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Preliminary Site Assessment

Site 18 Francis Street - Inchicore 110 kV (May 2011 - November 2014)

Electricity Supply Board

Project number: PR-427640_ACM_RP_ENV_008_9

ESB Reference: Site 18

31 July 2020

Quality Information

Prepared by	Checked by	Approved by
[redacted] Associate Director [redacted] Senior Environmental Scientist	[redacted] Associate Director	[redacted] Technical Director

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Prepared for:

Electricity Supply Board

Prepared by:

[redacted]
Associate Director
T: +353-1-238-3100
E: [redacted]@aecom.com

AECOM Ireland Limited
4th Floor
Adelphi Plaza
Georges Street Upper
Dún Laoghaire
Co. Dublin A96 T927
Ireland

T: +353 1 238 3100
aecom.com

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The site reconnaissance consisted of a general external inspection of the site aimed at identifying potential sources of ground contamination affecting the site. An environmental compliance audit and/or detailed structural inspection of existing buildings were outside the project brief. Similarly, the site visit excluded detailed consideration of the ecological or archaeological aspects of the site, and if such are believed to be of potential significance then it is recommended that specialist advice is sought.

Any risks identified in this Report are perceived risks, based on the information reviewed during the desk study and therefore partially based on conjecture from available information. The study is limited by the non-intrusive nature of the work and actual risks can only be assessed following a physical investigation of the site.

It should be noted that the effects of ground and water borne contamination on the environment are constantly under review, and authoritative guidance values are potentially subject to change. The conclusions presented

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The opinions expressed in this report and the comments and recommendations given are based on a desk assessment of readily available information and an initial site reconnaissance by an AECOM employee. At this stage intrusive investigations have yet to be undertaken at site to establish actual ground and groundwater conditions and to provide data for an assessment of the geo-environmental status of the site.

Unless otherwise stated in this Report, the assessments made assume that the sites and facilities will continue to be used for their current purpose without significant changes.

Where assessments of works or costs identified in this Report are made, such assessments are based upon the information available at the time and where appropriate are subject to further investigations or information which may become available.

Reference to historical Ordnance Survey (OS) maps and/or data provides invaluable information regarding the land use history of a site. However, it should be noted that historical evidence will be incomplete for the period pre-dating the first edition and between the release of successive maps and/or data.

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ABBREVIATIONS

AECOM	AECOM Ireland Limited
APEC	Area of Potential Environmental Concern
bgl	Below Ground Level
BH	Borehole
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
CSM	Conceptual Site Model
ESB	Electricity Supply Board
EPA	Environmental Protection Agency
GSI	Geological Survey Ireland
IEL	Industrial Emissions Licence
IPC	Integrated Pollution Control
ITM	Irish Transverse Mercator
km	Kilometre
kV	Kilovolt
LAB	Linear Alkyl Benzene
m OD	Metres above Ordnance Datum
NHA	Natural Heritage Areas
NAPL	Non-Aqueous Phase Liquid
NPWS	National Park and Wildlife Service
NWCPO	National Waste Collection Permit Office
OECD	Organisation for Economic Co-operation and Development
OPW	Office of Public Works
OSI	Ordnance Survey Ireland
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PCOC	Potential Constituents of Concern
pNHA	Proposed Natural Heritage Area
PSA	Preliminary Site Assessment
RFP	Request for Proposal
SAC	Special Area of Conservation
SDS	Safety Data Sheet
SIDS	Screening Information Datasets
SPA	Special Protection Area
TPH	Total Petroleum Hydrocarbons
WAC	Waste Acceptance Criteria
WFD	Water Framework Directive

EXECUTIVE SUMMARY

Introduction

AECOM Ireland Limited (AECOM) completed a Preliminary Site Assessment (PSA) of a cable fluid leak location on the Grand Canal northern tow path between the Electricity Supply Board (ESB) Inchicore station and Blackhorse Bridge on the Naas Road, Dublin 8 (the site).

ESB Networks operates and maintains a network of High Voltage (HV) underground cables of over 1,600 kilometres (km) across Ireland, of which approximately 175 km are insulated by a cable fluid. The majority of the fluid filled cables are located in urban settings across Dublin City and Cork City. The remainder are located outside these areas with limited numbers of fluid filled cables in other counties.

The length of each cable route varies and cable routes frequently extend across county boundaries. The cable fluid acts as an electrical insulator and aids the conduction of heat away from the conductor allowing the cable to be run more efficiently. Fluid filled cables are largely located in urban/suburban areas and so are particularly vulnerable to third party interference or damage. Over time cables can develop leaks due to corrosion/fracture/defects in the cable sheath and in joints and terminations. When such leaks occur, there is potential for pollution to occur to surface water, groundwater, soils and ecology.

A leak was identified by ESB Networks at this location in May 2011 and repaired in November 2014. AECOM understands that the fluid type lost from the cable was a mixture of linear alkyl benzene (LAB) and mineral oil based products.

Objective

The assessment reported herein comprises the first step of Stage 1: Site Characterisation & Assessment – Preliminary Site Assessment (PSA) and was carried out in accordance with *EPA Guidance on the Management of Contaminated Land and Groundwater at EPA Licensed Sites (July 2013),* and specifically the Guideline Template for Preliminary Site Assessment Report. This guidance draws on the *EPA Code of Practice (CoP), Code of Reference for Unregulated Waste Disposal Sites (2007*) and *UK Environment Agency, Model Procedures for the Management of Land Contamination, Contaminated Land Report (CLR) 11 (September 2004).*

In terms of the data requirement for PSA reports, both the EPA CoP and CLR 11 outline that the findings of this initial risk assessment stage are largely based on desk-study information and a site walkover to identify potential pollutant linkages, which are then evaluated using appropriate criteria.

As such, the objective of the PSA reported herein is to:

- Identify potential contamination sources (i.e. the cable fluid), pathways (i.e. breathing in vapours, movement through made ground / soil) and receptors (i.e. who/what will be affected) and the likely interactions between each element;
- Assess the potential severity of the hazard and the sensitivity of the receptor (ranging from minor to severe);
- Assess the likelihood that a risk will occur (ranging from unlikely to high likelihood); and
- Develop a preliminary conceptual site model (CSM) based on an overall assessment of each of these elements above.

The preliminary CSM will then be used to identify potential risks to human health (site users and/or nearby residents) and controlled waters (i.e. groundwater and surface water) which may be associated with a fluid leak from the identified location. It should be noted that this stage of the risk assessment process is based mostly on qualitative information sources and identification of a potential risk at this stage does not necessarily indicate the presence of a risk, but rather the need for further assessment.

In additional to the PSA, four rounds of surface water sampling and two rounds of sediment sampling have been undertaken at the site between July 2019 and June 2020, in order to assess the potential impact from the site on surface water bodies.

A table cross referencing the template headings from the EPA Guidance Template and where the corresponding information is reported herein is presented in Appendix B.

Assessment Findings

Based on the findings of the desktop study, the overall environmental sensitivity of the site is considered to be moderate. Identified sensitive receptors within 1 km of the site include:

- The Grand Canal located immediately south of the site, although this may be protected by low permeability clay (natural and/or engineered when the canal was constructed);
- The River Camac located approximately 500 m to the east of the site, although this may be protected by low permeability clay deposits which are likely to be encountered beneath the site; and
- The bedrock aquifer beneath the site, although this may also be protected by low permeability clay deposits which are likely to be encountered beneath the site.

It is estimated that 9,370 litres of cable fluid was released between May 2011 and November 2014. It is assumed, based on information provided to AECOM by ESB, that the fluid lost was a mixture of LAB and mineral oil based products. It is noted no mineral oil was detected during surface water and sediment sampling of the canal and an adjacent drain; however, in order to provide a conservative approach to the PSA, it is assumed mineral oil based products could be present in soil and groundwater at the leak location. Due to its high biodegradability, lower volatility and low solubility, it is considered that LABs are of less concern for adverse environmental impact than mineral oil based products. Given that there is potential for a mixture of both types of cable fluids to have been used at this site, potential contaminants of concern have been identified. A summary of the source audit findings is as follows:

Area of Potential Environmental Concern

Number	APEC	Potential Contaminants of Concern	Potential Media Impacted
1	Leak at (18) Francis Street – Inchicore 110 kV (May 2011 – November 2014)	LABs TPH BTEX VOCs SVOCs	Soil Groundwater Soil Vapour Ground Gas

Surface water and sediment sampling undertaken on the drain adjacent to the site and the Grand Canal. The drain runs from west to east along the northern site boundary paralleling the Grand Canal (water in the drain appeared stagnant and heavy weed growth/items of rubbish were observed). The analysis has indicated the presence of LAB within the drain surface water and sediment and, to a lesser extent, in sediment at where the drain discharges to the Grand Canal. However, concentrations of hydrocarbons have been below the detection limit in all surface water samples collected from the Grand Canal in each of the four rounds of monitoring. This indicates there is no significant impact to surface water within the canal. No mineral oil was detected during sampling.

The preliminary CSM developed for the site looked at potential source-pathway-receptor linkages identified during the assessment works and identified a moderate potential risk to the following receptors:

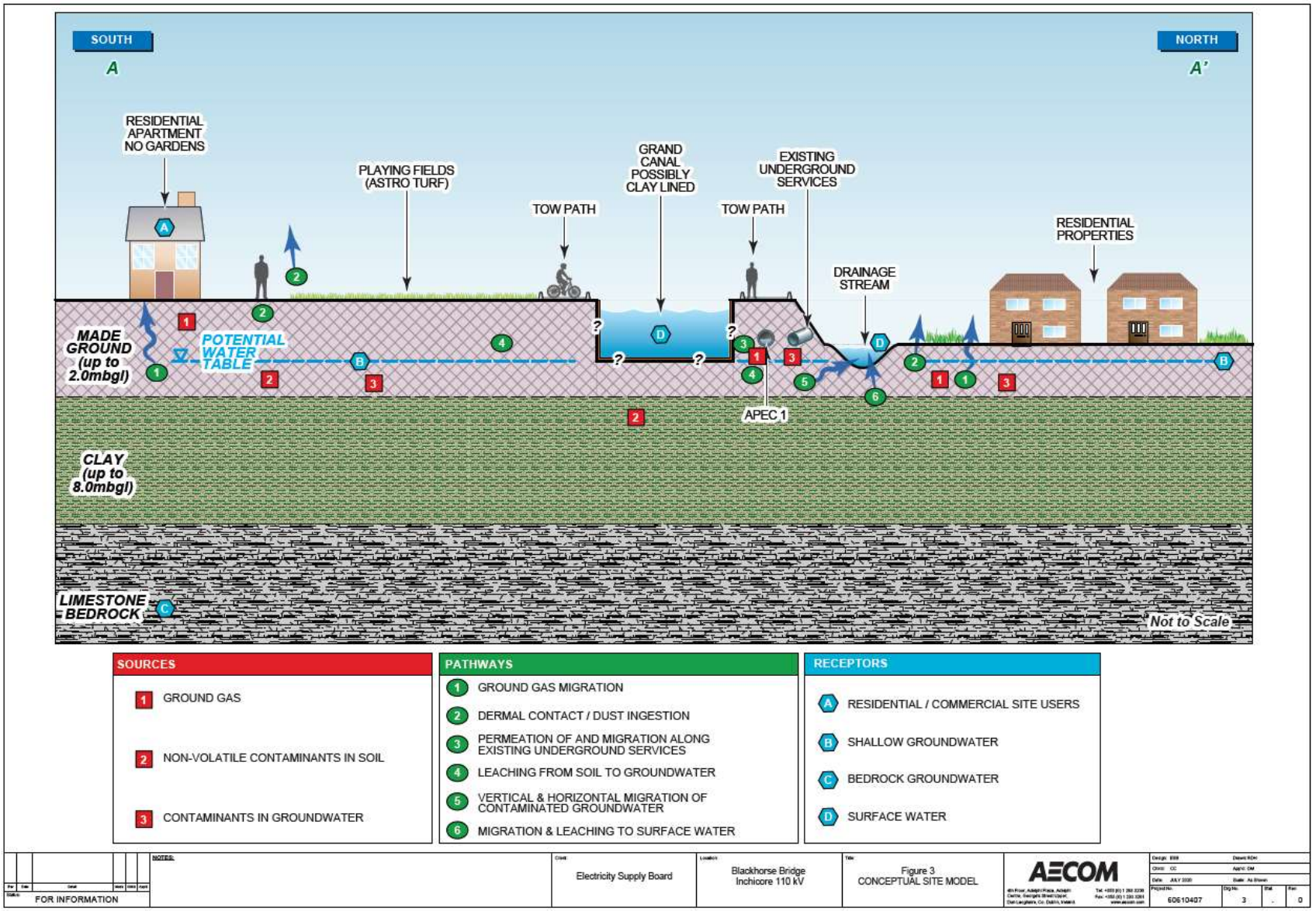
- Industrial/commercial and residential receptors due to the potential for ground gas generation resulting from degradation of NAPL (if present in soil and groundwater around the leak location); and
- Perched groundwater due to potential impact to groundwater chemistry from the presence of NAPL and associated biodegradation products around the leak location.

A low to moderate risk was identified to receptors from the potential for vapour migration from mineral oil based cable fluid (if present in soil and groundwater around the leak location) and from the migration of NAPL and potential breakdown products along preferential flow pathways such as existing underground services.

Potential impact to the bedrock aquifer from contaminants around the leak location was considered to be low to moderate due to the geology beneath the site.

Risks associated with other potential source-pathway-receptor linkages were considered to be low.

The risk assessment completed herein is preliminary in nature as it is generally based on an evaluation of qualitative data sources and surface water and limited sediment sampling (i.e. not on intrusive site investigation works). Consequently, identification of potential risk does not necessarily indicate a risk to a receptor, rather that further assessment may be required to investigate assumptions made in the CSM and quantify whether a potential risk actually exists. Generally, where a low or very low risk has been identified further assessment may not be deemed necessary to assess a particular SPR linkage, although further assessment may be deemed to be required to investigate CSM assumptions where the potential risk is considered to be low or very low due to the sensitivity of the receptor.


SOUTH
A
NORTH
A'
RESIDENTIAL APARTMENT NO GARDENS
PLAYING FIELDS (ASTRO TURF)
TOW PATH
GRAND CANAL POSSIBLY CLAY LINED
TOW PATH
EXISTING UNDERGROUND SERVICES
DRAINAGE STREAM
RESIDENTIAL PROPERTIES
MADE GROUND (up to 2.0mbgl)
POTENTIAL WATER TABLE
APEC 1
CLAY (up to 8.0mbgl)
LIMESTONE BEDROCK
Not to Scale
SOURCES
1 GROUND GAS
2 NON-VOLATILE CONTAMINANTS IN SOIL
3 CONTAMINANTS IN GROUNDWATER
PATHWAYS
1 GROUND GAS MIGRATION
2 DERMAL CONTACT / DUST INGESTION
3 PERMEATION OF AND MIGRATION ALONG EXISTING UNDERGROUND SERVICES
4 LEACHING FROM SOIL TO GROUNDWATER
5 VERTICAL & HORIZONTAL MIGRATION OF CONTAMINATED GROUNDWATER
6 MIGRATION & LEACHING TO SURFACE WATER
RECEPTORS
A RESIDENTIAL / COMMERCIAL SITE USERS
B SHALLOW GROUNDWATER
C BEDROCK GROUNDWATER
D SURFACE WATER
NOTES:
FOR INFORMATION
Client: Electricity Supply Board
Location: Blackhorse Bridge Inchicore 110 kV
Title: Figure 3 CONCEPTUAL SITE MODEL
AECOM
Project No: 60610407
Date: JULY 2020

EPA Contaminated Land and Groundwater Risk Assessment Methodology

Table1. EPA Methodology

Stage	Methodology	Report Reference	Report Date	Status
Stage 1: Site Characterisation and Assessment				
1.1	Preliminary Site Assessment	PR-427640_ACM_RP_ENV_008	31 July 2020	Final
1.2	Detailed Site Assessment			
1.3	Quantitative Risk Assessment			
Stage 2: Corrective Action and Feasibility Design				
2.1	Outline Corrective Action Strategy			
2.2	Feas bility Study and Outline Design			
2.3	Detailed Design			
2.4	Final Strategy and Implementation Plan			
Stage 3: Corrective Action Implementation and Aftercare				
3.1	Enabling Works			
3.2	Corrective Action Implementation and Verification			
3.3	Aftercare			

Source: EPA Guidance on the Management of Contaminated Land at EPA Sites

1. Introduction

AECOM Ireland Limited (AECOM) is pleased to present this preliminary site assessment (PSA) completed on behalf of Electricity Supply Board (ESB) for a site in Inchicore, Dublin 8, Ireland (the site).

This report was commissioned by ESB under a request for proposal (RFP) issued on 26 June 2019 (Ref. Qd-354120-01R460_002-001-001) and carried out in accordance with AECOM proposal reference: PR-427640_ACM_PL_ENV_001_3, dated 03 July 2019. AECOM understands that ESB has commissioned this report on behalf of ESB Networks.

1.1 Project Background

ESB Networks operates and maintains a network of High Voltage (HV) underground cables of over 1,600 kilometres (km) across Ireland, of which approximately 175 km are insulated by a cable fluid. The majority of the fluid filled cables are located in urban settings across Dublin City and Cork City. The remainder are located outside these areas with limited numbers of fluid filled cables in other counties.

The length of each cable route varies and cable routes frequently extend across county boundaries. The cable fluid acts as an electrical insulator and aids the conduction of heat away from the conductor allowing the cable to be run more efficiently. Fluid filled cables are largely located in urban/suburban areas and so are particularly vulnerable to third party interference or damage. Over time cables can develop leaks due to corrosion/fracture/defects in the cable sheath and in joints and terminations. When such leaks occur, there is potential for pollution to occur to surface water, groundwater, soils and ecology.

A leak was identified by ESB Networks at the site in May 2011 and repaired in November 2014. AECOM understand that the fluid type lost from the cable was a mixture of linear alkyl benzene (LAB) and mineral oil based products.

The site location is presented in Figure 1 and the site layout showing the site is presented in Figure 2.

1.2 Project Objective

The assessment reported herein comprises the first step of Stage 1: Site Characterisation & Assessment – Preliminary Site Assessment (PSA) and was carried out in accordance with *EPA Guidance on the Management of Contaminated Land and Groundwater at EPA Licensed Sites (July 2013),* and specifically the Guideline Template for Preliminary Site Assessment Report. This guidance draws on the *EPA Code of Practice (CoP), Code of Reference for Unregulated Waste Disposal Sites (2007*) and *UK Environment Agency, Model Procedures for the Management of Land Contamination, Contaminated Land Report (CLR) 11 (September 2004).*

In additional to the PSA, four rounds of surface water sampling and two rounds of sediment sampling have been undertaken at the site between July 2019 and June 2020, in order to assess the potential impact to surface water bodies from the site.

In terms of the data requirement for PSA reports, both the EPA CoP and CLR 11 outline that the findings of this initial risk assessment stage are largely based on desk-study information and a site walkover to identify potential pollutant linkages, which are then evaluated using appropriate criteria. In this instance, results of surface water and sediment sampling have been incorporated into the risk assessment.

As such, the objective of the PSA reported herein is to:

- Identify potential contamination sources (i.e. the cable fluid), pathways (i.e. breathing in vapours, movement through made ground / soil) and receptors (i.e. who/what will be affected) and the likely interactions between each element;
- Assess the potential severity of the hazard and the sensitivity of the receptor (ranging from minor to severe);
- Assess the likelihood that a risk will occur (ranging from unlikely to high likelihood); and

- Develop a preliminary conceptual site model (CSM) based on an overall assessment of each of these elements above.

The preliminary CSM will then be used to identify potential risks to human health (site users and/or nearby residents) and controlled waters (i.e. groundwater and surface water) which may be associated with a fluid leak from the identified location. It should be noted that this stage of the risk assessment process is based mostly on qualitative information sources and identification of a potential risk at this stage does not necessarily indicate the presence of a risk, but rather the need for further assessment.

A table cross referencing the template headings from the EPA Guidance Template and where the corresponding information is reported herein is presented in Appendix B.

2. Scope of Work

To achieve the above objective, the following scope of work was undertaken:

- A site walkover by AECOM staff (completed on 09 July 2019);
- A desktop review of site history to identify areas of potential environmental concern (APEC);
- A desktop review of publicly available information regarding the site's environmental setting and sensitivity, including:
  - Geological Survey of Ireland (GSI) Groundwater Public Viewer Maps (https://dcenr.maps.arcgis.com/apps/MapSeries), accessed 04 - 11 July 2019;
  - EPA Geoportal Site (https://gis.epa.ie/EPAMaps), accessed 04 - 11 July 2019;
  - EPA Incidents Database (https://www.epa.ie/newsandevents/incidents/recent/), accessed 04 - 11 July 2019;
  - Ordnance Survey of Ireland (OSI) (http://geohive.ie), accessed 04 - 11 July 2019;
  - Glucksman Map Library, Trinity College Dublin, accessed 17 July 2019;
  - Office of Public Works (OPW) Flood Maps (http://www.floodinfo.ie), accessed 04 - 11 July 2019;
  - National Parks and Wildlife Service (NPWS) (http://webgis.npws.ie/npwsviewer/), accessed 04 - 11 July 2019;
  - National Waste Collection Permit Office (NWCPO) website (http://www.nwcpo.ie/), accessed 04 - 11 July 2019;
- A review of information provided by ESB in the RFP;
- Four rounds of surface water sampling, undertaken on 09 July 2019, 05 December 2019, 02 March 2020 and 19 June 2020, with sediment samples taken on 09 July 2019 and 05 December 2019; and
- Data assessment and reporting.

3. Environmental Setting

3.1 Topography

The site is located in Inchicore, Dublin 8, which has an elevation of approximately 34 m above ordnance datum (m OD) and is topographically relatively flat. The wider area is generally low-lying and typically flat.

Grand Canal is located immediately south of the site, flowing to the east and discharging at the Grand Canal Dock. The Grand Canal falls rapidly from west to east across three locks along the southern site boundary.

3.2 Geology

Teagasc Soils Map indicates the site locally is overlain by made ground. To the north and south of the site, the Quaternary geology is comprised of glacial till derived from the underlying limestone bedrock.

The GSI Bedrock Geology Map (scale 1:100,000) indicates the site is underlain by the Dinantian marine basinal facies, dark-grey fine-grained limestones and shales of the Lucan formation. No geological features are noted within the surrounding area.

A number of geotechnical boreholes are located within the vicinity of the site. Immediately west of the site, a deep borehole (R526/B59366) was drilled within the ESB Networks Transformer Compound on Jamestown Road. This borehole was drilled to a recorded depth of 30.5 m below ground level (bgl) and recorded boulder clay up to 17 m bgl with a gravel layer within the boulder clay at 8 m bgl. Bedrock was encountered during drilling at a recorded depth of 19.5 m below ground level.

Three shallow boreholes drilled adjacent to the eastern portion of the site (R498) recorded made ground up to 1 m bgl underlain by clay up to 2 m bgl. A further four boreholes drilled as part of site investigation works for the Luas (tram rail system) adjacent to the eastern portion of the site (R7491) reported made ground up to 1.7 m bgl, underlain by stiff clay up to 7.5 m bgl. Bedrock was encountered at a minimum depth of 6.5 m bgl.

Two boreholes and a trial pit were excavated as part of the Blackhorse Bridge renovation works adjacent to the eastern portion of the site (R2212). Made ground was encountered up to 5.5 m bgl, underlain by boulder clay up to 7.6 m bgl. Bedrock was encountered at depths of 7 m bgl.

3.3 Hydrology

3.3.1 Surface Water Features

The site lies within the lower catchment of the River Liffey and Dublin Bay, which covers an area of 1,624 km^2.

The closest surface water body to the site is the Grand Canal (a proposed Natural Heritage Area (pNHA), Site Code 002104) located immediately south of the leak location. The canal flows to the east and discharges to the River Liffey Estuary approximately 1.7 km northeast of the site, which flows into South Dublin Bay (an SAC). This comprises the following protected sites:

- South Dublin Bay Special Area of Conservation (SAC) (Site Code 000210);
- South Dublin Bay and River Tolka Special Protection Area (SPA) (Site Code 004024); and
- South Dublin Bay proposed Natural Heritage Area (pNHA) (Site Code 000210).

As impervious materials are generally used to line canals during construction, it is not considered likely that the Grand Canal is in hydrological continuity with groundwater in the area.

A small unnamed drain runs from west to east along the northern site boundary paralleling the Grand Canal. The water in the drain appeared stagnant; heavy weed growth and items of rubbish (fire extinguisher, plastic bottles, cans, numerous glass bottles etc.) were observed. It is possible that both the stream can discharge into the canal and that the canal can discharge into the stream depending on hydraulic conditions within the canal system.

The Camac River flows from south to north and is the closest natural waterbody to the site; located approximately 500 m from the eastern portion of the site. The Camac River crosses (by culvert) the Grand Canal immediately east of the Blackhorse Bridge and discharges to the River Liffey approximately 3.3 km north east of the site.

Given their proximity to the site, both the Grand Canal and the Camac River are considered to be sensitive surface water receptors.

3.3.2 Surface Water Quality

The Grand Canal, which bounds the site to the south, is referred to as an Artificial Water Body (AWB) by the EPA under the Water Framework Directive (WFD). Waterways Ireland assess the biological quality of the Grand Canal, which along the section adjacent to the site during the period 2015 – 2017 was classified as 'Good' quality[1].

[1] EPA, *Water Quality in 2017, An Indicators Report*, 2018

The most significant natural surface water feature in the wider area is the Camac River. The most recent reported EPA water quality status of the Camac River (monitoring station below Blackhorse Bridge) is a Q Value of 3 and a rating 'Poor'. The WFD ecological status of the Camac River is characterised as being at risk of not meeting its WFD objectives.

The most significant surface water feature in the wider area is the River Liffey Estuary. The WFD status of both the upper and lower sections of the estuary (classified as a Transitional Water Body) is classified as 'Moderate' and characterised as being at risk of not meeting its WFD objectives.

3.3.3 Flooding

According to OPW Flood Maps, the site does not lie within the "River – Low Probability", "River – Medium Probability" or "River – High Probability" modelled extent of land that might be flooded by rivers in a moderate to very extreme event.

Parts of the surrounding area located within a 1 km radius to the west and east of the site lie within the "River – Low Probability", "River – Medium Probability" and "River – High Probability" indicating that flooding by rivers may occur during moderate to very extreme event in these areas.

The site is not in close proximity to the extent of land affected by coastal flood events.

3.4 Hydrogeology

3.4.1 Aquifer Classification

According to the GSI, the bedrock aquifer beneath the site is classified as a Locally Important Aquifer. The bedrock underlying the site is moderately productive in local zones. The soil permeability in the surrounding area is low; consequently the groundwater recharge in this aquifer is estimated by the GSI to be approximately 70 millimetres/year (mm/yr).

Given the likely low permeability of the underlying geology as outlined in Section 3.2, perched groundwater is likely to be present. It is noted that variation in overburden could result in situations where the groundwater within the made ground is in continuity with groundwater in the bedrock aquifer (e.g. where there is a minimal thickness of low permeability clay present between the two strata).

Regional groundwater flow direction is likely to be to the north and northeast towards the River Liffey and Camac River. A more detailed site assessment would be required to assess the local groundwater flow regime.

According to the GSI wells and springs database, there are no springs but two groundwater wells located within 1 km of the site. The first is located approximately 950 m to the west of the site and is recorded as industrial use with an 'Excellent' yield of 1,200 m^3/day. The other well is located approximately 870 m to the south of the site and is recorded as industrial use with a 'Good' yield of 381 m^3/day.

The site is not mapped as being located within a Source Protection Area for either a public water supply or a group water supply scheme.

3.4.2 Groundwater Vulnerability

The GSI National Groundwater Vulnerability Mapping identified that groundwater vulnerability associated with the site is "Moderate". However, some spatial variation in groundwater vulnerability is seen in the greater surrounding area of the site, where 200 m east of the site groundwater vulnerability is recorded as high to extreme in local areas.

3.4.3 Groundwater Quality

Groundwater beneath the site is part of the Dublin Groundwater Body (IE_EA_G_008) which, according to the EPA website, is classified as having 'Good' status and is characterised as being not at risk.

3.5 Natural Habitats and Protected Species

The Grand Canal is located immediately south of the site and is a pNHA.

The River Liffey is located approximately 1.3 km north of the site. The River Liffey flows easterly into South Dublin Bay (an SAC, SPA and pNHA). Site Codes for each of these protected areas are provided in Section 3.3.1.

There are no other protected areas within 1 km of the site.

3.6 Regulatory Database Search

3.6.1 National Waste Collection Permit Office

The National Waste Collection Permit Office (NWCPO) website was reviewed to identify authorised waste facilities within the jurisdiction of Dublin City Council near the site. The NWCPO website indicated that there are a number of Waste Permitted Facilities within 1 km of the site as summarised in Table 2 below.

Table 2. Dublin City County Council Waste Facilities within 1 km of the Site

Authorisation Number	Facility Name	Location	Waste Activity
WFP-DC-09-0008-02	Martin Services (Industrial) Limited	Unit 11 Bluebell Business Park Bluebell Dublin 12	Wastes whose collection and disposal is not subject to special requirements in order to prevent infection (for example dressings, plaster casts, linen, disposable clothing, diapers)
WFP-DC-11-0025-02	Rehab Enterprises Limited	The Rehab Building Kylemore Road Ballyfermot Dublin 10	Photographic film, mixed packaging and waste electronic equipment

3.6.2 Storm Water Discharges

Four Irish Water storm water overflow discharge locations have been identified within 1 km of the site, as summarised in Table 3 below.

Table 3. Storm Water Discharges

Emission ID	Name	Register No.
TPEFF0700D0034SW094	Ringsend	D0034-01
TPEFF0700D0034SW102	Ringsend	D0034-01
TPEFF0700D0034SW103	Ringsend	D0034-01
TPEFF0700D0034SW024	Ringsend	D0034-01

3.6.3 EPA Licensing

The EPA database of Waste Licences was consulted which identified two waste facilities within a 1 km radius of the site. Table 4 provides further details.

Table 4. EPA Waste Facilities within 1 km of the Site

Licence Number	Facility Name	Location	Licence Status
W0112	National Recycling and Environmental Protection Ltd	John F Kennedy Drive, JFK Industrial Estate, Naas Rd, Dublin 12, Dublin	Licenced
W0221	Labre Park Civic Amenity Site	Ballyfermot, Dublin 10, Dublin	Licenced

The EPA database of Industrial Emissions (IE) and Integrated Pollution Control (IPC) licences was consulted which identified a number of IE and IPC licences within 1 km of the site. Table 5 provides further details.

Table 5. EPA IE and IPC facilities within 1 km of the site

IE Register Number	Facility Name	Location	Distance to Site	Activity
P0796-01, IPC, Surrendered	Jamestown Shot Blasting & Metal Coating Limited	Jamestown Road, Inchicore, Dublin 8, Dublin	410 m	Industry
P0392-01, IE, Licenced	Jamestown Metal Resources Limited	Jamestown Road, Inchicore, Dublin 8., Dublin	505 m	Industry
W0054-02, IE, Licenced	SRCL Limited (Kylemore Road) trading as Eco-Safe Systems Ltd, Allied Industrial Estate, Kylemore Road, Dublin 10	Unit 1 A, Allied Industrial Estate, Kylemore Road, Ballyfermot, Dublin 10, Dublin	590 m	Industry
P0092-01, IPC, Licenced	Ultra-Packaging Limited	Unit 1, Allied Industrial Estate, Kylemore Road, Dublin 10, Dublin	695 m	Industry
P0094-01, IPC, Licenced	CVP Limited	Kylemore Road, Ballyfermot, Dublin 10, Dublin, 10	820 m	Industry

According to the EPA website, there are no Section 4 discharges[2] to water within 1 km of the site and there have been no reported environmental incidents within 1 km of the site since at least 2010.

3.7 Environmental Sensitivity

The overall environmental sensitivity of the site is considered to be moderate. Identified sensitive receptors within 1 km of the site include:

- The Grand Canal located immediately south of the site, although this may be protected by low permeability clay (natural and/or engineered when the canal was constructed);
- The River Camac located approximately 500 m to the east of the site, although this may be protected by low permeability clay deposits which are likely to be encountered beneath the site; and
- The groundwater aquifer beneath the site, although this may also be protected by low permeability clay deposits which are likely to be encountered beneath the site.

4. Source Audit Findings

4.1 Site Description

The site is situated in Inchicore, Dublin 8, approximately 5.5 km west of Dublin City centre. The leak site was located along a 400 m long section of a 110 kV cable running from Francis Street to the ESB station at Inchicore. The cable was installed in 1964 and is 5.6 km in length (see Figure 2). The location of the leak at cable joint (UG0826) is situated less than 10 m from the Grand Canal on the north bank (ITM 710853 732782); approximately 400 m from Blackhorse Bridge on the Inchicore side of the canal. It is estimated that the cable loss of fluid from the cable occurred between May 2011 and November 2014, with an estimated fluid volume loss of 9,370 Litres during that period.

No evidence of impact from the cable fluid release was noted during the site walkover. There were no visual signs of an oily sheen or hydrocarbon odours in the stream or the canal. There was strong vegetation growth observed along the canal banks with no visual signs of dieback.

[2] Section 4 discharges to water to support the characterisation of waterbodies for the 2nd Cycle of River Basin Management Planning. This dataset takes in account, among other datasets, the Section 4s dataset developed in 2005 as Point Source Pressures for the Article 5 Characterisation and Risk Assessment Report for the Water Framework Directive 2000/60/EC; (European Communities (Water Policy) Regulations 2003 (SI 722 of 2003)).

4.2 Surrounding Land Use

Land use in the immediate vicinity of the site is predominantly light industrial with some residential. Land use in the vicinity of the site is summarised in Table 6.

Table 6. Adjacent Land Use

Site boundary	Land Use
North	The surrounding land to the north (within 500 m) is predominantly industrial, with more residential and commercial mixed land use beyond this (within 1 km). Located immediately north of the site is the Jamestown Business Park hosting several light industrial business units including Proline Architectural Hardware, Lanz Stationary and Name Plate printing. Located 320 m north of the site lie two large diesel storage tanks of the Inchicore Railway Works.
East	Approximately 400 m to the northeast is a cluster of residential developments. The surrounding land to the east (within1 km), is predominately residential and commercial. Commercial buildings include hotels, shops, restaurants and bars. An Applegreen service station is located approximately 1 km to the east of the site. Approximately 800 m east of the site the River Camac intersects with the Grand Canal below Blackhorse Bridge.
South	The surrounding land use to the south (within a 1 km) is predominantly residential and commercial. The Grand Canal bounds the southern edge of the site and beyond this are artificial surfaced playing fields and houses/apartments with and without gardens.
West	Approximately 240 m east of the site, adjacent to Jamestown Business Park, is the ESB Networks Transformer Compound with three substations (Inchicore 10kV Substation, Inchicore 220 kV Substation, 22 kV GIS Substation). Located approx. 600 m northwest of the site is the Allied Industrial Estate and the Westlink Industrial Estate.

4.3 Historic Site Review

A review of historical maps and aerial photographs available from OSI, Glucksman Map Library (Trinity College Dublin) and Google Earth was carried out. A summary of the findings is presented in Table 7.

Table 7. Historic Map and Aerial Photograph Review

Year	Description
1829 to 1841 (OSI)	The site and the surrounding area appear to be predominantly undeveloped and in agricultural use. Few residential and industrial buildings exist within a 1 km radius north and south of the site. Approximately 160 m north of the site is Jamestown house which is surrounded by agricultural fields. Further north, approximately 1 km from the site is an historical quarry named “Old Quarry”. Approximately 700 m to the northeast of the site is a paper mill. The Blackhorse Bridge is located 500 m east of the site connecting Inchicore South to Drimnagh across the Grand Canal. Approximately 220 m south of the site is a woollen mills which is surrounded by agricultural land. Drimnagh Castle is located 800 m to the south of the site.
1897 to 1913 (OSI)	Significant developments can be seen on the 1897 – 1913 maps in the Ballyfermot and Jamestown areas, most notably the industrial appearance of the Inchicore Railway Works Station and the Great Southern and Western Railway line that runs southwest to northeast 600 m north of the site. Approximately 520 m northeast of the site, along Tyrconnell Road, sees the appearance of residential housing. To the south of the site, minor residential development has occurred with five residential houses built on the south bank of the Grand Canal approximately 100 m from the site.
1838 (Six inches to one statute mile) Trinity Map	Site is undeveloped with the land surrounding the site mostly undeveloped greenfields. The Inchicore Railway Works is located to the north of the site (coke oven is indicated). The Grand Canal is to the immediate south of the site running west to east. To the east is Whitehorse bridge that crosses over the Grand Canal. Jamestown House is located to the northwest of the site. The Bluebell river is to the southwest of the site.
1907 (1:2,500) Trinity Maps	The site is undeveloped, as is much of the land to the south. There are filter beds (Dublin Corporation Waterworks) along the southern side of the Grand Canal. There are 10 residential buildings to the southwest of the site. The Bluebell River is now named as the Cammock River. The land to the south of the Grand Canal is named as Bluebell. The bridge to the east is now named as Blackhorse Bridge. The land to the north has been more developed mostly with residential housing. Within the Inchicore Railway Works a gas works is indicated.

Year	Description
1936 (1:2,500) Trinity Maps	There has been further residential development to the south of the site. There is an electricity substation to the northwest of the site. South of Ireland Asphalt Works towing paths run either side of the Grand Canal. To the north there is mainly residential development. The Inchicore Railway Works is now the Great Southern Railway Works; several travelling cranes and tanks and the Drumm Battery Works are located on this site. There is a container factory located to the north of the site. There Nugget Polish Factory is approximately 700 m southwest of the site.
1943-44 (1:2,500) Trinity Maps	The area to the north of the site has been more developed. Land to the southeast of the site includes a large residential estate. There are electricity substations (and tanks) to the northwest and northeast of the site. The land to the north and northeast is heavily developed with residential properties, while the land to the northwest has not been as extensively developed. There is a sheep dip factory to the north of the site. There are two electricity substations to the northwest and north of the site.
1970 (1:1,000) Trinity Maps	To the north there are four factories and an iron foundry to the northeast.
1995 (OSI)	Substantial development of the Drimnagh, Inchicore and Jamestown area is shown on the 1995 aerial photograph. Significant urbanisation is seen within a 1 km radius north and south of the site. The surrounding land has been developed for industrial, residential and commercial use. To the north of the site, within a 500 m radius sees significant industrial development at the Inchicore Rail Works station, with a significant reduction of agricultural land. Approximately 320 m north of the site sees the appearance of two diesel storage tanks for the Inchicore Rail Works. To the south of the site, within in a 1 km radius, sees significant urban residential and commercial development, with a significant decrease in agricultural land.
2000 (OSI)	Minor industrial expansion is seen in the Jamestown area 200 m northwest of the site. The remaining surrounding land to the north and south of the site remains largely unchanged and heavily urbanised.
2005 (OSI)	More industrial development can be seen in the Jamestown, Inchicore area with the appearance of connecting roads and industrial buildings. Within a 1 km radius residential and commercial development remains unchanged.
2012 (Google Earth)	Little to no changes can been seen when comparing the 2005 and 2012 aerial photos in the Jamestown, Inchicore and Drimnagh areas.

4.4 Surface Water and Sediment Sampling

4.4.1 Sample Locations and Analysis

The Surface Water Monitoring Report is included as Appendix C. Surface water samples were taken from the Grand Canal and the drain adjacent to the repair site on four occasions, in July 2019, December 2019, March 2020 and June 2020. Sediment samples were also taken during the first two monitoring rounds. Approximate sample locations are shown on Figure A.

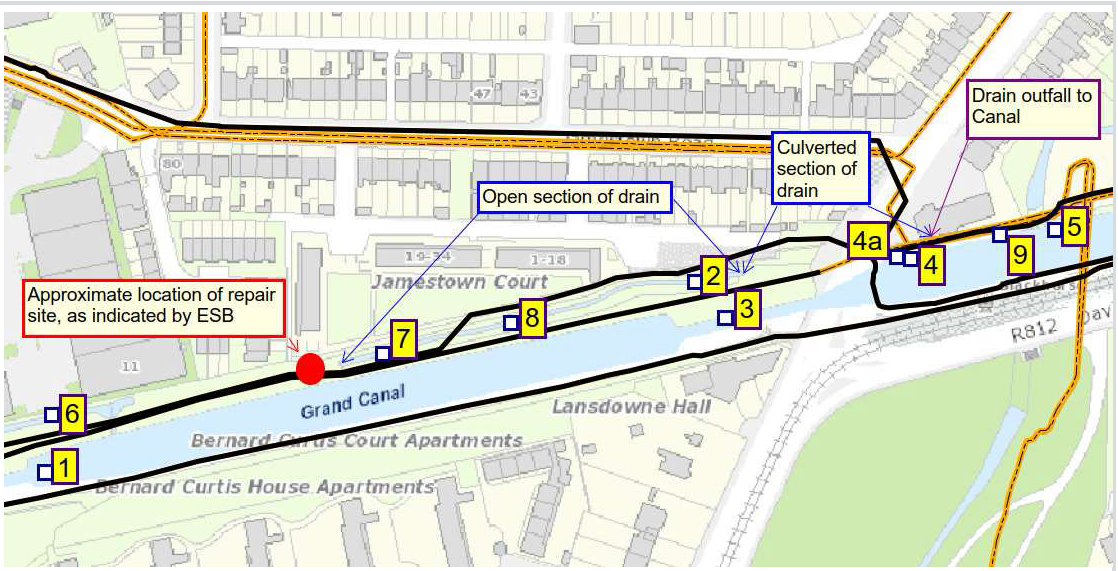


Figure A. Approximate Sample Locations

Sample locations are summarised in Table 8:

Table 8. Sampling Locations

Location	Sample Location No.	July 2019		December 2019			March 2020	June 2020
		Surface Water Sample	Sediment Sample	Surface Water Sample	Pore Water Sample	Sediment Sample	Surface Water Sample	Surface Water Sample
Canal, upstream of repair site	1	SW1	-	SW101	-	-	SW201	SW301
Drain, immediately upstream of bridge	2	SW2	SED2	SW102	PW102	SED102	SW202	SW302
Canal lock upstream of bridge	3	SW3	-	SW103	-	-	SW203	SW303
Canal, adjacent/below outfall from culvert, downstream of bridge	4	SW4	SED4	SW104	PW104	SED104	SW204	SW304
Canal, adjacent/below outfall from culvert, within the containment boom downstream of bridge	4a	-	-	-	-	-	SW204A	SW304A
Downstream location within canal	5	SW5	-	SW105	-	-	SW205	SW305
Drain, upstream of repair site	6	-	-	SW106	-	-	SW206	SW306
Drain, immediately downstream of repair site	7	-	-	SW107	-	-	SW207	SW307
Drain, between repair site and culvert	8	-	-	SW108	-	-	SW208	SW308
Canal, downstream of culvert outfall	9	-	-	SW109	-	-	SW209	SW309

Samples were tested for parameters including:

- Speciated total petroleum hydrocarbons (TPH);
- Benzene, toluene, ethylbenzene and xylene (BTEX) compounds;
- Polychlorinated Biphenyls (PCBs);
- Extractable petroleum hydrocarbon (EPH) CWG Interpretation;
- Polycyclic Aromatic Hydrocarbons (PAH);
- Volatile Organic Compounds (VOC); and
- Semi Volatile Organic Compounds (SVOC).

4.4.2 Results

With the exception of TPH, the above parameters in soil and sediment samples were less than the laboratory detection limited or below their relative assessment criteria.

Total TPH (>C_5-C_{35}) results from the four rounds of sampling are summarised in Table 9 below:

Table 9. Summary of TPH concentrations

Sample Location	TPH (>C5-C35 Aliphatics & Aromatics) Concentration						
	July 2019			December 2019		March 2020	June 2020
	SW (µg/l)	Sed (mg/kg)	SW (µg/l)	Sed (mg/kg)	PW (µg/l)	SW (µg/l)	SW (µg/l)
Canal samples							
SW1/SW101/SW201/SW301	<10	-	<10	-	-	<10	<10
SW3/SW103/SW203/SW303	<10	-	<10	-	-	<10	<10
SW4/SW104/SW204/SW304	<10	70	<10	105	4,910	<10	<10
SW204A/SW304A	-	-	-	-	-	<10	<10
SW5/SW105/SW205/SW305	<10	-	<10	-	-	<10	<10
SW109/SW209/SW309	-	-	<10	-	-	<10	<10
Drain samples							
SW2/SW102/SW202/SW302	740	12,153	<10	17,005	6,937	80	520
SW106/SW206/SW306	-	-	<10	-	-	<10	<10
SW107	-	-	240	-	-	-	-
SW108/SW208/SW308	-	-	16,640	-	-	170	2,390

Notes: SW = surface water; Sed. = sediment; PW = pore water.

Surface water results show similar results across the four monitoring rounds in the samples taken from the canal and in the drain upstream of the historical repair site, with all TPH concentrations below the MDL at these locations. EPH interpretation undertaken on samples indicated the presence of LAB in surface water and sediment in the drain, and in sediment in the canal (EPH was not detected in surface water in the canal). Mineral oil was not reported in any samples.

4.4.3 Discussion

Surface water in the drain upstream of the repair site was not found to contain detectable concentrations of TPH. During all sampling events, surface water samples within the drain downstream of the historical repair site were found to be impacted by TPH which was interpreted by the laboratory as LAB. While TPH concentrations in these samples exceeded GAC, the GAC for TPH is based on a conservative Interim Guideline Value.

Sediment within the drain was also visibly impacted by hydrocarbons, with a sheen forming on the surface of the water when the sediment was disturbed. The sediment was found to contain elevated concentrations of TPH, although no exceedances of GACs were noted (sampled in July and December only). Within the canal, TPH was not recorded above the MDL in any surface water samples, either upstream or downstream of the drain outfall, for all four sampling events completed through the year.

Sediment and porewater within sediment from the canal, immediately adjacent/below the drain outfall, were noted to contain concentrations of LAB; however, these were significantly lower than those recorded within the drain sediments.

4.5 Potential Sources

4.5.1 Cable Fluid Source

Information on the potential fluids released was provided in the ESB RFP document. Typically, fluid filled cables are installed in trenches approximately 1.2 m deep, 1.1 m wide and the depth to the top of the cable is typically 0.9 m – 1 m. The cables are typically surrounded by 0.35 m of sand and then the trench is backfilled with either clause 804 fill or trench arisings.

Based on information from the GSI, it is likely that the cable on this site is installed within sand and backfilled with made ground, therefore leaked fluid is likely to have migrated through either the sand surround or made ground (if sufficient permeability).

It is estimated that 9,370 litres of cable fluid was released between May 2011 and November 2014.

It is assumed, based on records and Safety Data Sheets (SDS) provided to AECOM by ESB, that the fluid lost was a mixture of the following cable fluid products:

- 'T 3788' manufactured by H&R ESP Ltd of Milton Keynes in the UK;
- 'Masse 106' produced by Felten & Guilleaume Energietechnik AG in Germany; and
- Shell Diala Cable Oil.

T 3788 is a low viscosity blend of linear alkyl benzenes (LABs) (CAS # 67774-74-7). Shell Diala Cable Oil has the same CAS # as T 3788, so is essentially the same product but made by a different manufacturer. The SDS for Masse 106 does not give its CAS # or details of its composition but states that it is a blend of highly refined mineral oils and additives.

It is noted mineral oil was not detected in surface water or sediment in the drain or canal during sampling; however, in order to provide a conservative approach to the PSA, it is assumed mineral oil based products could be present in soil and groundwater at the leak location.

4.5.1.1 Linear Alkyl Benzenes

Physical and Chemical Properties

LABs have side alkyl chains of 10-13 carbon atoms in length attached to a benzene ring. The alkyl chain may be attached to the benzene ring at any position except the terminal (end) position. As LABs are a mixture, their precise physio-chemical properties are dependent upon the components of the mixture, but they are generally colourless, oily liquids, less dense than water, with very low aqueous solubility and low volatility. Their potential spreading in the ground will therefore be similar to other light non-aqueous phase liquids (LNAPL) but with very little mass loss due to volatilisation or dissolution.

Information relating to the nature and toxicity of linear alkyl benzenes has been primarily sourced from the following documents:

- Safety Data Sheet (SDS) for T 3788;
- European Union Risk Assessment Report, Benzene, C10-13 alkyl derivatives, 20 June 1997; and
- Organisation for Economic Co-operation and Development (OECD) Screening Information Datasets (SIDS) Initial Assessment Reports for High Production Volume Chemicals, United Nations Environment Programme, Chemicals Branch, May 2002.

The table below summarises the basic physical and chemical properties of LABs.

Table 10. Linear Alkyl Benzene Physical and Chemical Properties

Property	Description
Molecular Weight	239-243 g/mol
Melting Point	<-70^{o}C
Boiling Point	251-320^{o}C @ 1 atm (OECD)
Vapour Pressure @ 25^{o}C	6.5 x 10^{-5} kPa (OECD)

Property	Description
Aqueous Solubility	0.041 mg/L (OECD)
Henry's Law Constant	9.34 x 10^{-4} atm-m^3/mol (OECD)
Density	0.86 @ 20°C
Flash Point	140°C
Explosive Properties	None

LAB (C12) has a calculated octanol-water partition coefficient (Koc) of $2.2x10^4$ and is classified by the EU risk assessment as a high adsorptive substance.

Degradation

The OECD SIDS (2002) review concluded that LABs undergo "rapid primary biodegradation in natural waters and complete mineralisation by micro-organisms under aerobic conditions". A measured half-life in water of four to nine days was reported. Microorganisms in sewage sludge and soil were reported to rapidly and completely biodegrade LABs. Anaerobic biodegradation was inferred to occur, but at a slow rate.

Degradation in soil is expected to occur but to be slower than in surface water due to the much slower mixing and the limited availability of oxygen. Where oxygen is available, aerobic degradation would occur at the fringes of a body of LNAPL in the soil/groundwater, producing elevated carbon dioxide levels in the soil and potentially elevated alkalinity in the groundwater. In the absence of oxygen, anaerobic degradation may occur by methanogenesis or by reduction of sulphate, nitrate, ferric iron (Fe^{3+}) and manganese (Mn^{3+}). These processes could lead to reducing conditions in the groundwater, with depleted concentrations of sulphate (SO_4^-) and nitrate (NO_3^-) and increased concentrations of dissolved methane (CH_4), ferrous iron (Fe^{2+}) and dissolved manganese (Mn^{2+}). Such conditions would be expected to occur close to the LNAPL body and locally downgradient. With increased distance from the LNAPL, mixing with the surrounding groundwater and aeration from seasonal fluctuations and groundwater recharge would gradually allow ambient (most likely oxidised) conditions to be re-established.

Toxicity

According to the OECD review, LABs were assessed to be not acutely toxic to human health. Data from repeat exposure, reproductive and genotoxicity studies also indicated a low potential for toxic effects. The OECD concluded that "Linear alkyl benzenes do not present any significant acute or sub-chronic health effects by various exposure routes. LAB is not teratogenic (i.e. causing birth defects) and does not produce selective reproductive toxicity."

Laboratory studies have shown that repeated exposure to LABs may be irritating to the skin, and the SDS recommends the use of gloves when handling LABs. The low vapour pressure of LABs limits the potential for exposure via inhalation, and this is not expected to be a significant exposure route at normal temperatures.

Eco-toxicity studies reviewed by the OECD found no acute toxic effects on aquatic species tested at concentrations up to and exceeding solubility limits. The only exception to this was for the water flea Daphnia magna. No data was available regarding terrestrial eco-toxicity studies.

Due to its high biodegradability and rapid metabolism, the OECD concluded that LABs were of little concern for adverse environmental impact. The OECD and EU reviews of LABs both concluded that LABs were a low priority for further investigation.

4.5.1.2 Masse 106 Mineral Oil

Information on Masse 106 has been obtained from a Safety Data Sheet (SDS) dated 1995 provided by ESB.

Physical and Chemical Properties

Masse 106 is understood to be a blend of highly refined mineral oils and additives. The SDS does not provide information on the identity of the mineral oils or additives, or on their proportions within the oil.

The SDS states that containers of Masse 106 should be kept tightly closed and in a well-ventilated space and that it should be used only in well-ventilated areas. This suggests that Masse 106 may contain volatile components.

The table below summarises information from the SDS for Masse 106.

Table 11. Masse 106 Physical and Chemical Properties

Property	Description
Vapour Pressure @ 20°C	<0.01 hPa
Aqueous Solubility	negligible
Density	888 kg/m^3
Flash Point	145°C
Flammability range	0.6% volume to 6.5% volume
Kinematic viscosity@ 40°C	8.5 mm^2/s

Based on these properties, Masse 106 would behave as a relatively viscous LNAPL in the ground. The SDS states that if the product enters soil it will be adsorbed to soil particles and not be mobile.

Degradation

The SDS for Masse 106 indicates that it is not readily biodegradable. Nevertheless, as it is expected to be comprised mainly of petroleum hydrocarbon compounds, gradual degradation is expected to occur, especially in water. The rate of biodegradation is likely to depend on the availability of oxygen and of favourable geochemical conditions. As with LABs and with other petroleum hydrocarbons, where oxygen is available, aerobic degradation would be expected to occur at the fringes of a body of LNAPL in the soil/groundwater, producing elevated carbon dioxide levels in the soil and potentially elevated alkalinity in the groundwater. In the absence of oxygen, anaerobic degradation may occur by methanogenesis or by reduction of sulphate, nitrate, ferric iron (Fe^{3+}) and manganese (Mn^{3+}). These processes could lead to reducing conditions in the groundwater, with depleted concentrations of sulphate (SO_4^-) and nitrate (NO_3^-) and increased concentrations of dissolved methane (CH_4), ferrous iron (Fe^{2+}) and dissolved manganese (Mn^{2+}). Such conditions would be expected to occur close to the LNAPL body and locally downgradient. With increased distance from the LNAPL, mixing with the surrounding groundwater and aeration from seasonal fluctuations and groundwater recharge would gradually allow ambient (most likely oxidised) conditions to be re-established.

Toxicity

The 1995 SDS for Masse 106 states that the components of the preparation are not expected to impart hazardous properties to the product. Whilst this suggests the product is not hazardous, it is noted that standards for hazard assessment and SDS production have evolved since 1995 and therefore the information cannot be relied upon with full confidence in relation to current standards for hazard assessment.

The SDS indicates that Masse 106 is expected to be practically non-toxic to aquatic organisms.

In relation to human toxicity, the SDS gives the following information:

- It is expected to be slightly irritant, so all forms of skin contact should be minimised. It is not expected to be a skin sensitiser.

- Respiratory protection is not normally required but it should be used only in well-ventilated spaces. It is based on mineral oils and other components not known to be carcinogenic.

4.5.1.3 Surface Water Analysis

Surface water sampling has been undertaken in the drain adjacent to the repair site, as described in Section 4.4. The analysis undertaken has indicated that the drain has been impacted by LAB only, no mineral oil was detected. However, the presence of mineral oil in soil and groundwater around the leak location cannot be discounted on the basis of this sampling.

4.5.1.4 Conclusion

Based on the above, underground leakage of LABs is not likely to lead to significant issues from dissolved hydrocarbons or vapours. Although the components of Masse 106 are not known and its aqueous solubility is stated on the SDS as “negligible”, it is unclear what this means in the context of dissolution of components from a NAPL. Based on the requirement for it to be used only in well-ventilated spaces, it appears that Masse 106 contains some relatively volatile components.

The main concern from LABs and a concern also for mineral oils such as Masse 106 is the potential for them to migrate and spread as a LNAPL, downwards through unsaturated soil that is present and then laterally in the vicinity of the groundwater table. The extent of LNAPL migration will depend on the properties of the surrounding soil and on the saturation and pressure distribution within the LNAPL. These in turn would depend on the quantity of cable fluid lost and the timescale over which the leakage occurred.

Vapour impacts are considered to be unlikely from LABs but could be of concern for Masse 106, if found to be present as a source around the leak location.

Degradation of the cable fluid may lead to the generation of ground gas (including carbon dioxide and methane) and affect groundwater chemistry in the vicinity and locally downgradient of the LNAPL.

Given that a mixture of LABs and a mineral oil based cable fluid have been used in the past, potential contaminants of concern associated with mineral oil based fluids could include the following:

- Total Petroleum Hydrocarbons (TPH);
- Benzene, toluene, ethylbenzene and xylene (BTEX) compounds;
- Volatile organic compounds (VOCs); and
- Semi volatile organic compounds (SVOCs).

4.6 Source Audit Summary

Based on the assessment works completed, the primary APEC for this site comprises the leak location identified by ESB Networks. This is presented in Figure 2 and a description is provided in Table 12.

Table 12. Area of Potential Environmental Concern

Number	APEC	Potential Contaminants of Concern	Potential Media Impacted
1	Leak at (18) Francis Street - Inchicore 110 kV (May 2011 – November 2014)	LABs TPH BTEX VOCs SVOCs	Soil Groundwater Soil Vapour Ground Gas

Other potential off-site sources have also been identified based on the type of activity. However, no information is available for these sites therefore the only APEC assessed herein is the leak site beneath the north bank tow path on the Grand Canal adjacent to Jamestown Industrial Estate.

5. Conceptual Site Model

A preliminary Conceptual Site Model (CSM) has been developed identifying potential contaminant sources, contaminant migration pathways and potential receptors.

In the context of land contamination, there are three essential elements to any risk:

1. A **source** – a substance that is in, on or under the land and has the potential to cause harm or to cause pollution of controlled waters;
2. A **receptor** – in general terms, something that could be adversely affected by a contaminant, such as people, an ecological system, property, or a water body; and
3. A **pathway** – a route or means by which a receptor can be exposed to, or affected by, a contaminant.

Each of these elements can exist independently, but they create a risk only where they are linked together, so that a particular contaminant affects a particular receptor through a particular pathway. This kind of linked combination of contaminant–pathway–receptor is described as a pollutant linkage. The preliminary CSM was developed to describe viable source-pathway-receptor (SPR) linkages for the site, which are presented in Table 17 below.

By considering potential SPR linkages, an assessment of the human health and controlled water risks is made with reference to the significance and degree of the risk. The risk assessment has been undertaken with reference to BS10175-2011 + A2 2017 and CIRIA Document C552: 'Contaminated Land Risk assessment - A Guide to Good Practice' (2001).

The preliminary risk assessment completed for this site is based on consideration of whether a potential source of contamination can reach a receptor, and hence whether it is of major or minor significance. Considering that assessment works are still at preliminary stage and no intrusive investigation work has been completed, development of the preliminary CSM and assessment of potential risk is based on information provided by ESB on the nature of the leak, and on the AECOM site reconnaissance and desk based study. As such, only a qualitative assessment can be made around potential risks to receptors. This means that identification of potential risk does not necessarily indicate a risk to a receptor, rather that further assessment may be required to investigate assumptions made in the CSM and quantify whether a potential risk actually exists.

5.1 Qualitative Risk Assessment Methodology

A qualitative risk assessment has been carried out by assessing the severity of the potential consequence, taking into account both the potential severity of the hazard and the sensitivity of the target, based on the categories given in Table 13.

Table 13. Potential Hazard Severity Definition

Category	Definition
Severe	Acute risks to human health, catastrophic damage to buildings/property, major pollution of controlled waters.
Medium	Chronic risk to human health, pollution of sensitive controlled waters, significant effects on sensitive ecosystems or species, significant damage to buildings or structures.
Mild	Pollution of non-sensitive waters, minor damage to buildings or structures.
Minor	Requirement for protective equipment during site works to mitigate health effects, damage to non-sensitive ecosystems or species.

The likelihood of an event (probability) takes into account both the presence of the hazard and target and the integrity of the pathway and has been assessed based on the categories given in Table 14.

Table 14. Probability of Risk Definition

Category	Definition
High l kelihood	Pollutant linkage may be present, and risk is almost certain to occur in long term, or there is evidence of harm to the receptor.
Likely	Pollutant linkage may be present, and it is probable that the risk will occur over the long term.
Low l kelihood	Pollutant linkage may be present, and there is a possibility of the risk occurring, although there is no certainty that it will do so.
Unlikely	Pollutant linkage may be present, but the circumstances under which harm would occur are improbable.

The potential severity of the risk and the probability of the risk occurring have been combined in accordance with the following matrix in order to give a level of risk for each potential hazard as shown in the table below.

Table 15. Level of Risk for Potential Hazard Definition

Probability of Risk	Potential Severity			
	Severe	Medium	Mild	Minor
High	Very high	High	Moderate	Low/Moderate
Likely	High	Moderate	Low/Moderate	Low
Low	Moderate	Low/Moderate	Low	Very low
Unlikely	Low/Moderate	Low	Very low	Very low

A description of the levels of risk outlined in Table 16 is provided in the following table:

Table 16. Description of the Classified Risks and Likely Action Required

Level of Risk	Description
Very High Risk	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, or there is evidence that severe harm to a designated receptor is currently happening. This risk, if realised, is likely to result in substantial liability. Urgent investigation and remediation are likely to be required.
High Risk	Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation is required and remedial works may be necessary in the short term and are likely over the long term.
Moderate Risk	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild, if realised.
Low Risk	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.
Very Low Risk	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be severe.

5.2 Preliminary CSM Assumptions

Based on the findings of the desktop study and information provide in the RFP by ESB, the following assumptions were made in development of the CSM:

- The fluid assumed (based on records provided) to have leaked from the cable is a mixture of LAB and a mineral oil based cable fluid. As no mineral oil was detected during surface water and sediment sampling, the potential for mineral oil to be present around the leak location is considered a conservative approach;
- The geology beneath the site is assumed to comprise approximately 2 m of made ground underlain by clay up to a depth of 8 m bgl. Limestone bedrock (classified as a locally important aquifer) is assumed to be present at a depth of approximately 8 m bgl;
- Perched groundwater is assumed to be present at relatively shallow depths within the made ground. Situations could occur where groundwater within the made ground is in continuity with groundwater in the bedrock aquifer (e.g. where there is a minimal thickness of low permeability clay present between the two strata);
- It is assumed that the Grand Canal adjacent to the site is lined with an impermeable material such as clay, as was commonly used from the 1700s to early 20th Century to prevent leakage from the canal and thus loss of water level restricting navigation;
- It is assumed that the drain adjacent to the site is not lined and is in hydraulic continuity with groundwater beneath the site;
- It is assumed that there is direct connection between the site and the Grand Canal due to the presence of the drain discharging to the Grand Canal;
- Other below ground utilities including mains water are assumed to be present in the vicinity of the site; and
- It is assumed that industrial/commercial buildings adjacent to the site have no basements.

The preliminary CSM is presented graphically in Figure 3.

Table 17. Conceptual Site Model

Source	Pathway	Receptor	Severity	Likelihood	Potential Risk	Discussion
LAB / Volatile TPH and VOC concentrations in soils	Inhalation of vapours which have migrated from the ground to above ground buildings and basements.	Industrial/commercial/ low to high density residential scenario.	Medium	Low Likelihood	Low / Moderate	Based on records provided, a mixture of LAB and mineral oil is assumed to be the cable fluid used. While no mineral oil was detected during surface water and sediment sampling, the potential for mineral oil to be present in soil and groundwater around the leak location is being considered as a conservative approach. The low vapour pressure of LABs limits the potential for exposure via inhalation, and this is not expected to be a significant exposure route at normal temperatures. It is considered that there is a low to moderate risk from the inhalation of vapours from potential mineral oil-based products present beneath the site. Further assessment would be required to fully evaluate this potential risk.
NAPL and non-volatile TPH, VOC and SVOC concentrations in soils	Soil and dust ingestion from near surface soils. Dermal contact with near surface soils. Inhalation of fugitive dust from near surface soils. Ingestion of soils via consumption of vegetables grown in near surface soils.	Industrial/commercial/ low to high density residential with plant uptake scenario.	Medium	Unlikely	Low	Based on the volume of cable fluid released and the assumed mixture of cable fluid used in the past, it is possible that a mineral based cable fluid may have migrated beneath low density residential houses with gardens or public open space adjacent to the canal. Given the l kely depth to the cable, surface soils are unlikely to be affected and exposure via this pathway is not considered likely.
		Intrusive site workers.	Minor	Likely	Low	Workers carrying out intrusive works adjacent to the site may come into contact with mineral oil based NAPL and impacted soil, meaning there will be a requirement to wear personal protective equipment to mitigate against potential impacts. Given the relatively low toxicity of LABs (assessed to be not acutely toxic), exposure to LABs is not considered to represent a significant risk. However, health and safety plans and the selection of appropriate personal protective equipment for intrusive works should take into consideration the presence of LAB.
NAPL and TPH, VOC, SVOC concentrations in groundwater	Migration of ground gas generated from the degradation of the cable fluid to above ground buildings.	Industrial/commercial/ low to high density residential scenario.	Severe	Low Likelihood	Moderate	If a significant source of NAPL (LAB or mineral oil) is present on groundwater, there is potential for ground gas to be generated from degradation processes. The likelihood of ground gas being generated in significant quantities is considered to be low, however given the potential severity of the impact, further assessment would be required to fully evaluate this potential risk.

Source	Pathway	Receptor	Severity	Likelihood	Potential Risk	Discussion
NAPL and TPH, VOC and SVOC concentrations in soils	Permeation of LAB NAPL through plastic water supply pipes.	Industrial/commercial/ low to high density residential with plant uptake scenario.	Medium	Unlikely	Low	Public water mains likely to be present in the vicinity of the leak, servicing commercial and residential properties have the potential to be impacted. With respect to LABs, the WHO drinking water guideline (DWG) for the relevant aromatic fraction[3] is 0.09 mg/l and as the solubility limit of LAB is 0.041 mg/L (OECD) i.e. less than the DWG, LAB cannot dissolve into the water supply above this level. Furthermore, water will be moving rapidly in the pipe under pressurised conditions making it unlikely to reach the solubility limit. In respect of the potential presence of mineral oil, the aqueous solubility of the known product used (Masse 106) is stated on the SDS as "negligible". It is unclear what this means in the context of dissolution of components from a NAPL. ESB has consulted with Irish Water (statutory body responsible for water supply) regarding the potential risk for cable fluid present in the vicinity of water supply pipes. Following review of their records, AECOM understands that Irish Water do not have concerns regarding impact of water supplies from cable fluid leaks. It is therefore considered that the potential risk of a pollutant linkage being present is low. As a precaution, investigation works should be carried out as part of future assessment works to further assess this source-pathway-receptor linkage.
NAPL and TPH, VOC and SVOC concentrations in soils	Migration of potential contaminants along preferential flow pathways such as underground services, permeable backfill around the electricity cable and drain adjacent to site.	Camac River and Grand Canal.	Medium	Unlikely	Low	While the drain adjacent to the repair site has been impacted by LAB, no impact to surface water in the Grand Canal has been detected from four rounds of surface water monitoring undertaken at the site.

Source	Pathway	Receptor	Severity	Likelihood	Potential Risk	Discussion
NAPL and TPH, VOC and SVOC concentrations in soils	Migration of potential contaminants along preferential flow pathways such as underground services and permeable backfill around the electricity cable.	Industrial/commercial/ low to high density residential with plant uptake scenario.	Medium	Low Likelihood	Low / Moderate	Likely to be a high concentration of services present in the vicinity of the leak given the urban setting. If the soil / made ground around the leak is generally clay, the leaking fluid will likely have migrated mainly along any permeable backfill around the cable. The cable fluids used are likely to absorb strongly to aquifer materials (made ground and clay), consequently the potential for migration over significant distances is considered to be low to moderate. Further assessment would be required to fully evaluate this potential risk.
NAPL	Migration in saturated and unsaturated soil.	Perched groundwater beneath the site.	Medium	L kely	Moderate	Considering the volume of cable fluid released over the 41-month leak period, it is considered highly likely that perched groundwater has been impacted. Impacts could occur due to the presence of NAPL and associated biodegradation products. Further works would be required to assess for the presence of NAPL in the vicinity of the leak location and fully evaluate this potential risk.
Dissolved phase leaching from NAPL or from soils containing elevated concentrations of TPH, VOCs and SVOCs	Leaching from soil to groundwater. Vertical and horizontal migration of contaminants through groundwater. Horizontal migration of contaminants through groundwater to nearby surface water receptors.	Groundwater in superficial deposits beneath the site.	Medium	L kely	Moderate	Considering the volume of cable fluid released over the 41-month leak period, it is considered likely that groundwater in superficial deposits has been impacted. Further assessment would be required to quantify any impact from the presence of dissolved phase contamination in groundwater in the vicinity of the leak location.
LAB, TPH and VOC, SVOC concentrations in groundwater		Groundwater in limestone bedrock aquifer beneath the site.	Medium	Low Likelihood	Low / Moderate	Information on the local geology indicates the presence of underlying stiff clay, which would reduce vertical migration of groundwater to the bedrock aquifer. Further assessment would be required to fully evaluate this potential risk.

Source	Pathway	Receptor	Severity	Likelihood	Potential Risk	Discussion
		Camac River and Grand Canal.	Medium	Unlikely	Low	The Grand Canal is considered to be a sensitive controlled waters receptor and therefore any pollution would be a potential hazard of medium severity. However, the probability of risk is considered unlikely. No vis ble impact to surface water in the Canal downstream of the drain outlet was observed during four site visits. Four rounds of surface water monitoring did not indicate concentrations of TPH compounds at any sampled locations within the canal above the MDL. Furthermore, LAB is not considered a highly toxic substance to aquatic organisms.

6. Conclusions

AECOM completed a Preliminary Site Assessment and surface/sediment water sampling of the site located on the north bank of the Grand Canal to the west of Blackhorse Bridge Dublin, 8. The objective of the works was to identify potential risks to human health and controlled waters that may be associated with a fluid leak from the identified location.

Based on the findings of the desktop study, the overall environmental sensitivity of the site is considered to be moderate. Identified sensitive receptors within 1 km of the site include:

- The Grand Canal located immediately south of the site, although this may be protected by low permeability clay (natural and/or engineered when the canal was constructed);
- The River Camac located approximately 500 m to the east of the site, although this may be protected by low permeability clay deposits which are likely to be encountered beneath the site; and
- The groundwater aquifer beneath the site, although this may also be protected by low permeability clay deposits which are likely to be encountered beneath the site.

It is estimated that 9,370 litres of cable fluid was released between May 2011 and November 2014. It is assumed, based on information provided to AECOM by ESB, that the fluid lost was a mixture of LAB and mineral oil based products. It is noted no mineral oil was detected during surface water and sediment sampling of the canal and drain; however, in order to provide a conservative approach to the PSA, it is assumed mineral oil based products could be present in soil and groundwater at the leak location. Due to its high biodegradability, lower volatility and low solubility, it is considered that LABs are of less concern for adverse environmental impact than mineral oil based products. Given that there is potential for a mixture of both types of cable fluids to have been used at this site, potential contaminants of concern have been identified. A summary of the source audit findings is as follows:

Table 18. Area of Potential Environmental Concern

Number	APEC	Potential Contaminants of Concern	Potential Media Impacted
1	Leak at (18) Francis Street – Inchicore 110 kV (May 2011 – November 2014)	LABs TPH BTEX VOCs SVOCs	Soil Groundwater Soil Vapour Ground Gas

Surface water and sediment sampling undertaken on the drain adjacent to the site and the Grand Canal. The drain runs from west to east along the northern site boundary paralleling the Grand Canal (water in the drain appeared stagnant and heavy weed growth/items of rubbish were observed). The analysis has indicated the presence of LAB within the drain surface water and sediment and, to a lesser extent, in sediment at where the drain discharges to the Grand Canal. However, concentrations of hydrocarbons have been below the detection limit in all surface water samples collected from the Grand Canal in each of the four rounds of monitoring. This indicates there is no significant impact to surface water within the canal. No mineral oil was detected during sampling.

The preliminary CSM developed for the site looked at potential source-pathway-receptor linkages identified during the assessment works and identified a moderate potential risk to the following receptors:

- Industrial/commercial and residential receptors due to the potential for ground gas generation resulting from degradation of NAPL (if present in soil and groundwater around the leak location); and
- Perched groundwater due to potential impact to groundwater chemistry from the presence of NAPL and associated biodegradation products around the leak location.

A low to moderate risk was identified to receptors from the potential for vapour migration from mineral oil based cable fluid (if present in soil and groundwater around the leak location) and from the migration

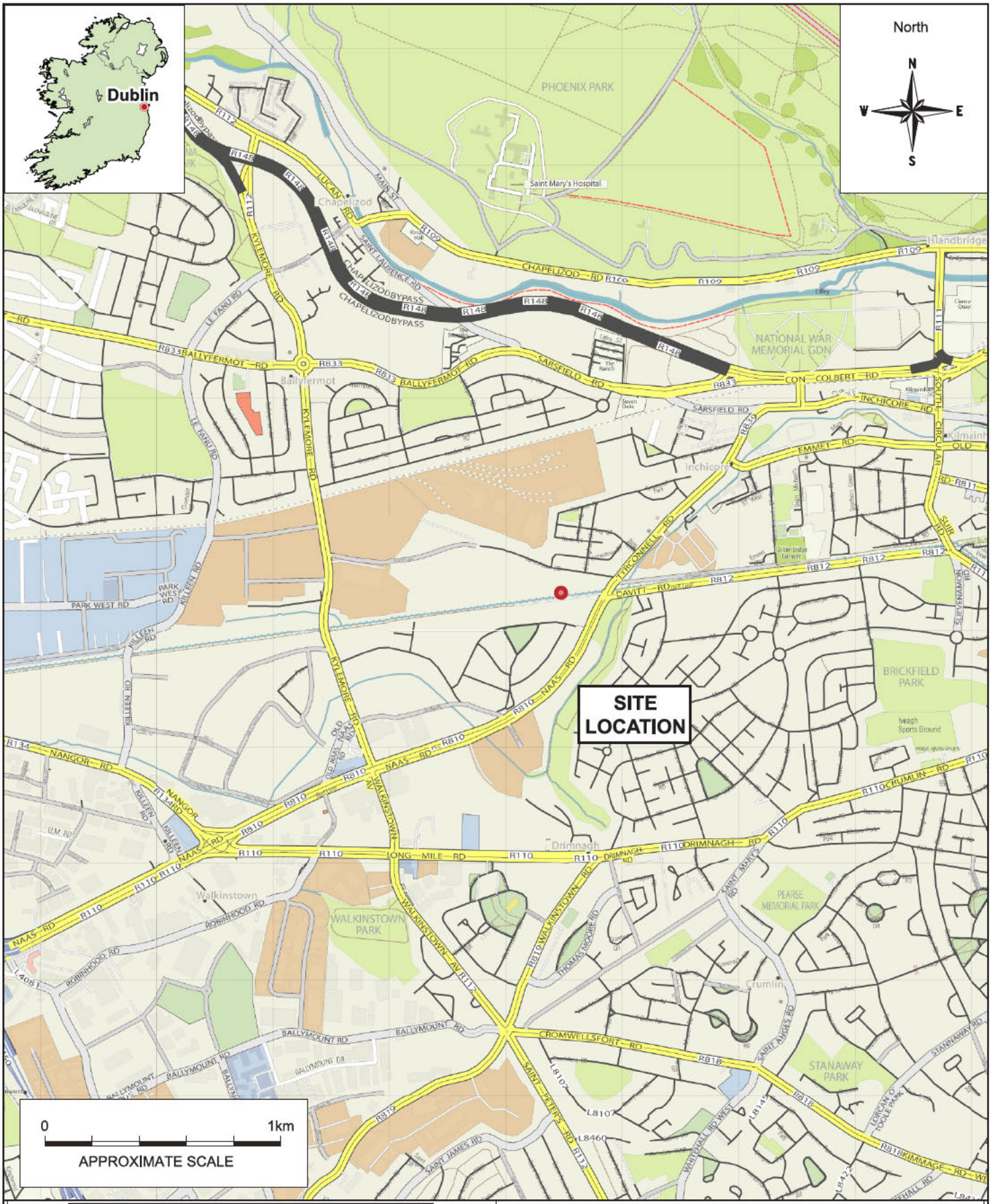
of NAPL and potential breakdown products along preferential flow pathways such as existing underground services.

Potential impact to the bedrock aquifer from contaminants around the leak location was considered to be low to moderate due to the geology beneath the site.

Risks associated with other potential source-pathway-receptor linkages were considered to be low.

The risk assessment completed herein is preliminary in nature as it can only be based on an evaluation of qualitative data sources (i.e. not on intrusive site investigation works). Consequently, identification of potential risk does not necessarily indicate a risk to a receptor, rather that further assessment may be required to investigate assumptions made in the CSM and quantify whether a potential risk actually exists. Generally, where a low or very low risk has been identified further assessment may not be deemed necessary to assess a particular SPR linkage, although further assessment may be deemed to be required to investigate CSM assumptions where the potential risk is considered to be low or very low due to the sensitivity of the receptor.

Figures



Client

ELECTRICITY SUPPLY BOARD

Location

SITE 18
Francis Street
Inchicore 110 kV

Drawing Title

FIGURE 1 - SITE LOCATION MAP

AECOM

4TH FLOOR, ADELPHI PLAZA, ADELPHI CENTRE, GEORGE'S STREET UPPER,
DUN LAOGHAIRE, CO. DUBLIN, IRELAND. T+353 (0)1 238 3100, F +353 (0)1 238 3199

DRAWN	ILLUSTRATED	CHECKED	APPROVED	DATE
RH		CC	DM	AUG 19

SCALE	Job No.	REV.
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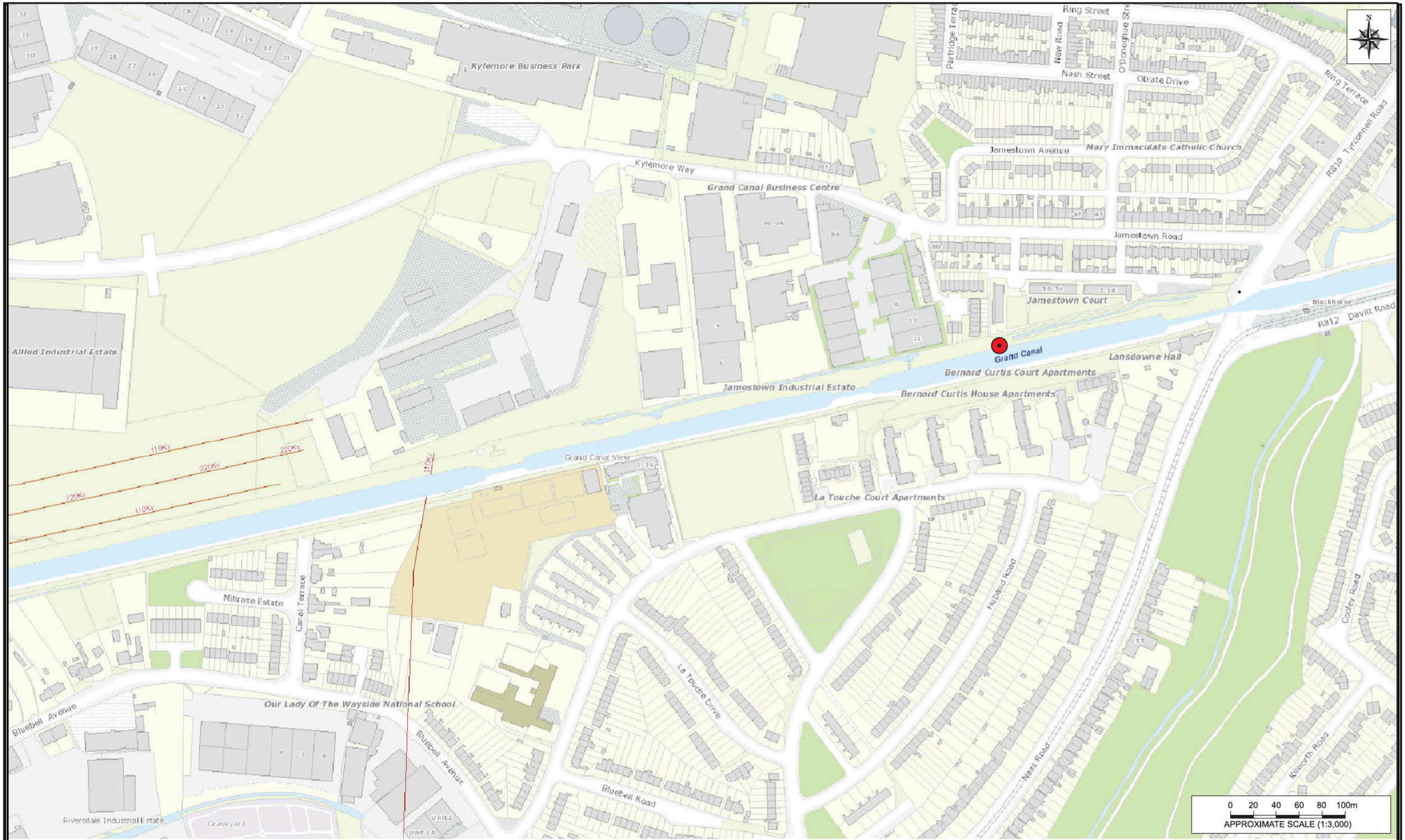


KEY:

Indicatve Leak Location

NOTES:

Rev	Date	Detail	Made	Chk'd	App'd
Status:	FOR INFORMATION				

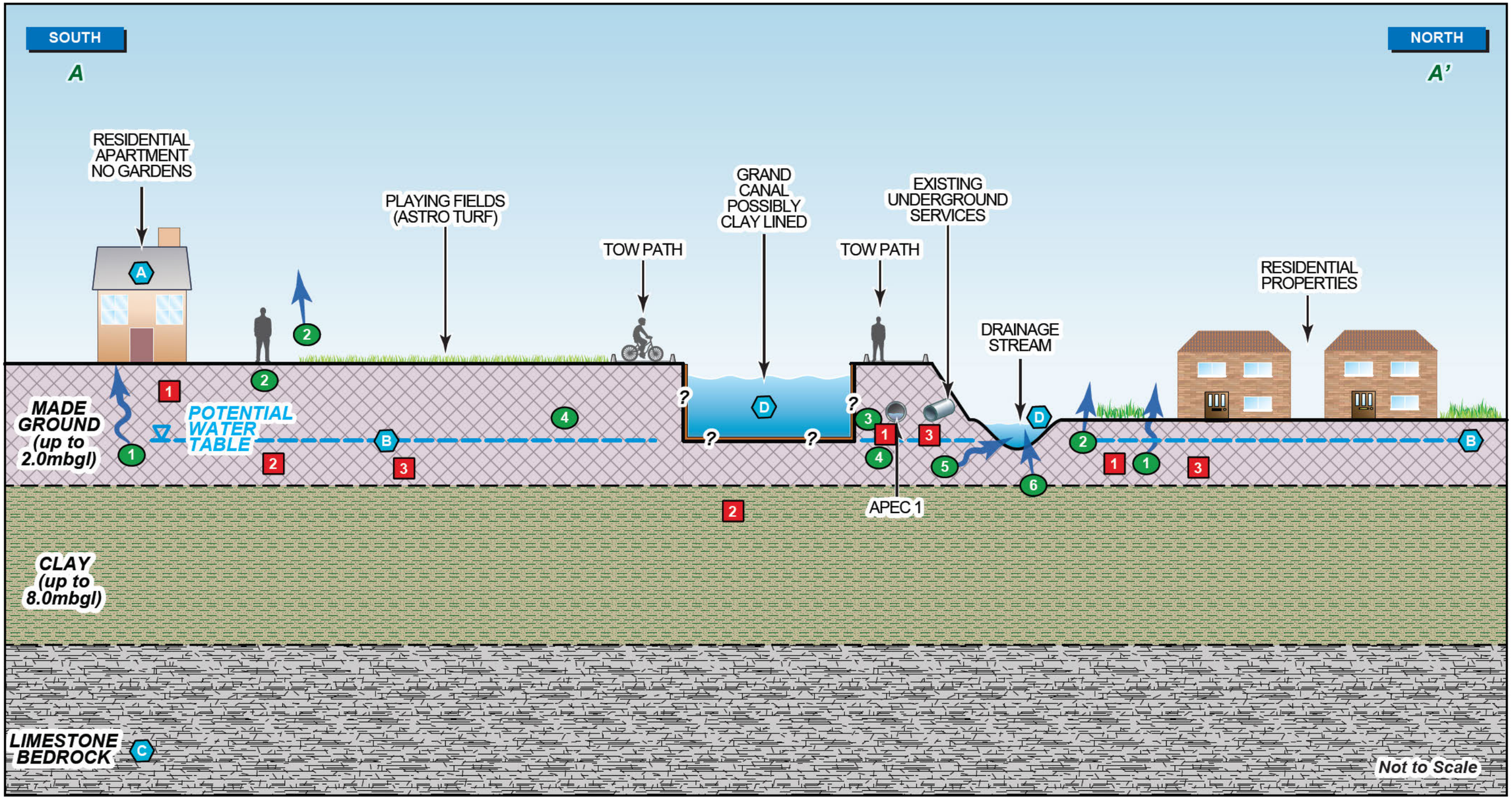
Client: ELECTRICITY SUPPLY BOARD

Location: SITE 18 Francis Street Inchicore 110 kV

Title: FIGURE 2 SITE LAYOUT PLAN

AECOM
4th Floor, Adelphi Plaza, Adelphi Centre, George's Street Upper, Dun Laoghaire, Co. Dublin, Ireland.
Tel: +353 (0) 1 293 3200
Fax: +353 (0) 1 293 3201
www.aecom.com

Design: ESB	Drawn: RDH		
Chk'd: CC	App'd: DM		
Date: AUG 2019	Scale: As Shown		
Project No. 60610407	Drg No. 2	Stat. .	Rev: 0



SOURCES	PATHWAYS	RECEPTORS
1 GROUND GAS	1 GROUND GAS MIGRATION	A RESIDENTIAL / COMMERCIAL SITE USERS
2 NON-VOLATILE CONTAMINANTS IN SOIL	2 DERMAL CONTACT / DUST INGESTION	B SHALLOW GROUNDWATER
3 CONTAMINANTS IN GROUNDWATER	3 PERMEATION OF AND MIGRATION ALONG EXISTING UNDERGROUND SERVICES	C BEDROCK GROUNDWATER
	4 LEACHING FROM SOIL TO GROUNDWATER	D SURFACE WATER
	5 VERTICAL & HORIZONTAL MIGRATION OF CONTAMINATED GROUNDWATER	
	6 MIGRATION & LEACHING TO SURFACE WATER	

Rev	Date	Detail	Made	Chk'd	App'd

Status: FOR INFORMATION

NOTES:

Client: Electricity Supply Board

Location: Blackhorse Bridge Inchicore 110 kV

Title: Figure 3 CONCEPTUAL SITE MODEL

AECOM
4th Floor, Adelphi Plaza, Adelphi Centre, George's Street Upper, Dun Laoghaire, Co. Dublin, Ireland.
Tel +353 (0) 1 293 3200
Fax +353 (0) 1 293 3201
www.aecom.com

Design	ESB	Drawn	RDH
Chk'd	CC	App'd	DM
Date	JULY 2020	Scale	As Shown

Project No.	Drg No.	Stat.	Rev
60610407	3	.	0