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ESB Networks Historic Cable Fluid Losses: Preliminary Site Assessment

Location 67: Finglas – North Wall – 220 kV
November 1998 – December 1998

Prepared for

ESB Networks
Engineering Major Projects
One Dublin Airport Central
Dublin Airport
Cloghran
Co. Dublin

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EXECUTIVE SUMMARY

This report presents a preliminary site assessment (PSA) of the potential environmental impacts associated with the historic loss of cable fluid from a section of underground cable located adjacent to Alexandra Road, North Dock, Dublin Port. ESB records indicate that 2,363 litres of cable fluid (a mixture of linear alkyl benzenes, refined mineral oil and additives) leaked into the ground from the subject section of cable over a period of one month between November and December 1998.

The PSA was performed with reference to the EPA's 2013 publication "*Guidance on the Management of Contaminated Land and Groundwater at EPA Licensed Sites*". The EPA's guidance document outlines a staged and risk-based approach to contaminated land and groundwater assessment, with the PSA being the first stage in the process. By its nature the PSA stage is precautionary and conservative, aiming to identify those potential "pollutant linkages" where more detailed assessment is required.

Generally, more detailed assessment is only necessary where the assessed risk to a potential receptor is moderate, high or very high. However, in cases where the potential receptor is particularly sensitive, more detailed assessment may be recommended even if the assessed risk is low.

The findings of the preliminary site assessment can be summarised as follows:

- The leak location is situated on the southern verge of Alexandra Road, close to the intersection with No.2 Branch Road South in Dublin Port;
- The River Liffey lies approximately 550m south of the leak location, and the River Tolka estuary, a designated SPA (site code 004024), lies approximately 500m to the north;
- The land use in the vicinity of the leak location is industrial and commercial associated with Dublin Port operations. The closest building to the leak location is an industrial warehouse <10m to the south;
- The topography in the vicinity of the leak location is flat, with no discernible topographic gradient;
- Based on available geological maps, the area of the leak location is underlain by made ground, which is inferred to be underlain by beach sands. These deposits typically underlain by low-permeability glacial till within the area of interest. The underlying bedrock is mapped as dark-grey argillaceous & cherty limestone & shale;
- Groundwater within the limestone bedrock underlying the area of interest is classified by the GSI as a "locally important" aquifer from a productivity perspective. Vulnerability of the bedrock aquifer from a contamination standpoint is "low". The WFD status of the local groundwater body is "good", and the associated risk classification is "not at risk" of achieving WFD objectives;

- The key receptors potentially at risk of impact from the subject leak are considered to be the South Dublin Bay and River Tolka Estuary SPA, flora and fauna dependent on these water bodies, the bedrock aquifer underlying the area. and water mains in the vicinity of the leak location (if present). Occupants of buildings in the vicinity of the leak are also considered potential receptors via a vapour intrusion pathway; however, because of the expected low volatility of the cable fluid, the risk of impact is probably low.

A preliminary risk assessment was completed that considered the potential risk posed by the subject leak on the identified potential receptors. The findings of this preliminary risk assessment are summarised in the following table:

Receptor	**Risk Category**	**Comment**
South Dublin Bay & River Tolka Estuary SPA; River Liffey; Ecosystems dependent on the above water bodies	Low	No preferential pathway linking the leak location to the River Liffey or the nearby estuary has been identified. It is understood that ESB has received no reports of pollution of the River Liffey or the River Tolka Estuary that could be linked to the subject loss of cable fluid. Although there is potential for residual oil to be present in the source area, the pathway to the adjacent water bodies is relatively long and as such the risk of impact is considered low.
Water mains/ Water supply	Low	Whilst the potential for organic compounds to permeate water mains is known (in particular plastic water pipes and the joints of other types of water pipes), the potential for constituents of the cable fluid to permeate water mains was not established during the PSA. The risk category assumes that cable fluid may be present as residual LNAPL in the water main trench and that there is potential for constituents of it to permeate water pipes. However, the low solubility of these compounds and the expected low rate of permeation are such that they are unlikely to impact water quality in the pipes.
Bedrock aquifer	Low	The bedrock is classified as a "locally important" aquifer. Vulnerability rating is "low" close to the leak location. In addition, the water table in the overburden is expected to be shallow and the glacial till to have low permeability, reducing the potential for downward migration of cable fluid to the bedrock aquifer. No preferential pathways potentially linking the leak location to the aquifer have been identified.
Users of buildings where there are potential confined spaces	Very low	There is a large industrial building close to the leak location that extends up to the edge of Alexandra Road. There appears to be potential for cable fluid to have migrated beneath the building foundations close to the leak location. No health effects are anticipated.

Further investigation of the risk to the above-mentioned receptors (i.e. the South Dublin Bay and River Tolka Estuary SPA, the River Liffey, water mains, the bedrock aquifer and occupants of nearby buildings) is not considered necessary.

* * * * * * *

1 INTRODUCTION

1.1 Project Background

Geosyntec Consultants Ltd (Geosyntec) is pleased to present the Electricity Supply Board (ESB) this Preliminary Site Assessment (PSA), which relates to the potential environmental impacts associated with the historic loss of cable fluid from a section of fluid-filled cable located adjacent to Alexandra Road in North Dock, Dublin Port. The alignment of the subject section of cable and the approximate location of the historic loss of cable fluid are illustrated in Figure 1.

The PSA was completed in accordance with Geosyntec proposal reference 190607 dated June 2019 and was authorised by the ESB as an extension to the original project scope on 15th October 2019. The PSA was led by Mr Graham Webb, who is an environmental engineer with over 25 years' relevant experience, and Mr Jim Wragg, who is a contaminant hydrogeologist with over 30 years' relevant experience.

ESB Networks operates and maintains a network of High Voltage (HV) underground cables of over 1,600 km across Ireland, of which approximately 205 km (175 km operational) are insulated by a cable fluid. The majority of these fluid-filled cables are located in urban settings across Dublin city and Cork city. The cable fluid acts as an electrical insulator and aids the conduction of heat away from the conductor allowing the cable to be operated more efficiently. The cables are vulnerable to third party interference or damage, and over time, cables can develop leaks due to defects developing in the cable sheath and in joints and terminations. When such leaks occur, there is potential for pollution to arise.

In the case of the section of fluid-filled cable that is the subject of this PSA, ESB records indicate that 2,363 litres of cable fluid leaked into the ground from the cable over a period of one month between November and December 1998.

1.2 Objective and Scope of Work

The primary objective of the PSA was to complete a preliminary assessment of the potential types, locations, extent and significance of environmental impacts associated with the subject historic cable fluid loss. The PSA was performed with reference to the EPA's 2013 publication "*Guidance on the Management of Contaminated Land and Groundwater at EPA Licensed Sites*". This PSA report is based on the EPA's guideline template report for PSAs, which is linked to the 2013 guidance.

The EPA's 2013 guidance document outlines a staged approach to contaminated land and groundwater assessment, with the PSA being the first stage in the process. During the PSA stage, the guidance requires the assessor to identify environmental "receptors" - including groundwater and surface water bodes and flora and fauna dependent on them as well as people - who are potentially at risk from the source of contamination, and to qualitatively assess the risk to each environmental receptor by considering the viability of each source-pathway-receptor "pollutant linkage". Those pollutant linkages where there is considered to be a moderate or high risk of impact from the source of contamination, or where the receptor is particularly sensitive, are identified through this process. These pollutant linkages are then carried forward to the next stage of the process during which more detailed assessment can be completed. Given the above, the PSA stage of the process is precautionary and conservative in nature.

Generally, more detailed assessment is only necessary where the assessed risk to a potential receptor is moderate, high or very high. However, in cases where the potential receptor is particularly sensitive, more detailed assessment may be recommended even if the assessed risk is low.

The PSA for the subject loss of cable fluid was based on a desk study of publicly available information and information provided by the ESB, a walkover survey of the immediate vicinity of the cable within approximately 200 metres of the location of the historic loss of cable fluid, and a reconnaissance of the surrounding area.

Information for the desk study element of the PSA was obtained from the following sources:

- Ordnance Survey Ireland (OSI) website (www.osi.ie): historic maps, historic aerial images, recent "street-view" map;
- Environmental Protection Agency (EPA) websites (www.epa.ie and www.catchments.ie): locations of EPA-licensed facilities, locations of Natura 2000 sites and National Heritage Areas (NHAs), information on groundwater and surface water quality, including Water Framework Directive (WFD) classifications;
- Geological Survey of Ireland (GSI) website (www.gsi.ie): overburden and bedrock geology, information on groundwater resources and groundwater vulnerability;
- Office of Public Works (OPW) website (www.opw.ie): flood risk;
- National Waste Collection Permit Office (NWCPO) website (www.nwcpo.ie): register of companies holding waste facility permits or certificates of registration issued by local authorities;
- ESB records outlining the location of the cable fluid loss, the volume of fluid lost and the period over which the fluid loss occurred;
- Safety Data Sheets (SDSs) provided by the ESB for the cable fluids understood to have been used in the subject cable at the time of the cable fluid loss.

The walkover survey and reconnaissance of the area surrounding the subject section of cable was completed by Mr Graham Webb of Geosyntec on 17th October 2019. A series of photographs taken at the time of the walkover survey and reconnaissance is included in Appendix A.

During the walkover survey and reconnaissance, information on the following aspects were recorded:

- The environmental setting, with regard to local topography, surface water drainage and the proximity of local surface water courses;
- Land use, in particular the proximity of residential properties and other potentially sensitive land uses close to the subject section of cable;
- The proximity of the subject section of cable to other below-ground infrastructure, such as water mains, gas mains and sewers;
- Distressed vegetation, which may be indicative of subsurface contamination.

Central to the PSA was the development of a preliminary Conceptual Site Model, which presents potential source-pathway-receptor (SPR) linkages identified during the PSA, and a preliminary assessment of the risk posed to identified human or environmental receptors from residual cable fluid potentially remaining in the vicinity of the subject section of cable.

2 DETAILS OF LOSS EVENT

2.1 Introduction

In the case of the section of fluid-filled cable that is the subject of this PSA, ESB records indicate that 2,363 litres of cable fluid leaked into the ground from the cable over a period of one month between November and December 1998. The type of fluid that was present in the cable is identified in ESB records as a high-pressure cable oil (Shrieve DF 500) which comprises a mixture of linear alkylbenzenes and polybutene.

2.2 Properties of Cable Fluid

The properties of the fluids understood to have been used in the subject section of cable over the period of the leak, based on information contained within the Safety Data Sheets (SDSs) provided by ESB, are as follows:

Property	**Shrieve DF 500 - Alkylbenzene (Benzene, C14-C30 Alkyl derivatives) [84 - 93 %] and Polybutene [7 – 16%]**
Boiling Point	Not stated
Flash Point	175°C
Flammability	Not stated
Explosive properties	Not stated
Vapour pressure	0.0001 kPA at 40°C
Density	0.86 g/cm^3 at 20°C
Solubility in water	Negligible
Kinematic Viscosity	90 - 140 mm^2/s typical

It is noted that the fluid lost to ground at this location was from a high-pressure cable and that the cable fluid in such cables is more viscous at ambient temperature than that used in low pressure cables. Indications are that the kinematic viscosity of this cable fluid type is similar to that of a light-grade lubricating oil.

In their 2010 publication "*Classification of Hazardous and Non-Hazardous Substances in Groundwater*", the EPA classifies all petroleum hydrocarbon compounds listed in the document, including linear alkyl benzenes, as hazardous in groundwater. However, this is on the basis that they are former List I substances and it is stated in the document that these classifications are "under review". Based on the methodology outlined in the above-mentioned publication (which is based on the persistence, toxicity and potential to bioaccumulate of the substance in the environment) and publicly-available information on its properties, Geosyntec has concluded that linear alkyl benzenes should be classified as non-hazardous in groundwater. Similarly, based on the information presented in the SDS for polybutene included in Appendix C, Geosyntec has concluded that this substance is also likely to be classified as non-hazardous in groundwater.

2.3 Fate & Transport of Cable Fluid

The fate and transport of cable fluid entering the subsurface during and following the subject leak can be expected to be controlled by the following factors:

- The blend of alkyl benzenes and polybutene that makes up the cable fluid is less dense than water;
- The cable fluid has a low water solubility (< 1 mg/l);
- The compounds in the cable fluid are semi or non-volatile;
- The compounds present in the cable fluid can be expected to biodegrade but at rates that are controlled by the surface area of the fluid in the subsurface (i.e. in the form of a light non-aqueous phase liquid or LNAPL), its solubility where in contact with groundwater, the availability of electron acceptors and the presence of appropriate microbial populations.

Following creation of a breach in the cable structure, the conceptual model of the dispersion of the cable fluid into the subsurface at the subject location can be described as follows:

- As the cable fluid is less dense than water it will tend to migrate into the pore spaces in the sand bedding around the cable and downward under the force of gravity until it reaches either a water table or low permeability horizon, such as natural silt or clay at the base of the cable trench (if present);

- The cable fluid will tend to spread laterally whilst:
    - There is a driving head provided by leakage of further cable fluid;
    - There is a path of relatively low resistance, e.g. the sand bedding around the cable, potentially permeable fill material in other service trenches that the cable trench intersects, or permeable horizons in the overburden.

The migration potential of the cable fluid released to the subsurface as a result of the subject leak is discussed in more detail in Section 4.

3 SITE ENVIRONMENTAL SETTING

3.1 Proximity of Site to Designated Ecologically Sensitive Areas

The National Parks and Wildlife Service on-line mapping tool was consulted to check if the leak location lies close to designated ecologically sensitive areas. The River Tolka Estuary, which lies circa 500m north of the leak location, forms part of the South Dublin Bay and River Tolka Estuary Special Protection Area (SPA - site code 004024). In addition, 1.5km south of the leak location is the South Dublin Bay Special Area of Conservation (SAC – site code 000210).

3.2 Surrounding Land Use & Field Observations

The leak location is situated on the southern edge of Alexandra Road, close to the intersection with No.2 Branch Road South in the western area of North Dock, Dublin Port (refer to Figure 1). The Alexandra Basin is located approximately 250m south of the leak location; this basin is connected to the River Liffey, which lies approximately 550m south of the leak location. The River Liffey is tidal at this point, and discharges to Dublin Bay approximately 1.8 km east of the leak location.

Land use in the vicinity of the leak location is industrial and commercial. Shipping container storage yards and industrial warehouses surround the leak location to the west, south and east. To the north and immediately adjacent to Alexandra Road is an oil depot with a small tank farm and a lorry yard. The closest building to the leak location is an unmarked industrial warehouse which extends to the edge of the footpath adjacent to the leak location.

The earliest historic map of the area available from the OSI's website is dated 1837 – 1842. On this map, the leak location is situated in the estuaries of the River Tolka and River Liffey, both of which discharge into Dublin Bay.

The historic map dated 1888 – 1913 shows that the area was subsequently built up and developed into Alexandra Basin and Dublin Port with shipbuilding yards, oil tank farms, chemical works and docks shown to the west of the leak location. The leak location is within an area of vacant land.

The earliest aerial image available from OSI's website (other than 19th century historical maps) is dated 1995. This image shows that in 1995, the layout of the area in the vicinity of the leak location was similar to that observed today.

Based on information from the EPA's and NWCPO's websites there are eight facilities in the vicinity of the leak location that operate under an Industrial Emissions licence, an Integrated Pollution Control licence, a Waste licence or a Waste Facility Permit. These facilities are as follows:

- Electricity Supply Board, Alexandra Road, Dublin 1 (EPA licence reg no. P0579-03);
- Alumina Chemicals Ireland, Promenade Road, Tolka Quay, Dublin 3 (EPA license reg no. P0074-01);
- Irish Tar & Bitumen Suppliers, Alexandra Road, Dublin 1 (EPA license reg no. P0086-01);
- Indaver Ireland Limited, Tolka Quay Road, Dublin 1 (EPA license reg no. W0036);
- Dublin Port Company, Port Centre, Alexandra Road, Dublin 1 (EPA license reg no. P1022-02);
- Brooks Thomas Limited, Upper Mayor Street, Dublin 1 (EPA license reg no. P0345-01);
- Everlac Paints Ltd., 8 Hanover Quay, Dublin 2 (EPA license reg no. P0468-01);
- Cahill Printers Ltd., East Wall Road, Dublin 3 (EPA licence reg no. P0298-01);

There are no recent records for Cahill Printers Ltd, Everlac Paints Ltd, Brooks Thomas Limited and Alumina Chemicals Ireland on the EPA's website, and on this basis it is assumed that these facilities closed several years ago. The remaining EPA licensed facilities have recent records on the EPA's website and so appear to be still operating.

3.3 Topography & Surface Water

The leak location lies at an elevation of less than 10 m above Ordnance Datum within an area of flat ground. The closest water course to the leak location is the Alexandra Basin. This is approximately 250m south of the leak location and is connected to the River Liffey approximately 550m south. The River Tolka is approximately 500m to the north. Both the River Liffey and the River Tolka are tidal in the vicinity of Dublin Port and are classified by the EPA as a "transitional" water bodies. Under the WFD classification system these sections of the rivers are currently listed as being "at risk" of not meeting WFD objectives and water quality (for the period 2010 – 2015) is categorised as "moderate".

The leak location is not in an area that is indicated by the OPW as being at risk of fluvial flooding.

3.4 Geology & Hydrogeology

The bedrock geology underling the leak location is mapped by the GSI as dark limestones and shale (known as 'Calp' limestone). Near-surface overburden deposits are indicated by the GSI to comprise urban deposits (i.e. made ground), which are inferred to overlie beach sands. These deposits are typically underlain by low-permeability glacial till within the area of interest.

The groundwater body (GWB) underlying the leak location and the surrounding area is known as the Dublin GWB. This GWB covers an area of approximately 837 km^2 extending west from the Dublin coastline to the village of Kilmeage in Co. Kildare and extending from Malahide in north Co. Dublin to the southern limits of Dublin city. The GSI classifies the Dublin GWB as a "locally important aquifer which is moderately productive only in local zones". Groundwater flow direction in the bedrock aquifer (and also in the overburden) can be expected to be divergent in the vicinity of the leak location with flow either towards the River Tolka to the north or the River Liffey to the south.

The vulnerability of the bedrock aquifer in the vicinity of the leak location is classified by the GSI as "low" which suggests that bedrock is relatively deep in the vicinity of the leak location.

A search of the GSI's online database indicated that there is one recorded bedrock well within a 1 km radius of the leak location. This well did not extend to bedrock and no yield was reported.

The EPA is responsible for classifying GWBs in Ireland in terms of water quality and their ability to meet objectives set out in the EU Water Framework Directive. Based on the most recent round of EPA monitoring (2010 – 2015), the status of the Dublin GWB was categorised as "good" and it was categorised as "not at risk" with regard to achieving WFD objectives.

4 CONCEPTUAL SITE MODEL

4.1 Introduction

For the purposes of this PSA, it has been assumed that the top of the fluid filled cable is buried at a depth of 0.9 – 1.1m below ground level within a backfilled trench that is around 1.2m deep. The trench backfill is assumed to comprise a 0.35 m deep sand layer (0.85m bgl) above which the trench is filled with selected excavated material.

For the purposes of the PSA, strata adjacent to and below the cable trench have been assumed to comprise either:

- Granular fill materials associated with historical development and/or land raises in the vicinity of the cable route;
- Granular fill materials associated with trench backfill for other underground services that intersect the route of the fluid filled cable, and/or;
- Beach sands associated with the River Tolka and River Liffey.

4.2 Source & Potential Migration Pathways

Based on the expected nature of overburden material and/or fill material in the vicinity of the leak location, cable fluid lost to ground in this case can be expected to have spread laterally within the permeable sand bedding within the cable trench, and also potentially radially into the surrounding fill material or natural soil, assuming this material is predominantly granular in nature.

We have developed a series of indicative estimates for the subject leak location under different ground condition scenarios, with regard to the extent of cable fluid migration. These estimates have assumed that the cable is installed within a 0.35m thick sand bedding and surround layer in a trench 1.1m wide cut into low permeability silt or clay soils, which can be expected at the subject location.

- As outlined above, assuming the cable trench passes through predominantly granular material in the vicinity of the leak location, a radial spreading of the cable fluid can be expected. If a 0.2m deep soil zone is impacted with a LNAPL saturation of 40% then the theoretical radius of cable fluid LNAPL impact away from the release would be 6.9 m. Tidal fluctuation of the water table over time is likely to have resulted in further limited expansion of this LNAPL body;
- In the case where the cable trench passes through lower permeability material (which is considered unlikely in this case), the cable fluid can be expected to migrate preferentially along the line of the cable trench, within the sand bedding and surround material. In this case, if (i) the sand bedding is dry, (ii) the cable fluid saturation reaches 40% residual saturation of the pore space in the sand bedding, and (iii) the cable fluid does not migrate into the overlying back-fill material, the theoretical length of trench impacted by LNAPL migration is 77m. Given that the ground elevations along the line of the cable are relatively level, there appears to be potential for cable fluid to migrate along the sand bedding in both directions from the leak location under this scenario;
- Considering a variation of the previous case, where the base of the trench contains perched water then this would lower the LNAPL saturation in the sand layer surrounding the cable. This could result in LNAPL migration through the back-fill material above the sand bedding layer, but only if it is sufficiently permeable. The thickness of LNAPL-saturated soils will likely be less under this scenario than that outlined above, but the cable fluid may spread further. If a 40% residual cable fluid saturation is assumed in relatively permeable backfill material over a 0.2m thickness, this would lead to a theoretical length of trench impacted by cable fluid of 134m.
- The cable fluid may have some semi-volatile components and as such will generate a modest vapour pressure. However, this may be attenuated by biodegradation processes in the shallow soils. In aerobic shallow soils and groundwater, degradation of alkyl benzenes

is expected to be relatively quick (half-life in soil of 15 days[1]). Polybutene is also reported to biodegrade readily in aerobic conditions. Conversely, degradation is expected to be negligible in anaerobic conditions. Degradation products of alkyl benzenes include toluene and ethylbenzene, which have relatively high vapour pressures. However, these products would be expected to be only generated in small quantities and would themselves also degrade quickly.

- Cable fluid has the potential to migrate from the source to underneath confined spaced receptors (such as building cellars), either in LNAPL form or via migration in the dissolved phase in groundwater flow following dissolution from the LNAPL. Vapours generated from the LNAPL or groundwater have the potential to migrate through the unsaturated zone and building defects into confined spaces, where they may be breathed in by building occupants, potentially causing toxic and/or nuisance effects. In the event that free or dissolved phase impacts have migrated beneath or in the immediate vicinity of buildings with confined spaces, then the potential effects of vapour intrusion should be considered.

In addition to the above scenarios, the following potential migration pathways were considered as part of the PSA, but they were not carried forward to the preliminary risk assessment because the source-pathway-receptor (SPR) linkage was not considered viable:

- Soil and dust ingestion from near-surface soils;
- Dermal contact with near-surface soils;
- Inhalation of fugitive dust from near-surface soils; and
- Ingestion of soils via consumption of vegetables grown in near-surface soils.

4.3 Potential Receptors

With the above migration pathways in mind, the River Liffey and River Tolka estuaries (the latter of which forms part of a SPA), ecosystems dependent on these water bodies, and the underlying bedrock aquifer, appear to be the key environmental receptors potentially at risk of impact from the leak of cable fluid from this location.

The potential for cable fluid (or some of its constituent compounds) to permeate buried water mains close to the leak location (if present) and impact water quality in the water mains also needs to be considered. Given the predominantly industrial land use in the vicinity of the leak location and the low volatility of the cable fluid, the risk to users of buildings close to the leak location is likely to be low.

[1] Energy cable saturant SDS – refer to Appendix B

Groundworks contractors performing future tasks in the vicinity of the leak location could also be considered potential receptors (via direct contact, inhalation and ingestion pathways). However, it has been assumed that the potential risks posed to future groundworks contractors would be adequately mitigated through effective health and safety planning and work control procedures at the time the works are being carried out. As a result, groundworks contractors have not been considered potential receptors in the preliminary risk assessment presented in the following section.

5 PRELIMINARY RISK ASSESSMENT

The key potential source-pathway-receptor (SPR) linkages associated with the subject loss of cable fluid are presented in this section, together with a preliminary assessment of the risk posed to the identified receptors. The preliminary risk assessment is based on the methodology outlined in CIRIA C552 (2001) "*Contaminated Land Risk Assessment – A Guide to Good Practice*". This methodology requires the classification of the magnitude of the **consequence** (severity) of a risk occurring, and the **probability** of a risk occurring. The risk assessment methodology is summarised in Tables 1 – 4 below.

The potential consequences of contamination risks occurring are classified in accordance with Table 1.

Table 1: Classification of Consequence

Classification	Definition of Consequence
Severe	• Short-term (acute) risk to human health likely to result in significant harm. • Short-term risk of pollution of sensitive water resource. • Catastrophic damage to buildings/property. • A short-term risk to a particular ecosystem, or organism forming part of such ecosystem.
Medium	• Chronic damage to human health. • Pollution of sensitive water resources. • A significant change in a particular ecosystem, or organism forming part of such ecosystem.
Mild	• Pollution of non-sensitive water resources. • Significant damage to crops, buildings, structures and services. • Damage to sensitive buildings/structures/services or the environment.
Minor	• Harm, although not necessarily significant harm, which may result in a financial loss, or expenditure to resolve. • Non-permanent health effects to human health (easily prevented by means such as personal protective clothing etc.) • Easily repairable effects of damage to buildings, structures and services.

The probability of contamination risks occurring are classified in accordance with Table 2.

Table 2: Classification of Probability

Classification	Definition of Probability
High Likelihood	Circumstances are such that an event appears very likely in the short-term or almost inevitable in the long-term; or there is already evidence that such an event has occurred.
Likely	Circumstances are such that such an event is not inevitable, but is possible in the short-term and is likely over the long-term.
Low Likelihood	Circumstances are such that it is by no means certain that an event would occur even over a longer period, and it is less likely in the short-term.
Unlikely	Circumstances are such that it is improbable that an event would occur even in the very long-term.

For each viable SPR linkage, the potential risks are evaluated, as presented in Table 3.

Definitions of the risk categories, together with the investigatory and remedial actions that may be necessary in each case are presented in Table 4.

Table 3: Risk Matrix

		Severe	Medium	Mild	Minor
Probability	**High likelihood**	Very high risk	High risk	Moderate risk	Low risk
	Likely	High risk	Moderate risk	Moderate risk	Low risk
	Low likelihood	Moderate risk	Moderate risk	Low risk	Very low risk
	Unlikely	Low risk	Low risk	Very low risk	Very low risk

Table 4: Definition of Risk Categories and Likely Actions Required

Risk Category	Definition and likely actions required
Very high	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 a substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required.
High	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 (if not undertaken already) is required and remedial works may be necessary in the short term and are likely over the longer term.
Moderate	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is relatively unlikely that any such harm would be severe. If any harm were to occur, it is more likely that the harm would be relatively mild. Investigation (if not already undertaken) is normally required to clarify the risk and to determine the potential liability. Some remedial works may be required in the longer term.
Low	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 be mild.
Very low	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.

The key potential SPR linkages associated with the subject loss of cable fluid are presented in Table 5 below, together with a preliminary assessment of the risk posed to the identified receptors in each case, in line with the above methodology.

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Table 5: Preliminary Risk Assessment for Location 50

Source	Potential Pathway	Receptor	Consequence	Probability	Risk Category	Comment
Loss of cable fluid (linear alkyl benzenes, refined mineral oil and additives) over a one-month period during the period November – December 1998 (estimated 2,363 litres).	Predominantly lateral migration of cable fluid from the leak location along the cable trench, and/or through granular lenses within the overburden or infill material, potentially followed by migration along other preferential pathways (e.g. other in-filled services trenches that intersect the cable trench).	River Tolka Estuary (a SPA) and River Liffey; Ecosystems dependent on the above water bodies	Medium	Low likelihood	Low	No preferential pathway linking the leak location to the River Liffey or the nearby estuary has been identified. It is understood that ESB has received no reports of pollution of the River Liffey or the River Tolka Estuary that could be linked to the subject loss of cable fluid. Although there is potential for residual oil to be present in the source area, the pathway to the adjacent water bodies is relatively long and as such the risk of impact is considered low.
	Predominantly lateral migration of cable fluid from the leak location along the cable trench, and/or through granular lenses within the overburden, and subsequent migration into backfilled trenches containing water mains (if present). Permeation of constituents of the cable fluid through the walls or joints of the water mains.	Water mains/ Water supply	Medium	Unlikely	Low	Whilst the potential for organic compounds to permeate water mains is known (in particular plastic water pipes and the joints of other types of water pipes), the potential for constituents of the cable fluid to permeate water mains was not established during the PSA. The risk category assumes that cable fluid may be present as residual LNAPL in the water main trench and that there is potential for constituents of it to permeate water pipes. However, the low solubility of these compounds and the expected low rate of permeation are such that they are unlikely to impact water quality in the pipes.

Table 5: Preliminary Risk Assessment for Location 50

Source	Potential Pathway	Receptor	Consequence	Probability	Risk Category	Comment
(as above)	Vertical migration of cable fluid via permeable lenses in the overburden and/or via granular material in in-filled services trenches to groundwater in the bedrock aquifer, followed by dissolution of cable fluid and generation of a dissolved-phase plume of alkyl benzenes in the bedrock aquifer.	Bedrock aquifer	Mild	Low Likelihood	Low	The bedrock is classified as a "locally important" aquifer. Vulnerability rating is "low" close to the leak location. In addition, the water table in the overburden is expected to be shallow and the glacial till to have low permeability, reducing the potential for downward migration of cable fluid to the bedrock aquifer. No preferential pathways potentially linking the leak location to the aquifer have been identified.
(as above)	Predominantly lateral migration of cable fluid from the leak location along the cable trench, and/or through granular lenses within the overburden, followed by migration along other preferential pathways (e.g. other in-filled services trenches that intersect the cable trench). Release of vapour-phase hydrocarbons and/or daughter products from the LNAPL (noting that there is limited potential for this to occur) and migration in the vapour phase into buildings.	Occupants of buildings where there are potential confined spaces	Minor	Low Likelihood	Very low	There is a large industrial building close to the leak location that extends up to the edge of Alexandra Road. There appears to be potential for cable fluid to have migrated beneath the building foundations close to the leak location. No health effects are anticipated.

6 CONCLUSIONS

The following conclusions have been drawn based on the information reviewed and observations made during this PSA:

- The leak location is situated on the southern edge of Alexandra Road, close to the intersection with No.2 Branch Road South in North Dock, Dublin Port;
- Land use in the vicinity of the leak location is industrial and commercial associated with Dublin Port operations. The closest building to the leak location is a warehouse, which extends up to the edge of the footpath adjacent to the leak location;
- The River Liffey lies approximately 550m south of the leak location, and the River Tolka Estuary, which forms part of a designated SPA, lies approximately 500m to the north. The Alexandra Basin is the closest water body to the leak location at 250m south, which connects to the River Liffey;
- Based on available geological maps, the area of the leak location is underlain by made ground, which is inferred to be underlain by beach sands. These deposits are typically underlain by low-permeability glacial till. The underlying bedrock is mapped as dark-grey argillaceous & cherty limestone & shale ("Calp");
- Groundwater within the limestone bedrock underlying the area of interest is classified by the GSI as a "locally important" aquifer from a productivity perspective. Vulnerability of the bedrock aquifer from a contamination standpoint is "low". The WFD status of the local groundwater body is "good", and the associated risk classification is "not at risk" of achieving WFD objectives;
- The key receptors potentially at risk of impact from the subject leak are considered to be the South Dublin Bay and River Tolka Estuary SPA, including flora and fauna dependent on this water body, the River Liffey estuary, the bedrock aquifer underlying the area, and water mains in the vicinity of the leak location (if present). Occupants of buildings in the vicinity of the leak are also considered potential receptors via a vapour intrusion pathway, although the risk of impact is low;

Following the preliminary risk assessment methodology outlined in CIRIA publication C552 (2001), the appropriate risk category for these potential receptors and the associated SPR linkages are considered to be:

- River Liffey Estuary - Low
- River Tolka Estuary SPA - Low
- Water mains - Low
- Bedrock aquifer - Low
- Users of nearby buildings - Very low

Further investigation of the risk to the above-mentioned receptors (i.e. the South Dublin Bay and River Tolka Estuary SPA, the River Liffey, water mains, the bedrock aquifer and occupants of nearby buildings) is not considered necessary.

* * * * * * *

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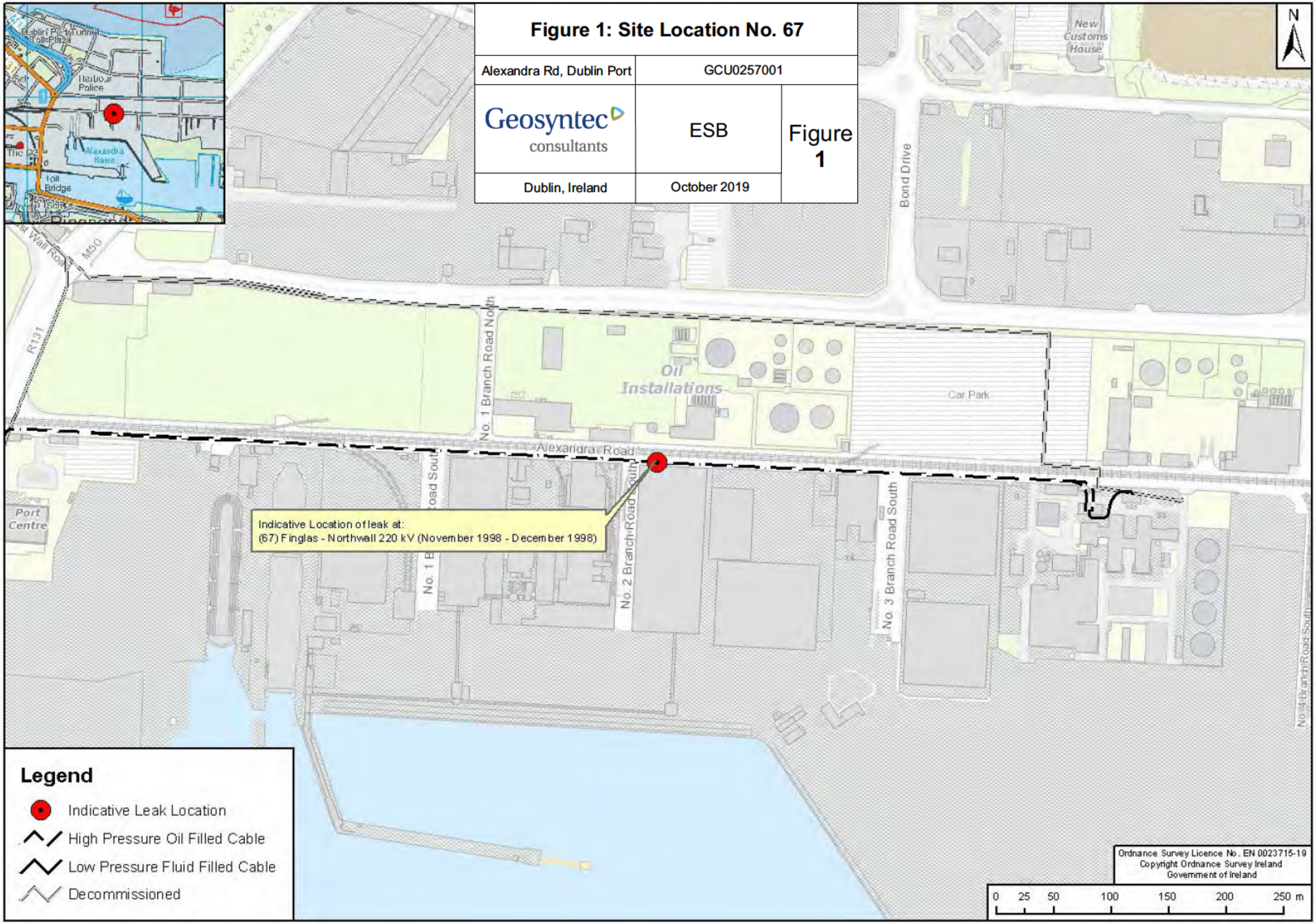
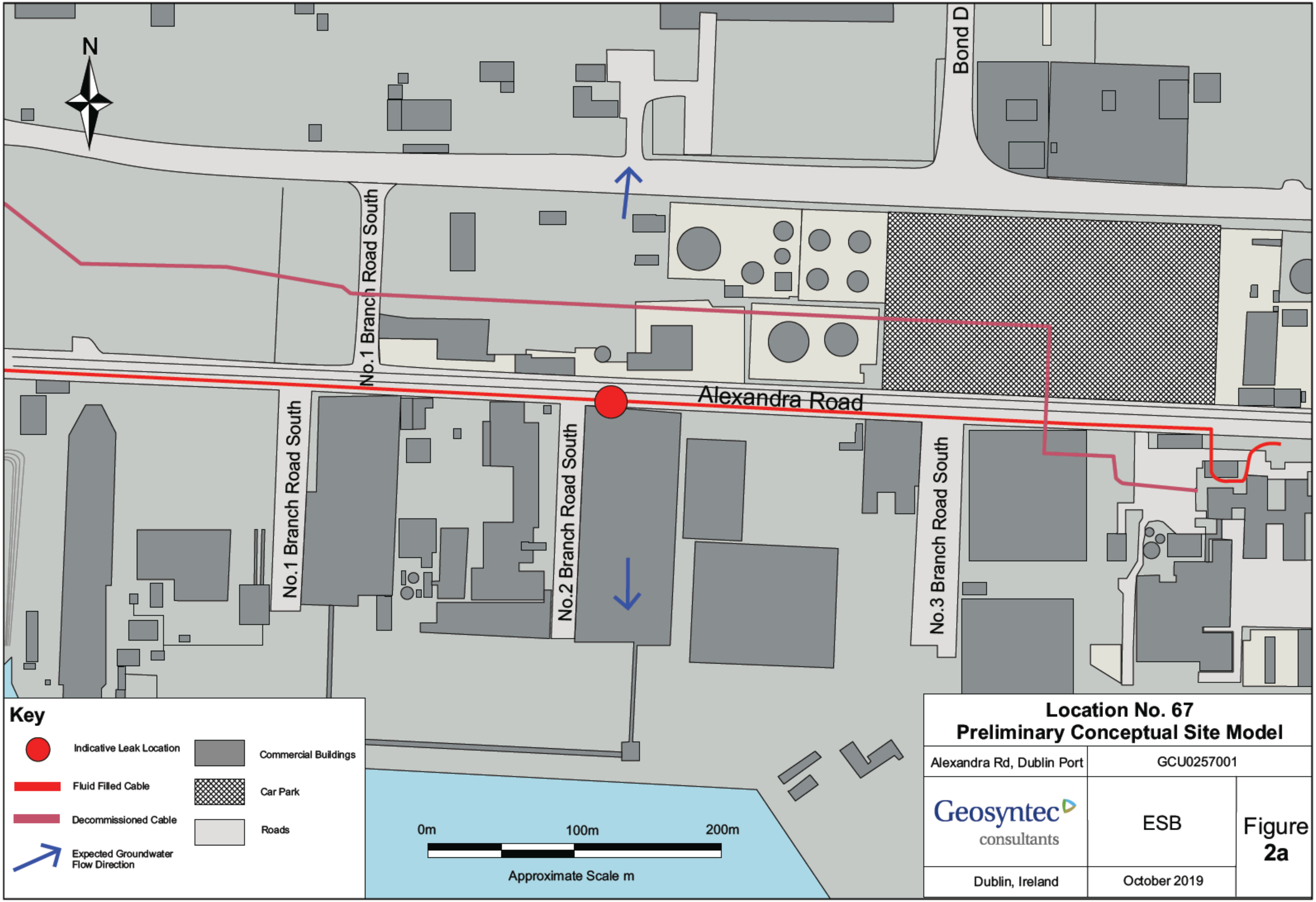
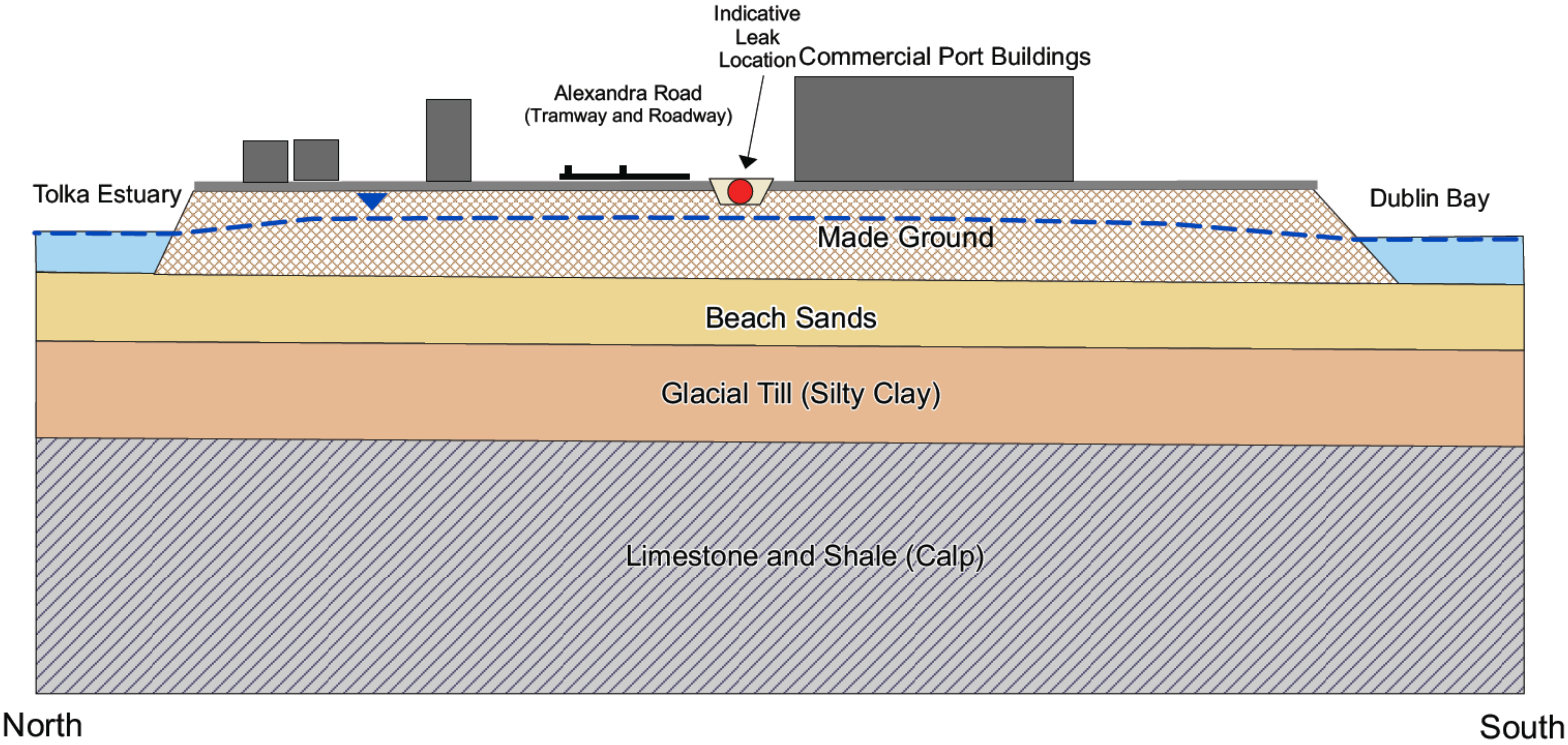


Figure 1: Site Location No. 67
Alexandra Rd, Dublin Port
GCU0257001
Geosyntec consultants
ESB
Figure 1
Dublin, Ireland
October 2019
N
Dublin Port Tunnel Toll Plaza
Harbour Police
Alexandra Basin
Toll Bridge
New Customs House
Bond Drive
M50
R131
No. 1 Branch Road North
Oil Installations
Car Park
Alexandra Road
Port Centre
No. 1 Branch Road South
No. 2 Branch Road South
No. 3 Branch Road South
No. 4 Branch Road South
Indicative Location of leak at:
(67) Finglas - Northwall 220 kV (November 1998 - December 1998)
Legend
Indicative Leak Location
High Pressure Oil Filled Cable
Low Pressure Fluid Filled Cable
Decommissioned
Ordnance Survey Licence No. EN 0023715-19
Copyright Ordnance Survey Ireland
Government of Ireland
0 25 50 100 150 200 250 m


N
Bond D
No.1 Branch Road South
Alexandra Road
No.1 Branch Road South
No.2 Branch Road South
No.3 Branch Road South
Key
Indicative Leak Location
Fluid Filled Cable
Decommissioned Cable
Expected Groundwater Flow Direction
Commercial Buildings
Car Park
Roads
0m
100m
200m
Approximate Scale m
Location No. 67
Preliminary Conceptual Site Model
Alexandra Rd, Dublin Port
GCU0257001
Geosyntec consultants
ESB
Figure 2a
Dublin, Ireland
October 2019



Location 67 - Preliminary Conceptual Site Model		
Alexandra Rd, Dublin Port	GCU0257001	
Geosyntec consultants	ESB	Figure **2b**
Dublin, Ireland	October 2019	

Geosyntec consultants

Appendix A - Photolog

A

P

P

E

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A

Photograph 1 – Leak location

Appendix B – Historical Maps and Aerial Images

A

P

P

E

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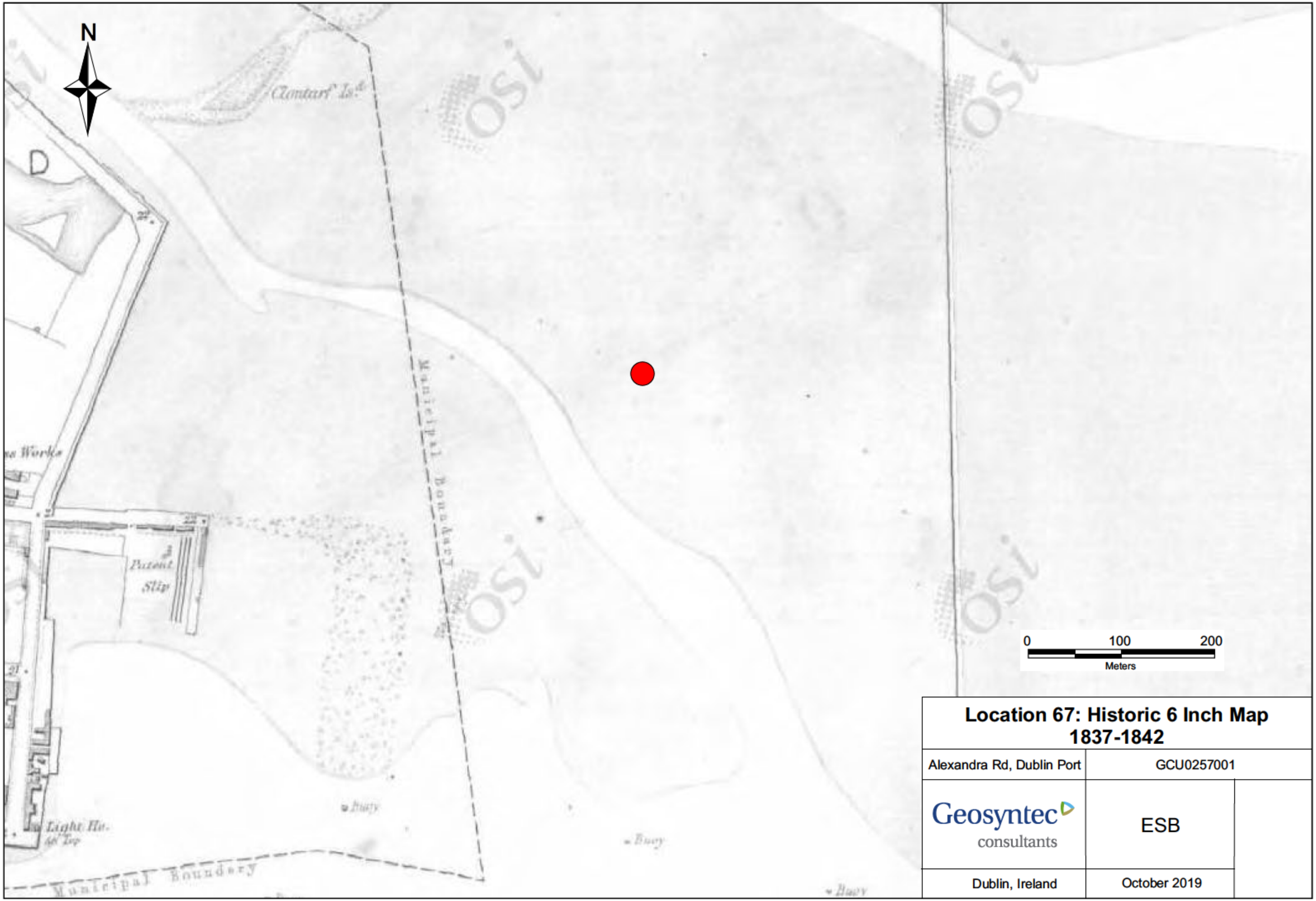
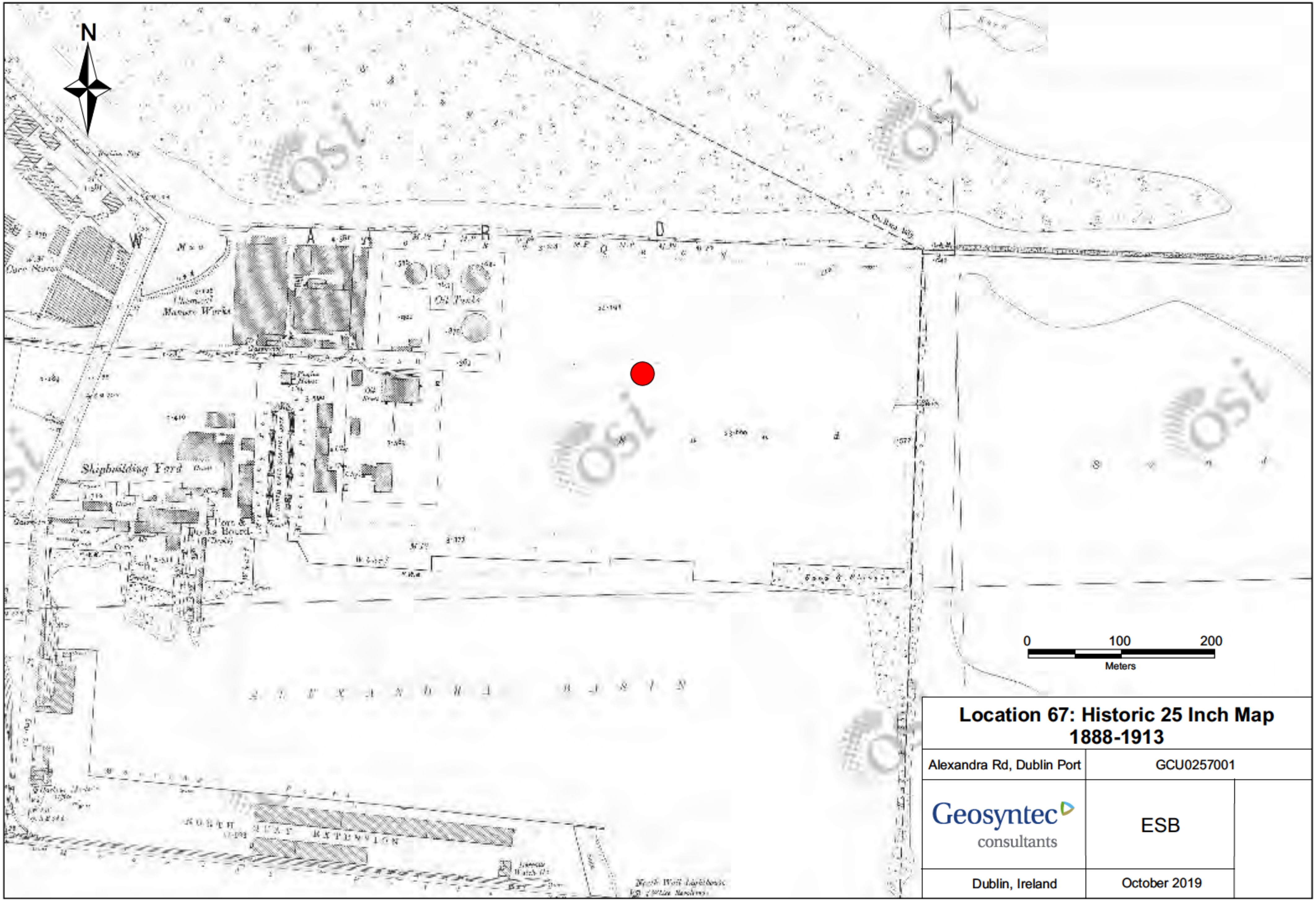
X

B



Location 67: Historic 6 Inch Map 1837-1842	
Alexandra Rd, Dublin Port	GCU0257001
Geosyntec consultants	ESB
Dublin, Ireland	October 2019



Location 67: Historic 25 Inch Map 1888-1913

Alexandra Rd, Dublin Port	GCU0257001
Geosyntec consultants	ESB
Dublin, Ireland	October 2019

Location 67: Aerial Map 2017

Alexandra Rd, Dublin Port	GCU0257001
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Dublin, Ireland	October 2019

Appendix C – Safety Data Sheet for Cable Fluid

A P P E N D I X C

MATERIAL SAFETY DATA SHEET

Shrieve Chemical Products Company
1717 Woodstead Court
Woodlands, TX 77380
(281) 367-4226

PRODUCT IDENTIFICATION	
Trade Name:	Shrieve DF 500
Chemical Family:	Alkylaryl Hydrocarbon/Polybutene
Chemical Name:	Alkylbenzene (Benzene, C_{14}-C_{30} Alkyl derivatives)/Polybutene
CAS Number(s):	68855-24-3 (84-93%)/9003-29-6 (7-16%)
TSCA Inventory:	Benzene C_{14}-C_{30} alkyl derivatives appears on the Inventory of Chemical Substances published by the U.S. Environmental Protection Agency (EPA) under authority of the Toxic Substances Control Act (TSCA). All Polybutene components also listed by TSCA.
DOT Proper Shipping Name:	Not Applicable
DOT Hazard Class/I.D. No.:	Not Applicable
DOT Label(s):	Not Applicable
U.S. Surface Freight Classification:	Petroleum Alkylate Detergent Intermediate (Petroleum Oil, N.O.I.B.N.)
IATA Dangerous Good:	Not defined as a dangerous good by IATA for air transportation
Hazardous Chemical(s) Under OSHA: Hazard Communication Standard (CFR 1910.1200):	Non hazardous
SARA Hazard Notification:	Not Applicable (contains no chemicals subject to SARA 302 or 313 [toxic chemicals])

PHYSICAL DATA	
Appearance and odor:	Water-white to yellowish amber oily liquid, slight hydrocarbon odor
Solubility:	Soluble in hydrocarbons; insoluble in water
Boiling Point (°C):	N/A
Melting Point:	Not Applicable
Average Molecular Weight:	425 (typical)
Specific Gravity (@ 15.6/15.6° C):	0.87
Vapor Pressure (mm Hg @ 40° C):	LT 0.001
Vapor Density:	Not Applicable
Viscosity (cSt @ 40° C):	90 - 104
Pour Point (°C):	-40

FIRE AND EXPLOSION DATA	
Flash Point (°C CoC)	175
Auto ignition Temperature (°C):	421
Flammability Limits:	Unknown
Extinguishing Media:	CO_2, Dry chemical, foam, water fog

Special Fire Fighting Procedure:	Cool exposed equipment with water spray. Firefighters and others exposed to vapors or products of combustion should use self-contained breathing apparatus and wear full protective clothing.

HEALTH HAZARD INFORMATION

NATURE OF HAZARD

Eyes:	Expected to cause no more than minor eye irritation. Application of a similar product into the eyes of rabbits produced very slight membrane irritation without corneal injury. Avoid eye contact as good industrial practice.
Skin:	Not a primary skin irritant but may cause skin irritation on repeated or prolonged contact. Application of a similar product onto the skin of rabbits produced slight erythema and edema. The Draize score was 0.6. Not expected to be acutely toxic by skin absorption. The acute dermal LD_{50} (rabbits) was greater than 5g/kg for a similar product.
Inhalation:	Avoid breathing vapor or mist. Under normal use conditions, this product is not an inhalation hazard. Prolonged exposure to vapors may cause dizziness and headaches.
Ingestion:	May cause nausea. Not expected to be acutely toxic by ingestion. The acute oral LD_{50} (rat) was greater than 5 g/kg for a similar product.

FIRST AID

Eyes:	Immediately flush eyes with plenty of water for at least 15 minutes while holding the eyelids open. If irritation persists, see a physician.
Skin:	Remove contaminated clothing. Wash skin thoroughly with soap and water. Launder contaminated clothing. See a doctor if irritation persists.
Inhalation:	Remove to fresh air. If not breathing, give artificial respiration and seek medical attention immediately. Remove material from eyes, skin and clothing.
Ingestion:	If swallowed, call a physician immediately. ONLY induce vomiting at the instruction of a physician. Never give anything by mouth to an unconscious person. If medical advice cannot be obtained, take the person, product container and MSDS to the nearest medical emergency center.

EXPOSURE LIMITS

No Federal OSHA PEL or ACGIM TLV has been established for this material.

SPECIAL PRECAUTIONS

Emptied container retains vapor and product residue. Observe all labeled safeguards until container is cleaned, reconditioned or destroyed.

SPECIAL PROTECTIVE INFORMATION

Eyes:	No special eye protection is necessary. Avoid eye contact as good industrial practice.
Skin:	Avoid prolonged or frequently repeated contact. Skin contact can be minimized by wearing impervious protective clothing including gloves.
Respiratory:	Avoid breathing vapor or mist. Use NIOSH/MSHA approved respiratory equipment when airborne exposure is excessive. Consult respirator manufacturer to determine appropriate type equipment for given application.
Ventilation:	Mechanical ventilation is recommended if handling at elevated temperatures or if it is handled in such a manner as to cause mists or vapor to form.

REACTIVITY DATA	
Stability:	Stable (Thermal, Light)
Incompatibility:	May react with strong oxidizing materials
Hazardous Decomposition Products:	Normal combustion forms carbon dioxide and water vapor. Incomplete combustion can form carbon monoxide.
Hazardous Polymerization:	Will not occur

SPILL, LEAK AND DISPOSAL INFORMATION

- This material is not expected to present any environmental problems other than those normally associated with oil spills.
- Contain spills and leaks to prevent discharge to the environment.
- Absorb spillage with inert material, then place in a chemical waste container. For large spills, dike for later disposal.
- Discarded product should be incinerated or disposed of only in accordance with local, state and federal regulations.
- U.S. Coast Guard regulations require immediate reporting of spills that could reach any waterway including intermittent dry creeks. Report spills to Coast Guard toll free number (800) 424-8802.

ENVIRONMENTAL EFFECTS

Environmental Toxicity Information for a Similar Product.

96-hr LC_{50} Rainbow Trout (Salmo gairdneri): >1000 mg/l practically non-toxic

96-hr LC_{50} Sheepshead Minnow (Cyprinodon variegatus): >1000 mg/l practically non-toxic

Biodegradation: This material has not been tested for biodegradation. It is expected to be resistant.

SHIPPING AND TRANSFER

SHIPPING INFORMATION

This product is not a hazardous material or hazardous substance as defined by the Department of Transportation, nor is it a dangerous good as defined by IATA for air transportation.

TRANSFER INFORMATION

Electrostatic Accumulation Hazard: When transferring this product, there is potential for the accumulation of static electricity. Consideration should be given to bonding and grounding of equipment during loading, unloading and transfer of this product.

DATE: 1/15/98	SUPERSEDES 10/15/96