January 2020

Environmental Risk Assessment

Site at Prusselstown

Kildare County Council

Athy, Co. Kildare

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1 INTRODUCTION

Malone O'Regan Environmental (MOR) was appointed by Kildare County Council (KCC) to undertake an Environmental Risk Assessment (ERA), Appropriate Assessment (AA) and, where appropriate, preparation of a site-specific remediation plan for the former Prusselstown refuse depot located in Athy, Co. Kildare (the Site).

This report has been prepared in accordance with the Environmental Protection Agency's (EPA) published Code of Practice: Environmental Risk Assessment for Unregulated Waste Disposal Sites (2007) hereafter referred to as the 'CoP'.

1.1 Project Understanding

The Site has been identified as a legacy landfill Site and was entered on KCC's Section 22 Register of unregulated waste disposal sites under the Waste Management Act, 1996 (as amended).

In accordance with the CoP, the Tier 1 assessment carried out by KCC classified the Site as a High-Risk Site, due to the location of a hotel development on-site and dwellings within 30 meters of the Prusselstown refuse depot.

The Site was operated by KCC and is believed to have accepted mainly municipal and some commercial and industrial wastes, although there are no records to support this. According to the KCC's brief, the Site is also believed to have been in use from the 1970s until mid-1980s and it is understood that the local authority does not own the lands occupied by the Site.

In this regard, under the CoP and Waste Regulations, KCC has a responsibility to assess the intrinsic risk of the Site to potential receptors, which is to be evaluated with intrusive and non-intrusive site investigations.

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1.2 Background Information Reviewed

The following document was reviewed during this assessment:

- Conceptual Site Model and Risk Assessment (Tier 1 – Risk Assessment) completed by Kildare County Council (Environment Section);

Other information sources were reviewed during this assessment, which included the following:

- Geological Survey Ireland (GSI database online);
- Environmental Protection Agency – EPA Envision online mapping; and,
- National Parks and Wildlife Services – Map viewer.

1.3 Project Objectives

This report presents the findings of the Tier 1 Risk Screening (KCC and MOR), Tier 2 Site Investigations and Testing, Tier 3 Refinement of Conceptual Site Model (CSM) and the Quantitative Risk Assessment (QRA) and recommendations for the unlicensed Prusselstown refuse depot in accordance with the CoP. The overall project objectives of the ERA were as follows:

a) To confirm whether there were any risks posed by the imported material to the receiving environment, i.e. risks of landfill gas migration to the hotel (on site) and to bordering residential dwellings. To confirm the risk of leachate migration to nearby surface water (Athy Stream) and to groundwater beneath the Site;

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b) To develop and update the preliminary conceptual site model (CSM) for the Site, which identifies contaminant source, pathways and receptor linkages and refinement of the CSM through all stages of the investigation;

c) To determine the requirement for any remediation works at the Site and to provide costing for the specific remedial works; and,

d) To provide the basis for KCC's application to the EPA for a Certificate of Authorisation as required under the Waste Management Regulations, 2008 (S.I. No. 524 of 2008) (Certification of Historic Unlicensed Waste Disposal and Recovery Activity).

1.4 Scope of Works

The scope of works undertaken comprised of the following:

- **Desk based study** and walkover survey of the Site and updating of the preliminary Conceptual Site Model (CSM)*;*
- **Geophysical survey** to assess subsurface conditions, including the extent of the imported materials, and to assist in the targeting of locations for investigation;
- **Excavation of seven (7 No) trial pits** at locations across the Site to delineate the extent (horizontal and vertical) and composition of the imported material;
- **Collection of three (3 No) soil samples** from the trial pit locations for laboratory analysis;
- **Collection of one (1 No) soil sample** from the capping material to assess for permeability, moisture and particle size distribution;
- **Installation of three (3 No) combined leachate and landfill gas monitoring wells** within the body of the imported material to determine the presence of landfill gas and/or leachate;
- **Installation of three (3 No) groundwater monitoring wells** to characterise groundwater quality upgradient and downgradient of the imported material;
- **Topographical survey** of the site investigation locations (groundwater and leachate/landfill gas wells) to Ordnance Datum;
- **Environmental monitoring** including the collection of groundwater and leachate samples from the newly installed monitoring wells, and surface water samples on two (2 No) occasions. A further groundwater sample was collected from a groundwater well (private well) serving the hotel via the hotel's kitchen tap. The sample was analysed by an independent laboratory (IAS laboratories) and the results have been included into this report;
- **Landfill gas monitoring** undertaken during three (3 No) monitoring events from the newly installed wells;
- **Gas monitoring survey** of surface emissions, inside and outside the site boundary and an internal survey within the hotel premises on one occasion. The surveys utilised an Inficon IRwin Detector (Inficon) to assess the existence of a potential linkage between landfill gas and identified receptors;
- Preparation of a Screening for **Appropriate Assessment (AA**) which complies with Article 6 of the Habitats Directive 92/43/EEC (EC 2001) and S.I. No. 477/2011 (European Communities (Birds and Natural Habitats) Regulations 2011);
- **Generic Risk Assessment** Tier 2 Site Investigation and Testing, Tier 3 Refinement of CSM and Quantitative Risk Assessment and Recommendations in accordance with the EPA Code of Practice; and,

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- Preparation of an **Environmental Risk Assessment Report**.

All intrusive site investigation works were undertaken in accordance with BS10175-2011+A2:2017 'Investigation of Potentially Contaminated Sites - Code of Practice'.

1.5 Competent Person

To ensure the quality of the data and conclusions presented in this report, all work was carried out by appropriately qualified and experienced MOR personnel and overseen by Thomas Vainio-Mattila (PGeo), who is qualified, trained and experienced to the standard set out in section 2.3 of Code of Practice: Environmental Risk Assessment for Unregulated Waste Disposal Sites (EPA, 2007) and listed on the IGI Register of Qualified Geoscientists/Competent Persons.

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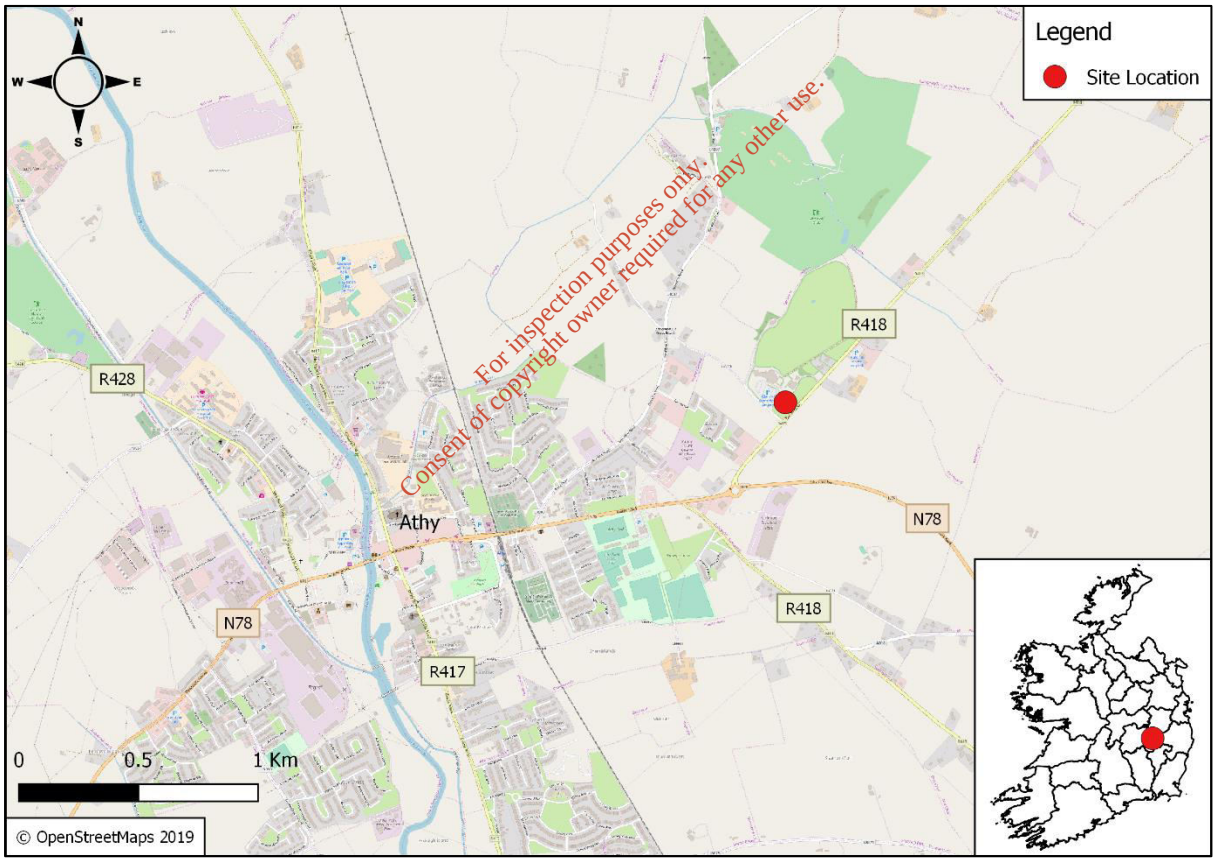
2 SITE SETTING

2.1 Site Location

The Site is located c. 1.6km north-east of the centre of Athy town, County Kildare. The Site is accessed through a third-class road R418 off the national road N78, and it is located within the Townlands of Gallowshill and Prusselstown, refer to Figure 2-1. The area of the Site is approximately 4.4 hectares (ha) and is currently occupied by a hotel with an associated car park, a field to the west of the hotel and a grassed area for sheep, horses and alpacas to the east and south of the Site.

There are a number of residential properties along the northern boundary of the Site, the closest one at c. 11m from the boundary. There is a residential property c. 150m south-west of the site, a petrol station c. 160m south-west of the Site and the town centre is c. 1.6km south-west of the Site. The Athy Stream is located c. 600m north of the Site and the River Barrow is located c.1.6km south-west of the Site.

Figure 2-1: Site Location



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2.2 Site History

The Historic 25" map of the Site published c.1888-1913 by the OSI database (Geohive, 2018) shows a gravel pit within the western part of the Site.

OSI orthophotography images from 1995 show that the Site had been restored. Therefore, it is assumed that filling of the area took place prior to 1995 (deposition of imported material during the 1980s). Images from 2000 show that the area was covered by grass. Images from 2005 show that the hotel had been built and that a residential property was located to the north of the Site. There were some areas of exposed ground, which corresponded to the original

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gravel pit in the northern segment of the western Site boundary and to the north of the hotel. The images from 2005-2012 show a similar layout to those described above.

Historical Google Earth aerial imagery dated 18th April 2009 indicate that the hotel and car park were present. The image was taken some time between 2000 and 2005 according to the OSI orthophotography database. Subsequent Google Earth aerial images (from 2011) show the current layout of the Site.

It is believed that the site was in operation from the early 1970s to mid-1980s. According to KCC (Tier 1), its files show that the Site was used as a refuse depot from approximately 1st January 1981 to 2nd February 1982. However, no historical records from the Site were made available during the preparation of this report to confirm this.

2.3 Environmental Site Setting

2.3.1 Geology

2.3.1.1 Subsoils

Based on the Teagasc subsoil maps the Site is largely underlain by glaciofluvial sand and gravels (Carboniferous) derived mainly from calcareous parent materials (limestone), refer to Drawing No. 1.

2.3.1.2 Bedrock

Based on the GSI database (GSI, 2018), the bedrock underlying the quaternary deposits is generally comprised of the Ballysteen Formation, which consists of dark-grey muddy limestone and shale. The Ballysteen Formation is normally described as irregularly bedded and nodular bedded argillaceous bioclastic limestones (wackestones and packstones), interbedded with fossiliferous calcareous shales, refer to Drawing No. 2.

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2.3.2 Hydrogeology

2.3.2.1 Aquifer Classification

Bedrock Aquifer

The bedrock aquifer beneath the Site is classified by the GSI (2018) as a Locally Important Aquifer (Ll), where the bedrock is moderately productive only in local zones associated with the Ballysteen Formation (refer to Drawing No. 3).

Sand and Gravel Aquifer

The gravel aquifer beneath the Site is comprised of the Barrow Gravels and is classified by the GSI (2018) as being a 'Regionally Important Gravel Aquifer (Rg)', refer to Drawing No. 4.

2.3.2.2 Groundwater Vulnerability

Groundwater vulnerability provides a measure of the ability of contaminants to migrate vertically to an aquifer and is a function of the subsoil permeability (usually dependent on subsoil type) and its thickness (EPA, 2007). According to the GSI's mapping (GSI, 2018), the vulnerability rating at the Site is classified as High (H). Refer to Drawing No. 5.

2.3.2.3 Groundwater Flow Direction

Based on a review of available information, including the topographical gradient, the inferred groundwater flow direction is to the south / south-west towards the River Barrow. Refer to Drawing No. 6A and 6B.

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2.3.2.4 Groundwater Use and Protection

A search of the GSI groundwater well database identified c. twenty-one (21 No) wells with different uses (domestic, industrial and agricultural) within a 2km radius of the Site, refer to Drawing No. 7.

2.3.3 Hydrology

2.3.3.1 Hydrological Receptors

The Athy Stream is located c. 570m north-east, c. 950m north and c. 850m north-west of the Site. The River Barrow is also located c. 1.69km south-west of the Site and the Grand Canal is c. 2.13km to the south-west. The Site is located within the Barrow hydrometric area and the sub-catchment Barrow_SC_080 (EPA, 2018). Refer to Drawing No. 8.

2.3.3.2 Protected Area Receptors

A Public Supply Source of Inner Protection Area (SI) was identified approximately 1.60km west of the Site in the townland of Athy. A Source of Outer Protection Area (SO) was identified at 2.50km west of the Site.

2.3.4 Ecology

2.3.4.1 European Designated Sites

There is one European Designated Natura 2000 Site, located within 10km of the Site. The location is identified in Drawing No. 10 and listed in Table 2-1 below.

Table 2-1: European Designated Sites

Site Name	Site Code	Distance (km) & Direction
Special Area of Conservation		
River Barrow and River Nore SAC	002162	c. 1.70km west of the Site

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An Appropriate Assessment Stage 1 Screening Report (AA) that forms part of the project was prepared for the Site and has been submitted as a stand-alone document (refer to Appendix I), at the end of this report. The screening assessment concluded that the Site does not currently have any adverse effect on any European Designated sites or any of their designated features of interest.

2.3.4.2 Natural Heritage Areas

No Natural Heritage Areas (NHAs) were identified within 5km of the Site. One (1 No.) proposed Natural Heritage Areas (pNHA) was located within 2km of the Site and a further one (1 No) pNHA was located within a 5km radius of the Site. Refer to Drawing No. 11 and Table 2-2 below.

Table 2-2: Nationally Designated Sites

Site Name	Code	Distance (km) & Direction
Proposed Natural Heritage Areas (pNHAs)		
Barrow Valley at Tankardstown	000858	c. 4.7km south of the Site
Grand Canal	002104	c. 2.25km west of the Site

2.3.5 Infrastructure

Service ducts and infrastructure can provide a pathway for the migration of contaminants from the Site to identified receptors. The utility providers Gas Networks Ireland, ESB and Eircom

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were contacted in October 2018 – the responses indicated that there were a number of underground services present within the proposed site investigation area. KCC provided MOR with a map from Irish Water, that shows a “150mm uPVC pipe” to the south-west of the Site, a “150mm unknown pipe” to the north-west of the Site and a “500mm ductile iron pipe” to the south-east of the Site, which were not shown on any of the other site maps. KCC also indicated that the Hotel is connected to the public foul system (not shown in any of the maps).

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3 EXISTING SITE CONDITIONS

3.1 Walkover Survey

A walkover survey was completed by a MOR Consultant on the 13th November 2018. The purpose of this walkover survey was to establish the current land use of the Site and the surrounding area. The Site inspection examined each of the possible SPR linkages and attempted to delineate, from visual inspection, the extent of the imported material.

In general, the topography is mainly flat in the east of the Site, while in the north-west the Site is slightly undulating.

The Site comprises a hotel in the central segment, a field to the south-east with grazing animals (alpacas, sheep and horses) and a further field of different ownership on the west side of the hotel grounds.

Ongoing renovations (i.e. painting, building an extension at the back of the hotel, earth movements at the back of the hotel) of some areas of the hotel were noted during the duration of the Site Investigation works.

There was no evidence of landfill gas during the walkover survey (i.e. odour or vegetation die back).

The ground was observed to be mostly firm and dry.

No noxious/notifiable species (i.e. Japanese Knotweed) were observed within the Site or around the perimeter of the Site.

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4 TIER 1 - RISK SCREENING, PRELIMINARY CONCEPTUAL SITE MODEL AND RISK PRIORITISATION

4.1 Risk Screening

In accordance with the EPA CoP a Risk Screening that assessed the source-pathway-receptor (SPR) linkages was undertaken by developing a Preliminary Conceptual Site Model (CSM) for the Site.

4.2 Preliminary Conceptual Site Model

A preliminary CSM was developed by KCC as part of its Tier 1 assessment of the Site, which identified the possible source-pathway-receptor linkages. Refer to Appendix A for the Tier 1 Assessment.

MOR reviewed and updated the preliminary CSM, refer to Table 4-1 below and Appendix B for the preliminary risk screening carried out by MOR.

Table 4-1: Preliminary Conceptual Site Model Summary

Element	Description	Rationale
Source	Imported Material	• The principal potential source of contamination is the imported material, which has the potential to generate leachate and landfill gas. • Type of Imported Material - It is believed that the Site accepted municipal waste and some commercial and industrial waste. • Records indicate that the Site was used as a refuse depot from approximately 1st January 1981 to 2nd February 1982 (according to the Tier 1 report (KCC)). However, it is believed that the Site was operated from the early 1970s to mid-1980s (according to KCC's project brief) by the local authority. No supporting records were available. • Extent of Imported Material – According to KCC's project brief, it was expected that the footprint of the waste is limited to the north-western segment of the Site (0.86ha) and the area of grassland and part of the car park to the south (1.0ha).
Pathway	Aquifer Beneath the Site	• A sand & gravel aquifer (Regionally Important Aquifer) and a bedrock aquifer (Locally Important Aquifer) were identified beneath the Site (GSI mapping).
	Landfill gas migration via Sand and Gravels	• Possible landfill gas migration via permeable sand and gravel materials towards identified receptor locations.
	Leachate	• Possible migration of leachate through the made ground.
	Surface water Body	• Surface water bodies – Athy Stream c. 570m north-east and c. 850m north-west of the Site.
Receptor	Properties	• Human presence – There is a hotel with a car park on site. There are a number of nearby residential properties c. 11m and c. 100m to the north-east of the Site. A further residential property is located c. 140m north of the hotel and c. 65m from the northern boundary of the western field. A petrol station is located c. 160m south-west of the Site, a residential development is located c. 150m south-west of the site and the town centre is c. 1.6km south-west of the Site.
	Private Wells	• Twenty-one (21 No) private groundwater wells, with different uses (domestic, industrial and agricultural), were identified within a 2km radius of the Site, including the private well supplying the hotel at the Site.

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Element	Description	Rationale
	Public Water Supply Well	• A trial well, a public supply well (KCC) and an infiltration gallery (KCC) were identified c. 1.75km south-west/west of the Site – according to KCC they are no longer in use. • A Public Supply Source of Inner Protection Area (SI) was identified c. 1.60km west of the Site and the SO (Outer Protection Area) was identified at c. 2.50km west of the Site.
	Surface Water	• The Athy Stream is located c. 570m north-east and c. 850m to the north-west of the Site. • The River Barrow is located c. 1.69km south-west of the Site.
	Aquifer Beneath the Site	• Regionally Important Sand and Gravel Aquifer– Private wells. • Locally Important Bedrock Aquifer – Moderately productive – Potential usage not known.
	Protected Sites	• Site located within area of moderate-high environmental sensitivity – due to the important sand and gravel aquifer beneath the Site and its high vulnerability. The closest SAC (River Barrow and River Nore SAC) is c. 1.70km west of the Site.

4.3 Risk Prioritisation

Risk prioritisation was completed for the Site in accordance with the EPA Code of Practice (EPA, 2007). The risk prioritisation process assigns a score to each linkage where the overall site score is the maximum of the individual linkages. The scoring system allocates higher numbers for the higher risk elements and thus it allows a meaningful comparison to be made between different linkages.

Using the methodology developed by the EPA, the individual linkages were normalised to a rating of 100. The result calculated provides an indication of the relative risk associated with the SPR linkage at the Site. Table 4-2 below contains a summary of the results from the site prioritisation exercise.

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Table 4-2: Preliminary Site Prioritisation Summary

SPR	Linkages	Pathway via	SPR Value	Maximum Score	Normalised Score
SPR1	Leachate c>Surface Water	Combined groundwater and surface water	28	300	9%
SPR2	Leachate c> SWDTE	Combined groundwater and surface water	0	300	0%
SPR3	Leachate c> Human Presence (private well)	Groundwater Pathway	84	240	35%
SPR4	Leachate c> GWDTE	Groundwater Pathway	0	240	0%
SPR5	Leachate c> Aquifer	Groundwater Pathway	140	400	35%
SPR6	Leachate c> Public Supply	Groundwater Pathway	0	560	0%
SPR7	Leachate c> Surface Water	Groundwater Pathway	28	240	12%
SPR8	Leachate c> Surface Water	Surface Water Pathway	0	60	0%
SPR9	Leachate c> SWDTE	Surface Water Pathway	0	60	0%
SPR10	Landfill Gas c> Human Presence – off-site	Lateral and Vertical	105	150	70%

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SPR11	Landfill Gas ⇨ Human Presence – onsite	Lateral and Vertical	175	250	70%
OVERALL RISK SCORE			**HIGH**		

Risk Classification	**Range of Risk Scores**
HIGH Risk (Class A)	Score greater than or equal to 70% for any individual SPR linkages
MODERATE Risk (Class B)	Score between 40% and 70% for any individual SPR linkages
LOW Risk (Class C)	Score less than 40% for any individual SPR linkages

Sites with a score greater than or equal to 70% for any of the site specific SPR linkages are considered to represent potential high risk or high uncertainty sites (Class A).

Sites with a score ranging between 40% and 70% for any of the site specific SPR linkages are considered to represent potential moderate risk (Class B).

Sites with a score less than 40% for all of the site specific SPR linkages are considered to represent potential low risk (Class C).

The risk classification assigned to the Site after the desk study was Class A (High Risk). It represents the intrinsic risk that the Site (imported material) poses to the environment. The SPR linkages that represent a potential higher risk are SPR10 and SPR11 (risk of landfill gas migration to off and on-site receptors) with a score of 70%. The remaining SPR linkages were determined to be low risk. However, pollutant linkages SPR3 (normalised score – 35%), SPR5 (normalised score – 35%) and SPR7 (normalised score – 12%), which assess the potential for leachate migration to nearby receptors (private wells – human consumption), to the aquifer beneath the site and to the nearest surface water respectively, were also assessed further.

The pollutant linkages that were not considered further for this assessment were:

- SPR1 linkage (normalised score – 9%), which assesses the potential for leachate migration through on site drainage ditches to surface water receptors. This pollutant linkage was deemed negligible during the site walkover;
- SPR2 linkage, which assesses the potential for leachate migration to a protected area receptor (surface water dependant terrestrial ecosystem (SWDTE)) was not assessed further. There were no protected areas identified in the vicinity of the Site and the linkage scored 0% during the risk screening;
- SPR4 linkage, which assesses the potential for leachate migration (vertical and horizontal) to groundwater dependent terrestrial ecosystems (GWDTE) was deemed negligible as a GWDTE was not identified during the desk study and the linkage scored 0% during the risk screening;
- SPR6 linkage, which assesses the potential for leachate migration (vertical and horizontal) to a public supply well (or group schemes), was deemed negligible as there was no supply wells or group schemes identified during the desk study and the SPR linkage scored 0% during the risk screening;
- SPR8 and SPR9 linkages, which assess the potential for leachate migration to surface water bodies and surface water ecosystems, were deemed negligible, as there were no surface water bodies or surface water ecosystems identified during the desk study and the SPR linkages scored 0% during the risk screening;

The potential risk for the identified SPR linkages was assessed and reviewed further during the Tier 2 – Exploratory and Main Site Investigation Stage.

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5 TIER 2 - EXPLORATORY AND MAIN SITE INVESTIGATION - METHODOLOGY

The following section describes the works carried out during the Tier 2 Exploratory and Main Site Investigations in compliance with the EPA CoP.

5.1 Non-Intrusive Site Investigation

5.1.1 Preparatory Works – Health and Safety

The Site Works were carried out in strict accordance with MOR's safety protocols and all recognised best practice health and safety procedures.

5.1.2 Underground Utility Identification

An underground utility identification and locating procedure was completed prior to initiating any ground disturbance activities at the Site. The utility providers Gas Networks Ireland, ESB and Eircom were contacted in October 2018 – the responses indicated that there were a number of underground services within the proposed site investigation area.

5.1.3 Geophysical Survey

A geophysical survey was completed on the 6th and 8th of November 2018 on the Site by Apex Geoservices Ltd. (Apex) and involved the collection of 800 Electromagnetic (EM) conductivity data points, six (6 No) Electrical Resistivity Tomography (ERT) profiles, three (3 No) seismic refraction profiles and three (3 No) 1D Multi-Channel Analysis of Surface Waves (MASW) across the Site. A copy of the Apex report is included in Appendix C. The primary objective was to assess the subsurface conditions as far as possible (depth to bedrock and information on groundwater) and to determine the thickness, extent and volume of imported material present on Site.

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The brief overview of works provided by Apex is set out below:

1. EM ground conductivity survey across the site. The conductivity survey provided information on the extent of the imported material and any variations within the imported material. It was also used to screen for any leachate plumes and obtain background values for the soils;
2. ERT provided information on the thickness and extent of the imported material and identified areas of possible leachate; and,
3. Seismic refraction profiles were carried out to aid the interpretation of the resistivity data and to provide detail on the depth to bedrock.
4. MASW provided information about the soil cohesion ranges and an indication of the base of waste material. Shear wave and velocity values were determined for the made ground/imported material and underlying soil material.

5.1.4 Topographical Survey

A topographical survey was undertaken after the installation of the wells in order to survey all locations to Ordnance Datum as part of the Tier 2 site investigations. The survey was carried out on the 26th April 2019.

5.2 Intrusive Site Investigation

The intrusive site investigation works were undertaken in accordance with BS10175 – 2011+A2:2017 "Investigation of Potentially Contaminated Sites – Code of Practice'' and supervised on a full-time basis by an experienced MOR environmental consultant. The first phase of works (installation of leachate/gas wells and trial pits) was carried out during

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January 2019, the second phase of site works was carried out in April 2019 (installation of groundwater wells). The scope of work completed is described in the following sections.

5.2.1 Trial Pit Excavation

Trial pitting excavations at seven (7 No) locations were carried out on the 17th of January 2019. The objective of the trial pitting was to assess the lateral extent and composition of the imported material. In this regard any visual or olfactory evidence of contamination was recorded including photographic evidence. A MOR environmental consultant was on site during all of the trial pit excavations.

The excavation of the trial pits to a maximum depth of approximately 5.0mbgl was undertaken using a 13-tonne tracked excavator. Each trial pit was logged in accordance with the BS 5930:2015 standards. Locations for the trial pits were selected based on initial discussions with KCC, findings of the desk-based studies, the site walkover and the results of the geophysical survey. Each trial pit was re-instated to as close to its original condition as possible. Exact locations are shown in Drawing No. 12. Refer to Appendix D for trial pit logs and also for photographic records of all trial pits. Three (3 No) different sub-surface profiles were recorded at the Site;

- Profile 1 – Trial pits on the eastern boundary of the Site (TPC) and to the north-west of the hotel building (TPD);
- Profile 2 – Trial pits located in the field to the south-east and east of the hotel (TPA and TPB); and
- Profile 3 – Trial pits located in the field on the western segment of the Site (TPE, TPF and TPG).

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Table 5-1 below depicts the first soil profile (Profile 1) encountered at the Site during trial pitting.

Table 5-1: Typical Trial Pit Profile 1

Depths (mbgl)	Profile
0.0 – 3.3	Natural Ground – Gravelly clay with cobbles and boulders.

mbgl - metres below ground level

Table 5-2 below depicts the second soil profile (Profile 2) encountered at the Site during trial pitting.

Table 5-2: Typical Trial Pit Profile 2

Depths (mbgl)	Profile
0.0 – 0.8	Made Ground – Gravelly clay with cobbles.
0.6 – 2.6	Made Ground – Gravelly clay with cobbles and occasional/some wood, plastic, glass, metal, car parts and plastic. Strong decomposition odour.
1.1 – 5.0	Made Ground – Sandy clay and occasional concrete, red bricks, glass and metal. Slight to moderate odour of burning.

mbgl - metres below ground level

Table 5-3 below depicts the third soil profile (Profile 3) encountered at the Site during trial pitting.

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Table 5-3: Typical Trial Pit Profile 3

Depths (mbgl)	Profile
0.0 – 1.4	Made Ground – Gravelly clay with cobbles and rare metal, plastic, red bricks and wood.
1.0 – 4.0	Made Ground – Sandy clay and some/many plastic, cloths, glass, pieces of carpet, mattress, cans (baby formula), lids, steel sheeting, metal and milk cartons. Strong decomposition odour and odour of historical burning.

mbgl - metres below ground level

5.2.2 Leachate and Gas Wells

A shell and auger rig were mobilised to the Site from the 9th to the 15th of January 2019 to install shallow leachate/gas wells (L1A to L3A). The three (3 No) combined leachate and gas monitoring wells were installed within the imported material to maximum depths ranging from 5.1 to 8.5mbgl. During the installation works the MOR consultant noted any field evidence of contamination through the soil/lithological profile to ensure that a conduit was not provided to the underlying aquifer. The borehole logs are shown in Appendix E. Refer to Table 5-4 for details on the installation and Drawing No. 13 for leachate borehole locations.

Table 5-4: Installation Details

Borehole ID	Final Depth (mbgl)	Screened Depth (mbgl)	Comments
L1A	5.1	1.0 – 5.1	No natural ground encountered
L2A	8.5	1.0 – 8.5	No natural ground encountered
L3A	6.5	1.0 – 6.5	No natural ground encountered

mbgl - metres below ground level

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5.2.3 Groundwater Wells

Three (3 No) groundwater monitoring wells were installed between the 10th and the 15th of April 2019 to a maximum depth of 17.3mbgl using an air rotary drill rig. The wells were installed in order to characterise groundwater quality upgradient and downgradient of the imported fill materials, refer to Drawing No. 14 for groundwater monitoring well locations. The borehole logs are shown in Appendix E.

Table 5-5 shows details of the groundwater well installation and static water level taken after the completion of the well installation.

Table 5-5: Summary – Groundwater Well Installation

Sample ID	Final Depth (mbgl)	Screened Depth (mbgl)	Screened Lithology	Static Water Level (mbgl)
GW1A	17.3	8.3 – 17.3	Gravel	12.6
GW2A	14.3	4.3 – 14.3	Sand and Gravel	12.4
GW3A	17.3	4.3 – 17.3	Sand and Gravel	8.9

mbgl - metres below ground level

Both the groundwater monitoring wells, and leachate / gas wells were constructed with 50mm PVC blank casing and slotted screen and were fitted with a rubber bung seal and gas valve. The wells were finished flush to ground level with the exception at GW2A, GW3A and L1A, which were finished with an upright cover. In accordance with best practice, the borehole

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annulus at all locations was backfilled with pea gravel to approximately 0.5m above the screened interval followed by a bentonite seal to the surface.

5.3 Imported Material Laboratory Analysis

Three (3 No) soil samples were collected during the trial pit excavation at the Site. Samples were sealed in appropriate laboratory supplied containers and stored in cool dark conditions for transfer to Exova (Jones Environmental Ltd), a UKAS accredited laboratory for analysis. Sample details including the location and depth of samples were recorded on chain of custody (COC) records and kept for tracking purposes.

The soil samples were analysed for the inert criteria as stipulated in 2003/33/EC European Waste Acceptance Criteria (WAC) (EU, 2003), as previously agreed with KCC, as follows:

Soil:

- Metals: antimony, arsenic, barium, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium, zinc, sulphate, boron;
- pH;
- Moisture content;
- Total cyanide;
- Total organic carbon (TOC);
- Sulphide and Elemental Sulphur;
- Hexavalent Chromium and Chromium III;
- MTBE, Benzene, toluene, ethylbenzene and total xylenes (BTEX) and phenol;
- Polychlorinated biphenyls (PCBs);
- Mineral oil;
- Asbestos;
- Polycyclic aromatic hydrocarbons (PAHs); and,
- Total petroleum hydrocarbons (TPH CWG).

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Soil/Waste Leachate (CEN 10:1):

- Indicators and inorganics: chloride, fluoride, sulphate, dissolved organic carbon (DOC), ammoniacal nitrogen and total dissolved solids (TDS);
- Metals: antimony, arsenic, barium, cadmium, chromium, copper, lead, molybdenum, nickel, selenium, zinc, mercury, and boron; and,
- Phenol.

5.4 Environmental Monitoring

Monitoring was carried out at the Site on 25th April 2019, 9th May 29th May 2019, 23rd October 2019 (routine monitoring of the hotel's private well) and 19th December 2019. The details of the scope of the monitoring completed are summarised in Table 5-6 and the methodology is outlined below. All sampling locations are shown in Drawing No. 15.

The monitoring events were conducted, and samples collected by appropriately qualified and experienced MOR consultants in accordance with MOR ISO procedures and industry best practice standards (i.e. ISO 5667).

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Table 5-6: Summary of Environmental Monitoring

Date	Groundwater Monitoring Events	Leachate Monitoring Events	Surface Water Monitoring Events	Gas Monitoring Events	Surface VOC Emissions Survey (FID)
25th April 2019	GW1A, GW2A and GW3A	L1A, L2A and L3A	SW1A and SW2A	L1A, L2A, L3A, GW1A, GW2A and GW3A	
9th May 2019	GW1A, GW2A and GW3A	L1A, L2A and L3A	SW1A and SW2A	L1A, L2A, L3A, GW1A, GW2A and GW3A	
29th May 2019				L1A, L2A, L3A, GW1A, GW2A and GW3A	Locations within and outside of the Site
23rd Oct 2019	Private well at Hotel (by IAS Laboratories)				
19th Dec 2019					Locations within the hotel building

5.4.1 Leachate

Leachate monitoring was undertaken over two (2 No) monitoring events, on 25th April 2019 and 9th May 2019 at the new combined leachate/gas monitoring wells. Leachate samples were retrieved from the monitoring location L1A during both monitoring events. The monitoring locations L2A and L3A were dry during both monitoring events and no leachate samples could be retrieved.

All leachate samples were collected in accordance with best practice procedures (ISO 5667-11:2009) using a disposable bailer to avoid cross contamination. The sample containers were kept cool and in darkness and were sent to a UKAS accredited laboratory (Exova Ltd.) for analysis. In order to maintain sample integrity, a chain of custody (COC) record was completed to track sample possession from time of collection to time of analysis. Refer to Appendix F for the COC records.

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Leachate samples were analysed in the laboratory for a broad range of potential contaminants. The leachate analytical suite closely followed the parameters set out in Table C.2 of the EPA Landfill Monitoring Manual (2003) for 'Groundwater Baseline'. The requirements of Table D2 are also included in the proposed suite of analysis for the full screen. The leachate analytical suite for this site included the following parameters;

- Temperature, Dissolved Oxygen, Electrical Conductivity, Oxidation Reduction Potential and pH;
- Metals (Arsenic, Boron, Cadmium, Calcium, Chromium, Copper, Iron, Lead, Magnesium, Manganese, Mercury, Nickel, Potassium, Sodium and Zinc);
- Sulphate, Chloride and Fluoride;
- Ammoniacal Nitrogen;
- Total Oxidised Nitrogen (TON);
- Molybdate Reactive Phosphorous (MRP);
- Total Cyanide;
- Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD);
- Acid Herbicides;
- Organochlorine Pesticides (33 compounds);
- Organophosphorus pesticides (21 compounds);
- Pesticides (Atrazine & Simazine);
- Semi-Volatile Organic Compounds SVOCs (including PAHs, phenols and chlorinated phenols);

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- Volatile Organic Compounds (including BTEX/MTBE);
- Total Monohydric Phenols – HPLC;
- Tributyltin, Triphenyltin, Dibutyltin;
- Extractable Petroleum Hydrocarbons (EPH) including mineral oil; and,
- Total Petroleum Hydrocarbons (TPH).

5.4.2 Groundwater

Groundwater monitoring was undertaken over two (2 No) monitoring events, on 25th April 2019 and 9th May 2019 at the groundwater monitoring locations (GW1A to GW3A). A sample from the hotel's private well was analysed for a reduced suite of parameters during the hotel's routine monitoring.

During the two (2 No) monitoring events. Each well was purged prior to sample collection in accordance with standard best practice methods using dedicated equipment. During purging, water quality measurements were taken as well as notes on the physical appearance of the purged water. After purging, the groundwater samples were decanted into labelled containers supplied by the laboratory. All samples were collected in accordance with best practice procedures (ISO 5667-11:2009) using dedicated sampling equipment to avoid cross contamination. The sample containers were kept cool and in darkness and were sent to a UKAS accredited laboratory (Exova Ltd.) for analysis. In order to maintain sample integrity, a chain of custody record was completed to track sample possession from time of collection to time of analysis.

Groundwater samples (GW1A to GW3A) were analysed in the laboratory for a broad range of potential contaminants. The groundwater analytical suite closely followed the parameters set out in Table C.2 for the EPA Landfill Monitoring Manual (2003) for 'Groundwater Baseline'. The requirements of Table D2 were also included in the suite of analysis for the full screen. The groundwater analytical suite for the Site included the following parameters;

- Temperature, Dissolved Oxygen, Electrical Conductivity, Oxidation Reduction Potential and pH;
- Sulphate, Chloride, Fluoride;
- Metals (Arsenic, Boron, Cadmium, Calcium, Chromium, Copper, Iron, Lead, Magnesium, Manganese, Mercury, Nickel, Potassium, Sodium and Zinc);
- Ammoniacal Nitrogen;
- Molybdate Reactive Phosphorous (MRP);
- Total Dissolved Solids (TDS), Total Organic Carbon (TOC);
- Total Oxidised Nitrogen;
- Total Alkalinity as CaCO3;
- Total Cyanide;
- Acid Herbicides;
- Organochlorine Pesticides (33 compounds);
- Organophosphorus pesticides (21 compounds);
- Pesticides (Atrazine & Simazine);
- Semi-Volatile Organic Compounds SVOCs (including PAHs, phenols and chlorinated phenols);
- Volatile Organic Compounds (including BTEX/MTBE);
- Total Phenols – HPLC;
- Tributyltin, Triphenyltin, Dibutyltin;
- Extractable Petroleum Hydrocarbons (EPH) including mineral oil; and,
- Total Petroleum Hydrocarbons (TPH); and,
- Faecal and Total Coliforms.

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The hotel's private well was analysed for the following suite of parameters:

- E. Coli, Total Coliforms and T.V.C @ 22 °C;
- Aluminium, Iron, Manganese, Calcium, Sodium, Potassium, Lead, Copper and Magnesium;
- Ammonia, Nitrate, Nitrite, Chloride and Sulphate;
- pH, Colour, Conductivity, Total Hardness and Turbidity.

5.4.3 Surface Water

Two (2 No) surface water samples (SW1A and SW2A) were collected upstream and downstream of the Athy Stream to the north and north-east of the Site over two monitoring events on 25th April 2019 and 9th May 2019. The surface water monitoring locations are shown in Drawing No. 16.

All samples were collected in accordance with best practice procedures (ISO 5667-11:2009). During sample collection, water quality measurements of EC, temperature and DO, were taken as well as notes on the physical appearance of the water samples. Surface water samples were collected and decanted into labelled containers supplied by a UKAS and ISO 17025 accredited laboratory. The sample containers were kept cool and in darkness and were sent to the laboratory for analysis. In order to maintain sample integrity, a chain of custody document was completed to track sample possession from time of sample collection to time of analysis.

Surface water samples were analysed for the following parameters:

- Temperature, Dissolved Oxygen, Electrical Conductivity, Oxidation Reduction Potential and pH;
- Metals (Arsenic, Boron, Cadmium, Calcium, Chromium, Copper, Iron, Lead, Magnesium, Manganese, Mercury, Nickel, Potassium, Sodium and Zinc);
- Sulphate, Chloride and Fluoride;
- Ammoniacal Nitrogen;
- Total Oxidised Nitrogen (TON);
- Total Suspended Solids (TSS);
- Molybdate Reactive Phosphorous (MRP);
- Total Cyanide;
- Total Alkalinity as CaCO3;
- Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD);
- Acid Herbicides;
- Organochlorine Pesticides (33 compounds);
- Organophosphorous pesticides (21 compounds);
- Pesticides (Atrazine & Simazine);
- Semi-Volatile Organic Compounds SVOCs (including PAHs, phenols and chlorinated phenols);
- Volatile Organic Compounds (including BTEX/MTBE);
- Total Monohydric Phenols – HPLC;
- Tributyltin, Triphenyltin, Dibutyltin;
- Extractable Petroleum Hydrocarbons (EPH) including mineral oil; and,
- Total Petroleum Hydrocarbons (TPH).

5.4.4 Landfill Gas

As part of the Site Investigations, gas monitoring was undertaken on three (3 No) occasions, 25th April 2019, 9th May 2019 and 29th May 2019. Landfill gas monitoring was undertaken at the three (3 No) new combined leachate/gas monitoring wells (L1A, L2A and L3A) and on the

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three (3 No) groundwater wells (GW1A, GW2A and GW3A). Landfill gas was monitored via a gas valve fitted to the gas wells using a portable GA2000 gas meter.

The following parameters were recorded during each monitoring event:

- Stable and peak methane;
- %LEL methane;
- Carbon dioxide;
- Oxygen;
- Hydrogen sulphide;
- Carbon monoxide;
- Barometric pressure;
- Relative pressure; and,
- Flow.

5.4.5 Surface VOC Monitoring Survey

Surface VOC emission monitoring was undertaken within and outside of the Site boundary on 29th May 2019. The survey was undertaken using a portable natural gas detector Inficon IRwin Detector (Inficon). The Inficon measures VOCs in parts per million (ppm). The Inficon can identify the ingress of low levels of VOCs into buildings e.g. along cracks in the foundations. The range of detection is from 1ppm to 100 % CH_4.

The survey was undertaken at fifty-one (51 No) locations within the Site boundary. All surface locations measured where recorded, if an elevated CH_4 reading was measured the location was noted using a handheld GPS.

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5.4.6 Internal VOC Monitoring Survey – Building

A comprehensive internal VOC emission monitoring was undertaken at eighty-one (81 No) locations within the hotel on the 19th December 2019. The survey was undertaken using a portable natural gas detector as described in section 5.4.5.

The measurements were taken in the following locations:

- Room 106 – All four (4 No) corners at the skirting board and in the corner beside the bathtub in the toilet area;
- Storage room beside room 120 - Three (3 No) corners at the skirting board;
- The Woodstock Boardroom – Along the skirting board (all four (4 No) corners) and beside the exit door (skirting board);
- Games room and children's room - All four (4 No) corners at the skirting board in both rooms;
- Ladies toilet – A number of spot measurements along the skirting board in the toilet;
- Corridor glass door (near room 122) – along the skirting board;
- Outside room 121 – along the skirting board;
- Outside room 120 – along the skirting board;
- Fire exit – along the skirting board (both sides of the door);
- Under the stairs area – one location at the skirting board;
- Outside room 116 – along he skirting board;
- Fire exit beside game room - One location at the skirting board;
- Corridor beside the stairs to first floor - All four (4 No) corners at the skirting board;
- Laundry room – A number of spot measurements along the skirting board and under the sink;
- The Shackleton Suite – A number of spot measurements around the boundary of the room (at the skirting board);

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- Kitchen off the Shackleton Suite - A number of spot measurements in the kitchen (i.e. drainage, storeroom, outside the cool room, etc.);
- The Edward Fitzgerald Room – A number of spot measurements around the boundary of the room (at the skirting board); and,
- Gents toilets - All four (4 No) corners at the skirting board and at the drains.

5.5 Assessment Criteria

Field measured parameters and laboratory analytical results for groundwater and leachate samples collected were compared, where applicable, to the following groundwater generic assessment criteria (referred to hereafter as groundwater GAC):

- Statutory Instrument S.I. No. 9 of 2010: European Communities Environmental Objectives (Groundwater) Regulations 2010, as amended 2012 (S.I. No. 149 of 2012) and 2016 (S.I. No.366 of 2016) (EU, 2010).

In the absence of Groundwater Regulation Values for specific parameters, the following assessment criteria were used for indicative purposes:

- The Interim Guideline Values (IGVs) for Groundwater from the Environmental Protection Agency (EPA, 2003), 'Towards setting guideline values for the protection of groundwater; Interim Report'; and,
- European Communities (Drinking Water) (S.I. No. 278 - No. 2) Regulation 2007, as amended 2014 (S.I. No. 122 of 2014), as amended 2017 (S.I. No. 464 of 2017) (EU, 2007).

The laboratory analysis for surface water samples and leachate samples were compared, where applicable, to the following generic assessment criteria:

- Surface Water Regulations 2009 (SI No. 272 of 2009) as amended (S.I. No. 372 of 2012 and S.I. No. 386 of 2015. (EU, 2009)

The laboratory analysis for soil samples were compared, where applicable, to the following generic assessment criteria:

- The 2003/33/EC European Waste Acceptance Criteria (referred to hereafter as WAC); and,

Landfill gas results were compared to published standards values contained, as applicable, in the following:

- EPA 1997 Thresholds (Environmental Protection Agency (EPA, 1997): Landfill Manuals - Landfill Operational Practices. EPA, Ireland).

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6 TIER 2 - RESULTS

6.1 Geophysical Survey

The integrated interpretation of the geophysical survey identified imported material across an approximate area of 1.71ha on Site. A layer of topsoil/capping layer comprising sandy gravelly clay c. 0.3-1.5m thick was present in areas where made ground/waste was interpreted. Made ground was interpreted to be very soft-soft / very loose-loose. Soils consisting of sandy gravelly clay, clayey silty gravel and silty sandy gravel were interpreted across the Site. The upper 3.2m of soil was interpreted as soft-firm/loose-medium dense becoming stiff-very stiff/dense-very dense. The geophysical report is included in Appendix C.

According to the geophysical report, there are two types of waste encountered on Site:

- Waste type 1: Made ground/waste (municipal including organic and C&D), with a thickness of c. 2.9-11.7mbgl, with the thickest areas in the south and northwest of the Site; and
- Waste type 2: Made ground/waste (C&D and municipal mixed with CLAY) with a thickness of 0.3-11.9mbgl, where present.

The combined thickness of both types of imported material ranges from 0.3m in the southwest to 15.6m in the south and northwest of the Site.

The natural material, where the imported material was not interpreted, was interpreted as clayey silty gravel, clayey silty gravel and silty sandy gravel up to 25m thick. Resistivity and Seismic values indicated the possibility of a transition to weathered rock/dark limestone at depth.

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6.2 Topographical Survey

The topographical survey confirmed that the groundwater monitoring well at the lowest elevation is in the western part of the Site (GW3A) at 67.40maOD (ground level), and the groundwater monitoring well with the highest elevation is located south of the Site (GW1A) at 71.08maOD. Refer to Drawing No. 6A and 6B for the recorded levels at the Site used to infer the groundwater flow direction.

6.3 Surface

No evidence of surface contamination was observed inside or outside the Site boundary during the Site walkover, in regard to spillages or surface run-off contamination (i.e. visual sheen).

6.3.1 Surface VOC Monitoring Results

Surface emissions were measured at 51 locations inside and outside the Site boundary on the 29th May 2019. The survey extended to the perimeter of the hotel to assess for potential gas entering the building. No elevated VOC's were detected at any of the locations measured. Refer to Drawing No. 17.

6.3.2 Internal VOC Monitoring Results – Building

The internal VOC emissions survey of the hotel area was undertaken on the 19th December 2019. The survey detected VOC concentrations within the typical background concentration range in all areas included in the survey. The following Table 6-1 depicts the surveyed locations and the VOC concentrations detected.

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Table 6-1: Summary Results – Internal VOC Emissions

Location	Ranges (ppm)
Room 106	6-14
Storage room beside room 120	0-14
The Woodstock Boardroom	0-7
Game room and children's room	0-8
Ladies toilet	5-11
Corridor glass door (near room 122)	15-17
Outside room 121	0
Outside room 120	5
Fire exit	5-7
Under the stairs area	0
Outside room 116	5
Fire exit beside game room	5
Corridor beside the stairs to first floor	0-6
Laundry room	6-11
The Shackleton Suite	6-8
Kitchen off the Shackleton Suite	0-33
The Edward Fitzgerald Room	6-7
Gents toilets	0-7

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6.4 Subsurface Material

6.4.1 Trial Pitting, Leachate/Gas Wells and Groundwater Wells

The subsurface profile encountered during trial pitting within the area of imported material comprised a capping layer with a thickness ranging from 0.6mbgl to 1.4mbgl, generally comprised of dark brown gravelly clay with occasional cobbles.

The imported waste material beneath the capping layer was observed at thickness of 0.6 to 5.0 meters and comprised mixed waste, which generally included red bricks, concrete, plastic, metal, wood, cloths, glass, cables, pieces of carpet, mattress, oil can, milk cartons, metal cans (milk formula) and their lids, steel sheeting, supermarket bags and pieces of throw (textiles).

No waste was encountered in locations TPC and TPD, they were excavated in natural ground (clay). TPA, TPB, TPE, TPF and TPG terminated in made ground. Please refer to Table 6-1 for details.

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Table 6-2: Trial Pits Summary

Sample ID	Final Depth (mbgl)	Waste Depth (mbgl)	Composition of Waste	Comments
TPA	4.1	1.1-4.1	Wood, plastic, glass, metal, concrete, coal, red bricks and cables	Slight odour of burnt material
TPB	5.0	0.6-5.0	Plastic, sacks, glass bottles and car metal parts	Strong decomposition odour & moderate odour of burnt material.
TPC	3.2	-	-	No waste encountered
TPD	3.3	-	-	No waste encountered
TPE	3.1	1.4-3.1	Plastic, red bricks, cloths, glass bottles, oil can, carpet and mattress	Moderate decomposition and hydrocarbon odours
TPF	3.5	1.3-3.5	Plastic, wood, plastic glasses, milk cartons, metal, can (milk formula), metal lids, steel sheeting, supermarket bags, pieces of throw and hard metal	Strong decomposition odour
TPG	4.0	1.0-4.0	Plastic bottles, concrete, glass jars, glass, metal wires and wood	Slight sweet odour and odour of burnt material

mbgl - metres below ground level

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Imported material was encountered in all leachate borehole locations (L1A to L3A) installed within the waste body. The imported material generally consisted of rare/occasional wood, concrete, red bricks, metal, plastic, broken glass, concrete, clothes and lids.

The leachate/gas wells (L1A to L3A) all terminated in made ground, depths ranging from 5.1mbgl (L1A) to 8.5mbgl (L2A). No natural ground was encountered in any of the leachate/gas wells. Leachate was encountered at L1A during drilling. Refer to Table 6-3 for details.

Table 6-3: Leachate Wells Summary

Sample ID	Final Depth (mbgl)	Depth of Waste (mbgl)	Composition of Waste	Leachate (mbgl)
L1A	5.1 - Obstruction	1.8 – 5.1	Plastic, cloths, red bricks, wood, concrete, metal and plastic bottles	1.8
L2A	8.5 - Obstruction	1.5 – 8.5	Hard plastic, clothes, glass, red bricks, wood, lids and burnt tyre	-
L3A	6.5 - Obstruction	1.4 – 6.5	Plastic, glass, red bricks, concrete and hard plastic	-

mbgl - metres below ground level

Bedrock was not encountered during the installation of the groundwater wells. The depths of the groundwater wells ranged from 14.3mbgl at GW2A to 17.3mbgl at GW1A and GW3A. Groundwater strikes were encountered at 14.0mbgl, 15.5mbgl and 16.8mbgl at GW1A, at 9.8mbgl at GW2A and at 9.6mbgl, 10.7mbgl and 11.2mbgl at GW3A.

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6.5 Extent of Imported Material

6.5.1 Vertical Extent of Imported Material

The maximum vertical extent of imported material observed during the trial pitting and borehole installation ranged from 5.1mbgl northwest of the Site to 8.5mbgl southeast of the Site. However, it is believed that the imported material extended beyond those depths. The geophysical survey (Apex Geoservices Ltd) indicated a combined thickness for both types of waste ranging from c. 0.3m in the southwest to 15.6m in the south and northwest of the Site.

6.5.2 Horizontal Extent of Imported Material

The horizontal extent of waste materials has been delineated according to the findings of the site investigations, including trial pit and borehole investigations, and the geophysical survey. The south, south-western and south-east boundaries were delimited by the Gallow Hill Court road and the Dublin road and the eastern boundary was delimited by the Dublin road, whose construction predated the fill activity. The western boundary is defined by the historical western edge of the gravel pit and the interpreted results of the geophysical survey. The northern boundary of the imported material is delimited based on the geophysical survey. There is no evidence of imported material either beneath or directly north of the hotel.

The area of the Site believed to be underlain by waste is approximately 1.71ha. Refer to Drawing No. 18 for an approximation of the waste delineation drawn by MOR as supplied by Apex.

6.5.3 Volume of Waste

Volumetric calculations of waste were completed by Apex using measurements of the thickness of the imported material from the investigation locations on Site and geophysical survey data. Apex have estimated the total volume of the imported material to be in the region of 114,920m^3 (i.e. 160,888tonnes, using a multiplier of 1.4tonnes/m^3), refer to Table 6-4 below.

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Table 6-4: Estimated Volume of Waste

Extent (ha)	Average Thickness (m)	Volume (m^3)	Tonnes (1.4tonnes/m^3)
0.52	10.2	53,040	74,256
1.19	5.2	61,880	86,632
Total		**114,920**	**160,888**

6.6 Groundwater Levels

6.6.1 Water Levels Results

Static groundwater levels were measured at each monitoring well (groundwater and leachate wells) and the groundwater level was recorded relative to a fixed reference point; the top of the casing at all of the wells. The fixed reference point at each well was surveyed to Ordnance Datum to enable an inferred groundwater flow direction at the Site to be derived, refer to Table 6-5 below and Table 1 (See table at the end of the report).

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Table 6-5: Groundwater Levels Summary

Sample ID	Water Level (mbtoci) – 23rd April 2019	Groundwater Level (mAOD)	Water Level (mbtoci) – 8th / 9th May 2019	Groundwater Level (mAOD)
L1A	3.91	65.36	3.93	65.34
L2A	Dry	-	Dry	-
L3A	Dry	-	Dry	-
GW1A	12.36	58.72	12.43	58.65
GW2A	8.85	59.22	8.92	59.15
GW3A	8.78	59.02	8.84	58.96

mAOD – meters above Ordnance Datum
mbtoci – meters below top of casing inner
mbtoc – meters below top of casing

6.6.2 Inferred Groundwater Flow Direction

The results confirm that the groundwater flow direction beneath the Site is to the south / south-west. Refer to Drawing No. 6A and 6B.

6.7 Laboratory Analytical Results

6.7.1 Imported Material Results

The three (3 No) soil analytical results from the samples collected during the trial pitting at TPA, TPF and TPG were assessed relative to the industry standard criteria outlined in the document 'Establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of and Annex II to Directive 1999/31/EC (2003/33/EC)'. The criteria used were as follows:

- Criteria for landfills for inert waste;
- Criteria for landfills for non-hazardous waste; and,
- Criteria for landfills for hazardous waste.

The results are described in detail below and soil analytical results are presented in Table 2 (See table at the end of the report). Refer to Appendix G for laboratory results (Exova).

Indicators and Inorganics

Total Organic Carbon (TOC)
The TOC concentration at sampling locations TPF (3.44%) and TPA (19.8%) exceeded the inert WAC (3%). The sampling location TPA exceeded the hazardous WAC (6%). No determination was possible at sampling location TPG.

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Asbestos
Chrysotile fibre bundles were visually detected in the laboratory at sampling location TPG. Quantification in the laboratory recorded concentrations of <0.001%. No asbestos was identified at sampling locations TPA and TPF.

Petroleum Hydrocarbons
TPH/EPH/Mineral Oil/PCB's
Mineral oil concentrations ranged from <30mg/kg at TPA to 905mg/kg at TPF and exceeded the relevant WAC for inert landfills (500mg/kg) at TPF. Sample locations at TPA and TPG did not exceed the inert WAC.

The interpretation of EPH indicated "PAH's and lubrication oil" at TPA, "Degraded diesel, possible PAH'S, lubricating oil and naturally occurring compounds" at TPF and "PAH's and lubrication oil" at TPG.

Benzene, Toluene, Ethylbenzene and Xylenes (m/p-xylene and o-xylene) concentrations did not exceed the inert WAC (6mg/kg) at any sample locations.

TPH (Aliphatic and Aromatic) concentrations ranged from <0.1mg/kg to 1,495mg/kg. There is no WAC for TPH's.

The total concentrations for Polychlorinated Biphenyls (PCBs - 7 congeners) ranged from <35ug/kg (TPA and TPG) to <700mg/kg (TPF) and did not exceed the inert WAC (1,000ug/kg) at any sample locations.

MTBE
MTBE concentrations were <5ug/kg at all sample locations. There is no WAC limit for MTBE.

Polycyclic Aromatic Hydrocarbons (PAH's)
The total PAH's 17 ranged from <0.64 to 10.7mg/kg (TPG and TPA respectively) and did not exceed the inert WAC limit (100mg/kg) at any sample locations.

Soil Leachate

Metals

Antimony
Antimony concentrations ranged from <0.02 to 0.11mg/kg at TPF and TPG respectively and slightly exceeded the inert WAC (0.06mg/kg) at TPA (0.1mg/kg) and TPG (0.11mg/kg).

Arsenic
Arsenic concentrations at all sample locations did not exceed the inert WAC (0.5mg/kg) and ranged from 0.1mg/kg (TPA and TPF) to 0.054mg/kg (TPG).

Barium
Barium concentrations at all sample locations did not exceed the inert WAC (20mg/kg) and ranged from 0.2 to 0.59mg/kg at TPA and TPG respectively.

Boron
Boron concentrations ranged from 0.4mg/kg to 9.97mg/kg at TPA and TPG respectively. There is no WAC for Boron.

Cadmium
Cadmium concentrations did not exceed the inert WAC (0.04mg/kg) and were reported at <0.005mg/kg at all sample locations.

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Chromium
Chromium concentrations did not exceed the inert WAC (0.5mg/kg) and ranged from <0.015 at TPF and TPG to 0.2mg/kg at TPA.

Copper
Copper concentrations did not exceed the inert WAC (2mg/kg) and were reported at <0.07mg/kg at all sample locations.

Lead
Lead concentrations did not exceed the inert WAC (0.5mg/kg) and ranged from <0.05mg/kg at TPA to 0.1mg/kg at TPF and TPG.

Molybdenum
Molybdenum concentrations ranged from 0.1 to 0.78mg/kg at TPA and TPG respectively and slightly exceeded the inert WAC (0.5mg/kg) at TPG (0.78mg/kg).

Nickel
Nickel concentrations at all sample locations did not exceed the inert WAC (0.4mg/kg) and ranged from <0.02mg/kg at TPA and TPG to 0.1mg/kg at TPF.

Selenium
Selenium concentrations at all sample locations did not exceed the inert WAC (0.1mg/kg) and were reported at <0.03mg/kg at all sample locations.

Zinc
Zinc concentrations at all sample locations did not exceed the inert WAC (4mg/kg) and ranged from <0.03mg/kg at TPG to 0.1mg/kg at TPA.

Mercury
Mercury concentrations at all sample locations did not exceed the inert WAC (0.01mg/kg) and were reported at <0.0001mg/kg at all sample locations.

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Indicators and inorganics
Sulphate
Sulphate concentrations ranged from 132 to 2,095mg/kg at TPA and TPF respectively and exceeded the inert WAC (1,000mg/kg) at TPF.

Ammoniacal Nitrogen
Ammoniacal Nitrogen concentrations ranged from 0.9mg/kg to 426.9mg/kg at TPA and TPF respectively. There is no WAC limit for ammoniacal nitrogen.

Chloride
Chloride concentrations at all sample locations did not exceed the inert WAC (800mg/kg) and ranged from <3mg/kg at TPA to 78mg/kg at TPF.

Fluoride
Fluoride concentrations at all sample locations did not exceed the inert WAC (10mg/kg) and were reported at <3mg/kg at all sample locations.

Dissolved Organic Carbon (DOC)
DOC concentrations at all sample locations did not exceed the inert WAC (500mg/kg) and ranged from 30 to 180mg/kg at TPA and TPF respectively.

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Total *Dissolved Solids (TDS)*
TDS concentrations ranged from 1,760 to 4,210mg/kg at TPA and TPF respectively and exceeded slightly the inert WAC (4,000mg/kg) at TPF.

Phenols

Phenol concentrations at all sample locations did not exceed the inert WAC (1mg/kg) and were reported at <0.1mg/kg at all sample locations.

6.7.2 Soil Geotechnical Results

One (1 No) undisturbed sample (GW04) was collected from the capping layer on 11th April 2019 and sent to Causeway Geotechnical limited for geotechnical (permeability, moisture content, bulk and dry density) testing, please refer to Appendix H for the complete report. Refer to Table 6-6 below for a summary of the laboratory tests.

Table 6-6: Geotechnical Testing Laboratory Results.

Sample ID / Depth (mbgl)	Soil Description	Moisture Content %	Bulk Density (mg/m^3)	Dry Density (mg/m^3)	Permeability (m/s)
GW04 **0.0-0.45**	Brown very gravelly very sandy CLAY	20	2.09	1.75	$4.9x10^{-9}$

Soil permeability results indicated that the capping layer overlying the imported material has a low permeability, thus impeding rainfall infiltration into the waste material.

GW04 was also tested for Particle Size Distribution (PSD) in accordance with BS1377:1990: Part 2: Clauses 9.2 & 9.4. The sample was reported by the geotechnical testing laboratory as brown very gravelly very sandy CLAY.

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6.7.3 Groundwater Results

Groundwater results were assessed relative to available Irish legislative and guideline standards. The results are described in detail below and groundwater analytical results are presented in Table 3 (See table at the end of the report). Refer to Appendix G for laboratory results (Exova (GW1 to GW3A) and IAS laboratory (private well)).

Indicators
Field Indicators
Field measured parameters including pH, Electrical Conductivity (EC), Dissolved Oxygen (DO), Temperature and Oxidation Reduction Potential (ORP) were measured during the groundwater sampling. EC values measured ranged from 707.0µS/cm (GW3A-first sampling event) to 875.0µS/cm (GW1A-first sampling event). EC values exceeded the groundwater regulation value of 800µS/cm at GW1A (both sampling events) and GW2A (first sampling event). pH values ranged from 7.12pH units (GW1A-second sampling event) to 7.38pH units (GW1A-first sampling event), which were below the groundwater regulation values (6.5-9.5 pH units).

There are no guideline values for DO or ORP. DO concentrations measured ranged from 37.80% (GW3A-first sampling event) to 79.52% (GW2A-first sampling event). ORP concentrations ranged from 96.27mV (GW1A-second sampling event) to 369.49mV (GW1A-first sampling event). A positive ORP is indicative of oxidising conditions.

Total Hardness and Turbidity were measured at the private well. The concentration of total hardness was 394mg/l, which exceeded the IGV of 200mg/l. There is no drinking water

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regulations value for total hardness. Turbidity was <0.02NTU, according to the drinking water regulations, the threshold is described as "acceptable to consumers and no abnormal change".

Indicators and inorganics

Ammoniacal Nitrogen

Ammoniacal nitrogen concentrations were <0.03mg/l at each monitoring sampling locations (GW1A, GW2A and GW3A) during both monitoring sampling events, with the only exception at the private well (0.02mg/l). Ammoniacal Nitrogen concentrations did not exceed the relevant groundwater regulation value of 0.065mg/l N.

Nitrite

Nitrite concentration was 0.03mg/l during the October routine monitoring event at the private well. Nitrite concentrations did not exceed the relevant groundwater regulation value of 3.75mg/l NO_2 and drinking water regulation value of 0.5 mg/l NO_2.

Nitrate

Nitrate concentration was 16.5mg/l during the October routine monitoring event at the private well. Nitrate concentrations did not exceed the relevant groundwater regulation value of 37.5mg/l NO_3 and drinking water regulation value of 50mg/l NO_3.

Molybdate Reactive Phosphorus (MRP)

MRP concentrations were reported <0.03mg/l at each monitoring sampling location for both monitoring sampling events and did not exceed the relevant groundwater regulation value of 0.035mg/l as P.

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Fluoride

Fluoride concentrations were reported <0.3mg/l at each monitoring sampling location for both sampling events. Concentrations did not exceed the relevant drinking water regulation value of 0.8mg/l or the IGV of 1mg/l. There is no groundwater regulation value for Fluoride.

Chloride

Chloride concentrations ranged from 30.1mg/l (GW3A-first sampling event) to 83.7mg/l (GW1A-first sampling event). Concentrations did not exceed the relevant groundwater regulation value of 187.5mg/l.

Sulphate

Sulphate concentrations ranged from 20.12mg/l (private well-October 2019) to 79.0mg/l (GW1A-first sampling event) and did not exceed the relevant groundwater regulation value of 187.5mg/l.

Reported concentrations of Total Dissolved Solids, Total Oxidised Nitrogen, Total Alkalinity, Total Cyanide and Total Organic Carbon were below the relevant groundwater regulation values for all parameters, where applicable.

Microbiological parameters

Total Coliforms

Total coliforms ranged from <1cfu/100ml (GW1A-first sampling event) to 165.8cfu/100ml (GW3A-first sampling event). The EPA IGV of 0 MPN/100ml was exceeded at GW1A (first sampling event), GW2 (both sampling events) and GW3 (both sampling events).

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Faecal Coliforms
Faecal coliforms were reported <1cfu/100ml at each monitoring sampling location during both monitoring sampling events and did not exceed the EPA IGV of 0MPN/100ml.

Total Coliforms, E. Coli and T.V.C @ 22°C were reported 0cfu/100ml during the October routine monitoring event at the private well.

Dissolved Metals
Concentrations of the dissolved metals – Boron, Cadmium, Calcium, Chromium, Iron, Lead, Magnesium, Manganese, Mercury, Nickel, Sodium and Zinc were below the relevant groundwater regulation values for all parameters.

Arsenic
Arsenic concentrations ranged from <2.5ug/l (GW1A-first sampling event and GW2A and GW3A both sampling events) to 8.10ug/l (GW1A-second sampling event). Concentrations slightly exceeded the relevant groundwater regulation value of 7.5ug/l at GW1A (second sampling event).

Copper
Copper concentrations ranged from <7ug/l (GW1A, GW2A and GW3A both sampling events) to 93ug/l (Private Well-October monitoring event). Concentrations did not exceed the relevant drinking water regulation value of 2,000ug/l. The IGV of 30ug/l was only exceeded at the private well.

Potassium
Potassium concentrations ranged from 1.8mg/l (GW3A-second sampling event) to 8.3mg/l (GW1A-second sampling event). Concentrations exceeded the relevant groundwater regulation value of 5mg/l at GW1A (both sampling events).

Aluminium
Aluminium concentration was reported <20ug/l during the October routine monitoring event at the private well. The concentration did not exceed the relevant groundwater and drinking regulation values of 150ug/l and 200ug/l respectively. Aluminium was not analysed for in the groundwater wells (GW1A to GW3A).

sVOCs
Reported concentrations of phenols, phthalates, PAHs and Additional sVOCs were below the relevant groundwater regulation values for all parameters at GW1A, GW2A and GW3A, where applicable.

VOCs
Reported concentrations of VOCs were below the relevant groundwater regulation values for all parameters at GW1A, GW2A and GW3A, where applicable.

Pesticides
Reported concentrations of atrazine and simazine were below the groundwater quality values at GW1A, GW2A and GW3A.

Organochlorine and Organophosphorus Pesticides
Concentrations of the organochlorine and organophosphorus pesticides were below the relevant groundwater regulation values for all parameters at GW1A, GW2A and GW3A, where applicable.

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Herbicides
Reported concentrations of acid herbicides were below the relevant groundwater regulation values for all parameters at GW1A, GW2A and GW3A, where applicable.

Total Petroleum Hydrocarbons (TPH CWG)
Reported concentrations of TPH CWG were below the groundwater quality values for all parameters at GW1A, GW2A and GW3A, where applicable.

MTBE and BTEX
Reported concentrations of benzene, toluene, ethylbenzene, xylenes and methyl tertiary butyl ether did not exceed the relevant groundwater regulation values and IGV, where applicable.

6.7.4 Leachate Results

Leachate samples were analysed and screened against the groundwater and surface water criteria to clearly define if there were any risks to human, groundwater or environmental health. Leachate results together with the relevant assessment criteria are presented in Table 4 (See table at the end of the report).

Indicators
Field Indicators
Similarly to the groundwater samples (section 6.7.3), field measured parameters such as pH, EC, DO, temperature and ORP were measured at monitoring sampling location L1A. EC values measured ranged from 1,288µS/cm (L1A-second sampling event) to 1,500µS/cm (L1A-first sampling event) and exceeded the groundwater regulation of 800 µS/cm during both monitoring sampling events. pH values measured ranged from 7.15pH units (L1A-second sampling event) to 7.51pH units (L1A-first sampling event), which were below the groundwater regulation values (6.5-9.5 pH units). DO concentration measured ranged from 2mg/l (L1A-second sampling event) to 3mg/l (L1A-first sampling event). There is no assessment criteria available for DO. The ORP reading ranged from -40.96V (L1A-first sampling event) to -89.8mV (L1A-second sampling event). There is no assessment criteria available for ORP.

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Indicators and inorganics
Ammoniacal Nitrogen
Ammoniacal nitrogen concentrations ranged from 31.0mg/l N (L1A-second sampling event) to 39.03mg/l N (L1A-first sampling event), which exceeded the groundwater regulation value (0.065mg/l) and surface water regulation (0.040mg/l) during both monitoring sampling events.

Molybdate Reactive Phosphorus (MRP)
MRP concentrations were <0.03mg/l P at L1A during both monitoring sampling events, and did not exceed the relevant groundwater regulation value of 0.035mg/l P and surface water regulation (0.025mg/l) during both monitoring sampling events.

Chloride
Chloride concentrations ranged from 22.8mg/l N (L1A-second sampling event) to 25.80mg/l (L1A-first sampling event) and did not exceed the groundwater regulation value of 187.5mg/l chloride) during both monitoring sampling events.

BOD
Biochemical Oxygen Demand (BOD) concentrations ranged from 7mg/l (L1A-second sampling event) to 10mg/l (L1A-first sampling event, which exceeded the relevant surface water regulation value of 1.3mg/l during both sampling events.

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Concentrations of the remaining indicators and inorganics – Sulphate, Fluoride, Cyanide, COD and TON were below the relevant groundwater regulation values for all parameters at L1A, where applicable.

Metals

Arsenic

Dissolved arsenic concentrations ranged from <2.5ug/l (L1A-first sampling event) to 17.1ug/l (L1A-second sampling event), which exceeded the groundwater regulation value of 7.5ug/l during the second sampling event.

Calcium

Dissolved calcium concentrations ranged from 254.3mg/l (L1A-second sampling event) to 255.10mg/l (L1A-first sampling event). Concentrations exceeded the EPA IGV value of 200mg/l during both monitoring sampling events.

Manganese

Dissolved manganese concentrations ranged from 1,031ug/l (L1A-first sampling event) to 1,331ug/l (L1A-second sampling event). Concentrations exceeded the EPA IGV value of 50ug/l during both monitoring sampling events.

Potassium

Dissolved potassium concentrations ranged from 25mg/l (L1A-second sampling event) to 28.3mg/l (L1A-second sampling event). Concentrations exceeded the EPA IGV value of 5mg/l during both monitoring sampling events.

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Concentrations of the remaining dissolved metals – Boron, cadmium, chromium, copper, iron, lead, magnesium, mercury, nickel, sodium and zinc were below the relevant groundwater regulation values, IGV and surface water regulations for all parameters.

Pesticides

Reported concentrations of atrazine and simazine were below the groundwater and surface water regulation values and IGV at L1A.

Organochlorine and Organophosphorus Pesticides

Concentrations of the organochlorine and organophosphorus pesticides did not exceed their groundwater, surface water regulation values and IGV, for all parameters analysed, at L1A during both monitoring sampling events.

Total Petroleum Hydrocarbons (TPH's)

TPH's

Reported concentrations of aliphatic and aromatics did not exceed the EPA IGV, for all parameters analysed, at L1A during both monitoring sampling events.

MTBE and BTEX

Reported concentrations of benzene, toluene, ethylbenzene, xylenes and methyl tertiary butyl ether did not exceed the relevant groundwater, surface water and IGV, where applicable.

sVOCs

Reported concentrations of phenols, PAH's, phthalates and additional sVOCs were below the relevant groundwater regulation values for all parameters at L1A, where applicable.

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VOCs
Reported concentrations of VOCs were below the relevant groundwater regulation values for all parameters at L1A, where applicable.

6.7.5 Surface Water Results

The surface water results were assessed relative to the Irish Surface Water Standards (S.I. No. 272 of 2009 as amended (S.I. No. 372 of 2012 and S.I. No. 386 of 2015). Surface water analytical results together with relevant assessment criteria are described in detail below. Surface water analytical results are presented in Table 5 (See table at the end of the report). Refer to Appendix G for laboratory results (Exova).

Field indicators
Field measured parameters including pH, EC, DO, temperature and ORP were measured at SW1A and SW2A. pH results ranged from 7.51pH units at SW2A (second sampling event) to 7.86pH units at SW2A (first sampling event). All samples were within the guideline range of 6.0-9.0 pH units. EC concentrations ranged from 631µS/cm (SW1A -second sampling event) to 731µS/cm (SW2A-first sampling event). There is no guideline value for EC. DO concentrations ranged from 85.98% at SW1A (second sampling event) to 98.96% at SW2A (first sampling event). All samples were within relevant standard range. Measurements for ORP ranged from 135.08mV at SW1A (first sampling event) to 181.78mV at SW2A (second sampling event). There is no guideline value for ORP.

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Indicators and inorganics
Ammoniacal nitrogen
Ammoniacal nitrogen concentrations ranged from <0.03mg/l at SW1A (first sampling event) and SW2A (both sampling events) to 0.03mg/l at SW1A (second sampling event) and did not exceed the relevant surface water regulation value of 0.04mg/l N annual mean.

Molybdate Reactive Phosphorus (MRP)
MRP concentrations were <0.03mg/l at SW1A and SW2A and did not exceed the relevant surface water regulation value of 0.025mg/l as P annual mean.

Biological Oxygen Demand (BOD)
BOD concentrations were <1mg/l at SW1A and SW2A during both monitoring sampling events and did not exceed the relevant surface water regulation value of 1.3mg/l.

Reported concentrations of TON, Total Cyanide, Total Alkalinity as $CaCO_3$, COD, TSS, Chloride, Fluoride and Sulphate were below the relevant surface water regulation values at SW1A and SW2A, where applicable.

Metals
There were no reported exceedances for any of the metals analysed - Arsenic, Boron, Cadmium, Calcium, Chromium, Copper, Iron, Lead, Magnesium, Manganese, Mercury, Nickel, Potassium, Sodium and Zinc, when compared to the relevant surface water regulation values, where applicable.

sVOCs
Reported concentrations of phenols, PAH's, phthalates and additional sVOCs were below the relevant surface water regulation values for all parameters at SW1A and SW2A, where applicable.

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VOCs
Reported concentrations of VOCs were below the surface water regulation values for all parameters at SW1A and SW2A, where applicable.

MTBE and BTEX
Methyl tertiary butyl ether concentrations were <0.1ug/l at SW1A and SW2A. There is no surface water regulation value for MTBE.
Benzene, Toluene, Ethylbenzene and p/m-o Xylenes were all below the surface water regulation values at SW1A and SW2A.

Total Petroleum Hydrocarbons (TPH's)
Reported concentrations of TPH's ranged from <5 to <10ug/l for all the parameters analysed at SW1A and SW2A. There are no surface water regulation values for TPH's.

Pesticides
Reported concentrations of atrazine and simazine were below the surface water regulation values at SW1A and SW2A.

Organochlorine and Organophosphorus Pesticides
Concentrations of the organochlorine and organophosphorus pesticides were below the surface water regulation values for all parameters at SW1A and SW2A, where applicable.

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6.7.6 Landfill Gas Results

In total three (3 No) landfill gas monitoring events were completed at the Site, as part of the Environmental Site Investigation, during April and May 2019 for the groundwater and leachate/ gas wells.

Methane and carbon dioxide results (concentrations expressed as a percentage in volume (%v/v) were assessed relative to the EPA 1997 threshold values outlined in the document 'Landfill Manuals – Landfill Operational Practices' (EPA, 1997). Refer to Table 6 (See table at the end of the report) for gas monitoring results together with the relevant assessment criteria.

Landfill Gas "Within the Imported Material"

L1A
Stable methane concentration ranged from 4.5% v/v (first monitoring event) v/v to 6.0% v/v (second monitoring event). The threshold value for stable methane is 1.0% v/v. Carbon dioxide concentration ranged from 8.8% v/v (second monitoring event) to 12.5% v/v (first monitoring event). The threshold value for carbon dioxide is 1.5% v/v. Hydrogen sulphide was not detected at this well for any of the gas sampling events. Carbon monoxide ranged from 0.0ppm (first monitoring event) to 1.0ppm (second and third monitoring events). The gas monitoring events indicated no flow in the well.

L2A
Stable methane concentration ranged from 0.1% v/v (first and second monitoring events) to 0.3% v/v (third monitoring event). Carbon dioxide concentration ranged from 1.5% v/v (second monitoring event) to 7.9% v/v (third monitoring event). Hydrogen sulphide was not detected at this well for any of the gas sampling events. Carbon monoxide ranged from 0.0ppm (first and third monitoring events) to 1.0ppm (second monitoring event). The gas monitoring events indicated no flow in the well.

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L3A
Stable methane concentration ranged from 0.1% v/v (first and second monitoring events) to 1.4% v/v (third monitoring event). Carbon dioxide concentration ranged from 1.1% v/v (second monitoring event) to 9.2% v/v (third monitoring event). Hydrogen sulphide was not detected at this well for any of the gas sampling events. Carbon monoxide ranged from 0.0ppm (first and second monitoring events) to 1.0ppm (third monitoring event). The gas monitoring events indicated no flow in the well.

Landfill Gas "Outside the Imported Material"

GW1A
Stable methane concentration ranged from 0.0% v/v (third monitoring events) to 0.1% v/v (first and second monitoring event). Carbon dioxide concentration ranged from 0.1% v/v (first and second monitoring events) to 0.4% v/v (third monitoring event). Hydrogen sulphide was not detected at this well for any of the gas sampling events. Carbon monoxide ranged from 0.0ppm (first and third monitoring events) to 1.0ppm (second monitoring event). The gas monitoring events indicated no flow in the well.

GW2A
Stable methane concentration ranged from 0.0% v/v (first and third monitoring events) to 0.1% v/v (second monitoring event). Carbon dioxide concentration ranged from 0.1% v/v (second monitoring event) to 3.8% v/v (first monitoring event). Hydrogen sulphide was not detected at this well for any of the gas sampling events. Carbon monoxide ranged from 0.0ppm (first and third monitoring events) to 1.0ppm (second monitoring event). The gas monitoring events indicated no flow in the well.

GW3A
Stable methane concentration ranged from 0.0% v/v (first monitoring event) to 0.1% v/v (second and third monitoring events). Carbon dioxide concentration ranged from 0.9% v/v (third monitoring event) to 4.6% v/v (second monitoring event). Hydrogen sulphide was not detected at this well for any of the gas sampling events. Carbon monoxide ranged from 0.0ppm (first and third monitoring events) to 1.0ppm (second monitoring event). The gas monitoring events indicated no flow in the well.

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7 TIER 3 – REFINEMENT OF CONCEPTUAL SITE MODEL

In accordance with the EPA CoP the preliminary CSM was refined utilising the information collected during the Tier 2 Intrusive Site Investigations. Refer to Table 7-1 below for the updated CSM and Drawing No. 19 for a schematic CSM of the Site.

Table 7-1: Updated Conceptual Site Model

Element	Description	Rationale
Source	Imported Material	• Overall area of the Site c. 4.4ha – estimated area of imported material c. 1.71ha (geophysical survey) comprising variable amounts of municipal including organic and C&D waste. • Volume of the imported material estimated at 114,920m^3 (160,888 tonnes). • An existing capping layer (0.6 to 1.4m thick) was identified during the site investigation (trial pitting) as predominantly brown gravelly clay and during the geotechnical laboratory report as brown very gravelly very sandy clay. The clay layer will act as a natural barrier impeding rainfall infiltration into the waste material due to the low permeability (4.9x10-9 m/s). • Soil analytical results mainly complied with the inert WAC screening values. There were some exceedances in Total Organic Carbon, Mineral Oil, Antimony, Molybdenum, Sulphate and Total Dissolved Solids, which complied with non-hazardous WAC. Asbestos fibre bundles were identified at TPG but were below the analytical limit of quantification. Asbestos in soils at such low concentrations pose no risk to human health or the surrounding environment, based on the current use of the Site. • Leachate – Presence of leachate confirmed at specific locations during trial pitting and leachate monitoring well installation. Some exceedances reported in the leachate (i.e. ammoniacal nitrogen, potassium, manganese, calcium and arsenic). • Elevated Methane – Identified at leachate well location L1A during all monitoring events. Only one exceedance at L3A. • VOC's were not detected during the surface monitoring survey inside and outside the boundary of the Site or within the hotel premises.
Pathway	Aquifer Beneath the Site	• Sand and Gravel aquifer identified - No impact identified to the underlying aquifer or receptors – Groundwater and Surface water results.
	Landfill gas migration via Sand and Gravels	• Presence of landfill gas (methane) – Only detected at L1A, L3A with a single exceedance. • Not detected at L2A and groundwater wells. • No flow measured in gas wells, which indicates that landfill gas is not generated by the imported materials. • No VOC's detected on Site or inside the hotel building, which indicates that there is no generation or migration of gas within the Site.
	Leachate	• Leachate at L1A – Some elevated parameters in leachate, but these were not observed in groundwater or surface water, hence it can be concluded that the exceedances would not pose a risk to the environment and identified receptors.
	Surface water Body	• Surface water bodies – Athy Stream c. 580m north-east and c. 850m to the north-west of the Site is not being impacted by the imported material on Site (surface water results).
Receptor	Properties	• No risk to receptors identified (properties) – Groundwater and Surface water results. • Presence of leachate - Leachate is unlikely to migrate laterally or horizontally as proven by the groundwater (GW1A to GW3A and private well) and surface water results. No identified risk of landfill gas migration into the building (hotel) - VOC

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Element	Description	Rationale
		monitoring surveys.
	Private Wells	• The identified wells within the 2km radius of the Site are not being impacted; 1. Wells upgradient of the Site and the private well (hotel) – Groundwater flow direction to the south / south-west towards the River Barrow and groundwater and surface water results showed no impact to the underlying aquifer 2. Downgradient of the Site – There is no contamination migrating off-site to the underlying aquifer (groundwater and surface water results).
	Public Water Supply Well	• The Site will not pose a risk to the water supply wells (c. 1.75km south-west/west of the Site and infiltration gallery - no longer in use (according to the Waterworks office at KCC – September 2019). They do not supply water to Athy town any longer. • The Source of Inner Protection Area (SI) and Source of Outer Protection Area (SO) (c. 1.60km and 2.50km west of the Site) - No impact on SO or SI due to lack of impact on groundwater and surface water quality.
	Surface Water	• Athy Stream is not being impacted by the imported materials – based on the surface water results and groundwater flow direction. • River Barrow is not at risk based on the groundwater results, as there was no impact on groundwater.
	Aquifer Beneath the Site	• Leachate results reported exceedances of a number of parameters at L1A. However, it was concluded that leachate is not migrating to the identified receptors and aquifer beneath the site (groundwater and surface water results).
	Protected Sites	• Site located within an area of environmental sensitivity – sand and gravel aquifer of high vulnerability. • Closest SAC (River Barrow and River Nore SAC) c. 1.70km west of the Site – unlikely to be impacted by the imported material.

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The updated risk prioritisation assessment is presented in Table 7-2 below.

Table 7-2: Updated Site Prioritisation Summary

SPR	Linkages	Pathway via	SPR Value	Maximum Score	Normalised Score
SPR1	Leachate c:>Surface Water	Combined groundwater and surface water	28	300	9%
SPR2	Leachate c:> SWDTE	Combined groundwater and surface water	0	300	0%
SPR3	Leachate c:> Human Presence (private well)	Groundwater Pathway	84	240	35%
SPR4	Leachate c:> GWDTE	Groundwater Pathway	0	240	0%
SPR5	Leachate c:> Aquifer	Groundwater Pathway	140	400	35%
SPR6	Leachate c:> Public Supply	Groundwater Pathway	0	560	0%
SPR7	Leachate c:> Surface Water	Groundwater Pathway	28	240	12%
SPR8	Leachate c:> Surface Water	Surface Water Pathway	0	60	0%

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SPR9	Leachate c:> SWDTE	Surface Water Pathway	0	60	0%
SPR10	Landfill Gas c:> Human Presence – off-site	Lateral and Vertical	63	150	42%
SPR11	Landfill Gas c:> Human Presence – onsite	Lateral and Vertical	105	250	42%
OVERALL RISK SCORE			**MODERATE**		

Risk Classification	**Range of Risk Scores**
HIGH Risk (Class A)	Score greater than or equal to 70% for any individual SPR linkages
MODERATE Risk (Class B)	Score between 40% and 70% for any individual SPR linkages
LOW Risk (Class C)	Score less than 40% for any individual SPR linkages

The results of the individual SPR linkages have been adjusted on the basis of the results of the Tier 2 Site Investigation, so that the risk prioritisation for the Site has been classified as Moderate. Refer to Appendix B for the updated Risk Screening.

As discussed in section 4.2, pollutant linkages SPR1, SPR2, SPR4, SPR6, SPR8 and SPR9 were not considered further as they were deemed negligible. It was confirmed during the refinement of the CSM that those pollutant linkages have been broken.

The following sections discuss the SPR linkages identified during the refinement of the CSM.

7.1 Imported Material

Analytical results indicated that the imported material is mainly composed of inert material, with the exception of a number of reported exceedances, which complied with non-hazardous WAC material (Antimony, Sulphate, Molybdenum and TDS) and an exceedance in Total Organic Carbon at TPA which complied with the hazardous waste criteria (WAC). Asbestos (chrysotile) fibre bundles were detected at sampling location TPG. The concentrations were below the limit of quantification (<0.001%). Therefore, it can be concluded that asbestos does not pose a risk to any identified receptors with the current use of the Site.

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7.1.1 Vertical and Horizontal Extent of Waste

In order to verify the vertical and horizontal extent of the waste body identified during the geophysical survey, a number of site investigations were undertaken (excavation of trial pits and installation of monitoring wells (leachate and groundwater)). The monitoring locations were positioned within and outside of the waste body at selected locations in accordance with BS10175-2011+A2:2017. The information from the site investigations were used to 'fine tune' the results of the geophysical survey to further increase the confidence of the geophysical model.

According to the geophysical report, two types of waste were encountered on Site, as follows:

- Waste type 1: Made ground/waste (municipal including organic and C&D), with a thickness of c. 2.9-11.7mbgl, with the thickest areas in the south and northwest of the Site; and
- Waste type 2: Made ground/waste (C&D and municipal mixed with CLAY) with a thickness of 0.3-11.9mbgl, where present.

The total volume of imported material, comprising the two types of waste, within the Site, according to the geophysical survey, is estimated to be in the region of 114,920m^3 (i.e. 160,888tonnes when using a multiplier of 1.4 tonnes/m^3).

A layer of topsoil/capping material comprised of dark brown gravelly clay c. 0.6-1.4m thickness was present on site according to the findings of the site investigation. This capping material is

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impeding rainfall infiltration into the imported material, thus mitigating against leachate generation.

7.2 Leachate

Leachate was encountered during the trial pitting excavation and during the installation of the combined leachate/gas well L1A. Leachate samples were retrieved from leachate well L1A during both monitoring sampling events.

A number of parameters analysed exceeded the regulation values and are further considered below:

Exceedances for electrical conductivity were noted at L1A during both monitoring sampling events. Electrical Conductivity values are influenced by the geology of the area - limestone and clay soils have higher values. There is no human health risk associated with the electrical conductivity. Electrical Conductivity is used as an indicator parameter.

Ammoniacal nitrogen concentrations reported elevated exceedances at L1A during both monitoring events. A strong odour of decomposition, consistent with decomposing organic matter, and a slight sweet odour were noted during the excavation of the trial pits and during the leachate well installations, which suggest that degradation of organic matter is occurring within the made ground. This is supported by the exceedances in total organic carbon at trial pits TPA and TPF, which also suggest that there is organic material decomposing within the waste. During the excavation of the trial pits and the installation of the leachate/gas wells natural ground was not encountered, and therefore the composition and permeability of the underlying soils beneath the imported material is unknown. Additionally, there is a large head difference of approximately 6.0m between the landfill leachate (c. 65maOD) and the groundwater (c. 59maOD), which suggests that there is relatively poor connection between them, and therefore, any potential contamination arising from the imported material is unlikely to have a significant effect on groundwater. Furthermore, ammoniacal nitrogen exceedances were not reported in the groundwater or surface water samples, which suggests that there is no pathway connecting the leachate arising from the imported material to the identified receptors. Consequently, the ammoniacal nitrogen concentration would not pose a risk to groundwater or any identified receptors and it is no longer considered to be a contaminant of potential concern.

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BOD concentrations reported elevated exceedances of the surface water guidance value L1A during both monitoring sampling events.

Arsenic concentrations reported a slight exceedance during the second monitoring event (L1A). As discussed in section 7.3, the detection of arsenic in GW1 appears to be a one-off occurrence, based on the large difference in water levels (maOD levels – see above) between leachate and groundwater and lack of other indicators of landfill contaminants in groundwater, it is unlikely that the detection of arsenic in GW1 is due to leakage of landfill leachate. It is believed that the concentrations of arsenic in the leachate samples (L1A) do not pose a risk of migration to the underlying aquifer or any identified receptors, and therefore, it is no longer considered to be a contaminant of potential concern.

Calcium, manganese and potassium concentrations reported exceedances at L1A during both monitoring events. Those parameters are naturally occurring and are normally associated with the type of bedrock and soils. There is no human health risk associated with these exceedances and they would not pose a risk to groundwater. They are not considered to be a contaminant of potential concern.

The elevated concentrations of a number of parameters identified in the leachate were not identified in any of the groundwater and surface water results, with the exception in arsenic at GW1A (downgradient well), refer to section 7.3. Therefore, it is reasonable to assume that the

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leachate generated due to the imported material is not migrating downwards or horizontally and therefore will not pose a risk to the underlying aquifer or any identified receptors.

7.3 Groundwater

There were a number of exceedances at the upgradient and downgradient wells during both monitoring sampling events in electrical conductivity and total coliforms. There was an exceedance of arsenic during the second monitoring event, and of potassium during both monitoring events, at GW1A (downgradient well), which were not detected at GW2A (upgradient well) and GW3A (downgradient – cross gradient).

There were exceedances reported in electrical conductivity. However, as discussed in section 7.2, there is no human health risk associated with electrical conductivity, as it is used as an indicator parameter.

Slight exceedances in potassium were reported at the downgradient well (GW1A). Potassium occurs widely in the environment and it is also an essential element present in animal and plant tissues. Currently, there is no evidence to support potassium being a risk to human health (World Health Organisation, 2009). During the site visits, the presence of animals (i.e. sheep, horses, etc) was noted in the field beside GW1A, which may contribute to the elevated potassium level. Potassium is not considered to be a contaminant of potential concern.

A slight exceedance in dissolved arsenic concentration was reported at the downgradient well (GW1A) during the second monitoring event, which marginally exceeded the Groundwater Regulations value of 7.5ug/l. However, the dissolved arsenic concentration did not exceed the recommended limit in drinking water (10ug/l). A layer described as “black very sandy, clay layer, with an odour of burnt material” was encountered during the installation of GW1A from 1.4 to 2.7mbgl, which may be the cause of the slightly elevated dissolved arsenic detected in the groundwater at this location. Arsenic is a naturally occurring element and it can be introduced to groundwater as the minerals in rocks dissolve. It can also be introduced to the environment through waste incineration (National Federation of Group Water Schemes, 2011). Furthermore, the reported concentrations of arsenic in the leachate well (L1A) were relatively low during both monitoring events, and the concentrations of arsenic in the groundwater well GW3A (downgradient of L1A) were lower than those reported at L1A. Additionally, the dissolved arsenic concentrations reported in the soil samples (trial pits) were relatively low and thus, it is reasonable to conclude that there is not a significant source of dissolved arsenic arising from the imported material and that the detection of arsenic in GW1 appears to be an isolated occurrence, which is unlikely to originate from the imported material (leachate). Accordingly, it is believed that the dissolved arsenic concentrations reported within the imported material are not impacting upon the aquifer (Drinking Water Regulations (10ug/l)). Therefore, the arsenic would not pose a risk to potential users or the environment. Arsenic is not considered to be a contaminant of potential concern.

The highest exceedances in coliforms were observed at GW3A followed by GW2A, which reported slightly lower exceedances than GW3A. These exceedances reported at the upgradient and cross-gradient wells are potentially related to the use of manure-based fertilizers at the adjacent agricultural field to the north-west, and at the agricultural field to the north of the Site, respectively. Total coliforms concentrations reported at GW1A were lower than those reported at GW2A and GW3A. Coliform bacteria, apart from E. Coli, does not indicate the presence of faecal contamination (NFGWS, 2011). Faecal coliforms were not detected as an exceedance and therefore, an elevated total coliform is not considered to reflect microbial contamination. Total coliforms would not pose a risk to groundwater or any identified receptors. Total coliforms are not considered to be a contaminant of potential concern.

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7.4 Surface Water

Laboratory surface water results reported at both monitoring sampling locations upstream and downstream (SW1A and SW2A) of the Athy Stream, which runs c. 580m north-east of the Site and c.850m north-west of the Site, were compared with the applicable guideline values. The results indicated that there were no exceedances of any of the parameters analysed. Reported concentrations indicated that water quality upstream of the Athy Stream at SW1A were very similar to water quality downstream of the River at SW2A.

7.5 Landfill Gas

The landfill gas assessment identified that methane concentrations within the imported material ranged from 0.1% (v/v) to 6.0% (v/v) and carbon dioxide ranged between 1.1% (v/v) and 12.5% (v/v). Refer to table 6 (see table at the end of the report) for complete results. No flow was detected.

Methane was not identified at locations outside the imported materials (GW1A to GW3A). Carbon dioxide ranged between 0.1% (v/v) to 4.6% (v/v). No flow was detected.

The flow rate indicates the level of gas movement through the permeable layers. The purpose of measuring gas flow rates is to predict surface emissions and from these deduce the potential for gas ingress into buildings (CIRIA, 2007). The flow rate indicates the level of gas movement through the permeable layers. Furthermore, surface emission rate measures the potential for gas to escape from a particular area on the ground. The very low flow rates observed, and the results of the VOC monitoring surveys, on and off-Site and within the hotel building, demonstrated that the imported material is not actively generating landfill gas and it is therefore not migrating vertically or laterally. Therefore, it would not affect any potential receptors (on or off-site).

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8 TIER 3 – GENERIC QUANTITATIVE RISK ASSESSMENT

In accordance with the EPA COP a quantitative risk assessment is required where the site is deemed, following the risk screening process, to intrinsically pose a high or moderate risk to the environment or human health. There are two basic types of quantitative risk assessments:

- **Generic Quantitative Risk Assessment (GQRA)**, which uses relevant generic assessment criteria (GAC) (i.e. values which are generally applicable to an entire class or group e.g. based on proposed future land use) or guidelines, and
- **Detailed Quantitative Risk Assessment (DQRA), which** requires the development of site-specific assessment criteria (SSAC). Subsequently the representative site concentrations are compared to the site-specific criteria. Different risk assessment modelling tools and numerical groundwater flow models can be utilised during the process.

The decision on which type of QRA should be used is site specific. For this environmental risk assessment, which deemed the Site as a Moderate risk Site, it was considered sufficient to carry out a GQRA due to the availability of Site-Specific environmental quality data, i.e. results of environmental monitoring were compared against existing guideline values and generic assessment criteria.

8.1 Generic Assessment Criteria

According to the EPA CoP, the potential risk shall be assessed for each identified pollutant linkage by comparing the representative site concentrations with generic assessment criteria (groundwater, EPA IGV, drinking water and surface water regulations) or screening levels.

8.2 Results of Generic Risk Assessment

The Environmental Risk Assessment (Tier 2 Site Investigation and Testing, Tier 3 Risk Assessment: Refinement of Conceptual Site Model and Quantitative Risk Assessment and Recommendations for Remediation) at Prusselstown refuse depot concluded as follows:

- The leachate results reported a number of exceedances (electrical conductivity, ammoniacal nitrogen, BOD, arsenic, calcium, manganese and potassium). However, there is no evidence to suggest that the leachate generated from the imported material is impacting on groundwater, surface water and associated receptors;
- The groundwater quality underlying the Site displayed a number of exceedances (electrical conductivity, potassium, arsenic and total coliforms). However, there was no evidence to suggest that the Site is impacting on groundwater quality;
- The surface water monitoring results of the Athy Stream showed that the concentrations upstream and downstream of the site were broadly similar, and therefore, that there is no impact arising from the Site; and,
- Landfill gas migration is not taking place.

Based on the assessment of the groundwater, surface water, leachate monitoring results and the landfill gas measurements, there is now sufficient data to confirm that the imported material does not pose an unacceptable risk to groundwater, human health or associated receptors. The hotel, the residential properties and the petrol station identified in and around the Site will not be at significant risk, as there is no evidence that the Site is impacting groundwater and surface water and therefore, the potential pollutant linkages (SPR3, SPR5 and SPR7) are no longer valid.

The linkages of greatest concern according to the preliminary conceptual site model include the risk of landfill gas migration to off-site receptors (SPR10) and the risk of landfill gas migration to onsite receptors (SPR11). These linkages reported a normalised score of 42% in both cases. As described in section 7.5, due to the site location, the low flow rates observed

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in all monitoring locations and the findings of the VOC monitoring surveys inside and outside the site boundary and within the hotel building, it can be concluded that the observed landfill gas concentrations do not pose a risk to human health or the environment and that the pollutant linkages SPR10 and SPR11 are no longer valid.

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9 CONCLUSIONS

The Tier 1 Conceptual Site Model (KCC, 2018), Risk Screening and Prioritisation, Tier 2 Main Site Investigation and Testing and the Refinement of Conceptual Site Model (undertaken by MOR in accordance with the CoP) included the following works:

- Installation of five (5 No.) trial pits (TPA to TPG), three (3 No.) leachate/gas monitoring wells (L1A to L3A) and three (3 No.) groundwater monitoring wells (GW1A to GW3A); and
- Laboratory analysis of three (3 No.) soil samples, six (6 No.) groundwater samples, four (4 No.) surface water and two (2 No.) leachate samples, completion of three (3 No.) landfill gas monitoring events and one (1 No.) gas monitoring survey (surface emissions).

Based on the findings of the Site Investigations and data assessment undertaken by MOR between January and April 2019 in accordance with the CoP, it is reasonable to conclude the following;

- The Site was in operation from the early 1970s to mid-1980s. According to KCC's files the Site was used as a refuse depot from approximately 1st January 1981 to 2nd February 1982;
- The Site is located within a sensitive receiving environment based on the high-extreme vulnerability rating assigned. This vulnerability rating was assigned due to the presence of an important gravel aquifer beneath the Site. However, the River Barrow and River Nore SAC is c. 1.70km west of the Site and therefore there would not be any potential risks arising from the Site to the SAC;
- The hydrogeological setting of the Site comprises a regionally important gravel aquifer underlain by the Ballysteen Formation and a locally important bedrock aquifer;
- Groundwater flow direction in the underlying aquifer is interpreted to be to the south / south-west towards the River Barrow;
- In general, the imported material comprises gravelly/sandy clay with mixed imported material, with a thickness of c. 0.6-8.5mbgl (trial pits and leachate/gas wells data). Natural ground was not encountered during the trial pit excavations and leachate/gas well installations, with the exception at TPC and TPD, which were excavated in natural ground. Bedrock was not encountered during the groundwater well installations;
- The preliminary CSM identified the source associated with the Site as;
    - *The imported material underneath the Site.*

  The potential pathways were identified as follows;
    - *Shallow Sand and Gravel aquifer and subsoils.*

  The key environmental receptors were identified as follows;
    - *The groundwater (sand & gravel aquifer) beneath the Site, the surface water (Athy Stream / River Barrow), the hotel adjacent to the imported material, the residential properties in the vicinity of the Site (c.15m) and the ecologically protected sites within the 10km radius.*
- The imported materials comprised mainly gravelly, clay and ashy material with variable amounts of red bricks, concrete, glass, wood, plastic, metal, cables, car parts, cloths, pieces of carpets and mattress, milk cartons, metal cans, lids, steel sheeting, supermarket bags and textiles;

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- The capping material encountered during the site investigations (trial pit) was identified as brown gravelly clay with a thickness of 0.6 to 1.4m. According to the geotechnical results the capping material was classified as brown very gravelly very sandy CLAY, with low permeability $4.9x10^{-9}$ m/s. The low permeability of the capping material overlying the imported material would impede rainfall infiltration and therefore reduce the generation of leachate.
- The soil laboratory results of three (3 No.) of the trial pits were compliant with the inert Waste Acceptance Criteria (WAC) limits. There were some exceedances in antimony, molybdenum, sulphate and total dissolved solids, which complied with the non-hazardous WAC. An exceedance was noted in Total Organic Carbon in TPA, which complied with the hazardous WAC. There was a visual identification only of asbestos fibres at TPG, which were quantified at concentrations <0.001%, confirming that the imported material present on site, with the current use of the Site, poses a low risk of contamination to the underlying strata (natural ground);
- The leachate results indicate that there were some exceedances of the parameters analysed. However, it was concluded that they would not pose a risk to human health and the environment, and do not require further assessment;
- The groundwater results (GW1A to GW3A and the private well) confirm that the imported material has not negatively impacted upon the underlying aquifer. There were a number of exceedances in the groundwater, which it was concluded do not pose a risk to human health and the environment and do not require further assessment;
- The surface water results confirm that the imported materials have not negatively impacted on the Athy Stream. The risk to surface water is considered to be low;
- This assessment did not identify any impacts from the imported materials on the ecological receptors on-site or within the surrounding vicinity;
- Elevated Methane (CH_4) was detected at leachate/gas locations L1A. Methane was not detected at groundwater monitoring locations external to the imported materials GW1A to GW3A during any sampling event. Given the very low flow concentrations of methane and the surface VOC monitoring surveys measured within and outside of the Site and within the hotel building, the detected gas concentrations are not considered to represent a risk to any identified receptors (on and off-site);
- In strict accordance with the CoP and taking cognisance of the intrusive site investigation and the updated conceptual site model, the site would be classified as a Moderate Risk site. During the data assessment, it was concluded that the pathways to the receptors were broken and therefore the pollutant linkages no longer exist; and,
- According to the Environmental Risk Assessment carried out for the Site, it is believed that the imported materials have not resulted in any impacts on the identified human receptors or environmental receptors.

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10 RISK EVALUATION

The site is deemed Moderate Risk based on the risk evaluation of the Site as set out below:

- **The End Use of the Site** - The Site is currently used for recreational and agricultural purposes due to the presence of the hotel on the Site and the agricultural field to the west of the Site.
- **Source** – The Site was used as a refuse depot from approximately 1st January 1981 to 2nd February 1982 predominantly for municipal waste, including organic waste, and for C&D waste across an area of 1.71ha, with an estimated imported material volume of 114,920m^3 (160,888tonnes). The areas where imported materials were deposited have been capped with variable thicknesses (0.3 to 1.5metres) of low permeability materials.
- **Pathways** –The Site Investigation and testing have shown that there is no potential for leachate and landfill gas migration, i.e. the rate of leachate generation within the Site is considered to be low and the landfill gas flow rates are also low; and,
- **Receptor** – The underlying groundwater body and residential dwellings can be considered as receptors of potential contamination (i.e. leachate and landfill gas migration). The previous site investigations (Tier 1 – CSM, Risk Screening and Prioritisation) indicated potential linkages between landfill gas within the Site and the closest receptor within and in close proximity to the Site. Landfill gas surveys and leachate assessment carried out during the Tier 2 – Exploratory and Main Site Investigation and Tier 3 – Quantitative Risk Assessment confirmed that landfill gas and leachate are not migrating to these receptors.

According to the EPA CoP the Site has been classified as a Class B – Moderate Risk Site.

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Revised Site Classification

In general terms, former landfill sites that are not generating leachate or landfill gas or sites where active remediation measures have been undertaken to eliminate potential risks can be classified as low risk sites. Sites that do present potential risks are categorised as high-risk sites and typically require some active remedial measures. Sites that have the potential to generate gas and leachate but have been confirmed not to present any current risks that would warrant active remedial measures, would fall into the moderate risk category.

Site specific data collected during the Tier 2 Site Investigation and Tier 3 Refinement of CSM and Quantitative Risk Assessment have established that there were no significant environmental or human health risks to the assessed on and offsite receptors.

According to the CoP, “it is not acceptable to reduce the risk classification purely on the basis that the data indicates that there is no impact”. However, if the SPR linkages have been broken and the level of risk has been reduced, “then the classification of the Site may be lowered accordingly in consultation with the regulatory authority”. Therefore, it is considered appropriate that the Site should be reclassified as a Moderate category risk (Class B). Validation sampling is recommended as a prudent approach to further validate the findings of the risk assessment.

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11 RECOMMENDATIONS

We would consider that the Site has been well characterised at this juncture given the comprehensive investigations undertaken. Based on the evaluation of the current data set in accordance with recognised best practice criteria, it is our opinion that there is enough evidence to conclude that the Site does not present a potential environmental risk to the underlying aquifer or potential receptors and therefore, in strict accordance with the CoP, that no further actions are required.

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12 REMEDIAL MEASURES

The CoP requires that suitable remedial measures are discussed depending on the results of the QRA. As stated in the previous Section 11, the Site has been well characterised and it has been concluded that the Site, in its current status, does not require any further actions, hence no remedial measures are proposed.

According to the CoP, a hazard may be present even if a Site has been classified as a low risk site. “It is critical…that if there is a proposed change in land-use then a re-appraisal of the risk, based on detailed site investigations, shall be carried out.” The CoP requires that Sites should be reviewed every year taking cognisance of new information and that Sites should be re-assessed after 5 years to take account of further guidance issued and any change to the land use or new developments in the vicinity of the Site.

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TABLES

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Prusselstown, Athy
County Kildare

Table 1: Groundwater Level Measurements

Well ID	Elevation of Reference (cover level)	Total Depth	Total Depth	Diff Total Depth inner and outer	Depth to Water	Water Level (Column of Water)	Depth to Water	Water Level (Column of Water)
	mAOD	mbtoc	mbtoci	m	mbtoci	mAOD	mbtoci	mAOD
					23/04/2019		08-09/05/2019	
L1A	69.27	5.42	5.30	0.12	4.10	65.17	4.12	65.15
L2A	71.76	8.26	8.15	0.11	dry	-	dry	-
L3A	69.67	6.34	6.23	0.11	dry	-	dry	-
GW1A	71.08	17.25	17.16	0.09	12.36	58.72	12.43	58.65
GW2A	68.07	14.68	14.42	0.26	9.00	59.07	9.07	59.00
GW3A	67.80	17.73	17.40	0.33	8.85	58.95	8.91	58.89

Notes:

mAOD	denotes metres above ordnance datum.
mbtoci	denotes metres below top of inner casing.
-	denotes not available/not measured.

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Prusselstown, Athy
County Kildare

Table 2: Soils Analytical Results

Sample ID			Waste Acceptance Criteria (WAC)[1]			TPA	TPF	TPG
Laboratory Report No.			Inert Waste Acceptance Criteria	*Non-Hazardous Waste Acceptance Criteria*	Hazardous Wate Acceptance Criteria	Exova 19/1582 Depth 3.80-4.10m	Exova 19/1582 Depth 1.60-2.00m	Exova 19/1582 Depth 3.60-4.00m
Laboratory Sample No.						1-3	4-6	7-9
Sample Date						17/01/19	17/01/19	17/01/2019
Parameter	**Units**	**LOD**						
Soil Characteristic Parameters								
Natural Moisture Content	%	0.1	~	~	~	34.1	36.9	52.3
Moisture Content (% Wet Weight)	%	0.1	~	~	~	25.4	27	34.3
Moisture Content 105C (% Dry Weight)	%	0.1	~	~	~	32.1	25.6	49.5
Dry Matter Content Ratio 105°C	%	0.1	~	~	~	75.7	79.6	66.9
pH	Ph Units	0.01	~	~	~	7.71	7.88	7.95
Indicatiors and Inorganics								
Total Organic Carbon	%	0.02	3	~	6	**19.8**	**3.44**	NDP
Sulphide	mg/kg	10	~	~	~	<10	41	<10
Elemental Sulphur	mg/kg	1	~	~	~	28	1422	11
Asbestos Screen & Identification								
General Description						Soil/Stones	Soil/Stones	Soil/Stones
Asbestos Fibres			~	~	~	NAD	NAD	Fibre Bundles
Asbestos Fibres (2)			~	~	~			
Asbestos ACM			~	~	~	NAD	NAD	NAD
Asbestos ACM (2)			~	~	~			
Asbestos Type			~	~	~	NAD	NAD	Chrysotile
Asbestos Type (2)			~	~	~			
Asbestos Level Screen			~	~	~	NAD	NAD	less than 0.1%
Mass of Dry Sample		g	~	~	~			
Total Detailed Gravimetric Quantification (% Asb)[#]						NA	NA	<0.001
Total Gravimetric Quantification (ACM + Detailed) (% Asb)[#]						NA	NA	<0.001
Total ACM Gravimetric Quantification	mass %	0.001	~	~	~	NA	NA	<0.001
Asbestos PCOM Quantification (Fibres)	mass %	0.001	~	~	~	NA	NA	<0.001
Asbestos Gravimetric & PCOM Total	mass %	0.001	~	~	~	NA	NA	<0.001
Mass of raw test portion	kg		~	~	~	0.1	0.1	0.1344
Mass of dried test portion	kg		~	~	~	0.1	0.1	0.09
Metals (Totals)								
Antimony	mg/kg	1	~	~	~	11.0	5.0	8
Arsenic	mg/kg	0.5	~	~	~	56.0	10.2	16.1
Barium	mg/kg	1	~	~	~	581.0	136.0	308
Cadmium	mg/kg	0.1	~	~	~	1.6	1.5	0.6
Chromium	mg/kg	0.5	~	~	~	79.6	227.3	26.8
Copper	mg/kg	1	~	~	~	237.0	91.0	32
Lead	mg/kg	5	~	~	~	377.0	78.0	73
Mercury	mg/kg	0.1	~	~	~	1.0	0.1	0.2
Molybdenum	mg/kg	0.1	~	~	~	9.1	3.8	6.5
Nickel	mg/kg	0.7	~	~	~	51.7	31.4	33.8
Selenium	mg/kg	1	~	~	~	3.0	2.0	2
Total Sulphate as SO4	mg/kg	50	~	~	~	1811.0	6467.0	5713
Water Soluble Boron	mg/kg	0.1	~	~	~	3.3	8.2	28.8
Zinc	mg/kg	5	~	~	~	706.0	555.0	302
Hexavalent Chromium	mg/kg	0.3	~	~	~	<0.3	<0.3	<0.3
Chromium III	mg/kg	0.5	~	~	~	79.6	227.3	26.8
Total Cyanide	mg/kg	0.5	~	~	~	1.2	1.0	<0.5
Polycyclic Aromatic Hydrocarbons (PAHs) (M-S)								
Naphthalene	mg/kg	0.04	~	~	~	0.4	0.1	<0.04
Acenaphthylene	mg/kg	0.03	~	~	~	0.1	<0.03	<0.03
Acenaphthene	mg/kg	0.05	~	~	~	<0.05	<0.05	<0.05
Fluorene	mg/kg	0.04	~	~	~	<0.04	0.1	<0.04
Phenanthrene	mg/kg	0.03	~	~	~	0.6	0.3	<0.03
Anthracene	mg/kg	0.04	~	~	~	0.1	<0.04	<0.04
Fluoranthene	mg/kg	0.03	~	~	~	1.0	0.3	<0.03
Pyrene	mg/kg	0.03	~	~	~	0.8	0.2	<0.03
Benzo(a)anthracene	mg/kg	0.06	~	~	~	0.9	0.1	<0.06
Chrysene	mg/kg	0.02	~	~	~	0.9	0.1	<0.02
Benzo(bk)fluoranthene	mg/kg	0.07	~	~	~	2.3	0.3	<0.07
Benzo(a)pyrene	mg/kg	0.04	~	~	~	1.2	0.1	<0.04
Indeno(123cd)pyrene	mg/kg	0.04	~	~	~	1.0	0.1	<0.04
Dibenzo(ah)anthracene	mg/kg	0.04	~	~	~	0.4	<0.04	<0.04
Benzo(ghi)perylene	mg/kg	0.04	~	~	~	0.9	0.1	<0.04
Coronene	mg/kg	0.04	~	~	~	0.2	<0.04	<0.04
PAH 6 Total	mg/kg	0.22	~	~	~	6.4	0.9	<0.22
PAH 17 Total	mg/kg	0.64	100*	~	~	10.7	1.9	<0.64
Benzo(b)fluoranthene	mg/kg	0.05	~	~	~	1.7	0.2	<0.05
Benzo(k)fluoranthene	mg/kg	0.02	~	~	~	0.7	0.1	<0.02
Benzo(j)fluoranthene	mg/kg	1	~	~	~	<1	<1	<1
PAH Surrogate % Recovery	%	0	~	~	~	100.0	95.0	99
EPH CWG Interpretation			~	~	~	PAH's & lubricating oil	Degraded diesel, Possible PAH's, lubricating oil &	PAH's & lubricating oil
Mineral Oil (C10-C40)	mg/kg	30	500	~	~	<30	**905**	97
TPH CWG								
Aliphatics								
>C5-C6	mg/kg	0.1	~	~	~	<0.1	<0.1	<0.1
>C6-C8	mg/kg	0.1	~	~	~	<0.1	<0.1	<0.1
>C8-C10	mg/kg	0.1	~	~	~	<0.1	<0.1	<0.1
>C10-C12	mg/kg	0.2	~	~	~	<0.2	4.8	<0.2
>C12-C16	mg/kg	4	~	~	~	<4	47.0	<4
>C16-C21	mg/kg	7	~	~	~	<7	119.0	<7
>C21-C35	mg/kg	7	~	~	~	28.0	672.0	97
>C35-C40	mg/kg	7	~	~	~	<7	62.0	<7
Total aliphatics C5-40	mg/kg	26	~	~	~	28.0	905.0	97
>C6-C10	mg/kg	0.1	~	~	~	<0.1	<0.1	<0.1
>C10-C25	mg/kg	10	~	~	~	<10	360.0	<10
>C25-C35	mg/kg	10	~	~	~	32.0	494.0	82
Aromatics								
>C5-EC7	mg/kg	0.1	~	~	~	<0.1	<0.1	<0.1
>EC7-EC8	mg/kg	0.1	~	~	~	<0.1	<0.1	<0.1
>EC8-EC10	mg/kg	0.1	~	~	~	<0.1	<0.1	<0.1
>EC10-EC12	mg/kg	0.2	~	~	~	<0.2	6.6	<0.2
>EC12-EC16	mg/kg	4	~	~	~	<4	19.0	<4
>EC16-EC21	mg/kg	7	~	~	~	<7	79.0	11
>EC21-EC35	mg/kg	7	~	~	~	115.0	423.0	117
>EC35-EC40	mg/kg	7	~	~	~	17.0	62.0	27
Total aromatics C5-40	mg/kg	26	~	~	~	132.0	590.0	155
Total aliphatics and aromatics(C5-40)	mg/kg	52	~	~	~	160.0	1495.0	252
>EC6-EC10	mg/kg	0.1	~	~	~	<0.1	<0.1	<0.1
>EC10-EC25	mg/kg	10	~	~	~	19.0	200.0	29
>EC25-EC35	mg/kg	10	~	~	~	93.0	331.0	94
Petroleum Hydrocarbons								
MTBE	ug/kg	5	~	~	~	<5	<5	<5
Benzene	ug/kg	5	6000	~	~	<5	<5	<5
Toluene	ug/kg	5	6000	~	~	<5	<5	<5
Ethylbenzene	ug/kg	5	6000	~	~	<5	<5	<5
m/p-Xylene	ug/kg	5	6000	~	~	<5	8.0	<5
o-Xylene	ug/kg	5	6000	~	~	<5	<5	<5
Polychlorinated Biphenyls (PCBs)								
PCB 28	ug/kg	5	~	~	~	<5	<100	<5
PCB 52	ug/kg	5	~	~	~	<5	<100	<5
PCB 101	ug/kg	5	~	~	~	<5	<100	<5
PCB 118	ug/kg	5	~	~	~	<5	<100	<5
PCB 138	ug/kg	5	~	~	~	<5	<100	<5
PCB 153	ug/kg	5	~	~	~	<5	<100	<5
PCB 180	ug/kg	5	~	~	~	<5	<100	<5
Total 7 PCBs	ug/kg	5	1000	~	~	<35	<700	<35
Phenols								
Phenol	mg/kg	0.01	~	~	~	<0.01	<0.01	<0.01

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Table 2: Soils Analytical Results

Sample ID			Waste Acceptance Criteria (WAC)[1]			TPA	TPF	TPG
Laboratory Report No.			Inert Waste Acceptance Criteria	*Non-Hazardous Waste Acceptance Criteria*	Hazardous Wate Acceptance Criteria	Exova 19/1582 Depth 3.80-4.10m	Exova 19/1582 Depth 1.60-2.00m	Exova 19/1582 Depth 3.60-4.00m
Laboratory Sample No.						1-3	4-6	7-9
Sample Date						17/01/19	17/01/19	17/01/2019
Parameter	**Units**	**LOD**						
Leachate CEN 10:1								
Parameters								
Dissolved Antimony	mg/kg	<0.02	0.06	0.7	5	**0.1**	<0.02	**0.11**
Dissolved Arsenic	mg/kg	<0.025	0.5	2	25	0.1	0.1	0.054
Dissolved Barium	mg/kg	<0.03	20	100	300	0.2	0.3	0.59
Dissolved Boron	mg/kg	<0.12	~	~	~	0.4	3.7	9.97
Dissolved Cadmium	mg/kg	<0.005	0.04	1	5	<0.005	<0.005	<0.005
Dissolved Chromium	mg/kg	<0.015	0.50	10	70	0.2	<0.015	<0.015
Dissolved Copper	mg/kg	<0.07	2	50	100	<0.07	<0.07	<0.07
Dissolved Lead	mg/kg	<0.05	0.5	10	50	<0.05	0.1	0.1
Dissolved Molybdenum	mg/kg	<0.02	0.5	10	30	0.1	0.5	**0.78**
Dissolved Nickel	mg/kg	<0.02	0.4	10	40	<0.02	0.1	<0.02
Dissolved Selenium	mg/kg	<0.03	0.10	0.50	7	<0.03	<0.03	<0.03
Dissolved Zinc	mg/kg	<0.03	4	50	200	0.1	0.04	<0.03
Mercury Dissolved by CVAF	mg/kg	<0.0001	0.01	0.20	2	<0.0001	<0.0001	<0.0001
Total Phenols	mg/kg	<0.1	1	~	~	<0.1	<0.1	<0.1
Fluoride	mg/kg	<3	10	150	500	<3	<3	<3
Ammoniacal Nitrogen as N	mg/kg	<0.3	~	~	~	0.9	426.9	40.2
Sulphate as SO4	mg/kg	<0.5	1000	20000	50000	132.0	**2095.0**	803
Chloride	mg/kg	<3	800	15000	25000	<3	78.0	14
Dissolved Organic Carbon	mg/kg	<20	500	800	1000	30.0	180.0	80
Total Dissolved Solids	mg/kg	<350	4000	60000	100000	1760	**4210**	3608

Notes:

1	Council Decision of 19 December 2002 Establishing Criteria and Procedures for the
Bold	Denotes value exceeds Inert Waste Acceptance Criteria
Italics	Denotes value exceeds Non-Hazardous Waste Acceptance Criteria
Underline	Denotes value exceeds Hazardous Wate Acceptance Criteria
NAD	NAD. No asbestos detected
*	Muphys Environmental (inert) waste acceptance screening value. Waste Licence W0129-02. EPA Waste Licence are taken from the 2002 European Landfill Directive (2003/33/EC).

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Table 3: Groundwater Analytical Results

Sample ID		Groundwater Quality Standards			GW1A		GW2A		GW3A		Private Well (Hotel)
Laboratory Report No.		Groundwater Regulations (S.I. No. 9 of 2010, SI No. 149 of 2012, SI No. 366 of 2016) [1]	*EPA Interim Guideline Value (IGV) for Groundwater* [2]	Drinking Water Standards (S.I. 278 of 2007 & S.I. 122 of 2014 & S.I. 464 of 2017[3])	19/6806	19/7606	19/6806	19/7606	19/6806	19/7606	5742L01
Sample Date					25/04/2019	09/05/2019	25/04/2019	09/05/2019	25/04/2019	09/05/2019	23/10/2019
Field Parameters	**Unit**										
Temperature	°C	–	25	–	11.52	11.01	11.48	10.39	11.59	12.02	–
Dissolved Oxygen	mg/l	–	–	–	7.00	7.00	8.42	9.00	4.00	8.00	–
Dissolved Oxygen (DO)	%	–	NAC	–	66.31		79.52		37.80		–
Electrical Conductivity (EC)	µS/cm	800 / 1,875 #	1,000	2,500	**875.00**	**858.00**	**805.00**	727.00	707.00	718.00	711.00
Oxidation Reduction Potential (ORP)	mV	–	–	–	369.49	96.27	365.04	165.48	358.73	188.64	–
pH	pH units	–	6.5-9.5	6.5-9.5	7.38	7.12	7.21	7.14	7.28	7.37	7.20
Colour	N/A	–	NAC	ATC and NAC	Brown	Brown	Brown	Brown	Cloudy	Clear	1.5
Odour / Other observations	N/A	–	–	ATC and NAC	Silty, No odour, NEC	Silty, No odour, NEC	Silty, No Odour, NEC	Silty, No Odour, NEC	Few SS, NEC	Few SS, NEC	–
Total Hardness	mol CaCO3	–	200	–	–	–	–	–	–	–	*394*
Turbidity	NTU	–	–	ATC and NAC	–	–	–	–	–	–	<0.02
Laboratory Parameters											
Inorganics											
Sulphate	mg/l	187.5	200	250	79	58.2	43.4	20.3	26.4	22.1	20.12
Chloride	mg/l	187.5	30	250	*83.7*	*83.2*	*50*	*49.8*	*30.1*	*33.1*	*41.2*
Fluoride	mg/l	–	1	0.8	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	–
Molybdate Reactive Phosphuros (MRP)	mg/l P	0.035	–	–	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	–
Ammoniacal Nitrogen as N	mg/l	0.065	0.12 *	0.23 *	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.02
Ammoniacal Nitrogen as NH3	mg/l	0.08	0.15	0.28	–	–	–	–	–	–	0.02
Nitrite as NO2	mg/l	3.75	0.1	0.5	–	–	–	–	–	–	0.03
Nitrate as NO3	mg/l	37.5	25	50	–	–	–	–	–	–	16.15
Indicators											
Total Organic Carbon (TOC)	mg/l	–	NAC	NAC	<2	<2	<2	<2	<2	<2	–
Total Cyanide	µg/l	–	10	50	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Total Alkalinity as $CaCO_3$	mg/l	–	NAC	–	666	962	4770	3430	342	328	–
Total Oxidised Nitrogen as N	mg/l	–	NAC	–	7.60	7.50	8.90	9.10	7.80	7.90	–
Total Dissolved Solids (TDS)	mg/l	–	1,000	–	673	753	530	532	516	500	–
Microbiological											
Faecal Coliforms	cfu/100ml	–	0	0	<1	<1	<1	<1	<1	<1	0
Total Coliforms	cfu/100ml	–	0	0	<1.0	*3.1*	*7.4*	*9.6*	*166.8*	*27.2*	0
TVC @ 22C	cfu/100ml	–	–	–	–	–	–	–	–	–	0
Metals											
Dissolved Arsenic	ug/l	7.5	10	10	<2.5	**8.10**	<2.5	<2.5	<2.5	<2.5	–
Dissolved Boron	ug/l	–	1,000	1,000	92	98	23	26	39	45	–
Dissolved Cadmium	ug/l	–	5	5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	–
Dissolved Calcium	mg/l	–	200	–	148.7	150.4	142.9	146.0	142.0	131.3	112.0
Dissolved Chromium	ug/l	37.5	30	50	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	–
Dissolved Copper	ug/l	–	30	2000	<7	<7	<7	<7	<7	<7	*93*
Total Dissolved Iron	ug/l	–	200	200	<20	<20	<20	<20	<20	<20	<20
Dissolved Lead	ug/l	7.5	10	10	<5	<5	<5	<5	<5	<5	<1
Dissolved Magnesium	mg/l	–	50	–	19.9	20.8	14.2	14.5	18.5	18.2	27.3
Dissolved Manganese	ug/l	–	50	50	3	4	<2	<2	<2	<2	27
Dissolved Mercury	ug/l	0.75	1	1	<1	<1	<1	<1	<1	<1	–
Dissolved Nickel	ug/l	–	20	20	<2	<2	<2	<2	<2	<2	–
Dissolved Potassium	mg/l	–	5	–	*7.6*	*8.3*	2.1	2.0	1.9	1.8	1.64
Dissolved Sodium	mg/l	–	150	200	45.4	42.7	15.0	14.3	11.3	11.5	15.2
Dissolved Zinc	ug/l	75	100	–	<3	<3	<3	<3	<3	<3	–
Aluminium	ug/l	150	200	200	–	–	–	–	–	–	<20
Pesticides											
Atrazine	µg/l	0.075	1	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Simazine	µg/l	0.075	1	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Organochlorine Pesticides											
Aldrin	ug/l	–	0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Alpha-HCH (BHC)	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Beta-HCH (BHC)	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Chlorothalonil	ug/l	–	–	–	<2.50	<2.50	<2.50	<2.50	<2.50	<2.50	–
cis-Chlordane	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Delta-HCH (BHC)	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Dieldrin	ug/l	0.075	0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Endosulphan I	ug/l	–	0.001	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Endosulphan II	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Endosulphan sulphate	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Endrin	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Gamma-HCH (BHC)	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Heptachlor	ug/l	–	–	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Heptachlor Epoxide	ug/l	–	–	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Hexachlorobenzene	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Isodrin	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
o,p'-DDE	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
o,p'-DDT	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
o,p'-Methoxychlor	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
o,p'-TDE	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
p,p'-DDE	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
p,p'-DDT	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
p,p'-Methoxychlor	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
p,p'-TDE	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Pendimethalin	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Permethrin I	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Permethrin II	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Quintozene (PCNB)	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Tecnazene	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Telodrin	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
trans-Chlordane	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Triadimefon	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Triallate	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Trifluralin	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Acid Herbicides											
Benazolin	ug/l	–	–	–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	–
Bentazone	ug/l	0.075	–	–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	–
Bromoxynil	ug/l	–	–	–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	–
Clopyralid	ug/l	–	–	–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	–
4 - CPA	ug/l	–	–	–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	–
2,4 - D	ug/l	0.075	–	–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	–
2,4 - DB	ug/l	–	–	–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	–
Dicamba	ug/l	–	–	–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	–
Dichloroprop	ug/l	–	–	–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	–
Diclofop	ug/l	–	–	–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	–
Fenoprop	ug/l	–	–	–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	–
Flamprop	ug/l	–	–	–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	–
Flamprop – isopropyl	ug/l	–	–	–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	–
Ioxynil	ug/l	–	–	–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	–
MCPA	ug/l	0.075		–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	–
MCPB	ug/l	–	–	–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	–
Mecoprop	ug/l	0.075		–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	–
Picloram	ug/l	–	–	–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	–
Pentachlorophenol	ug/l	–	–	–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	–
2,4,5 - T	ug/l	–	–	–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	–
2,3,6 - TBA	ug/l	–	–	–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	–
Triclopyr	ug/l	–	–	–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Organophosphorus Pesticides											
Azinphos ethyl	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Azinphos methyl	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Carbophenothion	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Chlorfenvinphos	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Chlorpyrifos	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Chlorpyrifos-methyl	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Diazinon	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Dichlorvos	ug/l	–	0.001	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Disulfoton	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Dimethoate	ug/l			–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Ethion	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Ethyl Parathion (Parathion)	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Etrimphos	ug/l			–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Fenitrothion	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Fenthion	ug/l			–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Malathion	ug/l	–	0.01	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Methyl Parathion	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Mevinphos	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Phosalone	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Pirimiphos Methyl	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Propetamphos	ug/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Triazophos	ug/l				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
Dibutyltin	ug/l	–	–	–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	–
Tributyltin	ug/l	–	–	–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	–
Triphenyltin	ug/l	–	–	–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	–
TPH CWG											
Aliphatics											
>C5-C6	ug/l	–	–	–	<10	<10	<10	<10	<10	<10	–
>C6-C8	ug/l	–	–	–	<10	<10	<10	<10	<10	<10	–
>C8-C10	ug/l	–	–	–	<10	<10	<10	<10	<10	<10	–
>C10-C12	ug/l	–	–	–	<5	<5	<5	<5	<5	<5	–
>C12-C16	ug/l	–	–	–	<10	<10	<10	<10	<10	<10	–
>C16-C21	ug/l	–	–	–	<10	<10	<10	<10	<10	<10	–
>C21-C35	ug/l	–	–	–	<10	<10	<10	<10	<10	<10	–
Total aliphatics C5-35	ug/l	–	–	–	<10	<10	<10	<10	<10	<10	–
Aromatics											
>C5-EC7	ug/l	–	–	–	<10	<10	<10	<10	<10	<10	–
>EC7-EC8	ug/l	–	–	–	<10	<10	<10	<10	<10	<10	–
>EC8-EC10	ug/l	–	–	–	<10	<10	<10	<10	<10	<10	–
>EC10-EC12	ug/l	–	–	–	<5	<5	<5	<5	<5	<5	–
>EC12-EC16	ug/l	–	–	–	<10	<10	<10	<10	<10	<10	–
>EC16-EC21	ug/l	–	–	–	<10	<10	<10	<10	<10	<10	–
>EC21-EC35	ug/l	–	–	–	<10	<10	<10	<10	<10	<10	–
Total aromatics C5-35	ug/l	–	–	–	<10	<10	<10	<10	<10	<10	–
Total aliphatics and aromatics(C5-35)	ug/l	–	10	–	<10	<10	<10	<10	<10	<10	–
GRO (>C4-C8)	ug/l	–	–	–	<10	<10	<10	<10	<10	<10	–
GRO (>C8-C12)	ug/l	–	–	–	<10	<10	<10	<10	<10	<10	–
GRO (>C4-C12)	ug/l	–	–	–	<10	<10	<10	<10	<10	<10	–
Methyl Tertiary Butyl Ether	ug/l	10	30	–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	–
Benzene	ug/l	0.75	1	1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	–
Toluene	ug/l	525	10	–	<5	<5	<5	<5	<5	<5	–
Ethylbenzene	ug/l	–	10	–	<1	<1	<1	<1	<1	<1	–
m/p-Xylene	ug/l	–	10	–	<2	<2	<2	<2	<2	<2	–
o-Xylene	ug/l	–	10	–	<1	<1	<1	<1	<1	<1	–
EPH (C8-C40)	ug/l	–	–	–	<10	<10	<10	<10	<10	<10	–
C8-C40 Mineral Oil (Calculation)	ug/l	–	–	–	<10	<10	<10	<10	<10	<10	–

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Prusselstown, Athy
County Kildare

Table 3: Groundwater Analytical Results

Sample ID		Groundwater Quality Standards			GW1A		GW2A		GW3A		Private Well (Hotel)
Laboratory Report No.		Groundwater Regulations (S.I. No. 9 of 2010, SI No. 149 of 2012, SI No. 366 of 2016) [1]	*EPA Interim Guideline Value (IGV) for Groundwater* [2]	Drinking Water Standards (S.I. 278 of 2007 & S.I. 122 of 2014 & S.I. 464 of 2017[3])	19/6806	19/7606	19/6806	19/7606	19/6806	19/7606	5742L01
Sample Date					25/04/2019	09/05/2019	25/04/2019	09/05/2019	25/04/2019	09/05/2019	23/10/2019
Semi-Volatile organic compounds (SVOCs)											
Phenols											
2-Chlorophenol	µg/ l	–	200	–	<1	<1	<1	<1	<1	<1	–
2-Methylphenol	µg/ l	–	–	–	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	–
2-Nitrophenol	µg/ l	–	–	–	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	–
2,4-Dichlorophenol	µg/ l	–	–	–	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	–
2,4-Dimethylphenol	µg/ l	–	–	–	<1	<1	<1	<1	<1	<1	–
2,4,5-Trichlorophenol	µg/ l	–	–	–	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	–
2,4,6-Trichlorophenol	µg/ l	–	200	–	<1	<1	<1	<1	<1	<1	–
4-Chloro-3-methylphenol	µg/ l	–	–	–	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	–
4-Methylphenol	µg/ l	–	–	–	<1	<1	<1	<1	<1	<1	–
4-Nitrophenol	µg/ l	–	–	–	<10	<10	<10	<10	<10	<10	–
Pentachlorophenol	µg/ l	–	2	–	<1	<1	<1	<1	<1	<1	–
Phenol	µg/ l	–	0.5 [5]	–	<1	<1	<1	<1	<1	<1	–
Total Phenols HPLC	mg/l	–	–	–	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	–
PAHs											
2-Chloronaphthalene	µg/ l	–	–	–	<1	<1	<1	<1	<1	<1	–
2-Methylnaphthalene	µg/ l	–	–	–	<1	<1	<1	<1	<1	<1	–
Naphthalene	µg/ l	–	1	–	<1	<1	<1	<1	<1	<1	–
Acenaphthylene	µg/ l	–	–	–	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	–
Acenaphthene	µg/ l	–	–	–	<1	<1	<1	<1	<1	<1	–
Fluorene	µg/ l	–	–	–	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	–
Phenanthrene	µg/ l	–	–	–	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	–
Anthracene	µg/ l	–	10,000	–	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	–
Fluoranthene	µg/ l	–	1	–	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	–
Pyrene	µg/ l	–	–	–	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	–
Benzo(a)anthracene	µg/ l	–	–	–	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	–
Chrysene	µg/ l	–	–	–	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	–
Benzo(bk)fluoranthene	µg/ l	0.075 [4]	0.55 [7]	0.1 [4]	<1	<1	<1	<1	<1	<1	–
Benzo(a)pyrene	µg/ l	0.0075	0.01	0.01	<1	<1	<1	<1	<1	<1	–
Indeno(123cd)pyrene	µg/ l	0.075 [4]	0.05	0.1 [4]	<1	<1	<1	<1	<1	<1	–
Dibenzo(ah)anthracene	µg/ l	–	–	–	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	–
Benzo(ghi)perylene	µg/ l	0.075 [4]	0.05	0.1 [4]	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	–
Phthalates											
Bis(2-ethylhexyl) phthalate	µg/ l	–	8	–	<5	<5	<5	<5	<5	<5	–
Butylbenzyl phthalate	µg/ l	–	–	–	<1	<1	<1	<1	<1	<1	–
Di-n-butyl phthalate	µg/ l	–	2	–	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	–
Di-n-Octyl phthalate	µg/ l	–	–	–	<1	<1	<1	<1	<1	<1	–
Diethyl phthalate	µg/ l	–	–	–	<1	<1	<1	<1	<1	<1	–
Dimethyl phthalate	µg/ l	–	–	–	<1	<1	<1	<1	<1	<1	–
Additional SVOCs											
1,2-Dichlorobenzene	µg/ l	–	10	–	<1	<1	<1	<1	<1	<1	–
1,2,4-Trichlorobenzene	µg/ l	–	0.4	–	<1	<1	<1	<1	<1	<1	–
1,3-Dichlorobenzene	µg/ l	–	–	–	<1	<1	<1	<1	<1	<1	–
1,4-Dichlorobenzene	µg/ l	–	–	–	<1	<1	<1	<1	<1	<1	–
2-Nitroaniline	µg/ l	–	–	–	<1	<1	<1	<1	<1	<1	–
2,4-Dinitrotoluene	µg/ l	–	–	–	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	–
2,6-Dinitrotoluene	µg/ l	–	–	–	<1	<1	<1	<1	<1	<1	–
3-Nitroaniline	µg/ l	–	–	–	<1	<1	<1	<1	<1	<1	–
4-Bromophenylphenylether	µg/ l	–	–	–	<1	<1	<1	<1	<1	<1	–
4-Chloroaniline	µg/ l	–	–	–	<1	<1	<1	<1	<1	<1	–
4-Chlorophenylphenylether	µg/ l	–	–	–	<1	<1	<1	<1	<1	<1	–
4-Nitroaniline	µg/ l	–	–	–	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	–
Azobenzene	µg/ l	–	–	–	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	–
Bis(2-chloroethoxy)methane	µg/ l	–	–	–	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	–
Bis(2-chloroethyl)ether	µg/ l	–	–	–	<1	<1	<1	<1	<1	<1	–
Carbazole	µg/ l	–	–	–	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	–
Dibenzofuran	µg/ l	–	–	–	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	–
Hexachlorobenzene	µg/ l	–	0.03	–	<1	<1	<1	<1	<1	<1	–
Hexachlorobutadiene	µg/ l	–	0.1	–	<1	<1	<1	<1	<1	<1	–
Hexachlorocyclopentadiene	µg/ l	–	–	–	<1	<1	<1	<1	<1	<1	–
Hexachloroethane	µg/ l	–	–	–	<1	<1	<1	<1	<1	<1	–
Isophorone	µg/ l	–	–	–	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	–
N-nitrosodi-n-propylamine	µg/ l	–	–	–	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	–
Nitrobenzene	µg/ l	–	10	–	<1	<1	<1	<1	<1	<1	–
Volatile organic compounds (VOCs)											
Dichlorodifluoromethane	µg/l	–	–	–	<2	<2	<2	<2	<2	<2	–
Methyl Tertiary Butyl Ether	µg/l	10	30	–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	–
Chloromethane	µg/l	–	–	–	<3	<3	<3	<3	<3	<3	–
Vinyl Chloride	µg/l	0.375	–	0.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	–
Bromomethane	µg/l	–	–	–	<1	<1	<1	<1	<1	<1	–
Chloroethane	µg/l	–	–	–	<3	<3	<3	<3	<3	<3	–
Trichlorofluoromethane	µg/l	–	–	–	<3	<3	<3	<3	<3	<3	–
1,1-Dichloroethene	µg/l	–	30	–	<3	<3	<3	<3	<3	<3	–
Dichloromethane	µg/l	–	10	–	<5	<5	<5	<5	<5	<5	–
trans-1-2-Dichloroethene	µg/l	–	–	–	<3	<3	<3	<3	<3	<3	–
1,1-Dichloroethane	µg/l	–	–	–	<3	<3	<3	<3	<3	<3	–
cis-1-2-Dichloroethene	µg/l	–	–	–	<3	<3	<3	<3	<3	<3	–
2,2-Dichloropropane	µg/l	–	–	–	<1	<1	<1	<1	<1	<1	–
Bromochloromethane	µg/l	–	–	–	<2	<2	<2	<2	<2	<2	–
Chloroform	µg/l	75 [5]	–	100 [5]	<2	<2	<2	<2	<2	<2	–
1,1,1-Trichloroethane	µg/l	–	500	–	<2	<2	<2	<2	<2	<2	–
1,1-Dichloropropene	µg/l	–	–	–	<3	<3	<3	<3	<3	<3	–
Carbon tetrachloride *	µg/l	–	2	–	<2	<2	<2	<2	<2	<2	–
1,2-Dichloroethane	µg/l	2.25	3	3	<2	<2	<2	<2	<2	<2	–
Benzene	µg/l	0.75	1	1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	–
Trichloroethene	µg/l	7.5	70	10 [6]	<3	<3	<3	<3	<3	<3	–
1,2-Dichloropropane	µg/l	–	–	–	<2	<2	<2	<2	<2	<2	–
Dibromomethane	µg/l	–	–	–	<3	<3	<3	<3	<3	<3	–
Bromodichloromethane	µg/l	75 [5]	–	100 [5]	<2	<2	<2	<2	<2	<2	–
cis-1-3-Dichloropropene	µg/l	–	–	–	<2	<2	<2	<2	<2	<2	–
Toluene	µg/l	525	10	–	<5	<5	<5	<5	<5	<5	–
trans-1-3-Dichloropropene	µg/l	–	–	–	<2	<2	<2	<2	<2	<2	–
1,1,2-Trichloroethane	µg/l	–	–	–	<2	<2	<2	<2	<2	<2	–
Tetrachloroethene	µg/l	7.5 [6]	40	10 [6]	<3	<3	<3	<3	<3	<3	–
1,3-Dichloropropane	µg/l	–	–	–	<2	<2	<2	<2	<2	<2	–
Dibromochloromethane	µg/l	75 [5]	–	100 [5]	<2	<2	<2	<2	<2	<2	–
1,2-Dibromoethane	µg/l	–	–	–	<2	<2	<2	<2	<2	<2	–
Chlorobenzene	µg/l	–	1	–	<2	<2	<2	<2	<2	<2	–
1,1,1,2-Tetrachloroethane	µg/l	–	–	–	<2	<2	<2	<2	<2	<2	–
Ethylbenzene	µg/l	–	10	–	<1	<1	<1	<1	<1	<1	–
p/m-Xylene	µg/l	–	10 **	–	<2	<2	<2	<2	<2	<2	–
o-Xylene	µg/l	–	10 **	–	<1	<1	<1	<1	<1	<1	–
Styrene	µg/l	–	–	–	<2	<2	<2	<2	<2	<2	–
Bromoform	µg/l	75 [5]	–	100 [5]	<2	<2	<2	<2	<2	<2	–
Isopropylbenzene	µg/l	–	–	–	<3	<3	<3	<3	<3	<3	–
1,1,2,2-Tetrachloroethane	µg/l	–	–	–	<4	<4	<4	<4	<4	<4	–
Bromobenzene	µg/l	–	–	–	<2	<2	<2	<2	<2	<2	–
1,2,3-Trichloropropane	µg/l	–	–	–	<3	<3	<3	<3	<3	<3	–
Propylbenzene	µg/l	–	–	–	<3	<3	<3	<3	<3	<3	–
2-Chlorotoluene	µg/l	–	–	–	<3	<3	<3	<3	<3	<3	–
1,3,5-Trimethylbenzene	µg/l	–	–	–	<3	<3	<3	<3	<3	<3	–
4-Chlorotoluene	µg/l	–	–	–	<3	<3	<3	<3	<3	<3	–
tert-Butylbenzene	µg/l	–	–	–	<3	<3	<3	<3	<3	<3	–
1,2,4-Trimethylbenzene	µg/l	–	–	–	<3	<3	<3	<3	<3	<3	–
sec-Butylbenzene	µg/l	–	–	–	<3	<3	<3	<3	<3	<3	–
4-Isopropyltoluene	µg/l	–	–	–	<3	<3	<3	<3	<3	<3	–
1,3-Dichlorobenzene	µg/l	–	–	–	<3	<3	<3	<3	<3	<3	–
1,4-Dichlorobenzene	µg/l	–	–	–	<3	<3	<3	<3	<3	<3	–
n-Butylbenzene	µg/l	–	–	–	<3	<3	<3	<3	<3	<3	–
1,2-Dichlorobenzene	µg/l	–	10	–	<3	<3	<3	<3	<3	<3	–
1,2-Dibromo-3-chloropropane	µg/l	–	–	–	<2	<2	<2	<2	<2	<2	–
1,2,4-Trichlorobenzene	µg/l	–	0.4	–	<3	<3	<3	<3	<3	<3	–
Hexachlorobutadiene	µg/l	–	0.1	–	<3	<3	<3	<3	<3	<3	–
Naphthalene	µg/l	–	1	–	<2	<2	<2	<2	<2	<2	–
1,2,3-Trichlorobenzene	µg/l	–	–	–	<3	<3	<3	<3	<3	<3	–

Notes:

Bold denotes value exceeds groundwater regulations.

Italics denotes value exceeds IGV where no groundwater regulation is available.

Underlined denotes value exceeds drinking water standards.

MDL denotes method detection limit.

ATC denotes acceptable to consumers

NEC denotes no evidence of contamination

SS denotes Suspended Solids.

NAC denotes no abnormal change.

- denotes parameter not analysed/ recorded.

– denotes groundwater quality standard unavailable.

* denotes groundwater regulations are for dissolved metals, used groundwater regulation for total metals for comparison purposes only.

◊ denotes standard relates to phenols.

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# denotes lower value - assessment for the presence of saline/other instrusion; higher value - assessment of the general quality of groundwater in terms of whether its ability to support human uses has been significantly impaired by pollution.

denotes lower value - assessment of adverse impacts of chemical inputs from groundwater on associated surface water bodies; higher value - assessment of the general quality of groundwater in terms of whether its ability to support human uses has been

* denotes standards converted from ammonium (NH4) to ammonia as N (=14/18).

** denotes standard is for total xylenes.

1: European Communities Environmental Objectives (Groundwater) Regulations 2010; S.I. No. 9 of 2010. Amendment SI no 149 of 2012, Amendment SI No. 366 of 2016.

2: Environmental Protection Agency (EPA), 2003. Towards Setting Guideline Values for the Protection of Groundwater in Ireland - Interim Report. EPA, Ireland.

3: SI No. 278 of 2007; European communities (Drinking Water) (No. 2) Regulation 2007. SI No. 122 of 2014. SI No. 464 of 2017; European Union (Drinking Water) Regulations 2014

4: Denotes regulation value is for "Total Polycyclic Aromatic Hydrocarbons", sum of 4 (Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(123cd)pyrene & Benzo(ghi)perylene).

5: Denotes regulation value is for "Total Trihalomethanes".

6: Denotes regulation value is for "Total Tetrachloroethene and Trichloroethene".

7: Denotes groundwater quality standard is the sum of Benzo(b)fluoranthene & Benzo(k)fluoranthene.

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County Kildare

Table 4: Leachate Analytical Results

Sample ID		**Groundwater Quality Standards**			**Surface Water Quality Standards**	**L1A**	
Laboratory Report No.		**Groundwater Regulations (S.I. No. 9 of 2010, SI No. 366 of 2016)** [1]	*EPA Interim Guideline Value (IGV) for Groundwater* [2]	*Drinking Water Standards (SI 278 of 2007 Drinking Water Standards & SI 122 of 2014)* [3]	**Surface Water Regulations 2009 (SI No. 272 of 2009) as amended (S.I. No. 372 of 2012 and S.I. No. 386 of 2015) - Annual Mean**	19-6650	19-7606
Sample Date						25/04/19	09/05/19
Field Parameters	**Unit**						
Temperature	°C	~	25	~	~	~	~
Dissolved Oxygen	mg/l	~	~	~	~	3	2
Oxidation Reduction Potential (ORP)	mV	~	~	~	~	-40.96	-89.8
Electrical Conductivity (EC)	µS/cm	800 / 1,875 [#]	1,000	2,500	~	*1500*	*1288*
pH	pH units	~	6.5-9.5	6.5-9.5	~	7.51	7.15
Colour	N/A	~	NAC	ATC and NAC	~	Grey/Black	Grey/Black
Odour / Other observations	N/A	~	~	ATC and NAC	~	Slight odour, SS, NEC	Slight odour, SS, NEC
Laboratory Parameters							
Sulphate	mg/l	187.5	200	250	~	33.70	87.6
Chloride	mg/l	187.50	30	250	~	25.80	22.8
Fluoride	mg/l	~	1	0.8	1.5	<0.3	<0.3
Total Oxidised Nitrogen as N	mg/l	~	NAC	~	~	<0.2	<0.2
Molybdate Reactive Phosphuros (MRP)	mg/l P	0.035	~	~	0.025	<0.03	<0.03
Total Cyanide	µg/l	~	10	50	10	0.04	0.01
Ammoniacal Nitrogen as N	mg/l	0.065	0.12	0.23	≤0.040	***39.03***	***31***
BOD (Settled)	mg/l	~	~	~	1.3	10	7
COD (Settled)	mg/l	~	~	~	~	69	49
Metals (Dissolved)							
Arsenic	µg/l	7.5	10	10	20	<2.5	***17.1***
Boron	µg/l	~	1,000	1,000	~	286	298
Cadmium	µg/l	~	5	5	0.2	<0.5	<0.5
Calcium	mg/l	~	200	~	~	*255.10*	*254.3*
Chromium	µg/l	37.5	30	50	0.6	<1.5	<1.5
Copper	µg/l	~	30	2,000	5	<7	<7
Iron	µg/l	~	200	200	~	<20	65
Lead	µg/l	7.5	10	25	1.3	<5	<5
Magnesium	mg/l	~	50	~	~	26.10	24.5
Manganese	µg/l	~	50	50	~	*1.031*	*1331*
Mercury	µg/l	0.75	1	1	~	<1	<1
Nickel	µg/l	~	20	20	8.6	5	4
Potassium	mg/l	~	5	~	~	*28.3*	*25*
Sodium	mg/l	~	150	200	~	21.90	22.8
Zinc	µg/l	75	100	~	40	27	5
Dibutyltin	µg/l	~	~	~	~	<0.1	<0.1
Tributyltin	µg/l	~	~	~	0.0002	<0.1	<0.1
Triphenyltin	µg/l	~	~	~	~	<0.1	<0.1
TPH CWG							
Aliphatics							
>C5-C6	ug/l	~	~	~	~	<10	<10
>C6-C8	ug/l	~	~	~	~	<10	<10
>C8-C10	ug/l	~	~	~	~	<10	<10
>C10-C12	ug/l	~	~	~	~	<5	<5
>C12-C16	ug/l	~	~	~	~	<10	<10
>C16-C21	ug/l	~	~	~	~	<10	<10
>C21-C35	ug/l	~	~	~	~	<10	<10
Total aliphatics C5-35	ug/l	~	~	~		<10	<10
Aromatics							
>C5-EC7	ug/l	~	~	~	~	<10	<10
>EC7-EC8	ug/l	~	~	~	~	<10	<10
>EC8-EC10	ug/l	~	~	~	~	<10	<10
>EC10-EC12	ug/l	~	~	~	~	<5	<5
>EC12-EC16	ug/l	~	~	~	~	<10	<10
>EC16-EC21	ug/l	~	~	~	~	<10	<10
>EC21-EC35	ug/l	~	~	~	~	<10	<10
Total aromatics C5-35	ug/l	~	~	~	~	<10	<10
Total aliphatics and aromatics(C5-35)	ug/l	~	10	~	~	<10	<10
GRO (>C4-C8)	ug/l	~	~	~	~	<10	<10
GRO (>C8-C12)	ug/l	~	~	~	~	16	<10
GRO (>C4-C12)	ug/l	~	~	~	~	16	<10
Methyl Tertiary Butyl Ether	ug/l	10	30	~		<0.1	<0.1
Benzene	ug/l	0.75	1	1		<0.5	<0.5
Toluene	ug/l	525	10	~		<5	<5
Ethylbenzene	ug/l	~	10	~		<1	<1
m/p-Xylene	ug/l	~	10	~		<2	<2
o-Xylene	ug/l	~	10	~		<1	<1
EPH (C8-C40)	ug/l	~	~	~		<10	<10
C8-C40 Mineral Oil (Calculation)	ug/l	~	~	~		<10	<10
Pesticides							
Organochlorine Pesticides							
Aldrin	ug/l	~	0.01	0.03	Σ=0.005	<0.01	<0.01
Alpha-HCH (BHC)	ug/l	~	~	~	~	<0.01	<0.01
Beta-HCH (BHC)	ug/l	~	~	~	~	<0.01	<0.01
Chlorothalonil		~	~	~	~	<2.50	<2.50
cis-Chlordane		~	~	~	~	<0.01	<0.01
Delta-HCH (BHC)	ug/l	~	~	~	~	<0.01	<0.01
Dieldrin	ug/l	~	0.01	0.03	Σ=0.005	<0.01	<0.01
Endosulphan I	ug/l	~	0.001	~	~	<0.01	<0.01
Endosulphan II	ug/l	~	~	~	~	<0.01	<0.01
Endosulphan sulphate	ug/l	~	~	~	~	<0.01	<0.01
Endrin	ug/l	~	~	~	Σ=0.005	<0.01	<0.01
Gamma-HCH (BHC)	ug/l	~	~	~	~	<0.01	<0.01
Heptachlor	ug/l	~	~	0.03	~	<0.01	<0.01
Heptachlor Epoxide	ug/l	~	~	0.03	~	<0.01	<0.01
Hexachlorobenzene	ug/l	~	~	~	~	<0.01	<0.01
Isodrin	ug/l	~	~	~	Σ=0.01	<0.01	<0.01
o,p'-DDE	ug/l	~	~	~	~	<0.01	<0.01
o,p'-DDT	ug/l	~	~	~	0.01	<0.01	<0.01
o,p'-Methoxychlor	ug/l	~	~	~	~	<0.01	<0.01
o,p'-TDE	ug/l	~	~	~	~	<0.01	<0.01
p,p'-DDE	ug/l	~	~	~	~	<0.01	<0.01
p,p'-DDT	ug/l	~	~	~	~	<0.01	<0.01
p,p'-Methoxychlor	ug/l	~	~	~	~	<0.01	<0.01
p,p'-TDE	ug/l	~	~	~	~	<0.01	<0.01
Pendimethalin	ug/l	~	~	~	~	<0.01	<0.01
Permethrin I	ug/l	~	~	~	~	<0.01	<0.01
Permethrin II	ug/l	~	~	~	~	<0.01	<0.01
Quintozene (PCNB)	ug/l	~	~	~	~	<0.01	<0.01
Tecnazene	ug/l	~	~	~	~	<0.01	<0.01
Telodrin	ug/l	~	~	~	~	<0.01	<0.01
trans-Chlordane	ug/l	~	~	~	~	<0.01	<0.01
Triadimefon	ug/l	~	~	~	~	<0.01	<0.01
Triallate	ug/l	~	~	~	~	<0.01	<0.01
Trifluralin	ug/l	~	~	~	~	<0.01	<0.01
Benazolin	ug/l	~	~	~	~	<0.1	<0.1
Bentazone	ug/l	~	~	~	~	<0.1	<0.1
Bromoxynil	ug/l	~	~	~	~	<0.1	<0.1
Clopyralid	ug/l	~	~	~	~	<0.1	<0.1
4 - CPA	ug/l	~	~	~	~	<0.1	<0.1
2,4 - D	ug/l	~	~	~	~	<0.1	<0.1
2,4 - DB	ug/l	~	~	~	~	<0.1	<0.1
Dicamba	ug/l	~	~	~	~	<0.1	<0.1
Dichloroprop	ug/l	~	~	~	~	<0.1	<0.1
Diclofop	ug/l	~	~	~	~	<0.1	<0.1
Fenoprop	ug/l	~	~	~	~	<0.1	<0.1
Flamprop	ug/l	~	~	~	~	<0.1	<0.1
Flamprop – isopropyl	ug/l	~	~	~	~	<0.1	<0.1
Ioxynil	ug/l	~	~	~	~	<0.1	<0.1
MCPA	ug/l	0.075	~	~	~	<0.1	<0.1
MCPB	ug/l	~	~	~	~	<0.1	<0.1
Mecoprop	ug/l	0.075	~	~	~	<0.1	<0.1
Picloram	ug/l	~	~	~	~	<0.1	<0.1
Pentachlorophenol	ug/l	~	~	~	~	<0.1	<0.1
2,4,5 - T	ug/l	~	~	~	~	<0.1	<0.1
2,3,6 - TBA	ug/l	~	~	~	~	<0.1	<0.1
Triclopyr	ug/l	~	~	~	~	<0.1	<0.1
Organophosphorus Pesticides							
Azinphos ethyl	ug/l	~	~	~	~	<0.01	<0.01
Azinphos methyl	ug/l	~	~	~	~	<0.01	<0.01
Carbophenothion	ug/l	~	~	~	~	<0.01	<0.01
Chlorfenvinphos	ug/l	~	~	~	0.1	<0.01	<0.01
Chlorpyrifos	ug/l	~	~	~	0.03	<0.01	<0.01
Chlorpyrifos-methyl	ug/l	~	~	~		<0.01	<0.01
Diazinon	ug/l	~	0.001	~	0.01	<0.01	<0.01
Dichlorvos	ug/l	~	~	~	0.00006	<0.01	<0.01
Disulfoton	ug/l			~	~	<0.01	<0.01
Dimethoate	ug/l	~	~	~	0.8	<0.01	<0.01
Ethion	ug/l	~	~	~	~	<0.01	<0.01
Ethyl Parathion (Parathion)	ug/l			~	~	<0.01	<0.01
Etrimphos	ug/l	~	~	~	~	<0.01	<0.01
Fenitrothion	ug/l			~	~	<0.01	<0.01
Fenthion	ug/l	~	0.01	~	~	<0.01	<0.01
Malathion	ug/l	~	~	~	~	<0.01	<0.01
Methyl Parathion	ug/l	~	~	~	~	<0.01	<0.01
Mevinphos	ug/l	~	~	~	~	<0.01	<0.01
Phosalone	ug/l	~	~	~	~	<0.01	<0.01
Pirimiphos Methyl	ug/l	~	~	~	~	<0.01	<0.01
Propetamphos	ug/l	~	~	~	~	<0.01	<0.01
Triazophos	ug/l	~	~	~	~	<0.01	<0.01
Atrazine	µg/l	0.075	1	~	0.6	<0.01	<0.01
Simazine	µg/l	0.075	1	~	1	<0.01	<0.01

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Table 4: Leachate Analytical Results

Sample ID		Groundwater Quality Standards			Surface Water Quality Standards	L1A	
Laboratory Report No.		Groundwater Regulations (S.I. No. 9 of 2010, SI No. 149 of 2012, SI No. 366 of 2016) [1]	*EPA Interim Guideline Value (IGV) for Groundwater* [2]	*Drinking Water Standards (SI 278 of 2007 Drinking Water Standards & SI 122 of 2014).* [3]	**Surface Water Regulations 2009 (SI No. 272 of 2009) as amended (S.I. No. 372 of 2012 and S.I. No. 386 of 2015) - Annual Mean**	19-6650	19-7606
Sample Date						25/04/19	09/05/19
Semi-Volatile Organic Compounds (SVOC's)							
Phenols							
2-Chlorophenol	µg/ l	~	200	~	~	<1	<1
2-Methylphenol	µg/ l	~	~	~	~	<0.5	<0.5
2-Nitrophenol	µg/ l	~	~	~	~	<0.5	<0.5
2,4-Dichlorophenol	µg/ l	~	~	~	~	<0.5	<0.5
2,4-Dimethylphenol	µg/ l	~	~	~	~	<1	<1
2,4,5-Trichlorophenol	µg/ l	~	~	~	~	<0.5	<0.5
2,4,6-Trichlorophenol	µg/ l	~	200	~	~	<1	<1
4-Chloro-3-methylphenol	µg/ l	~	~	~	~	<0.5	<0.5
4-Methylphenol	µg/ l	~	~	~	~	<1	<1
4-Nitrophenol	µg/ l	~	~	~	~	<10	<10
Pentachlorophenol	µg/ l	~	2	~	0.4	<1	<1
Phenol	µg/ l	~	0.5	~	8	<1	<1
PAHs							
2-Chloronaphthalene	µg/ l	~	~	~	~	<1	<1
2-Methylnaphthalene	µg/ l	~	~	~	~	<1	<1
Naphthalene	µg/ l	~	~	~	2	<1	<1
Acenaphthylene	µg/ l	~	~	~	~	<0.5	<0.5
Acenaphthene	µg/ l	~	1	~	~	<1	<1
Fluorene	µg/ l	~	~	~	~	<0.5	<0.5
Phenanthrene	µg/ l	~	~	~	~	<0.5	<0.5
Anthracene	µg/ l	~	~	~	0.1	<0.5	<0.5
Fluoranthene	µg/ l	~	~	~	0.0063	<0.5	<0.5
Pyrene	µg/ l	~	10,000	~	~	<0.5	<0.5
Benz(a)anthracene	µg/ l	~	1	~	~	<0.5	<0.5
Chrysene	µg/ l	~	~	~	~	<0.5	<0.5
Benzo(bk)fluoranthene	µg/ l	0.075 [3]	0.55	0.1 [4]	0.03	<1	<1
Benzo(a)pyrene	µg/ l	0.0075	0.01	0.01	0.00017	<1	<1
Indeno(123cd)pyrene	µg/ l	0.075 [3]	0.05	0.1 [4]	0.002	<1	<1
Dibenzo(ah)anthracene	µg/ l	~	~	~	~	<0.5	<0.5
Benzo(ghi)perylene	µg/ l	0.075 [3]	0.05	0.1 [4]	0.002	<0.5	<0.5
Phthalates							
Bis(2-ethylhexyl) phthalate	µg/ l	~	8	~	1.3	<5	<5
Butylbenzyl phthalate	µg/ l	~	~	~	~	<1	<1
Di-n-butyl phthalate	µg/ l	~	2	~	~	<1.5	<1.5
Di-n-Octyl phthalate	µg/ l	~	~	~	~	<1	<1
Diethyl phthalate	µg/ l	~	~	~	~	<1	<1
Dimethyl phthalate	µg/ l	~	~	~	~	<1	<1
Additional SVOCs							
SVOC TICs (trace organics)	µg/l	~	~	~	~		
1,2-Dichlorobenzene	µg/ l	~	10	~	~	<1	<1
1,2,4-Trichlorobenzene	µg/ l	~	0.4	~	0.4	<1	<1
1,3-Dichlorobenzene	µg/ l	~	~	~	~	<1	<1
1,4-Dichlorobenzene	µg/ l	~	~	~	~	<1	<1
2-Nitroaniline	µg/ l	~	~	~	~	<1	<1
2,4-Dinitrotoluene	µg/ l	~	~	~	~	<0.5	<0.5
2,6-Dinitrotoluene	µg/ l	~	~	~	~	<1	<1
3-Nitroaniline	µg/ l	~	~	~	~	<1	<1
4-Bromophenylphenylether	µg/ l	~	~	~	~	<1	<1
4-Chloroaniline	µg/ l	~	~	~	~	<1	<1
4-Chlorophenylphenylether	µg/ l	~	~	~	~	<1	<1
4-Nitroaniline	µg/ l	~	~	~	~	<0.5	<0.5
Azobenzene	µg/ l	~	~	~	~	<0.5	<0.5
Bis(2-chloroethoxy)methane	µg/ l	~	~	~	~	<0.5	<0.5
Bis(2-chloroethyl)ether	µg/ l	~	~	~	~	<1	<1
Carbazole	µg/ l	~	~	~	~	<0.5	<0.5
Dibenzofuran	µg/ l	~	~	~	~	<0.5	<0.5
Hexachlorobenzene	µg/ l	~	0.03	~	0.05	<1	<1
Hexachlorobutadiene	µg/ l	~	0.1	~	0.6	<1	<1
Hexachlorocyclopentadiene	µg/ l	~	~	~	~	<1	<1
Hexachloroethane	µg/ l	~	~	~	~	<1	<1
Isophorone	µg/ l	~	~	~	~	<0.5	<0.5
N-nitrosodi-n-propylamine	µg/ l	~	~	~	~	<0.5	<0.5
Nitrobenzene	µg/ l	~	10	~	~	<1	<1
VOCs							
VOCs TICs (trace organics)	µg/l	~	~	~	~	<2	<2
Dichlorodifluoromethane	µg/l	~	~	~	~	<0.1	<0.1
Methyl Tertiary Butyl Ether	µg/l	10	30	~	~	<3	<3
Chloromethane	µg/l	~	~	~	~	<0.1	<0.1
Vinyl Chloride	µg/l	0.375	~	~	~	<1	<1
Bromomethane	µg/l	~	~	~	~	<3	<3
Chloroethane	µg/l	~	~	~	~	<3	<3
Trichlorofluoromethane	µg/l	~	~	~	~	<3	<3
1,1-Dichloroethene	µg/l	~	30	~	~	<5	<5
Dichloromethane	µg/l	~	10	~	20	<3	<3
trans-1-2-Dichloroethene	µg/l	~	~	~	~	<3	<3
1,1-Dichloroethane	µg/l	~	~	~	~	<3	<3
cis-1-2-Dichloroethene	µg/l	~	~	~	~	<1	<1
2,2-Dichloropropane	µg/l	~	~	~	~	<2	<2
Bromochloromethane	µg/l	~	~	~	~	<2	<2
Chloroform	µg/l	75 [4]	12	~	~	<2	<2
1,1,1-Trichloroethane	µg/l	~	500	~	~	<3	<3
1,1-Dichloropropene	µg/l	~	~	~	~	<2	<2
Carbon tetrachloride	µg/l	~	2	~	12	<2	<2
1,2-Dichloroethane	µg/l	2.25	3	3	10	<0.5	<0.5
Benzene	µg/l	0.75	1	1	10	<3	<3
Trichloroethene	µg/l	7.5 [5]	10	10 [7]	~	<2	<2
1,2-Dichloropropane	µg/l	~	~	~	~	<3	<3
Dibromomethane	µg/l	~	~	~	~	<2	<2
Bromodichloromethane	µg/l	75 [4]	~	100 [6]	20	<2	<2
cis-1-3-Dichloropropene	µg/l	~	~	~	~	<5	<5
Toluene	µg/l	525	10	~	10	<2	<2
trans-1-3-Dichloropropene	µg/l	~	~	~	~	<2	<2
1,1,2-Trichloroethane	µg/l	~	~	~	~	<3	<3
Tetrachloroethene	µg/l	7.5 [5]	10	~	~	<2	<2
1,3-Dichloropropane	µg/l	~	~	~	~	<2	<2
Dibromochloromethane	µg/l	75 [4]	~	~	~	<2	<2
1,2-Dibromoethane	µg/l	~	~	~	~	<2	<2
Chlorobenzene	µg/l	~	1	~	~	<2	<2
1,1,1,2-Tetrachloroethane	µg/l	~	~	~	~	<1	<1
Ethylbenzene	µg/l	~	10	~	~	<2	<2
p/m-Xylene	µg/l	~	10 **	~	~	<1	<1
o-Xylene	µg/l	~	10 **	~	10	<2	<2
Styrene	µg/l	~	~	~	10	<2	<2
Bromoform	µg/l	75 [4]	~	~	~	<3	<3
Isopropylbenzene	µg/l	~	~	~	~	<4	<4
1,1,2,2-Tetrachloroethane	µg/l	~	~	~	~	<2	<2
Bromobenzene	µg/l	~	~	~	~	<3	<3
1,2,3-Trichloropropane	µg/l	~	~	~	~	<3	<3
Propylbenzene	µg/l	~	~	~	~	<3	<3
2-Chlorotoluene	µg/l	~	~	~	~	<3	<3
1,3,5-Trimethylbenzene	µg/l	~	~	~	~	<3	<3
4-Chlorotoluene	µg/l	~	~	~	~	<3	<3
tert-Butylbenzene	µg/l	~	~	~	~	<3	<3
1,2,4-Trimethylbenzene	µg/l	~	~	~	~	<3	<3
sec-Butylbenzene	µg/l	~	~	~	~	<3	<3
4-Isopropyltoluene	µg/l	~	~	~	~	<3	<3
1,3-Dichlorobenzene	µg/l	~	~	~	~	<3	<3
1,4-Dichlorobenzene	µg/l	~	~	~	~	<3	<3
n-Butylbenzene	µg/l	~	~	~	~	<3	<3
1,2-Dichlorobenzene	µg/l	~	10	~	~	<2	<2
1,2-Dibromo-3-chloropropane	µg/l	~	~	~	~	<3	<3
1,2,4-Trichlorobenzene	µg/l	~	0.4	~	0.4	<3	<3
Hexachlorobutadiene	µg/l	~	0.1	~	0.6	<2	<2
1,2,3-Trichlorobenzene	µg/l	~	~	~	~	<3	<3

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Notes:
" denotes groundwater regulations are for dissolved metals, used groundwater regulation for total metals for comparison purposes only.
NAC denotes not abnormal colour
# denotes lower value - assessment for the presence of saline/other instrusion; higher value - assessment of the general quality of groundwater in terms of whether its ability to support human uses has been significantly impaired by pollution.
NA denotes Not Applicable.
SS denotes Suspended Solids
** denotes standard is for total xylenes.
- denotes parameter not analysed/ recorded.
1: European Communities Environmental Objectives (Groundwater) Regulations 2010; S.I. No. 9 of 2010. Amendment SI no 149 of 2012, Amendment SI No. 366 of 2016.
2: Environmental Protection Agency (EPA), 2003. Towards Setting Guideline Values for the Protection of Groundwater in Ireland - Interim Report. EPA, Ireland.
3: SI No. 278 of 2007; European communities (Drinking Water) (No. 2) Regulation 2007. SI No. 122 of 2014; European Union (Drinking Water) Regulations 2014[8].
3: Denotes regulation value is for "Total Polycyclic Aromatic Hydrocarbons", sum of 4 (Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(123cd)pyrene & Benzo(ghi)perylene).
4: Denotes regulation value is for "Total Trihalomethanes".
5: Denotes regulation value is for "Total Tetrachloroethene and Trichloroethene".

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Prusselstown, Athy
County Kildare

Table 5: Surface Water Analytical Results

Sample ID		Surface Water Quality Standards	SW1A		SW2A	
Laboratory Report No.		Surface Water Regulations 2009 (SI No. 272 of 2009) as amended (S.I. No. 372 of 2012 and S.I. No. 386 of 2015) - Annual Mean	19-1582	19-7606	19-1582	19-7606
Sample Date			25/04/19	19/05/19	25/04/19	19/05/19
Field Parameters	**Unit**					
Temperature	ºC	~	9.79	9.28	11.06	10.31
Dissolved Oxygen	mg/l	~	9.71	10	10.56	10
Dissolved Oxygen (DO)	%	>=80 <=120	88.24	85.98	98.96	97.84
Oxidation Reduction Potential (ORP)	mV	~	135.08	167.1	172.41	181.78
Electrical Conductivity (EC)	µS/cm	~	685.00	631.00	731.00	641.00
pH	pH units	>=6.0 <=9.0	7.74	7.62	7.86	7.51
Colour	N/A	~	Clear	Clear	Clear	Clear
Odour / Other observations	N/A	~	NEC	NEC	NEC	NEC
Laboratory Parameters						
Sulphate	mg/l	~	29.20	22.60	24.30	22.90
Chloride	mg/l	~	27.40	27.80	26.80	28.10
Fluoride	mg/l	1.5	<0.3	<0.3	<0.3	<0.3
Total Oxidised Nitrogen as N	mg/l	~	9.10	8.80	8.90	8.70
Molybdate Reactive Phosphuros (MRP)	mg/l P	0.025	<0.03	<0.03	<0.03	<0.03
Total Cyanide	µg/l	10	<0.01	<0.01	<0.01	<0.01
Ammoniacal Nitrogen as N	mg/l	0.04	<0.03	0.03	<0.03	<0.03
Total Alkalinity as CaCO3	mg/l	~	274	262	284	270
Total Suspended Solids	mg/l	~	<10	<10	<10	<10
BOD (Settled)	mg/l	High Status <=1.3 mean Good Status<=1.5mean	<1	<1	<1	<1
COD (Settled)	mg/l	~	13	<7	9	<7
Metals (Dissolved)						
Arsenic	µg/l	20	<2.5	<2.5	<2.5	<2.5
Boron	µg/l	~	23	32	21	30
Cadmium	µg/l	0.2	<0.5	<0.5	<0.5	<0.5
Calcium	mg/l	~	104.70	128.30	128.90	123.20
Chromium	µg/l	0.6	<1.5	<1.5	<1.5	<1.5
Copper	µg/l	5	<7	<7	<7	<7
Iron	µg/l	~	<20	<20	<20	<20
Lead	µg/l	1.3	<5	<5	<5	<5
Magnesium	mg/l	~	17.20	16.70	17.70	17.10
Manganese	µg/l	~	<2	2	<2	<2
Mercury	µg/l	0.07	<1	<1	<1	<1
Nickel	µg/l	8.6	<2	<2	<2	<2
Potassium	mg/l	~	2.10	2.10	2.30	2.10
Sodium	mg/l	~	9.20	8.90	9.50	9.10
Zinc	µg/l	40	<3	<3	<3	<3
Dibutyltin	µg/l	~	<0.1	<0.1	<0.1	<0.1
Tributyltin	µg/l	0.0002	<0.1	<0.1	<0.1	<0.1
Triphenyltin	µg/l	~	<0.1	<0.1	<0.1	<0.1
TPH CWG						
Aliphatics						
>C5-C6	ug/l	~	<10	<10	<10	<10
>C6-C8	ug/l	~	<10	<10	<10	<10
>C8-C10	ug/l	~	<10	<10	<10	<10
>C10-C12	ug/l	~	<5	<5	<5	<5
>C12-C16	ug/l	~	<10	<10	<10	<10
>C16-C21	ug/l	~	<10	<10	<10	<10
>C21-C35	ug/l	~	<10	<10	<10	<10
Total aliphatics C5-35	ug/l	~	<10	<10	<10	<10
Aromatics						
>C5-EC7	ug/l	~	<10	<10	<10	<10
>EC7-EC8	ug/l	~	<10	<10	<10	<10
>EC8-EC10	ug/l	~	<10	<10	<10	<10
>EC10-EC12	ug/l	~	<5	<5	<5	<5
>EC12-EC16	ug/l	~	<10	<10	<10	<10
>EC16-EC21	ug/l	~	<10	<10	<10	<10
>EC21-EC35	ug/l	~	<10	<10	<10	<10
Total aromatics C5-35	ug/l	~	<10	<10	<10	<10
Total aliphatics and aromatics(C5-35)	ug/l	~	<10	<10	<10	<10
GRO (>C4-C8)	ug/l	~	<10	<10	<10	<10
GRO (>C8-C12)	ug/l	~	<10	<10	<10	<10
GRO (>C4-C12)	ug/l	~	<10	<10	<10	<10
Methyl Tertiary Butyl Ether	ug/l	~	<0.1	<0.1	<0.1	<0.1
Benzene	ug/l	8	<0.5	<0.5	<0.5	<0.5
Toluene	ug/l	10	<5	<5	<5	<5
Ethylbenzene	ug/l	~	<1	<1	<1	<1
m/p-Xylene	ug/l	10	<2	<2	<2	<2
o-Xylene	ug/l	10	<1	<1	<1	<1
EPH (C8-C40)	ug/l	~	<10	<10	<10	<10
C8-C40 Mineral Oil (Calculation)	ug/l	~	<10	<10	<10	<10
Pesticides						
Organochlorine Pesticides						
Aldrin	ug/l	Σ=0.005	<0.01	<0.01	<0.01	<0.01
Alpha-HCH (BHC)	ug/l	~	<0.01	<0.01	<0.01	<0.01
Beta-HCH (BHC)	ug/l	~	<0.01	<0.01	<0.01	<0.01
Chlorothalonil		~	<2.50	<2.50	<2.50	<2.50
cis-Chlordane		~	<0.01	<0.01	<0.01	<0.01
Delta-HCH (BHC)	ug/l	~	<0.01	<0.01	<0.01	<0.01
Dieldrin	ug/l	Σ=0.005	<0.01	<0.01	<0.01	<0.01
Endosulphan I	ug/l	~	<0.01	<0.01	<0.01	<0.01
Endosulphan II	ug/l	~	<0.01	<0.01	<0.01	<0.01
Endosulphan sulphate	ug/l	~	<0.01	<0.01	<0.01	<0.01
Endrin	ug/l	Σ=0.005	<0.01	<0.01	<0.01	<0.01
Gamma-HCH (BHC)	ug/l	~	<0.01	<0.01	<0.01	<0.01
Heptachlor	ug/l	1×10^{-8}	<0.01	<0.01	<0.01	<0.01
Heptachlor Epoxide	ug/l	~	<0.01	<0.01	<0.01	<0.01
Hexachlorobenzene	ug/l	0.05	<0.01	<0.01	<0.01	<0.01
Isodrin	ug/l	Σ=0.005	<0.01	<0.01	<0.01	<0.01
o,p'-DDE	ug/l	~	<0.01	<0.01	<0.01	<0.01
o,p'-DDT	ug/l	~	<0.01	<0.01	<0.01	<0.01
o,p'-Methoxychlor	ug/l	~	<0.01	<0.01	<0.01	<0.01
o,p'-TDE	ug/l	~	<0.01	<0.01	<0.01	<0.01
p,p'-DDE	ug/l	~	<0.01	<0.01	<0.01	<0.01
p,p'-DDT	ug/l	0.01	<0.01	<0.01	<0.01	<0.01
p,p'-Methoxychlor	ug/l	~	<0.01	<0.01	<0.01	<0.01
p,p'-TDE	ug/l	~	<0.01	<0.01	<0.01	<0.01
Pendimethalin	ug/l	~	<0.01	<0.01	<0.01	<0.01
Permethrin I	ug/l	~	<0.01	<0.01	<0.01	<0.01
Permethrin II	ug/l	~	<0.01	<0.01	<0.01	<0.01
Quintozene (PCNB)	ug/l	~	<0.01	<0.01	<0.01	<0.01
Tecnazene	ug/l	~	<0.01	<0.01	<0.01	<0.01
Telodrin	ug/l	~	<0.01	<0.01	<0.01	<0.01
trans-Chlordane	ug/l	~	<0.01	<0.01	<0.01	<0.01
Triadimefon	ug/l	~	<0.01	<0.01	<0.01	<0.01
Triallate	ug/l	~	<0.01	<0.01	<0.01	<0.01
Trifluralin	ug/l	~	<0.01	<0.01	<0.01	<0.01
Benazolin	ug/l	~	<0.1	<0.1	<0.1	<0.1
Bentazone	ug/l	~	<0.1	<0.1	<0.1	<0.1
Bromoxynil	ug/l	~	<0.1	<0.1	<0.1	<0.1
Clopyralid	ug/l	~	<0.1	<0.1	<0.1	<0.1
4 - CPA	ug/l	~	<0.1	<0.1	<0.1	<0.1
2,4 - D	ug/l	~	<0.1	<0.1	<0.1	<0.1
2,4 - DB	ug/l	~	<0.1	<0.1	<0.1	<0.1
Dicamba	ug/l	~	<0.1	<0.1	<0.1	<0.1
Dichloroprop	ug/l	~	<0.1	<0.1	<0.1	<0.1
Diclofop	ug/l	~	<0.1	<0.1	<0.1	<0.1
Fenoprop	ug/l	~	<0.1	<0.1	<0.1	<0.1
Flamprop	ug/l	~	<0.1	<0.1	<0.1	<0.1
Flamprop – isopropyl	ug/l	~	<0.1	<0.1	<0.1	<0.1
Ioxynil	ug/l	~	<0.1	<0.1	<0.1	<0.1
MCPA	ug/l	~	<0.1	<0.1	<0.1	<0.1
MCPB	ug/l	~	<0.1	<0.1	<0.1	<0.1
Mecoprop	ug/l	~	<0.1	<0.1	<0.1	<0.1
Picloram	ug/l	~	<0.1	<0.1	<0.1	<0.1
Pentachlorophenol	ug/l	0.4	<0.1	<0.1	<0.1	<0.1
2,4,5 - T	ug/l	~	<0.1	<0.1	<0.1	<0.1
2,3,6 - TBA	ug/l	~	<0.1	<0.1	<0.1	<0.1
Triclopyr	ug/l	~	<0.1	<0.1	<0.1	<0.1
Organophosphorus Pesticides						
Azinphos ethyl	ug/l	~	<0.01	<0.01	<0.01	<0.01
Azinphos methyl	ug/l	~	<0.01	<0.01	<0.01	<0.01
Carbophenothion	ug/l	~	<0.01	<0.01	<0.01	<0.01
Chlorfenvinphos	ug/l	0.1	<0.01	<0.01	<0.01	<0.01
Chlorpyrifos	ug/l	0.03	<0.01	<0.01	<0.01	<0.01
Chlorpyrifos-methyl	ug/l		<0.01	<0.01	<0.01	<0.01
Diazinon	ug/l	0.01	<0.01	<0.01	<0.01	<0.01
Dichlorvos	ug/l	0.00006	<0.01	<0.01	<0.01	<0.01
Disulfoton	ug/l	~	<0.01	<0.01	<0.01	<0.01
Dimethoate	ug/l	0.8	<0.01	<0.01	<0.01	<0.01
Ethion	ug/l	~	<0.01	<0.01	<0.01	<0.01
Ethyl Parathion (Parathion)	ug/l	~	<0.01	<0.01	<0.01	<0.01
Etrimphos	ug/l	~	<0.01	<0.01	<0.01	<0.01
Fenitrothion	ug/l	~	<0.01	<0.01	<0.01	<0.01
Fenthion	ug/l	~	<0.01	<0.01	<0.01	<0.01
Malathion	ug/l	~	<0.01	<0.01	<0.01	<0.01
Methyl Parathion	ug/l	~	<0.01	<0.01	<0.01	<0.01
Mevinphos	ug/l	~	<0.01	<0.01	<0.01	<0.01
Phosalone	ug/l	~	<0.01	<0.01	<0.01	<0.01
Pirimiphos Methyl	ug/l	~	<0.01	<0.01	<0.01	<0.01
Propetamphos	ug/l	~	<0.01	<0.01	<0.01	<0.01
Triazophos	ug/l	~	<0.01	<0.01	<0.01	<0.01
Atrazine	µg/l	0.6	<0.01	<0.01	<0.01	<0.01
Simazine	µg/l	1	<0.01	<0.01	<0.01	<0.01

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Table 5: Surface Water Analytical Results

Sample ID		Surface Water Quality Standards	SW1A		SW2A	
Laboratory Report No.		Surface Water Regulations 2009 (SI No. 272 of 2009) as amended (S.I. No. 372 of 2012 and S.I. No. 386 of 2015) - Annual Mean	19-1582	19-7606	19-1582	19-7606
Sample Date			25/04/19	19/05/19	25/04/19	19/05/19
Semi-Volatile Organic Compounds (SVOC's)						
Phenols						
2-Chlorophenol	µg/ l	~	<1	<1	<1	<1
2-Methylphenol	µg/ l	~	<0.5	<0.5	<0.5	<0.5
2-Nitrophenol	µg/ l	~	<0.5	<0.5	<0.5	<0.5
2,4-Dichlorophenol	µg/ l	~	<0.5	<0.5	<0.5	<0.5
2,4-Dimethylphenol	µg/ l	~	<1	<1	<1	<1
2,4,5-Trichlorophenol	µg/ l	~	<0.5	<0.5	<0.5	<0.5
2,4,6-Trichlorophenol	µg/ l	~	<1	<1	<1	<1
4-Chloro-3-methylphenol	µg/ l	~	<0.5	<0.5	<0.5	<0.5
4-Methylphenol	µg/ l	~	<1	<1	<1	<1
4-Nitrophenol	µg/ l	~	<10	<10	<10	<10
Pentachlorophenol	µg/ l	0.4	<1	<1	<1	<1
Phenol	µg/ l	8	<1	<1	<1	<1
PAHs						
2-Chloronaphthalene	µg/ l	~	<1	<1	<1	<1
2-Methylnaphthalene	µg/ l	~	<1	<1	<1	<1
Naphthalene	µg/ l	2	<1	<1	<1	<1
Acenaphthylene	µg/ l	~	<0.5	<0.5	<0.5	<0.5
Acenaphthene	µg/ l	~	<1	<1	<1	<1
Fluorene	µg/ l	~	<0.5	<0.5	<0.5	<0.5
Phenanthrene	µg/ l	~	<0.5	<0.5	<0.5	<0.5
Anthracene	µg/ l	0.1	<0.5	<0.5	<0.5	<0.5
Fluoranthene	µg/ l	0.0063	<0.5	<0.5	<0.5	<0.5
Pyrene	µg/ l	~	<0.5	<0.5	<0.5	<0.5
Benz(a)anthracene	µg/ l	~	<0.5	<0.5	<0.5	<0.5
Chrysene	µg/ l	~	<0.5	<0.5	<0.5	<0.5
Benzo(bk)fluoranthene	µg/ l	0.03	<1	<1	<1	<1
Benzo(a)pyrene	µg/ l	0.00017	<1	<1	<1	<1
Indeno(123cd)pyrene	µg/ l	0.002	<1	<1	<1	<1
Dibenzo(ah)anthracene	µg/ l	~	<0.5	<0.5	<0.5	<0.5
Benzo(ghi)perylene	µg/ l	0.002	<0.5	<0.5	<0.5	<0.5
Phthalates						
Bis(2-ethylhexyl) phthalate	µg/ l	1.3	<5	<5	<5	<5
Butylbenzyl phthalate	µg/ l	~	<1	<1	<1	<1
Di-n-butyl phthalate	µg/ l	~	<1.5	<1.5	<1.5	<1.5
Di-n-Octyl phthalate	µg/ l	~	<1	<1	<1	<1
Diethyl phthalate	µg/ l	~	<1	<1	<1	<1
Dimethyl phthalate	µg/ l	~	<1	<1	<1	<1
Additional SVOCs						
SVOC TICs (trace organics)	µg/l	~				
1,2-Dichlorobenzene	µg/ l	~	<1	<1	<1	<1
1,2,4-Trichlorobenzene	µg/ l	0.4	<1	<1	<1	<1
1,3-Dichlorobenzene	µg/ l	~	<1	<1	<1	<1
1,4-Dichlorobenzene	µg/ l	~	<1	<1	<1	<1
2-Nitroaniline	µg/ l	~	<1	<1	<1	<1
2,4-Dinitrotoluene	µg/ l	~	<0.5	<0.5	<0.5	<0.5
2,6-Dinitrotoluene	µg/ l	~	<1	<1	<1	<1
3-Nitroaniline	µg/ l	~	<1	<1	<1	<1
4-Bromophenylphenylether	µg/ l	~	<1	<1	<1	<1
4-Chloroaniline	µg/ l	~	<1	<1	<1	<1
4-Chlorophenylphenylether	µg/ l	~	<1	<1	<1	<1
4-Nitroaniline	µg/ l	~	<0.5	<0.5	<0.5	<0.5
Azobenzene	µg/ l	~	<0.5	<0.5	<0.5	<0.5
Bis(2-chloroethoxy)methane	µg/ l	~	<0.5	<0.5	<0.5	<0.5
Bis(2-chloroethyl)ether	µg/ l	~	<1	<1	<1	<1
Carbazole	µg/ l	~	<0.5	<0.5	<0.5	<0.5
Dibenzofuran	µg/ l	~	<0.5	<0.5	<0.5	<0.5
Hexachlorobenzene	µg/ l	0.05	<1	<1	<1	<1
Hexachlorobutadiene	µg/ l	0.6	<1	<1	<1	<1
Hexachlorocyclopentadiene	µg/ l	~	<1	<1	<1	<1
Hexachloroethane	µg/ l	~	<1	<1	<1	<1
Isophorone	µg/ l	~	<0.5	<0.5	<0.5	<0.5
N-nitrosodi-n-propylamine	µg/ l	~	<0.5	<0.5	<0.5	<0.5
Nitrobenzene	µg/ l	~	<1	<1	<1	<1
VOCs						
VOCs TICs (trace organics)	µg/l	~	<2	<2	<2	<2
Dichlorodifluoromethane	µg/l	~	<0.1	<0.1	<0.1	<0.1
Methyl Tertiary Butyl Ether	µg/l	~	<3	<3	<3	<3
Chloromethane	µg/l	~	<0.1	<0.1	<0.1	<0.1
Vinyl Chloride	µg/l	~	<1	<1	<1	<1
Bromomethane	µg/l	~	<3	<3	<3	<3
Chloroethane	µg/l	~	<3	<3	<3	<3
Trichlorofluoromethane	µg/l	~	<3	<3	<3	<3
1,1-Dichloroethene	µg/l	~	<5	<5	<5	<5
Dichloromethane	µg/l	20	<3	<3	<3	<3
trans-1-2-Dichloroethene	µg/l	~	<3	<3	<3	<3
1,1-Dichloroethane	µg/l	~	<3	<3	<3	<3
cis-1-2-Dichloroethene	µg/l	~	<1	<1	<1	<1
2,2-Dichloropropane	µg/l	~	<2	<2	<2	<2
Bromochloromethane	µg/l	~	<2	<2	<2	<2
Chloroform	µg/l	~	<2	<2	<2	<2
1,1,1-Trichloroethane	µg/l	~	<3	<3	<3	<3
1,1-Dichloropropene	µg/l	~	<2	<2	<2	<2
Carbon tetrachloride	µg/l	12	<2	<2	<2	<2
1,2-Dichloroethane	µg/l	10	<0.5	<0.5	<0.5	<0.5
Benzene	µg/l	10	<3	<3	<3	<3
Trichloroethene	µg/l	~	<2	<2	<2	<2
1,2-Dichloropropane	µg/l	~	<3	<3	<3	<3
Dibromomethane	µg/l	~	<2	<2	<2	<2
Bromodichloromethane	µg/l	20	<2	<2	<2	<2
cis-1-3-Dichloropropene	µg/l	~	<5	<5	<5	<5
Toluene	µg/l	10	<2	<2	<2	<2
trans-1-3-Dichloropropene	µg/l	~	<2	<2	<2	<2
1,1,2-Trichloroethane	µg/l	~	<3	<3	<3	<3
Tetrachloroethene	µg/l	~	<2	<2	<2	<2
1,3-Dichloropropane	µg/l	~	<2	<2	<2	<2
Dibromochloromethane	µg/l	~	<2	<2	<2	<2
1,2-Dibromoethane	µg/l	~	<2	<2	<2	<2
Chlorobenzene	µg/l	~	<2	<2	<2	<2
1,1,1,2-Tetrachloroethane	µg/l	~	<1	<1	<1	<1
Ethylbenzene	µg/l	~	<2	<2	<2	<2
p/m-Xylene	µg/l	10	<1	<1	<1	<1
o-Xylene	µg/l	10	<2	<2	<2	<2
Styrene	µg/l	~	<2	<2	<2	<2
Bromoform	µg/l	~	<3	<3	<3	<3
Isopropylbenzene	µg/l	~	<4	<4	<4	<4
1,1,2,2-Tetrachloroethane	µg/l	~	<2	<2	<2	<2
Bromobenzene	µg/l	~	<3	<3	<3	<3
1,2,3-Trichloropropane	µg/l	~	<3	<3	<3	<3
Propylbenzene	µg/l	~	<3	<3	<3	<3
2-Chlorotoluene	µg/l	~	<3	<3	<3	<3
1,3,5-Trimethylbenzene	µg/l	~	<3	<3	<3	<3
4-Chlorotoluene	µg/l	~	<3	<3	<3	<3
tert-Butylbenzene	µg/l	~	<3	<3	<3	<3
1,2,4-Trimethylbenzene	µg/l	~	<3	<3	<3	<3
sec-Butylbenzene	µg/l	~	<3	<3	<3	<3
4-Isopropyltoluene	µg/l	~	<3	<3	<3	<3
1,3-Dichlorobenzene	µg/l	~	<3	<3	<3	<3
1,4-Dichlorobenzene	µg/l	~	<3	<3	<3	<3
n-Butylbenzene	µg/l	~	<3	<3	<3	<3
1,2-Dichlorobenzene	µg/l	~	<2	<2	<2	<2
1,2-Dibromo-3-chloropropane	µg/l	~	<3	<3	<3	<3
1,2,4-Trichlorobenzene	µg/l	0.4	<3	<3	<3	<3
Hexachlorobutadiene	µg/l	0.6	<2	<2	<2	<2
1,2,3-Trichlorobenzene	µg/l	~	<3	<3	<3	<3

Notes:

" denotes groundwater regulations are for dissolved metals, used groundwater regulation for total metals for comparison purposes only.

NAC denotes not abnormal colour

# denotes lower value - assessment for the presence of saline/other instrusion; higher value - assessment of the general quality of groundwater in terms of whether its ability to support human uses has been significantly impaired by pollution.

NA denotes Not Applicable.

SS denotes Suspended Solids

** denotes standard is for total xylenes.

- denotes parameter not analysed/ recorded.

1: European Communities Environmental Objectives (Groundwater) Regulations 2010; S.I. No. 9 of 2010. Amendment SI no 149 of 2012, Amendment SI No. 366 of 2016.

2: Environmental Protection Agency (EPA), 2003. Towards Setting Guideline Values for the Protection of Groundwater in Ireland - Interim Report. EPA, Ireland.

3: SI No. 278 of 2007; European communities (Drinking Water) (No. 2) Regulation 2007. SI No. 122 of 2014; European Union (Drinking Water) Regulations 2014[8]

3: Denotes regulation value is for "Total Polycyclic Aromatic Hydrocarbons", sum of 4 (Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(123cd)pyrene & Benzo(ghi)perylene).

4: Denotes regulation value is for "Total Trihalomethanes".

5: Denotes regulation value is for "Total Tetrachloroethene and Trichloroethene".

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Prusselstown, Athy
County Kildare

Table 6: Landfill Gas Monitoring Results

Monitoring Well I.D.	Monitoring Event	Monitoring Date	Monitoring Time (24 hr)	Flow Measurement	Stable Methane (CH_4)	Carbon Dioxide (CO_2)	Oxygen (O_2)	Balance	LEL	Peak Methane (CH_4)	Atmospheric Pressure	Relative Pressure	Carbon Monoxide (CO)	Hydrogen Sulphide (H_2S)
			Units	l/h	%	%	%	%	%	%	mb	mb	ppm	ppm
L1A	M1	25/04/2019	-	0.0	**4.5**	**12.5**	0.4	82.6	89.0	**4.5**	985	61.95	0.0	0.0
	M2	09/05/2019	-	0.0	**6.0**	**8.8**	6.8	78.3	>>>	**6.1**	993	62.03	1.0	0.0
	M3	29/05/2019	09:05	0.0	**4.8**	**10.3**	5.4	79.6	96.0	**4.8**	1005	62.17	1.0	0.0
L2A	M1	25/04/2019	-	0.0	0.1	**2.7**	16.0	81.2	1.0	0.1	984	61.76	0.0	0.0
	M2	09/05/2019	-	0.0	0.1	**1.5**	19.6	78.7	2.0	0.1	993	62.00	1.0	0.0
	M3	29/05/2019	08:23	0.0	0.3	7.9	0.6	91.1	7.0	0.4	1005	61.85	0.0	0.0
L3A	M1	25/04/2019	-	-0.1	0.1	**2.6**	18.2	79.1	2.0	0.1	985	61.88	0.0	0.0
	M2	09/05/2019	-	0.0	0.1	1.1	20.7	78.1	2.0	0.1	993	62.04	0.0	0.0
	M3	29/05/2019	08:52	0.0	**1.4**	**9.2**	1.6	88.0	20.0	**1.4**	1005	62.00	1.0	0.0
GW1A	M1	25/04/2019	-	0.0	0.1	0.1	22.8	79.0	1.0	0.1	985	61.79	0.0	0.0
	M2	09/05/2019	-	0.0	0.1	0.1	21.1	78.7	2.0	0.1	993	62.00	1.0	0.0
	M3	29/05/2019	08:15	0.0	0.0	0.4	20.7	78.9	0.0	0.1	1005	61.85	0.0	0.0
GW2A	M1	25/04/2019	-	-0.1	0.0	**3.8**	15.0	81.2	0.0	0.0	985	61.87	0.0	0.0
	M2	09/05/2019	-	0.0	0.1	0.1	21.2	78.6	2.0	0.1	993	61.90	1.0	0.0
	M3	29/05/2019	08:38	0.0	0.0	**1.6**	18.7	79.7	0.0	0.0	1005	61.85	0.0	0.0
GW3A	M1	25/04/2019	-	0.0	0.0	1.1	19.1	79.8	0.0	0.1	985	61.95	0.0	0.0
	M2	09/05/2019	-	0.0	0.1	**4.6**	12	83.3	2.0	0.1	994	62.50	1.0	0.0
	M3	29/05/2019	09:14	0.0	0.1	0.9	19.0	79.9	1.0	0.1	1005	62.04	0.0	0.0
EPA 1997 Thresholds[1]				~	**1.0**	**1.5**	~	~	~	**1.0**	~	~	~	~

Notes:
LEL denotes Lower Explosive Limit (expressed as percentage of 5% v/v methane).
- denotes not measurement
>>> denotes exceeds the LEL.
~ denotes no threshold available.
Bold denotes level exceeds EPA threshold.
1: Environmental Protection Agency (EPA) 1997: Landfill Manuals - Landfill operational Practices. EPA, Ireland.

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DRAWINGS

EPA Export 23-10-2020:06:42:37

N
W
E
S

Legend

- Site Location

Subsoils

- Alluvium
- Cut peat
- Fen peat
- Glaciofluvial sands & gravels
- Karstified limestone at surface
- Lake sediments
- Made Ground
- Limestone Tills

TLs
Made
A
GLs
L
KaRck
FenPt

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0 500 1000 m

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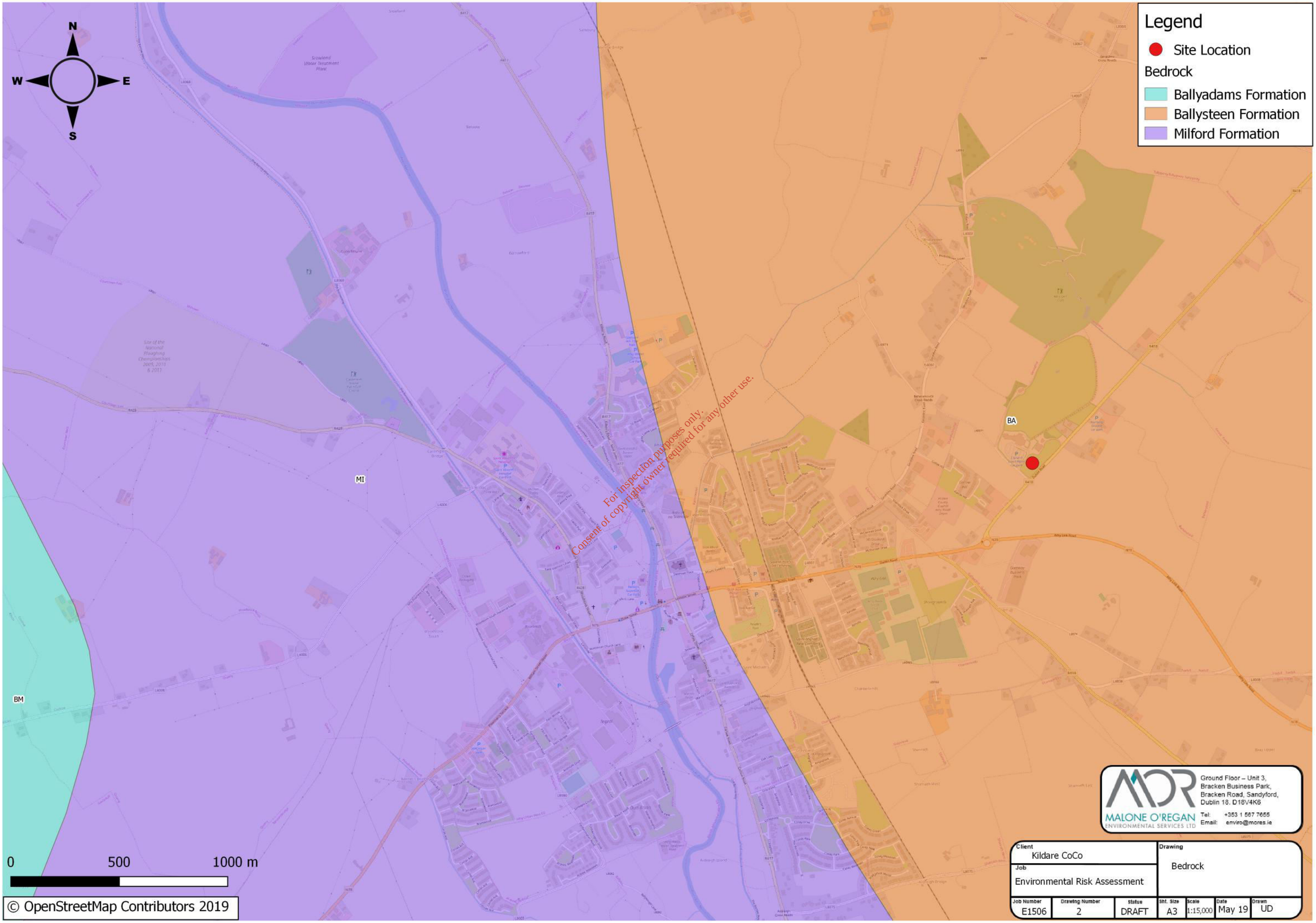
Client: Kildare CoCo			Drawing: Subsoils			
Job: Environmental Risk Assessment						
Job Number: E1506	Drawing Number: 1	Status: DRAFT	Sht. Size: A3	Scale: 1:15,000	Date: May 19	Drawn: UD

EPA Export 23-10-2020:06:42:37



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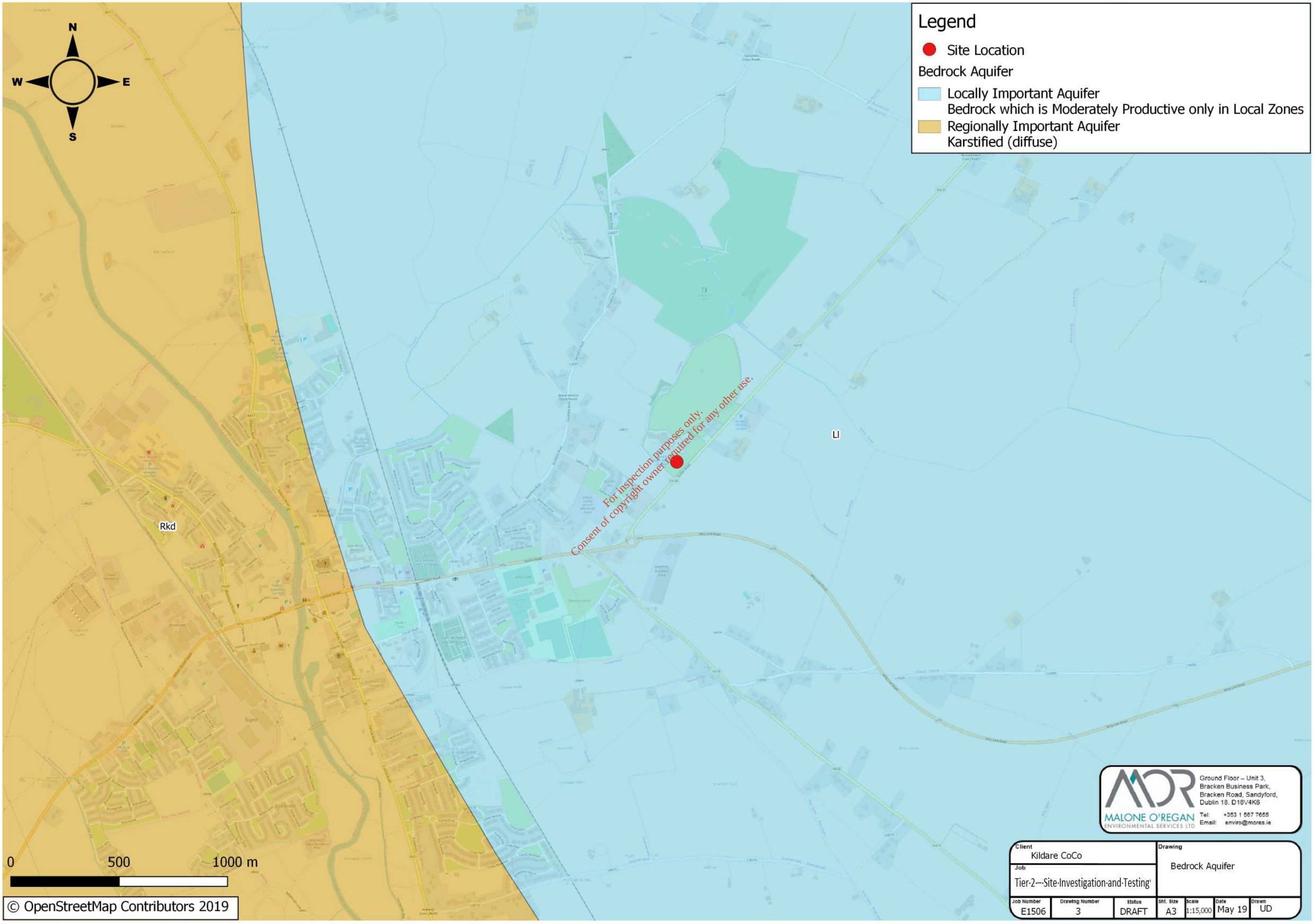

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N
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Legend
Site Location
Sand & Gravel Aquifer
Regionally Important

Rg

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Client	Drawing
Kildare CoCo	Sand and Gravel Aquifer
Job: Environmental Risk Assessment	

Job Number	Drawing Number	Status	Sht. Size	Scale	Date	Drawn
E1506	4	DRAFT	A3	1:15,000	May 19	UD

EPA Export 23-10-2020:06:42:37

N
W
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S

Legend

Site Location

Groundwater Vulnerability

Extreme

High

Moderate

H

E

M

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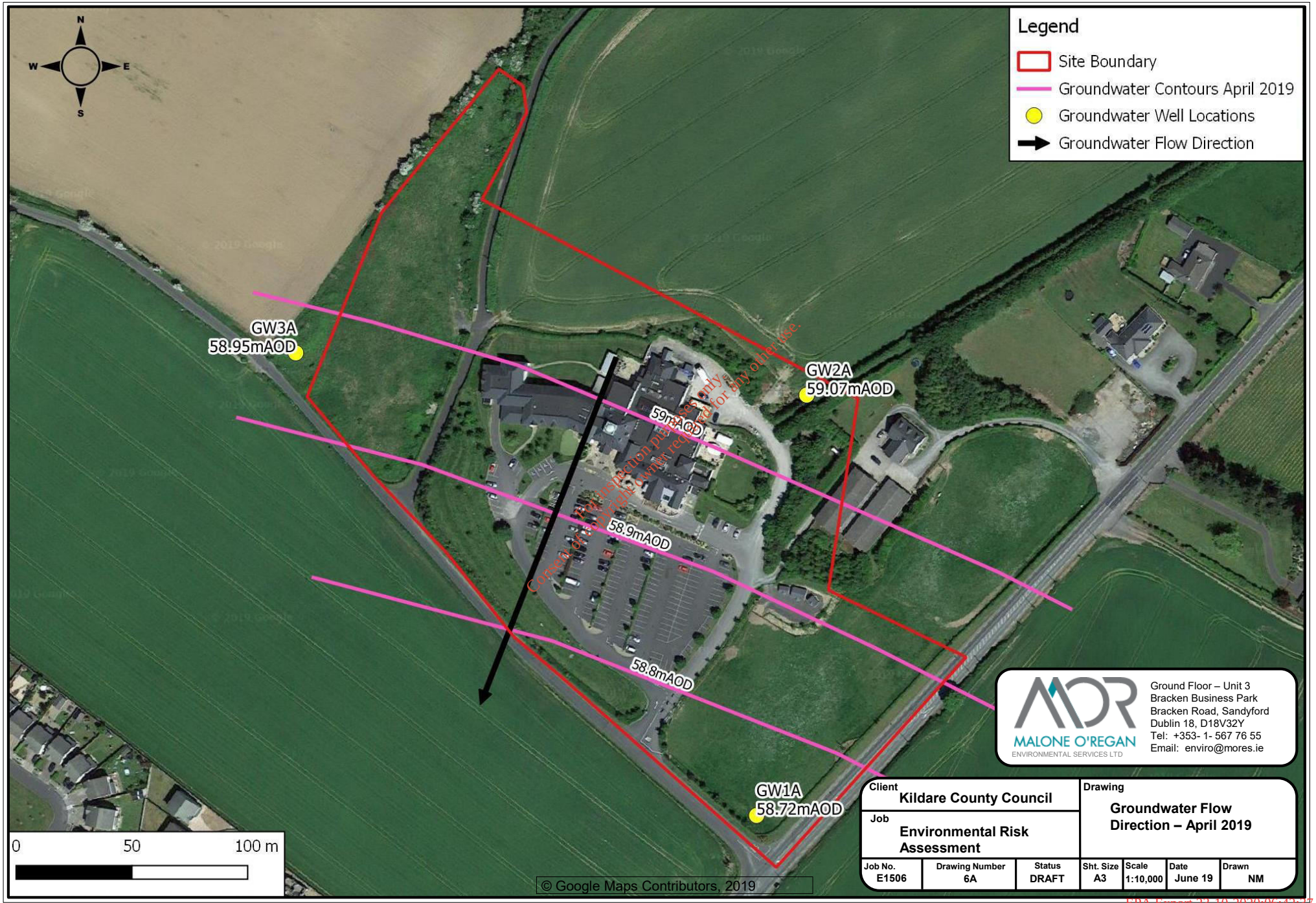
Client	Drawing
Kildare CoCo	Groundwater Vulnerability
Job: Environmental Risk Assessment	

Job Number	Drawing Number	Status	Sht. Size	Scale	Date	Drawn
E1506	5	DRAFT	A3	1:15,000	May 19	UD

EPA Export 23-10-2020:06:42:37



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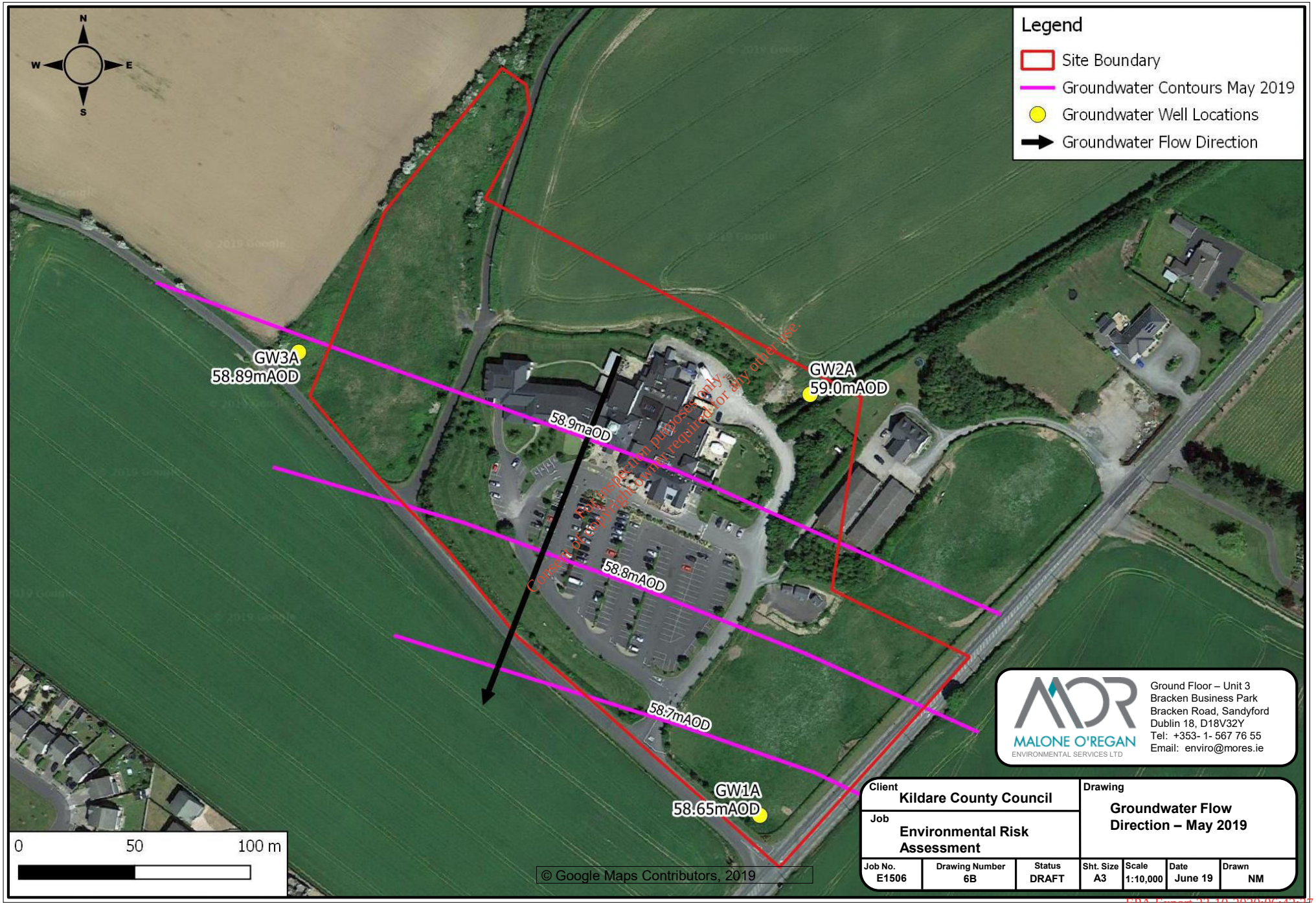
Client: Kildare County Council			Drawing: Groundwater Flow Direction – April 2019			
Job: Environmental Risk Assessment						
Job No. E1506	Drawing Number 6A	Status DRAFT	Sht. Size A3	Scale 1:10,000	Date June 19	Drawn NM

EPA Export 23-10-2020:06:42:37



EPA Export 23-10-2020:06:42:37

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Legend

- Site Location
- 2km Buffer

Groundwater Wells

- Agri & domestic use
- Domestic use only
- Industrial use
- Other
- Public supply (Co Co)
- Unknown

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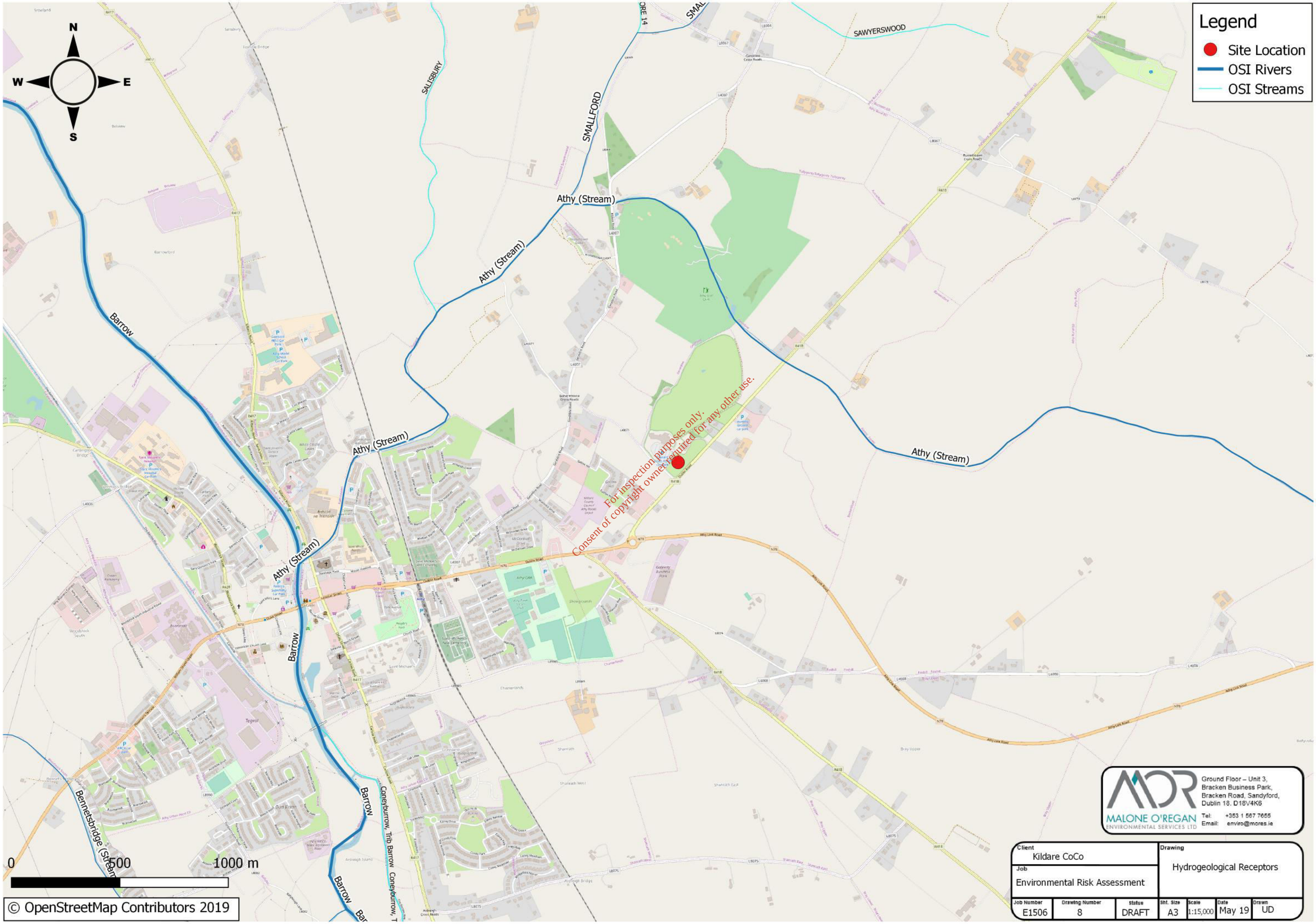
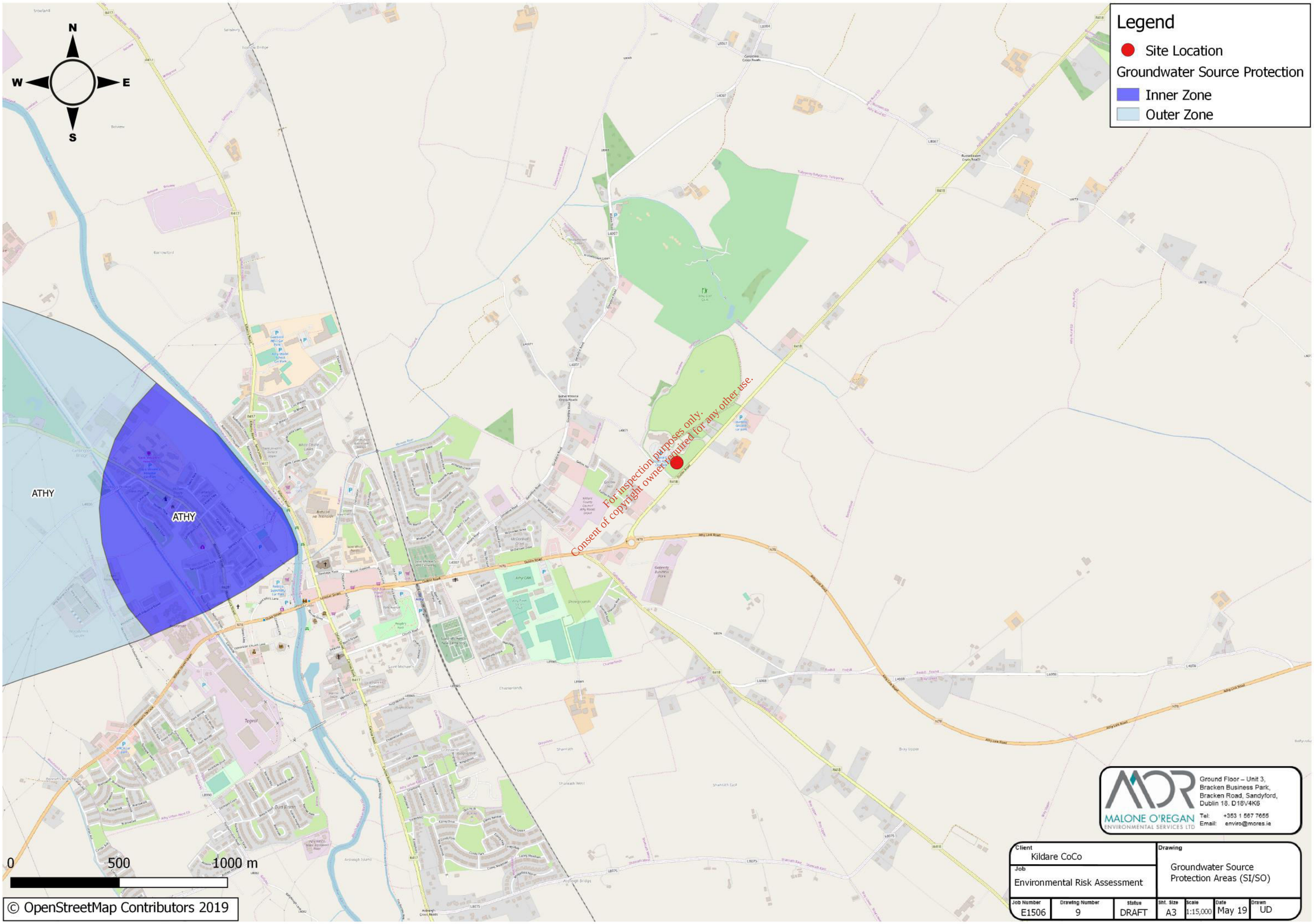
Client	Drawing
Kildare CoCo	Groundwater Wells within 2km of the Site
Job: Environmental Risk Assessment	

Job Number	Drawing Number	Status	Sht. Size	Scale	Date	Drawn
E1506	7	DRAFT	A3	1:15,000	May 19	UD



EPA Export 23-10-2020:06:42:37



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Client: Kildare CoCo			Drawing: Groundwater Source Protection Areas (SI/SO)				
Job: Environmental Risk Assessment							
Job Number	Drawing Number	Status	Sht. Size	Scale	Date	Drawn	
E1506	9	DRAFT	A3	1:15,000	May 19	UD	

EPA Export 23-10-2020:06:42:37

N
W
E
S

Legend
- Site Location
- 2km Buffer
- Special Area of Conservation

River Barrow And River Nore SAC

0 500 1000 m

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Client	Drawing
Kildare CoCo	Special Areas of Conservation
Job: Environmental Risk Assessment	

Job Number	Drawing Number	Status	Sht. Size	Scale	Date	Drawn
E1506	10	DRAFT	A3	1:15,000	May 19	UD

EPA Export 23-10-2020:06:42:37

N
W
E
S

anal

Grand Canal

Barrow Valley At Tankardstown Bridge

Legend

- Site Location
- 5km Buffer
- Proposed Natural Heritage Area

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Client	Drawing
Kildare CoCo	Proposed Natural Heritage Area
Job: Environmental Risk Assessment	

Job Number	Drawing Number	Status	Sht. Size	Scale	Date	Drawn
E1506	11	DRAFT	A3	1:40,000	May 19	UD

EPA Export 23-10-2020:06:42:38

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Client	Drawing
Kildare County Council	Trial Pit Locations
Job Environmental Risk Assessment	

Job No.	Drawing Number	Status	Sht. Size	Scale	Date	Drawn
E1506	12	DRAFT	A3	1:10,000	June 19	NM

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Client	Drawing
Kildare County Council	Leachate / Gas Well Locations
Job Environmental Risk Assessment	

Job No.	Drawing Number	Status	Sht. Size	Scale	Date	Drawn
E1506	13	DRAFT	A3	1:10,000	June 19	NM

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Bracken Business Park
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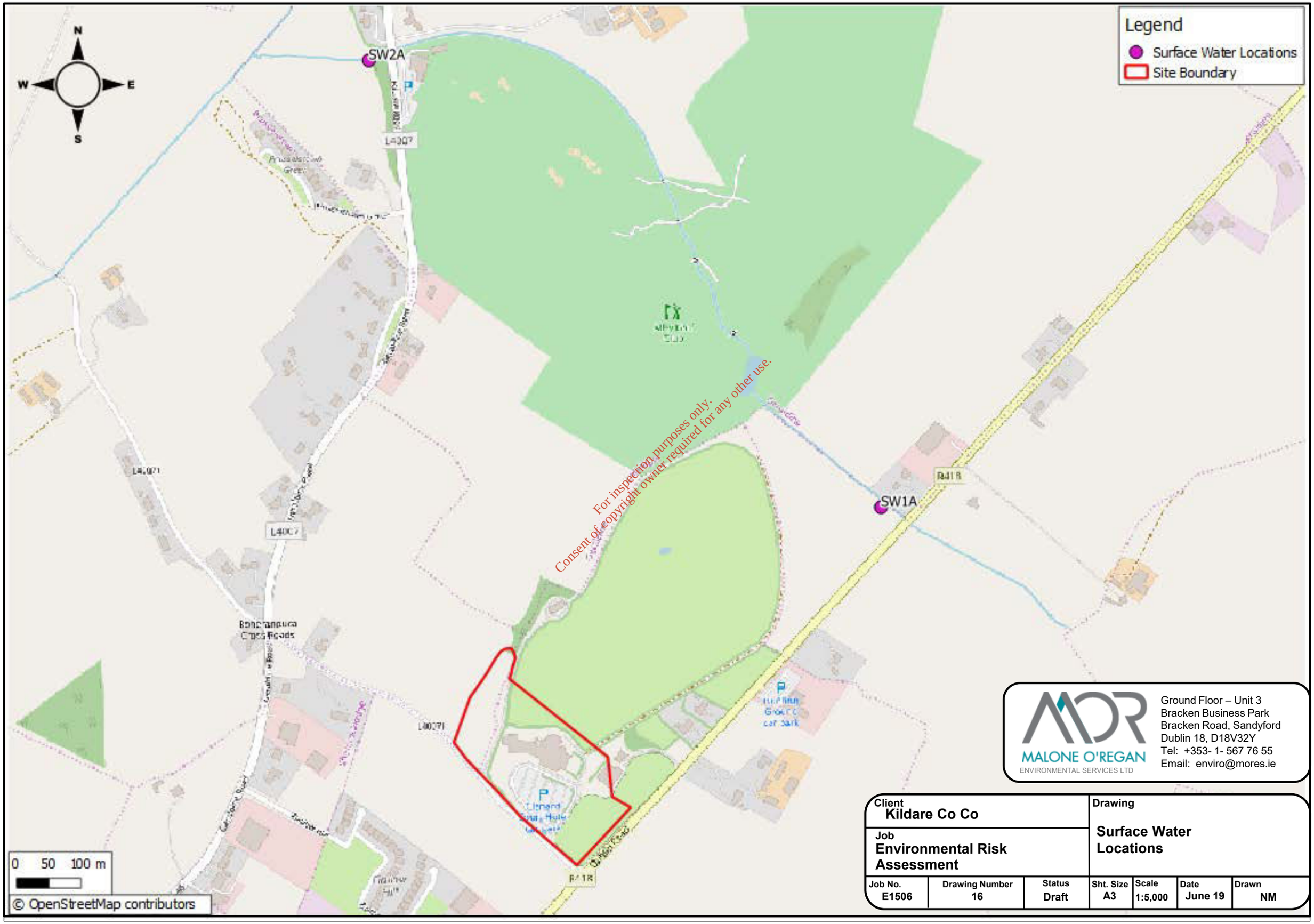
Tel: +353- 1- 567 76 55
Email: enviro@mores.ie

Client: Kildare County Council			Drawing: Ground Well Locations			
Job: Environmental Risk Assessment						
Job No. E1506	Drawing Number 14	Status DRAFT	Sht. Size A3	Scale 1:10,000	Date June 19	Drawn NM

EPA Export 23-10-2020:06:42:38

EPA Export 23-10-2020:06:42:38



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Client	Drawing
Kildare Co Co	Surface Water Locations
Job Environmental Risk Assessment	

Job No.	Drawing Number	Status	Sht. Size	Scale	Date	Drawn
E1506	16	Draft	A3	1:5,000	June 19	NM

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Client: Kildare County Council			Drawing: Surface VOC Survey Locations			
Job: Environmental Risk Assessment						
Job No. E1506	Drawing Number 17	Status DRAFT	Sht. Size A3	Scale 1:10,000	Date June 19	Drawn NM

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Client	Drawing
Kildare County Council	Approximate Extent of the Waste
Job	
Environmental Risk Assessment	

Job No.	Drawing Number	Status	Sht. Size	Scale	Date	Drawn
E1506	18	DRAFT	A3	1:10,000	June 19	NM

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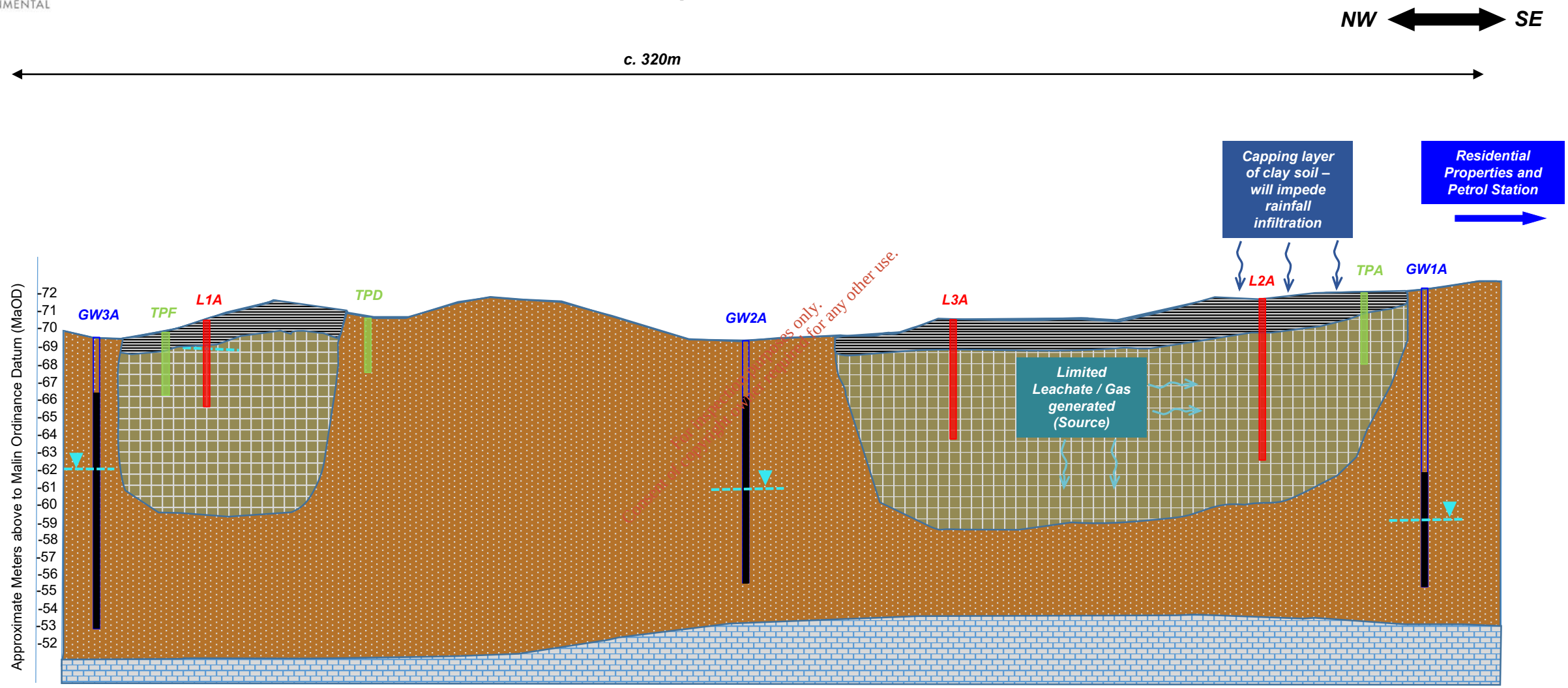
Prusselstown Site, Athy, Co. Kildare – Conceptual Site Model



Drawing No. 19

EPA Export 23-10-2020:06:42:38