3FMProject

Bringing
Dublin Port
To 2040

Environmental Impact Assessment Report

Appendix 8.1

Volume 3 Part 3

COMHLACHT CHALAFORT ÁTHA CLIATH
DUBLIN PORT COMPANY

rps
A TETRA TECH COMPANY

Third & Final
Masterplan
Project

DUBLIN PORT: 3FM

Preliminary Risk Assessment (Desk Study) Report

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Dublin Port 3FM
Preliminary Risk
Assessment (Desk Study)
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1 INTRODUCTION

1.1 Project description

RPS was appointed by Dublin Port Company to undertake a Preliminary Risk Assessment (Desk Study) Report for the proposed 3FM Project. The 3FM Project will include the development of particular areas of Dublin Port lands on the Poolbeg Peninsula providing additional port capacity, infrastructure and facilities including an overall road network to entirely remove port traffic from public roads in the vicinity of Dublin Port.

This report describes the research and assessments undertaken to assess the ground conditions and potential for any ground contamination that may have arisen from the site's present and historical use.

1.2 Report Objectives and Scope

The objectives of this report are as follows:

- Collate desk study information regarding the site and surrounds to allow the identification of potential contaminant sources, potential pathways and potential receptors. This will form the basis of the Preliminary Risk Assessment and production of a Conceptual Site Model (CSM).
- Collation of existing geo-environmental data to facilitate a risk assessment with regard to potential risks to human health and environmental risks.
- Assessment of the above to determine if intrusive ground investigation and further assessment will be necessary.

1.3 Sources of Information

Sources of information used in the production of this report include:

- Internet based aerial photography
- Ordnance Survey Ireland mapviewer
- (http://maps.osi.ie/publicviewer/#V2,719558,734710,9,7)
- Geological Survey Ireland Spatial Resources Map Viewer – Department of Communications, Climate Action and Environment (http://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=a30af518e87a4c0ab2fbde2aaac3c228)
- Environmental Protection Agency Radon Map (http://www.epa.ie/radiation/radonmap/)
- Geological Survey of Ireland Geotechnical Data Viewer (http://spatial.dcenr.gov.ie/GeologicalSurvey/GeoTechnicalViewer/index.html)

- Environmental Protection Agency map viewer (https://gis.epa.ie/EPAMaps/)
- Land and Soil EPA maps (Geohive maps)
- Environmental Assessment of Contamination Remediation Report Volume 1 – Dublin City Council, January 2017
- Baseline for Environmental Assessment of Contamination Remediation Report Volume 2 – Dublin City Council, January 2017
- Tier 1 Environmental Risk Assessment, Historic Landfill at Shelly Banks, Co. Dublin – Dublin City Council, June 2019

1.4 Guidance

The following guidance documents have been used in the production of this report. In the absence of government guidance on contaminated land risk assessment within Ireland, current guidance provided by the UK Environment Agency (EA) has been utilised to form the basis of this assessment.

- Land Contamination Risk Management (LCRM) - How to assess and manage the risks from land contamination. Environment Agency, July 2023.

1.5 Risk Assessment

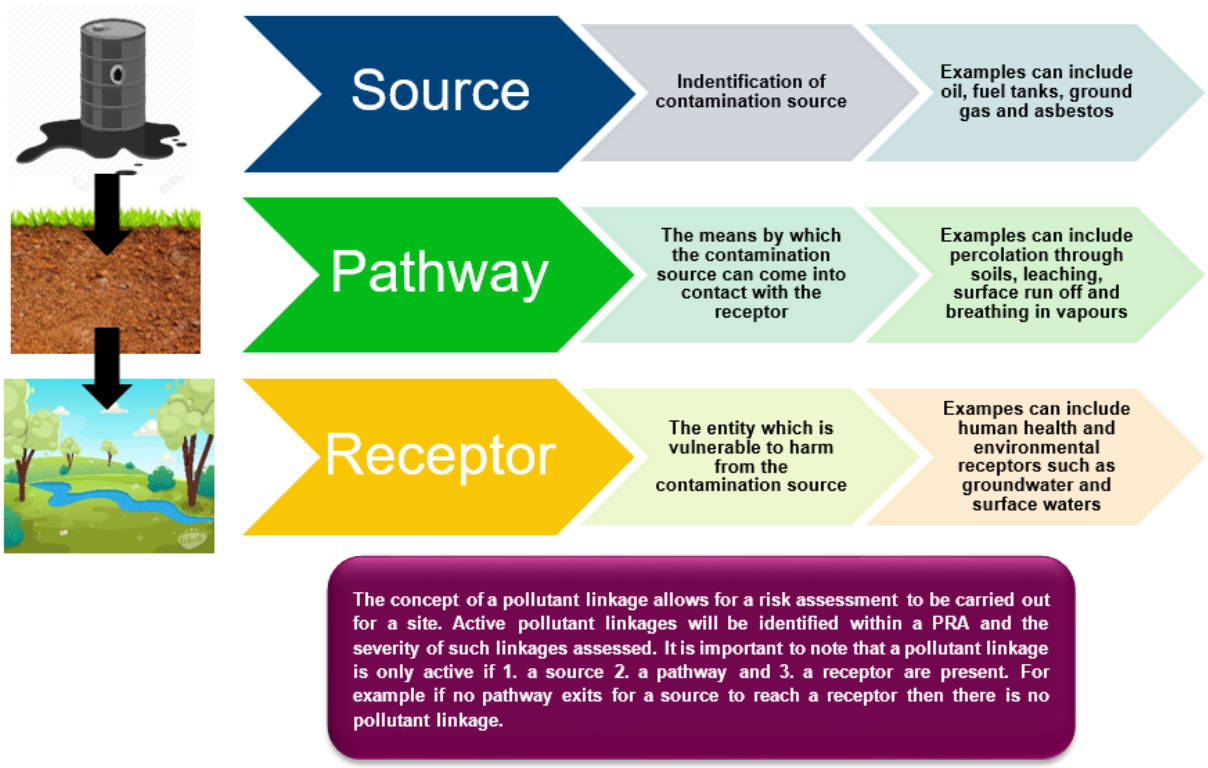
Underpinning the guidance within LCRM is a source-pathway-receptor methodology, which is used to identify Significant Pollutant Linkages (SPLs). The following definitions apply: -

- **Source**: a contaminant or pollutant that is in, on or under the land and that has the potential to cause harm or pollution.
- **Pathway**: a route by which a receptor is or could be affected by a contaminant
- **Receptor**: something that could be adversely affected by a contaminant, for example a person, controlled waters, an organism, an ecosystem, or Part 2A receptors such as buildings, crops, or animals

An important thread throughout the overall process of risk assessment is the need to formulate and develop a conceptual model for the site, which supports the identification and assessment of pollutant linkages. Development of the conceptual model forms the main part of the preliminary risk assessment, and the model is subsequently refined or revised as more information and understanding is obtained through the risk assessment process. A risk is present only when a source-pathway-receptor linkage is present and active. Without a pollutant linkage, there is not a risk, even if a contaminant is present.

1.6 Pollutant Linkage Diagram

Figure 1-1 Pollutant Linkage Diagram



1.7 Limitations

This report is for the use of Dublin Port Company only and should not be relied upon by other parties unless specifically advised by RPS in writing. Furthermore, new information, design changes, changed practices or new legislation may necessitate revised interpretation of the report after its date of submission.

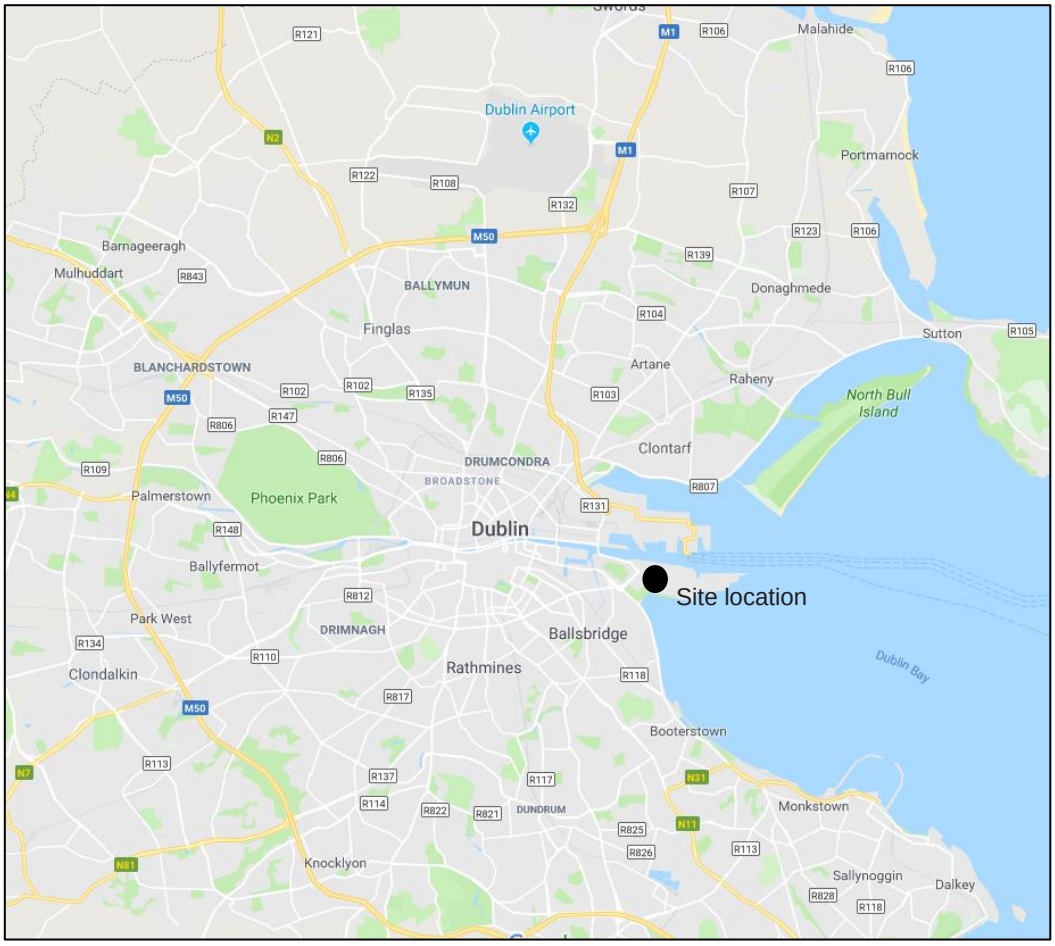
This report has been prepared by RPS on the basis of the available information received during the study period. Although every reasonable effort has been made to obtain all relevant information, all potential contaminants, environmental constraints or liabilities associated with the site may not necessarily have been revealed.

2 SITE DESCRIPTION

2.1 Site Location

As shown on Figure 2.1, the proposed 3FM Project is located in the Poolbeg area of the peninsula which extends into Dublin Bay just south of the mouth of the River Liffey, approximately 4km east of Dublin city centre.

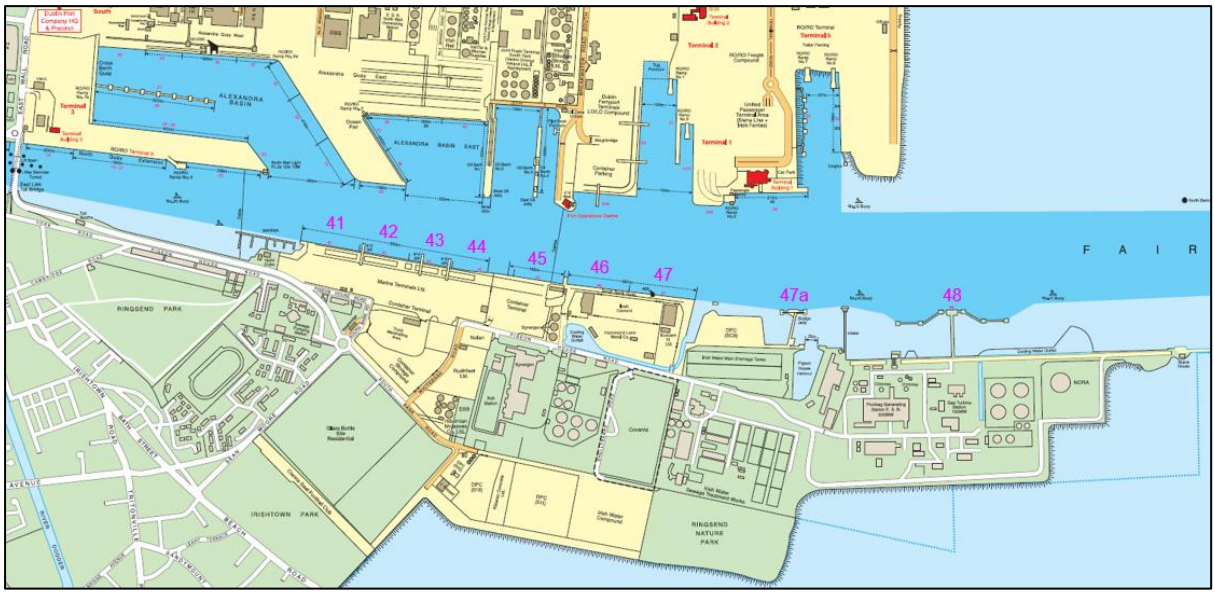
Figure 2-1 Site Location



The Site is located within the southern lands of Dublin Port in Dublin city, and forms part of an active port. The existing site layout is shown on Figure 2.2.

The site is spread over a number of active sites under the ownership of Dublin Port Company and third parties including Dublin City Council, ESB, Irish Water and NORA.

Figure 2-2: Existing Site Layout (colour scheme – yellow owned by DPC, green owned by others)



2.2 Study Area

The study area is set out in Figure 2.3.

Figure 2-3 Study Area

Maritime Village – Poolbeg Yacht & Boat Club

The Poolbeg Yacht & Boat Club, Marina and Stella Maris Rowing Club comprise a key sporting and amenity centre which is in daily use by members of the clubs, visitors and the local community.

Area K - Marine Terminals Ltd (MTL) Lo Lo Terminal

MTL operate a Lo-Lo container freight terminal. The terminal contains rail mounted gantry (RMG) cranes and rubber tyred gantry (RTG) mobile cranes. Containers are stored up to six high within the terminal.

Area L

Area L is currently utilised by three DPC tenants;

- Irish Cement (cement and petroleum coke).
- Hammond Lane (scrap metal); and
- EcoCem (eco-cement production).

The quayside area, comprising Berth 46 and Berth 47, is shared between the three operators. Separate manifolds are set into the quayside to transfer molasses, vegetable oil and fuel to storage tanks from ships which also use these berths. Harbour Mobile Cranes and smaller mobile plant, including long reach excavators, serve the berths.

The landside area is being used for bulk storage of petroleum coke, cement and scrap metal, with warehouses and plant to process the metal and produce cement products.

Area O

The Port owned lands located on the southern side of the Poolbeg Peninsula comprise a brownfield / hardstand site which is currently being used for a range of activities including;

- Kilsaran Concrete Ltd plant which comprises a concrete batching plant and associated facilities.
- Bissett Engineering plant which is currently not operational; and
- Site compounds to facilitate engineering contractor's offices for works at Uisce Éireann's Ringsend WwTP in temporary site cabin facilities, with car parking, fencing and materials storage. Previously this was used as a construction compound for works at the Encyclis (formerly Covanta) Waste to Energy Facility.

Roadways and Footways

There are a number of roads and footways which lie within the application boundary of the 3FM Project.

The existing road network is primarily owned by DCC, with the exception of White Bank Road and the eastern portion of South Bank Road which are owned by DPC. The network serves the various commercial sites on the Poolbeg Peninsula, as well as providing public access to the amenity areas, notably to the Great South Wall where Dublin City Council maintain a public carpark.

A corridor for a roadway through DPC's northern lands lies within the application boundary of the 3FM Project, to connect a proposed bridge crossing of the River Liffey to Alexandra Road, thereby removing the majority of port related traffic from East Wall Road.

Sludge Jetty/Turning Circle

The sludge jetty was formerly used to load sewage sludge onto vessels for disposal at sea. This practice is now prohibited, and the sludge jetty is no longer used and has fallen into a state of disrepair.

The land adjacent to the sludge jetty where the turning circle will part encompass was previously infilled with construction and demolition waste under a Foreshore License authorisation.

Area N

Area N is located offshore adjacent to the ESB Poolbeg generating station and the NORA Poolbegg oil storage facility and the Great South Wall.

2.2.1 Contamination sources

Potential On site contamination sources

The study area is located predominantly with areas of reclamation, formally the foreshore. Made ground was used to reclaim the land in the early 1970s, consisting of hydraulic fill material including sands, silts, clays and gravel, as well as some brick, glass and cinders.

Area O formally operated as a landfill known as the Irishtown Tip Head. The Irishtown Tip Head commenced operations in 1948 in Ringsend. The filling operations moved sequentially eastwards before its eventual capping in 1978. Municipal waste and construction and demolition waste material were deposited at the landfill which was not a fully engineered landfill in line with modern best practice and standards.

The area of land adjacent to the sludge jetty where the turning circle will part encompass was previously infilled with construction and demolition waste under a Foreshore License authorisation in the early 2000s.

Due to the previous history of reclamation and landfilling and the various heavy industrial uses that have been present over the decades on the peninsula, it is expected that there is a potential for ground contamination to be present

Current industrial usage such as operational activities within Plot L including a petcoke storage area operated by Irish Cement, Hammond Lane Metal Recycling (scrap metal dealer), Ecocem Ireland Plant (cement manufacturer) and a number of fuel tanks are considered to be potential sources of contamination.

2.2.2 Ground Cover

There are a variety of surface materials on the Poolbeg Peninsula, including topsoil, concrete and tarmac finishes.

2.2.3 Localised site topography

The study area is generally level.

2.3 Surrounding Land-use

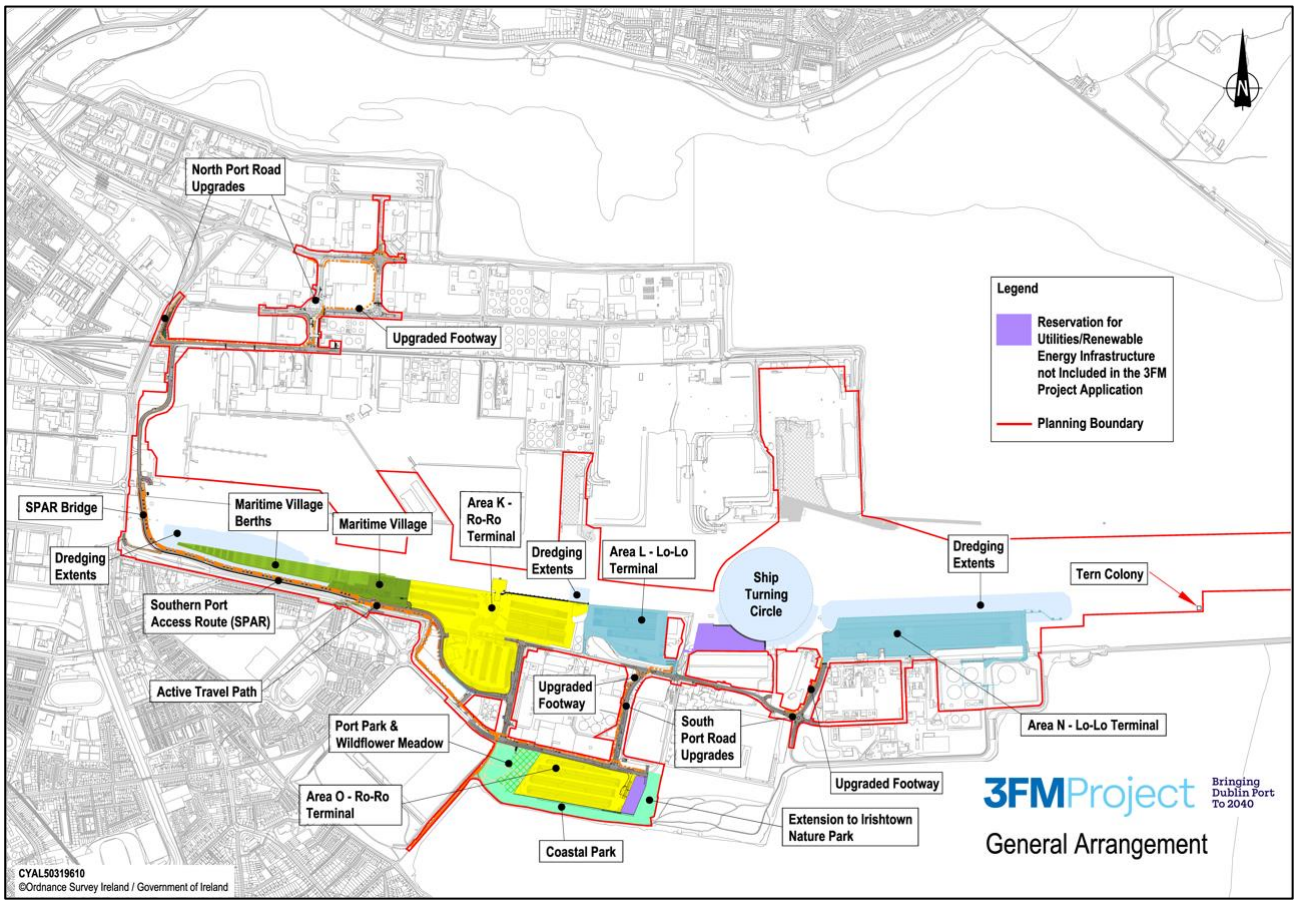
The pertinent surrounding land uses of the site are listed below.

- NORA Ringsend Facility located to the west of Shellybanks Road, comprising a number of tanks all containing winter grade diesel.
- NORA Poolbeg (Shellybanks Road) Facility adjacent to the ESB Poolbeg Generating Station, comprising of a number of tanks containing winter grade diesel and Jet A1 fuel, with one tank filled with water for fire-fighting purposes.
- ESB Poolbeg generating station.
- Synergen (Dublin Bay Power) Ringsend generating station.
- Uisce Eireann Ringsend wastewater treatment plant.
- Encyclis waste to energy facility.
- Former Irish Glass Bottle site (currently being redeveloped for residential use).

2.4 Proposed Development

The proposed 3FM Masterplan development is shown in Figure 2.4.

Figure 2-4 Proposed General Arrangement



3 SITE HISTORY

3.1 Historical Development of the Site

A review of available historical ordnance survey maps was undertaken to ascertain the development history of the site. Table 3.1 provides a summary of potentially contaminating activities during the history of the site and its surrounding area; snapshots of the maps are included in Appendix B.

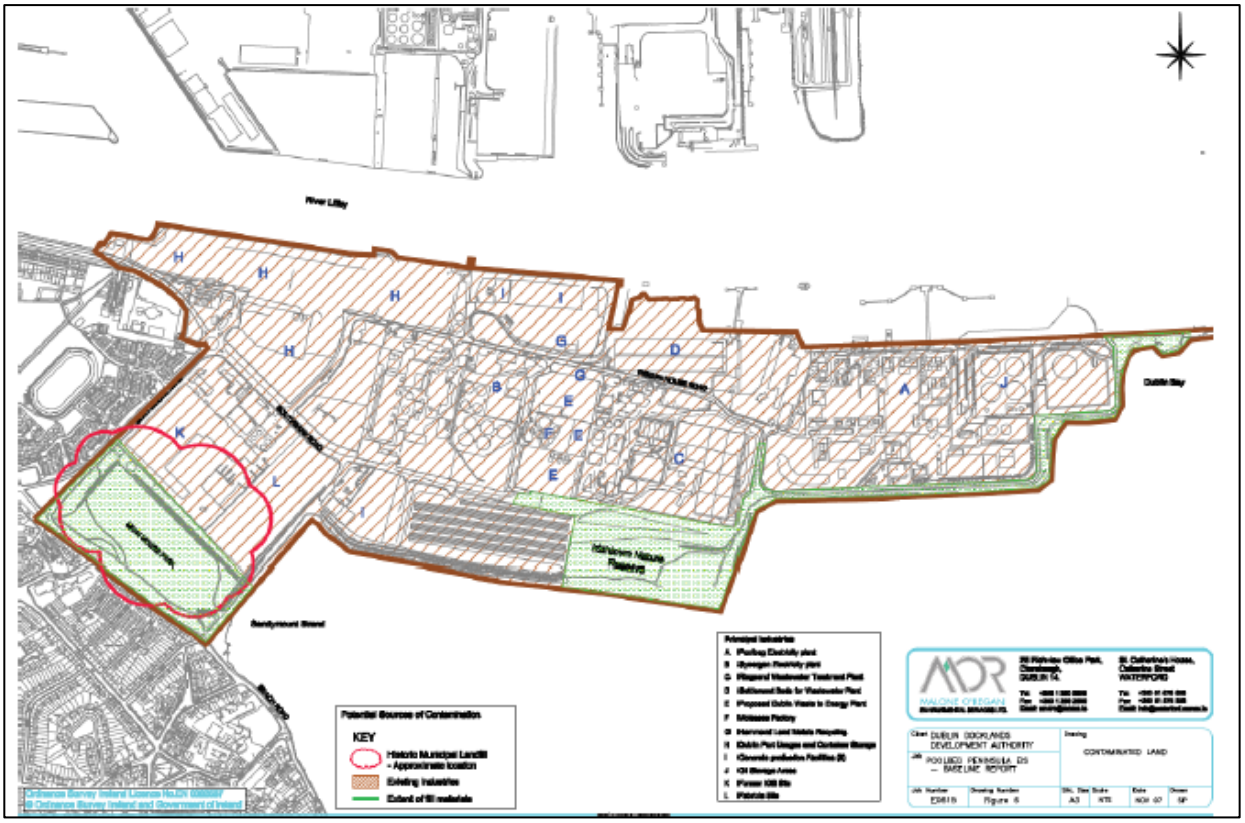
Table 3-1 Historical Site and Surrounding Area Development

Date	Site History	Surrounding Landuse history
c. 1830s Historic 6 Inch First Edition	The site is undeveloped; it consists of mud flats that have not been reclaimed for development.	A Harbour, barracks and Pigeon House Fort have been developed to the northeast of the site, along the bank of the River Liffey. The South Wall extending to the east ending at Poolbeg Lighthouse. A number of potentially contaminating land uses are present to the western boundary of the site, including a rope works, Lime and Salt Works and Glass Works.
c. 1890s	The site is undeveloped in this period; it consists of mud flats that have not been reclaimed for development.	Increased development is present in the area to the east of the site. Dublin Port has extended has been extended with a number of quay extensions, railway line, timber yard and a coal yard. Increased development is also present heading eastward including electricity works and outfall works present surrounding Pigeon House Fort.

Lands in the South of the Poolbeg peninsula were historically used by Dublin City Council as a landfill. The Irishtown Tip Head, reported to have commenced in 1948, before closure and capping in 1978. Following the capping of this area the lands were leased to the Irish Glass Bottlers (IGB) Ltd. This historic municipal landfill's approximate location is highlighted in Figure 3.1.

The Irish Glass Bottle facility ceased works in 2004, site decommissioning, demolition and remediation works were completed between December 2007 and December 2008 at the site. The works were necessary to facilitate the surrender of the site Integrated Pollution License from the Environmental Protection Agency. This will be covered further in section 5.

Figure 3-1 Summary of previous land-uses Extract from EACR Volume 1 by CAAS Ltd



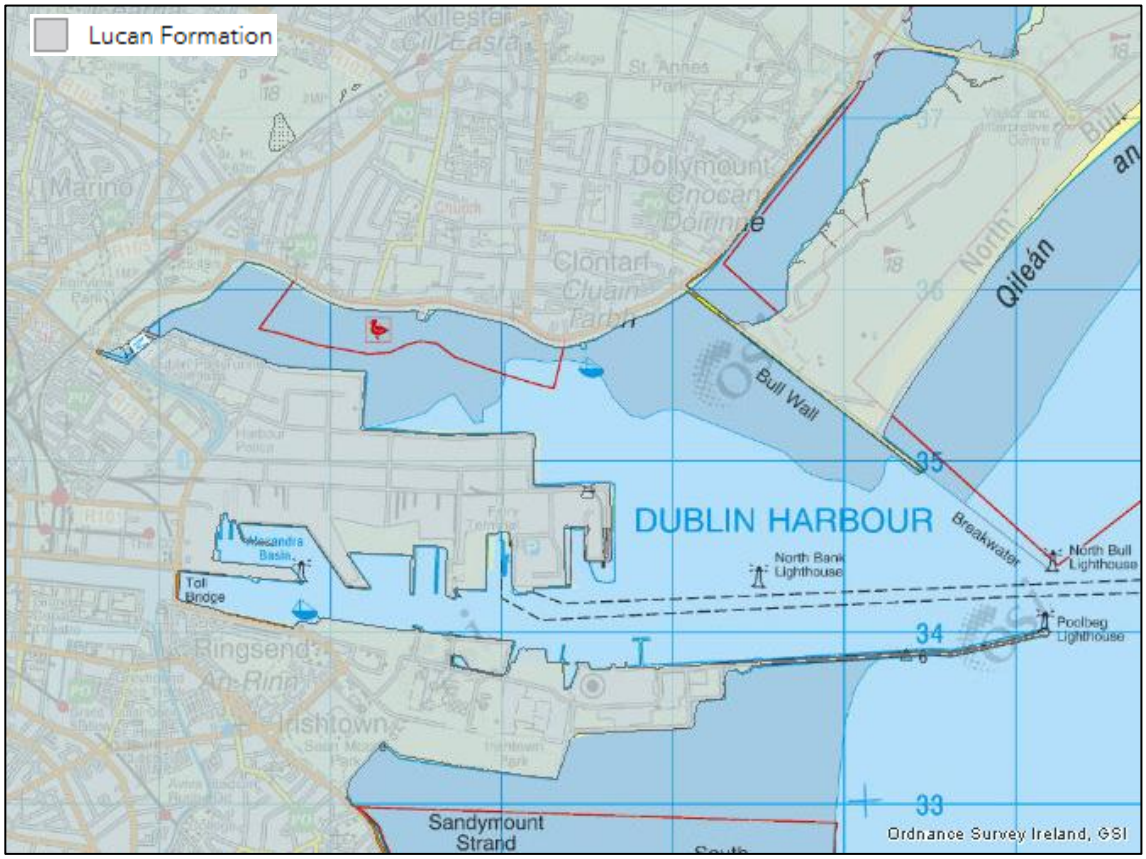
4 SITE GEOLOGY AND HYDROGEOLOGY

Information held online by Geological Survey Ireland at their Spatial Resources Map Viewer was used to identify the geological and hydrogeological conditions of the site. The following describes the findings of this preliminary research.

4.1 Solid Geology

The bedrock geology anticipated in the vicinity of the site is shown on Figure 4.1. The entire Dublin area is underlain by the Lucan Formation. The formation comprises dark-grey to black, fine-grained, occasionally cherty, micritic limestones that weather paler, usually to pale grey. There are also rare, dark, coarser grained, calcarenitic limestones, which are sometimes graded, present. The formation ranges from 300m to 800m in thickness and is Carboniferous.

Figure 4-1 Solid Geology (taken from GSI)

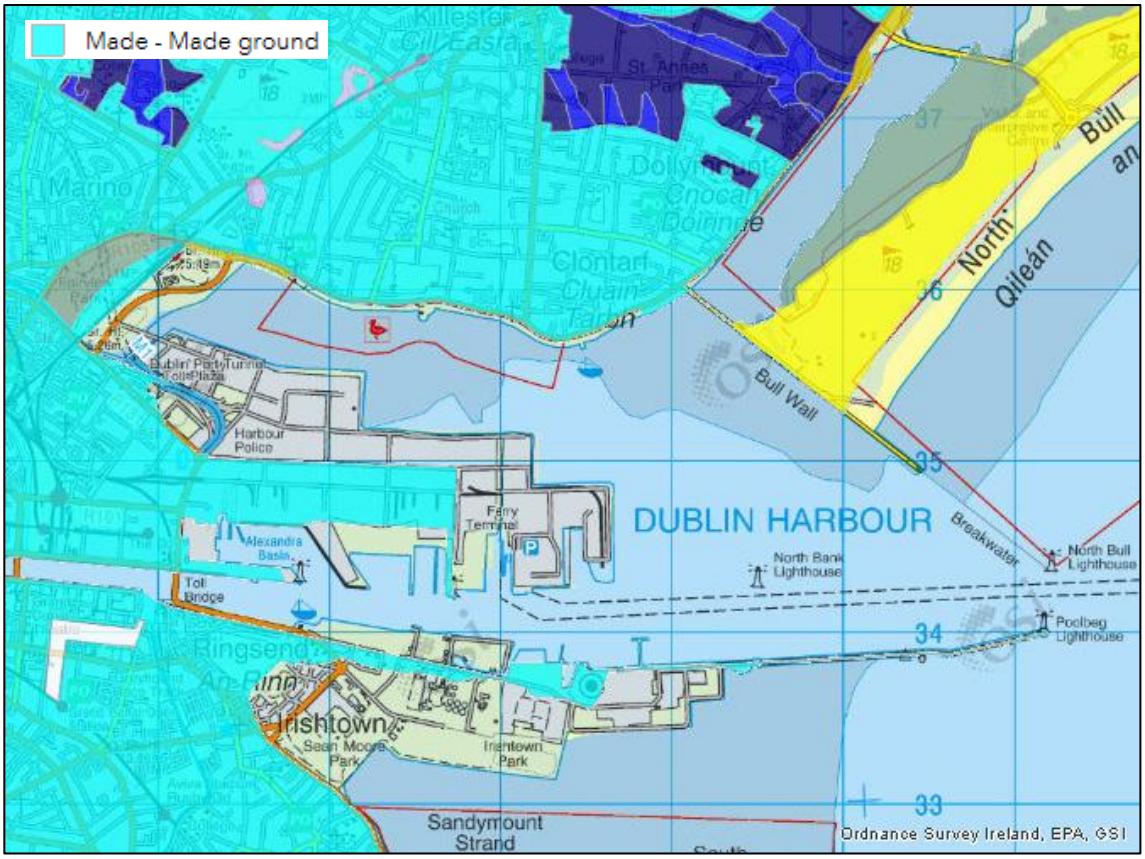


4.2 Drift Geology

The drift geology of the area is expected to principally reflect the depositional process of the last glaciation when an extensive ice sheet that extended into the Irish Sea covered the region. Typically, during the ice advance boulder clays were deposited sub-glacially as lodgement till over the eroded rock head surface, whilst moraine deposits were laid down at the glacier margins. Subsequently, with the progressive retreat of the ice sheet from the region, fluvio-glacial deposits (sand, gravel and silt) were laid down by melt waters discharging from the front of the glacier. Recent deposition prior to reclamation of the site principally reflects marine erosional and depositional processes, which have modified the glacial deposits.

As shown on Figure 4.2, the study area for the 3FM project is not mapped on drift geology maps provided by GSI, however, it is anticipated that the area is predominantly underlain by made ground (fill deposits).

Figure 4-2 Drift Geology (taken from GSI)



4.3 Hydrogeology

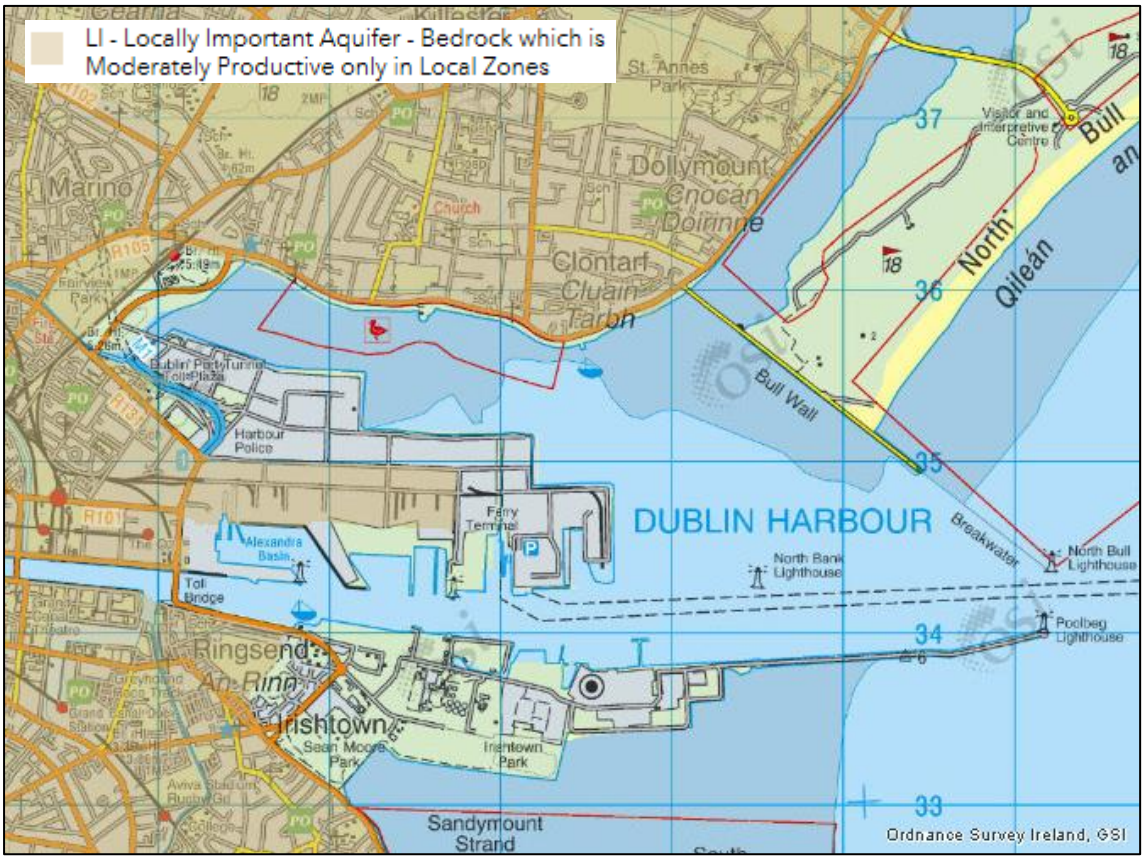
The hydrogeology of the area has been described by the Geological Survey of Ireland as complex and very variable. The Limestone bedrock is generally considered to be indurated and hence dominated by fissure permeability (e.g., joints and faults). Such permeability is likely to be low except where coarse, clean Limestones where present, have been karstified, dolomitised or are highly fractured.

The Lower Carboniferous rocks that underlie the region have been classified by the Geological Survey of Ireland as “Locally Important Aquifer, bedrock which is moderately productive only in local zones” (Figure 4.3). These locally productive zones are due to the presence of more permeable strata that are encountered in different parts of the outcrop area due to substantial faults, fractures or fissures. The limited groundwater movement within the rock tends to be restricted to the weathered horizons or to non-extensive fractured zones. These zones tend to have a limited hydraulic continuity, low storage capacity and low potential yield.

The Quaternary drift is considered the principal medium for groundwater movement in the area. The infiltration capacity of the clay deposits would be limited due to their low permeability and hence groundwater movement is likely to be confined to the fluvio-glacial sand and gravel deposits that overlie the clays. The potential importance of the Quaternary drift deposits as a groundwater resource is a function of their permeability, thickness and extent. The low permeable fine grained glacial clays represent aquitards that limit infiltration and restrict recharge to bedrock aquifers when sufficiently thick. The overlying fluvio-glacial sand and gravel deposits represent material with a significantly higher permeability. Consequently, these deposits have a high potential recharge and storage capacity.

It is generally expected that groundwater levels beneath the site will remain close to sea level and may exhibit tidal variation. Given that the peninsula is surrounded on three sides by the sea and that no part is greater that c. 500m from the sea. The effect of the sea is also expected to be seen in groundwater quality. Groundwater at the site is expected to be brackish / saline and unsuitable for potable supply due to the saline intrusion.

Figure 4-3 Bedrock Aquifer (taken from GSI's Spatial Resources portal)

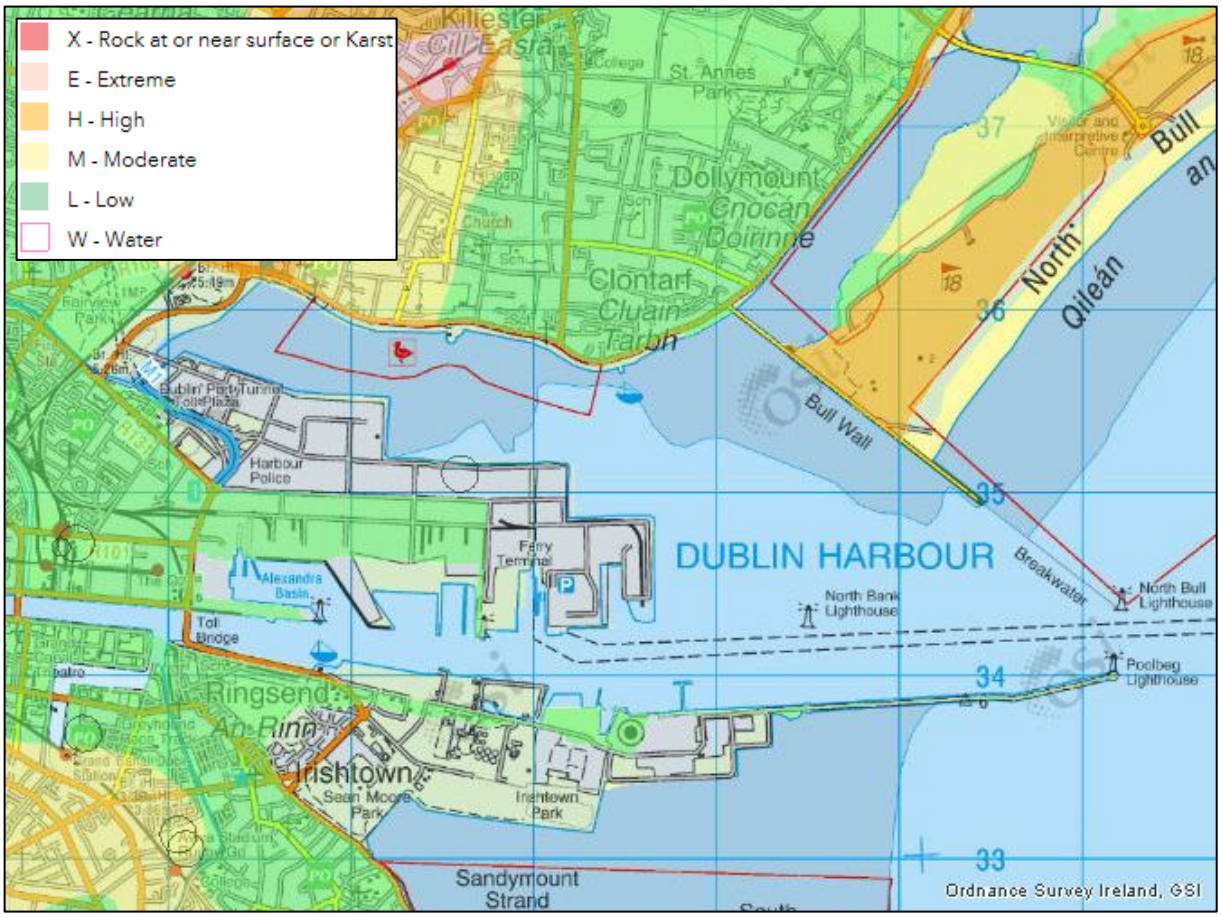


4.4 Groundwater vulnerability

In accordance with the Water Framework Directive (2000/60/EC) it is necessary to understand the groundwater vulnerability of the site, which is defined as the tendency and likelihood for general contaminants to reach the water table after introduction at the ground surface.

According to the GSI map for groundwater vulnerability (Figure 4.4), the site is partially mapped, these areas have a low groundwater vulnerability indicating that the natural groundwater is unlikely to be easily contaminated by human activities.

Figure 4-4 Groundwater Vulnerability (taken from GSI)



4.5 Groundwater Status

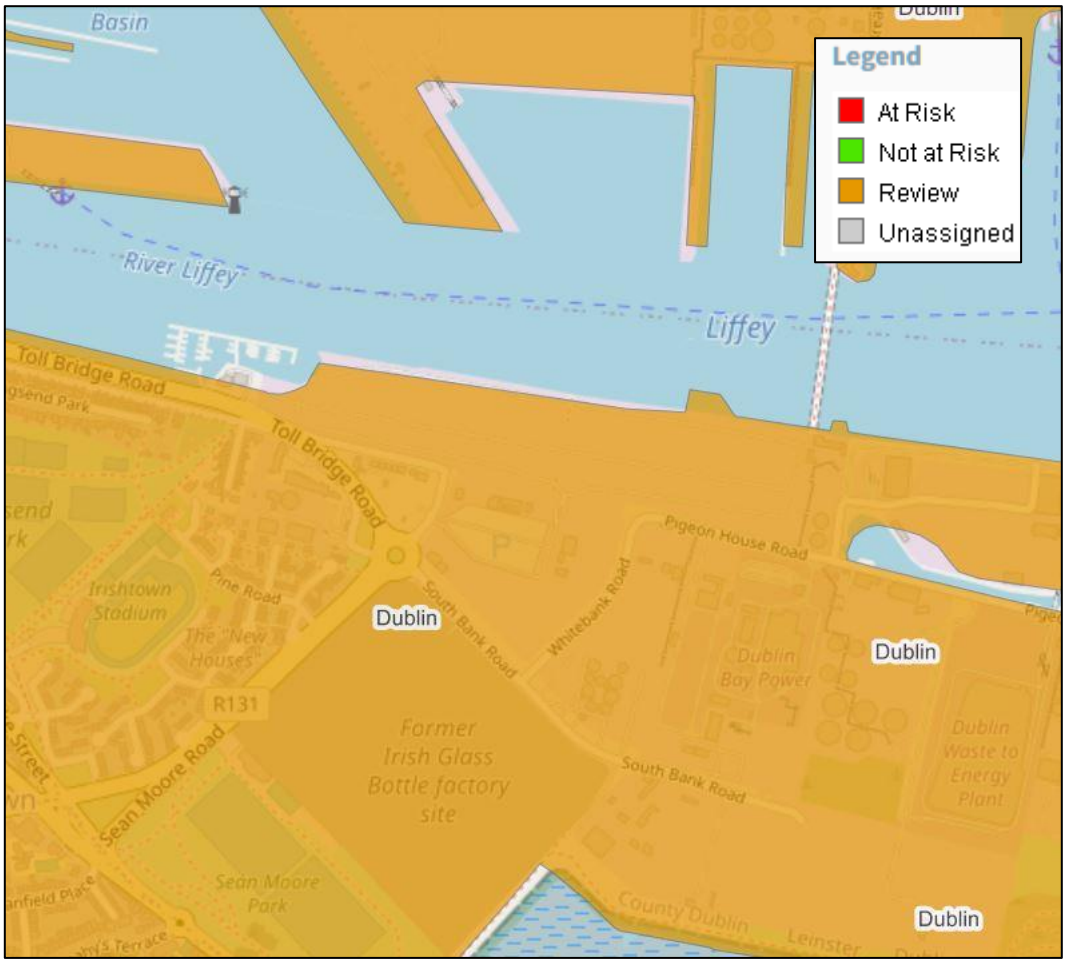
An assessment carried out under the Water Framework Directive (WFD) 2013-2018 groundwater body (EPA, 2022) has concluded that the groundwater within the bedrock aquifer is presently of 'Good Status'.

Figure 4-5 Water Framework Directive status 2013 – 2018 (taken from EPA maps)

4.6 Water Framework Directive risk status

Groundwater Risk looks at the current water quality and trends and is used to highlight waterbodies that are at risk of deteriorating or being at less than Good status in the future. As seen in Figure 4.6, the site is categorised as being under review.

Figure 4-6 Water Framework Directive risk status (taken from EPA maps)

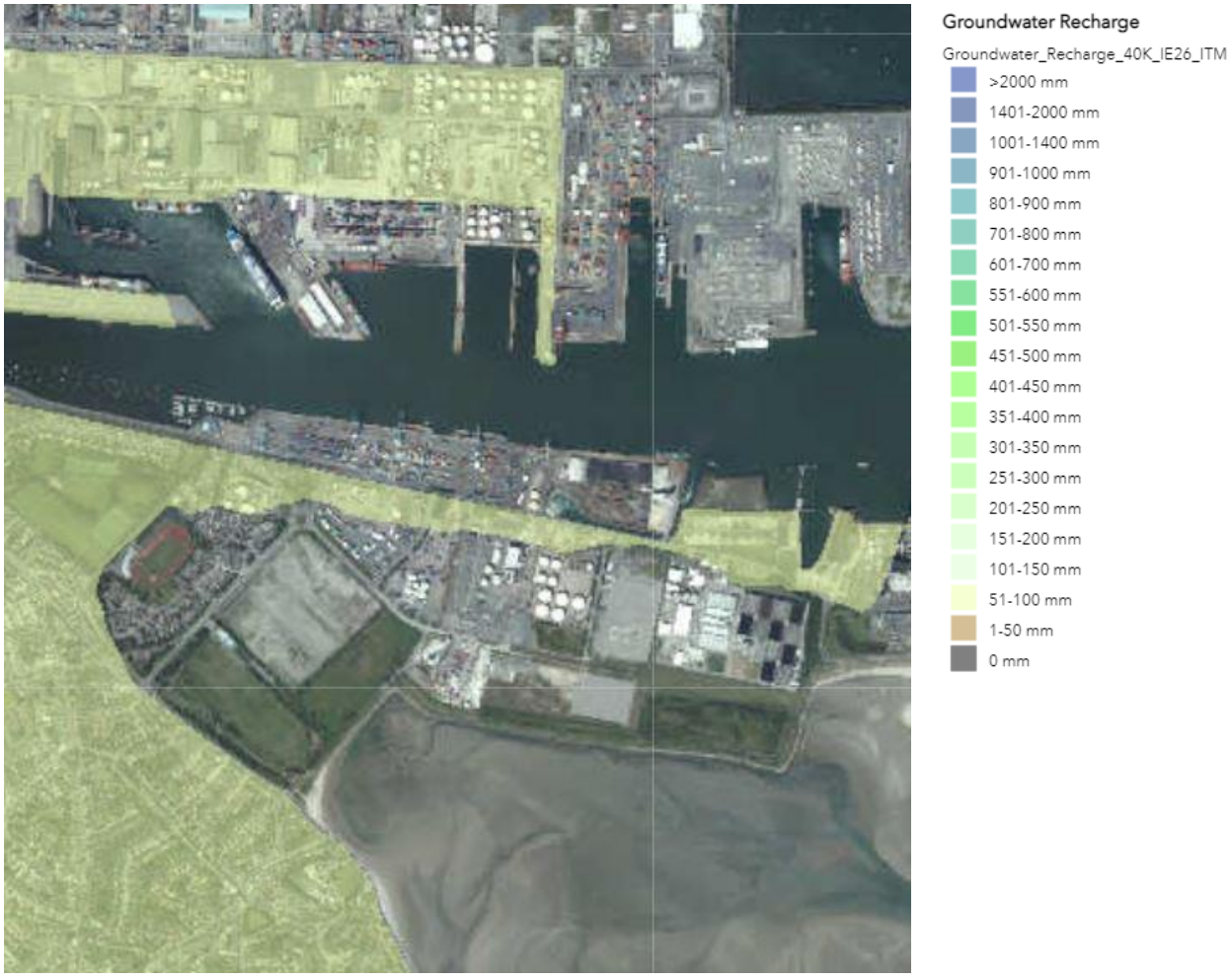


4.7 Groundwater Recharge

Diffuse recharge generally occurs via rainfall percolating through the subsoil and reaching the bedrock aquifer. Recharge is higher in areas where the subsoil is thinner and/or more permeable. The proportion of the effective rainfall that recharges the aquifer is largely determined by the thickness and permeability of the soil and subsoil, and by the slope.

Average recharge is 55mm/yr on the charted areas surrounding the site, with large proportions remaining unmapped. This does not account for leakage to the ground from water supply, storm drains and sewers.

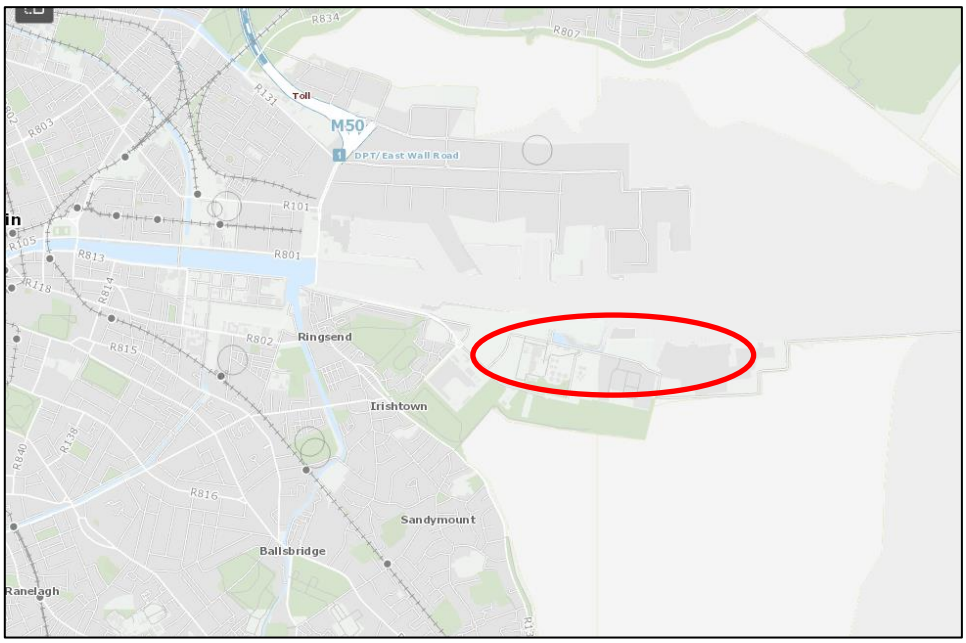
Figure 4-7 Groundwater Recharge (taken from GSI)



4.8 Groundwater Wells and Springs

During consultation with the GSI GeoIndex web viewer, it was found that there were no groundwater wells and springs in a 500m radius of the site as per Figure 4.8.

Figure 4-8 Groundwater Wells and Springs (taken from GSI)



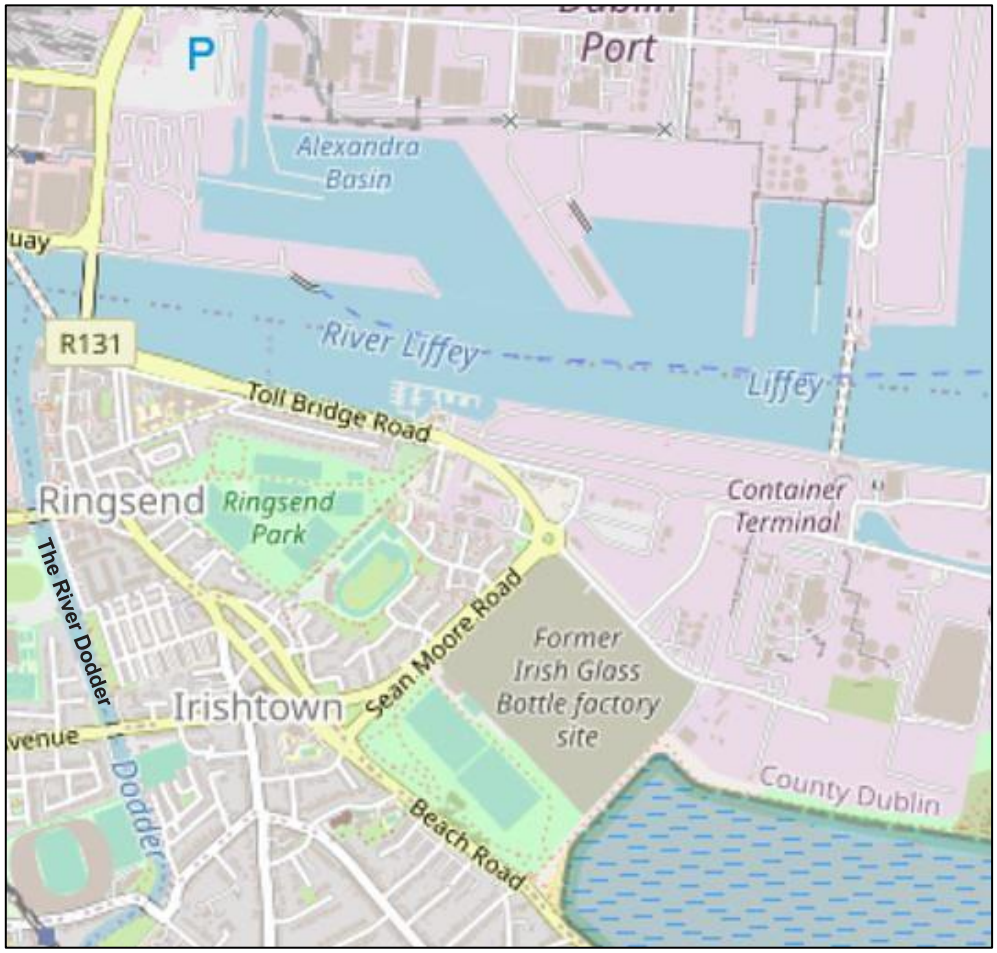
Groundwater Wells and Springs

Groundwater Wells and Springs

4.9 Surface Water Hydrology

The River Liffey is the dominant surface water feature that runs through the centre of Dublin, flowing from west to east before discharging into the Irish Sea. The transitional water quality status for The River Liffey from 2018 to 2020 under the Water Framework Directive (WFD), is described as being good and unpolluted. The Dodder River flows into the River Liffey just west of Tom Clarke Bridge.

Figure 4-9 Surface Water Features (Mapping by GSI)



4.10 Licenses and Permits

A search was undertaken on the Environmental Protection Agency map viewer to investigate if any Industrial Emission licences (IELs) and Integrated Pollution Control (IPC) sites which are present surrounding the scheme area.

An IEL is held by The Hammond Lane Metal Company Limited which is located within Area L. The licence (P1002-01) is categorised as 'recovery, or a mix of recovery and disposal, of a non-hazardous waste'. As seen from Figure 4.10, an IEL is also held c.330m south at Synergen Power Limited.

The IPC is located c.340m southeast of the site at Becbay Limited the former Irish Glass Bottle factory site (since 1994), categorised as being previously industrial in nature before being surrendered to state control in 2009. The EPA monitored the clean-up of the industrial contaminants across this 25-acre site by the Becbay owners prior to it being surrendered; concluding all environmental pollutants linked to the manufacturing legacy were cleared. Previous site investigations as well as general information revealed that the entire Poolbeg Peninsula area was constructed on a former landfill, with reports of up to 7m of fill material which this clean-up did not include (Cunnane Stratton Reynolds, 2009).

Figure 4.10 also reports two IELs outside a 500m radius of the site. The IEL located c.800m southeast of the site is Dublin Waste to Energy Limited and c.1.5km east is Electricity Supply Board (Poolbeg); both are categorised as being IELs and industrial in nature.

Figure 4-10 Industrial Emission licences (IELs) and Integrated Pollution Control (IPC) (taken from EPA)

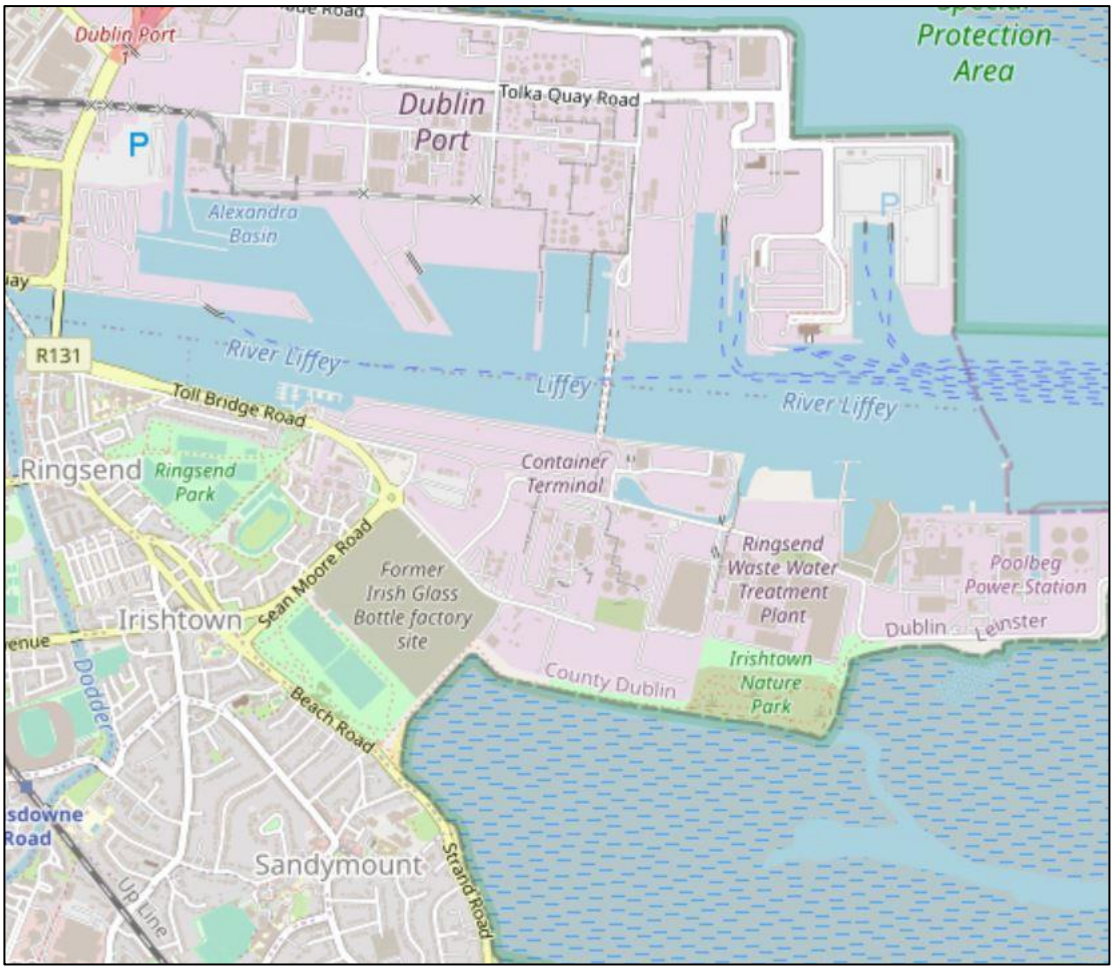
IEL
- Licensed
- Applied
- Surrendered
- Other

IPC
- Licensed
- Applied
- Surrendered
- Other

4.11 Waste Facilities

No current licensed waste facilities are located in a 500m to 1km radius of the site as per Figure 4.11.

Figure 4-11 Waste Facilities (taken from EPA)

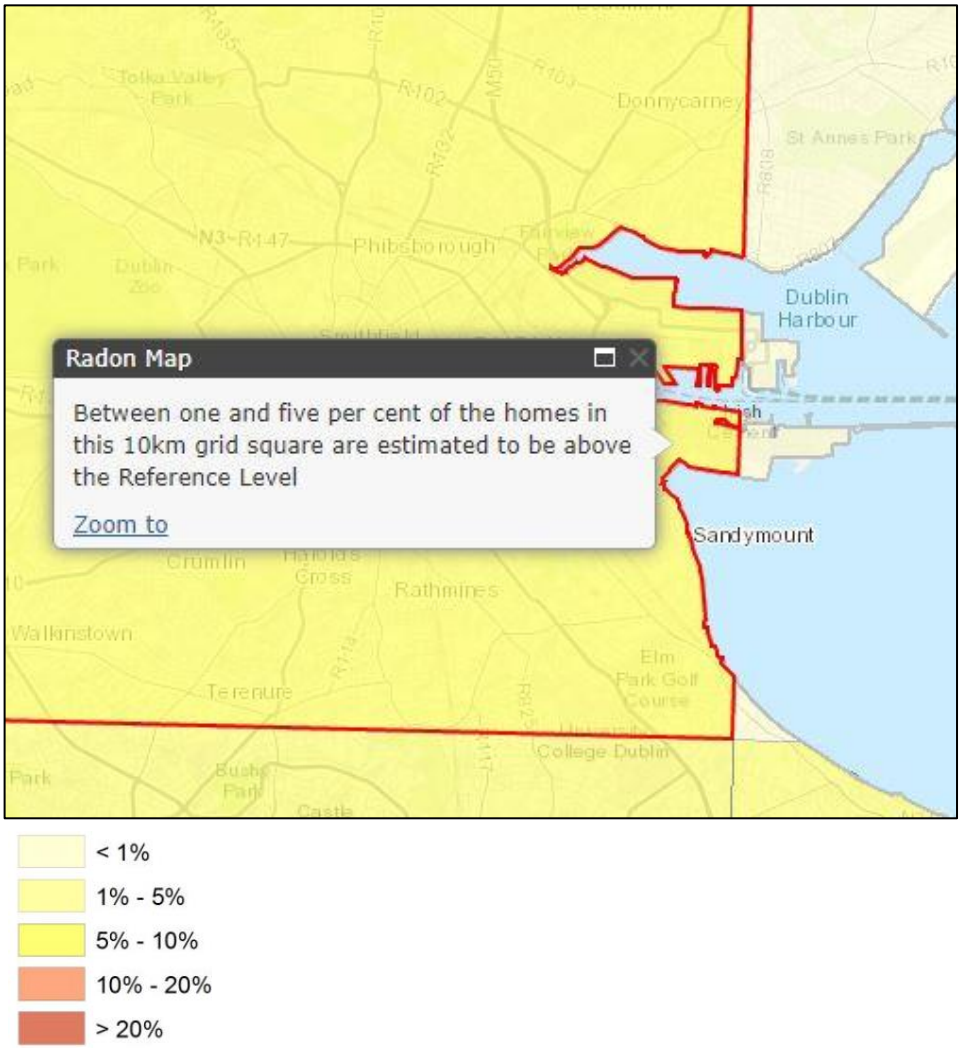


Waste Facilities
- Licensed
- Applied
- Surrendered
- Other

4.12 Radon

The site is located in a 10km grid square with between one and five per cent of the homes estimated to be above the Reference Level.

Figure 4-12 Radon Map Ireland (taken from Radon Maps Ireland)



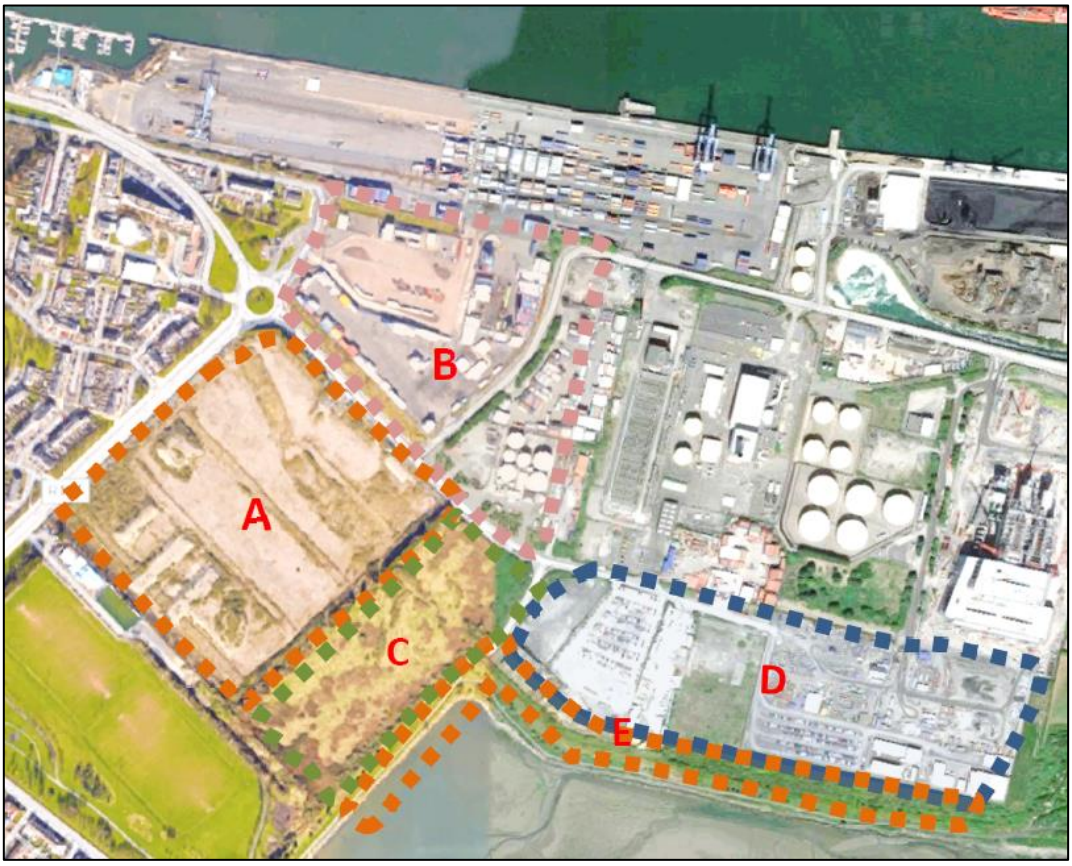
5 PREVIOUS REPORTS

5.1 Environmental Assessment of Contamination Remediation Report Volume 1 – Dublin City Council, January 2017

5.1.1 Introduction

This report was prepared by CAAS Ltd on behalf of Dublin City Council in 2017 to provide an Environmental Assessment of Contamination and Remediation for the Poolbeg Planning Scheme Area. The site was characterised as five distinct areas of use, Figure 5.1 details the areas A-E. The report builds upon investigations and previous environmental assessments in order to inform planning and design for future landuse. By dividing the land into strategic development zones, the effects of contamination can be remediated and improved by ensuring that the proposed landuse types are compatible with the prospective risks. A risk profile was utilised to evaluate the potential risk of contamination for each of the Characterisation Areas. A summary of the five distinct areas and their respective risk profile is included in Table 5.1.

Figure 5-1 Site Characterisation Zones used in ECAR assessment 2017.



5.1.2 Contamination issues being addressed

A risk profile was utilised to categorise the five distinct areas, informed by historic evidence of contamination and previous reports, this report will be included in Appendix C.

The main 'known threats' outlined in the report are as follows:

- Storage tanks exists in this area
- These areas are known to be used for metal working
- These areas are known to be used for concrete production
- These areas are known to be used, in part, for IGB waste disposal
- These areas have been used for external storage, and for servicing of vehicles

The 'known resolutions' to these issues of potential contaminations are that due to the surrendering of the IPC license of the Irish Glass Bottle site to the EPA, this indicates that any soil contamination present has been remediated. Also, any laydown and compound areas have been resurfaced with imported hardcore.

Table 5-1 Evaluation of potential risk of contamination for each of distinct areas.

Site Characterisation by areas of use	Use (2017 investigation)	Risk Profile / Knowledge of Contamination Potential
Area A - The Western Lands	An unoccupied area that has been cleared of contaminated soils	High knowledge of potential risk due to previous landuse as former IGB site/landfill. Low potential risk due to substantial de-contamination completed.
Area B - The Northern Lands	Lands currently used for a range of port-related and logistics uses	Unknown potential risk. Low knowledge of contamination potential.
Area C - The Central Lands	An unoccupied area	Medium potential risk. Moderate knowledge of contamination potential. Evidence of landfill gas emission, evidence of Soil Contamination, Polycyclic Aromatic Hydrocarbons (PAHs), Gasworks waste and Asbestos.
Area D - The Eastern Lands	Lands with a variety of active uses	High potential risk. Poor knowledge of contamination potential.
Area E - The Shore Lands	Amenity areas used for public recreation	The Coastal path due to this area being the edging of the landfilling has high potential risk of contamination. However, the knowledge of contamination potential is classed as very poor.

5.1.3 Conclusions and Recommendations

The following approaches were concluded upon:

1. Accept that the entire site has the potential for legacy effects of contamination.
2. Maintain a vertical separation barrier – all of the land, including those that have been remediated, are still continually at risk of being affected by prior contamination. Advised by ARUP, the strategic approach adopted at the IGB site is proposed for the site as a whole.

   'The provision of basement space, beneath the future proposed mixed-use development for carparking and ancillary services - as a method to create a wide (and ventilated) physical barrier between the existing legacy fill and the future habitable space of the new development.'
3. Achieve Protection by Strategic Guidelines for Land-use allocation.
4. Require Developers to prepare Site Remediation Report.
5. Implement a contamination interception, monitoring and mitigation management system.

5.2 Baseline for Environmental Assessment of Contamination Remediation Report Volume 2 – Dublin City Council, January 2017

Three main sources of information where utilised to support the Environmental Assessment of Contamination and Remediation. This report will be included in Appendix C.

Site Description of IGB Site ARUP, 2016 Site History and Surrounding Land Use

Site Decommissioning, Demolition and Remediation (DDR) works were completed at the former Irish Glass Bottle Facility between December 2007 and December 2008. These works were necessary in order to facilitate the surrender of the site IPC License from the EPA. All remnants of plant, buildings and operations associated with the manufacture of glass bottles at the facility were removed. Special consideration was given during the DDR works to the fact that the site was previously a landfill.

Site specific target levels (SSTLs) were designed with reference to scenarios allowed for in the site development masterplan, in particular the necessary excavation levels required to facilitate site redevelopment. An excavation level of nominally 2m was decided upon to ensure removal of IGB production facility buildings and infrastructure. In order to create a wide and ventilated physical

barrier between the existing legacy fill and the future habitable space of the new development a basement space was chosen. This option was appealing as it allowed for deeper deposits of legacy landfill to be left, reducing the quantity of waste required for export and disposal. Where possible, inert material created during the excavation and demolition activities was utilised as crushed capping material and for the establishment of road footprints.

These remediation works were carried out with the idea in mind that no further remediation works would be necessary, any additional protection measures would be those normally used in the redevelopment of brownfield sites. The site has remained undeveloped since this time. The layout is described as:

1. Formation Capping Layer – a 300 mm thick capping layer is placed over the excavated material on site.

2. Perimeter Berm – a 7.5m wedge was to be left round the perimeter of the site. A number of majority utility pipes and cables running close to the site boundary along Sean Moore Road and South Bank Road have not been disturbed by virtue of leaving this berm in place.

3. Services – original services at the site were moved and terminated, the heavy fuel oil supply line was plugged and terminated at the site boundary.

4. Stockpiles - a number of stockpiles of crushed materials, produced during the demolition works remain on site for future use in site development.

Closure, Restoration and Aftercare Management Plan (CRAMP)

The Closure, Restoration and Aftercare Management Plan for the IGB site documented the site conditions and mapped the path to clean closure of the site. Extensive environmental monitoring and validation was carried out throughout each phase. The validation sampling process demonstrated that no potential residual impacts of the IGB operations remained at the site. This sampling formed part of the Site-Specific Quantitative Risk Assessment. Validation sampling carried out throughout the remediation works ensured all remnants of the IGB operations had been removed, the quality of the material underlying the landfill was determined; and the protection measures utilised were validated.

The laboratory analysis used during the validation sampling was site specific, these SSTLs were for both the current site status and the required protection measures for the proposed future development. Acceptable results for the site-specific design were demonstrated, no additional remediation was required.

Figure 5-2 Aerial Photograph of the Irish Glass Bottle Site prior to remediation

Section 7 of EIS for Dublin Docklands Development Authority Poolbeg Peninsula Planning Scheme – Geotechnical, Soils & Ground Conditions Malone O'Regan, 2009

The second supporting document is a chapter prepared by Malone O'Regan discussing the existing soils, geology and general ground conditions as well as providing an overview of the existing contamination within the Draft Planning Scheme Area. The chapter addresses the potential effects of thew proposed scheme at the Poolbeg Peninsula on the soils and geology and what measures may be employed to reduce, and if possible, eliminate potential impacts. Any contaminants believed to be present and that would have the potential to impact on human health or the environment were also identified in the chapter.

Ground Conditions – General

Within the majority of the Draft Planning Scheme Area the subsoil consists of made ground overlying recent marine deposits of mixed silts or clays and fine sands and glacial and fluvio glacial deposits of sands and gravels with occasional cobbles and boulders. Underlying this strata are deposits of sandy clays with some silt and sand layers overlying weathered rock of boulders, cobbles, gravels, clays and silts on strong, dark grey, mostly thinly bedded, fine grained carboniferous limestone bedrock.

Made Ground / Fill material

Municipal waste as part of the Irishtown Tip Head from 1945 to 1978 as well as, general construction and demolition waste make up the made ground within the area of the Draft Planning Scheme. Hydraulic Fill is also noted as being utilised to reclaim distinct areas. Previous site investigations in the Poolbeg area have logged made ground as being 1.6 to 5.6m in thickness. The Mott McDonald Pettit Report (2008) details of builder's rubble and similar dry fill present which would have been used to construct roads in locations to the west of the peninsula; landfill material was tipped either side of the roads.

The Fabrizia and IGB sites were historically constructed within the area of a Dublin Corporation landfill. Domestic waste was also dumped in this area during this period. During the sites operation and after closure no soil gas venting or collection systems were installed, therefore landfill gas could potentially be present.

Landfill Gas

As part of the Poolbeg Peninsula was utilised as a landfill for municipal solid waste landfill gas production is expected. Methane gas, carbon dioxide and small quantities of hydrogen sulphide form due to a portion of the municipal solid waste biodegrading anaerobically. Landfill gas production using peaks between 5 and 20 years after closure and then begin to decline. However, this is not always the case with some landfills producing gas for up to 50 years after closure. Landfill gas surveys from 2004 on the peninsula revealed that methane gas was continuing to be produced. Even so, overall methane gas production levels were low, declining between 1999 and 2004.

Fabrizia Site

An Environmental Impact Statement (EIS) soil and geology assessment was completed by AWN Consulting to accompany the 2004 mixed use office, residential and supportive retail facilities proposal on the Fabrizia site. Reports identified waste such as timber, bricks, concrete slabs, cabling, rag and metal household product containers. This domestic refuse and construction and demolition waste was 3 – 3.5m in thickness beneath 1m of topsoil, this is consistent with descriptions of the Irishtown Tip Head located within the area.

An additional site investigation was carried out at the Fabrizia site in 1999 due to a suspected oil leak. Gasworks waste was identified as well as elevated concentrations of Polycyclic Aromatic Hydrocarbons. An investigation in 2004 determined that landfill gas was still being produced at the site, reporting maximum methane concentrations of 23.1% and carbon dioxide concentrations of 29.2%. The levels recorded in 2004 exceed the DOE limits for both methane and carbon dioxide of 1.5% and 0.5%, respectively. It was concluded that further assessment of the landfill gas production and any remedial engineering design measures would be required prior to any development.

IGB Site

The report discusses three previous assessments carried out at the IGB site. Consistent with general information for the Poolbeg Peninsula area, the site investigation confirmed that the entire site had been constructed upon a former landfill. The report indicated that there was up to 7.0m of backfill material including rubble, plastic, timber, rocks, glass jars, bricks, clay, sand and hardcore fill.

Dublin Docklands Development Authority Poolbeg Peninsula Planning Scheme Geotechnical Report – Mott MacDonald Pettit, May 2008.

This preliminary, desk based Geotechnical/ Contaminated Land assessment was prepared by Mott MacDonald Pettit in order to highlight key contamination issues and the engineering implications of these. It also briefly addresses geotechnical conditions on site and the effects these will have on buildings/ foundations etc.

The area of proposed redevelopment is located at Poolbeg Peninsula, an area consisting mainly of reclaimed land. The majority of the area was a part of the foreshore before a series of reclamation projects beginning in the 1900's. The fill utilised in the reclamation of the area consisted of both inert material, including material dredged from the seabed, and domestic waste. Up until 1978 the peninsula was used as a domestic landfill. It was found through soil analysis that the primary use of the landfill was domestic, however the likelihood of some industrial materials having been dumped there can't be ruled out. There are reports of ashes from power stations as well as the by products from nearby town gas manufacturing plant encountered within the soils. High ground water levels are likely as the area is surrounded on three sides by the sea.

Existing ground conditions summary:

- **Bedrock Geology**: bedrock on the peninsula lies between 30 and 50m below ground level. Shallow rock is found at the tip of the peninsula around Sean Moore Park and the IGB/Fabrizia sites. Bedrock in this region consists of sedimentary rocks that are assigned to the Calp Formation of the Carboniferous era. Rock in this area is comprised of dark grey fine-grained limestones with interbedded shales, with the overall mechanical strength is described as strong to very strong.

- **Drift Geology**: the drift geology of the Poolbeg area consists mainly of deposits from the late glaciation period.

- **Marine Deposits**: marine or seabed deposits up to 2.5m thick is overlying the drift geology. Riverine deposits from the Liffey and Dodder were found. This strata generally consists of soft or loose to medium dense sandy silt and slightly clayey/ silty fine sand including shell fragments and some fine gravel.

- **Made Ground**: the composition of the made ground in the area is highly variable but commonly consists of a mixture of gravels, sands, silts and clays, including rubble, bricks, concrete, glass, timber and cinders from the Power station. Frequent industrial usage of the land in the Poolbeg area means that hotspots of soil contamination are likely to be encountered. Hydrocarbon contamination is reported throughout the Poolbeg area with the strong likelihood of other contaminants being encountered also. Exact records of the infill material, its volumes and locations do not exist, but it is known that the landfilled area is predominately to the western part of the peninsula and may stretch as far as the Poolbeg Power station. The landfill practices of this time period would not comply with modern standards for domestic waste disposal.

- **Surface Material**: there are a variety of surface materials on the Poolbeg Peninsula, including topsoil, concrete and tarmac finishes. Due to the surfaces being predominately impermeable the majority of the runoff will be discharging directly into the sea.

- **Groundwater**: groundwater flow in the peninsula area is principally throughout the drift layers rather than the limestone bedrock. Tide levels will have a significant influence on groundwater due to no part of the peninsula being more than 500m from the sea. Saline intrusion can cause the groundwater to be brackish, the effect of the sea on groundwater quality. The shallow depths of soil cover provide very little protection to the groundwater in the area and so it would be classified as highly vulnerable. Previous studies have confirmed that this is an issue when combined with the industrial history of the peninsula leading to polluted groundwater in the region.

5.3 Tier 1 Environmental Risk Assessment, Historic Landfill at Shelley Banks, Co. Dublin – Dublin City Council, June 2019

This Tier 1 Environmental Risk Assessment was undertaken by Fehily Timoney on behalf of Dublin City Council. The Environmental Risk Assessment was undertaken in accordance with the EPA Code of Practice (CoP) for Unregulated Waste Disposal Sites.

The report covers a part of Area O and classifies the site as Moderate Risk Classification (Class B) in accordance with the EPA CoP.

6 PREVIOUS GROUND INVESTIGATION

6.1 GSI Geotechnical viewer

The GSI Geotechnical viewer was consulted to gain an understanding of historical site investigations undertaken on or in proximity to the site. The full downloaded reports including location plans are included in Appendix B; the relevant boreholes are summarised in the sections below.

6.1.1 Pigeon House Road (near Plumbing Station and Irish Glass Bottle PLC)

Four boreholes were historically drilled in proximity to the existing Pigeon House Road, the stretch of road which dissects the site areas known as K1 and K2. The cable percussion (shell and auger) drilling method was utilised to drill to a maximum depth of 9m and are detailed in Tables 6.1 - 6.7.

Table 6-1 Borehole 92419 (BH1)

Depth (m begl)	Ground Conditions
0.0 – 0.80	Organic topsoil
0.80 – 2.70	Loose fine sand with shells & some stones
2.70 – 3.70	Soft black organic SILT with an occasional cobble
3.70 – 5.50	Very soft, grey, sandy SILT
5.50 – 6.40	Very soft grey sandy silt and gravel
6.40 – 8.80	Compact coarse sandy gravel and shells
8.80 – 9.10	Soft grey sandy silt with gravel, shells and traces of clay

Table 6-2 Borehole 92420 (BH2)

Depth (m begl)	Ground Conditions
0.0 – 0.30	Organic top soil
0.30 – 1.20	Brown sandy silt with traces of clay
1.20 – 1.80	Fine brown silty sand and gravel
1.20 – 2.70	Soft brown clayey silt with traces of fine sand, small stones and cobbles
2.70 – 5.20	Soft black organic silt with small stones and cobbles
5.20 – 7.30	Compact coarse sandy gravel and cobbles

7.30 – 9.10	Very fine sand with traces of silt and fragments of shells (hole blowing)

Table 6-3 Borehole 92421 (BH3)

Depth (m begl)	Ground Conditions
0.0 – 0.30	Organic topsoil
0.30 – 1.20	Filling of clay, ashes, clinker and brick
1.20 – 1.80	Coarse sandy gravel
1.80 – 5.20	Soft black organic silt with layers of gravel
5.20 – 6.40	Compact medium to large sandy gravel and cobbles
6.40 – 8.20	Compact coarse sandy gravel and shells
8.20 – 9.10	Fine silty sand with gravel, stones and fragments of shells

Table 6-4 Borehole 92422 (BH4)

Depth (m begl)	Ground Conditions
0.0 – 0.30	Organic topsoil
0.30 – 4.80	Filling of sandy clay, silt, gravel and brick.
4.80 – 5.60	Compact sandy gravel and cobbles
5.60 – 9.10	Small sandy gravel with layers of fine sand

6.1.2 Proposed 'C' Power Station Ringsend

Ten boreholes were historically drilled within the land between Pigeon House Road and South Bank Road, the site area K2 is included within this boundary. A rotary drill with a diamond bit was utilised to drill to a maximum depth of 48m and an overview of the strata encountered in order below.

- Made ground – this layer consisting of 2.40 - 7m of majority ash, clinker, brick and concrete fragments with some gravel and sand.
- Alluvium – this material is an estuarine deposit consisting of 17-26m of soft black and dark grey clayey silt, as well as sandy gravel and mentions of compact clayey fine sandy silt.
- Boulder Clay – An average thickness of 4.90-13.10m consisting of a variety of finer to coarser gravel and cobbles within firm to stiff dark grey sandy clay.

- Bedrock - described as hard grey in colour, limestone in places with the occasional shale band in some boreholes.

6.1.3 Alexandra Basin

Four boreholes were historically drilled to understand sub-soil conditions within the area known as Alexandra Basin along East Wall Road, this investigation is within the northern portion of the site. Cable percussion was the drilling method for this investigation, with borehole 4 being deepened using rotary drilling methods.

Table 6-5 Borehole (BH1)

Depth (m begl)	Ground Conditions
0.0 – 4.60	Made ground
4.60 – 7.30	Soft grey black SILT with some small stones
7.30 – 7.45	Fine gravel
7.45 – 10.10	Soft to firm grey black SILT, with some cobbles and shells
10.10 – 10.35	Firm grey sandy CLAY
10.35 – 16.15	Firm to stiff grey black very silty CLAY with some stones, and some lenses of sandy silt
16.15 – 19.50	Boulder clay

Table 6-6 Borehole (BH2)

Depth (m begl)	Ground Conditions
0.0 – 4.30	Made ground
4.60 – 5.80	Grey and black SILT with some gravel
5.80 – 10.65	Fine to coarse SAND and GRAVEL, some cobbles and boulders
10.65 – 15.85	Stiff dark grey/black very silty CLAY with lenses of sand
15.85 – 25.75	Boulder clay

Table 6-7 Borehole (BH3)

Depth (m begl)	Ground Conditions
0.0 – 2.15	Made ground
2.15 – 5.50	Fine to coarse gravel with lenses of black silt and some cobbles
5.50 – 10.35	Fine to coarse sand and gravel with occasional cobbles and boulders

10.35 – 10.65	Coarse gravel with lenses of black-grey silt
10.65 – 13.10	Compact sand and gravel with numerous cobbles
13.10 – 17.10	Boulder Clay

7 OVERVIEW OF POTENTIAL CONTAMINATION

7.1 Introduction

The nature of potential contamination that may have arisen from the past activities on and surrounding the study area is considered below.

7.2 On Site Sources

7.2.1 Current Land Use

As the study area is formed on reclaimed ground, made ground will underlie the proposed 3FM development. The nature of this made ground is unknown and has the potential to contain contamination.

Operational activities within Area L, include the storage of petcoke by Irish Cement, a metal recycling facility (Hammond Lane Metal Recycling) and Ecocem Ireland Plant (cement manufacturer) which are potential sources of contamination. A number of identified above ground fuel tanks supporting the various industrial processes at the site are also considered potential sources of hydrocarbon contamination. Fuel tanks may lead to contamination of sub soils and impact human health receptors through direct dermal contact, inhalation and ingestion. Shallow ground water bodies beneath the site may be impacted if there are any above or below ground storage tanks at the site that have experienced leaks or spillages, this has the potential to impact the deeper bedrock aquifer via a vertical pathway. The nearby River Liffey may be impacted if a pathway exists for the lateral migration of hydrocarbon contaminated shallow/deep groundwater off site.

The former landfill at Area O is considered to be a potential source of contamination. Municipal and C&D waste has been deposited in this area. Waste material has the potential to generate elevated concentrations of ground borne gases such as Methane and/or Carbon Dioxide. The nature and timescale for the operation of the landfill may also have results in asbestos containing materials (ACM) being disposed at the site.

7.2.2 Previous Land Use – Historical Development

Due to the previous history of reclamation and landfilling and the various heavy industrial uses that have been present over the decades on the peninsula, it is expected that the potential for contamination will be present.

7.2.3 Radon Gas

As demonstrated on the Environmental Protection Agency (EPA) Radon Map, the study area is located in a 10km grid square with between one and five per cent of the homes estimated to be above the Reference Level. As such radon gas is anticipated to be moderate.

7.3 Off site sources

7.3.1 Surrounding Land Uses – Current

The surrounding land use comprises extensive industrial landuse in the surrounding port areas including significant fuel storage, power stations and sub-stations and these may have the potential for ground contamination.

7.3.2 Surrounding Land Uses – Historical

Historical potentially contaminating activities are present in the area surrounding the site including the old Poolbeg Power Station, former Fabrizia site and the former Irish Glass Bottle site.

8 CONCEPTUAL SITE MODEL AND RISK ASSESSMENT

8.1 Outline Conceptual Site Model

Risk estimation involves detailed evaluation of source - pathway - receptor scenarios to determine whether a linkage exists between any sources of contamination and potential receptors. A risk exists where a receptor is exposed to a source of contamination, via a pathway. If any element of the source-pathway-target linkage is absent, then no risk is present.

In order to consider potential risks at the study area, a conceptual site model was developed, to examine the potential source - pathway - receptor linkages that may exist on the site. The conceptual model and the risk assessment for the site are illustrated in Table 8.1.

Table 8-1 Risk Assessment & Outline Conceptual Site Model

Source	Potential Pathway(s)	Potential Receptor(s)	Relevant Source – Pathway – Receptor Linkage	Further Investigation Required
On site sources				
Contaminants within the soils and groundwater	Dermal contact, ingestion of/and direct inhalation of potential contaminants present within soil and / or fugitive dusts	Humans in form of future site users (commercial, site workers), landscaping and maintenance workers	Potential sources of contamination present on site include fuel storage and substations. The nature of the made ground underlying the site is unknown; it may have the potential to contain contamination (including asbestos).	Yes – targeted ground investigation required.
	Subsurface infiltration, leaching from sub-soils and groundwater flow Surface run-off	Perched groundwater, bedrock aquifer, River Liffey	Contaminants in soil have the potential to leach through sub-soils and effect perched groundwater, adjacent surface water and/or the bedrock aquifer.	
Soil gas: Made Ground or highly organic soils may contain high organic content that is degrading and producing Methane, Carbon dioxide and depleted Oxygen gases	Migration along cracks in foundations and service trenches	Humans in form of future site users, site workers, landscaping and maintenance workers.	As part of the Poolbeg Peninsula was utilised as a landfill for municipal solid waste landfill gas production is expected. Methane gas, Carbon Dioxide and small quantities of Hydrogen Sulphide form due to a portion of the municipal solid waste biodegrading anaerobically. There is the potential for an active pollutant linkage involving ground gas ingress into buildings and impacting human health receptors. As the entire area is formed on reclaimed ground, made ground will underlie the majority of the study area.	Yes – targeted ground investigation required.
Current and historical surrounding land uses	Subsurface infiltration, leaching from sub-soils and groundwater flow.	Humans in form of future site users, site workers, landscaping and maintenance workers. Shallow groundwater, bedrock aquifer and The River Liffey.	Contamination sources associated with the former IGB site, Fabrizia site and the previous industrial usage of this area may have the potential to remain in subsoils and shallow groundwater.	Yes – targeted ground investigation required.

9 CONCLUSIONS AND RECOMMENDATIONS

9.1 Conclusions

- The desk study has highlighted the potential contamination sources, pathways and receptors which are likely to be present on the site.
- In accordance with LCRM, an intrusive ground investigation and quantitative risk assessment should be carried out if the site is redeveloped to ascertain if the source – pathway – receptor linkages are present.

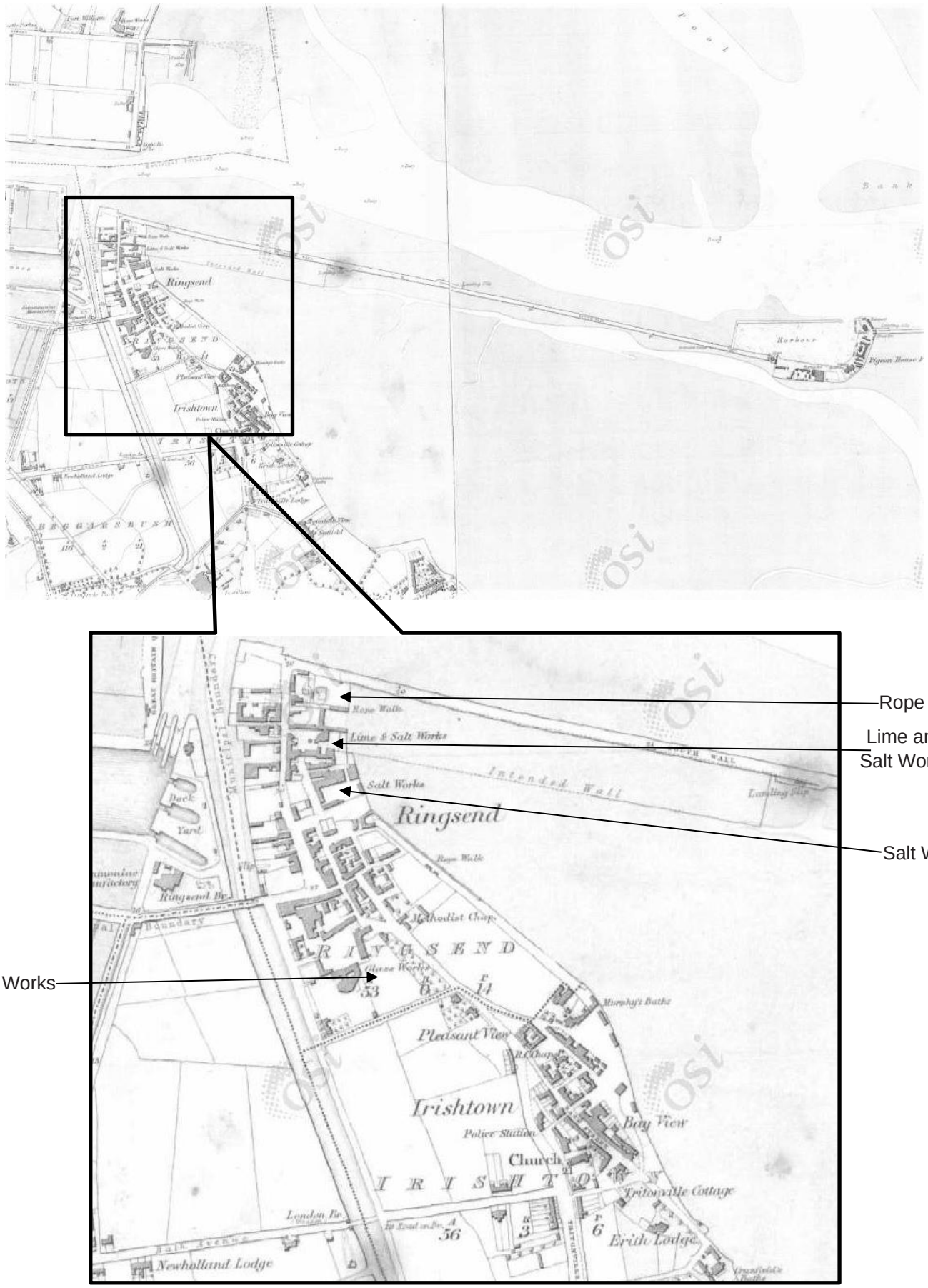
9.2 Recommendations

- A number of boreholes should be advanced across the site with a density as suggested in BS10175:2011+A2:2017 having consideration of the development proposals.
- A number of representative sub-soil samples will be collected and sent for laboratory analysis. The suites of analysis will include; Metals, Asbestos, Polycyclic Aromatic Hydrocarbons, Inorganics, Hydrocarbons (TPH CWG), PCBs and Dioxins, Volatile Organic Compounds and Semi Volatile Organic Compounds.
- Boreholes will be installed with monitoring installations to facilitate the collection of groundwater samples. Groundwater samples will be analysed as per a similar suite of analysis as described above for soils.
- Monitoring of soil borne gases and a gas risk assessment will be carried out as per the guidance contained within CIRIA C665 and ‘The Local Authority Guide to Ground Gases’.
- A Generic Quantitative Risk Assessment (GQRA) will be undertaken to ascertain the potential risks to future site users (human health) and environmental receptors.
- If deemed necessary from the GQRA, a Detailed Quantitative Risk Assessment (DQRA) will be undertaken to set site specific remedial targets for the development.

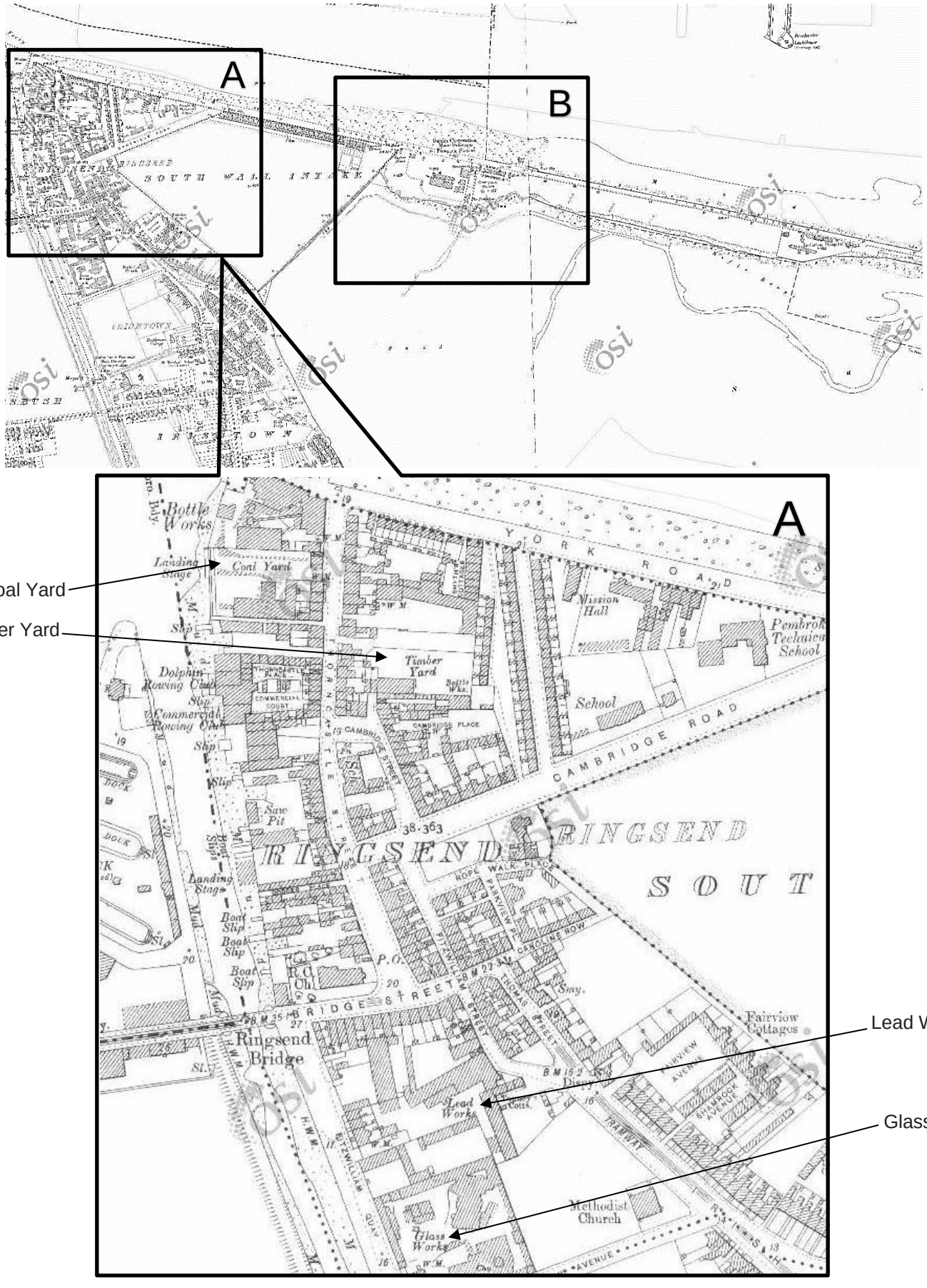
Appendix A

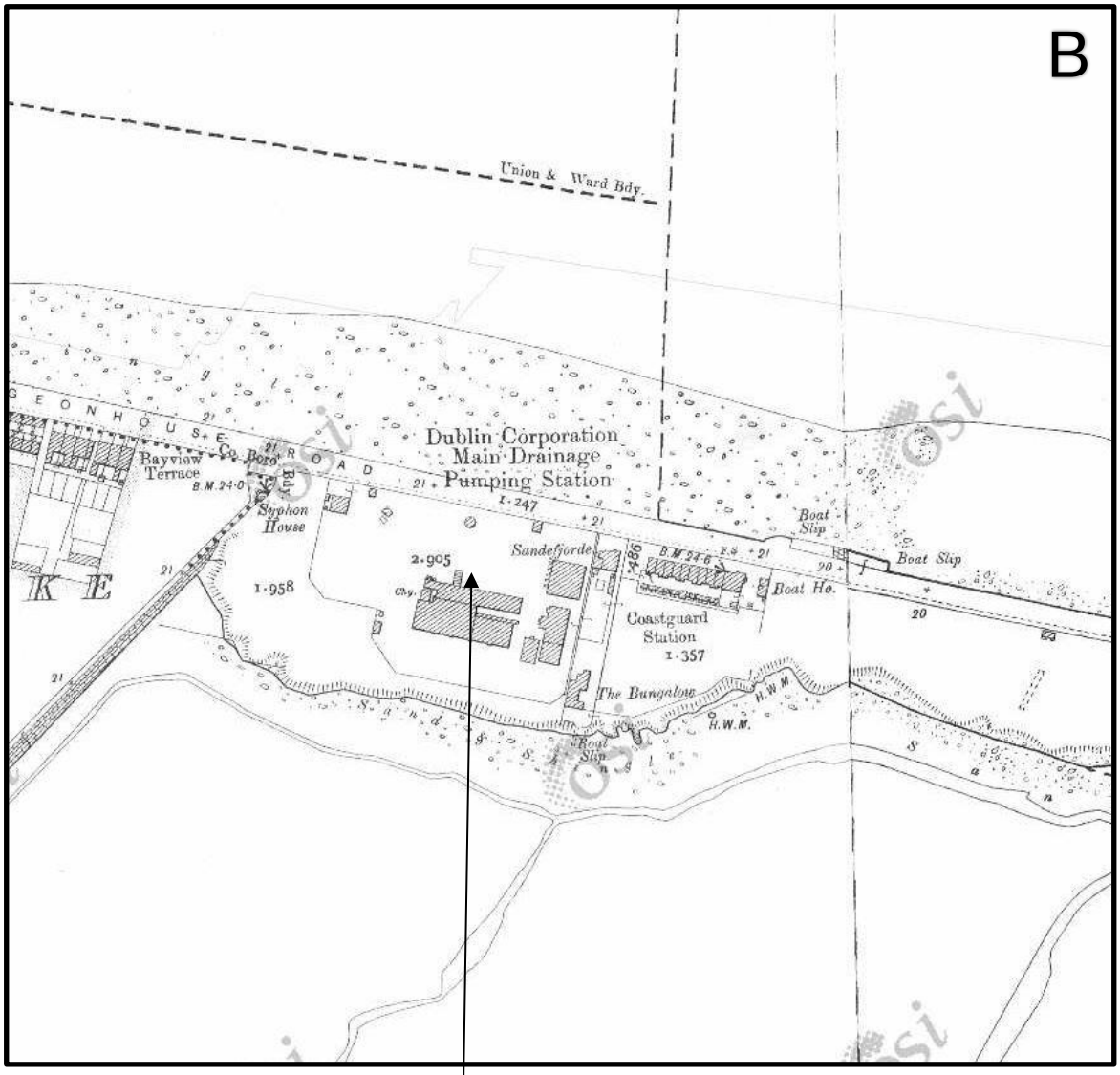
Historical maps

OSI Historical map 6 Inch First Edition, 1829-1841



OSI Historical map 6 Inch First Edition, 1897-1913




B
Union & Ward Bdy.
Dublin Corporation
Main Drainage
Pumping Station
Rayview
Terrace
Co. Boro'
Rly.
Siphon
House
Sandefjorde
Boat Slip
Boat Slip
Boat Ho.
Coastguard
Station
1·357
The Bungalow
H.W.M.
H.W.M.
Boat
Slip
2·905
1·958
1·247
B.M. 24·0
B.M. 24·6
K E
Pumping Station

Appendix B

Previous Ground Investigations

1. BORING RECORDS

2. LOGS OF BOREHOLES

3. WATER LEVEL RECORDINGS

4. SITE PLAN

PIGEON HOUSE ROAD

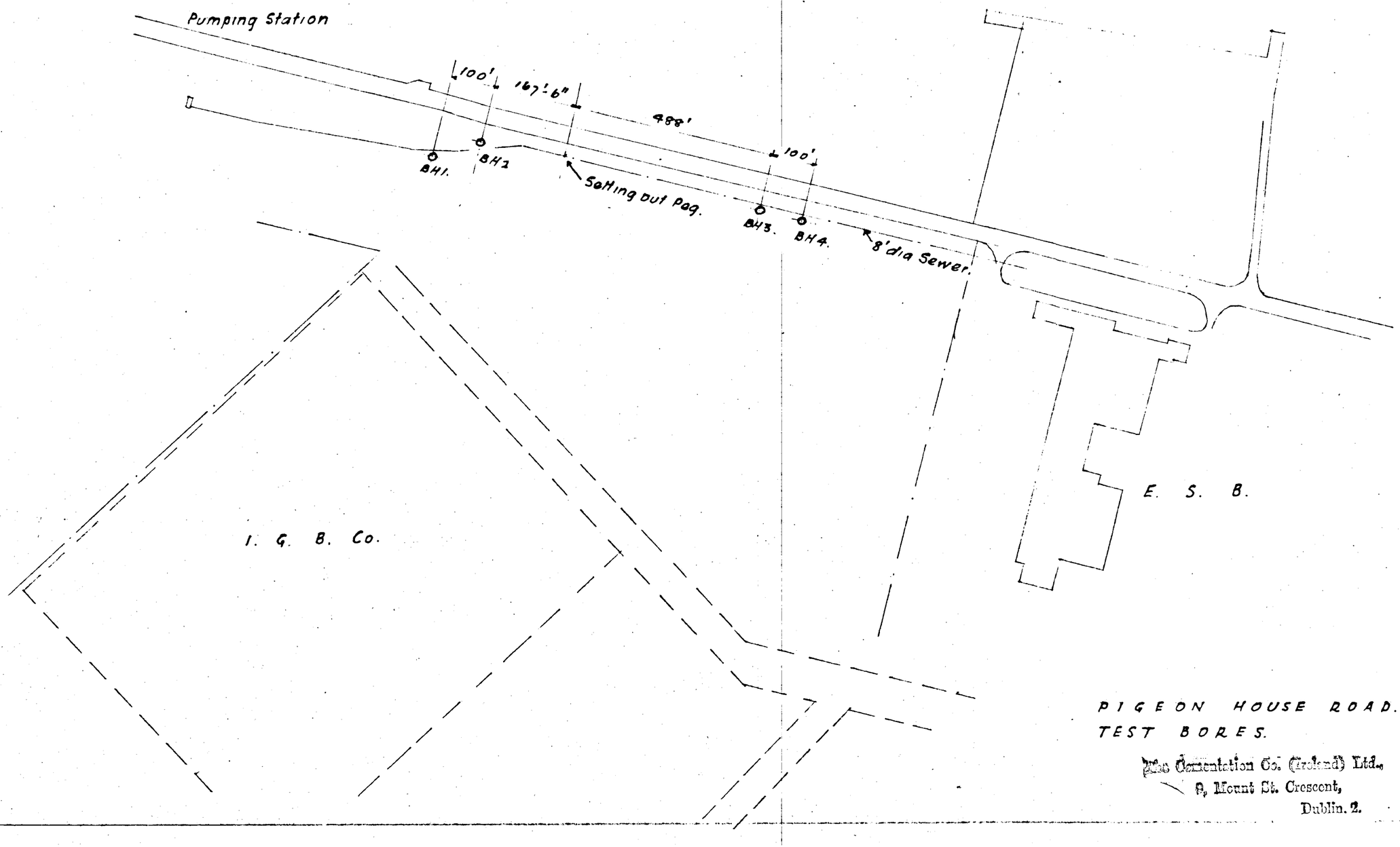
Water levels recorded in boreholes 2 and 3 on the 28th April 1965.

B.H.	Time	Level O.D.	
2	8.15 a.m.	9. 8	Two hours before high tide
	10.30 "	11. 3	High tide
	12.30 p.m.	10. 8	2 hours after high tide
	4.30 "	6. 3	Low tide
	5.30 "	5. 3	1 hour after low tide

B.H.	Time	Level O.D.	
3	8.15 a.m.	8. 7	Two hours before high tide
	10.30 "	9. 7	High tide
	12.30 p.m	9. 2	2 hours after high tide
	4.30 "	7. 7	Low tide
	5.30 "	7. 2	1 hour after low tide

Water levels recorded in borehole No. 3 on the 29th April 1965

B.H.	Time	Level O.D.	
3	6.30 a.m.	9.12	
	9.30 "	9.70	
	10.30 "	10.70	
	11.30 "	11.20	High tide 10.59
	12.30 p.m.	10.20	
	1.30 "	9.45	
	2.30 "	8.70	
	3.30 "	8.20	
	4.30 "	7.70	
	5.30 "	7.20	Low tide 5 p.m. approx.
	6.30 "	7.20	



PIGEON HOUSE ROAD.
TEST BORES.

The Cementation Co. (Ireland) Ltd.,
9, Mount St. Crescent,
Dublin. 2.

THE CEMENTATION CO., (IRELAND) LTD.

SOIL INVESTIGATION

BORING RECORD

CONTRACT Pigeon House Road. BOREHOLE No. 4.

Report No. Order No. 92422

Bored for Dublin Port & Docks Board

Site Address Pigeon House Rd., Dublin.

Boring Commenced 29/4/65 Boring Completed 30/4/65

Type of Boring Shell & Auger Diameter of Borehole 8 ins.

Ground Level 23.0 O.D.

Water Struck (1) 7'6" B.G.L. (2) (3)

Standing Water Level

Remarks

Description of Strata	Depth From	Depth To	Thickness	Samples Ref No.	Type	Depth
Organic top soil	0	1'0"	1'0"			
Filling of sandy clay, silt, gravel and brick etc.	1'0"	16'0"	15'0"	11180	J	5'0"
				11181	J	7'6"
				11182	W	7'6"
				11182	J	10'0"
				11183	J	12'6"
				11184	J	15'0"
Soft black organic silt.	16'0"	17'0"	1'0"			
Compact sandy gravel and cobbles	17'0"	18'6"	1'6"	1185	J	17'6"
Small sandy gravel with layers of fine sand.	18'6"	30'0"	11'6"	1186	J	20'0"
				1187	J	22'6"
				1188	J	25'0"
				1189	J	30'0"

Standard Penetration Tests.

At	5'0"	3	blows to	12"
"	7'6"	2	" "	"
"	10'0"	1	" "	"
"	12'6"	1	" "	"
"	15'0"	6	" "	"
"	17'6"	26	" "	"
"	20'0"	20	" "	"
"	22'6"	27	" "	"
"	25'0"	19	" "	"
"	27'6"	19	" "	"
"	30'0"	27	" "	"

THE CEMENTATION CO., (IRELAND) LTD.

SOIL INVESTIGATION

BORING RECORD

CONTRACT Pigeon House Road. BOREHOLE No. 3.

Report No. Order No. 92429

Bored for Dublin Port & Docks Board

Site Address Pigeon House Road, Dublin

Boring Commenced 27/4/65 Boring Completed 28/4/65

Type of Boring Shell & Auger Diameter of Borehole 8 ins.

Ground Level 23.7 O.D.

Water Struck (1) 15'B.G.L. (2) (3)

Standing Water Level

Remarks

Description of Strata	Depth From	Depth To	Thickness	Samples Ref No.	Samples Type	Samples Depth
Organic top soil	0 0	1'0"	1'0"			
Filling of clay, ashes, clinker and brick.	1'0"	4'0"	3'0"	11167	J	2'6"
Coarse sandy gravel	4'0"	6'0"	2'0"	11168	J	5'0"
Soft black organic silt with layers of gravel	6'0"	17'0"	11'0"	11169 11170 11171 11172 11173	J J J J W	7'6" 10'0" 12'6" 15'0" 15'0"
Compact medium to large sandy gravel & cobbles.	17'0"	21'0"	4'0"	11174 11175	J J	17'6" 20'0"
Compact fine to medium sand, gravel and shells.	21'0"	27'0"	6'0"	11176 11177	J J	22'6" 25'0"
Fine silty sand with gravel, stones and fragments of shells.	27'0"	30'0"	3'0"	11178 11179	J J	27'6" 30'0"

Standard Penetration Tests.

At 2'6"	4	blows to	12"
" 5'0"	16	" "	"
" 7'6"	2	" "	18"
" 10'0"	2	" "	"
" 12'6"	2	" "	12"
" 15'0"	2	" "	"
" 17'6"	48	" "	"
" 20'0"	55	" "	"
" 22'6"	26	" "	"
" 25'0"	35	" "	"
" 27'6"	28	" "	"

THE CEMENTATION CO., (IRELAND) LTD.

SOIL INVESTIGATION

BORING RECORD

CONTRACT Pigeon House Road, BOREHOLE No. 2.

Report No. Order No. 9242

Bored for Dublin Port & Docks Board

Site Address Pigeon House Road, Dublin

Boring Commenced 23/4/65 Boring Completed 26/4/65

Type of Boring Shell & Auger Diameter of Borehole 8 ins.

Ground Level 24.8 O.D.

Water Struck (1) 15:B.G.L. (2) (3)

Standing Water Level

Remarks

Description of Strata	Depth From	Depth To	Thickness	Samples Ref No.	Type	Depth
Organic top soil	0"	1'0"	1'0"			
Brown sandy silt with traces of clay	1'0"	4'0"	3'0"	1154	J	2'6"
Fine brown silty sand and gravel	4'0"	6'0"	2'0"	11155	J	5'0"
Soft brown clayey silt with traces of fine sand, small stones & cobbles	6'0"	9'0"	3'0"	11156	J	7'6"
Soft black organic silt with small stones & cobbles.	9'0"	17'0"	8'0"	11157 11158 11166 11159	J J W J	10'0" 12'6" 15'0" 15'9"
Compact coarse sandy gravel and cobbles	17'0"	24'0"	7'0"	11160 11161 11162	J J J	17'6" 20'0" 22'6"
Very fine sand with traces of silt and fragments of shells (Hole blowing)	24'0"	30'0"	6'0"	11163 11164 11165	J J J	25'0" 27'6" 30'0"

Standard Penetration Tests

At 2'6"	3 blows to 12"	
" 5'0"	3 " " "	
" 7'6"	2 " " "	
" 10'0"	2 " " "	
" 12'6"	4 " " "	
" 15'0"	13 " " "	
" 17'6"	35 " " "	
" 20'0"	18 " " "	
" 22'6"	16 " " "	
" 25'0"	No. Resistance	
" 27'6"	" "	

THE CEMENTATION CO., (IRELAND) LTD.

SOIL INVESTIGATION

BORING RECORD

CONTRACT Pigeon House Road — BOREHOLE No. 1

Report No. — Order No. 92419

Bored for Dublin Port & Docks Board

Site Address Pigeon House Road, Dublin.

Boring Commenced 21/4/65 — Boring Completed 22/4/65

Type of Boring Shell & Auger — Diameter of Borehole 8 ins.

Ground Level 25.0 O.D.

Water Struck (1) 13' B.G.L. (2) (3)

Standing Water Level

Remarks Highest water level recorded 13'0" and lowest 15'9" below ground level.

Description of Strata	Depth From	Depth To	Thickness	Samples Ref No.	Type	Depth
Organic top soil	0	2'6"	2'6"			
Loose fine sand with shells & some stones	2'6"	9'0"	6'6"	10692 10693	J J	5'0" 7'6"
Soft black organic silt with an occasional cobble.	9'0"	12'0"	3'0"	10694	J	10'0"
Very soft grey sandy silt.	12'0"	18'0"	6'0"	10695 10697 10696	J W J	12'6" 13'0" 15'0"
Very soft grey sandy silt and gravel	18'0"	21'0"	3'0"	10698 10699	J J	19'6" 20'0"
Compact coarse sandy gravel and shells	21'0"	29'0"	8'0"	10700 11151 11152	J J J	22'6" 25'0" 27'6"
Soft grey sandy silt with gravel, shells and traces of clay	29'0"	30'0"	1'0"	11153	J	30'0"

~~Standard Penetration Tests~~

At 5'0" 4 blows to 12"
" 7'6" 4 " " 15"
" 10'0" 2 " " 18"
" 12'6" No resistance
" 15'0" " "
" 17'6" 1 blow to 12"
" 20'0" 5 " " "
" 22'6" 27 " " "
" 25'0" 27 " " "
" 27'6" 25 " " "
" 30'0" 10 " " "

REPORT

SITE INVESTIGATION FOR PROPOSED 'C' POWER STATION
RINGSEND, DUBLIN, EIRE.

Date February, 1965 **No.** 4091/3

SOIL MECHANICS LIMITED

65 OLD CHURCH STREET LONDON SW3

Telegrams—Edaphos London S.W.3
Telex—24351

Telephone—FLAxman 8111

REPORT NO. 4091/3

SITE INVESTIGATION FOR PROPOSED 'C' POWER STATION

RINGSEND, DUBLIN, EIRE.

C O N T E N T S

REPORT NO. 4091/3

SITE INVESTIGATION FOR PROPOSED 'C' POWER STATION

RINGSEND, DUBLIN, EIRE.

SUMMARY

Ten borings with diamond drilling into rock indicated a succession of made ground, predominately granular and of varying compactness 8 to 23 ft. thick, alluvium 56 to 86 ft. thick, consisting mainly of medium dense sand 4 to 17 ft. thick, and medium dense sandy gravel 30 to 40 ft. thick. In a few cases there is overlying soft clayey silt. Occasionally there is a layer of compact sandy silt or soft clay within the upper part of the alluvium. The lower part of the alluvium comprises moderately compact estuarine clayey silts and firm silty clays 29 to 50 ft. thick. Below the alluvium very stiff boulder clay with gravel and cobbles some 16 to 43 ft. thick overlies hard limestone bedrock. The succession revealed by the boreholes was similar to that previously encountered at the Ringsend 'A' station. Laboratory tests indicated that the properties of the estuarine silty clays and clayey silts are comparable to those found at the 'A' station site. Depending on the siting of lighter loaded structures the upper sands and gravels of the alluvial deposits should be capable of supporting these structures, but the possibilities of soft clay layers occurring at the sites of these structures should be taken into account. The boulder clay was very stiff and granular and it was not possible to obtain a measurement of its strength and compressibility. In view of the considerable thickness of boulder clay it is suggested that loading tests should be carried out on piles founded in the top of this stratum since, if satisfactory, a considerable saving on foundation costs could be effected. In the event of large diameter piles being required to found into sound bedrock this was found to be shallowest at about 71 ft. below datum on the south west corner of the site, dipping to about 116 ft. below datum at the north east corner of the site.

REPORT NO. 4091/3

SITE INVESTIGATION FOR PROPOSED 'C' POWER STATION RINGSEND, DUBLIN, EIRE

INTRODUCTION

The Electricity Supply Board (ESB) propose to construct a new power station adjacent to the present 'A' Station at Ringsend, Dublin.

In December, 1962, ESB asked Soil Mechanics Limited (SML) to put down one boring at each of three sites, one east of the existing Old Pigeon House Station, one immediately east of the 'A' Station in the area of the present ash lagoon and the third immediately west of the 'A' Station. The borings were planned to follow additional work at Ringsend 'A' Station and at the 'A' Station wharf carried out in January-March, 1963.

The choice of site ultimately chosen for the next power station will, in addition to the ground conditions, also be governed by the feasibility of providing satisfactory cooling water intake and outlet systems. The cooling water problem is being dealt with separately by ESB and SML are only concerned with investigating the ground conditions.

Based on the results of the initial three borings ESB requested additional borings in the area east of Pigeon House Station now designated 'B' Station site. Subsequently SML were also requested to put down further borings on a grid over the area to the west of 'A' Station which is now designated Ringsend 'C' site.

At present it appears that 'B' Station site is likely to be developed first and for the detailed investigation of this site reference should be made to S.M. Report No. 4091/4406/1. The present report covers the borings at 'C' Station site which were put down over the period 3rd April to 27th November, 1963.

A list of investigations carried out by SML at Ringsend is given in Appendix A.

Ringsend 'C' site lies immediately west of the existing 'A' Station and is bounded on the north by Pigeon House Road and on the south by Sandymount Bay as shown on the site plan Fig. 15 and Key plan Fig. 16. The site covers an area some 1000 ft. square, but of this the area investigated covered only some 600 ft. square for the station building, chimneys, offices and workshop stores.

A general description of the geology of the area is given in S.M. Report No. 2154/4 but briefly, below fill material, consists of sand and gravels, estuarine laminated clays and silts, and possibly glacial drift over Carboniferous limestone bedrock.

THE BORINGS

Ten soft ground borings with diamond drilling into rock were put down in the positions shown on the site plan Fig. 15. The boreholes were numbered B3 and B15 to B23 inclusive to continue the latest sequence of boreholes at Ringsend for the new station. The borehole logs with detailed descriptions of the strata encountered are given in Fig. 1-10 and sections through the site, giving a tentative interpolation of strata between the boreholes, are shown in Fig. 11a and b.

Levels are referred to the Irish Ordnance Datum (I.O.D.).

The following succession of strata was encountered:-

Made Ground

This was about 8 to 23 ft. thick, consisting generally of:-

(a) Ash, clinker, brick and concrete fragments with some gravel and sand.

Alluvium

This was about 56 to 86 ft. thick, consisting of:-

(b) Soft black and dark grey clayey micaceous SILT to about 2 to 10 ft. thick. Only encountered in Boreholes B15, 16, 19 and 21.

(c) SAND with some gravel, 4 to 17 ft. thick encountered in Boreholes B3, 18, 20 and 22, and sandy GRAVEL about 7 to 35 ft. thick, which was revealed in all boreholes. In a few boreholes a sandy SILT layer some 2 to 12 ft. thick occurs within the sandy gravel, and in Boreholes B22, and 23 soft and soft to firm silty CLAY 9 and 13 ft. thick respectively, occurs in this upper granular part of the alluvium. The overall thickness of stratum (c) varies from about 30 to 40 ft.

(d) Compact clayey fine sandy SILT or generally firm silty CLAY, often laminated was encountered in all boreholes, the thickness varying from about 29 to 50 ft. In places, this material, which is an estuarine deposit, is predominantly a silt and elsewhere predominantly clay.

Glacial Drift

(e) Boulder Clay 16 to 43 ft. thick consisting of fine medium and coarse GRAVEL and COBBLES in a matrix of firm to stiff and stiff dark grey sandy CLAY. The gravel content increases and becomes coarser with depth and in Borehole B3 the bottom 11ft. of the stratum is mainly cobbles and boulders with some sand.

Bedrock

(f) Hard dark grey generally arenaceous but in places argillaceous LIMESTONE with some fossiliferous zones and some calcite veining. There are occasional thin black shale bands in some boreholes and a few steeply inclined joints. The dip, where visible, is generally about 20 to 30° but in Borehole B17 appeared to be only 10 to 15° and in Boreholes B16 and 22 was somewhat steeper at about 40 to 45°. The top of apparently sound bedrock, below any very jointed and weathered zone, was shallowest at about 71 ft. below I.O.D. at the south west corner of the site, and deepest at about 116 ft. below I.O.D. at the north east corner of the site. The top 2 to 6 ft. of the bedrock in a number of boreholes was very broken.

Water level observations were made during the boring operations and in a number of cases water had to be added to assist boring in the upper dry granular fill above the water table. The water table generall appears to fluctuate between about 4 and 13 ft. above datum. Observatio tubes were installed in Boreholes B20 and B22 towards the base of stratum (c) to enable the client to check on water level variations. Readings taken in these tubes, given on the logs, show agreement in water level with respect to datum.

FIELD TESTS

Standard penetration tests, as described in Appendix B, were carried out in the predominantly granular materials. Eight tests in the made ground gave N values ranging from 6 (loose) to 146 (very dense).

In the clayey silt stratum (b) two tests with N values of 5 and 7 indicate the material to be loose or soft. In stratum (c) in the sand with some gravel, N values ranged from 9 to 23 with an average of 17 indicating the material to be medium dense. In the sandy gravel N values range from 10 to 45 with an average of 22, again indicating medium dense material. One test in the sandy silt layer within the sandy gravel indicated this to be compact and one test in the silty clay confirmed that this was soft. Two tests in the top of the estuarine silt indicated this to be only loose to moderately compact but it is thought that these low results may have been due to disturbance in the borehole. In the boulder clay except for Boreholes B17 and B19, N values were in excess of 70 indicating very dense or hard material, and even in Boreholes B17 and B19 N values ranged from 31 to 53 indicating dense to very dense or hard material.

LABORATORY TESTS

In order to obtain some comparison between the existing 'A' station site and the proposed 'B' and 'C' Station sites, we were requested to carry out a limited programme of laboratory tests. Details of possible structures for 'C' Station are not available but it is anticipated that as for 'A' Station the chimneys, turbine and boiler house equipment will be carried on piles founded into bedrock. The characteristics of the superficial deposits will be more relevant to the lighter structures, such as workshops, offices and storage tanks. Apart from the isolated cases where soft clays occur in the upper part of the alluvium, the estuarine clays and silts existing below the upper alluvial sands and gravels may be stressed. Comparison of the thicknesses of the clayey silts and silty clay indicated that Boreholes B15 and B22 on the 'C' station site and B5 and B12 on the 'B' station site, were comparable with Boreholes 30 to 33 and 35 on the 'A' station site.

Liquid and plastic limit tests together with particle size determinations were made on four samples from Borehole B15 of the laminated silty clay and on two samples from B22 where a clayey silt predominates. The particle size distribution curves given in Fig. 12 indicated that, with one exception, the

samples tested were very silty clays. The exception, sample B15/33 was a clayey silt. The liquid and plastic limit tests are given in Table 1 and are plotted in Fig. 13. This figure also gives the results of previous tests carried out on the 'A' station site and it will be seen that the present results lie within the range covered by earlier tests.

Subsequently three undrained triaxial tests were carried out from samples of estuarine deposits from Borehole B15, the samples being saturated before testing. The results given in Table II indicated shear strengths varying from between 1,470 and 3,050lb/sq.ft. Apart from the result from sample B15/19 which was higher than average, it is seen on Fig. 14 that the other two results are in agreement with previous shear strengths measured on the estuarine clays and silts.

DISCUSSION

The boreholes revealed a similar succession to that previously encountered at the 'A' station. Below the fill, which is variable in its degree of compaction, the upper sands and gravels of the alluvial deposits are at least medium dense and, provided due attention is paid to the possibility of soft clay as at Borehole 22 occurring within these deposits, should be capable of carrying the lighter loaded structures.

The estuarine silty clays, and clayey silts are comparable with those found at the 'A' station site. Comparison of the liquid and plastic limit results from 'C' station with the results from earlier tests at the 'A' station.

The liquid and plastic limit results from 'C' station could not be directly compared with all the results from 'A' station since in a number of cases mechanical analyses had not been carried out on the corresponding 'A' station samples and some of these visually described as silty clays may in fact have been clayey silts, or vice versa. However, it would appear that generally the 'C' station results fall within the range indicated from the 'A' station site.

As mentioned above, the shear strengths of the estuarine deposits also appear comparable with the 'A' station site. No consolidation tests were carried out, but in view of the similarity of the materials on both sites it would appear reasonable to assume that compressibilities given in previous

first approximation.

One of the problems on the 'A' station site had been the depths to which it had been necessary to take Benoto pile foundations, in order to ensure their founding into bedrock. We had been asked whether it was feasible to obtain a measurement of the strength and compressibility of the boulder clay overlying bedrock, since, if this was capable of carrying the pile loads, considerable saving might be effected by founding the piles in the top of the boulder clay, thus reducing the length of piles by some 16 to 40 ft.

It was found that due to the granular nature of the boulder clay it was not possible except in one instance, to obtain open drive samples, and due to the granular nature of the soil even this was considered disturbed. Standard penetration tests were often impracticable due to the presence of cobbles and the generally stiff nature of the boulder clay. A possible alternative method to obtain the required data appeared to be the use of a pressuremeter. This essentially requires a probe to be inserted into a borehole in order that increments of pressure may be applied to the walls of the borehole. For this purpose a relatively clean open borehole is required An attempt was made to drill an NX hole in the boulder clay at the position of Borehole B20 to determine whether the hole would remain open after the withdrawal of the core barrel. The drill penetrated a depth of 3 ft. in the boulder clay and the core barrel was then withdrawn. On attempting to reintroduce the core barrel into the hole it was found that it had partly collapsed and the core barrel could only be dropped in to a depth of 18 inch We therefore considered that this method was impracticable. The possibility of driving a solid probe some 4 ft. into the boulder clay in the hope that it might be possible to force a way through or break up smallish cobbles was also considered although it would be appreciated that if boulders were encountered progress would be impossible. However, since there was some doubt as to whether 'C' station site might in fact be developed, the client decided that the additional expense in trying to assess the characteristics of the boulder clay by means of pressuremeter tests was not warranted. In view of the possible savings on foundation costs it is suggested that it may well be worthwhile carrying out a series of loading tests on piles

founded in the boulder clay.

In the event of the site eventually being developed as a power station and it being decided to carry certain foundations down to sound bedrock, this was found shallowest at about 71 ft. below I.O.D. at the south west corner of the site, dipping to about 116 ft. below I.O.D. at the north east corner of the site.

For SOIL MECHANICS LIMITED.

Engineer.

Director.

RDC/SH/4091/3
February, 1965.

REPORT NO. 4091/3

APPENDIX 'A'.

LIST OF SITE INVESTIGATIONS CARRIED OUT AT RINGSEND, BY SOIL MECHANICS LTD.

S.M. Report No.	Title	Date
636/1	Ringsend Power Station - Soil Tests	January, 1950
636/2	Ringsend Power Station - Soil Tests	March, 1951
1143/1	Ringsend Power Station Extension, Settlement Analysis	August, 1952
1143/2	Ringsend Power Station Extension - Soil Tests	July, 1952
2154/1	Site investigation for a proposed extension to Ringsend Power Station, Dublin, Eire.	October, 1957
2339/1	Preliminary Investigation for a Power Station in Sandymount Bay, Dublin, Eire.	October, 1957
3709/1	Additional borings for a proposed extension to Ringsend Power Station, Dublin, Eire.	October, 1961
4091/1	Additional borings for extension G7 to Generator Hall, Ringsend Power Station, Dublin, Eire.	May, 1963
4091/2	Investigation of Wharf Stability, Ringsend Power Station, Dublin, Eire	February, 1964
4091/3	Site Investigation for proposed 'C' Power Station, Ringsend, Dublin, Eire.	February, 1965

APPENDIX B

STANDARD PENETRATION TESTS

In order to give an indication of the density of non-cohesive soils, such as sands and gravels, the standard penetration test has been adopted.

A two-inch external diameter thick-walled sample tube is driven into the ground at the bottom of the borehole by means of a 140 lb. hammer falling freely through 30 in. The tube is first driven an initial 6 in. to allow for the presence of disturbed material at the bottom of the borehole. The number of standard blows (N) required to drive the sampler a further 12 in. is recorded. The sample tube used is one originally developed by the Raymond Concrete Pile Company in the United States, where a sufficient number of tests has been made in conjunction with field investigation to show that the results, although essentially empirical, may be applied to foundation design.

For sands:

Values of N	Density
Less than 10	Loose
Between 10 and 30	Medium
Between 30 and 50	Dense
Greater than 50	Very dense

SOIL MECHANICS LTD.
65, Old Church Street,
LONDON, S.W.3.

TABLE I
INDEX PROPERTIES

SHEET No. T1

LOC. 4091/3 NAME Ringsend 'C', Dublin. DATE 20.8.64.

Bore Hole No.	Sample No.	DEPTH From	DEPTH To	Natural Moisture Content %	Liquid Limit %	Plastic Limit %	Type of Sample
B15	19				38	20	
	23				40	20	
	29				43	18	
	33				25	15	
B22	23				39	19	
	29				42	21	

Note:- Vertical strips were taken to do liquid and plastic limits.

TABLE II

SHEET No. T2.

UNDRAINED TRIAXIAL TEST RESULTS

LOC. No. 4091 NAME Ringsend 'C', Dublin DATE 8/9/64

Rate of Strain during test 2. per cent/minute

Bore Hole No.	Sample No.	Cell Pressure lb./sq. in.	Compressive Stress at Failure lb./sq. in.	Strain at Failure per cent	Bulk Density lb./cu. ft.	Moisture Content per cent	Shear Strength or Cohesion lb./sq. ft.	Angle of Shearing Resistance degrees
15	19	30	48.4	24.0	130	23		
		50	33.9	28.9	132	24	3050	0
		70	44.8	26.7	131	23		
15	23	30	23.4	14.0	129	25		
		50	17.9	12.0	129	25	1470	0
		70	20.0	12.9	129	25		
15	29	40	17.8	15.1	133	23		
		60	28.0	22.5	135	22	1810	0
		80	29.6	23.1	132	23		

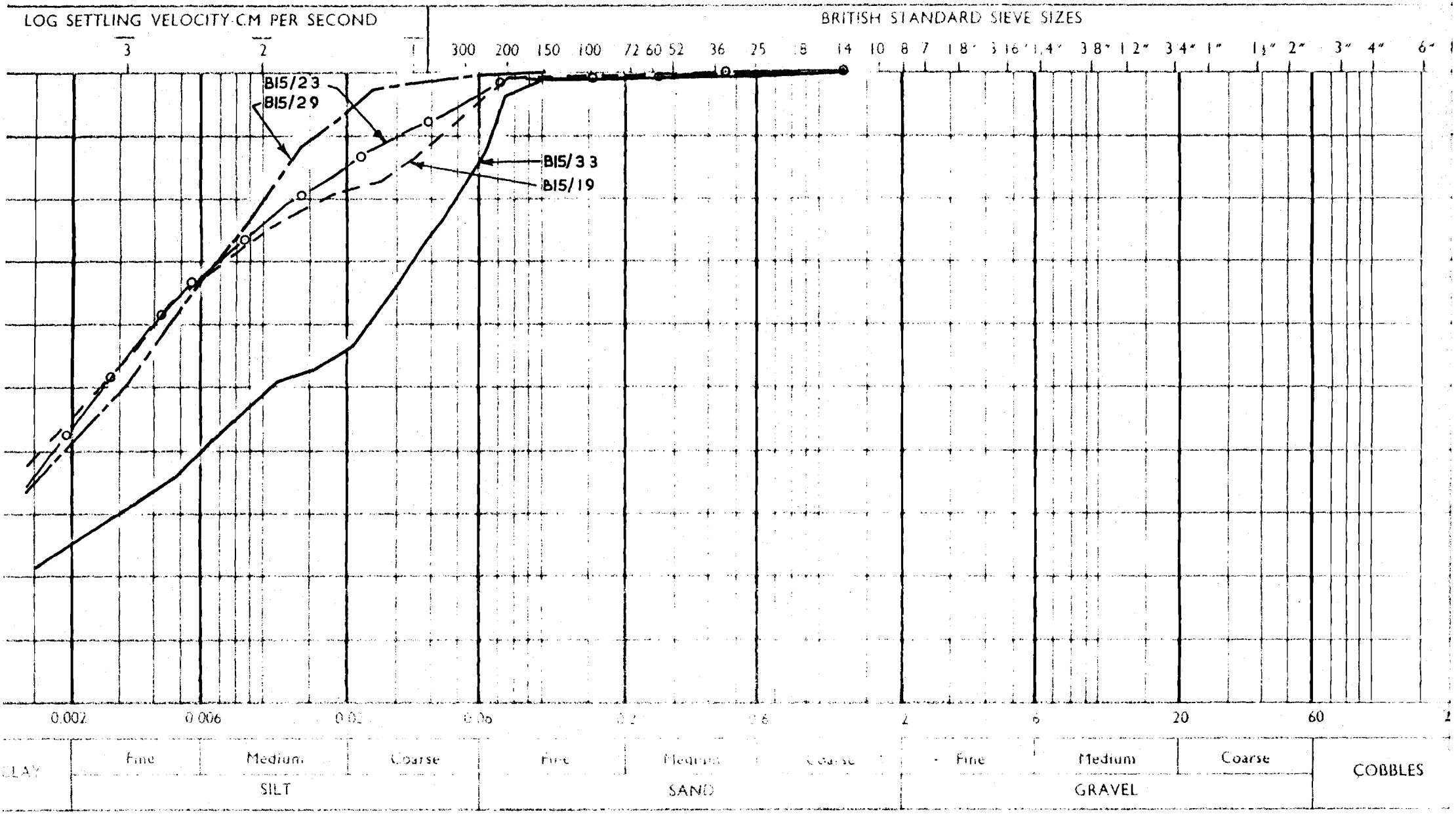
N.B. Bulk density and moisture content given for fully saturated specimens.

SOIL MECHANICS LTD.

PARTICLE SIZE DISTRIBUTION

ATION No. 4091/3 BORE HOLE No SAMPLE No PRETREATMENT DETAILS

E OF TEST . DESCRIPTION



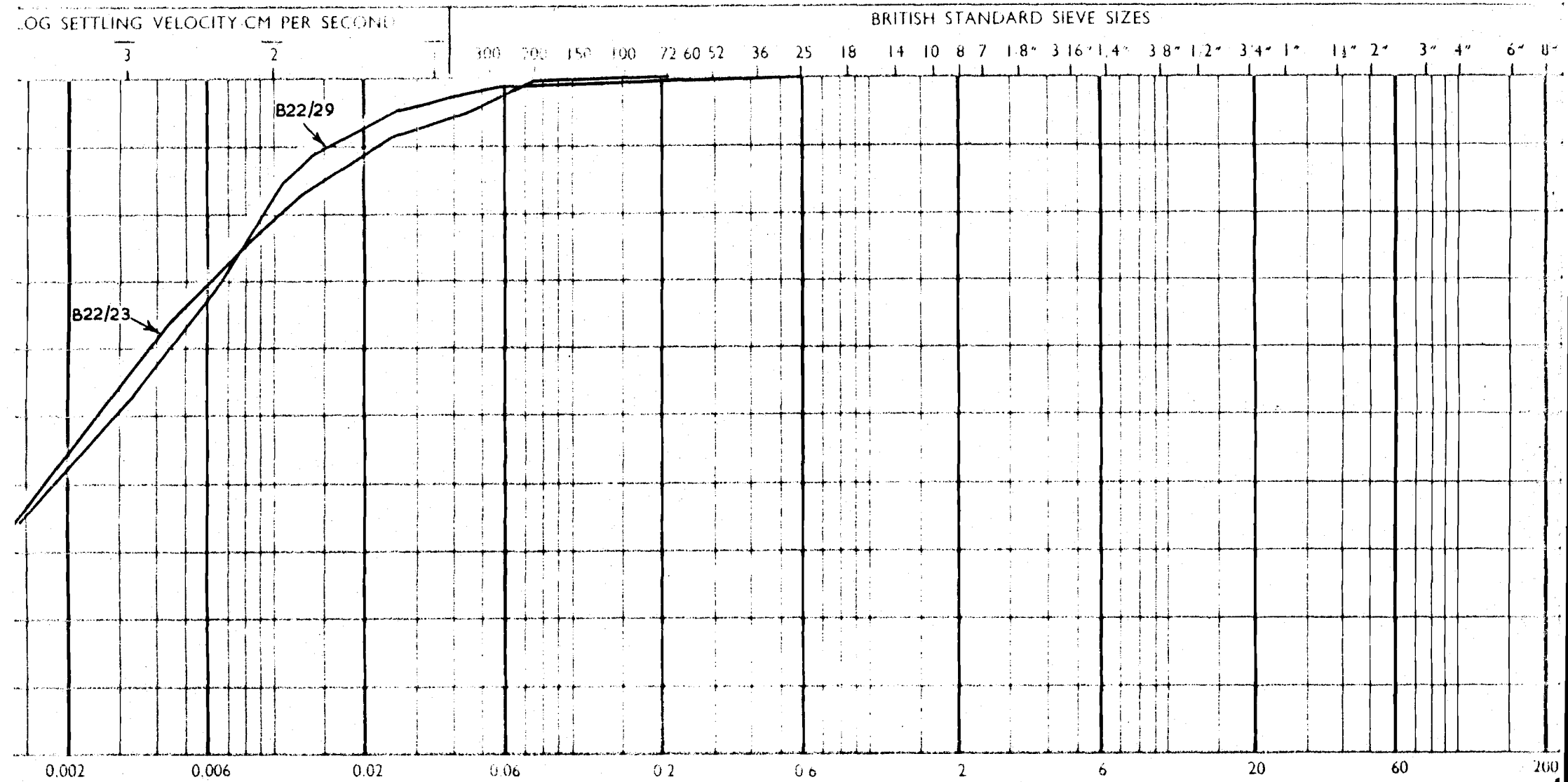
SOIL MECHANICS LTD.

PARTICLE SIZE DISTRIBUTION

Form No. K4

ON No. 4091/3 BORE [illegible] SAMPLE No. PRETREATMENT DETAILS

DF TEST DESCRIPTION



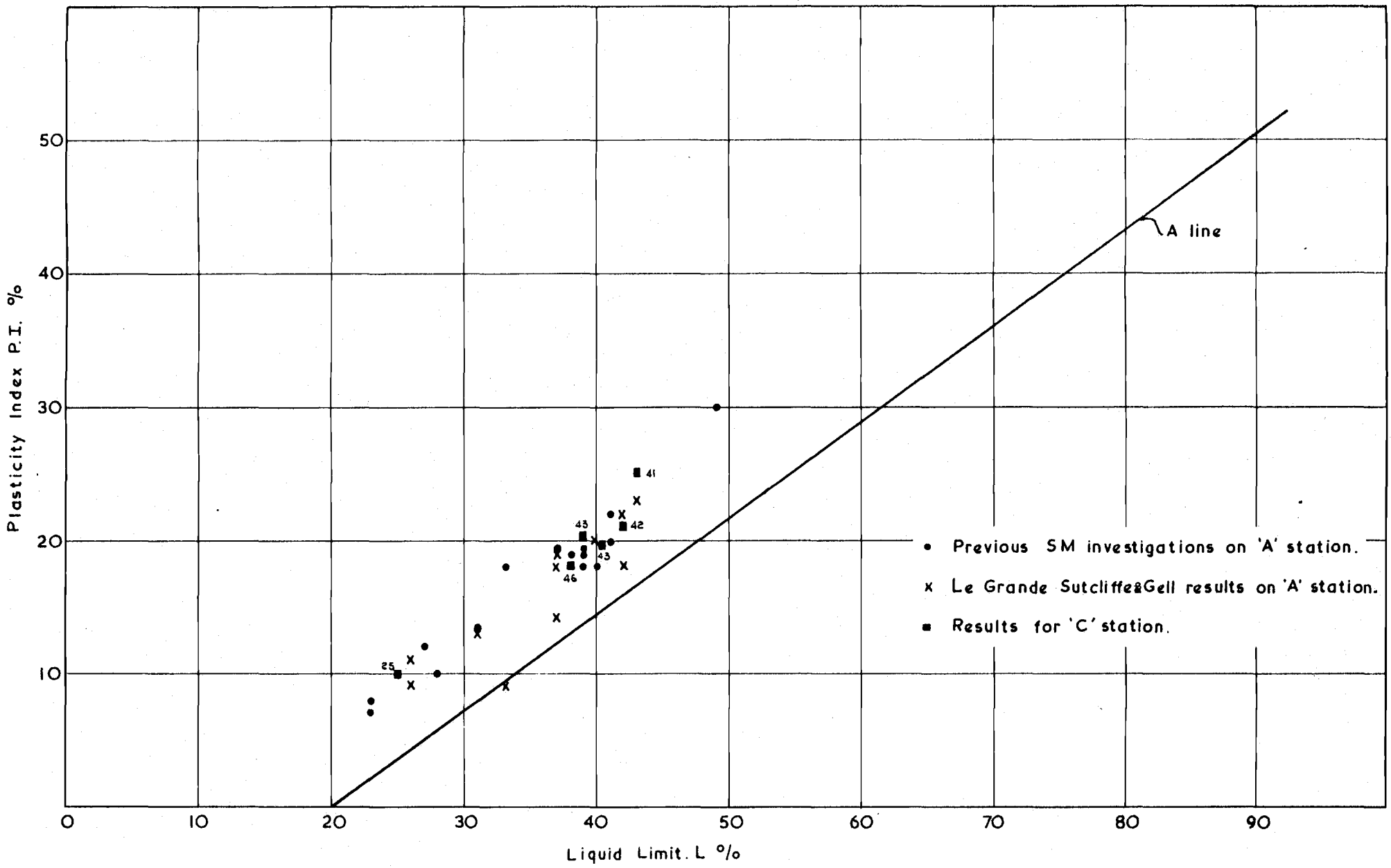
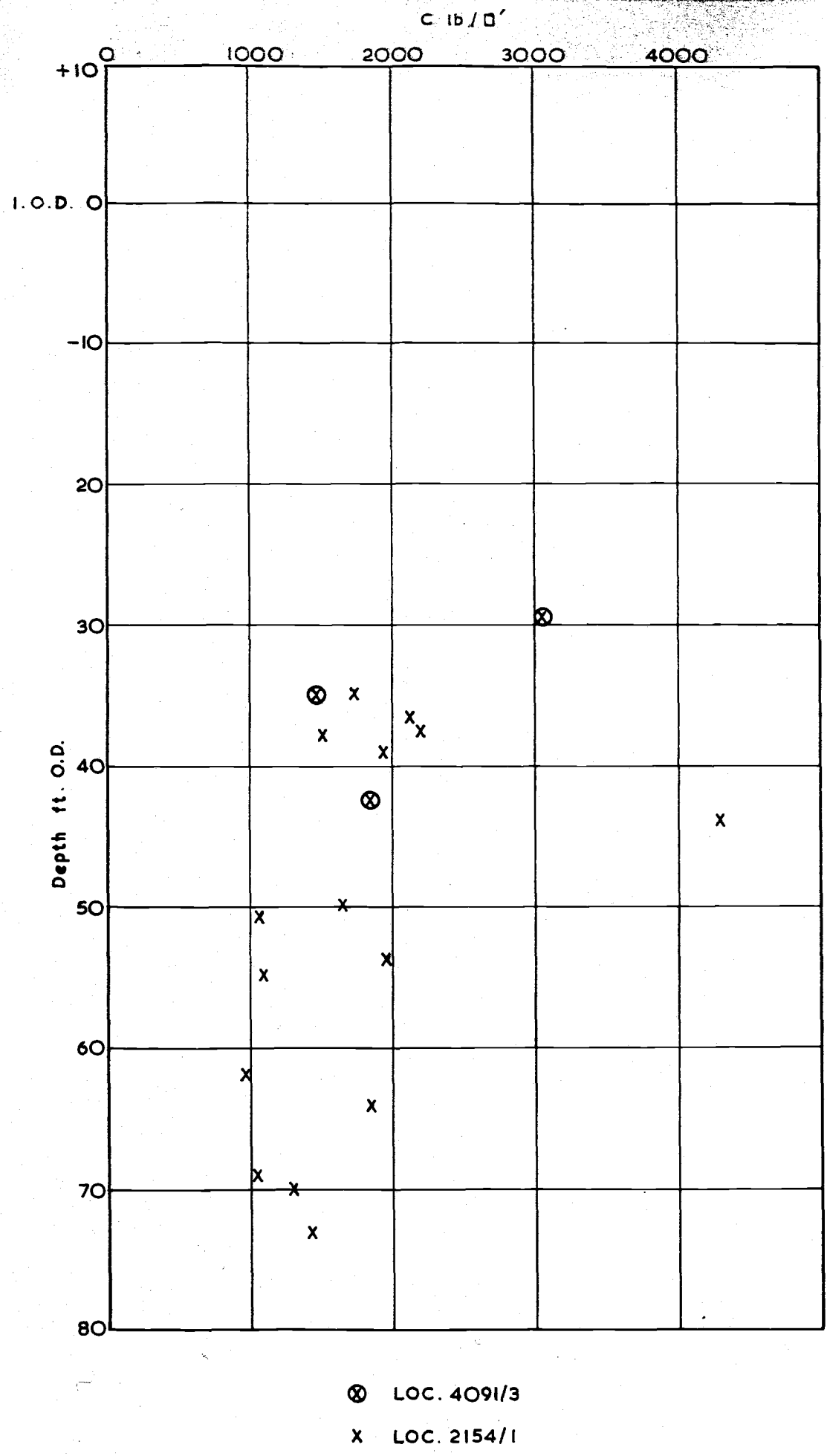

Plasticity Index P.I. %
Liquid Limit. L %
A line
Previous SM investigations on 'A' station.
Le Grande Sutcliffe&Gell results on 'A' station.
Results for 'C' station.
0
10
20
30
40
50
60
70
80
90
10
20
30
40
50
41
42
43
45
46
25

Fig. 13


C lb/□'
0
1000
2000
3000
4000
+10
I.O.D. 0
-10
20
30
40
50
60
70
80
Depth ft. O.D.
⊗ LOC. 4091/3
X LOC. 2154/1

KEY PLAN

SCALE: ½ in. = 1 mile

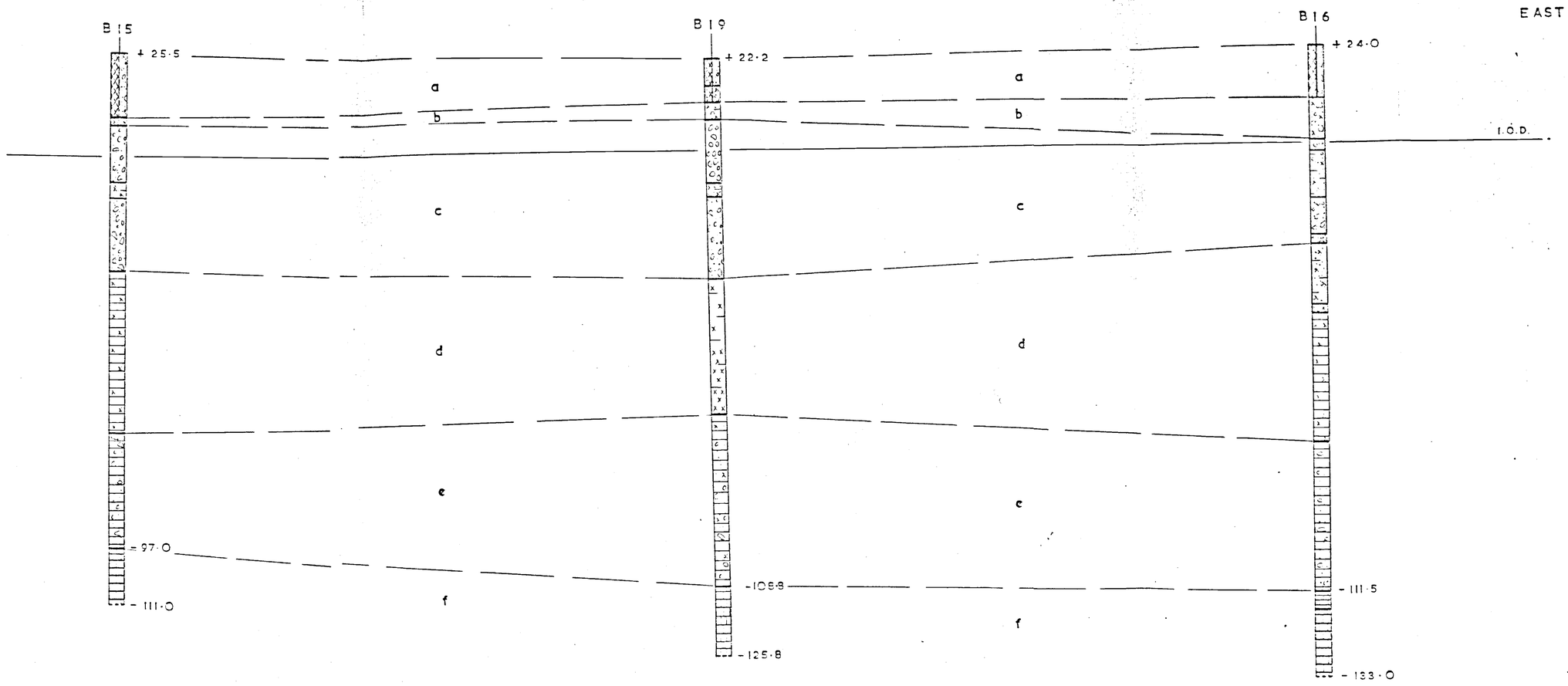
LOC 4091/3
RINGSEND
DUBLIN

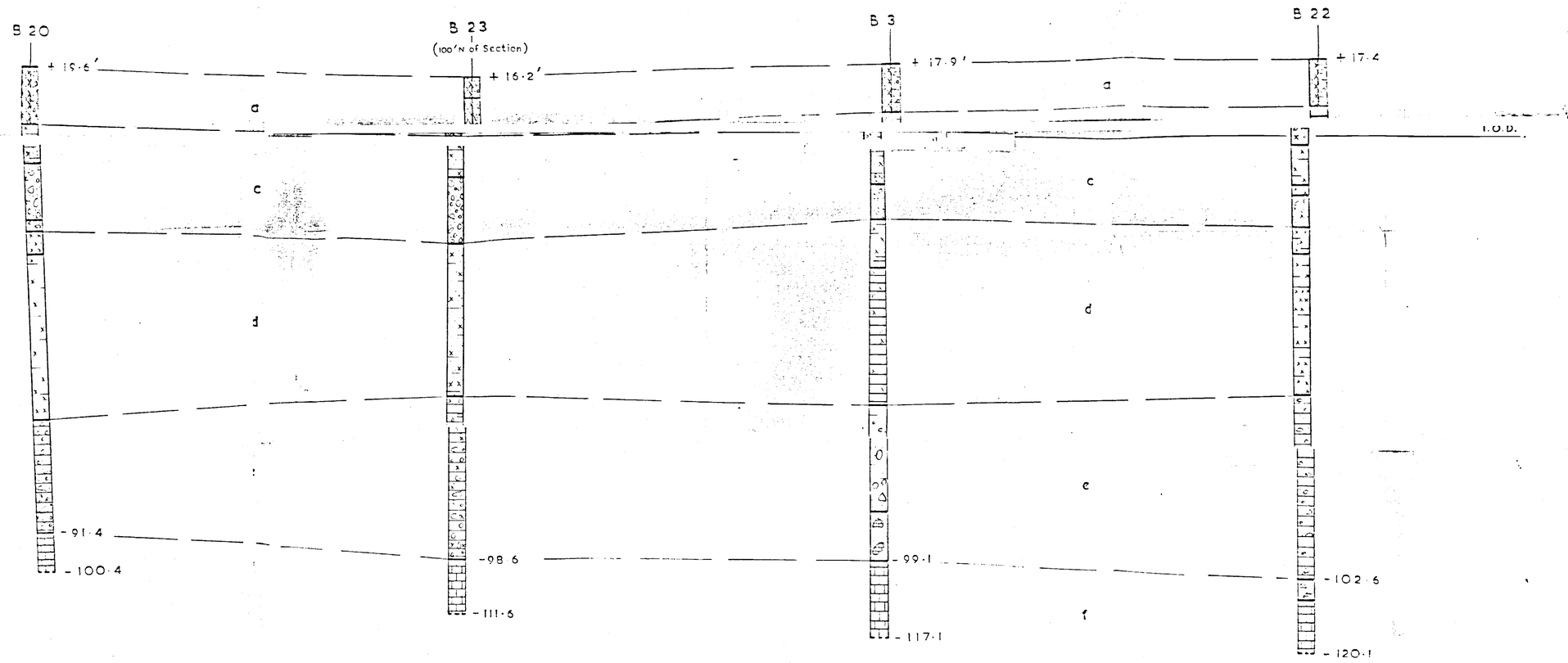
SOIL MECHANICS LTD
65 OLD CHURCH ST.
LONDON, S.W.3

Fig. IIa

WEST

EAST





Note:- Possible interpolation only

LOC 4091/3
RINGSEND 'C' POWER STATION, DUBLIN.

SECTION THROUGH BOREHOLES

SCALES:- Horizontal :- 1 in to 40 ft.
Vertical :- 1 in to 20 ft.

SOIL MECHANIC LTD.,
65, OLD CHURCH ST
LOND-

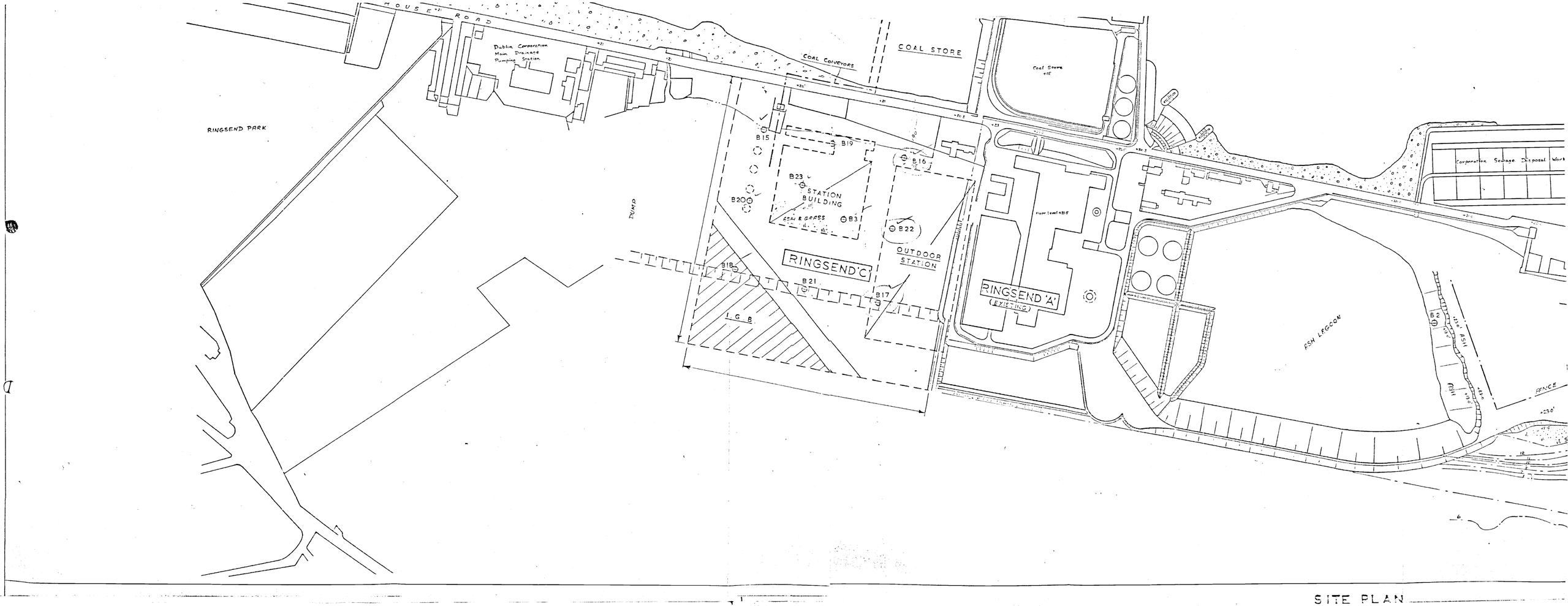
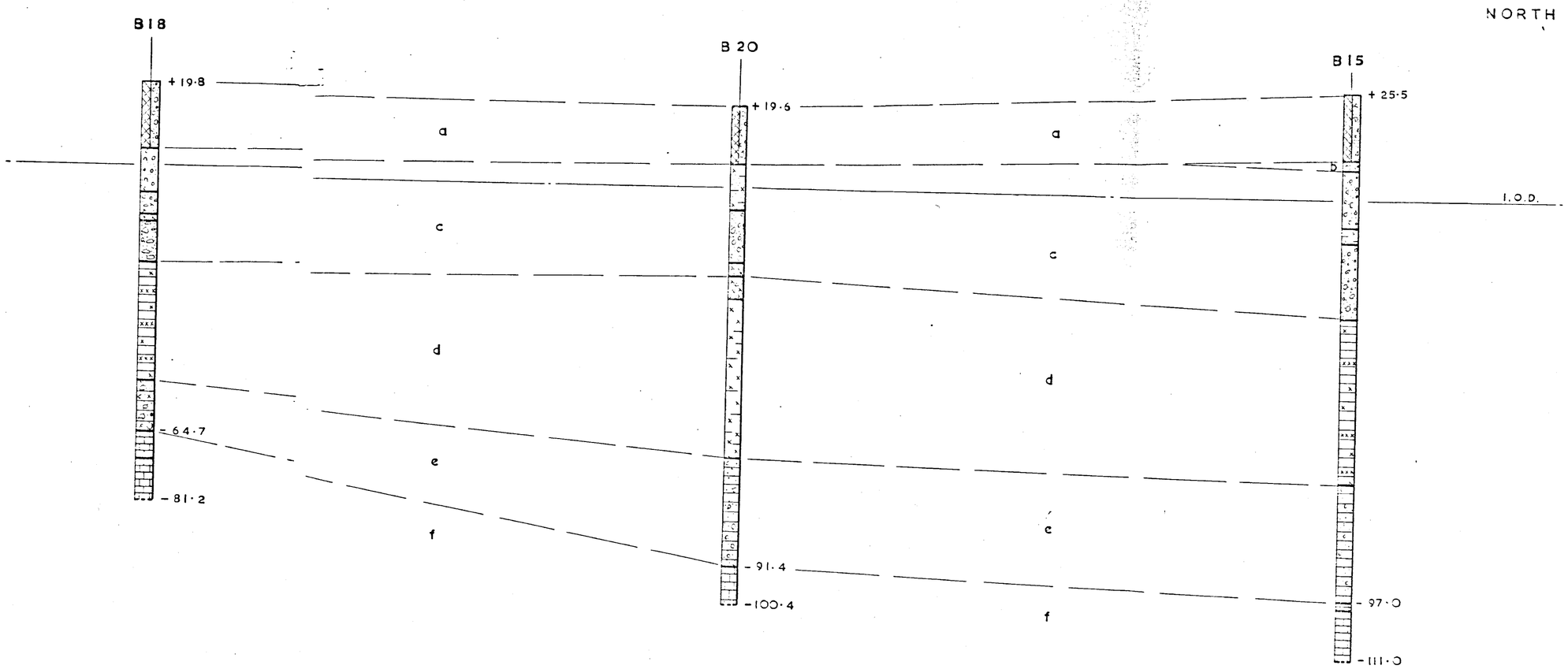

HOUSE ROAD
Dublin Corporation Main Drainage Pumping Station
RINGSEND PARK
COAL CONVEYORS
COAL STORE
Coal Store +15
Corporation Sewage Disposal Works
B15
B19
B16
B23
STATION BUILDING
B20
ASH & GRASS
B31
B22
OUTDOOR STATION
RINGSEND 'C'
B18
B21
B17
I. G. B.
RINGSEND 'A' (EXISTING)
Floor Level 42.5 F
ASH LAGOON
B2
ASH
FENCE
+23.0'
SITE PLAN

Fig. 11b

SOUTH

NORTH



Note : Possible interpolation only.

LOC. 4091/3

RINGSEND 'C' POWER STATION DUBLIN.

SECTION THROUGH BOREHOLES

SCALES :- Horizontal :- 1 in. to 40 ft.
Vertical :- 1 in. to 20 ft.

SOIL MECHANICS LTD
65, OLD CHURCH ST,
LONDON S.W.3.

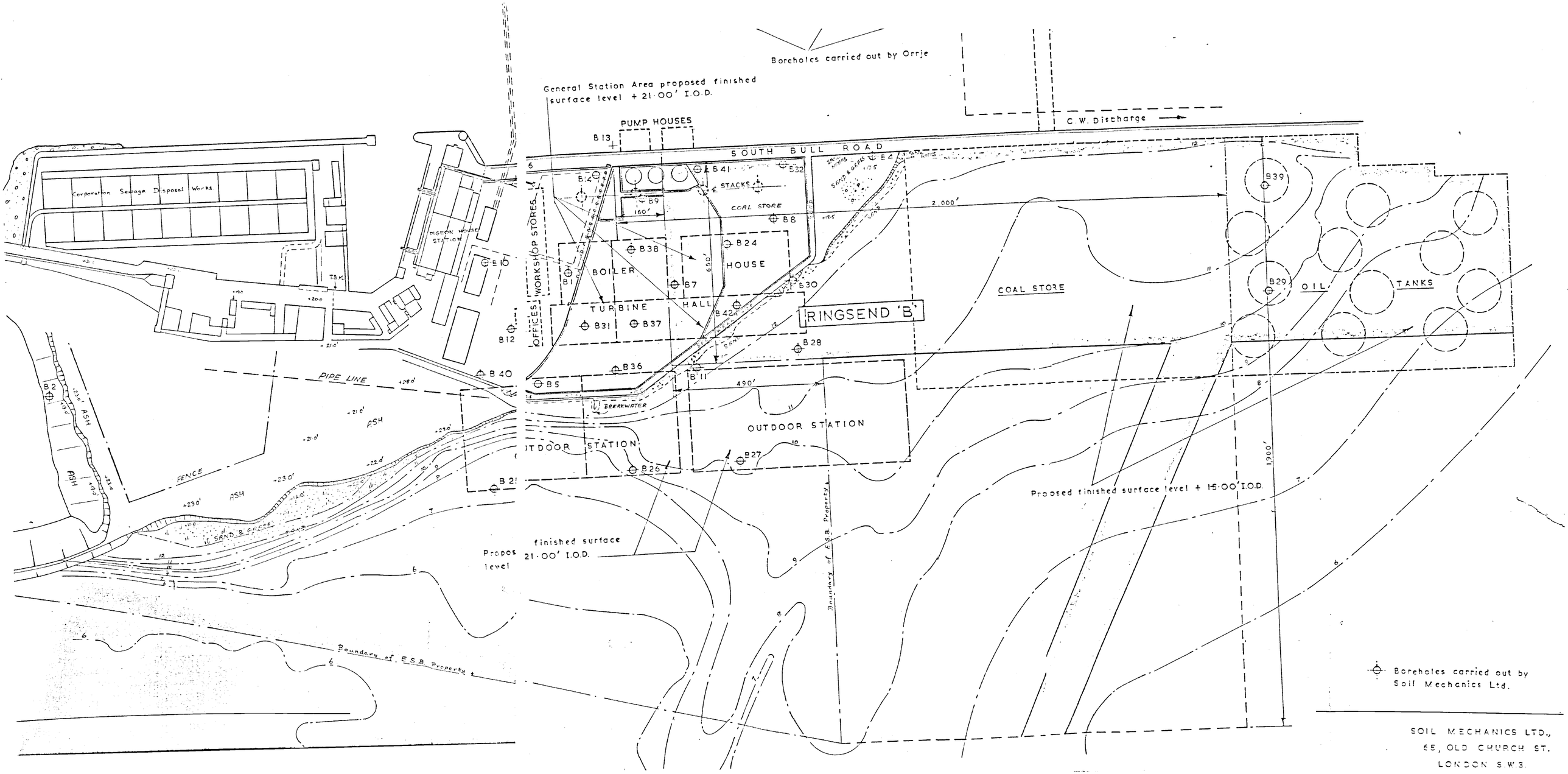

Boreholes carried out by Orrje
General Station Area proposed finished surface level + 21·00' I.O.D.
PUMP HOUSES
B13
C.W. Discharge
SOUTH BULL ROAD
Corporation Sewage Disposal Works
PIGEON HOUSE STATION
T.B.M.
B10
B41
B32
STACKS
COAL STORE
B9
160'
B8
B38
B24
HOUSE
BOILER
B1
B7
B30
TURBINE HALL
B31
B37
B42
RINGSEND 'B'
OFFICES
WORKSHOP
STORES
B12
B40
B28
B36
B5
B11
490'
BREAKWATER
PIPE LINE
ASH
FENCE
SAND & GRAVEL
B2
B25
B27
OUTDOOR STATION
B39
B29
OIL TANKS
2,000'
1,900'
COAL STORE
Proposed finished surface level + 15·00' I.O.D.
finished surface
21·00' I.O.D.
Boundary of E.S.B. Property
Boreholes carried out by Soil Mechanics Ltd.
SOIL MECHANICS LTD.,
65, OLD CHURCH ST.
LONDON S.W.3.

Fig. 8

BOREHOLE LOG

LOCATION - No. 4091/3 RINGSEND POWER STATION, DUBLIN - 'C' Station

CARRIED OUT FOR Electricity Supply Board. 72444

BOREHOLE No. B.21. DIAMETER: 12, 10 & 8 in & NX (3 in nominal)

GROUND LEVEL: +20.0 ft. I.O.D. DATE: 3rd to 18th October 1963.

DESCRIPTION.	REDUCED LEVEL	LEGEND	SAMPLE	DEPTH	THICKNESS
	+20.0			0' 0"	
ASH, CLINKER, CONCRETE fragments, some BRICK, GLASS, GRAVEL, SAND, SHELLS, METAL SURFACE & some black organic SILT.	a.		1. 2. 3. 4. 5. 6.		23' 0"
Soft light grey clayey SILT with small peaty inclusions & a few shells	-3.0 b.		7. 8.	23' 0"	5' 0"
Dense angular coarse medium & fine GRAVEL with some coarse to medium sand & some small shells.	-8.0 c		9. 10.	28' 0"	5' 0"
Very dense light grey-brown coarse to medium with some fine SAND & a little medium to fine gravel cobbles	-13.0 c.		11.	33' 0"	3' 0"
Very dense very dark coarse medium & fine GRAVEL with some grey brown coarse medium & fine sand. cobbles	-16.0 c.		12. 13 14.	36' 0"	7' 6"
Grey brown fine to medium SAND with occasional pockets of gravel & some silt.	-23.5 c.		15. 16.	43' 6"	2' 6"
Rounded coarse medium & fine GRAVEL with a little coarse sand.	-24.0 -27.5		17. 18.	46' 0" 47' 6"	1' 6"
Generally firm in places firm to stiff grey-brown very silty laminated CLAY with partings of silt & fine sand. In a few places silt predominates & in some zones is cross-laminated or ripple formations	d.		19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30.		32' 6"
	-60.0		31.	80' 0"	
Stiff to very stiff grey sandy CLAY with much coarse medium & fine gravel, cobble & boulder size pieces of rock. (Boulder Clay)	e.		32. 33. 34.		16' 0"
			35.	(92' 0")	
Hard grey very broken argillaceous LIMESTONE	-76.0 f		34. 37. 38. 39.	96' 0"	4' 6"
Hard grey very jointed argillaceous LIMESTONE (vesiculiferous in places), dip about 20°, shaley between 105' & 106 ft. Considerable vertical jointing.	-80.5 f.		40. 41. 42.	100' 6"	7' 0" penetrated
	-87.5			107' 6"	
END OF BOREHOLE					

‡ N = 42 — 50 blows for 6in penetration

‡ N = 62 — 56 blows for 6in penetration

‡ — 30 blows for 3in penetration

Water level observations.

Date	Time	Depth of borehole	Depth to cuttings	Depth to water
Water added to borehole to assist with boring to a depth of 12 ft.				
3/10	1800	12' 0"	12' 0"	7' 6"
4/10	1800	27' 0"	27' 0"	11' 0"
5/10	1600	40' 0"	40' 0"	8' 6"
7/10	0730	"	"	8' 0"
"	1800	48' 0"	47' 6"	14' 0"
8/10	0730	"	"	11' 6"
"	1800	62' 6"	60' 0"	"
9/10	1800	78' 6"	"	13' 6"
10/10	0730	"	"	10' 6"
"	1600	82' 0"	82' 0"	13' 0"
11/10	0730	"	"	10' 6"
"	1800	84' 0"	84' 0"	15' 0"
12/10	0730	"	"	11' 0"
"	1600	87' 0"	87' 0"	14' 6"
15/10	0730	90' 0"	90' 0"	11' 0"
"	1800	92' 0"	92' 0"	16' 0"
16/10	0730	"	"	13' 0"
"	1800	96' 0"	96' 0"	G-L*
17/10	0730	"	"	12' 6"
"	1800	102' 0"	102' 0"	G-L*
18/10	0730	"	"	16' 6"

* Drilling water at end of day.

Core recovery (%)

50
45
30
30 to 100' 6"
100 from 100' 6"
100
100

Scale: 1in = 10 ft. • Disturbed Sample ‡ Core Sample △ Water Sample

SOIL MECHANICS LTD. 65 OLD CHURCH ST. S.W.3

Fig. 1

BOREHOLE LOG

LOCATION NO. 4311/3 RINGSEND POWER STATION, DUBLIN — 'C' Station.

CARRIED OUT FOR Electricity Supply Board.

92437

BOREHOLE NO. - 3.3. DIAMETER: 10 & 8 in & NX (3 in. nominal)

GROUND LEVEL + 17.9 ft. I.O.D. DATE: 3rd to 12th & 18th to 24th April 1963.

DESCRIPTION	REDUCED LEVEL	LEGEND	SAMPLE	DEPTH	THICKNESS
	+17.9			0' 0"	
FILLED GROUND comprising CINDERS some brown silty CLAY with occasional gravel & pieces of glass.	a.		1. 2. 3. 4.		11' 6"
	+6.4		5. 6. 7. 8.	11' 6"	
Compact grey silty fine SAND with shell fragments. Some fine medium & coarse gravel at 15 ft. Becomes mainly silty & clayey towards base of stratum.	C.		9. 10. 11.		17' 3"
some clay	-10.8		12.	28' 9"	
Fine medium & coarse GRAVEL with coarse sand & occasional cobbles.	C.		13. 14.		7' 6"
silty fine sand	-13.3		15.	36' 3"	
Dense grey fine sandy SILT with traces of clay & some laminations. Occasional small shell fragments. compact grey silty fine sand.	d.		16. 17. 18. 19.		11' 9"
	-30.1		20.	48' 9"	
occasional fine gravel.			21. 22. 23.		
Firm becoming firm to stiff grey silty laminated CLAY.	d.		24. 25.		32' 3"
clayey silt.			26. 27. 28. 29. 30. 31.		
	-62.4		32. 33. 34. 35. 36. 37. 38.	80' 3"	
Rounded & angular fine medium & coarse GRAVEL with medium & coarse sandy stiff dark grey CLAY (Boulder clay)	e.		39. 40. 41.		25' 9"
cobbles			42.	(98' 6")	
Stiff dark grey very sandy boulder CLAY with coarse medium & fine gravel & limestone cobbles & boulders.			43. 44. 45. 46.	106' 0"	
	-93.1		47. 48.		11' 0"
Limestone COBBLES & BOULDERS with some sand.	e.		49. 50. 51.		
	-99.1		52.	117' 0"	
Hard grey arenaceous LIMESTONE fossiliferous in places. A little calcite veining, a few very thin shaley bands. Dip where visible about 20°.	f.		53. 54. 55. 56.		13' 0" penetrated
	-117.1		57.	135' 0"	
END OF BOREHOLE.					

Note:- N = the number of blows for a Standard Penetration Test

N = 12

N = 9

N = 12

N = 42

N = 32

N = 72

N = 62

* 50 blows for 6in penetration

* 55 " " " "

Water level observations

Date	Time	Depth of borehole	Depth of casing	Depth to water
3/4	1800	3' 0"	8' 0"	Dry
4/4	0730	"	"	"
"	At	12' 0"	Water appeared	
"	1800	27' 0"	27' 0"	20' 6
5/4	0730	"	"	13' 0
"	1800	44' 0"	42' 6"	16' 0
6/4	0730	"	"	15' 0
"	1800	50' 0"	46' 0"	18' 0
8/4	0730	"	"	10' 0
"	1800	62' 0"	"	18' 0
9/4	0730	"	"	10' 0
"	1800	73' 0"	"	23' 0
10/4	0730	"	"	10' 6
"	1800	86' 0"	86' 0"	13' 0
11/4	0730	"	"	9' 6
"	1800	94' 0"	87' 0"	21' 0
12/4	0730	"	"	17' 6
"	1800	99' 0"	"	13' 0
13/4	0730	98' 0"	98' 0"	6' 3
"	1800	106' 0"	100' 0"	5' 4
15/4	0730	"	"	5' 7
"	1800	112' 0"	110' 0"	5' 4
22/4	0730	"	"	5' 5
"	1800	113' 0"	113' 0"	4' 5
23/4	0730	"	"	5' 5
"	1800	129' 0"	"	5' 4
	0730	"	"	5' 3

* Water level rose

Core recovery %

25
75
40
37
25
25
37
37
25
25
100
100
100
100
100

Drawn by: A.E.P.

Scale: 1in = 10 ft. ● Disturbed Sample. ▮ Core Sample. △ Water Sample.

SOIL MECHANICS LTD., 65, OLD CHURCH ST., S.W. 3.

Fig. 2

BOREHOLE LOG

LOCATION NO. 4091/3 RINGSEND POWER STATION, DUBLIN. – 'C' Station.

307 CARRIED OUT FOR Electricity Supply Board. 92438

BOREHOLE NO. 315 DIAMETER: 12, 10 & 8 in & NX (3 in nominal)

GROUND LEVEL: +25·5 ft. I.O.D. DATE: 4th to 19th September 1963.

DESCRIPTION	REDUCED LEVEL	LEGEND	SAMPLE	DEPTH	THICKNESS
Note: P.t dug to a depth of 7½ below ground level.					
	+25·5			0' 0"	
ASH & CLINKER with some BRICK steel, rubber & glass.	a.		1. 2. 3.		16' 0"
Soft dark organic SILT with some coarse & medium gravel.	+9·5 b +7·5		4. 5.	16' 0" 18' 0"	2' 0"
Medium dense sub-angular coarse medium & fine GRAVEL with some medium to fine sand.	c.		6. 7 8		14' 0"
Light grey slightly clayey fine sandy SILT with occasional fine shell fragments.	-6·5 c -10·0		9. 10. 11.	32' 0" 35' 6"	3' 6"
Dense mainly fine to medium GRAVEL with some coarse SAND. Becomes markedly more gravelly & less sandy below 49 ft.	c.		12. 13. 14 15. 16. 17.		18' 6"
	-28·5		18. 19. 20 21 22. 23 24. 25 26. 27.	54' 0"	
Firm grey-brown silty laminated CLAY with partings of micaceous silt & fine sand. In a few places a clayey laminated silt predominates.	d.				+0' 0"

Note: N = the number of blows for a Standard Penetration Test.

- 73 blows for 6 in penetration
- N = 31
- N = 20
- N = 27
- N = 19
- N = 19
- N = 13
- N = 23
- N = 45
- N = 32
- N = 30
- N = 30
- N = 17

Water level observations.

Date	Time	Depth of borehole	Depth of casing	Depth to water
5/9	1300	25' 0"	25' 0"	14' 0
6/9	0730	"	"	18' 0
"	1300	40' 0"	40' 0"	"
7/9	0730	"	"	16' 0
"	1600	55' 0"	55' 0"	13' 0
9/9	0730	"	"	9' 0
"	1300	65' 0"	53' 0"	12' 0
10/9	0730	"	"	10' 0
"	1300	85' 0"	"	13' 0
11/9	0730	"	"	21' 0
"		94' 0"	"	Dry
12/9	0730	"	"	10' 0
"	1400	103' 0"	"	22' 0
13/9	0730	"	103' 0"	20' 6
"	1300	106' 6"	106' 6"	21' 0
14/9	0730	"	"	13' 6
"	1500	111' 0"	111' 0"	21' 6
16/9	0730	"	"	19' 0
"	1300	118' 0"	118' 0"	22' 0
17/9	0730	"	"	23' 6

	-63·5		30. 31. 32. 33. 34. 35 36 37 38.	94' 0"	
Very stiff grey sandy CLAY with much coarse medium & fine gravel some cobbles & boulders. (Boulder Clay)	e.		39. 40. 41. 42. 43. 44. 45.		23' 6"
Broken hard grey arenaceous LIMESTONE possibly due to jointing.	-87·0		46.	122' 6"	1' 5"
Hard grey arenaceous LIMESTONE little calcite mining mainly between 25' 6" to 127' 0". Some jointing. Bedding planes inclined 25 to 30°. Occasional thin shale bands. Fossiliferous in places.	-88·5 f.		47. 48 49 50	124' 0"	12' 6" penetration
	-111·0			136' 6"	
END OF BOREHOLE					

- 33 blows for 3 in. penetration
- 63 " " " "
- 79 " " 6 in " "
- 50 " " 3 in "
- 61 " "
- 35 blows for initial 6 in penetration
- 41 " " 3 in penetration
- 43 " " " "
- 53 blows for initial 6 in penetration
- 43 blows for 3 in penetration
- 46 " " " "

Core recovery %

30
100
95
70
100

x After initial 6 in of Standard Penetration Test.

Scale: 1 in = 10 ft. ● Disturbed Sample. ▮ Core Sample. △ Water Sample.

SOIL MECHANICS LTD., 65, OLD CHURCH ST., S.W.3.

Fig. 9

BOREHOLE LOG

LOCATION NO. 4031/3 RINGSEND POWER STATION, DUBLIN. — 'C' Station.

CARRIED OUT FOR Electricity Supply Board.

97465

BOREHOLE NO. 322. DIAMETER: 12, 10 & 8 in. & NK (3 in. nominal)

GROUND LEVEL: +17.4 ft. I.O.D. DATE: 23rd October to 11th November 1963

DESCRIPTION	REDUCED LEVEL	LEGEND	SAMPLE	DEPTH	THICKNESS
Dark brown & dark grey CLAY, SAND & ASH with some CLINKER & roots	+17.4	a.	1. 2. 3. 4.	0' 0"	11' 6"
Dark grey very silty fine SAND with some fine brash & shell. Occasional exposures	+5.9	c.	5.	11' 6"	2' 6"
Medium dense grey silty coarse medium & fine SAND with some sub-rounded fine to medium & some coarse GRAVEL. Becomes more gravelly with depth.	+3.4	c.	6. 7.	14' 0"	5' 6"
Soft to firm grey sandy very silty CLAY with occasional pockets of brown partly decayed vegetation & occasional shells. Below about 23 ft, becomes less sandy with depth.	-2.1	c.	8. 9. 10. 11.	19' 6"	9' 0"
Blue-grey very silty & clayey slightly micaceous coarse SAND	-11.1	c.	12.	28' 6"	2' 3"
Dense mainly fine with occasional medium & coarse GRAVEL with some coarse to medium & little fine SAND. Becomes more sandy & less gravelly with depth & also clayey & silty.	-13.4	c.	13. 14. 15.	30' 9"	7' 3"
Compact (firm to stiff) brownish-grey very slightly clayey fine sandy SILT.	-20.6	d.	16. 17. 18.	38' 0"	6' 6"
Compact (firm to stiff) brownish-grey clayey SILT. In places laminated with partings of light brown silty fine sand, also in places very clayey.	-27.1	d.	19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31.	44' 6"	33' 6"
Stiff to very stiff grey silty slightly sandy CLAY with numerous rounded sub-angular rock fragments of assorted sizes including cobbles & boulders. Becomes very sandy below 104 ft. (Boulder Clay)	-60.4	e.	32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48.	70' 0"	42' 0"
Very broken core, clay very variable in colour, cobbles & boulders of hard dark grey argillaceous LIMESTONE with occasional very thin veins of calcite. Very argillaceous between 123 & 125 ft.	-102.6	f.	49. 50. 51.	120' 0"	5' 0"
Hard dark grey argillaceous LIMESTONE (in 10 ft-5" run) very extremely fine calcite veins some thicker veins up to ½ in every 3 to 6 in to 129 ft & between 132 & 135 ft & 6 in. Some very thin shaley seams. Below 135 ft mainly fossiliferous with occasional thin calcite veins.	-107.6	f.	52. 53. 54.	125' 0"	12' 6" penetration
END OF BOREHOLE.	-120.1			137' 6"	

Note: Observation tube installed at 5 ft above base of lowest sand & gravel stratum ie at 33 ft. below ground level. *

Subsequent water level readings taken given below.

Date	Time	Depth to water below G.L.	Reduced water level
3/12	1610	6' 7"	+10.9
5/12	1605	6' 6"	+10.9
6/12	0910	"	"

‡ N = 26

‡ N = 34

Water level observations

Date	Time	Depth of borehole	Depth to tube	Depth to water
23/10	After 15 mins	7' 6"	7' 6"	Water appeared 6' 0"
"	1800	12' 0"	12' 0"	6' 0"
24/10	0730	"	"	6' 0"
"	1800	30' 0"	30' 0"	6' 6"
25/10	0730	"	"	9' 0"
"	1800	45' 0"	45' 0"	9' 0"
26/10	1600	53' 0"	"	11' 6"
27/10	1800	70' 0"	"	12' 0"
28/10	0730	"	"	9' 0"
"	1800	80' 0"	"	11' 9"
30/10	0730	"	"	8' 9"
"	1800	88' 0"	88' 0"	9' 6"
31/10	0730	"	"	8' 6"
"	1800	96' 0"	95' 0"	11' 9"
1/11	0730	"	"	8' 0"
"	1800	98' 0"	"	12' 0"
2/11	0730	"	"	8' 0"
"	1600	90' 0"	"	11' 3"
4/11	0730	"	"	9' 0"
"	1730	97' 0"	"	10' 6"
5/11	0730	"	"	9' 3"
"	1730	103' 0"	"	12' 9"
6/11	0730	"	"	10' 0"
"	1730	110' 0"	"	11' 9"
7/11	0730	"	"	9' 6"

• 32 blows for 3in. penetration

• 57 blows for 6in. penetration

• 47 blows for 6in. penetration

• 36 blows for 3in. penetration

• 50 blows for initial 6in. penetration

• 48 blows for 6in. penetration

• 50 blows for initial 6in. penetration

Core Recovery %

70
40
40
100
100
100

Note: N = number of blows for a Standard Penetration Test.

Scale: 1 in = 10 ft. • Disturbed Sample. ▮ Core Sample. △ Water Sample.

Fig. 7

BOREHOLE LOG

92443

007

LOCATION No. 4091/3 RINGSEND POWER STATION, DUBLIN – 'C' Station

CARRIED OUT FOR Electricity Supply Board.

BOREHOLE No. B.20 DIAMETER: 12, 10 & 8 in & NX (3 in nominal)

GROUND LEVEL: +19.6 ft. I.O.D. DATE: 18th October to 6th November 1963

DESCRIPTION.	REDUCED LEVEL	LEGEND	SAMPLE	DEPTH	THICKNESS
	+19·6			0' 0"	
Mostly ASH & SAND with some clinker, slate, wood, china, glass, fragments of brick & concrete.	a.		1. 2. 3.		14' 0"
	+5·6		4.	14' 0"	
Medium dense, predominantly grey slightly silty & clayey fine medium & coarse SAND with some sub-rounded & occasional rounded fine medium & coarse gravel & a few shells.	c.		5. 6.		11' 0"
	-5·4		7.	25' 0"	
Medium dense sub-rounded fine medium & coarse GRAVEL with some mostly grey slightly silty fine medium & coarse sand	c.		8. 9. 10.		13' 0"
Loose speckled grey & black to dark slightly silty fine, medium & coarse SAND with occasional coarse to medium gravel.	-18·4 c.		11.	38' 0"	3' 0"
Compact (firm to stiff) brownish-grey fine sandy SILT.	-21·4 d.		12 13.	41' 0"	5' 6"
	-26·9		14 15. 16. 17. 18. 19. 20. 21 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40 41 42 43. 44. 45.	46' 6"	38' 6"
slightly laminated					
Compact (firm to stiff) becoming fairly compact (firm) at 60 ft. brownish-grey clayey SILT. Very slightly micaceous in places.	d.				
	-65·4			85' 0"	
Very stiff grey sandy CLAY with much coarse, medium & fine gravel, cobble & boulder size sub-angular rock fragments. Proportion of rock fragments increasing with depth & predominately below 104 ft. 6 in. (Boulder clay.)	e.			(98' 0")	26' 0"
	-91·4			111' 0"	
Hard dark grey finely bedded occasionally LIMESTONE, dip 15 to 20°, with small patches of white calcite, some very black shaley bands, also shaley beds, dip about 25° about 1½" thick. Occasional thin steeply dipping calcite veins.	f.				9' 0" proved
	-100·4			120' 0"	
END OF BOREHOLE					

Note: Observation tube installed at 5 ft. above base of gravel & sand strata ie. at 36 ft. below ground level. Subsequent readings * N = 17 given below

* N = 15

* N = 9

* N = 22

* N = 17

* N = 19

* N = 16

* N = 17

* N = 9

Water level observations

Date	Time	Depth of borehole	Depth to water	Depth to water
Water added to borehole to grout with boring to a depth of 14 ft.				
18/10	1500	15' 0"	15' 0"	7' 0"
19/10	0730	"	"	11' 0"
"	1600	32' 0"	32' 0"	13' 0"
21/10	0730	"	"	11' 0"
"	1530	45' 0"	45' 0"	12' 0"
22/10	0730	"	"	13' 0"
"	1800	60' 0"	48' 0"	14' 6"
23/10	0730	"	"	13' 0"
"	1800	72' 0"	"	14' 6"
24/10	0730	"	"	12' 6"
"	1800	85' 0"	"	14' 6"
25/10	1230	"	"	14' 0"
"	1800	87' 6"	87' 6"	11' 0"
28/10	0730	"	"	9' 0"
"	1600	92' 0"	92' 0"	12' 0"
30/10	1300	"	"	11' 6"
"	1800	95' 0"	95' 0"	14' 0"
31/10	0730	"	"	12' 0"
"	1800	98' 0"	98' 0"	13' 0"

Date	Time	Depth to water below G.L.	Reduced water level.
3/12	1615	8' 4"	+11·3
5/12	1615	8' 1"	+11·6
6/12	1605	8' 4"	+11·3

* 43 blows for 3 in. penetration

* 36 " " " "

* 43 " " " "

Core recovery %

60
55
75
70
85
75
100
100

Note: N = the number of blows for a Standard Penetration Test

Scale: 1 in = 10 ft. • Disturbed Sample ▮ Core Sample △ Water Sample

Fig. 6

BOREHOLE LOG

LOCATION NO. 4091/3 RINGSEND POWER STATION, DUBLIN — 'C' Station

CARRIED OUT FOR Electricity Supply Board. 92442

BOREHOLE NO. B.19. DIAMETER: 12, 10 & 8 in. & Nx (3 in. nominal).

GROUND LEVEL: +22·2 ft. I.O.D. DATE: 23rd September to 5th October & 11th to 15th October 1963.

DESCRIPTION	REDUCED LEVEL	LEGEND	SAMPLE	DEPTH	THICKNESS
BRICK ASH, CONCRETE, some SAND & fine & medium GRAVEL (=fill)	+22·2		1.	0' 0"	7' 0"
Grey very silty fine SAND. (Possibly Hydraulic fill)	a. +15·2 a		2. 3.	7' 0"	4' 0"
Soft dark grey clayey micaceous SILT, with occasional fine gravel & shells.	+11·2 b.		4.	11' 0"	4' 3"
Medium dense rounded fine medium & coarse GRAVEL with some medium to fine sand & shells.	+6·9 c.		5. 6. 7.	15' 3"	15' 9"
Soft grey clayey fine sandy SILT with some fine shells, fine to medium gravel & a few thin laminations (¼") of very silty clay.	−8·8 c. −12·1		8. 9. 10. 11.	31' 0" 34' 3"	4' 3"
Loose to medium dense fine medium & coarse GRAVEL with some, generally fine to medium, occasionally coarse sand. Grading rather variable.	c.		12. 13. 14. 15.		19' 9"
Compact (firm to stiff) becoming fairly compact (firm) at 50-55 brownish-grey clayey SILT with small lenses of grey silty fine to medium sand. In places laminated (about 5/16") & with some partings of light brown slightly micaceous silt.	−31·3 d. laminated		16. 17. 18. 19. 20. 21. 22. 23. 24. 25.	54' 0"	34' 6"
Stiff dark grey silty slightly sandy CLAY with numerous rock fragments of assorted sizes including some cobbles & boulders, mostly sub-angular mainly dark grey limestone occasionally some sandstone. (Boulder Clay)	−66·3 e.		27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42.	88' 6" (123' 0")	42' 6"
Hard dark grey argillaceous LIMESTONE arenaceous in places. Very shaley from about 131 ft 6 in & also at 132, 133 & 136 ft. Bedding where visible about 20°, little calcite veining, very little vertical jointing	−100·8 f. −125·8 END OF BOREHOLE		43. 44. 45. 46. 47. 48. 49.	131' 0" 148' 0"	17' 0" penetrated

Note: N = the number of blo for a Standard Penetrati Test.

N =	5
N =	19
N =	19
N =	21
N =	20
N =	13
N =	21
N =	14
N =	10
N =	7
N =	5
N =	53
N =	34
N =	31
N =	34
N =	50

Water level observations

Date	Time	Depth of borehole	Depth of tubes	Dep to wat
Water level to borehole to agree with casing to a depth of 15' +.				
23/9	1900	15' 0"	15' 0"	7'
24/9	0730	"	"	14'
"	1800	30' 0"	30' 0"	17'
25/9	0730	"	"	14'
"	1800	45' 0"	45' 0"	16'
26/9	0730	"	"	14'
"	1900	60' 0"	60' 0"	15'
27/9	0730	"	"	"
"	1800	75' 0"	"	21'
"	1600	90' 0"	"	20'
30/9	0730	"	"	18'
"	1800	90' 0"	90' 0"	23'
1/10	1300	102' 0"	102' 0"	26'
2/10	0730	"	"	17'
"	1300	110' 0"	110' 0"	21'
3/10	0730	"	"	16'
"	1330	118' 0"	118' 0"	18'
4/10	1300	121' 0"	"	19'
5/10	0730	"	"	15'
"	1600	123' 0"	"	18'

40 blows for 3 in penetration

Core recovered %
10
6
75
37
75
100
100

Scale: 1 in = 10 ft. ● Disturbed Sample. ▮ Core Sample. △ Water Sample.

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Fig. 5

BOREHOLE LOG

LOCATION No. 4091/3 RINGSEND POWER STATION, DUBLIN – 'C' Station.

CARRIED OUT FOR Electricity Supply Board. 92441

BOREHOLE No. B.13. DIAMETER: 10, 3 & 6in & NX (3in nominal)

GROUND LEVEL: +19·8 ft. I.C.D. DATE: 29th August to 2nd September 1963.

DESCRIPTION.	REDUCED LEVEL	LEGEND	SAMPLE	DEPTH	THICKNESS
	+19·3			0' 0"	
ASH, CLINKER BRICK & SLATE fragments, with some sand & a little gravel & glass.	a.		1. 2. 3.		16' 0"
	+3·3			16' 0"	
Medium dense grey micaceous fine to medium SAND with some fine shell fragments. Sand & shells become more coarse with depth below about 21 ft. Also some occasional gravel	C.		4. 5. 6.		10' 9"
	−7·0			26' 9"	
Medium dense fine to medium with occasional coarse GRAVEL with some coarse medium & fine sand & patches of silt.	C.		7.		5' 3"
Grey fine sandy SILT with occasional small shells.	−12·2		8. 9.	32' 0"	1' 6"
	−13·7		10. 11.	33' 6"	
Very dense rounded & sub-angular coarse medium & fine GRAVEL & COBBLES with some coarse medium & fine sand.	C.		12. 13. 14. 15. 16.		9' 3"
	−23·5			43' 3"	
Firm occurring firm to stiff with depth grey or brown silty laminated CLAY with partings of silt & fine sand. Clay becomes very silty below about 64 ft.	d		17. 18. 19. 20. 21. 22. 23. 24. 25. 26.		29' 9"
	−52·2				
Stiff becoming very stiff silty sandy CLAY with numerous assorted gravel size rock fragments. (Boulder Clay)	D		27. 28. 29. 30. 31. 32. 33. 34. 35. 36.		12' 0"
Patches of very broken core between better core of hard grey arenaceous slightly fossiliferous LIMESTONE. Some vertical jointing to 30° then very close [illegible] some silt & sand in open joints.	−64·7			84' 6" (86' 0")	6' 6"
Hard grey mainly arenaceous slightly fossiliferous LIMESTONE, dipping where visible about 20°, little vertical jointing.	−71·2		37.	91' 0"	10' 9" penetrated
	−81·2		38.	101' 0"	
END OF BOREHOLE					

Note: N = The number of blows for a Standard Penetration Test.

‡ N = 19

‡ N = 15

‡ N = 23

‡ N = 36

• 42 blows for 6in penetration

• 62 blows for initial 6in penetration

• 35 blows for 3in penetration

Water level observations

Date	Time	Depth of borehole	Depth to water	Depth of water
20/8		16' 0"	16' 0"	
"	1830	20' 0"	20' 0"	14' 0"
21/8	0730	"	"	12' 0"
"	1130	35' 0"	35' 0"	10' 0"
22/8	0730	"	"	13' 0"
"	1330	42' 0"	42' 0"	14' 0"
23/8	0730	"	"	12' 0"
"	1830	55' 0"	47' 0"	16' 0"
24/8	0730	"	"	12' 0"
"	1600	67' 0"	"	14' 0"
26/8	0730	"	"	11' 6"
"	1900	73' 9"	"	14' 0"
27/8	0730	"	"	12' 0"
"	1830	82' 0"	82' 0"	17' 0"
29/8				4' 0"
"	1830	86' 0"	86' 0"	16' 0"

• 54 blows for 9in penetration

• 52 blows for 9in penetration

• 74 blows for 3in penetration

Core recovery %

70

90

65

75

75

B.H.-13

Scale: 1in = 10ft. • Disturbed Sample ‡ Core Sample △ Water Sample

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Fig. 4

BOREHOLE LOG

LOCATION No. 4091/3 RINGSEND POWER STATION, DUBLIN. — 'C' Station.

CARRIED OUT FOR Electricity Supply Board 92440.

BOREHOLE No. B.17. DIAMETER: 12, 10 & 8 in & NK (3in nominal)

GROUND LEVEL: +18·8 ft. I.C.D. DATE: 19th September to 9th October 1963.

DESCRIPTION.	REDUCED LEVEL	LEGEND	SAMPLE	DEPTH	THICKNESS
ASH, BRICK & sandy gravelly CLAY FILL with some WOOD.	+18·8 a.		1 2 3	9' 0"	9' 0"
Fine medium & some coarse GRAVEL, coarse to medium SAND & shells with some black organic sandy SILT.	+10·8 c.		4	8' 0"	3' 6"
Fine to medium with a little coarse GRAVEL with some coarse sand & a few shells.	+ 7·3 c.		5 6 7	11' 6"	7' 6"
Soft light grey clayey SILT with a few traces of vegetable matter. Some sand, a few shells & gravel in top of stratum	−0·2 c.		8 9 10	19' 0"	7' 6"
Dense coarse medium & fine GRAVEL with some coarse to medium sand. layers of cobbles	−7·7 c.		11 12 13 14 15	26' 6"	14' 0"
Compact grey & grey-brown clayey fine sandy SILT in places laminated & sandy partings	−21·7 d.		16 17 18 19 20 21	40' 6"	12' 6"
Firm dark grey-brown very silty, laminated CLAY with partings of silt	−34·2 d.		22 23 24 25 26 27 28 29 30 31 32 33 34 35 36	53' 0"	32' 6"
Stiff grey sandy CLAY with much coarse medium & fine gravel, cobble & boulder size pieces of rock. In places very sandy & gravelly. (Boulder Clay).	−66·7 e.		37 38 39 40 41 42 43 44 45 46 47 48 49	85' 6" (102' 0")	22' 6"
Hard grey argillaceous LIMESTONE Some calcite veining. In places very shaley especially from 114 to 118 ft. Fossiliferous & arenaceous between 110 & 114 ft. Bedding where visible about 10 to 15°. Some near vertical jointing.	−90·2 f.			103' 0"	10' 0" plus
END OF BOREHOLE	−99·2			113' 0"	

Note: N = the number of blows from Standard Penetration Test.

• 50 blows for 6 in penetration

‡ N = 45

Water level observations

Date	Time	Depth of borehole	Depth of casing	Depth to water
18/9		8' 0"	8' 0"	Water approx 7' 0"
"	1800	10' 0"	10' 0"	
19/9	0730	"	"	6' 0"
"	1800	30' 0"	30' 0"	9' 0"
20/9	0730	"	"	6' 9"
"	1800	40' 0"	40' 0"	11' 6"
21/9	0730	"	"	7' 3"
"	1600	45' 0"	45' 0"	11' 6"
23/9	0730	"	"	5' 3"
"	1800	65' 0"	"	12' 6"
24/9	0730	"	"	6' 0"
"	1800	80' 0"	"	9' 6"
25/9	0730	"	"	6' 6"
"	1800	90' 0"	90' 0"	3' 6"
26/9	0730	"	"	6' 3"

‡ N = 46

‡ N = 43

‡ N = 50

Core recovery %

60
60
80
100
100
95
95

Scale: 1in = 10ft. • Disturbed Sample ▮ Core Sample △ Water Sample

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Fig. 3

BOREHOLE LOG

LOCATION NO. 4091/3 RINGSEND POWER STATION, DUBLIN – 'C' Station.

CARRIED OUT FOR Electricity Supply Board. 92439

BOREHOLE NO. B.16. DIAMETER: 10, 8 & 6 in & NX (3 in nominal)

GROUND LEVEL: +24·0 ft I.O.D. DATE: 20th August to 16th September 1953.

DESCRIPTION	REDUCED LEVEL	LEGEND	SAMPLE	DEPTH	THICKNESS
Note: Trial pit put down to a depth of 4 ft. ASH, CLINKER, BRICK & CONCRETE fragments, with a little gravel & wire	+24·0	a.	1. 2. 3.	0′ 0″	13′ 0″
	+11·0		4. 5.	13′ 0″	
Soft black organic sandy micaceous SILT with some coarse medium & fine gravel.		b.	6. 7. 8.		10′ 6″
Coarse medium & fine GRAVEL with a very little silty sand. Some tree roots & vegetation	+0·5		9.	23′ 6″	2′ 6″
Soft to firm light grey slightly clayey fine sandy SILT with some shells & gravel & occasional traces of brown vegetable matter	−2·0	c.	10. 11. 12. 13. 14. 15.	26′ 0″	11′ 9″
Dense rounded coarse medium & fine GRAVEL with some coarse to medium sand. Some gravel & sand	−13·8	c.	16. 17. 18. 19.	37′ 9″	9′ 3″
Medium to fine GRAVEL in a matrix of firm brown silty clay.	−23·0		20.	47′ 0″	1′ 6″
	−24·5		21.	48′ 6″	
Fairly compact grey-brown clayey fine sandy SILT in places slightly laminated.		d.	22. 23. 24. 25. 26.		16′ 0″
Medium to fine GRAVEL with a little silty clay or clayey silt.	−43·5		27.	64′ 6″	2′ 0″
	−42·5		28.	66′ 6″	
Firm grey-brown very silty laminated CLAY with partings of fine sand.		d.	29. 30. 31. 32. 33. 34. 35. 36.		32′ 0″
Stiff grey sandy CLAY with much coarse medium & fine gravel cobble & boulder size pieces of rock, mostly limestone, some sandstone. In places very sandy & gravelly. (Boulder clay)	−74·5	e.	41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59.	93′ 6″	37′ 0″
Broken core only of dark grey recrystallised LIMESTONE possibly due to jointing.	−111·5	f.	60. 61. 62.	135′ 6″	4′ 6″
Hard dark grey argillaceous LIMESTONE. Fossiliferous in places some calcite veining. Occasional thin black shale bands, more shaley between 145 & 146 ft. Bedding where visible about 45°	−116·0	f.	63. 64.	140′ 0″	17′ 0″ per 5′ 6″
	−133·0	END OF BOREHOLE		157′ 0″	

Note: N = the number of blows for a Standard Penetration Test.

N = 7

N = 17

N = 67

N = 35

Water level observations

Date	Time	Depth of borehole	Depth of casing	Depth to water
Water had to be added to the borehole to keep it filled during coring to a depth of 27 ft.				
21/8	1800	30′ 0″	30′ 0″	23′
22/8	0730	"	"	11′
"	1830	45′ 0″	45′ 0″	13′
23/8	0730	"	"	10′
"	1800	60′ 0″	43′ 0″	18′
24/8	0730	"	"	14′
"	1800	75′ 0″	67′ 0″	16′
26/8	0730	"	"	18′
"	1800	90′ 0″	"	23′
27/8	0730	"	"	19′
"	1800	95′ 0″	"	24′
28/8	0730	"	"	22′
"	1800	101′ 0″	100′ 0″	31′
29/8	0730	"	"	28′
"	1800	104′ 0″	104′ 0″	33′
30/8	0730	"	"	31′
"	1800	106′ 0″	106′ 0″	34′
3/9	0730	110′ 0″	110′ 0″	15′
"	1800	116′ 0″	116′ 0″	6-7
4/9	0730	"	"	13′
"	1800	126′ 0″	126′ 0″	6-7
5/9	0730	"	"	15′
6/9	1800	140′ 0″	140′ 0″	6-7

× = NX hole

34 blows for 3 in penetration

79 blows for initial 5in penetration.

84 " " " " 6"

6 in NX limestone core recovered.

Note: The many large cobbles & boulders in the boulder clay necessitated the use of the diamond drill from 110 to 140 ft. Soft ground boring was then restarted after the withdrawal of the NX casing.

6 in of very broken core
12 in " " " "
12 in " " " "

Core recovery %
100
100
90
100

Scale: 1 in = 10 ft. ● Disturbed Sample. ▮ Core Sample. △ Water Sample.

Fig. 10

BOREHOLE LOG

9/2446

LOCATION No. 4091/3 RINGSEND POWER STATION, DUBLIN – 'C' Station.

CARRIED OUT FOR Electricity Supply Board

BOREHOLE No. B.23 DIAMETER: 12, 10 & 8 in. & NX (3in nominal)

GROUND LEVEL: +16.2 ft. I.O.D. DATE: 12th to 27th November 1963.

DESCRIPTION.	REDUCED LEVEL	LEGEND	SAMPLE	DEPTH	THICKNESS
Fragments of CONCRETE & BRICKS with some gravel & timber.	+16·2			0' 0"	
	a.				5' 0"
	+11·2			5' 0"	
Fine, medium & coarse mainly sub-rounded GRAVEL with some, predominantly grey clayey slightly silty fine, medium & coarse sand. Also some bricks, glass & timber	a.		• 1.		8' 0"
	+3·2		‡ 2.	13' 0"	–
			• 3.		
Soft grey silty CLAY with many small lenses of grey silty fine sand, a few small fleches of partly decayed vegetation & occasional shells.	C.		• 4.		13' 0"
			• 5.		
	−9·8		• 6.	26' 0"	
Medium dense sub-rounded mainly fine to medium with occasional coarse GRAVEL with some mostly grey coarse to medium with occasional fine, silty slightly clayey sand.	C.		• 7.		15' 0"
			• 8.		
			• 9.		
	−24·8		▯ 10.	41' 0"	
			• 11.		
Compact (firm to stiff) brownish-grey clayey slightly micaceous fine sandy SILT	d.		▯ 12.		
			• 13.		
			▯ 14.		
			• 15.		36' 0"
			• 16.		
			• 17.		
			▯ 18.		
			• 19.		
			▯ 20		
			• 21.		
			• 22.		
			• 23.		
	−60·8		• 24.	77' 0"	
Stiff grey becoming dark grey below about 95 ft silty, slightly sandy CLAY with numerous, mostly sub-angular mainly limestone, rock fragments of assorted sizes including cobbles & boulders. (Boulder Clay)	e.		• 25.		
			• 26.		
			• 27.		
			• 28.		
			• 29.		37' 9"
limestone cobble →			• 30.		
			• 31.		
			• 32.		
			• 33.		
			• 34.		
			• 35.		
four limestone cobbles			• 36.		
			• 37.		
			• 38.		
limestone boulder →			• 39.		
	−98·6		• 40.	114' 9"	
Hard dark grey argillaceous LIMESTONE, dip about 20°, occasional steeply dipping calcite veins. Below 118 ft. frequent thin shaley bands.	f.		• 41.		
			• 42.		13' 0" penetrated
			• 43.		
	−111·6			127' 9"	
END OF BOREHOLE					

Notes: (1) Pit put down to a depth of 5 ft below ground level.
(2) N = the number of blows for a Standard Penetration Test.

‡ N = 6
‡ N = 5
‡ N = 16
‡ N = 19
‡ N = 18
‡ N = 22

Water level observations.

Date	Time	Depth of borehole	Depth of tubes	Depth to water
12/11	1545	Dry at 5' 0"	–	water appeared at 4' 0"
"	1800	"	–	"
"	1730	10' 0"	10' 0"	"
13/11	0730	"	"	4' 6"
"	1730	25' 0"	25' 0"	4' 0"
14/11	0730	"	"	3' 9"
"	1730	37' 0"	37' 0"	4' 2"
15/11	0730	"	"	4' 0"
"	1730	58' 0"	46' 0"	5' 6"
16/11	0730	"	"	4' 6"
"	1600	64' 0"	"	5' 0"
18/11	1300	"	"	5' 6"
"	1700	70' 0"	64' 0"	7' 0"
19/11	0730	"	"	5' 3"
"	1700	80' 0"	"	6' 7"
21/11	0730	"	"	4' 3"
"	1700	87' 0"	87' 0"	13' 9"
25/11	0730	"	"	6' 3"
"	1700	95' 6"	95' 6"	11' 0"

• 25 blows for 3in penetration
• 65 " • 6in "
• 71 " • 6in "
• 31 " • 3in "
• 65 " • 6in "

Core recovery %

100
85
90
25
55
25
60
100
100
100
100
100

Scale: 1in = 10 ft. • Disturbed Sample ▮ Core Sample △ Water Sample

SOIL MECHANICS LTD 65 OLD CHURCH ST SW 3

Appendix C

Previous reports

Environmental Assessment of Contamination and Remediation

Volume 1

AS PART OF PREPARATION OF THE

STRATEGIC DEVELOPMENT ZONE PLANNING SCHEME

FOR

POOLBEG WEST

(SI No. 279 of 2016)

for: **Dublin City Council**

Civic Offices

Wood Quay

Dublin 8

by: **CAAS Ltd.**

2nd Floor, The Courtyard,

25 Great Strand Street,

Dublin 1

January 2017

Contents

Terms of Reference

This report has been prepared by CAAS Ltd. to provide an Environmental Assessment of Contamination and Remediation for the Poolbeg Planning Scheme Area.

It provides a desk-based assessment that is appropriate to the scale and level of detail of the Planning Scheme. It has regard to the EPA Guidance on the Management of Contaminated Land and Groundwater at EPA Licenced Sites. It provides a review of available documentation, a conceptual site model for the area of the Planning Scheme, a high-level qualitative risk assessment to establish low, medium and high risk areas. It also includes outline remediation measures.

Development proposals for individual sites within the Scheme area will require detailed site specific investigations and contaminated land risk assessments.

Study Team

This assessment has been led by Paul Fingleton, under Director, Conor Skehan. Each have over 25 years' experience in preparation and review of environmental assessments for projects and plans. David L'Estrange, who is leading the parallel Strategic Environmental Assessment of the Planning Scheme and has over 10 years' experience in SEA of Plans has also contributed to this assessment.

Review of Documentation

Document	Main Points
Site Description of IGB Site ARUP, 2016	• Site history and description • Remediation Works • Services
North Lotts & Grand Canal Dock Planning Scheme SEA ER Planning and Economic Development Department, Dublin City Council, 2013	• SEA ER (including NTS) • Integration of SEA Process with Appropriate Assessment and Flood Risk Assessment Process • Matrix and Evaluation of the Planning Scheme • North Lotts and Grand Canal Dock Flood Risk Assessment
Desktop Study and Qualitative Risk Assessment of Potentially Contaminated Undeveloped Sites within North Lotts and Grand Canal Dock Flannery Nagel Environmental Ltd, 2012 (DCC SDZ Risk Assessment of Potentially Contaminated Undeveloped Sites)	• Source-pathway-receptor identification and assessment of severity and consequence • Qualitative risk assessment • Risk Assessment findings • Outline remediation measures
Poolbeg Peninsula : Geomorphological Perspectives J.A.G. Cooper & D.W.T. Jackson (not dated)	• Geomorphological & Sedimentological aspects of proposed work • Dune accumulation • Changes in sea bed

Section 7 of EIS for Dublin Docklands Development Authority Poolbeg Peninsula Planning Scheme – Geotechnical, Soils & Ground Conditions Malone O'Regan, 2009	• Existing Conditions • Contaminated Land • Appendix 7.1 is Geotechnical Report for Poolbeg Peninsula Planning Scheme by Mott MacDonald, May 2008 • Appendix 7.2 is "Investigation of Possible Oil Leak at South Bank Road, Ringsend, Dublin" from the 2004 EIS for the Fabrizia Mixed Use proposal, by NES
DDDA Civic Infrastructure Audit Poolbeg and Sandymount DDDA, 2008 (*DDDA Civic Infrastructure Audit Poolbeg & Sandymount Dublin Docklands Development Authority Final Report April 2008*)	• A detailed land use study (included identifying civic infrastructure Facilities) in the Poolbeg / Sandymount study area • Current situation/ Demographics/ Community/Gap analysis/ Recommendations • Area analysis and school analysis
Environmental Sustainability and Traffic & Transportation Baseline Report Cunnane Stratton Reynolds, RPS Ireland and MVA Consultancy, 2008 (*Environmental Impact Statement For Poolbeg Peninsula Emerging Draft Planning Scheme Environmental, Sustainability and Traffic & Transportation Baseline Report August 2008*)	• Description of the emerging Draft Planning Scheme; area and scope • Baseline Overview (EIS Chapters + Seveso Sites)
Dublin Waste to Energy Project EIS Elsam, 2006	• Appendix 11.1 is Geo-environmental Engineering Assessment
Dublin South Bank Strategic Development Framework Final Report DGEW, 2002 (*for Dublin City Council*)	• Detailed evaluation of the site • Drivers for change/ Character Area Approach/ Landscape and View Structure/Movement & Access/ Land Use Pattern/ Amenity Provision/ Volumetric Expression/ Potential Capacity/ Phasing

Assessment Objectives

This assessment has been prepared to provide an appropriate level of assessment of contaminated land issues for use in the development of the Planning Scheme and its associated Strategic Environmental Assessment. The assessment is strategic only and it prepared on the understanding that site specific desk study and intrusive investigations will be carried out as part of the detailed design and consent procedures for each site.

Figure 1 Site Characterisation Zones used in this assessment

Introduction

The site can be characterised as five distinct areas of use. The detailed site characteristics are assessed using these areas as a basis for description and analysis.

A The Western Lands – the former Irish Glass Bottle site

An unoccupied area that has been cleared of contaminated soils

B The Northern Lands – Dublin Port lands

Lands currently used for a range of port-related and logistics uses

C The Central Lands – the Fabrizia site

An unoccupied area

D The Eastern Lands – the ESB site

Lands with a variety of active uses

E The Shore Lands

Amenity areas used for public recreation.

Baseline

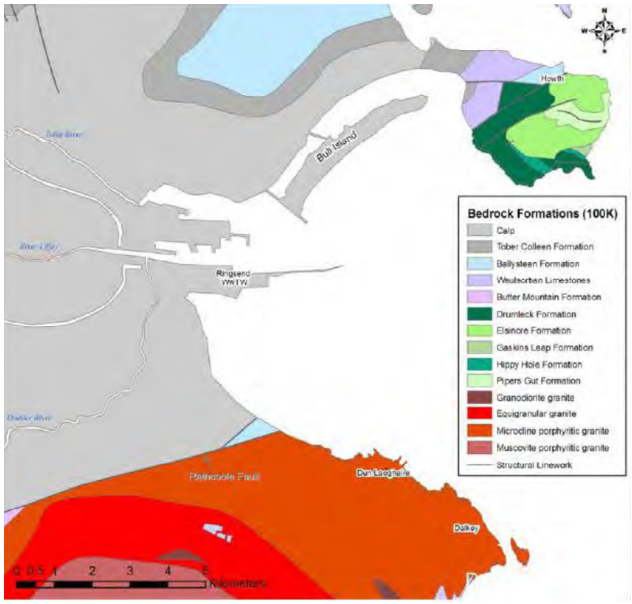


Figure 2 Generalised Bedrock Geology - Extract from the Ringsend WWTP Extension EIS

Geology

Bedrock Geology

The bedrock underlying the local area comprised moderately strong to strong, slightly laminated, grey to dark grey, fine to medium grained limestone with layers of Shale and occasional calcite veining.

Ground investigations carried out previously in the immediate vicinity of the Site indicate rock head levels between 36m and 45m bgl (-32mOD and -40mOD). Bedrock is completely obscured by an extensive blanket of Quaternary drift deposits and recent reclamation fill.

Drift Geology and Recent Deposits

Drift is a general term applied to all mineral material (clay, sand, silt, boulders) transported by a glacier and deposited directly by or from the ice, or by running water emanating from the glacier. It generally applies to Pleistocene glacial deposits.

The drift geology of the area principally reflects the depositional process of the last glaciation when an extensive ice sheet that extended into the Irish Sea covered the region. Typically during the ice advance boulder clays were deposited sub-glacially as lodgement till over the eroded rock head surface, whilst moraine deposits were laid down at the glacier margins.

Subsequently, with the progressive retreat of the ice sheet from the region, fluvio-glacial deposits (sand, gravel and silt) were laid down by melt waters discharging from the front of the glacier. Recent deposition prior to reclamation of the site principally reflects marine erosional and depositional processes, which have modified the glacial deposits.

The site is located entirely on made ground (fill deposits). Site lies on an area of reclamation that was formally the foreshore. Reclamation fill covers all remnants of the natural ground. The reclamation fill was deposited in the early 1970s, consisting of between 1.5m and 5.5m in thickness consisting of a mixture of gravels, sands, silts and clays, including rubble, bricks, concrete, glass, timber and cinders.

The attached Baseline Report [Volume 2] contains more detail on subsurface conditions.

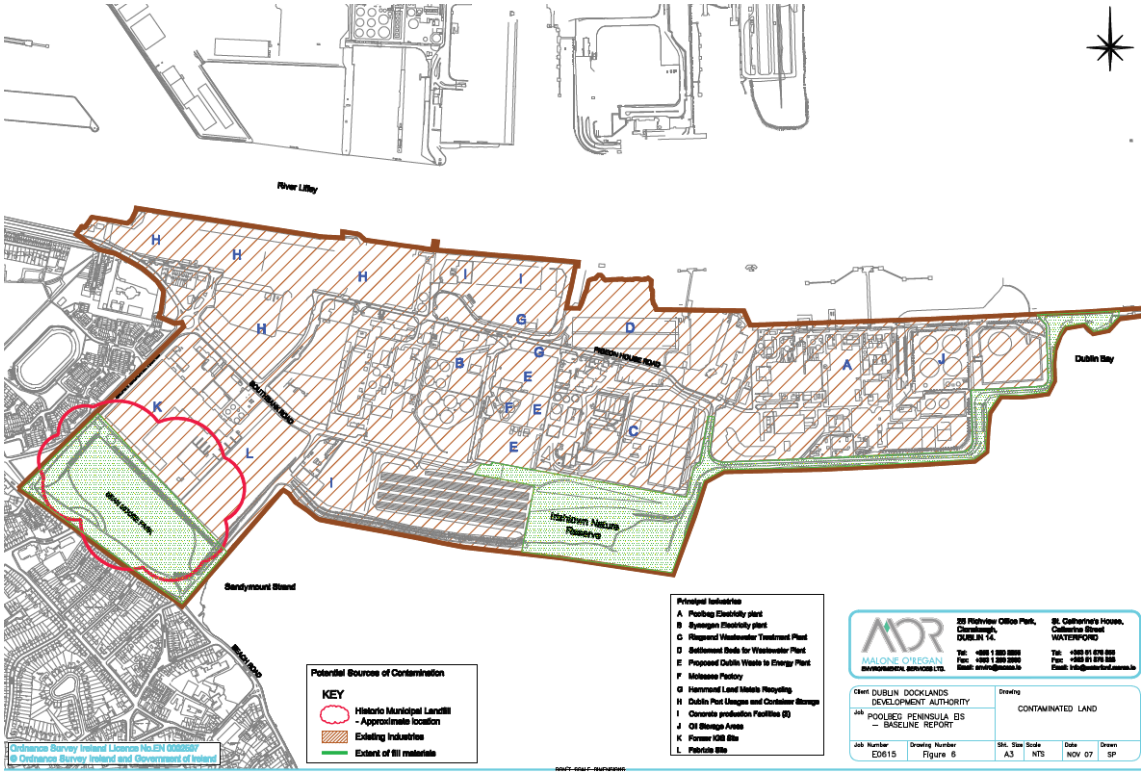


Figure 3 Summary of previous land-uses Extract from 2008 EIS Baseline DCC

Historical Background and Uses.

The eastern edge of the Draft Planning Scheme Area was first used in 1903 to generate electricity in Pigeon House. Land further to the east was subsequently reclaimed where Poolbeg Power Station, powered by oil, was opened in 1971.

Lands to the west were historically used by Dublin City Council as a landfill. The Irishtown Tip Head, which was reported to have commenced operation in 1948, was closed and capped in 1978. It is reported that the landfill was worked in a sequential fashion, with landfilling activities moving in an easterly direction over time (AWN, 2004). Following capping of the former landfill area around 1978, lands to the west of the overall development lands were leased to Irish Glass Bottlers (IGB) Ltd. until 2004. The IGB plant was also built on part of this landfill.

The central area of the site was and is currently used for the tank storage of molasses and oil. Other areas of the site were used by Dublin Port for storage and other associated port-related activities.

Areas within ESB lands have been used for pipe construction and latterly as a construction compound.

Concrete production facilities and a scrap metal works also currently operate in the scheme area.

Site Decommissioning, Demolition and Remediation (DDR) works were completed at the former Irish Glass Bottle facility between December 2007 and December 2008. The DDR works were designed to remove all vestiges of plant, buildings, operations and ancillary services associated with glass bottle manufacture at the facility in order to facilitate surrender of the site IPC Licence from the EPA.

Made Ground/ Fill Material

The made ground consists of distinct types of material which include the municipal waste filled as part of the Irishtown Tip Head (1945-1978) and general construction and demolition (C&D) waste. It is also reported that hydraulic fill material was used to reclaim distinct areas of the site (Arup, 2006).

Mott MacDonald Pettit (2008) report that site investigations in the Poolbeg area have previously logged made ground as being 1.6 to 5.6m in thickness. Typically, builder's rubble and similar dry fill were used to construct roads at locations to the west of the peninsula; landfill material was then tipped on either side of the roads.

Historically, the Fabrizia and IGB sites were constructed upon part of a Dublin Corporation landfill. It is understood that the general public also dumped refuse in this area during this period. The domestic and other waste beneath this site is expected to have been in the ground for somewhere in the region of 30 to 50 years. No soil gas venting or collection systems were installed on these sites during operation or after closure. Therefore landfill gas could potentially be still present (see further comment under Section 7.3.7).

There are no records available as to the exact types and quantities of materials which were dumped at the different sites across the Draft Scheme Area. However, from an examination of the trial pit logs and boreholes from site investigations carried out on the Fabrizia and IGB sites and from a review of a geotechnical assessment report produced by Mott MacDonald Pettit (2008) it would appear that much of the fill comprised of domestic and Construction and Demolition (C&D) waste. The composition varied greatly but commonly consist of a mixture of gravels, sands, silts, clays, rubble, bricks, concrete, glass, timber, concrete slabs, cabling, piping, rags, metal household containers and cinders (non-exhaustive list).

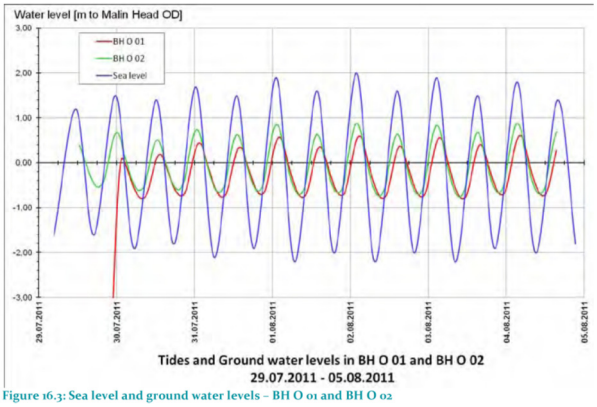


Figure 16.3: Sea level and ground water levels – BH O 01 and BH O 02

Figure 4 Extract from the Ringsend WWTP Extension EIS illustrating the link between tidal movements and groundwater levels

Hydrogeology

Groundwater movement in the region is likely to move principally in the drift layers rather than the hard limestone bedrock. The flow will also be restricted mainly to the sand and gravel drift layers since the stiff clay layers are less permeable. Given that the Peninsula is surrounded three sides by the sea and that no part of the Peninsula is more than 500m from the sea, tide levels will have a significant influence on groundwater. Previous studies suggest that groundwater is likely to be encountered at depths of 2m to 4m below ground level – i.e. tying in with high tide levels. See Figure above] Shallow groundwater across the Site was interpreted to flow from generally west to east.

The effect of the sea is also seen in groundwater quality. Saline intrusion is likely meaning that the water is likely to be brackish. The shallow depths of soil cover over the groundwater table means the groundwater in the area would be classified as highly vulnerable. This combined with the industrial history of the area means that much of the groundwater in the area is likely to be polluted. Previous studies have confirmed this.

The Final Characterisation Report of the Eastern River Basin District says that the Dublin City water body is one of only two groundwater bodies in the entire Eastern River Basin District that is classified as being “At Risk of not reaching good status”.

Under the EU’s Groundwater Directive, there is a requirement to improve groundwater quality regardless of whether or not it is ever intended to use it. Remediation measures associated with the proposed works may lead to some improvement in groundwater quality but should certainly lead to no reduction in quality.

Contamination

Indications at this stage are that some level of contamination can be expected in most areas of the Peninsula[1]. This is due to the previous history of landfilling and reclamation and the many heavy industrial uses that have been in place on the Peninsula. The extent of contamination is likely to vary widely.

Landfill gases are also likely to be encountered at some sites with significant methane concentrations having been noted in previous studies.

For less serious contamination, it may be possible to trap the contaminants using material such as dense, impermeable clays. Provision for venting of gases may still be required. It should be noted that this approach is only really practical if deep or extensive excavations are not required.

There is considerable evidence of low level contamination with hydrocarbons across the entire Docklands area, including the Poolbeg Peninsula. These include total Petroleum Hydrocarbons and Polynuclear Aromatic Hydrocarbons (PAHs). These can come from oil or tar or from burnt tires or domestic waste. In some area, this material is in

concentrations above intervention limits and may need to be removed off site or treated.

There have been reports of high sulphate levels in parts of the Docklands including the Poolbeg Peninsula, meaning that Sulphate Resisting Cement may need to be considered on some sites.

Volatile Organic Compounds have been detected in previous studies. These would include benzene which is a proven carcinogen, as well as xylene, toluene and ethylbenzene.

Toxic metal including arsenic have been found in concentrations above intervention limits. Other heavy metals encountered included barium, chromium, mercury, nickel, lead and tin.

In many areas it will not be sufficiently contaminated to require that level of treatment. However, hydrocarbons can have very significant impacts on water pipes particularly the modern High Performance Polyethylene (HPPE) pipes which are now commonly used. Hydrocarbons can migrate through the walls of these pipes causing drinking water contamination. For this reason, pollutant resistant pipes are frequently specified in the Dockland areas. These would include, for example, aluminium lined HPPE pipes which are resistant to hydrocarbon ingress. These cost six times more than conventional HPPE but there is no impact on laying/ backfill costs so the overall cost difference is not that significant.

There is a possibility that phenolic compounds and cyanide compounds associated with the manufacture of town gas could be encountered. Phenolic compounds are a particular concern as they can cause tainting of water in plastic pipes.

It is anticipated that many development sites will have contaminated soil and groundwater arising from previous landfilling and heavy industrial uses. Landfill gases may also be encountered.

[1] *Indications at this stage are that some level of contamination can be expected in most areas of the Peninsula. This is due to the previous history of landfilling and reclamation and the many heavy industrial uses that have been in place on the Peninsula*. Dublin Docklands Development Authority Poolbeg Peninsula Planning Scheme Geotechnical Report Mott MacDonald Pettit May 2008 – See Volume 2, Appendix 3

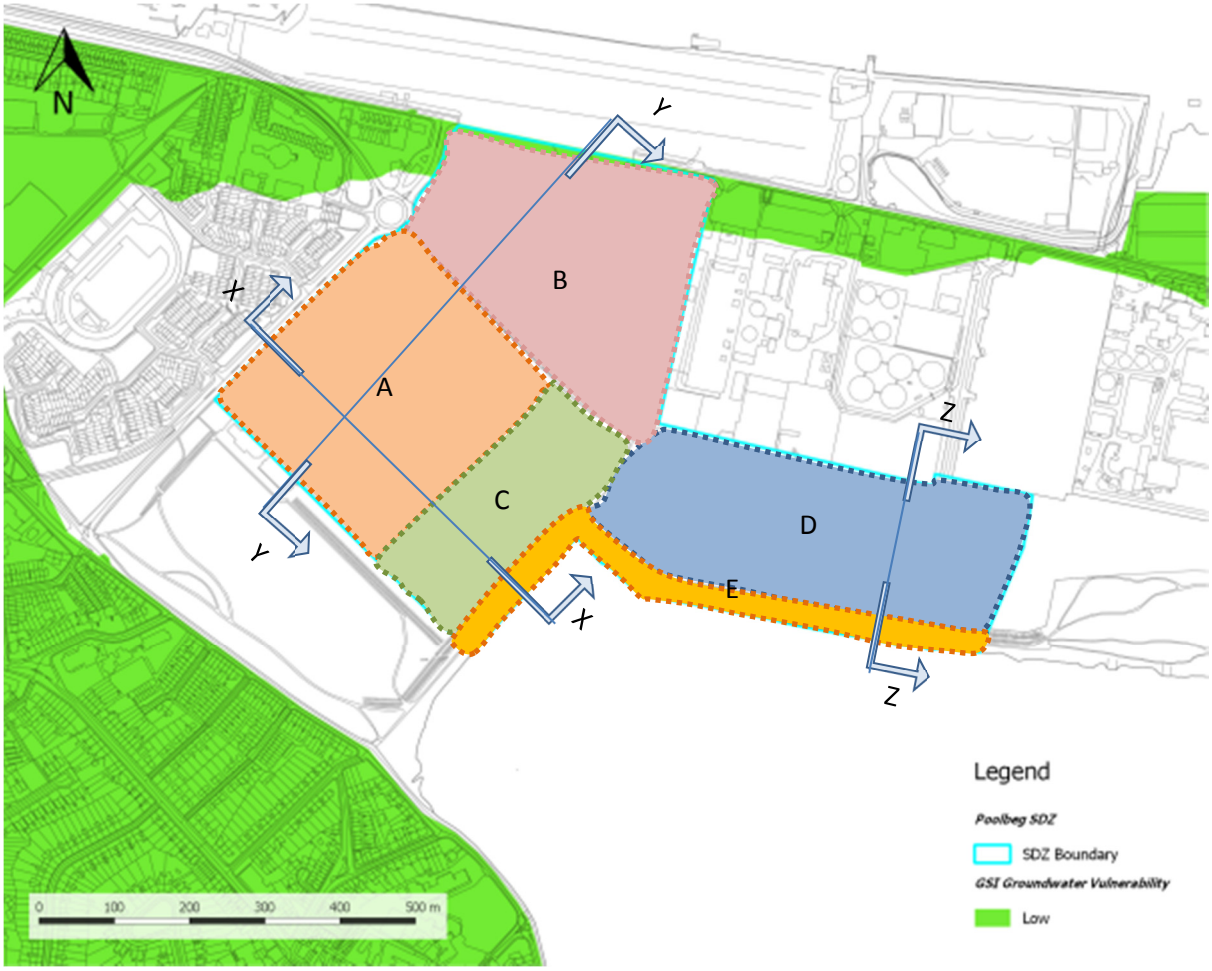


Figure 5 Characterisation Areas used for study

Conceptual Site Model [Plan]

The Site is initially characterised as having Five Regimes;

A The Western Lands – the former Irish Glass Bottle site

These filled lands were formerly occupied by the Irish Glass Bottle company. The lands have been remediated by the excavation and disposal of the upper layers of contaminated soil and by the establishment of a resolved surface to receive new development.

B The Northern Lands – Dublin Port lands

These filled lands are currently in a variety of uses – these include tanked storage areas, port-related activities and transport and logistics activities – as well as a road network.

C The Central Lands – the Fabrizia site

These filled lands are currently unused. The previous land use history is unclear – though parts are thoughts to have been used for the disposal of wastes from the IGB operations.

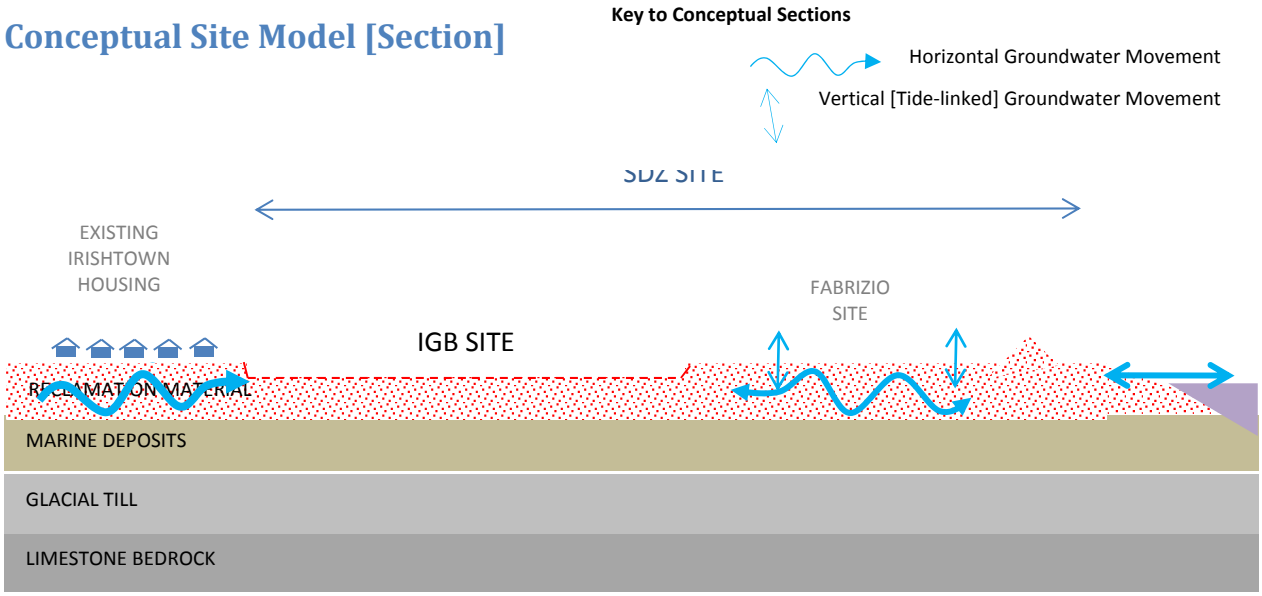
D The Eastern Lands – the ESB site

These filled lands were used for the disposal of municipal wastes, latterly as an amenity area associated with the adjoining power plant and subsequently have been used as an area for the manufacturing and dispatch of under-sea piping and more recently as a construction compound for an adjoining development project.

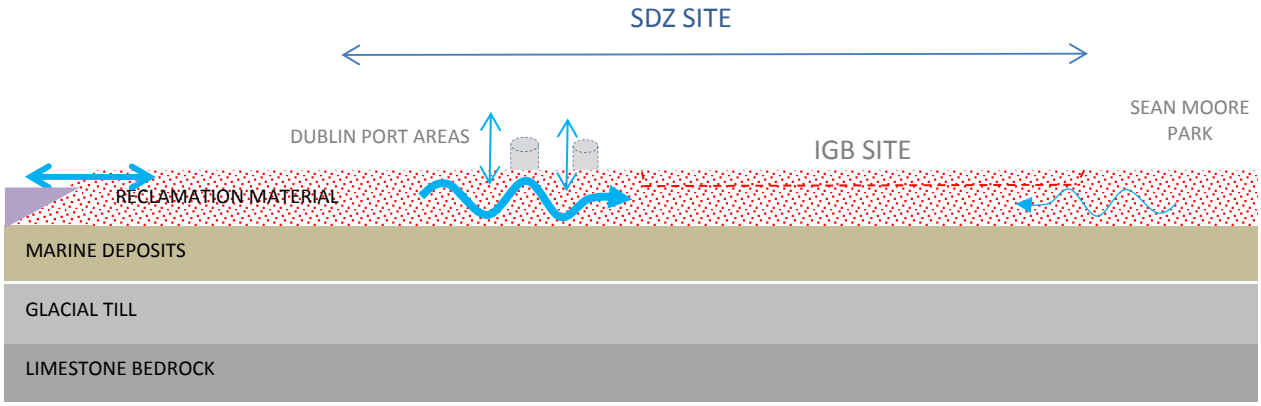
E The Shore Lands

These filled lands were used to enclose and contain placement of municipal waste. Subsequently a raised earthen berm was placed along the northern and western boundary to delineate a shore walk.

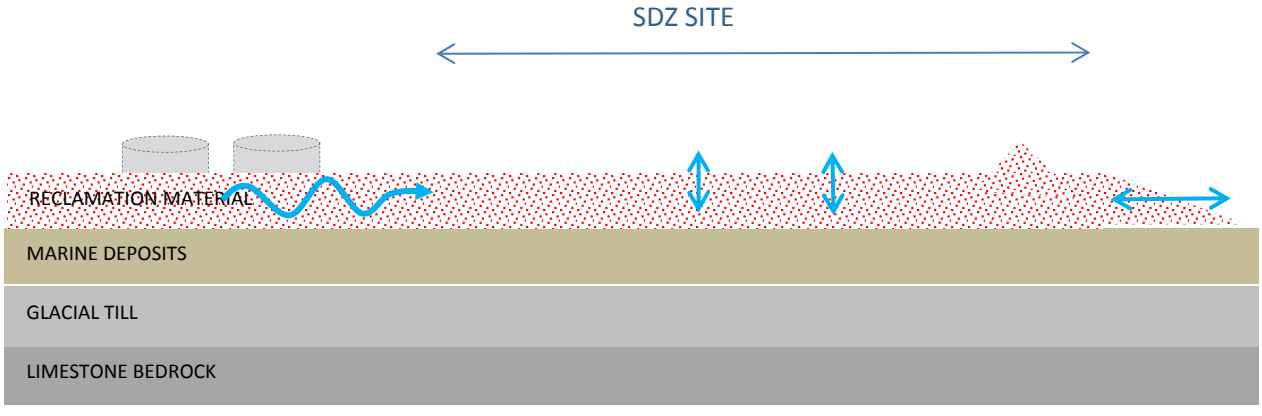
Conceptual Site Model [Section]



CONCEPTUAL SITE MODEL SECTION X - X



CONCEPTUAL SITE MODEL SECTION Y - Y



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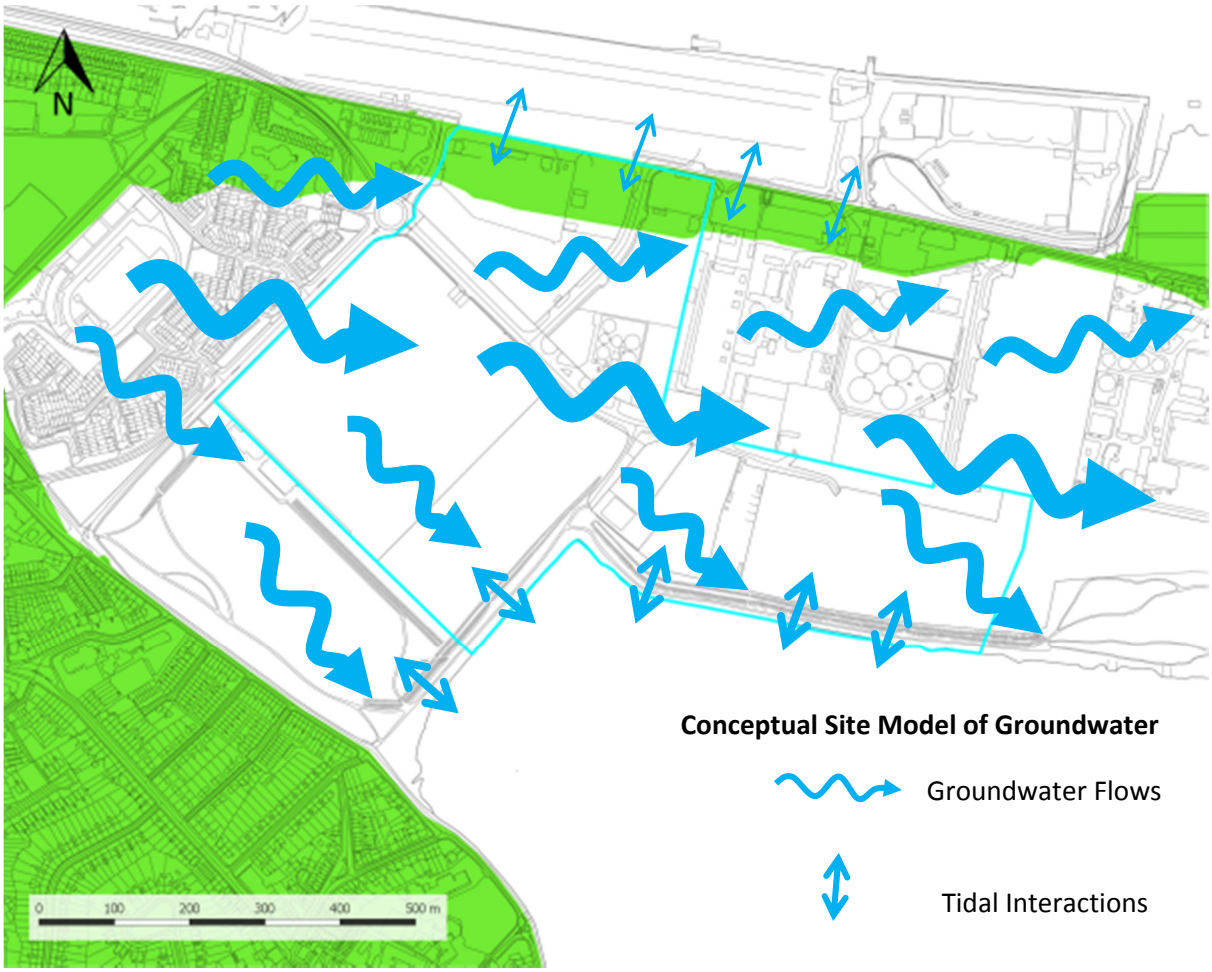


Conceptual Site Model of Groundwater

Groundwater is recorded at shallow depth – 3-4m bgl which is close to mean sea-level – and is characterised as being brackish to saline. Furthermore groundwater levels exhibit tidal variations

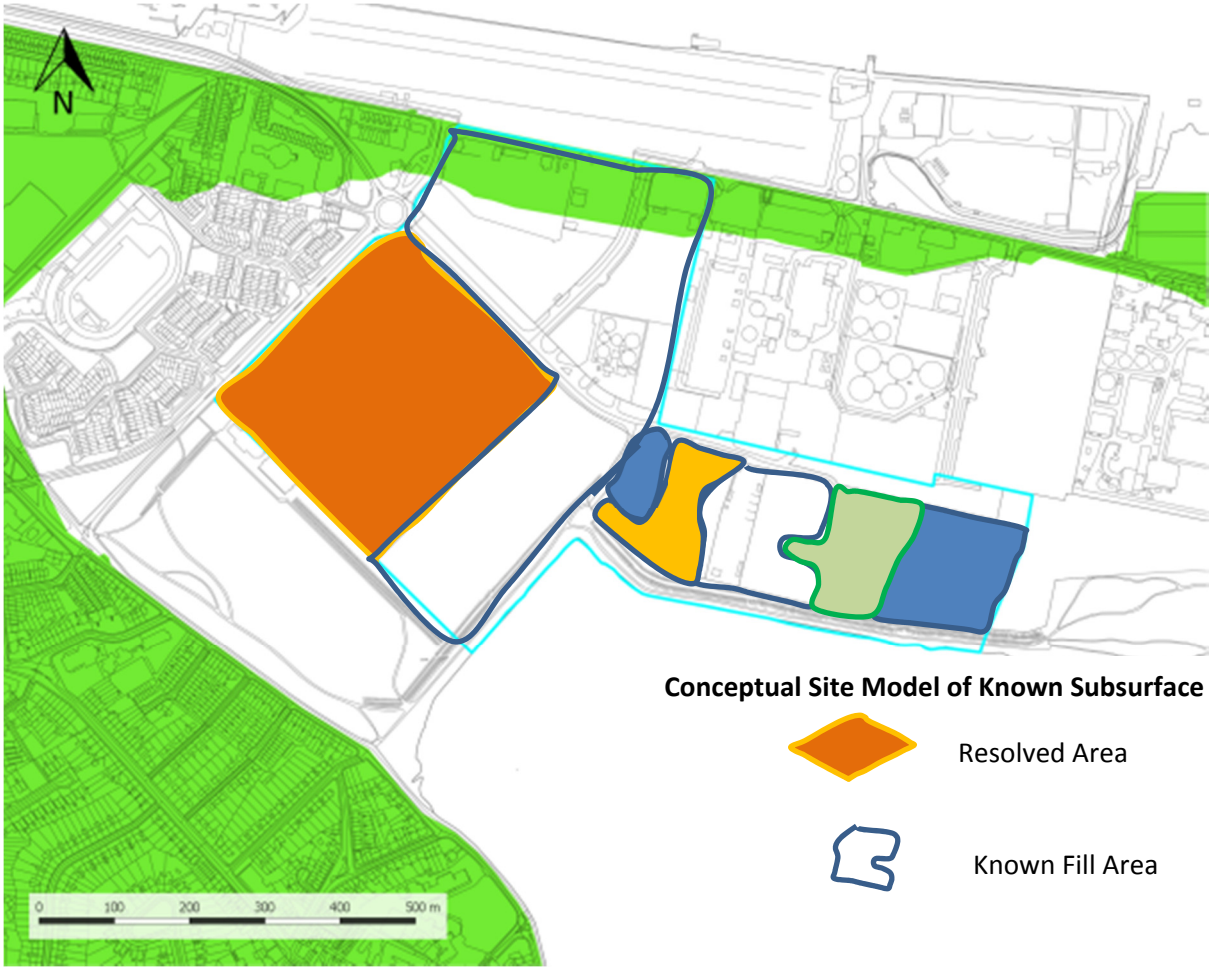
The upper layers of the site consist of dominantly porous material which facilitates unconfined groundwater movement. Potential for groundwater movement diminishes in the lower layers of marine sediments and glacial tills.

Groundwater investigations indicate that groundwater movement below the site has two principal components.

A vertical component –which follows both daily tidal movements [2m+] as well variations of larger amplitude that are influenced by seasonal tidal extremes as well as even larger irregular variations driven by atmospheric conditions – such as storms and low-pressure extremes.

A horizontal component – which generally flows from east to west – which diverts to run perpendicular to the shore along the land-sea junction. It is likely that there is slightly more rapid horizontal movement along the more porous southern and eastern shores.

The Conceptual Model of Site Groundwater illustrated above illustrates these movements – the thickness of the lines indicating the relative volumes of the flows. In general movement will have a higher velocity nearer to the surface and nearer the shore.



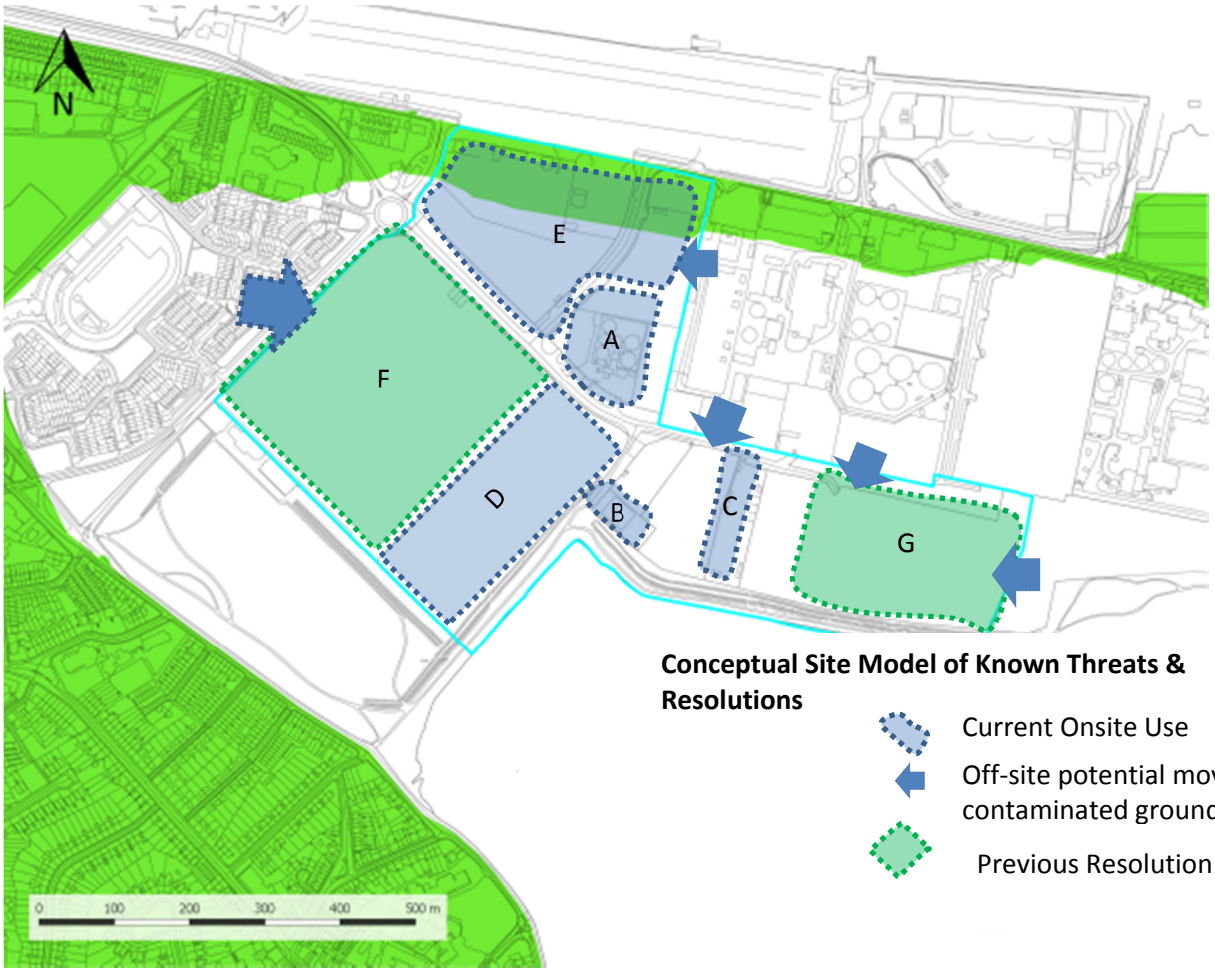
Conceptual Site Model of Known Subsurface

Lands to the west were historically used by Dublin City Council as a landfill. The Irishtown Tip Head, which was reported to have commenced operation in 1948, was closed and capped in 1978. It is reported that the landfill was worked in a sequential fashion, with landfilling activities moving in an easterly direction over time (AWN, 2004). Following capping of the former landfill area around 1978, lands to the west of the overall development lands were leased to Irish Glass Bottlers (IGB) Ltd. until 2004. The IGB plant was also built on part of this landfill.

It is understood that the general public also dumped refuse in this area during this period. The domestic and other waste beneath this site is expected to have been in the ground for somewhere in the region of 30 to 50 years. No soil gas venting or collection systems were installed on these sites during operation or after closure. Therefore landfill gas could potentially be still present.

There are no records available as to the exact types and quantities of materials which were dumped at the different sites across the Draft Scheme Area. However, from an examination of the trial pit logs and boreholes from site investigations carried out on the Fabrizia and IGB sites and from a review of a geotechnical assessment report produced by Mott MacDonald Pettit (2008) it would appear that much of the fill comprised of domestic and Construction and Demolition (C&D) waste. The composition varied greatly but commonly consist of a mixture of gravels, sands, silts, clays, rubble, bricks, concrete, glass, timber, concrete slabs, cabling, piping, rags, metal household containers and cinders (non-exhaustive list).

The results of surveys showed concentrations of contaminants at elevated levels reflecting the filling activities and industrial history of the area.



Threats and Resolutions

While all of the lands have been recovered from the sea using fill - at a conceptual level, the site can be conceived as having zones of known threat and resolution that locally increase or reduce the potential threats of contamination.

Known Threats

Contamination Threats are known or suspected to exist from the following Sources

A. Storage tanks exist in this area
B. These areas are known to be used for metal working
C. These areas are known to be used for concrete production
D. These areas are known to have been used, in part, for IGB waste disposal
E. These areas have been used for external storage, and for servicing of vehicles

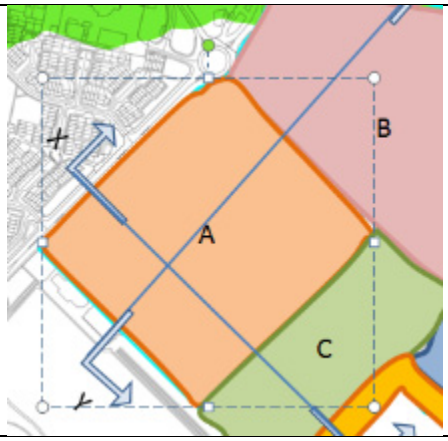
Known Resolutions

Resolutions or partial resolutions to contamination Threats are known to exist on the following Lands

F. IGB Site – full contaminated soil resolution
G. Laydown and Compound areas have been resurfaced with imported hardcore.

The factors set out previously were used to carry out an evaluation of the potential risk of contamination for each of the Characterisation Areas. The results are set out below.

A The Western Lands – the former Irish Glass Bottle site

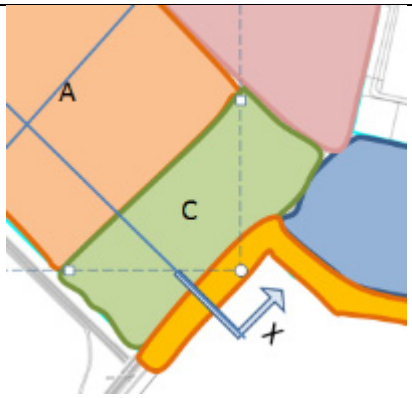


Sub-surface Conditions	• Marine Sediments • Residual landfill material
Previous Landuses	• Municipal Landfill • Glass Bottle Factory
Knowledge of Contamination Potential	• High • Substantial de-contamination completed
Potential Risk of Contamination	• Low • Residual risk of lateral movement of contaminants
Sources	• Malone O'Regan 2008

B The Northern Lands – Dublin Port lands

Sub-surface Conditions	• Marine Sediments • Landfill Material • Subsurface Foundations and Hardcore
Previous Landuses	• Port-related Activities • Unknown Previous Activities
Knowledge of Contamination Potential	• Low
Potential Risk of Contamination	• Unknown
Sources	• AWN 2004

C The Central Lands – the Fabrizia site



Sub-surface Conditions	• Marine Sediments • Landfill Material
Previous Landuses	• Municipal Landfill
Knowledge of Contamination Potential	• Moderate - good 2004 investigation by AWN
Potential Risk of Contamination Note 'Risk' includes consideration of the knowledge of the conditions. The knowledge of this site's high contamination potential increases the certainty – which reduces risk	• Medium • Evidence of landfill gas emission • Evidence of Soil Contamination • Polycyclic Aromatic Hydrocarbons (PAHs • Gasworks waste • Asbestos
Sources	• NES 1999 • AWN 2004 • Mott MacDonald Pettit 2008 • Malone O'Regan 2008

D The Eastern Lands – the ESB sites

Sub-surface Conditions	• Marine Sediments • Landfill Material • Surface Dressing of hardcore
Previous Landuses	• Municipal Landfill • Pitch and Putt Golf [part of] • Laydown/ casting site for pipeline • Construction Compound
Knowledge of Contamination Potential	• Poor – only inferred from 2004 investigation by AWN
Potential Risk of Contamination	• High
Sources	• AWN 2004 • Malone O'Regan 2008

E The Shore Lands

Sub-surface Conditions	• Marine Sediments • Landfill Edging Material • Pathway fill material
Previous Landuses	• Perimeter Landfill enclosure
Knowledge of Contamination Potential	• Very Poor
Potential Risk of Contamination	• High
Sources	• none

Description of Key Identified Risk

Conceptual Site Model of Contamination Risk

KEY	RISK	Definition	Source of Definition
	LOW RISK	No additional remediation was required.	IGB Site ARUP, 2016
	LOW-MEDIUM RISK	There is a low probability that remediation actions will be required. In most cases the development design will be able to mitigate the majority of risks	Desktop Study and Qualitative Risk Assessment of Potentially Contaminated Undeveloped Sites within North Lotts and Grand Canal Dock Flannery Nagel Environmental Limited 2016
	MEDIUM RISK	There is a medium probability that remediation actions will be required. However, such actions are likely to be localised or limited in extent and in some cases the development design could be used to mitigate some of the potential risks.	
	HIGH RISKS	There is a high probability that remediation actions will be required to manage risk, including removal & disposal, on site treatment, off-site treatment. Such activities are likely to require a waste management licence.	
	UNKNOWN RISKS	There is insufficient data to make any assessment of likely or probable risk. Treat same as 'High Risk'	

Summary, Conclusions and Recommendations

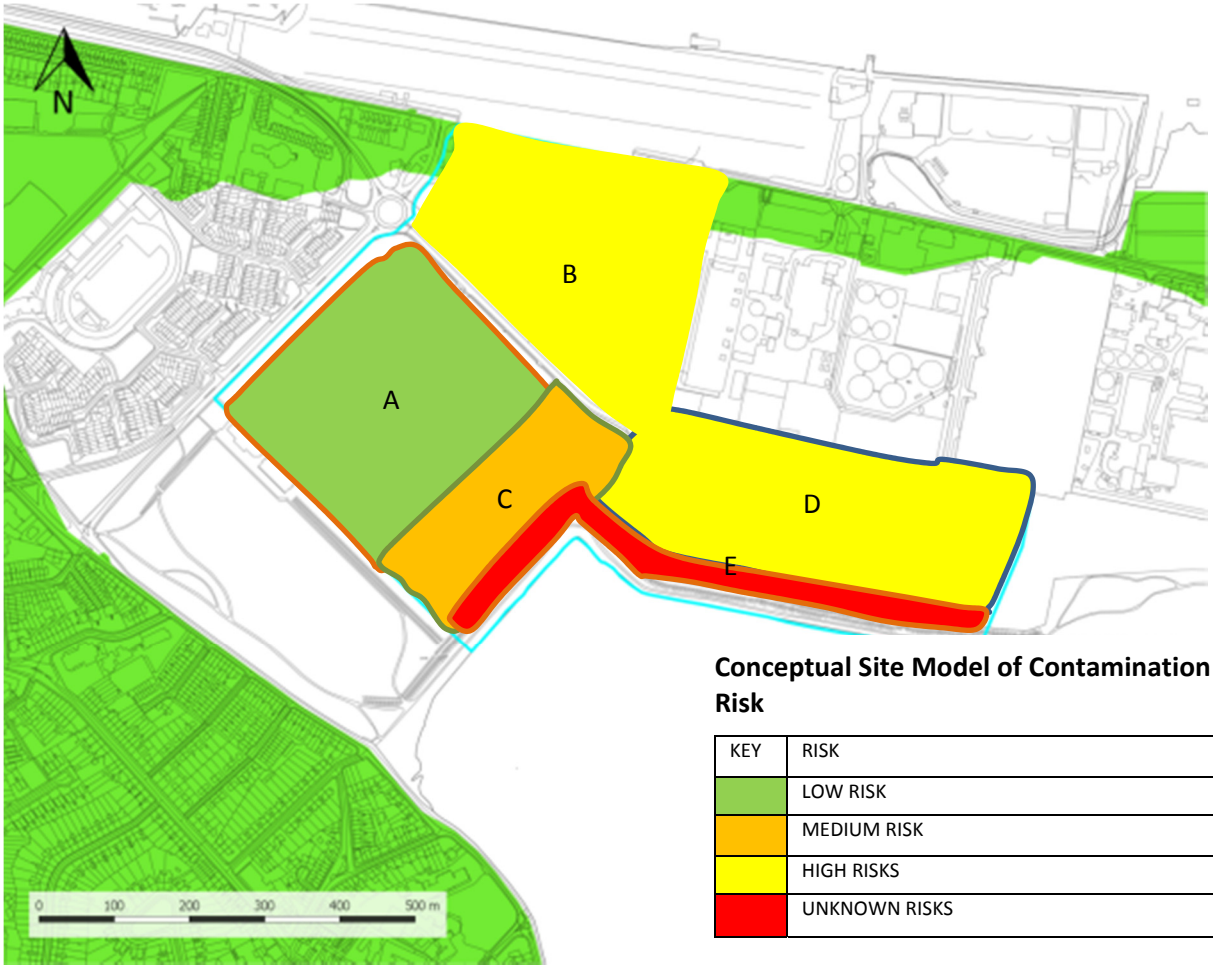
This investigation indicates that contamination of soil and water are likely to be encountered throughout these lands. This is a well understood feature that is commonly encountered during the redevelopment of brownfield sites – and especially in port-related areas.

The existence of contamination must be taken into account during both the planning and design states, though it does not represent an insurmountable obstacle to development. With the correct approach – and following the general recommendations set out below – the site can be redeveloped and used without giving rise to threats to either human health or to the natural environment.

The approach set out here is one of avoidance – to minimise excavation or disturbance during construction and to minimise exposure and/or occupation during use. This conservative approach is approach for an SDZ because it establishes very clear and unambiguous instructions for circumstances where many actors and agencies are likely to be involved in implementation.

The 'Conclusion and Recommendations' set out below indicates how the consideration of the issue of contamination should influence the development of the SDZ.

conclusion



Conceptual Site Model of Contamination Risk

KEY	RISK
	LOW RISK
	MEDIUM RISK
	HIGH RISKS
	UNKNOWN RISKS

The development of the SDZ should accommodate the issue of contamination by adopting th

following approaches:

1. Accept that the entire site has the potential for legacy effects of contamination

The history of contamination together with the porous soils and the dynamic marine-influenced nature of the groundwater regime means that there will always be a residual risk of effects on health and the stability of structures and services. A Strategic approach that acknowledges and accepts these realities will lead to an approach of avoidance – which is likely to be the most reliable, robust and resilient approach. The principle implication of this approach will be to adopt a vertical separation approach throughout the site.

2. Maintain a vertical separation barrier

All of the lands [including those that have been rehabilitated] have the potential to continue to be affected by the results of prior contamination in varying degrees. For this reason the strategic approach should continue to follow the approach adopted at the IGB site – as advised by ARUPs, namely

'The provision of basement space, beneath the future proposed mixed use development for car-parking and ancillary services - as a method to create a wide (and ventilated) physical barrier between the existing legacy fill and the future habitable space of the new development.'

Specific Recommendations

1. Achieve Protection by Strategic Guidelines for Land-use allocation

The SDZ can remediate and ameliorate the potential effects of contamination by ensuring that proposed landuse types are compatible with the potential risks. [see table below]

	Risk Profile			
LANDUSE TYPE	**Known Low Risk**	**Medium Risk**	**High Risk**	**Unknown Risk**
Below-grade occupation	Avoid	Avoid	Avoid	Avoid
At-grade Occupation	Avoid	Avoid	Avoid	Avoid
Un-occupied Ground Floor	Permissible	Permissible subject to finding of Site Remediation Report	Limited and Permissible only with conditions subject to finding of Site Remediation Report	Avoid
Un-occupied and ventilated Ground Floor	Permissible	Permissible with conditions	Permissible subject to finding of Site Remediation Report	Limited and Permissible only with conditions subject to finding of Site Remediation Report

2. Require Developers to prepare Site Remediation Report

Prior to the grant of approval developers will be required to carry out a full contaminated land risk assessment to demonstrate

- How the proposed landuses will be compatible with the protection of health and safety [including the durability of structures and services] – during both construction and occupation
- How any contaminated soil or water encountered will be appropriately dealt with. Any site investigation carried out on the Peninsula should include a requirement for gas monitoring.

Details of the likely actions required are set out in Appendix 1,2

3. Implement a contamination interception, monitoring and mitigation management system

- Prior to the implementation of the scheme devise and implement a contamination interception, monitoring and mitigation management system for the whole site – and especially for all marine-land boundaries – to safeguard against the mobilisation of contaminants during construction and operation.
- Put in place organisational and financial mechanisms to ensure that this system is kept in place for the foreseeable future.

Appendices

Appendix 1 Range of Outline Remediation Actions

Extracted from Desktop Study and Qualitative Risk Assessment of Potentially Contaminated Undeveloped Sites within North Lotts and Grand Canal Dock - Flannery Nagel Environmental Limited 2016

Pre-Development Phase:

• Site specific desk study and intrusive investigations (All Sites)
• Based on site investigations, establish Conceptual Site Model to identify whether risks exist (All Sites)
• Identify Risk Management Actions

These may range progressively from minor to rigorous as follows:

- 'do nothing'
- monitored natural attenuation,
- modifying the development to prevent exposure/migration (i.e. vapour barrier in basement)
- insitu / exsitu treatment (assisted bio degradation of contaminants) or
- contaminated soils removal and disposal.

Development Phase:

• Implementation of agreed Risk Management Action (minor to rigorous, as applicable)
• Protection of residents and workers during excavations/ demolition works
• Clearing/ sealing contaminant pathways in historical drains
• Protecting new services from contaminant ingress
• Contaminant controls during dewatering works
• Cross contamination controls to/ from adjoining sites
• Establish environmental risk management procedures

Post-Development

• Completion and Verification assessment of remediation works

Appendix 2 Range of Detailed Remediation Actions

Extracted from Desktop Study and Qualitative Risk Assessment of Potentially Contaminated Undeveloped Sites within North Lotts and Grand Canal Dock - Flannery Nagel Environmental Limited 2016

Pre-Development of Potentially Contaminated Land

The following activities need to be undertaken as part of planning and prior to commencement of any development on potentially contaminated land.

1. Desk Study

A desk based qualitative risk assessment will be required specific to the area proposed for development and for the type/nature of the development intended. The desk based assessment should include an initial conceptual site model, qualitative risk assessment and a justified scoping for an intrusive investigation. The work should be undertaken in accordance with the EPA Draft Framework for the Management of Contaminated Land and Groundwater at EPA Licensed Facilities, 2012, Stage 1, Preliminary Risk Assessment and the DEFRA Model Procedures for the Management of Land Contamination (CLR 11, 2004).

Particular attention should be given to any development that incorporates garden/common areas, deep/extensive excavations, potential off site sources of contamination and development where new services (pipelines/ drains etc) are required.

2 Intrusive Investigation

Intrusive investigations should be undertaken for all developments and should follow best practice including the EPA Draft Framework for the Management of Contaminated Land and Groundwater at EPA Licensed Facilities, 2012, Stage 1, Preliminary Risk Assessment and the DEFRA/ EA Model Procedures for the Management of Land Contamination (Contaminated Land Report 11, 2004.

The following should be key requirements:

1. Intrusive investigation should be undertaken on the basis of the conceptual site model completed within the desk study and prioritised based on the initial qualitative risk assessment (Task Stage 1);
2. The amount and location of boreholes, window samples of trial pits used for sampling purposes should have a sufficiently robust statistical basis, but should include specific targeting of identified environmental issues;
3. Sampling should be undertaken of underlying alluvial sediments as background or to support study into migration;
4. The chemical analysis should include a broad range of determinants' but should also reflect the specific industrial activity sources identified for the site, and associated typical contaminants (including asbestos);
5. Groundwater and surface water should be sampled, tested and monitored using a similar suite of chemical determinants';
6. Groundborne gas (methane/ carbon dioxide) and volatile organics, as well as pressure, flow and weather conditions should be monitored within the site;
7. Off-site contaminative sources and migration to or from the site should be considered;
8. Testing should include geotechnical soils classification, leachate testing and waste characterisation.

After intrusive site investigation, the conceptual site model and risk assessment should be updated from the desk study and specifically for the proposed development and related activities. The risk assessment should be undertaken using Generic Assessment Criteria (EA Using Soil Guideline Values) and if required full quantitative risk assessment methodologies. Modelling of contaminant fate and transport may be required for groundwater and a soil gas risk assessment may also be required.

The intrusive investigation is the basis of assessment of risk management options.

3 Risk Management Actions

The initial risk assessment provides a guide to the likely level of risk management requirements. The desk study and investigation for the specific development area will determine the environmental risks that will need to be managed.

Step 1: Options Assessment

At this stage available options for risk management are assessed, compared and agreed. Risk management options can range progressively as follows:

- 'do nothing'
- monitored natural attenuation,
- modifying the development to prevent exposure/migration
- insitu/exsitu treatment or
- contaminated soils removal and disposal.

The options assessment should take into account each source/pathway/receptor, potential residual risks, constraints, possible environmental impacts associated with each method, the ability to demonstrate that the risk management action is successful, as well as the requirements for regulatory licensing/ permits. Remedial options, in line with the EPA Draft Guidelines 2012, Stage 2, will need to consider how the site may change within the future and the requirements for maintenance where below-ground activities may be necessary. Both EA and CIRIA have guidance on options assessment requirements (Remedial Treatments for Contaminated Land SP104). The final assessment should arrive at a benefit analysis and the solution may involve one or more techniques.

Step 2: Selection and Implementation

The most appropriate options should be selected and objectives agreed prior to implementation. Implementation can be undertaken prior or during area development (i.e. soil removal, or vapour barrier construction, etc). The implementation should be appropriately managed and recorded to demonstrate that measures are completed and work undertaken have had no negative environmental impact (e.g. dust generation).

Step 3: Verification

Verification is an important step that is required to demonstrate that the risk management actions have achieved their objectives and that risks are being managed effectively. Verification may be as simple as recording that an activity has been undertaken, through to sampling and chemical testing to demonstrate that there is no residual contamination or that the treatment technology used has performed.

Step 4: Residual Risks

Where there is uncertainty or there is a possibility of residual risk or where additional future security is required, then further risk management measures such as warranty or insurance may be necessary.

Licences and Permits

Existing
Some plots have existing EPA Waste or IPPC licences which have ceased, are surrendered or, in some cases are still active (even though the operation is closed). In any such case, consultation will be required with the EPA to determine the most appropriate course of action to ensure that any environmental liabilities are managed prior or in completion of development. Where an active licence exists, it may be possible that its' conditions could encompass possible remedial options.

Required
In some cases the remedial requirements (soil removal/ remediation) or nature of the development (proposed waste facility or IPPC activity) will require an appropriate EPA licence. Any remediation licence should be related to the selected remedial objectives, and surrendered on completion of risk management work and prior to the completion of the development. Waste removal/ disposal must be undertaken by permitted operators.
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Development of Lands
These are activities that may be required as part of the development stage and which are often linked to the Risk Management Options Assessment carried out previously. The task numbering relates to the tasks described in *Risk Management Actions* [above]

1 Protection of residents
Risk management and development actions have the potential to impact on humans and property. Any development where this is a potential issue will be required to demonstrate that the residents are sufficiently protected from potential issues such as contaminant migration, dust, vibration and noise.

2 Potential asbestos management
The made ground underlying the site may have asbestos containing materials within the general demolition rubble or historical industrial waste. Further, many older buildings incorporate asbestos containing materials within the building fabric.
It is standard practice to test any suspected materials on a reasonable statistical basis and to demonstrate that appropriate actions have been taken to protect construction workers and nearby humans as well as ensuring that future users of the areas are also protected from any possible exposure.

3 Demolition
Most areas will require building demolition. Buildings may contain hazardous materials resulting from their industrial past such as old sumps, containers, supply pipelines, transformers (PCBs), refrigerants (F-gases/ODS) or asbestos. All potentially hazardous materials need to be assessed and removed prior to demolition, with appropriate procedures followed to protect workers, the public and property from exposure to contamination as well as ensuring there is no residual hazards to contaminate the soil or water.

4 Historical drainage and services
Some plots have, or are likely to have historical drainage and services. The developer will be required to assess whether any residual contamination is in the drains, and if so have them cleaned out, waste removed and properly disposed. To prevent old services becoming potential contaminant pathways in the future (and where there is no intention to re-use the service) they should be removed, filled in with clean material or sealed.

5 New or upgraded services
Where new services are required (particularly water services) then consideration should be given to the ground conditions and whether any aggressive or damaging contaminants are present in the soil which may migrate into services or in the long term damage the integrity of construction materials. This should be identified as part of the intrusive investigation (Task 2). Where there is a potential issue then the developer must demonstrate that new services have been suitable protected (i.e. using different materials, use of clean inert backfill, lining service trenches etc).

Measures may also be required to protect any workers who are involved with excavations where contamination may be present.

6 Dewatering

Dewatering may be required to support development where deeper foundations or basements are required. In these circumstances there is potential risk of contamination within the water and risk of pulling contamination towards the development area from an adjacent source (increasing migration). While this is an issue that should be taken into account at the risk management options stage (Task 3) the developer will need to demonstrate that they are not causing or aggravating a pollution problem and that the dewatering and disposal are appropriately managed and permitted.

7 Cross Contamination

Some plots and development areas may be located down-gradient from a potential source of contamination. This is an issue that should be addressed at the risk management options pre-development stage (Task 3). The developer should protect the development from future re-contamination resulting from migration from an adjacent and up-gradient contaminant source.

Environmental Risk Management

There are a number of development activities that may change the environmental profile and risk, including:

1. Deep excavations;
2. Laying new services;
3. Storage or placement of made ground; and
4. Deep drilling or piling.

These activities have the potential of increasing the pathways or contaminant migration or increasing the risk of exposure. These issues can be managed via a construction management plan which should be used to support demonstration that the developer has not introduced new contaminant pathways in the overall plot area.

Post Development

This is an activity that is required where environmental risks have been identified and where risk management measures have been applied during the development stage.

Completion and Verification

As specified in the requirements for the Risk Management Options (Task 3), the developer will need to demonstrate how all of the identified risks have been addressed and whether there is any residual risk that requires ongoing or future management. The final outcome is a deliverable identifying all risks, how each risk has been addressed and managed and how this has been verified through sampling, testing or monitoring and hence a demonstration that all environmental objectives have been met. Where residual risks may still be present the developer will be required to produce a strategy /procedure setting out how these are to be managed for the future or possible future changes that may occur within the development area

Planning Authority Recommendations

DCC will require documents from developers and will integrate these within its information management system. Furthermore, any strategy for the development zone will consider not only the areas suitable for private development but also the related public areas.

Review and authorisation
The following are potential documents that may be generated by each proposed development and will require review by the Planning Authority prior to planning approval, commencement of development works and on completion of the development.

- Desk Study
- Desk based study to identify site specific risks and scope intrusive investigation based on specific development requirements.

- Intrusive Investigation Asbestos Survey
- Intrusive investigation required for all development areas

- Risk Management Options Assessment
- Identifies the risks, the options and the selected solutions required for managing the risks.

- Licences and/or Permits
- Possible requirement where remedial or waste activity is required, Licence application to EPA, with copy to DCC for information.

- Waste Collection Permits are issued by the National Waste Collection Permit Office. Waste Facility Permits are issued by Local Authorities.

- Building Hazardous Materials Survey
- Survey required to identify residual hazards within buildings as part of demolition warrant/permit.

- Demolition Warrant/Permit
- Likely requirement for most areas of development.

- Environmental Management Plan
- Plan and implementation of management measures during construction works
- Completion and Verification Report

Final report detailing all risks, work undertaken in risk management and sampling, monitoring or otherwise to verify that the construction and development works have met the required objectives.

Managing Common Risks
Public infrastructure components within the SDZ area, include roads, tramways, services, pavements, quay-sides and parks. These are areas of land usually located between the private plots. It is possible that contamination could migrate from the private plot areas to public spaces and may present a potential future risk.
A management strategy is required to manage potential risk associated with common areas including:
• Development of a procedure to manage future excavations relating to services and/or infrastructure; and
• Review the development risk management options to ensure that the migration of contamination resulting from historical or construction activities is managed.

Information Management
Given the large number of references and publications as well as the numerous site investigations, remediation works, and waste licences relating to the study area, it is recommended that all the documents are site referenced, kept, maintained and managed centrally. This is particularly important if future developments need to rely on previous work undertaken and also to ensure that future work activities are co-ordinated.

Baseline for Environmental Assessment of Contamination and Remediation

Volume 2

AS PART OF PREPARATION OF THE

STRATEGIC DEVELOPMENT ZONE
PLANNING SCHEME
FOR
POOLBEG WEST
(SI No. 279 of 2016)

for: **Dublin City Council**

Civic Offices

Wood Quay

Dublin 8

by: **CAAS Ltd.**

2nd Floor, The Courtyard,

25 Great Strand Street,

Dublin 1

January 2017

Sources of Baseline Information to support the Environmental Assessment of Contamination and Remediation

These lands and their surroundings have been the subject of extensive previous site investigations and reporting. Three sets of reports summarise all of the most relevant investigations and findings. These reports – which are reproduced in full in the following pages - are as follows:

1. Site Description of IGB Site ARUP, 2016 Site History and Surrounding Land Use

2. Section 7 of EIS for Dublin Docklands Development Authority Poolbeg Peninsula Planning Scheme – Geotechnical, Soils & Ground Conditions Malone O'Regan, 2009

3. Dublin Docklands Development Authority Poolbeg Peninsula Planning Scheme Geotechnical Report *Mott MacDonald Pettit May 2008*

1. Site Description of IGB Site ARUP (2016)

Site History and Surrounding Land Use

The IGB site originally formed part of Dublin Bay. Historic maps from the National Library of Ireland show that the original shore line ran close to the Beach Road/Irishtown Road line. Ringsend was reclaimed early in the 19th century as the South Docklands continued to develop in an easterly direction along the banks of the River Liffey.

Dublin Corporation operated a landfill at Ringsend post-1948 to 1978, on reclaimed land forming the Poolbeg Peninsula. Dublin Corporation maps indicate that the infill material was predominantly domestic waste.

IGB production operations commenced at the site in 1967 and ceased in 2006.

A photograph of the pre-remediated site is provided below.

Photograph 1: Aerial Photograph of the Irish Glass Bottle Site prior to remediation

Site Description and History

Site Decommissioning, Demolition and Remediation (DDR) works were completed at the former Irish Glass Bottle facility between December 2007 and December 2008. The DDR works were designed to remove all vestiges of plant, buildings, operations and ancillary services associated with glass bottle manufacture at the facility in order to facilitate surrender of the site IPC Licence from the EPA. The DDR works were carried out with cognisance to **the site masterplan** which involved redevelopment of the site as a mixed use development.

Throughout the decommissioning, demolition, and remediation works on site, special consideration was given to the fact that the site was situated on an old landfill.

In particular the remediation strategy and remediation site specific target levels (SSTLs) were designed with reference to the scenarios allowed for in the site development masterplan, specifically in relation the necessary levels of excavation required to facilitate site redevelopment. The principles taken into consideration in designing the formation dig level are described below:

- The site's proximity to the sea and the possible influence of global warming effects was considered. As such the site nominal 'ground' levels were designed to be an order of 1 to 2 m higher than historical levels.
- An excavation level of nominally 2 m was chosen to ensure removal of all IGB production facility buildings and infrastructure.
- The provision of basement space, beneath the future proposed mixed use development for car-parking and ancillary services was chosen as a method to create a wide (and ventilated) physical barrier between the existing legacy fill and the future habitable space of the new development. This option allowed for leaving deeper deposits of the legacy landfill in place, hence reducing the quantity of waste that required export and disposal. This also ensured that large quantities of fill material would not require to be imported to the site for future development. This option created the most environmentally sustainable solution.
- Inert material produced during the demolition and excavation activities was re-used onsite where possible as crushed capping material and for establishing road footprints. This minimised the quantity of waste disposed off site and was in keeping with the EPA published "National Hazardous Waste Management Plan 2008-2012".

The site remediation works were completed with a view that no further remediation would be necessary and any additional protection measures required for future site development would be those normally implemented in the redevelopment of such brownfield sites.

The Decommissioning, Demolition and Remediation works rendered the site to a position where all traces of the licensed facility and a proportion of the legacy landfill (approximately 2 m depth) was removed from the site. Licence Surrender was granted from the Environmental Protection Agency in October 2009.

The site has remained dormant and undeveloped since this time frame.

Remediation Works

Upon completion of the decommissioning, demolition and remediation works at the site in December 2008, the site was closed and remote security was implemented. These works rendered the site to a position where all traces of the licensed facility and a proportion of the legacy landfill had been removed from the site. It was recognised that the residual material in place in the current remediated site comprised of consolidated domestic refuse and therefore appropriate and conservative protection measures were taken into consideration. As such, the site was covered with an inert capping layer ready for re-development.

The site layout reflected the proposed development plan for the site in terms of positioning of earthen roads and the positioning of services required for future site works. The current site condition also addressed the fact that planning for the proposed development was not in place at the time of licence surrender so the site would remain in an interim state until future development works commenced.

The site layout in this interim condition is described below.

Formation Capping Layer

A capping layer of 300 mm thickness is in place over the excavated landfill material on site. This ensures that site users in the interim condition are not directly exposed to landfill material. The material for the capping layer was provided by site won hardcore and on-site crushing of brick/concrete produced during the demolition phase of works on site. All surplus crushed material was stockpiled on site.

Perimeter Berm

The site excavation profile developed with cognisance to the proposed development plan for the site, allowed for a 7.5 m wedge to be left in place around the perimeter of the site. There are a number of major utility pipes and cables running close to the site boundary along Sean Moore Road and South Bank Road which have not been disturbed by virtue of leaving this berm in place. A slightly wider berm area was allowed for at the site entrance, due to the recessed position of the site entrance gates.

The sides of the berm incline at a slope of 1:2.5 into the excavation and are capped with a cover of 300 mm of crushed site won material. The material within the berm is similar to the material removed from elsewhere within the site during excavation, and consists of residual legacy landfill material.

A photograph of the perimeter berm and capping layer in place is provided below.

Photograph 2: site condition showing the perimeter berm

Services

The original site services (such as water and electricity supplies and foul sewer connections) were moved and terminated at the site boundary ready to facilitate future development requirements. The site heavy fuel oil supply line was plugged and terminated at the site boundary.

Build Up of Road Footprints

The lower level footprints of four earthen roads were formed on site during excavation works on site. These northwest-southeast trending road footprints have a finished level of +3.5 m OD and are capped with 300 mm of crushed stone.

The formation of the road footprints in these locations were in line with the design principles set out in the proposed masterplan for the site.

Stockpiles

A number of stockpiles of site won crushed material, produced during the demolition works remain on site for future use in site development. It was intended that this material will be re-used on site, and would not be removed from site.

Photograph 3: Aerial photograph indicating the rood footprints and stockpiles present

In order to surrender an IPC Licence a number of conditions must be satisfied. These conditions are stipulated in Section 95 of the Environmental Protection Agency Act 1992 as amended by the Protection of the Environment (PoE) Act 2003 (the "EPA Act 1992 as amended").

Firstly the licensed activity or installation must be considered. The PoE Act requires that the EPA must be satisfied that the particular activity is "not causing or likely to cause environmental pollution". In response to this requirement, a CRAMP (Closure, Restoration and Aftercare Management Plan) for the IGB site was agreed with the EPA.

In addition to the licensed activity, surrender of an IPC Licence also requires consideration of the site on which the licensed facility is located. The PoE Act stipulates that the EPA must be satisfied that the "site of the activity is in a satisfactory state" in order to accept licence surrender. The Quantitative Risk Assessment prepared for the site end use scenarios addressed this requirement.

Closure, Restoration and Aftercare Management Plan

The Closure, Restoration and Aftercare Management Plan (CRAMP) [1] for the IGB site documented the site conditions and mapped the path to clean closure of the site. The plan fully described the methodology to be used in each of the decommissioning, demolition and remediation phases of the works on site. The plan stipulated that the remediation strategy was linked to the future development site masterplan and addressed the elimination of risk from the underlying legacy landfill material; allowing the reuse potential of the site to be maximised.

Extensive environmental monitoring and validation was carried out throughout each of the phases of works on site. The success of the CRAMP was confirmed through a validation sampling process in order to demonstrate that no potential residual impacts of the IGB operations remained at the site. This validation sampling formed part of the Site Specific Quantitative Risk Assessment, which is described below.

Site Specific Quantitative Risk Assessment

The CRAMP specified the development of a site specific quantitative risk assessment for the site in terms of the end use scenarios. These end use scenarios comprised of:

- the current remediated site in its interim condition ready for site development.
- future construction and development plans for the site (as based on the understanding of the masterplan at the time)

The contaminants present and potential pathways for exposure were considered for both end use scenarios.

The CRAMP also recognised that future development at the site would require additional site specific risk assessments.

Validation Sampling

Validation sampling was carried out throughout the remediation works to:

- confirm that all vestiges of the IGB glass manufacturing operations had been removed from the site,
- determine the quality of the residual material in the underlying domestic landfill, and;
- validate the protection measures for the external environment and future site users.

The validation sampling process was also intended to provide data for any future risk assessments required under the statutory planning process, for the design of building protection measures in the future site development.

Site Specific Target Levels (SSTLs) were developed based on the understanding of the redevelopment masterplan in place at the time. Site-Specific Target Levels (SSTLs) are “clean-up” standards, calculated on the basis of site-specific information and parameters. SSTLs represent the mean concentration, in soil or groundwater that will prevent unsafe exposure to human or environmental receptors.

The derived SSTLs were compared to the contaminant concentrations detected on site to assess the need for response action. If the concentrations of a contaminant were found to be above the SSTL then an action plan would be developed to address this.

The laboratory analyses received for the validation sampling were compared to the Site Specific Target Levels (SSTLs) for both the current interim site status and required protection measures for the proposed future development.

This data demonstrated acceptable results for the specific design stipulations and no additional remediation was required.

2. Section 7 of EIS for Dublin Docklands Development Authority Poolbeg Peninsula Planning Scheme – Geotechnical, Soils & Ground Conditions Malone O'Regan, 2009

7.0 Effect on the Environment: Geotechnical, Soils & Ground Conditions.

7.1 Introduction.

7.1.1 This chapter has been prepared by Malone O'Regan and discusses the existing soils, geology and general ground conditions as well as providing an overview of existing contamination of the Draft Planning Scheme Area. The chapter also addresses the potential impacts of the Draft Planning Scheme at Poolbeg Peninsula on the soils and geology and the mitigation measures that may be employed to reduce/ eliminate potential impacts where necessary. Furthermore, this chapter identifies contaminants that have the potential to impact on human health or the environment.

7.2 Assessment Methodology.

7.2.1 A desk-based study of the Draft Planning Scheme Area was conducted which involved reviewing available geotechnical information held by the Geological Society of Ireland (GSI) and others on the area. The following sources were identified and reviewed during this assessment:

- Published Ordnance Survey mapping to assess the surface topography and landforms.
- Soils maps of Ireland.
- The *Dublin Docklands Area Strategic Environmental Assessment* of the *2008 Draft Docklands Master Plan.*
- Depth to bedrock data and other quaternary information obtained from the Geological Survey of Ireland (GSI) Geotechnical Map viewer from previous ground investigations.
- Geology of Kildare-Wicklow – GSI Publication.
- Existing geotechnical reports prepared for sites within and adjacent to the Draft Planning Scheme Area were also reviewed including available reports from the Dublin Waste to Energy Project, Fabrizia and Irish Glass Bottle development sites (See Section 7.7 References).

7.3 The Receiving Environment.

7.3.1 *The Draft Planning Scheme Area - Historical Background and Uses.*

7.3.1.1 The eastern edge of the Draft Planning Scheme Area was first used in 1903 to generate electricity in Pigeon House. Land further to the east was subsequently reclaimed where Poolbeg Power Station, powered by oil, was opened in 1971.

7.3.1.2 Lands to the west were historically used by Dublin City Council as a landfill. The Irishtown Tip Head, which was reported to have commenced operation in 1948, was closed and capped in 1978. It is reported that the landfill was worked in a sequential fashion, with landfilling activities moving in an easterly direction over time (AWN, 2004). Following capping of the former landfill area around 1978, lands to the west of the overall development lands were leased to Irish Glass Bottlers (IGB) Ltd. until 2004. The IGB plant was also built on part of this landfill.

7.3.1.3 The central area of the site was and is currently used for the tank storage of molasses and oil. Other areas of the site were used by Dublin Port for storage and other associated port-related activities.

7.3.1.4 Currently a redundant and overgrown pitch and putt course is located within ESB lands while a rowing clubhouse is also situated in the centre of the scheme area. Three concrete production facilities and a scrap metal works also currently operate in the Scheme area.

7.3.2 *Ground Conditions – General.*

7.3.2.1 The general ground conditions and geology are outlined in the Dublin Docklands Area *Strategic Environmental Assessment* of the *2008 Draft Docklands Master Plan.* Much of the subsoil in the Draft Planning Scheme Area is made up of made ground overlying recent marine deposits of mixed silts or clays and fine sands and glacial and fluvio glacial deposits of sands and gravels with some cobbles and boulders in places. This is underlain by glacio-marine deposits of sandy clays with some silt and sand layers overlying weathered rock of boulders, cobbles, gravels, clays and silts on strong, dark grey, mostly thinly bedded, fine grained carboniferous limestone bedrock (Arup, 2006).

7.3.3 *Made Ground/ Fill Material*.

7.3.3.1 The made ground within the Draft Planning Scheme Area consists of distinct types of material which include the municipal waste filled as part of the Irishtown Tip Head (1945-1978) and general construction and demolition (C&D) waste. It is also reported that hydraulic fill material was used to reclaim distinct areas of the site (Arup, 2006).

7.3.3.2 Mott MacDonald Pettit (2008) report that site investigations in the Poolbeg area have previously logged made ground as being 1.6 to 5.6m in thickness. The Mott McDonald Pettit Report (2008) is contained in Appendix 7.1. Typically, builder's rubble and similar dry fill were used to construct roads at locations to the west of the peninsula; landfill material was then tipped on either side of the roads.

7.3.3.3 Historically, the Fabrizia and IGB sites were constructed upon part of a Dublin Corporation landfill. It is understood that the general public also dumped refuse in this area during this period. The domestic and other waste beneath this site is expected to have been in the ground for somewhere in the region of 30 to 50 years. No soil gas venting or collection systems were installed on these sites during operation or after closure. Therefore landfill gas could potentially be still present (see further comment under Section 7.3.7).

7.3.3.4 There are no records available as to the exact types and quantities of materials which were dumped at the different sites across the Draft Scheme Area. However, from an examination of the trial pit logs and boreholes from site investigations carried out on the Fabrizia and IGB sites and from a review of a geotechnical assessment report produced by Mott MacDonald Pettit (2008) it would appear that much of the fill comprised of domestic and Construction and Demolition (C&D) waste. The composition varied greatly but commonly consist of a mixture of gravels, sands, silts, clays, rubble, bricks, concrete, glass, timber, concrete slabs, cabling, piping, rags, metal household containers and cinders (non-exhaustive list).

7.3.4 *Quaternary Deposits.*

7.3.4.1 Superficial soils have been well mapped in the Poolbeg area from the quantity of site investigations that have been undertaken. A review of the Geological Survey of Ireland (GSI) Geotechnical Map viewer and available geotechnical reports provided information on the thickness of superficial sediments and their composition within the Draft Planning Scheme Area.

7.3.4.2 According to the Geotechnical Report for the Poolbeg Peninsula Planning Scheme (Mott MacDonald Pettit, 2008), the soil overlying the limestone bedrock consists of a relatively thin layer of brown slightly silty or clayey gravel, with cobbles and/or boulders. This is overlain by over 20m of material consisting of stiff dark grey or black slightly sandy clay with layers and laminations of silt and silty sand overlain by silt with sand laminations. Above this is a layer over 10m deep of sands and gravels with occasional cobbles and boulders. This layer is occasionally silty in nature. Overlying the drift geology, the next layer consists of marine or seabed deposits up to 2.5m thick. There is also evidence of riverine deposits from the Liffey and Dodder. This layer generally includes soft or loose to medium dense sandy silt and slightly clayey/ silty fine sand including shell fragments and some fine gravel. Some silty clays are also encountered at this level but these are less common.

7.3.5 Bedrock.

7.3.5.1 The Geological Survey of Ireland (GSI) has published maps (at a scale of 1:100,000) and memoirs of the bedrock geology, Sheet 16 of which covers the Poolbeg Peninsula in which the Draft Planning Scheme Area is located. The sheets show the rock formations which are interpreted to be present below the surface drift deposits. The bedrock geology of Dublin is dominated by rocks of carboniferous age, and the scheme area is underlain by Calp Limestone (Dinantian Upper Impure Limestones). There are a number of faults in the Calp limestone however studies show that the area under review is unfaulted.

7.3.5.2 The geological map indicates that the Calp Limestone itself is comprised of dark grey to black limestone with shales. While the top 1m or so layer of rock is weathered, the overall mechanical strength is described as strong to very strong (Mott MacDonald Pettit, 2008).

7.3.5.3 Bedrock on the Peninsula lies between 30 and 50m below ground level. The deepest rock is in the central area with slightly shallower rock at the tip of the Peninsula and around Sean Moore Park and the IGB/ Fabrizia sites.

7.3.6 Landfill Gas.

7.3.6.1 As discussed in Section 7.3.1, part of the Poolbeg Peninsula was formerly used for the disposal of significant quantities of municipal solid waste, a portion of which is biodegradable and which biodegraded anaerobically to form methane gas and carbon dioxide and small quantities of hydrogen sulphide. Landfill gas production levels generally peak between 5 and 20 years after closure of a landfill and decline thereafter. However, landfills may continue to produce landfill gas for up to 50 years after closure. Landfill gases can pose a risk to human health and the environment at specific concentrations and depending on the site use if the necessary mitigation measures are not imposed including the requirement for a detailed risk assessment.

7.3.6.2 Landfill gas surveys completed in 2004 indicate that some areas on the Peninsula (e.g. south of the Fabrizia site) are continuing to produce methane gas. However, overall methane gas production levels are quite low, and have declined between 1999 and 2004. While flow from an active landfill can be as high as 50 litres/hour, gas flows of up to 0.8 litres per hour were recorded in some boreholes during an investigation of the Fabrizia site in 1999, which decreased to 0.1 litres per hour in 2004 indicating that gas production had declined (AWN, 2004).

7.3.6.3 The Department of the Environment (DOE) published guidelines in 2004 titled *'Protection of New Buildings and Occupants from Landfill Gas*'. The guidance document specifies limits of 1.5% v/v methane and 0.5% v/v carbon dioxide. Specialist engineering design must be used when constructing buildings on lands in excess of these limits. The DDDA will ensure that

landfill gas risk assessments and mitigation measures are taken into account for any development where the presence of landfill gas is suspected.

7.3.7 *Contamination.*

7.3.7.1 In recent years a number of site investigations were undertaken within the Poolbeg Peninsula area that involved the installation of boreholes and trial pits and associated soil sampling (both within and outside of the Draft Planning Scheme Area). The results showed concentrations of contaminants at elevated levels reflecting the filling activities and industrial history of the area. Reports from sites within the boundary of the Draft Planning Scheme Area and adjacent to it have been briefly reviewed in terms of contamination found and a factual summary of the findings presented in the reports are outlined in Sections 7.3.8 – 7.3.10 below.

7.3.8 *Fabrizia Site.*

7.3.8.1 AWN Consulting completed the soil and geology assessment of the Environmental Impact Statement (EIS) which accompanied the 2004 mixed use office, residential and supportive retail facilities proposal on the Fabrizia site. Reports indicate that there is 3.0-3.5m of domestic refuse and builders rubbles beneath 1m of topsoil (landfill cap) consistent with reports that the Irishtown Tip Head is located within that area. The waste identified included timber, bricks, concrete slabs, cabling, piping, rag and metal household product containers.

7.3.8.2 According to Appendix 14 of the Fabrizia EIS, in addition to the main site investigation (which was not available for review as part of this assessment), a site investigation was also carried out at the Fabrizia site in 1999 due to a suspected oil leak. The report identified the presence of gasworks waste as well as elevated concentrations of Polycyclic Aromatic Hydrocarbons (PAHs). Appendix 14 of the Fabrizia EIS is contained as Appendix 7.2.

7.3.8.3 Trial pits excavated at the Fabrizia site also highlighted some localised hydrocarbon contamination, notably in the north east corner. Some additional isolated contaminated areas (mainly metal contamination) were also identified at the site and some asbestos fibres noted in some of the trial pits. In general, asbestos fibres pose a risk if they become airborne. These potential risks may be mitigated against by a construction management plan, appropriate risk assessments and the implementation of any required remedial measures.

7.3.8.4 Landfill gas investigations also determined that landfill gas was still being produced at the site (AWN, 2004) and reported maximum concentrations of methane and carbon dioxide detected of 23.1% and 29.2%, respectively. It is clear from the limits detailed in Section 7.3.6.3 above that the levels recorded in 2004 exceed the DOE limits for methane and carbon dioxide of 1.5 % and 0.5 %, respectively; therefore further assessment of landfill gas production and remedial engineering design measures would be required prior to development based on those concentrations.

7.3.9 *IGB Site.*

7.3.9.1 A number of investigations and assessments were carried out at this site in 1996 (K.T. Cullen & Co.), 2005 (GES) and 2007 (Arup Consulting Engineers). The report produced by K.T. Cullen & Co. Ltd. (1996) was available for review. Consistent with general information for the Poolbeg Peninsula area, the site investigation indicated that the entire site had been constructed on a former landfill. It is reported that the overburden profile consists of up to 7.0m of backfill material consisting of rubble, plastic, timber, rocks, bricks, glass jars, paper, clay, sand and hardcore.

7.3.9.2 Analytical results were compared against the Dutch Intervention Values (RIVM, 2000). These intervention values represent the level of contamination above which there is a serious case of soil contamination. If the Intervention values are exceeded, clean up should be considered (unless and subsequent site specific risk assessment proves others) (Arup, 2006). Analytical results indicated that the material beneath the site was contaminated with varying levels of hydrocarbon, arsenic, lead, mercury and PAHs in excess of the Dutch I values (K.T. Cullen & Co., 1996).

7.3.9.3 There were no reports on landfill gas available for review with regards to the possible presence of landfill gas at this site.

7.3.10 *Proposed Waste-to-Energy Site.*

7.3.10.1 Arup Consulting Engineers carried out a desk based review (2006) of the site investigations that were undertaken at the proposed Dublin Waste to Energy Site in 2003 (Geotech Specialists Limited) and 2005 (RPS). This site is outside the Draft Planning Scheme Area, however the report gives further details on the general fill and contamination within the area and contains details on adjacent sites within the Draft Planning Scheme. The site investigations determined that in general made ground was 1.6m to 5.6 m thick across the site and consisted of a mixture of gravels, sands, silts, clays, rubble, bricks, concrete, glass, timber and cinder.

7.3.10.2 Analytical results were compared against the Dutch Intervention Values (RIVM, 2000). The results showed that the fill materials across the site showed evidence of hydrocarbon contamination, lead, copper and zinc at varying concentrations.

7.3.10.3 Landfill Gas: Elevated landfill gas concentrations at the adjacent site (south of the proposed Waste to Energy site and west of the nature reserve) were reported from monitoring carried out in 1997. Methane concentrations of 27-59% and carbon dioxide concentrations of 22-32% were reported. It is clear from the limits detailed in Section 7.3.6.3 that the levels recorded in 1997 exceed the DOE limits for methane and carbon dioxide of 1.5 % and 0.5 %, respectively; therefore further assessment of landfill gas production and remedial engineering design measures would be required prior to development based on those concentrations.

7.4 Relevant Characteristics of the Draft Planning Scheme.

7.4.1 *Construction Phase.*

7.4.1.1 The earthworks and construction phase will at a minimum involve contaminated soil disturbance and may potentially involve contaminated soil removal for design purposes (i.e. the construction of basements) or for risk assessment purposes (i.e. removal of contaminated material that exceeds a human health and environmental risk assessment) pending further site investigation and/or risk assessment.

7.4.1.2 A full geotechnical assessment will be required for each potential development site before detailed foundation design can be carried out. It is considered that conditions may not be favourable for conventional strip or raft foundations and therefore, it is likely that extensive piling will be required for significant building (Mott MacDonald, 2008).

7.4.1.3 There is a possibility that parts of the Peninsula might be filled in order to raise the levels. If this does happen, it may be possible to use soil stabilisation techniques as an alternative to deeper piles (Mott MacDonald, 2008). However, a full geotechnical assessment would need to be carried out before this could be considered further.

7.4.2 Operational Phase.

7.4.2.1 Given the nature of the development, the impact on existing soils arising from the Draft Planning Scheme in the long term is not expected to be significant. Heating will be via district or gas heating systems and therefore the potential for further soil contamination is limited.

7.5 Likely Impacts of the Draft Planning Scheme.

7.5.1 The potential impacts of the Draft Planning Scheme on soils and geology during the construction and operational phases are outlined below. The potential impact of contaminated land on groundwater and surface water is identified in Chapter 8.0 which deals with this topic. The potential impact of the presence of contaminated soil on human beings is identified below.

7.5.2 *Construction Phase.*

7.5.2.1 The bedrock on Poolbeg Peninsula is too deep to be impacted by the proposed Planning Scheme during the construction phase, even if piling operations are required.

7.5.2.2 As with all construction sites, there is the potential for contamination of soils by waste oil, fuel, chemical spillages etc. used during the construction stage. Mitigation measures are described below to address these potential concerns.

7.5.2.3 In case of excavation in areas where contaminated soil is present on site there is a risk of exposure and mobilisation of contaminants into clean soil.

7.5.2.4 Landfill gases and contaminated soils encountered during excavation works have also the potential to represent a risk for site workers and surrounding areas.

7.5.2.5 The potential impacts will be mitigated as described under Section 7.6 below.

7.5.4 Operational Phase.

7.5.4.1 In the long term, there is the potential for further contamination of existing soil as a result of run-off from surface and underground car parking areas and other paved areas across the site. Mitigation measures are outlined below to address this particular issue.

7.5.4.2 In addition, leakage from sewage pipelines could potentially contribute to heavy metal and bacterial contamination of subsoils which could then impact on the adjacent water bodies. Impacts on water are discussed in Chapter 8.0 – Water of this EIS.

7.5.4.3 Contaminated soil present could potentially affect future occupiers if pathways from the source of the contamination to the receptors (future occupiers) are present. Mitigation measures are described under Section 7.6 to prevent this occurrence.

7.5.4.4 Landfill gas could potentially migrate from undeveloped to developed areas. Mitigation measures to prevent this occurrence are described below.

'Do Nothing' Scenario.

7.5.4.5 The 'Do Nothing' scenario would not realise the potential to remediate areas of Poolbeg Peninsula compared to the 'Do Something' Scenario or the Draft Planning Scheme proceeding.

7.6 Mitigation.

7.6.1 Suitable remedial and mitigation measures which should be put in place during both the construction and operational phases are outlined below.

- Further site specific investigations and contaminated land risk assessments for construction and future users should be conducted in accordance with the standards for site investigation notably BS5930: 1999 'Code of Practice for Site Investigations' and

BS10175: 2001 'Investigations of Potentially Contaminated Sites – Code of Practice'. Specialist risk assessment practitioners should be employed to evaluate all potential risks to human beings or the environment prior to construction commencing.

- Contamination that is encountered within the Draft Scheme Area should be assessed against remedial targets derived from a site specific risk assessment and may require some form of intervention depending on the levels of contamination encountered and the recommendations derived from the risk assessment carried out at each site. This should be undertaken prior to any development works taking place.
- Furthermore, the *Dublin City Development Plan 2005-2011* indicates that where the previous history of a site suggests that contamination may have occurred, then developers will be responsible for undertaking a detailed site survey and analysis to establish whether contamination has occurred, as well as providing a detailed written report of the survey and assessment with recommendations for treating the affected ground.
- The DDDA will prohibit development until it is satisfied that the affected ground and any associated risks have been satisfactorily remediated.
- Remediation measures involving the excavation, removal or disposal of contaminated soil, where required, will be completed in accordance with the requirements of the *Waste Management Act 1996* and all subsequent regulations and standards that are current at the time the work is carried out.
- Design of all commercial and residential buildings will comply with current and relevant Building Regulations and any subsequent regulations, amendments and standards that are current at the time the work is carried out.
- Landfill gas emissions where observed on site will require suitable engineering design for gas mitigation and control at design stage. Soil gas barrier systems may be required to protect new buildings from adjoining undisturbed landfill areas.
- In order to minimise the potential for spillages to drains and possibly further to subsoils, all roadways will be effectively sealed with surface water discharges draining to sealed surface water drains. Similarly any run-off collecting in subterranean basement car parking areas – including run-off from oil, leaks, spillages or other sources – will also be collected in a sealed foul drainage system (see also Chapter 8.0 – Water for other related mitigation features).
- Developers will be required to draw up Construction Management Plans detailing protection measures for human health and the environment during construction including measures for waste management, soil handling, water run-off etc.

7.7 References.

Dublin Docklands Area Strategic Environmental Assessment of the Draft Master Plan, 2008.

Dublin Waste to Energy Project, Ringsend, Dublin, Chapter 11, Appendix 11.1 Geo-Environmental Engineering Assessment, Arup Consulting Engineers, Elsam, June 2006.

Mixed Use Office and Residential and Supporting Retail Facilities Development at South Bank Road, Ringsend, Dublin 24 for Fabrizia Developments, Environmental Impact Statement, Reid Associates, 2004.

Geology of Kildare - Wicklow: A Geological Description, with accompanying Bedrock Geology 1:100,000 scale map, Sheet 16, Kildare – Wicklow, McConnell and Philcox, 1994.

Poolbeg Peninsula Planning Scheme Geotechnical Report, Mott MacDonald Pettit, May 2008.

Dublin City Development Plan 2005-2011.

Proposed Development at Irish Glass Bottle Company Ltd. South Bank Road, Ringsend, Dublin for Becbay Ltd., Ground Investigation – Factual Report, Arup Consulting Engineers, August 2008.

Soil & Groundwater Quality Investigation, Irish Glass Bottle Ltd. Dublin 4 for Irish Glass Bottle Ltd. South Bank Road Irishtown Dublin 4 – KT Cullen & Co. Ltd, July 1996.

7.8 Appendices.

Appendix 7.1 Mott MacDonald Pettit Geotechnical Report for Poolbeg Peninsula Planning Scheme, May 2008.

Appendix 7.2 Appendix 14 "*Investigation of Possible Oil Leak at South bank Road, Ringsend, Dublin*" from the 2004 EIS for the Fabrizia Mixed Use Proposal.

3. Dublin Docklands Development Authority Poolbeg Peninsula Planning Scheme Geotechnical Report *Mott MacDonald Pettit May 2008*

Dublin Docklands Development Authority Poolbeg Peninsula Planning Scheme Geotechnical Report

1. Introduction

Mott MacDonald Pettit has been appointed by Dublin Docklands Development Authority as Infrastructure Consultant for the Poolbeg Peninsula Planning Scheme. Part of the remit is to provide a preliminary, desk based Geotechnical/ Contaminated Land assessment. This is required to provide geotechnical and environmental advice in relation to ground conditions and potential contamination and to identify measures that may be necessary to support development proposals. It should be noted that a more detailed contaminated land assessment will be undertaken as part of the Environmental Impact Statement for the Planning Scheme. This document does not propose to duplicate that process but to highlight key contamination issues and the engineering implications of these. It also sets out to give a brief overview of geotechnical conditions on site and the effects these will have on buildings/ foundations etc. Finally, this report will make recommendations as to future studies that may be required during the detailed design process. This report is intended as a desktop overview only and should not be relied upon for foundation design or even planning stage assessment. Any development proposed in this area will require a detailed geotechnical assessment, including a full site investigation, before design can commence.

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2. General

The proposed redevelopment site located at Poolbeg Peninsula is an area which consists mainly of reclaimed land. Soils in this area show the influence of glaciers, the sea and Liffey and Dodder Rivers. Up until the 1900's much of this area was in fact part of the foreshore before a series of reclamation projects gradually began filling the area. Fill consisted of both inert material, including material dredged from the seabed, and domestic waste. In particular, much of the Peninsula was used as a domestic landfill up until 1978. Analysis of soil samples suggests that the primary use of the landfill was domestic rather than industrial but the possibility of some industrial materials having been dumped there cannot be ruled out. Ashes from the power stations and by products from the nearby town gas manufacturing plant have also been encountered. This history of the site raises both geotechnical and contamination issues. The area is surrounded on three sides by the sea, meaning that high ground water levels are likely. The nature of soil conditions in the area means that detailed site specific information will be required for foundation design.

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3 Existing Conditions

3.1 Bedrock Geology

This is the geology of the solid rock which underlies the ground surface and overlying soils on the Peninsula. The Geological Survey of Ireland has produced a 1:100,000 Bedrock Geology series of maps for the country, Sheet 16 of which (Geology of Kildare – Wicklow) covers the Poolbeg Peninsula. Bedrock on the Peninsula lies between 30 and 50m below ground level. The deepest rock is in the central area with slightly shallower rock at the tip of the Peninsula and around Sean Moore Park and the IGB/ Fabrizia sites. The bedrock in this region consists of sedimentary rocks that are assigned to the Calp Formation of the Carboniferous era (also referred to as Dinantian Upper Impure Limestones). The geological map indicates that the rock in this area is comprised of dark grey fine grained limestones with

interbedded shales. While the top 1m or so layer of rock is weathered, the overall mechanical strength is described as strong to very strong. Given the depth of this rock, it is unlikely to have a direct effect on construction being too deep to require excavation and also too deep for either piles or traditional foundations to bear on it.

3.2 Drift Geology

This is the geology of all mineral material (clay, sand, silt, boulders) transported by a glacier and deposited directly by or from the ice, or by the flow of melt water from the glacier. The drift geology of the Poolbeg area consists mainly of deposits from the last glaciation period. Typically, these materials would have been deposited either beneath an advancing glacier or along its side as a moraine. As glaciers melted, further deposits were laid down by melt waters discharging from the front of the glacier. There is evidence that materials in this area have been modified by the typical marine processes of erosion and deposition prior to the recent period of reclamation. Drift deposits are overlain in places by marine materials which were deposited near the coastal fringes. The soil overlaying the limestone bedrock consists of a relatively thin layer of brown slightly silty or clayey gravel, with cobbles and/or boulders. This is overlain by over 20m of material consisting of stiff dark grey or black slightly sandy clay with layers and laminations of silt and silty sand overlain by silt with sand laminations. Above this is a layer over 10m deep of sands and gravels with occasional cobbles and boulders. This layer is occasionally silty in nature.

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3.3 Marine Deposits

Overlying the drift geology, the next layer consists of marine or seabed deposits up to 2.5m thick. There is also evidence of riverine deposits from the Liffey and Dodder. This layer generally includes soft or loose to medium dense sandy silt and slightly clayey/ silty fine sand including shell fragments and some fine gravel. Some silty clays are also encountered at this level but these are less common.

3.4 Made Ground

There are different types of made ground in the proposed redevelopment area. Inert fill essentially builders rubble or similar, has been placed either as part of the construction and development of the area or has been placed as part of the reclamation project from the sea. Dredged material from the seabed has also been used as fill. Site investigations in the Poolbeg area have previously logged made ground as being between 1.6m and 5.6m in thickness The composition of the made ground in the area is highly variable but commonly consists of a mixture of gravels, sands, silts and clays, including rubble, bricks, concrete, glass, timber and cinders from the Powerstation. The presence of made ground and the frequent industrial usage of land in the Poolbeg area means that hotspots of soil contamination are quite likely to be encountered. Hydrocarbon contamination has been encountered throughout the Peninsula and the history of local sites will give strong indications as to the kind of other contaminants that may be encountered there. In addition to areas being filled with rubble, large parts of the Peninsula have previously been used as a domestic land fill meaning that contamination associated with domestic wastes is certain in these areas. As stated previously, this area is not believed to have been commonly used for disposal of toxic industrial wastes though the possibility of this having occurred cannot be ruled out. Exact records of areas that were landfilled do not exist but it is known that the western part of the Peninsula was used and that the landfill may have extended as far as the Poolbeg Powerstation. The landfill practices at the time would not comply with modern standards for disposal of domestic waste.

3.5 Surface Material

There is a variety of different surface materials on the Peninsula from topsoil layers up to 1m deep to concrete or tarmacadam finishes. The Peninsula would have a relatively high impermeable area at this time. A lot of the surface water generated at the moment is likely to be discharging directly to the sea.
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3.6 Groundwater

Groundwater movement in the region is likely to move principally in the drift layers rather than the hard limestone bedrock. The flow will also be restricted mainly to the sand and gravel drift layers since the stiff clay layers are less permeable. Given that the Peninsula is surrounded three sides by the sea and that no part of the Peninsula is more than 500m from the sea, tide levels will have a significant influence on groundwater. Previous studies suggest that groundwater is likely to be encountered at depths of 2m to 4m below ground level – i.e. tying in with high tide levels. It has been suggested that this may be a perched aquifer with a deeper bedrock aquifer below this. This seems unlikely but a more detailed hydrogeological assessment would be required to confirm this. The effect of the sea is also seen in groundwater quality. Saline intrusion is likely meaning that the water is likely to be brackish. The shallow depths of soil cover over the groundwater table means the groundwater in the area would be classified as highly vulnerable. This combined with the industrial history of the area means that much of the groundwater in the area is likely to be polluted. Previous studies have confirmed this. The Final Characterisation Report of the Eastern River Basin District says that the Dublin City water body is one of only two groundwater bodies in the entire Eastern River Basin District that is classified as being "At Risk of not reaching good status". In the Poolbeg Peninsula area, the abstraction of groundwater for drinking water or other purposes is unlikely to happen in the foreseeable future. However under the EU's Groundwater Directive, there is a requirement to improve groundwater quality regardless of whether or not it is ever intended to use it. Remediation measures associated with the proposed works may lead to some improvement in groundwater quality but should certainly lead to no reduction in quality.
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4. Implications

4.1 Bedrock Geology

Bedrock on the Peninsula is between 30m and 50m deep. This means that it will have little direct affect on construction. The rock is too deep for it to affect excavations, even if particularly deep excavations were to be required. It is also too deep for either direct foundations or even most conventional piles to bear directly onto the rock.

4.2 Soil Types

The soil type in the area is very mixed and we must be very cautious in trying to make general comments. Full geotechnical assessment will be required for each potential development site before detailed foundation design can be carried out. This will include full site investigations and soil testing. It is known to date that a variety of soil types may be encountered on the Peninsula. These include gravel layers with cobbles and/or boulders and either stiff or sandy clays with laminations of silt/ sand. The upper layers consist of sands and gravels with occasional cobbles and boulders. Many of these layers would include silts and would generally include soft or loose materials. In addition to this there is a substantial amount of made ground. Geotechnical conditions in these areas could be very variable. While the stiff clays would appear to be favourable for construction, these are relatively deep and the presence of laminations means that the prediction of their behaviour should be carefully assessed. Layers close to the surface are likely to contain some softer material. The relatively high groundwater table, and the presence of permeable material, means that groundwater issues could be critical in

construction. This will be particularly relevant in the case of tunnels or deep excavations. The result of this is that conditions may not be favourable for conventional strip or even raft foundations. It is highly likely that any significant building anywhere on the Peninsula will require extensive piling. This is technically feasible but will impose costs on developers in the area. Some piling techniques involve the removal of material from deep underground. The use of these techniques may lead to an increased risk of encountering contaminated soil. Non piled solutions may well be used for roads/ pavements and the like. Where shallow foundations exist beside piled foundations, the risk of differential settlement should be considered. It is instructive to note that the buildings on the former IGB site were piled while surrounding pavements were not. This has lead to very obvious differential settlement on that site. There is a possibility that parts of the Peninsula might be filled in order to raise their levels. If this does happen, it may be possible to use soil stabilisation techniques as an alternative to deeper piles. There are a number of techniques available including the use of soil compaction, soil stabilisation using lime or other cementitious materials or the use of geogrids or geotextiles. A full geotechnical assessment would need to be carried out before this could be considered further.
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4.3 Contaminated Ground

Detailed assessments will need to be carried out on every site in the area to assess whether or not the soil and groundwater at that particular site is considered to be contaminated. In the absence of previous site investigations, these assessments are likely to include soil testing and interpretation. Indications at this stage are that some level of contamination can be expected in most areas of the Peninsula. This is due to the previous history of landfilling and reclamation and the many heavy industrial uses that have been in place on the Peninsula. The extent of contamination is likely to vary widely and there are a number of options for dealing with contaminants, depending on how serious the problem is at any particular location. The worst case scenario will be that soil may need to be removed from site and treated/disposed of elsewhere. Low level contamination can be dealt with in Ireland depending on the soil's classification in the European Waste Catalogue. Material could only be transported from the site by a specialist firm who hold a collection permit under the Waste Management (Collection Permit) Regulations 2007. The material would have to be transported to a licenced facility relevant to that waste type. There is no facility in Ireland capable of dealing with seriously contaminated/ hazardous soil any such waste encountered would have to be exported. The removal of this waste would have to comply with the Waste Management (Shipment of Wastes) Regulations 2007. Any removal of contaminated material will have to be done in conjunction with the Environmental Protection Agency and Dublin City Council. Landfill gases are likely to be encountered at some sites with significant methane concentrations having been noted in previous studies. Provision may be required for either trapping or venting these gases. Any site investigation carried out on the Peninsula should include a requirement for gas monitoring. This will have health and Safety implications during the construction phase as there is a possibility of poisonous, explosive or asphyxiating gases filling trenches or other excavations. For less serious contamination, it may be possible to trap the contaminants using material such as dense, impermeable clays. Provision for venting of gases may still be required. It should be noted that this approach is only really practical if deep or extensive excavations are not required. There is considerable evidence of low level contamination with hydrocarbons across the entire Docklands area, including the Poolbeg Peninsula. These include total Petroleum Hydrocarbons and Polynuclear Aromatic Hydrocarbons (PAHs). These can come from oil or tar or from burnt tires or domestic waste. In some area, this material is in concentrations above intervention limits and may need to be removed off site or treated. In many areas it will not be sufficiently contaminated to require that level of treatment. However, hydrocarbons can have very significant impacts on water pipes particularly the modern High Performance Polyethylene (HPPE) pipes which are now commonly used. Hydrocarbons can migrate

through the walls of these pipes causing drinking water contamination. For this reason, pollutant resistant pipes are frequently specified in the Dockland areas. These would include, for example, aluminium lined HPPE pipes which are resistant to hydrocarbon ingress. These cost six times more than conventional HPPE but there is no impact on laying/ backfill costs so the overall cost difference is not that significant. There is a possibility that phenolic compounds and cyanide compounds associated with the manufacture of town gas could be encountered. Phenolic compounds are a particular concern as they can cause tainting of water in plastic pipes. There have been reports of high sulphate levels in parts of the Docklands including the Poolbeg Peninsula, meaning that Sulphate Resisting Cement may need to be considered on some sites. Volatile Organic Compounds have been detected in previous studies. These would include benzene which is a proven carcinogen, as well as xylene, toluene and ethylbenzene. Toxic metal including arsenic have been found in concentrations above intervention limits. Other heavy metals encountered included barium, chromium, mercury, nickel, lead and tin.
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4.4 Groundwater
Groundwater on the Peninsula is likely to be high in all areas. This will have impacts for construction as de-watering is likely to be required in any area where significant excavation is required. It should be noted that any groundwater that is encountered may need to be treated as contaminated water – i.e. direct discharge to the sea is unlikely to be an option. Thus, groundwater is likely to be pumped to the foul sewer network, subject to local authority permission, or be pre treated prior to discharge to the sea. In either case, an IPPC licence may be required from the EPA. The use of infiltration techniques for stormwater drainage may not be possible due to the high ground water table and to concerns about the possible mobilisation of subsoil contaminants. Soil conditions suggest that contaminants could move vertically downwards before being trapped by clay or silt layers. The possibility of mobilised contaminants reaching the sea would have to be considered. The possibility of contaminated groundwater infiltrating into new or existing stormwater pipes and hence flowing to the sea would also need to be considered. As groundwater in the area is tidally affected, the impact of climate change will include an increase in groundwater levels and this should be considered in carrying out geotechnical design on the Peninsula.
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5. Conclusions
The Poolbeg Peninsula is an area which consists mainly of reclaimed land. Up until the 1900's much of this area was in fact part of the foreshore before a serious of reclamation projects gradually began filling the area. Fill consisted of both inert material including material dredged from the seabed, and domestic waste. In particular, much of the Peninsula was used as a domestic landfill up until 1978. The area is surrounded on three sides by the sea, meaning that high ground water levels are likely. The nature of soil conditions in the area means that foundation design will not be straightforward. Soil conditions are likely to be very variable with soft material in the upper layers and high ground water tables. Rock is not likely to be encountered within 30m of the surface. Detailed site investigation will be required at design stage but it is likely that significant piling will be required for any new structures. De-watering could be a serious issue on many sites particularly if deep excavations are required. It is almost certain that some level of ground contamination will be encountered throughout the Peninsula. This is due to the previous history of landfilling and reclamation and the many heavy industrial uses that have been in place on the Peninsula. Detailed assessments will need to be carried out on potential development site in the area to assess whether or not the soil and groundwater at that particular site is considered to be contaminated. These assessments are likely to include soil testing and interpretation and detailed hydrogeological studies. The extent of contamination is likely to vary widely and there are a number of options for

dealing with contaminants, depending on how serious the problem is at any particular location. The worst case scenario will be that soil may need to be removed from site and treated/disposed of elsewhere. Low level contamination can be dealt with in Ireland but seriously contaminated/ hazardous soil any such waste encountered would have to be exported. Any removal of contaminated material will have to be done in conjunction with the Environmental Protection Agency and Dublin City Council. There do not appear to be any geotechnical or contamination constraints that would prevent development taking place on the Peninsula but this will need to be confirmed by detailed investigations. Geotechnical and soil contamination issues do raise serious concerns that will have to be fully explored at detailed design stage. Dealing with soil conditions in this area is likely to impose additional costs on developers.

TIER 1 ENVIRONMENTAL RISK ASSESSMENT

HISTORIC LANDFILL AT SHELLEY BANKS, CO. DUBLIN

JUNE 2019

Comhairle Cathrach Bhaile Átha Cliath
Dublin City Council

FEHILY TIMONEY & COMPANY

TIER 1 ENVIRONMENTAL RISK ASSESSMENT

HISTORIC LANDFILL AT SHELLEY BANKS, CO. DUBLIN

User is Responsible for Checking the Revision Status of This Document

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Client: Dublin City Council

Keywords: Site Investigation, environmental risk assessment, waste, historic landfill, coastal erosion

Abstract: This report represents the findings of a Tier 1 risk assessment conducted at the historic landfill at Irishtown Nature Park, Ringsend, Co. Dublin, in accordance with the EPA Code of Practice on Environmental Risk Assessment for Unregulated Waste Disposal Sites.

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PREAMBLE

Fehily Timoney & Co. (FT) was appointed by Dublin City Council (DCC) to complete an environmental risk assessment (ERA) of a former Ringsend Urban landfill site at Shelley Banks. This ERA was carried out in accordance with the EPA Code of Practice (CoP) on ERA for Unregulated Waste Disposal Sites (2007).

The former Ringsend Urban Landfill site is located on public land overlooking South Dublin Bay and Shelley Banks Beach and can be accessed from Pigeon House Road via a public walkway. A Coastwatch Ireland survey undertaken in March 2015 identified the southern boundary of the former Ringsend Urban Landfill is currently exposed due to coastal erosion. The site, which was operated in the 1970s, contains an estimated 160,000 m^3 of waste which was operated as a land-raised scheme. Erosion of the clay walls of the former landfill has exposed waste material which is currently being washed into the intertidal South Dublin Bay. To date approximately 200 m of the southern face of the former landfill has been exposed.

The results of the Tier 1 assessment and risk model indicate that the site is a **Class B - Moderate risk**. The EPA describes these sites as a "moderate risk posed to the environment or human health". Detailed site investigations are required to be carried out on all high and moderate risk sites.

For a moderate risk site, the CoP directs that the site will have to apply for a certificate of registration which will be established in the context of Section 22 of the Waste Management Acts, 1996 to 2008.

A Tier 2 quantitative risk assessment is required for a site which is classified as moderate risk. FT recommend further intrusive site investigations and sampling as part of the Tier 2 assessment.

1. INTRODUCTION

1.1. Background

The site is located within the Irishtown Nature Park to the south of Ringsend Waste Water Treatment Plant. Irishtown Nature Park is a small man-made park between Irishtown and Sandymount Strand in Dublin 4 located along the Poolbeg Peninsula.

Dublin City Council[1] (DCC) operated a landfill during a building boom in the 1970s, where C&D rubble, industrial and commercial waste was deposited in its current location and operated as a land-raised scheme. The majority of waste was reportedly sourced from the redevelopment of Wood Quay during the 1970s. While the exact period of its operation is unclear, it is understood to have closed in 1978. DCC has placed the site on the Section 22 register (Ref: S22-02333) in accordance with the Waste Management (Certification of Historic Unlicensed Waste Disposal and Recovery Activity) Regulations, 2008.

Post closure, Dublin City Council in the early 1980s, along with local residents, began establishing the Irishtown Nature Park by planting seeds, trees, and tall grasses across the elevated landform. A shallow clay capping was reported to have been placed on top of the interred waste extending to the top of the rock armour on the eastern and southern boundary sometime between 1978 and 1980, prior to the intervention by Dublin City Council and local residents.

The southern boundary of the former landfill comprises part of the coastline and is currently exposed due to coastal erosion, mainly during high spring tide events. Significant erosion of the former landfill's clay barrier has occurred when high tides breach the rock armour causing waste to be released into the South Dublin Bay area in recent years.

Dublin City Council (DCC) retained FT to carry out a Tier 1 ERA in accordance with the EPA CoP on ERA for Unregulated Waste Disposal Sites.

1.2. Scope of Works and Project Objectives

The scope of work was to undertake a Tier 1 assessment of the site based on the risk assessment methodology approach, in accordance with the EPA CoP. This approach requires completion of a:

- Desktop Study
- Site Walkover
- Tier 1 Environmental Risk Assessment (ERA)
- Development of Conceptual Site Model (CSM)

1.2.1. Project Objectives

As part of the initial desk study a preliminary assessment of available information was undertaken. This was followed-up with a site walkover. The desk study and site walkover were used to inform the development of both the CSM and the ERA.

This report presents the findings of the assessment.

[1] Formerly Dublin Corporation until 1st January 2002

2. METHODOLOGY

2.1. Introduction

The investigation included the review of the following literature sources and websites:

- BS 10175: 2000, *Investigation of Potentially Contaminated Sites – Code of Practice*
- Waste Management (Certification of Historic Unlicensed Waste Disposal and Recovery Activity) Regulations, 2008.
- Geological Survey of Ireland, Groundwater Web Mapping: www.gsi.ie
- Environmental Protection Agency Maps: www.epa.ie
- National Parks and Wildlife Service Map Viewer and Site Synopses: www.npws.ie

A desktop review of all available documentation for the site was conducted and a visit was undertaken to carry out a detailed site walkover.

The documentation made available to FT for the desktop review included:

- Ringsend Historic Landfill – Waste Exposure Report and Recommendations, Coastwatch Ireland, October 2015.
- Waste Management Site Visit Report – Irishtown Landfill, Dublin City Council, January 2016.
- Site Walkover at Irishtown Historic Landfill, Dublin City Council, March 2019.
- Historical correspondence relating to the site between all interested parties, including Dublin City Council and Coastwatch Ireland.

Relevant background documentation has been included in Appendix 3 to this report.

2.2. Desk Study

This section of the report presents the findings of the desk study.

2.2.1. Site Description & On-Site Conditions

The site occupies a long and narrow area of land on the southside of the Poolbeg peninsula and Ringsend Wastewater Treatment Plant. Following intensive planting works by Dublin Corporation and local residents during the 1980s, the Irishtown Nature Park has established across the former landfill site. Mature trees and plants now exist across the site along with many bird species[2].

The nature park can be accessed from two locations; an off-road path located on Beach Road, opposite Marine Drive, meanders across the edge of Sandymount Strand for 1.4 kilometres up to the park entrance. A second entrance is located on Pigeon House Road near the Poolbeg Power Station.

The surface area of the former landfill site is approximately 500 m from east to west and 50-100 m from north to south. The landfill is bounded to the west and north by the Irishtown Nature Park, to the east by Shelley Banks beach and to the south by the intertidal area of South Dublin Bay.

Inspection of the landfill cap suggest that a shallow layer of clay and topsoil was placed on top of the interred waste extending to the top of the rock armour on the eastern and southern boundary.

[2] Site Synopsis - South Dublin Bay and River Tolka Estuary SPA (NPWS, May 2015)

Along the southern landfill perimeter, the rock armour and other erosion control (i.e. concrete groins) infrastructure appear to have slumped. Waste is exposed in the bank up to 4.5m above top of rock armoury.

The southern boundary of the former landfill comprises part of the coastline and is currently exposed due to coastal erosion. Erosion of the former landfill's clay cap has occurred causing evidence of general litter being released into South Dublin Bay. The area of visible coastal erosion where waste has been exposed stretches approximately 200m along the south facing edge of landfill.

An aerial photograph of the site is shown in Figure 2.1, overleaf.

Source: Google Maps, Indicative landfill site boundary outlined in red

Figure 2-1: Aerial Photograph of Site

2.2.2. Topography

The land in the site undulates slightly, with the gradient generally rising from east to west. Several minor paths criss-cross the hilly uplands of the park, some of which rise quite steeply. The paths traverse through areas of mature trees and grasses.

2.2.3. Geology

Drift/Quaternary Geology

The Quaternary Map provided by GSI Online identifies the quaternary sediments to the north of the site along the Poolbeg peninsula as 'urban made ground.' The sub-soils within the area are also described as 'urban made ground.' In the absence of a subsoil classification directly underlying the site, FT has interpreted the site to be comprised of 'urban made ground' on this basis.

The GSI describes the coast of Dublin and some distance inshore lie deposits of estuarine Irish Sea Till. The GSI describes thick deposits of till along Dublin's coast, over 10m thick in places, with subsoil thickness reducing further inland.

Solid or Bedrock Geology

The GSI online 1:100,000 scale bedrock geology map shows the site is founded on the Lucan Formation. The Lucan Formation is described as a Carboniferous '*dark limestone and shale (calp)*'.

The lithology is described as typically '*dark-grey to black, fine-grained, occasionally cherty, micritic limestones that weather paler, usually to pale grey*'.

The GSI quaternary and bedrock geology mapping is shown in Figure 2.2 and Figure 2.3.

2.2.4. Hydrogeology

An examination of the national bedrock aquifer map on the GSI online mapping shows the aquifer underlying the site is unclassified. The nearest aquifer located 500m to the west is a 'Locally Important Aquifer (LI) – Bedrock which is Moderately Productive only in Local Zones' as shown in Figure 2.4. Given the location of the landfill is situated over estuarine deposits and saline waters, it is considered there is no aquifer resource potential from this site.

The Water Framework Directive Groundwater Bodies dataset from GSI shows that the groundwater body underlying the site is the Dublin GWB and the flow regime is poorly productive bedrock with permeability in these rock units likely to be low.

Map Path: R:\Map Production\2019\P2010\Workspace\P2010_Fig2-2_QuaternaryGeology_A3.mxd

Legend

- Site Location

Quaternary Sediments

- A, Alluvium
- Ag, Alluvium (gravelly)
- As, Alluvium (sandy)
- Embankment
- GLs, Gravels derived from Limestones
- L, Lacustrine sediments
- Mbs, Marine beach sands
- Mesc, Esturine silts and clays
- Pier
- Rck, Bedrock outcrop or subcrop
- TGr, Till derived from granites
- TLs, Till derived from limestones
- TQz, Till derived from quartzites
- TdlMr, Tidal Marsh
- Urban
- Water
- Ws, Windblown sands
- Wsd, Windblown sands and dunes

Figure Title
Quaternary Geology

Figure No. 2.2

Project
Tier 1 Shelley Banks

Client
Dublin City Council

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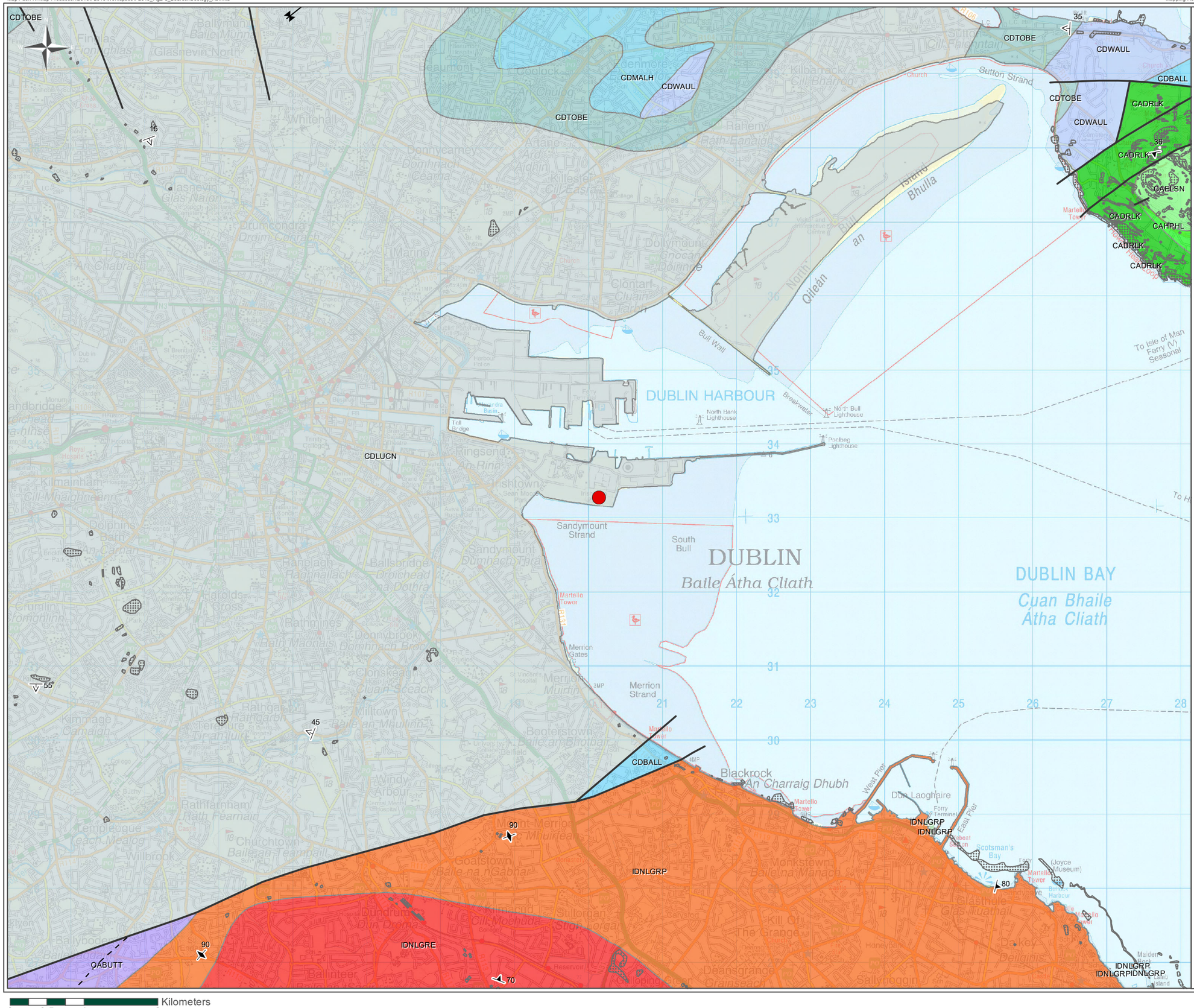
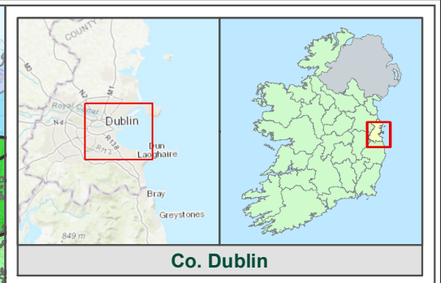
Kilometers
0 0.5 1 2

Map Path: R:\Map Production\2019\P2010\Workspace\P2010_Fig2-3_BedrockGeology_A3.mxd





Legend

- Bedrock Outcrop
- Site Location

Bedrock Structural Symbols

- Strike and dip of bedding, right way up
- Strike and dip of first foliation
- Strike of vertical first foliation

Stratigraphic and Structural Linework

- Area
- Fault
- Synclinal Axis

Bedrock Geology

- Drumleck Formation
- Elsinore Formation
- Hippy Hole Formation
- Ballysteen Formation
- Lucan Formation
- Malahide Formation
- Tober Colleen Formation
- Waulsortian Limestones
- Type 2e equigranular
- Type 2p microcline porphyritic
- Butter Mountain Formation

Figure Title
Bedrock Geology

Figure No. 2.3

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Dublin City Council

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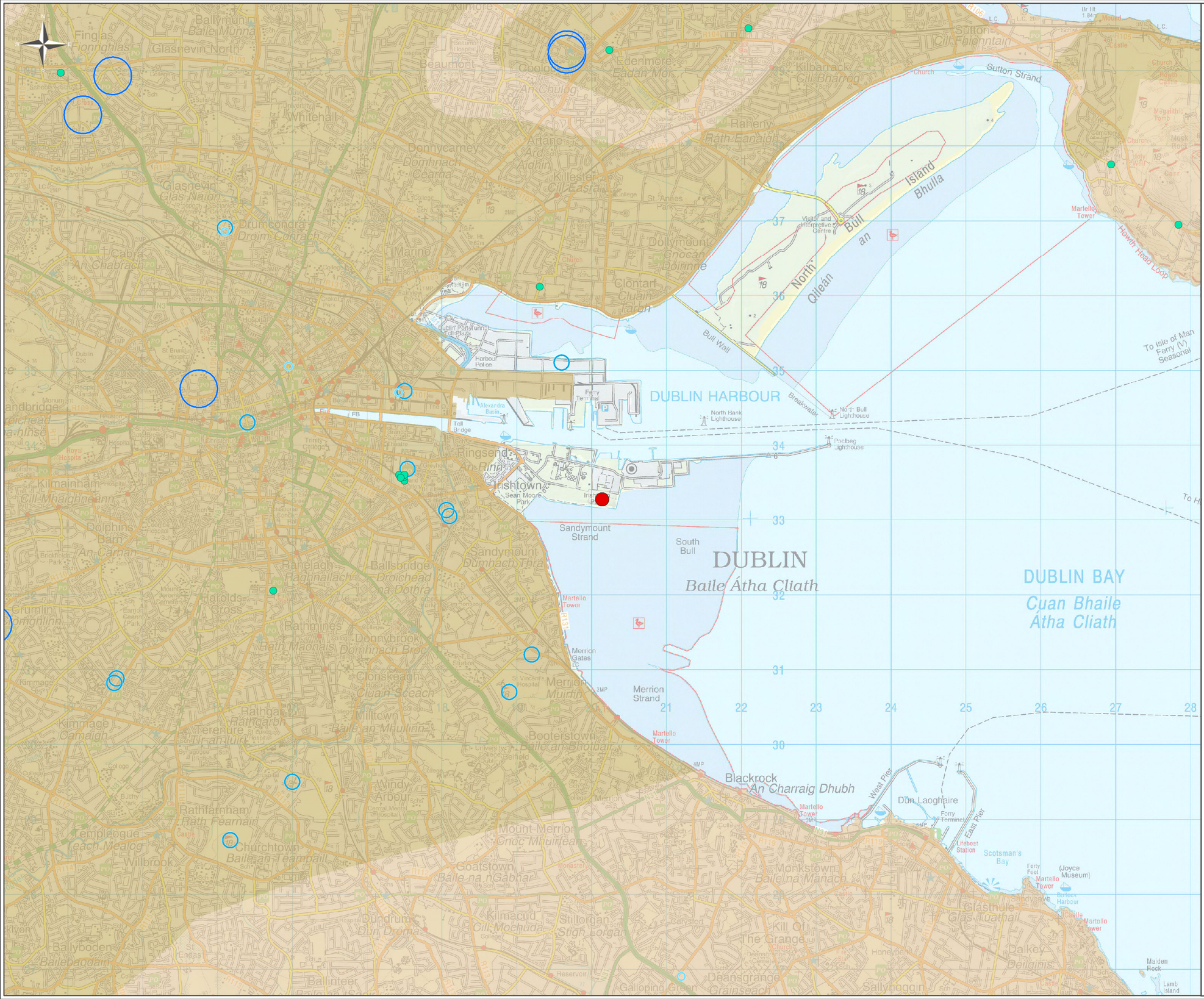
Map Path: R:\Map Production\2019\P2010\Workspace\P2010_Fig2-4_AquiferClassification_A3.mxd



Kilometers
0 0.5 1 2

Co. Dublin

Legend

- Site Location
- Groundwater Well (10-50m
- Groundwater Well (50-100m
- Groundwater Well (100-200m
- Groundwater Well (200-500m

Bedrock Aquifers

- LI: Locally Important Aquifer - Bedrock Mod Productive Locally
- PI: Poor Aquifer Bedrock Generally Unproductive Except Locally

Figure Title	Aquifer Classification
Figure No.	2.4
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2.2.5. Groundwater Vulnerability

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

The factors used in assessing groundwater vulnerability include subsoil type and thickness and recharge type as indicated in Table 2.2. The GSI procedure whereby groundwater protection is assessed is outlined in the EPA-GSI publication *Groundwater Protection Schemes* (DELG/EPA/GSI, 1999).

The procedure proposes a matrix, which relates vulnerability, source and resource such that a site is given a Response (R) to specific activities.

The GSI Online mapping data set identifies that the groundwater vulnerability for the site is classified as having a Low Vulnerability.

According to the Groundwater Recharge layer on the GSI Online mapping, most of the site consists of made ground, with low subsoil permeability and low groundwater vulnerability. The recharge coefficient is 20% and the average recharge rate is 59 mm/year over the site.

Groundwater vulnerability mapping for the site is shown in Figure 2.5.

Table 2-1: GSI Guidelines – Aquifer Vulnerability Mapping

Vulnerability Rating	Hydrogeological Conditions		
	Subsoil Permeability (Type) and Thickness		
	High Permeability (Sand/gravel)	**Moderate Permeability (e.g. Sandy soil)**	**Low Permeability (e.g. Clayey subsoil, clay, peat)**
Extreme (E)	0 - 3.0 m	0 - 3.0 m	0 - 3.0 m
High (H)	>3.0 m	3.0 -10.0 m	3.0 - 5.0 m
Moderate (M)	N/A	>10.0 m	5.0 - 10.0 m
Low (L)	N/A	N/A	>10 m

Notes:
N/A = Not Applicable
Precise permeability values cannot be given at present

Map Path: R:\Map Production\2019\P2010\Workspace\P2010_Fig2-5_GroundwaterVulnerability_A3.mxd

Legend

- Site Location

Groundwater Vulnerability

- E - Extreme
- H - High
- M - Moderate
- L - Low
- Water
- X - Rock Near Surface or Karst

Figure Title	Groundwater Vulnerability
Figure No.	2.5
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2.2.6. Hydrology

The coastline of the Irish Sea forms the southern and eastern boundary of the site. The Elm Park Stream flows into South Dublin Bay at Booterstown, approximately 500 m south of the site. The River Liffey and associated tributaries flow into Dublin Harbour which is located 200 m north of the site. The primary catchment of the rivers and streams entering Dublin Bay is the Liffey and Dublin Bay catchment, as identified by the Water Framework Directive.

The hydrology surrounding the site is illustrated in Figure 2.6.

2.2.7. Ecology

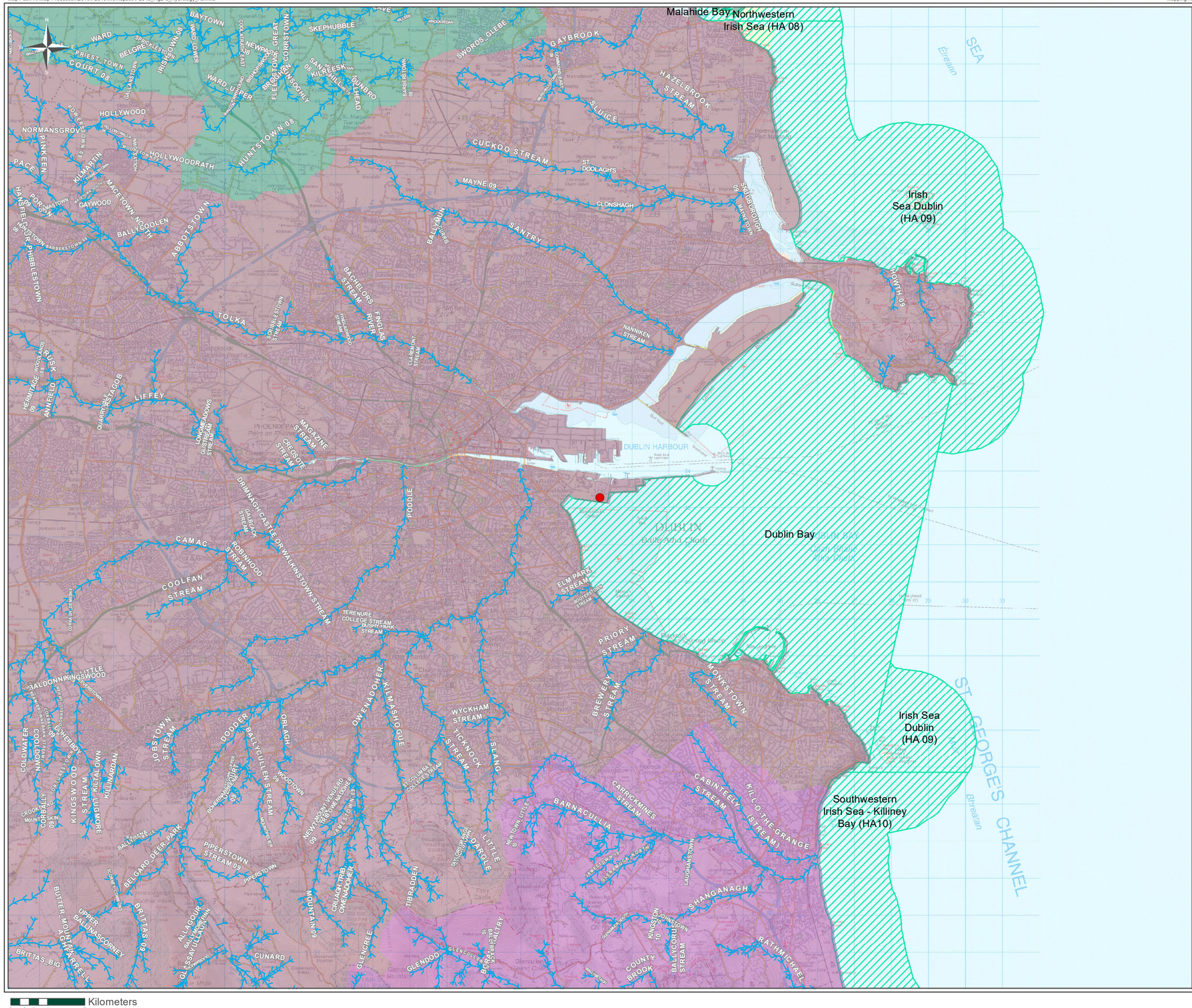
The site is located directly adjacent to the South Dublin Bay Special Area of Conservation (SAC) as identified under the EU Habitats Directive. The intertidal area (adjacent of the rock armour and former landfill) is also a Special Protection Area (SPA) under the EU Birds Directive, due to the large numbers of birds feeding and roosting in the area. The area has also been recognised as a UNESCO Biosphere Coastline since June 2015.

Present bird species include Oystercatchers, Black Headed Gulls, Turnstone and Sanderlings[3]. While a natural roosting site for these bird species exists at Shelley Banks Beach and South Dublin Bay, a two-hectare area of grassland has also been constructed adjacent to the Ringsend Waste Water Treatment Plant. This area is managed by Dublin City Council to provide feeding ground for Brent Geese, which migrate to the area from Canada and stay for the winter months through to March or April.

The ecologically protected sites adjacent to the site is presented in Figure 2.7.

[3] Site Synopsis - South Dublin Bay and River Tolka Estuary SPA (NPWS, May 2015)

Map Path: R:\Map Production\2019\P2010\Workspace\P2010_Fig2-6_Hydrology_A3.mxd



Legend

- Site Location
- Rivers

WFD Catchments

- Liffey and Dublin Bay
- Nanny-Delvin
- Ovoca-Vartry
- WFD Coastal Water Bodies

Kilometers
0 0.5 1 2

Figure Title	Hydrology
Figure No.	2.6
Project	Tier 1 Shelley Banks
Client	Dublin City Council
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Map Path: R:\Map Production\2019\P2010\Workspace\P2010_Fig2-7_EcologicallyDesignatedSites_A3.mxd

000205 (pNHA)
000205 (pNHA)
004025 (SPA)
000205 (pNHA)
000205 (SAC)
001208 (pNHA)
001763 (pNHA)
004016 (SPA)
000178 (pNHA)
000178 (pNHA)
002193 (SAC)
000203 (pNHA)
000203 (pNHA)
000203 (pNHA)
000199 (pNHA)
000199 (SAC)
002193 (SAC)
000202 (SAC)
000202 (pNHA)
002103 (pNHA)
000202 (pNHA)
000206 (pNHA)
000206 (SAC)
000202 (SAC)
004113 (SPA)
004006 (SPA)
000128 (pNHA)
000128 (pNHA)
000128 (pNHA)
004024 (SPA)
003000 (SAC)
000201 (pNHA)
000210 (pNHA)
000210 (SAC)
002104 (pNHA)
004024 (SPA)
001205 (pNHA)
000210 (pNHA)
001206 (pNHA)
001206 (pNHA)
000991 (pNHA)
001206 (pNHA)
004172 (SPA)
001212 (pNHA)
001753 (pNHA)
001206 (pNHA)
001206 (pNHA)
001209 (SAC)
001211 (pNHA)
001209 (pNHA)
001207 (pNHA)
002122 (SAC)
002122 (SAC)
004040 (SPA)
002122 (SAC)
004040 (SPA)
001202 (pNHA)
001202 (pNHA)

SEA
Éireann
DUBLIN BAY
Cuan Bhaile Átha Cliath
ST GEORGE'S CHANNEL
Muir Bhreatan

Kilometers
0 0.5 1 2

Co. Dublin

Legend

- Site Location
- Special Protection Area (SPA)
- Special Area of Conservation (SAC)
- Proposed Natural Heritage Area (pNHA)

Figure Title
Ecologically Designated Sites

Figure No. 2.7

Project
Tier 1 Shelley Banks

Client
Dublin City Council

Scale 1:100,000 **Page Size** A3

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2.2.8. Previous Site Surveys

A report was produced by Coastwatch Ireland in 2015 in response to a discovery made while undertaking a coastal survey along the 500 m stretch of coast adjacent to Irishtown Nature Park within South Dublin Bay. The survey described identifying evidence of storm tides disturbing the rock armoury and eroding the earthen banks containing the former urban landfill site, exposing and removing waste along the site's southern perimeter.

The report documented the exposed waste materials and raised concern that coastal erosion is removing waste material and presenting a risk to protected bird and marine species within the SAC / SPA from marine litter. Coastwatch Ireland proposed a number of recommendations to prevent the problem from worsening:

1. *An engineer's risk assessment to be carried out along the site perimeter and exposed waste, to consider options for:*
    a. *Low cost emergency works to avoid further waste exposure and possible sealing of the damaged areas, e.g. gabions installed along the wave-cut platform above the rock cement slabs which could be filled with citizen participation.*
    b. *A more planned development of a high biodiversity embankment to add to the quality of the splashzone of the site, and not just address the immediate waste loss issue.*
2. *Action taken should be carried out in exemplary manner to minimise disturbance and damage to the foreshore and turn it into an opportunity to significantly improve the splashzone quality.*
3. *The Coastwatch Ireland report also raised concerns about the number of other coastal landfill sites whose perimeters could be vulnerable to tidal storm surge damage. The report suggested an All-Ireland position is taken whereby field surveys of selected landfill site perimeters and desk study reviews are undertaken to establish how they are being monitored and secured in the event of problems. The recommendations promoted annual reviews of all coastal landfills in riverine and coastal zones should be carried out by local authorities to identify early detection of landfill destabilisation.*

In response to the findings of the Coastwatch Ireland report, a site walkover was carried out by DCC on the 19th January 2016. The site walkover report prepared by DCC confirmed and agreed with the findings and recommendations within the Coastwatch report. DCC also raised the possibility of applying for funding under the Poolbeg Community Gain Fund as an option to support the clean-up of the site. FT understands that the community fund has not been applied for to date.

A subsequent site walkover was undertaken by DCC on the 12th March 2019. The site walkover again examined the existing status of erosion and exposure of the waste body. Based on the findings of the walkover, DCC recommended further investigation of the site be conducted by way of a Tier I Risk Assessment.

The full reports of the above site assessments are presented in Appendix 3.

2.3. Site Investigation

The Tier 1 ERA comprised of a detailed site walkover by Mr. Daniel Hayden. The site walkover was conducted on the 3rd May 2019. The completed site walkover checklist, in accordance with the EPA CoP, is included in Appendix 1.

2.3.1. Site Walkover

The site is bounded to the south and east by the intertidal coastline of South Dublin Bay, to the north by Ringsend Wastewater Treatment Plant and to the west by Irishtown Nature Park and public amenity walking trails.

The site walkover noted evidence of recent erosion and exposure of the waste body along the southern perimeter of the site. During the site walkover it was found that substantial stretches of the clay walls of the former landfill have been eroded, leaving the waste body exposed to the intertidal movements of South Dublin Bay.

The area of visible coastal erosion where waste has been exposed stretches approximately 200m along the south facing edge of landfill. The types of waste encountered within the exposed clay embankment included fragments of residual domestic and C&D waste (steel bars, plastic sheeting, glass bottles, steel sheeting & mesh, fabric, steel piping, plastic containers, rubber tubing, tin cans, etc.), see Plate 2.1. No obvious signs of hazardous waste were observed during the walkover; however, asbestos could to be present in the waste body given the visible evidence of industrial and domestic waste encountered, the majority of which was reportedly sourced from the redevelopment of Wood Quay during the 1970s.

Plate 2-1: Waste exposure and signs of undercutting due to wave action

The rock armour and concrete groins appear to have slumped, and waste is exposed in the bank up to 4.5m above the top of the rock armoury.

It was noted that the site is currently very overgrown, particularly at the northern end of the site, and that the ground level is undulating. Litter from relatively recent public use was observed at the site.

The photos presented in Appendix 2 show the site itself and the type of materials that have been encountered during site walkovers in recent years.

3. RISK ASSESSMENT

3.1. Introduction

Risk assessment considers the likelihood of occurrence and the consequence of occurrence of an event (Royal Society, 1992[4]). ERA is based on the development of a Conceptual Site Model (CSM) which is used to determine the potential exposure of a vulnerable receptor to a contaminant. The CSM is used as the basis for the risk assessment. It is used to identify all possible sources (S), pathways (P) and receptors (R) as well as the processes that are likely to occur along each of the source-pathway-receptor (S-P-R) linkages and uncertainties.

Based on the desktop investigation and site walkover undertaken, this CSM takes the source of the contamination to be the residual inert domestic and C&D waste material in the made ground, the pathway to be the intertidal area and groundwater and the ultimate receptors to be South Dublin Bay to the south and east of site, areas of ecological importance (SPA and SAC) adjacent to the site and all human presence nearby the former landfill.

3.2. Potential Pathways and Receptors

A pathway is a mechanism or route by which a contaminant comes into contact with, or otherwise affects, a receptor. Contaminants associated with deposited waste may include leachate generated from groundwater/rainwater infiltration into the waste material and/or the generation of landfill gas from the degradation of the biodegradable fraction of deposited waste.

The potential pathways associated with the site are:

- groundwater/leachate migration
- landfill gas migration
- waste materials washed into South Dublin Bay by wave action

3.2.1. Groundwater/Leachate Migration

According to the EPA CoP, there are three main pathways for leachate migration. These are:

- vertically to the water table or top of an aquifer, where groundwater is the receptor
- vertically to an aquifer and then horizontally in the aquifer to a receptor such as a well, spring, stream or in this case, the adjacent coastline
- horizontally at the ground surface or at shallow depth to a surface receptor

The migration and attenuation of leachate from the site depends on the permeability and thickness of subsoil and on both the bedrock permeability value and type. These elements are encompassed in groundwater vulnerability, groundwater flow regime and surface water drainage. The main receptors to leachate migration from this site are:

- aquifer
- surface water bodies, including the nearby coastline
- bathing waters
- designated ecological areas
- human presence nearby the site

[4] Royal Society 1992, Risk: Analysis, Perception and Management. The Royal Society, London (ISBN 0-85403-467-6).

3.2.2. Landfill Gas Migration

According to the EPA CoP, there are two main pathways for landfill gas migration. These are

- Lateral migration via subsoil
- Vertical migration via subsoil

The migration of landfill gas from the site depends on the nature of the material deposited and the nature, permeability and thickness of the surrounding subsoil or bedrock. The main receptors to potential landfill gas migration from this site are:

- Human Presence nearby the waste body

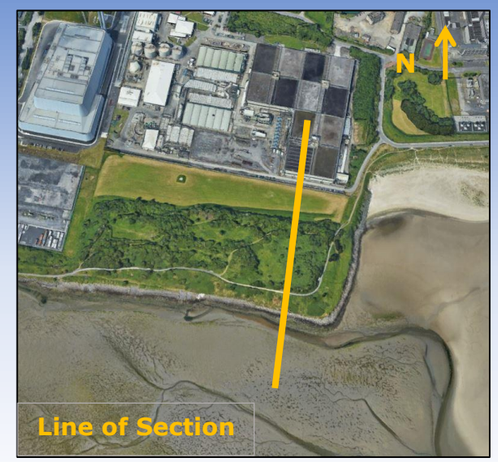
3.3. Conceptual Site Model

Based on the desktop investigation and site walkover undertaken, an assessment of the risk is made to understand the source – pathway – receptor (S-P-R) linkages identified in the preliminary investigation. The results and analysis of the investigation has enabled a basic conceptual model to be produced, which is presented in Figure 3.1, overleaf.

LANDDFILL GAS

LEACHATE MIGRATION

WASTE – ASSUMED C&D AND MUNICIPAL



RINGSEND WASTEWATER TREATMENT PLANT

2 Hectare Grassland Plot and SPA

IRISHTOWN NATURE PARK

Public access pathway

Exposed waste protruding along southern boundary

Spring tide wave action overtopping rock armour

Rock Armour

SOUTH DUBLIN BAY INTERTIDAL ZONE AND SPA / SAC

IRISH SEA TILL

IRISH SEA TILL

Bathing Waters

DARK LIMESTONE / SHALE BEDROCK

GROUNDWATER

Groundwater Vulnerability LOW

CROSS SECTION NORTH – SOUTH

FIGURE 3.1 SHELLEY BANKS HISTORIC LANDFILL CONCEPTUAL SITE MODEL

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3.4. Risk Prioritisation

Risk prioritisation enables resources to be prioritised on the highest risk facilities and on the highest source – pathway – receptor linkage potential.

The risk prioritisation process assigns a score to each linkage and the overall score is the maximum of the individual linkages for the site. The higher the score a site/linkage receives the higher the risk.

In order to classify the risk, scores will be applied to the information obtained during the site investigation. Where there is insufficient information available (i.e. where there is a high degree of uncertainty) the highest score is assumed.

In accordance with the EPA CoP (2007) the scoring matrixes are as follows:

- Leachate: Source/hazard scoring matrix based on waste footprint
- Landfill gas: Source/hazard scoring matrix based on waste footprint
- Leachate migration: Pathway (Vertical)
- Leachate migration: Pathway (Horizontal)
- Leachate migration: Pathway (Surface water drainage)
- Landfill gas: Pathway (Lateral migration potential)
- Landfill gas: Pathway (Upwards migration potential)
- Leachate migration: Receptor (Surface water drainage)
- Leachate migration: Receptor (Human presence)
- Leachate migration: Receptor (Protected areas – SWDTE or GWDTE) (Surface water/groundwater dependent terrestrial ecosystems)
- Leachate migration: Receptor (Aquifer category – Resource potential)
- Leachate migration: Receptor (Public water supplies – other than private wells)
- Leachate migration: Receptor (Surface water bodies)
- Landfill gas: Receptor (Human presence)

Table 3.1 calculates the points awarded to each of the headings listed above.

Table 3-1: Risk Classification Calculation

EPA Ref	Risk	Points	Rationale
1a	Leachate; source/hazard scoring matrix, based on waste footprint.	5	Based on a waste footprint of >1 and ≤5 ha and the waste type consisting of residual domestic and C&D. A reduced scoring of 5 has been used to reflect the age of the interred waste.
1b	Landfill gas; source/hazard scoring matrix, based on waste footprint.	3	Based on a waste footprint of >1 and ≤5 ha and the waste type consisting of residual domestic and C&D. A reduced scoring of 3 has been used to reflect the age and low biodegradability of the interred waste.
2a	Leachate migration: Pathway (Vertical)	0.5	GSI describes the groundwater vulnerability as Low
2b	Leachate migration: Pathway (Horizontal)	1	The nearest bedrock aquifer to the site is classified by the GSI as a Locally Important Aquifer (LI) – bedrock which is moderately productive only in Local Zones

EPA Ref	Risk	Points	Rationale
2c	Leachate migration: Pathway (Surface water drainage)	2	Connection between the waste body and intertidal zone of South Dublin Bay.
2d	Landfill gas: Pathway (Lateral migration potential)	3	Made ground (as per GSI online mapping)
2e	Landfill gas: Pathway (Upwards migration potential)	0	No buildings or enclosed spaces above waste body.
3a	Leachate migration: Receptor (Human presence)	3	Public leisure amenities Irishtown Nature Park and Shelley Banks beach on the eastern site boundary are within 50 m of the waste body. Nearby bathing waters within South Dublin Bay are also considered potential receptors.
3b	Leachate migration: Receptor (Protected areas – SWDTE or GWDTE) (Surface water/ groundwater dependent terrestrial ecosystems)	3	The nearest SAC/pNHA is located within 50m of the waste body
3c	Leachate migration: Receptor (Aquifer category – Resource potential)	1	A scoring of 1 has been used given the location of the landfill is situated over estuarine deposits and saline waters, and therefore presents minimal impact on aquifer resource potential.
3d	Leachate migration: Receptor (Public water supplies – other than private wells)	0	No known public water supply within 1 km
3e	Leachate migration: Receptor (Surface water bodies)	3	Coastline within 50 m of site boundary
3f	Landfill Gas: Receptor (Human presence)	1	Ringsend WWTP located greater than 150 m but less than 250 m north of the site boundary

Table 3-2: Normalised Score of S-P-R Linkage

Calculator		S-P-R Values	Maximum Score	Linkage	Normalised Score
Leachate migration through combined groundwater and surface water pathways					
SPR1	1a x (2a + 2b + 2c) x 3e	5 x (0.5+1+2) x 3 = **52.5**	300	Leachate => surface water	17.5%
SPR2	1a x (2a + 2b + 2c) x 3b	5 x (0.5+1+2) x 3 = **52.5**	300	Leachate => SWDTE	17.5%
Leachate migration through groundwater pathway					
SPR3	1a x (2a + 2b) x 3a	5 x (0.5+1) x 3 = **22.5**	240	Leachate => human presence	9.3%
SPR4	1a x (2a + 2b) x 3b	5 x (0.5+1) x 3 = **22.5**	240	Leachate => GWDTE	9.3%
SPR5	1a x (2a + 2b) x 3c	5 x (0.5+1) x 1 = **7.5**	400	Leachate => Aquifer	1.9%
SPR6	1a x (2a + 2b) x 3d	5 x (0.5+1) x 0 = **0**	560	Leachate => Surface Water	0%
SPR7	1a x (2a + 2b) x 3e	5 x (0.5+1) x 3 = **22.5**	240	Leachate => SWDTE	9.3%
Leachate migration through surface water pathway					
SPR8	1a x 2c x 3e	5 x 2 x 3 = **30**	60	Leachate => Surface Water	**50%**
SPR9	1a x 2c x 3b	5 x 2 x 3 = **30**	60	Leachate => SWDTE	**50%**
Landfill gas migration pathway (lateral & vertical)					
SPR10	1b x 2d x 3f	3 x 3 x 1 = **9**	150	Landfill Gas => Human Presence	6%
SPR11	1b x 2e x 3f	3 x 0 x 3 = **0**	250	Landfill Gas => Human Presence	0%
Site maximum S-P-R Score					**50%**
Risk Classification					**B – Moderate**

Table 3.2 shows the maximum S-P-R scoring for the site is **50%.**

The following are the risk classifications applied:

- Highest Risk (Class A) Greater than 70 for any individual SPR linkage
- Moderate Risk (Class B)41-69 for any individual SPR linkage
- Lowest Risk (Class C) Less than 40 for any individual SPR linkage

Based on this, the site can be classified as a **Moderate Risk Classification (Class B)**. The EPA describes these sites as a "moderate risk posed to the environment or human health". Detailed site investigations are required to be carried out on all high and moderate risk sites.

4. CONCLUSIONS & RECOMMENDATIONS

Dublin City Council (DCC) requested that an ERA be carried out for the site in accordance with the EPA CoP on ERA for Unregulated Waste Disposal Sites.

A Tier 1 study was conducted by FT in accordance with the CoP. The study consisted of a desktop study and a detailed site walkover. These works informed the development of the CSM and risk screening model.

The results of the Tier 1 assessment and risk model indicate that the site is a **Class B - moderate risk**. The EPA describes these sites as a "moderate risk posed to the environment or human health". Detailed site investigations are required to be carried out on all high and moderate risk sites.

A Tier 2 quantitative risk assessment is required for a site which is classified as moderate risk. The unique nature of this site in terms of its proximity to the South Dublin Bay SAC / SPA intertidal habitats and the erosion which it is subjected to indicates that such a risk assessment will be necessary.

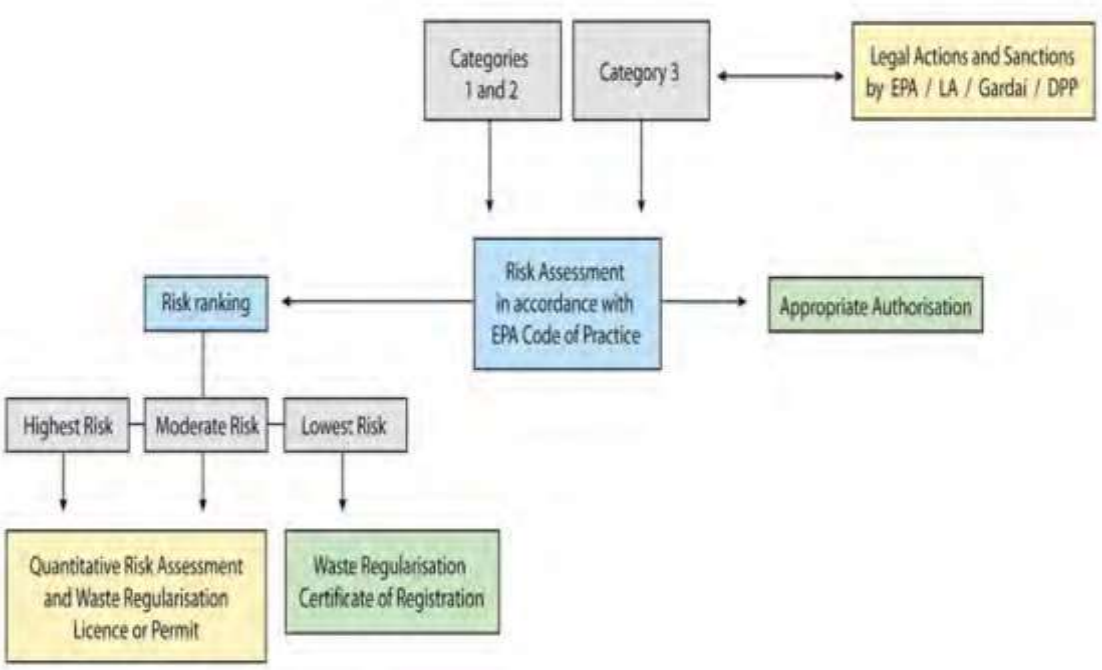

Figure 4-1: Extract from Section 1.3 of the EPA CoP

The exposure of waste at the site, poses a potential risk to human health and the adjacent SPA.

FT recommends further intrusive site investigations and sampling as part of the Tier 2 assessment. The intrusive site investigation should be designed in accordance with the unique characteristics of the site. FT recommended the following for consideration:

- trial pitting or auguring to confirm the depth, type and extent of waste;
- waste sampling and compositional characterisation;
- geophysical surveying to estimate the extent and depth of interred waste;
- installation of monitoring boreholes for sampling of groundwater/leachate;
- spike probing or borehole monitoring to identify the presence of otherwise of landfill gas;
- environmental sampling and analysis i.e. groundwaters, surface waters, intertidal zone, leachates if present.

For a moderate risk site, the CoP directs that the site will have to apply for a certificate of registration which will be established in the context of Section 22 of the Waste Management Acts, 1996 to 2008.

Appendix I

Site Walkover Checklist

Walkover Survey Checklist – 3rd May 2019

Information	Checked	Comment (include distances from site boundary)
1. What is the current land use?	√	Irishtown Nature Park and Shelley Banks beach. Public amenity owned by DCC and used for walking and cycling.
2. What are the neighbouring land uses?	√	The site is bounded to the west and north by the Irishtown Nature Park, to the east by Shelley Banks beach, and to the south by intertidal area of South Dublin Bay.
3. What is the size of the site?	√	The surface area of the site is approximately 500m from east to west and 50-100m from north to south. It is estimated that the waste body amounts to 160,000m^3 in volume.
4. What is the topography?	√	The land at the site undulates slightly, with the gradient generally rising from east to west. Rock armour bounds the south and west of the exposed waste rim.
5. Are there potential receptors (if yes, give details)?	√	Yes, South Dublin Bay SAC, SPA and UNESCO Biosphere Reserve.
Houses	√	No
Surface water features (if yes, distance and direction of flow)	√	Intertidal coastline borders the site to the south.
Any wetland or protected areas	√	Not within 1,000 m of site boundary
Public water supplies	√	No
Private wells	√	Not evident
Services	√	No evidence of pipelines or overhead electricity lines in the vicinity of the site.
Other buildings	√	The Ringsend Waste Water Treatment Plant is located approximately 200 m to the north of the site. The Poolbeg ESB power plant and Poolbeg smokestacks are located within 500 m north-east of the site.

Information	Checked	Comment (include distances from site boundary)
Other	√	Leisure activities with associated human receptors are located nearby the site – Shelley Banks beach at north-eastern boundary and Irishtown Nature Park has established on top of the historical landfill.
6. Are there any potential sources of contamination (if yes, give details)?	√	Yes – waste from former landfill
Surface waste (if yes, what type?)	√	Waste found to be protruding from existing clay walls of former landfill. Generally residual inert domestic, industrial and C&D waste.
Surface ponding of leachate	√	No
Leachate seepage	√	No
Landfill gas odours	√	No
7. Are there any outfalls to surface water? (If yes, are there discharges and what is the nature of discharge?)	√	No
8. Are there any signs of impact on the environment? (If yes, take photographic evidence)	√	Yes
Vegetation die off, bare ground	√	No
Leachate seepages	√	No
Odours	√	No
Litter	√	Yes – exposed waste body visibly protruding from clay walls of former landfill. Litter, including fishing nets, rope, glass / plastic bottles, steel, concrete also visible on rock armoured intertidal zone.
Gas bubbling through water	√	No
Signs of settlement	√	No
Subsidence, water logged areas	√	No
Drainage or hydraulic issues	√	No
Downstream water quality appears poorer than upstream water quality	√	No
9. Are there any indications of remedial measures? (Provide details)	√	Yes, rock armoury.
Capping	√	Clay barrier placed on former landfill – but now being eroded.
Landfill gas collection	√	No
Leachate collection	√	No
10. Describe fences and security features (if any)	√	No fences have been erected to separate the old landfill from public access.
Any other relevant information?		The area of visible coastal erosion where waste has been exposed stretches approximately 150m along the south facing edge of landfill. The rock armour and other erosion control materials have slumped, and waste is exposed in the bank up to 4.5m above top of rock armoury.

Appendix II

Photos from Recent Site Walkover

PHOTOGRAPHIC LOG

Consultants in Engineering and Environmental Sciences

www.fehilytimoney.ie

FEHILY TIMONEY & COMPANY

Client Name: Dublin City Council	**Site Location:** Shelley Banks Landfill	**Project Number:** P2010

Photo No. 1	**Date:** 03-05-19

Description:

View showing western entrance to the Irishtown Nature Park which marks one side of the indicative boundary for the former landfill.

Note mature vegetation across the site.

Photo No. 2	**Date:** 03-05-19

Description:

View showing Shelley Banks beach and rock armour along the eastern boundary of the former landfill.

PHOTOGRAPHIC LOG

Consultants in Engineering and Environmental Sciences

www.fehilytimoney.ie

FEHILY TIMONEY & COMPANY

Client Name: Dublin City Council	**Site Location:** Shelley Banks Landfill	**Project Number:** P2010

Photo No. 3	**Date:** 03-05-19

Description:

View from Shelley Banks beach at low tide showing rock armour perimeter and mature vegetation on top of landfill.

Photo No.4	**Date:** 03-05-19

Description:

View looking west along the southern perimeter of the landfill where exposed waste and disturbed rock armour have been discovered.

PHOTOGRAPHIC LOG

Consultants in Engineering and Environmental Sciences

www.fehilytimoney.ie

FEHILY TIMONEY & COMPANY

Client Name: Dublin City Council	**Site Location:** Shelley Banks Landfill	**Project Number:** P2010

Photo No. 5	**Date:** 03-05-19

Description:

View showing the evidence of recent erosion and exposure of the waste body where clay walls of the former landfill have been eroded.

Photo No. 6	**Date:** 03-05-19

Description:

View showing forms of waste encountered on the site included fragments of residual domestic and C&D waste (steel bars, plastic sheeting, glass bottles, steel sheeting & mesh, fabric, steel piping, plastic containers, rubber tubing, tin cans, etc.).

PHOTOGRAPHIC LOG

Consultants in Engineering and Environmental Sciences

www.fehilytimoney.ie

FEHILY TIMONEY & COMPANY

Client Name: Dublin City Council	**Site Location:** Shelley Banks Landfill	**Project Number:** P2010

Photo No. 7	**Date:** 03-05-19

Description:

View showing evidence of wave-cutting the landfill bank.

Forms of waste encountered on the site included fragments of residual domestic and C&D waste (steel bars, plastic sheeting, glass bottles, steel sheeting & mesh, fabric, steel piping, plastic containers, rubber tubing, tin cans, etc.).

Photo No. 8	**Date:** 03-05-19

Description:

View showing forms of waste encountered on the site included fragments of residual domestic and C&D waste (steel bars, plastic sheeting, glass bottles, steel sheeting & mesh, fabric, steel piping, plastic containers, rubber tubing, tin cans, etc.).

PHOTOGRAPHIC LOG

Consultants in Engineering and Environmental Sciences

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FEHILY TIMONEY & COMPANY

Client Name: Dublin City Council

Site Location: Shelley Banks Landfill

Project Number: P2010

Photo No. 7

Date: 26-06-18

Description:

View east showing the area of visible coastal erosion where waste has been exposed stretches approximately 200m along the south facing edge of landfill.

Photo No. 8

Date: 26-06-18

Description:

View of part of the UNESCO Biosphere Coastline showing natural roosting site for protected bird species at Shelley Banks Beach.

Present bird species include Oystercatchers, Black Headed Gulls, Turnstone and Sanderlings.

Note Ringsend WWTP in the background.

Appendix III

Previous Site Surveys




Coastwatch

Ringsend Landfill Waste Exposure Report and Recommendations

October 2015

Report by Keith Browne for Coastwatch with added insights by Karin Dubsky, Deborah Carlin, and Patrick Brady.

An Issue to Tackle: Ringsend Dump Waste Exposure

This report has been written in response to a discovery made while carrying out the Coastwatch survey in survey unit 8-4-11-4, a 500m stretch of coast adjacent to Irishtown Park in South Dublin Bay (see cover image). Wave overtopping and/or storm tides appear to have moved rock armour and earth holding in the long closed Ringsend urban landfill site, exposing and removing underlying waste in three places. Remedial action is required.

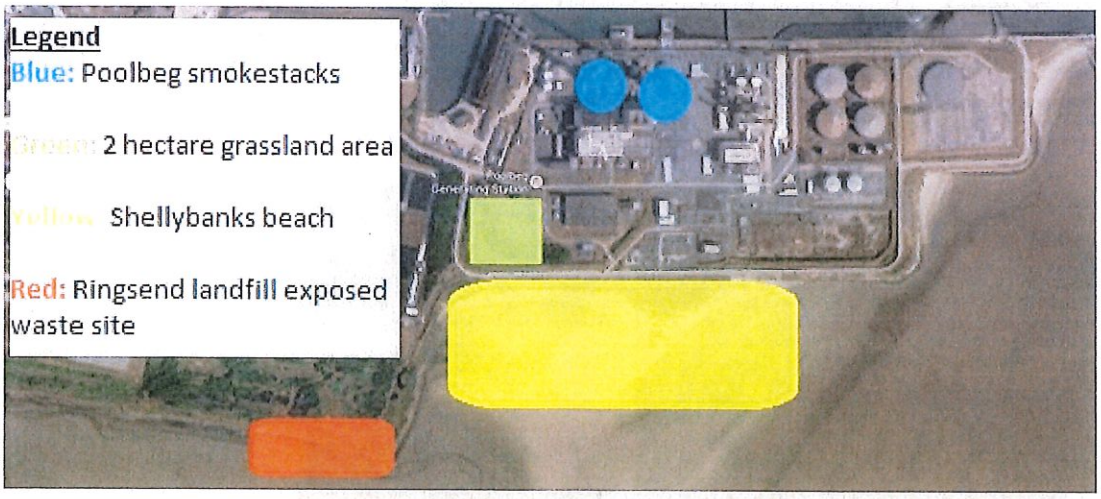
Location and significance

Adjacent to the exposed waste site rim at Ringsend is the attractive Shellybanks beach, with sand dune spit formation and good sea shell diversity. Just southwest of the survey site, there is a seagrass bed (*Zostera noltii*).

Designations

South Dublin Bay is a Special Area of Conservation (SAC) under the EU Habitats Directive. The intertidal area in front of the rock armour and dump is also a Special Protection Area (SPA) under the EU Birds Directive, due to the large numbers of birds feeding and roosting in the area. The area has also been part of the UNESCO Biosphere Coast since June 2015.

Image 1: Ringsend Nature Park, the erosion damage location and landmarks. (Source: Google maps)



Present bird species include Oystercatchers, Black-headed gulls, Turnstone and Sanderlings. While a natural roosting site for these bird species exists at Shellybanks beach and South Dublin Bay, a two hectare area of grassland has also been constructed adjacent to the waste site at Ringsend. This area is managed by Dublin City Council to provide feeding ground for Brent geese, which migrate to the area from Canada and stay for the winter months through to March or April.

The designation status of the South Dublin Bay as SAC, SPA and Biosphere Reserve is important, as it will inform how the necessary remedial works are carried out in order to avoid negatively impacting the site features, such as the seagrass or wintering birds.

Current situation of exposed waste at Ringsend

After the discovery of the waste exposure on the Ringsend landfill coast, two follow-up visits were made to the site; the first to measure and record waste in the damaged area, and the second to observe the site at high tide. Photographic evidence was gathered on both fieldtrips with just a few pictures included in this report.

Survey Measurement Visit

The area of visible damage was a 36m stretch of dump perimeter running from the most exposed corner of the dump facing out to sea back along the south facing edge to the end of the survey unit. The rock armour and other hard erosion control materials appear to have slumped, and waste was seen partially washed out and exposed in the bank up to 3.3m above the top of the armour (see Image 2).

Two smaller sections of exposed waste scoured patches were also recorded towards Shellybanks, but not yet investigated.

Image 2: Storm damage to the Ringsend landfill site, Dublin.

Near High Tide Visit

During a shore visit one hour after spring high tide on Tuesday 27th October, Coastwatch surveyors observed almost calm sea water reaching well into the base of the erosion control material. This further supported the view that on a full spring tide or during a swell with wave action the sea could easily extend above the armour and cause the erosion.

Additionally, it was noted that the armour was quite unsteady in this area, with a large number of slabs and rocks shifting as surveyors walked on them. With an unstable rock armour, high tides, and waves, it is very likely that the exposed dump area will continue to grow in size.

Image 3: High water line reaches well into the hard erosion control material of Ringsend landfill.

The photographs below (Images 4A, 4B, and 4C) show the differences in the type of protective material and in the rock armour angle on the south-facing coast where the waste exposure has occurred, compared to the east side of the dump adjacent to Shellybanks beach.

The damaged south-facing perimeter is made of demolition waste concrete slabs with some rock. It appears to have slumped so it doesn't reach high enough anymore. The east-facing perimeter defence is made of rock armour. Some slumping may have occurred here too, but this isn't obvious and would need to be confirmed by reference to the original design angle.

Image 4A, 4B, and 4C: Showing the comparison of rock armour on both the East and South side of the Ringsend site. (Source: Google maps)

Waste Exposed

The type of waste exposed included cloth, plastic sheeting, tin cans, rubber tubing, and various types of metal and glass bottles. No obvious signs of hazardous waste were observed at the time of the walk over.

Image 5A and 5B : Showing the largest exposure of waste occurring at the base of the Ringsend landfill.

The photos above (Images 5A and 5B) show that the sea is pulling out material, which then becomes marine litter. Currently, some of the dislodged waste remains at the base of the Ringsend landfill; how much waste gets washed out to the sea is unclear.

If preventive measures for erosion are not put into place, spring tides, rain and winter storms will be very likely to cause the waste exposure and littering problem to worsen.

As the content of old landfill sites may include hazardous materials, and the site is so accessible, Coastwatch urges early remedial action.

All Ireland Position

Turning to the bigger picture of climate change and changing weather patterns, Coastwatch is concerned about the number of other coastal landfill sites whose perimeter could be vulnerable to storms. Image 8 below shows a map of such sites which were subject to a Coastwatch field survey 20 years ago.

The only other landfill site included in this year's Coastwatch survey was Bray landfill, which is much worse than Dublin and subject to EPA investigation since last year.

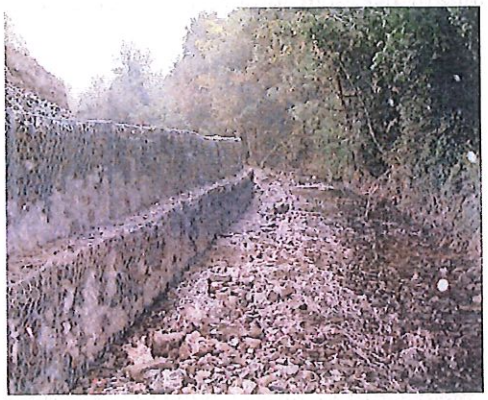
Recommendations

A number of steps could be taken in order to rectify the existing waste exposure problem at Ringsend and prevent the problem from getting worse. Coastwatch recommends:

1. An engineer's risk assessment carried out immediately on the site perimeter and exposed waste, followed by an expert review to consider options for:
   - Low cost emergency works to avoid further waste exposure and possible sealing of the damaged areas prior to winter storms. Gabions (See Image 7) which are removable and can be filled with citizen participation may suit on the wave cut platform above the rocks/cement slabs.
   - A more planned development of a high biodiversity embankment to add to the quality of the splashzone of the site, and not just address the immediate waste loss issue. This may qualify for EU funding under the current Horizon 2020 strand for cities.

2. Action decided upon should be carried out in exemplary manner to minimise disturbance and damage to the foreshore. Coastwatch would like to be included and contribute to solving the problem and turning it into an opportunity for a significantly improved the splashzone quality.

Image 7: Showing an example of woven mesh gabions constructed along a riverbank. (Source: www.geo-coastal.ie)



Regarding the All Ireland position, Coastwatch recommends:

3. A pilot field survey of select coastal landfill site perimeters and a desk study review of how they are being monitored and secured in case of problems. The results of the sample field surveys should inform whether it would be useful to draw up guidance on perimeter management and status reporting, which may fall outside the present closed landfill monitoring obligations.

4. An annual review and site visit to all coastal landfills and waste deposits in riverine and coastal zones should be carried out by local authorities to prevent or catch dump destabilisation early.

Image 8: A map of coastal landfill sites in Ireland. (Source: A survey of landfill sites, Irish Coastal Environment Group, 1995)

Acknowledgements:

We wish to thank the Department of the Environment Water Services for funding towards the Coastwatch Survey 2015.

Illustrations: Coastwatch map - http://worldmap.harvard.edu/maps/cwsurveyunits, Photos all Keith Browne, except Image 3 by Patrick Brady.

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Waste Management Site Visit Report for Irishtown landfill

Date of Site Visit: 19th January 2016
Time of Site Visit: 2pm

1. Introduction:

Dublin City Council received correspondence from Coastwatch Ireland in November 2015 containing a report which was written in response to a discovery made while carrying out a Coastwatch survey of a 500m stretch of coast adjacent to Irishtown Park in South Dublin Bay. The report concluded that wave overtopping and/or storm tides appear to have moved rock armour and earth holding in the historic Irishtown/Ringsend landfill site, exposing and removing underlying waste in three places.

The site is in DCC ownership under Parks control (Nature Park).

Dublin City Council conducted a site visit on 19th January 2016 to investigate the findings of the Coastwatch Ireland report.

2. Exposure Area:

The Coastwatch report detailed an area of visible damage as a 36m stretch running from the most exposed corner of the landfill facing out to sea back along the south facing edge. The report noted that rock armour and other hard erosion control materials appear to have slumped, and waste was seen partially washed out and exposed in the bank up to 3.3m above the top of the armour.

Two smaller sections of exposed waste towards Shellybanks were also recorded in the report.

A number of photographs were taken during the site visits, which confirm the findings in the Coastwatch report.

3. Waste Types:

The type of waste observed includes construction and demolition, metal, plastics, textiles, rubber tubing, along with possibly domestic or commercial waste such as tin cans, glass bottles. No obvious signs of hazardous waste were observed at the time of the walk over.

4. Risks:

South Dublin Bay is a Special Area of Conservation (SAC) under the EU Habitats Directive. The intertidal area in front of the rock armour and landfill is also a Special Protection Area (SPA) under the EU Birds Directive, due to the large numbers of birds feeding and roosting in the area. The area has also been part of the UNESCO Biosphere Coast since June 2015. The waste exposure area will continue to expand due to slumping of rock armour at the face of the landfill, storm events and high tides. As a result littering of the beach and surrounding areas of historic waste will continue.

5. Proposed Remedial Actions:

Recommendations from Coastwatch Ireland include:

1. An engineer's risk assessment carried out immediately on the site perimeter and exposed waste.
2. An expert review to consider options for:
   - Low cost emergency works to avoid further waste exposure and possible sealing of the damaged areas prior to winter storms. Gabions which are removable and

can be filled with citizen participation on the wave cut platform above the rocks/cement slabs.

- A more planned development of a high biodiversity embankment to add to the quality of the splashzone of the site. It was noted that may qualify for EU funding under the current Horizon 2020 strand for cities.

Along with the above recommendations from Coastwatch Ireland the possibility of applying for funding under the Poolbeg Community Gain Fund could also be an option for immediate clean up of the site.

6. Similar Sites:

Bray Harbour Landfill which is in the Dun Laoghaire Rathdown jurisdiction is also an historic landfill with exposed waste issues. Investigations have been ongoing since 2005 with EPA/OEE involvement since 2006. The EPAs advice and recommendations includes:

- Loose waste on beach and in cliff face to be removed
- Waste visible at top of cliff to be removed and replaced with clean subsoil and topsoil
- Provision of stone gabions along base to protect against erosion

The recommendations were not complied with and the EPA issued a Section 63 direction to undertake a risk assessment for which consultants are currently engaged for.

Wicklow county council are also arranging clean ups of wind blown litter from the landfill and signage.

7. Conclusions:

Waste at the Irishtown historic landfill is being exposed from Storm tides which appear to have moved rock armour and earth holding in the historic Irishtown/Ringsend landfill site, exposing and removing underlying waste.

Coastwatch Ireland requested that Dublin City Council undertake an initial investigation of the site, which is detailed in this report.

A combination of recommendations from the Coastwatch Ireland report, experience of Dun Laoghaire Rathdown County Council and Dublin City Council's site visit are detailed under Section 5 above 'Proposed Remedial Actions'.

Maria Douglas,
Executive Environmental Scientific Officer
Waste Mgt Regulation Office
25/02/16

Appendix A Photographs:

Photograph 1: Eastern Face of Landfill

Photograph 2: Eastern Face of Landfill

Photograph 3: Eastern Face of Landfill

Photograph 4: Waste Exposed at Southern Face of Landfill

Photograph 5: Example of Waste Exposed

Photograph 6: Example of Waste Exposed

Photograph 7: Waste Exposed along Southern Face of landfill

Photograph 7: Waste Exposed along Southern Face of landfill

Photograph 8: Example of Waste Exposed

Site Walkover at Irishtown Historic Landfill

A site walkover was carried out on 12th March by Officers Morris and Caird. The southern and eastern perimeters of the site were examined for evidence of erosion and exposure of the waste body to the Irish Sea.

During the site walkover it was found that significant stretches of the clay walls of the former landfill have been eroded, leaving the waste body exposed to the sea along the southern and eastern site boundaries. Approximately 400m of the face of the former landfill was found to be exposed. The forms of waste encountered on the site included residual domestic and C&D waste, with identifiable waste fragments were found to be consistent with the reported closure date of 1978. Asbestos was not encountered during the site walkover but is likely to be present in the waste body given the visible contents encountered. Staining was frequent along the exposed sections of the waste body.

Based on the findings of the site walkover it is recommended to conduct further investigation of the site to include Tier I Risk Assessment. Though this risk assessment may classify this site as low risk, the site's proximity to the coastline and the exposure of the waste body due to erosion including the possible presence of asbestos, further investigation may also be warranted.

Map

Red line denotes area of visible waste

Photographs