for a Dumping at Sea Permit from the Environmental Protection Agency; this will be subject to a separate consenting process.

Bedrock and other hard strata will most likely be removed by a combination of drilling and blasting, and/or the use of mechanical plant working from a floating or jack-up barge. Dredged rock and other suitable material will be re-used in the reclamation works.

Piling will be required for the construction of the maintenance and office building. Precast concrete piles will be installed to a competent underlying strata.

Construction activities may also include noise, dust, odour and site traffic generation problems as well as potential contamination issues arising with the use of fuel storage tanks, vehicles and the use of paints and oils.

The impact to soils and geology are considered to be slight and short term in nature. No significant impacts will occur.

11.4.1.2 Hydrogeology

At the construction stage during piling undertaken as part of the earthworks, groundwater may be encountered. Any potential groundwater encountered would require careful management in order to prevent further degradation of its quality. As there are no current potable groundwater abstractions within a 1km radius of the site (See EIS Volume III – Appendix 11.1), there will be no impact upon potable water supplies as a result of piling.

11.4.2 Operational Impacts

11.4.2.1 Potential Impacts to Groundwater

A number of activities can have an impact on groundwater resources, including:

- Excessive pumping e.g. from wells for water supply
- Saline intrusion (risk of over-abstraction in coastal areas pulling sea water into the groundwater body
- Pollution from nutrients, e.g. nitrates and phosphates
- Pollution from chemicals.

The proposed alterations is not anticipated to have an impact on the groundwater as it will not involve any abstraction of water and all surface runoff will be collected and diverted to the local waste water treatment system. Clean fill material will be used in the alterations to berth 1 therefore aquifer

protection zones do not need to be specified. Day to day operation of the Port will not involve the use of chemicals, however contingency measures will be put in place in the unlikely event of any oil spills as is best practice in all harbour developments.

11.4.2.2 Commercial Units

There are a number of commercial units located within the area and surrounding vicinity. Potential contaminants may arise from the storage of fuels, oils, greases and lubricants.

11.4.2.3 Contaminant Pathways

The majority of the site will be covered in hard-standing which will minimise contaminant exposure pathways in relation to human health.

Any made ground beneath the site may have the potential to be a source of harmful ground gases such as Methane and Carbon Dioxide. However the sand and gravel deposits underlying the site are of low organic content and the potential for ground gas generation is therefore low. No significant impacts will occur. The conceptual site model developed for the New Maintenance and Office Building Preliminary Risk Assessment Report (See EIS Volume III – Appendix 11.1) indicates that no source-pathway-receptor linkages will be present on the developed site and therefore the risk to human health and environmental receptors is considered to be low.

11.4.3 Cumulative Impacts

A range of projects (e.g. IMERC Masterplan, Spike Island Masterplan and East Tip Remediation Project, Haulbowline Island) has been taken into consideration as part of the cumulative assessment. When these projects have been considered as part of this assessment, no significant cumulative effects are predicted.

11.5 Mitigation Measures

11.5.1 Construction Phase Mitigation

As set out in section 11.4.1 the soils and geology assessment of the proposed alterations during the construction phase has not predicted any significant impacts.

The construction phase mitigation measures that formed part of the An Bord Pleanála approval of the permitted development of the Ringaskiddy Port Redevelopment remains entirely appropriate.

11.5.2 Operational Phase Mitigation

As set out in section 11.4.2 the soils and geology assessment of the proposed alterations during operation phase has not predicted any significant impacts.

The operational phase mitigation measures that formed part of the An Bord Pleanála approval of the permitted development of the Ringaskiddy Port Redevelopment therefore do not require any changes and remain entirely appropriate.

11.6 Residual Impacts

The residual impact relating to soils and groundwater by proposed alterations is considered negligible.