# Kerdiffstown Landfill Remediation Project

Annual Environmental Report 2021

IEL: P1063-01

Kildare County Council
Comhairle Contae Chill Dara

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| | Name | Date | Position |
|---|---|---|---|
| Prepared by | Ultan Downes | 31/03/22 | Senior Executive Scientist |
| | Claire McLaughlin | 31/03/22 | Executive Scientist |
| | Joan McCormack | 31/03/22 | Executive Scientist |
| | Sam McLeod | 31/03/22 | Environmental Technician |
| Approval by | Ultan Downes | 31/03/22 | Senior Executive Scientist |

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Glossary of Abbreviations / Definitions

| | |
|---|---|
| ABP | An Bord Pleanála |
| AER | Annual Environmental Report |
| BOD | Biochemical Oxygen Demand |
| COD | Chemical Oxygen Demand |
| C&D | Construction and Demolition |
| CSM | Conceptual Site Model |
| EC | Electrical Conductivity |
| EIAR | Environmental Impact Assessment Report |
| EPA | Environmental Protection Agency |
| GTV | Groundwater Threshold Value (as established by S.I No. 9 of 2010) |
| H&S | Health and Safety |
| IGV | Interim Groundwater Value (as established by S.I No. 9 of 2010) |
| KCC | Kildare County Council |
| KLRP | Kerdiffstown Landfill Remediation Project |
| LAeq | Equivalent average sound pressure level over the measuring period, |
| LA90 | The sound pressure level exceeded for ninety percent of the monitoring period which is used to determine the general background noise of an area, and |
| LA10 | The sound pressure level exceeded for ten percent of the monitoring period which provides an indication of the higher range of noise levels experienced in the area. |
| LOD | Limit of Detection |
| mAOD | metres Above Ordnance Datum |
| PAH | Polycyclic Aromatic Hydrocarbon |
| PGC | Palmerstown Golf Club |
| PSDP | Project Supervisor for the Design Stage |
| PRTR | Pollutant Release Transfer Register |
| TOC | Total Organic Carbon |
| SVOC | Semi-Volatile Organic Compound |
| VOC | Volatile Organic Compound |

# Executive Summary

This report summarises the results and findings of environmental monitoring undertaken in 2021 at the Kerdiffstown Landfill near Naas in County Kildare. The landfill is an in-filled sand and gravel quarry which was backfilled with wastes from the 1950s. The facility ceased accepting waste in June 2010. Since its closure the site has been managed and maintained pending remediation works.

The Kerdiffstown site occupies an area of approximately 31 hectares, with an estimated 3.1 million cubic metres of waste present[1]. Until June 2015 the site was under the control of the Environmental Protection Agency (EPA) following the abandonment of the site by the former operators in June 2010. The site is currently managed and maintained by Kildare County Council (KCC).

In March 2019, KCC were granted an Industrial Emissions Licence (IEL) from the EPA (EPA Reg No.: P1063-01). Schedule D of the licence specifies the required content of this report, and this report satisfies these requirements.

This report includes a summary of site activities, incidents and complaints, engineering works, environmental monitoring results, written procedures, summary waste and leachate records for the facility for the period January to December 2021. It also summarises proposed works at the site for 2022.

With respect to complaints, these are a rare occurrence having decreased significantly in recent years with four complaints reported in 2021. In addition, incidents reported are minor in nature with eight breaches in Emission Limit Values and seven breaches of Trigger Levels.

In 2021, a wide range of environmental monitoring was undertaken at the site including the following:

- Groundwater and surface water monitoring (measurements of water quality and groundwater levels) to establish the impacts from landfill leachate on the water environment,
- Landfill gas monitoring from onsite and offsite boreholes on a routine basis to determine landfill gas quality and potential for offsite impacts,
- Monitoring of leachate collected for offsite disposal and volumes of leachate discharged offsite on a weekly basis,
- Monthly odour assessments undertaken both on and off site,
- Surface emissions volatile organic compound (VOC) surveys to determine the quantities of VOCs being discharged through the landfill surface,
- Flare stack emissions testing to inform compliance with licence conditions,
- Noise monitoring,
- Dust monitoring in to determine the dust deposition rate.

[1] Figure estimated prior to the import of material for the main remediations works.

This report summarises the findings of the above monitoring and signposts the reader to documents produced for each of the monitoring activities.

The ongoing management of the landfill in its current unremediated state is maintaining a stable condition with the results of environmental monitoring within the ranges previously detected. Compliance with the Industrial Emission Licence is a primary objective for the project team both now and during the remediation works which began in late 2020.

# 1. Introduction

## 1.1. About this Report

This report includes a summary of all site activities, incidents and complaints, engineering works, environmental monitoring results, written procedures, summary waste and leachate records as well as detailed drawings for the Kerdiffstown Landfill facility for the period January to December 2021.

Following the commencement of an intervention at the site in February 2011 the Environmental Protection Agency (EPA) and between 2015 and 2021 Kildare County Council (KCC) has continued to take measures to manage activities at the site and to reduce the potential environmental impact of the site. In November 2018, KCC took ownership of the site and associated lands (See section 1.2.2 below for more details).

**Table 1.1 Kerdiffstown Landfill - General Information**

| | | |
|---|---|---|
| Industrial emissions register no: | P1063-01 | |
| Name of intervening authority, name, and address of facility: | Intervening Authority:<br>Kildare County Council<br>Áras Chill Dara,<br>Devoy Park,<br>Naas,<br>Co. Kildare | Address of Facility:<br>Kerdiffstown Landfill<br>Johnstown<br>Naas<br>Co. Kildare |
| Site Description: | Kerdiffstown landfill is located 0.5km Northwest of Johnstown, County Kildare, and 3.5 km north-east of Naas town. The landfill is an in-filled sand and gravel quarry which was backfilled with wastes from the 1950s. The facility ceased accepting waste in June 2010. Since the sites closure the site has been managed and maintained pending any restoration works.<br>The Kerdiffstown site occupies an area of approximately 31 ha, with an estimated 3.1 million $m^3$ of waste present prior to the remediation works commencing. | |

## 1.2. Background to Kerdiffstown Landfill Remediation Project

The landfill is an in-filled sand and gravel quarry which was progressively backfilled with wastes by a variety of operators from the 1950s onwards. The former operator first occupied the site and began receiving waste material during the mid-1990s.

In June 2010, Neiphin Trading, who operated the site between 1995 and 2010, vacated the site and it was left in an unsecured condition. In January 2011, a major fire developed within a mass of mounded waste material present in the north of the site which required the intervention of several regulatory agencies (including the EPA).

The site was under the control of the Kildare Fire Service until late February 2011, when it was handed over to the care of the EPA, who took emergency measures (under powers of the Waste Management Act) to contain and limit the environmental impact. Since the fire was brought under control and extinguished in 2011 the site remained under 'emergency measures and the EPA implemented a series of follow up works to deal with the most immediate risks. In June 2015 control of the site was handed over to KCC.

The facility at Kerdiffstown previously operated under waste licence W0047-01 issued by the EPA in 2003 (and subsequent revised licence W0047-02 issued in 2006). The site consisted of an extensive recycling facility, now dismantled, an authorised lined landfill which was partially filled with waste and a large area in which substantial quantities of waste has been deposited. The main area of waste deposition is in the unlined north-western area of the landfill. There are also smaller volumes of waste stockpiled around the site. The presence of such large quantities of waste and the lack of appropriate infrastructure to manage polluting emissions gives rise to the risk of environmental pollution.

The Kerdiffstown facility is no longer managed under the terms of the previous waste licence (W0047-02). The EPA and subsequently KCC took control and managed the site under emergency powers (Section 56 of the Waste Management Act (as amended)) until 12 November 2018 (see Section 1.3 below).

Although the former waste licence was no longer in effect (since September 2010) a range of environmental monitoring continued to be undertaken during between 2011 and up to March 2019. The range and frequency of monitoring was based on the requirements of the former waste licence which was subsequently modified to suit project requirements. The monitoring data gathered between 2011 and the first half of 2017 was used to support a planning application in the form of an Environmental Impact Assessment Report (EIAR) and an Industrial Emissions Licence (IEL) application to replace the former waste licence. Subsequent monitoring conducted in the latter half of 2017, throughout 2018 and up to February 2019 has been undertaken to monitor the environmental risk profile of the site and document any changes.

## 1.3. Current Regulatory Regime

The site is currently under the control of KCC with responsibility for implementing the remediation and ongoing management of the site. The statutory approvals required to undertake the remediation have been put in place as set out below.

In August 2017, an application for planning approval and compulsory purchase of associated lands was made to An Bord Pleanála (ABP) to enable the remediation of the site. Approval was granted in May 2018 (ABP Ref 09. JA0041) for both the planning application and compulsory purchase order (CPO). The lands associated with the Kerdiffstown facility are now in the possession of KCC effective from 12 November 2018.

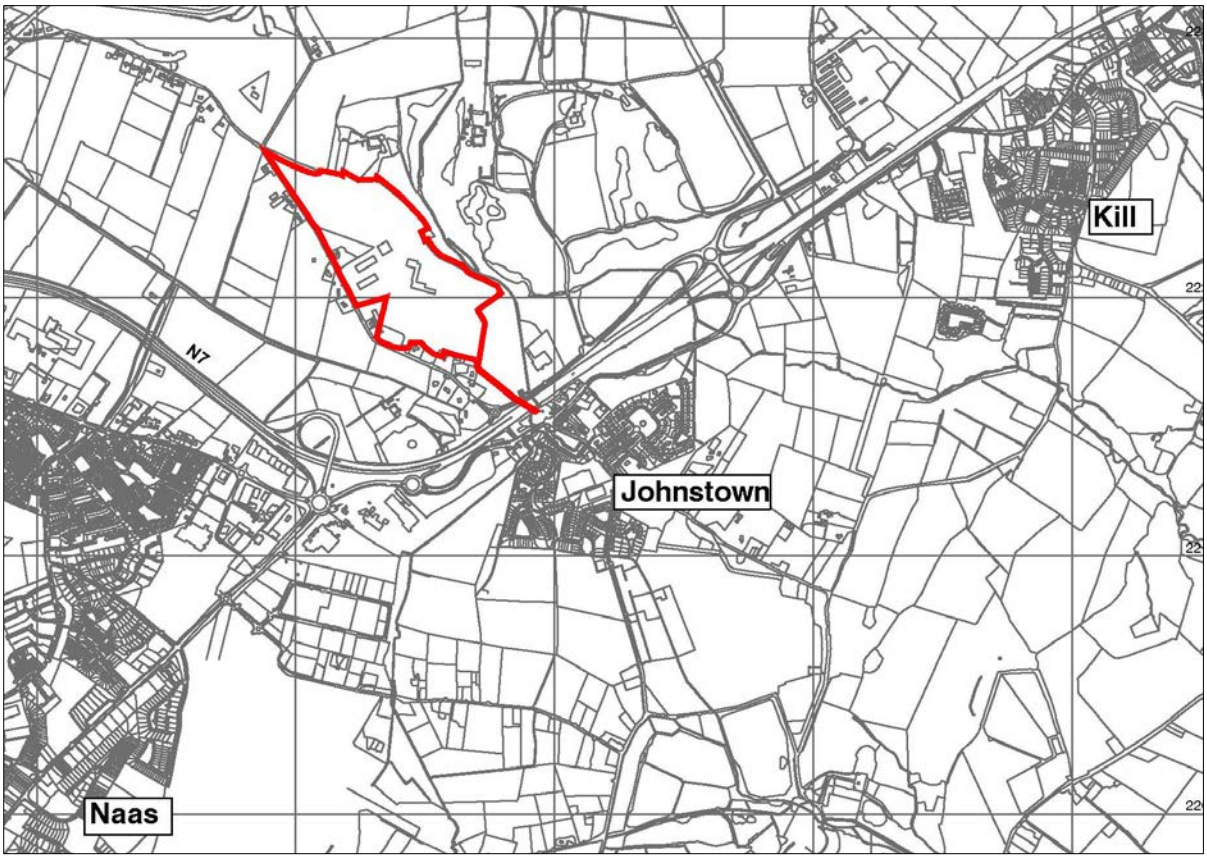
In September 2017, KCC applied for an Industrial Emissions Licence (IEL) to EPA the supported by an EIAR (EPA Licence Reg Number P1063-01). This licence was granted on 07 March 2019 and the requirements of this licence have been incorporated into this report.

## 1.4. Site Location

The site location is provided below in Plate 1.1 and attached as Figure 1. The site layout is provided in Figure 2. The site is located c. 3.5 km northeast of Naas and approximately 0.5 km northwest of the N7 and Johnstown village. To the northeast is parkland associated with Kerdiffstown House, to the north is a golf course and to the southwest and southeast are a mixture of land uses including residential, agriculture and worked out quarries.

The L2005 County Road from Sallins to Johnstown runs next to the western and southern site boundaries, with the nearest residential property approximately ten metres from the site boundary. It should be noted that the redline boundary as shown on all figures is the Industrial Emissions Licence boundary.

**Plate 1.1: Site Location Plan**




## 1.5. Current Site Layout

The current site layout is attached as Figure 2. Plate 1.2 below shows the site sub-divided into several discrete geographical areas, or zones, each of which has its own unique characteristics. The layout of the various zones with information on the key characteristics of the materials within each zone is summarised in Table 1.2.

## Plate 1.2: Site Zones

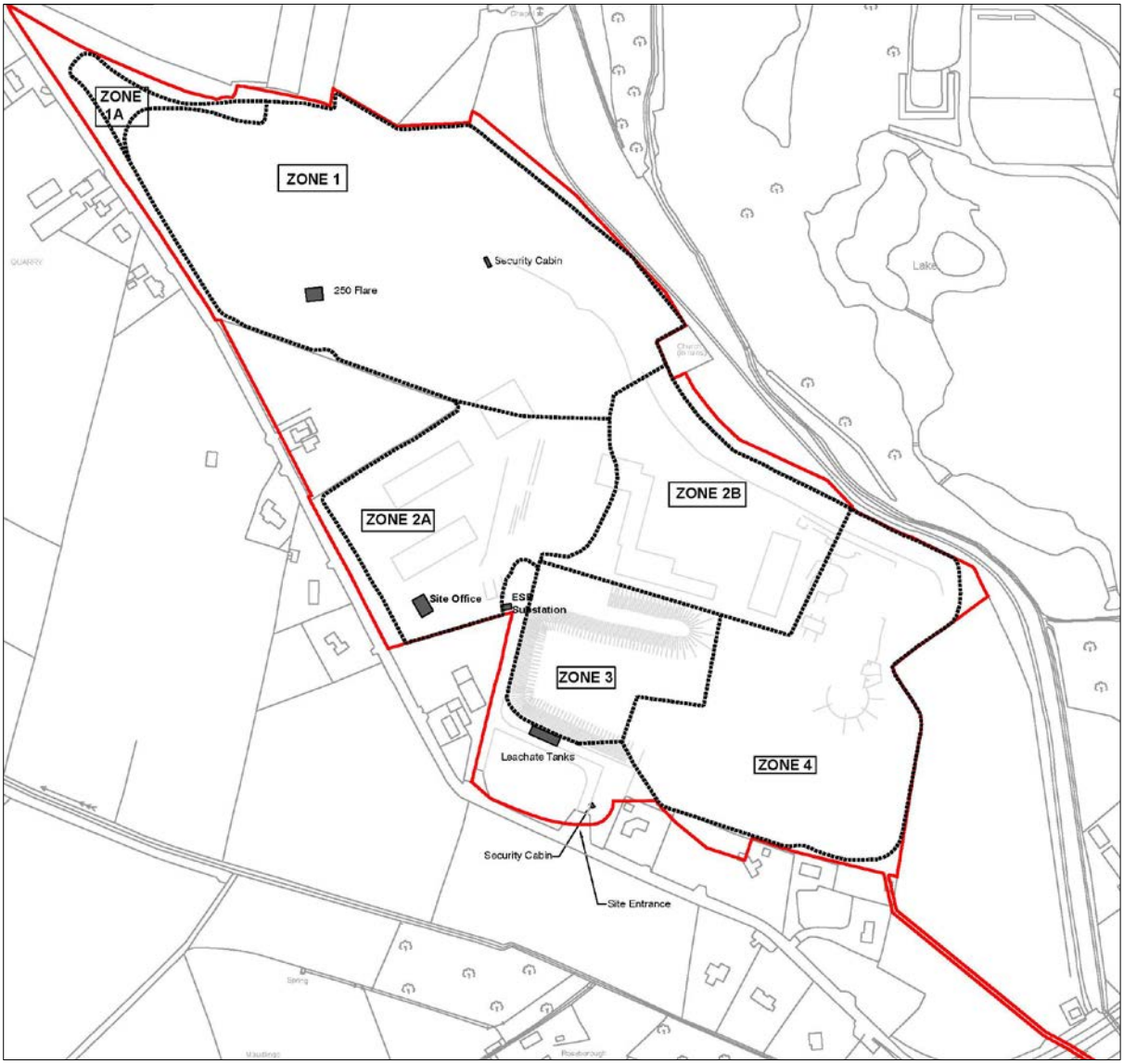


**Table 1.2 Key Characteristics of the Landfill Zones**

| Zone Number | Zone Key Characteristics |
|---|---|
| **Zone 1** (comprising sub Zone 1 & 1A)  | Estimated Area: 100,000m$^2$<br>Estimated Waste Volume: 2,023,000m$^3$<br>Wastes deposited in Zone 1 located to the north-west area of the site accounts for approximately 65% of the entire estimated volume of waste on site. The wastes in this area are typically unprocessed, highly odorous, and principally comprise non-hazardous mixed construction and demolition (C&D) wastes and household / Municipal Solid Wastes (MSW). C&D wastes are noted to contain varying amounts of clay, gravel, concrete, brick, wood, textile, plastic, rubber, and metal. The MSW within this zone is described as having plastic, textiles, wood, ash paper, cables, and steel in varying proportions. The MSW wastes are found over most of the zone, although there appears to be more C&D waste in the north-west corner of the zone. This area has therefore been designated as Zone 1A to reflect this reduced risk profile. To the southern end of Zone 1, wastes are observed to be more silty with C&D and MSW waste within the silt. Throughout Zone 1, where waste is encountered, it is considered that there is sufficient putrescible material (material that contains organic material which capable of decomposing) within the waste to class the wastes as non-hazardous biodegradable waste. |

| Zone Number | Zone Key Characteristics |
|---|---|
| **Zone 2** (comprising sub Zone 2A & 2B)  | Estimated Area: 83,000m$^2$<br>Estimated Waste Volume: 660,000m$^3$<br>Zone 2 previously comprised of with thick reinforced concrete hardstanding covering an area of approximately 58,000m$^2$ which form an impermeable layer over the wastes and prevent direct rainwater ingress. Walls from the former buildings of the waste processing facility also remained.<br>Wastes in this zone were observed to be unprocessed non-hazardous mixed C&D waste with varying amounts of clay, gravel, brick, concrete, wood, textile, paper, plastic, rubber, and metal. Domestic waste (MSW) is also present in this area at varying depths mixed in with C&D materials.<br>This area was originally assessed as one zone; however, review of ground investigations and subsequent monitoring data confirms that wastes in Zone 2A comprise more MSW than that in Zone 2B. Initial readings of gas shown on borehole logs show that relatively high concentrations of methane and carbon dioxide have been present in Zone 2A and 2B with two locations exceeding 20% methane. Monitoring undertaken in May and June 2017 shows a variable picture in Zone 2A with the average methane concentration ranging between 1.4% and 30 % v/v. Zone 2B shows very low concentrations of methane between 0.0% v/v and 0.9% v/v.<br>The majority of waste in Zone 2B is reported in the borehole logs to comprise unprocessed non-hazardous mixed C&D waste with varying amounts of clay, gravel, brick, concrete, wood, textile, paper, plastic, rubber (including tyres) and metal but with MSW also present at varying depths mixed in within the C&D materials.<br>The wastes are generally described as being dry, although damp or wet wastes are identified closer to the groundwater table with saturated wastes shown in the boreholes where waste is at the lowest elevation in Zone 2B (e.g., in BH9 and BH50). No saturated wastes have been identified in Zone 2A.<br>The areas beyond the hardstanding are in Zones 2A and 2B. Like Zone 1, there is no means of managing leachate generated in the waste although the presence of hardstanding will limit leachate generation through infiltration. |

| Zone Number | Zone Key Characteristics |
|---|---|
| **Zone 3**<br>  | Estimated Area: 24,000m$^2$<br>Estimated Waste Volume: 193,000m$^3$<br>Zone 3 comprises a cell with engineered basal and side slopes lining system and is referred to as the 'Lined Cell'. The wastes in Zone 3 comprise a mixture of waste similar to the wastes elsewhere on site including processed non-hazardous waste derived from composting tunnels, C&D materials and unprocessed domestic waste mixed through. Substantial quantities of woodchip were used as daily cover for the waste in the cell.<br>C&D wastes contain varying amounts of clay, gravel, concrete, brick, wood, textile, plastic, rubber, and metal. Non-hazardous waste excavated from the location of the fire at the site in 2011 was also deposited in the lined cell; volume approximately 35,000m$^3$. Following demolition of the site buildings in 2016, non-hazardous wastes that had been stockpiled in and around the buildings was removed and deposited to the lined cell; approximate volume 14,000m$^3$. During 2021, 75,000m3 of waste material from other Zones but primarily Zone 4 were moved to Zone 3.<br>Landfill gas wells extract gas to a flare. The average overall quality of gas from Zone 3, based on values recorded in the landfill gas extraction wells, is methane 25% v/v, carbon dioxide 25 %v/v and <1%v/v oxygen. Pumps located within inclined risers extending to the base of the cell extract leachate for transfer to tankers and removal from the site. |

| Zone Number | Zone Key Characteristics |
|---|---|
| **Zone 4**<br>  | Estimated Area: 45,000m$^2$<br>Estimated Waste Volume: 227,000m$^3$<br>Prior to the main remediation works starting, Zone 4 contained large waste stockpiles, redundant infrastructure, and concrete tanks/bays/walls in the lower yard area, with thick reinforced concrete hardstandings covering an area of approximately 12,000m$^2$. The area also contained a surface water soakaway lagoon which is cut into waste deposits and into which leachate from the adjacent waste stockpiles currently drained.<br>Stockpiles comprised both processed and unprocessed non-hazardous mixed C&D waste and household waste. During the site investigations it was concluded that the majority of waste in Zone 4 was comprised of C&D waste with a high proportion of inert material (predominantly reported as gravelly clay) with varying amounts of plastic, timber, textiles, steel, concrete, brick, PVC pipes.<br>During the excavation works as part of main remediation it was discovered that the Zone contained more municipal solid waste than anticipated. As a result, further site investigation was undertaken, and the review analysis of the material tested concluded that the Zone would be better served by applying the same capping solution that was planned for Zone 1 in order to better protect the groundwater beneath the site. In addition, gas extraction wells were installed across Zone 4. |

## 1.6. Conceptual Site Model (CSM)

To evaluate risks at the site a Source-Pathway-Receptor (S-P-R) based approach has been used. For a risk to exist there must be a source (e.g., landfilled wastes), a receptor (or receptor groups) and an environmental pathway, through which contaminants present within the source can come into contact with an identified receptor. This is the basis for the S-P-R conceptual model for environmental management.

- Conceptual Site Models (CSMs) for the different zones of the existing site have been developed based on the following guidance:
- Code of Practice: Environmental Risk Assessment for Unregulated Disposal Sites 2007 (EPA 2007),
- Framework Approach for the Management of Contaminated Land and Groundwater at EPA Licensed Facilities 2012a (EPA 2012a), and
- Model Procedures for the Management of Land Contamination (EA 2004).

The conceptual models are based on the long-established ‘source-pathway-receptor’ approach that without all three components being in place there can be no risk to the

receiving environment. The CSMs for the zones are presented graphically in Plate 1.3 and Plate 1.4 below for Zone 1 and as part of Figures 4.1 to 4.2. Within each figure the CSMs show how the identified source-pathway-receptor linkage will be addressed within the remediation works. The available information (historical aerial photos and the logs from DB09 and DB10) for the area of land to the south of Zones 3 and 4 would indicate that there is no waste in this area, and as such there is no source present and a pollution linkage does not exist for this land.

Whilst there has been no investigation of the area of land known as Tunny's Field, the historical aerial photos would suggest that waste is absent in this area and as such there is no source present and a pollution linkage does not exist for this area of land. Further information relating to the CSMs is available in Chapter 12 of the Environmental Impact Assessment Report available on https://kildarecoco.ie/AllServices/KerdiffstownPark/

## 1.7. Scope of Report

This Annual Environmental Report (AER) was prepared by KCC for the reporting year 01 January 2021 to 31 December 2021. The scope of the AER is based on Schedule D of the IEL (P1063-01). **Appendix A** provides a list of AER requirements and signposts the reader to the relevant section where the required information can be found.

The report includes a summary of all site activities, incidents and complaints, engineering works, environmental monitoring results, written procedures, summary waste and leachate records as well as relevant drawings for the year 2021.

Reporting of annual mass emissions and waste transfers has been completed using the Environmental Performance Reporting (EPR) online application as through the EPAs EDEN portal.

## 1.8. Reporting Completed During 2021

Table 1.3 summarises the reports that have been undertaken as part of the environmental monitoring tasks completed during 2021 It should be noted that some reports are not at final stage, but all data and conclusions have been compiled into this AER.

**Table 1.3 Reports Produced in 2021**

| Discipline | Title |
|---|---|
| Groundwater | Groundwater Quarterly Monitoring Report for Kildare County Council Q1 to Q4 2021 |
| Surface Water | Surface Water Quarterly Monitoring Report for Kildare County Council Q1 to Q4 2021 |
| Leachate | Leachate Quarterly Monitoring Report for Kildare County Council Q1 to Q4 2021 |
| Odour Monitoring | Monthly Odour Monitoring Reports |
| VOC Survey Report | Report on Surface Area Monitoring of Volatile Organic Compounds (VOCs) Emissions to Air (30 April 21)<br>Report on Surface Area Monitoring of Volatile Organic Compounds (VOCs) Emissions to Air (22 Nov 21) |
| Flare | Stack Emissions Testing Report (30 Apr 21)<br>Stack Emissions Testing Report (22 Nov 21) |
| Dust | Dust Monitoring Reports |
| Noise | Noise Monitoring Reports |
| Geophysical | Geophysical Survey 2021 (July 21) |

# 2. Management and Staffing Structure

## 2.1. Management and Staffing Structure of the Installation

The site was managed and maintained by the EPA between February 2011 and June 2015. In June 2015, KCC took over responsibility for the management of the site. Key KCC staff currently includes Mr. Joe Boland who serves as the Director of Services for the Environment Section of KCC and Mr Colm Flynn who is Acting Senior Engineer within the Environment department of KCC.

Ultan Downes is the Site Manager with responsibility for management of all activities and control systems on site. Key contacts are provided in Table 2.1.

**Table 2.1 Kerdiffstown Park Project Team**

| Name | Position |
|---|---|
| Joe Boland | Director of Services |
| Colm Flynn | Senior Engineer Acting |
| Ultan Downes | Site Manager (Senior Executive Scientist) |
| James Mulligan | Project Manager (Senior Executive Engineer) |
| Kathleen O'Brien | Executive Engineer |
| Claire McLaughlin | Executive Scientist |
| Joan McCormack | Executive Scientist |
| Samantha McLeod | Environmental Technician |
| John Harrison | Administrative Officer |
| Mary Nevin | Staff Officer |

In 2021, KCC also had a supporting team of various specialist contractors and consultants working on the Kerdiffstown Park Project. RPS Group is providing consultancy advice in relation to engineering aspects of the remediation project.

In November 2020, Wills Bros Ltd were appointed the main contractor to undertake the remediation works in accordance with the EPA approved Specified Engineering Works. As part of the remediation works there are approximately 60 extra people working onsite.

## 2.2. Environmental Management System

An environmental management system (EMS) for the facility was developed in June 2013 as part of the first phase of investigative works. **Tables 2.2** and **2.3** provide the names of environmental and standard operating procedures that form part of the EMS. The SOPs provide detailed information on how to manage and maintain

several key operations on site including procedures to follow in response to incidents and/or emergency situations and Health and Safety protocols.

The EMS is continually review in accordance with the IEL requirements and has been implemented on site since September 2019 to align with site arrangements and procedures to comply with the Licence.

**Table 2.2 Environmental Procedures**

| Environmental Procedures | |
|---|---|
| EP01 | Environmental Objectives and Targets Procedure |
| EP02 | Communication Procedure |
| EP03 | Training Procedure |
| EP04 | Complaints Procedure |
| EP05 | Purchasing Contractors, Goods and Services Procedure |
| EP06 | Document Control and Records Procedure |
| EP07 | Monitoring and Measurement Procedure |
| EP08 | Corrective and Preventative Action Procedure |
| EP09 | Management Review Procedure |
| EP10 | Audit and Compliance Procedure |

**Table 2.3 Standard Operating Procedures**

| Standard Operating Procedures | |
|---|---|
| SOP01 | Leachate Management Procedure |
| SOP02 | Landfill Gas Management Procedure |
| SOP03 | Surface Water Management Procedure |
| SOP04 | Environmental Monitoring Procedure |
| SOP05 | Site Security Procedure |
| SOP06 | Control of Contractors Procedure |
| SOP07 | Site Supervision Procedure |
| SOP08 | Spill Procedure |
| SOP09 | Waste Management Procedure |
| SOP10 | Delivery, Storage and use of Chemicals Procedure |
| SOP11 | Emergency Preparedness |
| SOP12 | Emergency Response |
| SOP13 | Lone Working Procedure |
| SOP14 | Leachate Tankering |
| SOP15 | Hazardous Waste Management |

### 2.2.1. Objectives and Targets 2021

The Environmental Goals outlined in Table 2.4 below have been driven by ensuring compliance with the new licence conditions granted in March 2019.

**Table 2.4 Environmental Goals Achieved in 2021**

| Environmental Objective | Target Date | Progress |
|---|---|---|
| Develop Management Plans for the installation based on IEL conditions. | September 2019 (6 months post licence grant) | Complete and subject to ongoing review. |
| Review and update Monitoring and Control Management Plan to develop Trigger Levels | Sept 2019 (6 months post licence grant) | Complete |
| Installation of an engineered capping system (Zones 1A, 1, 2A, 2B, 3) and cover system (Zone 4) to enable water control and limit leachate generation. | Within 7 years of IEAL issue date | Underway as part of remediation works. |
| Inspection and repair of existing concrete hardstandings (joints and cracks). | Within 7 years of IEAL issue date | Revised proposal determined for the capping of the areas on hardstanding removing the need to repair existing concrete. |
| Develop Construction Environmental Management Plan (CEMP) in advance of remediation works. | Prior to commencement of works by Appointed Main Contractor for the Remediation Works | Complete. CEMP developed as part of appointment of Wills Bros Ltd. |
| Install Installation Notice Board (As per Condition 3.3 of Licence) | April 2019 (1 month post licence grant) | Complete |
| Sumps, storage tanks, lagoons fitted with High level alarms (Condition 3.11) | Sept 2019 (6 months post licence grant) | Complete |
| Fugitive Emissions Programme (Condition 6.11) | Sept 2019 (6 months post licence grant) | Complete – included as part of EMS |

| Environmental Objective | Target Date | Progress |
|---|---|---|
| Pipe and Tank Integrity Testing (Condition 6.11) | Sept 2019 (6 months post licence grant) | Completed |
| Data Management System | Sept 2019 (6 months post licence grant) | Complete. Existing system documented |
| Energy Efficiency Audit (Condition 7.1) | Within 12 months of grant | Complete |
| Accident Prevention Procedure (Condition 9.1) | September 2019 (6 months post licence grant) | Complete |
| Emergency Response Procedure (Condition 9.2) | September 2019 (6 months post licence grant) | Complete |
| CRAMP (Condition 10.2) | September 2019 (6 months post licence grant) | Complete |
| ELRA (Condition 12.3.2) | September 2019 (6 months post licence grant) | Complete |
| Review and update Monitoring and Control Management Plan to develop Trigger Levels. | Trigger levels 2020 established and submitted to Agency for review. | Complete |
| Firewater Risk Assessment in accordance with new EPA Guidance. | Submitted in July 2020. | Complete |

### 2.2.2. Objectives and Targets 2022

Our 2022 objectives seek to maintain compliance with the licence and provide for continuous improvements in relation to site operations.

**Table 2.5 Environmental Objectives for 2022**

| Environmental Objectives | Target Date |
|---|---|
| Compliance with IEL Licence<br>• Compliance with IE Licence granted by EPA<br>• Maintenance of Site Documentation | Ongoing |
| Ongoing Management of the Site and associated infrastructure.<br>• Operation of the site on a day-to-day basis.<br>• Maintenance and control of landfill gas and leachate control systems.<br>• Site fully secured.<br>• Health & Safety management. | Ongoing |
| Complete Annual Environmental Monitoring Programme in accordance with requirements of Licence<br>• Groundwater and Surface Water Monitoring.<br>• Leachate Monitoring.<br>• Odour Monitoring.<br>• Landfill Gas Monitoring.<br>• Air Monitoring.<br>• Noise Monitoring.<br>• Geotechnical Monitoring.<br>• Meteorological Monitoring. | Ongoing |
| Soil Monitoring (Condition 6.22) | Not completed. Planned to be completed following completion of construction of leachate infrastructure compound. |
| Monitoring of Emissions to Sewer - install a composite sampler. (Schedule C.3.2) | Not complete as discharges to sewer not currently possible. This will be in place once discharge to sewer commences. |
| Install new landfill gas flares, sized according to ongoing gas pumping trials. | Final commissioning to be completed in 2022. |

| Environmental Objectives | Target Date |
|---|---|
| Extend gas management system across Zones 1 and 3. Revised as part of detailed design now includes Zone 2A / 2B and 42B.. | Largely complete with 86 new gas extraction wells installed, final commissioning to be completed in 2022. |
| Construct Landfill Infrastructure Compound including leachate treatment plant and leachate transfer pipeline to Johnstown PS for treatment and discharge of leachate from the site. | Underway as part of remediation works. |
| Installation of an engineered capping system across all zones to enable water control and limit leachate generation. | Underway as part of remediation works. |

## 2.3. Statement on Financial Provision

In 2015, the Minister of the Environment confirmed that the Department of the Environment (now known as Department of the Environment Climate and Communications (DECC)) will fund the costs of remediation and ongoing management costs of remediation, estimated to be €30 Million. In carrying forward the remediation project the Minister agreed that the Department of the Environment will act as Sanctioning Authority for the purposes of the Public Spending Code, and KCC will act as the Project Sponsor. The direct funding role will end when the site has been remediated and this has been confirmed by the EPA to the Minister.

KCC accepts responsibility for the aftercare maintenance and environmental monitoring costs. Furthermore, the minister indemnifies the Council with respect to any unforeseen environmental or related risks that arise in the period from the transfer date to certification by the EPA that remediation if complete and the aftercare period has commenced.

Under the terms of the Memorandum of Understanding the DECC will fund the costs of remediation and any liabilities arising during the remediation up to the point where the remediation project has been completed and aftercare period has been deemed to have commenced by the EPA.

Thereafter KCC will make provision for aftercare costs for the facility and will agree documentation with the Agency in this regard prior to the commencement of aftercare period. Appropriate Environmental Insurance will also be put in place to cover any unforeseen events during the aftercare period with an appropriate product agreed to the satisfaction of the Agency at the appropriate time.

KCC submitted an updated Environmental Liabilities Risk Assessment (ELRA) to the EPA in September 2019 and is currently awaiting feedback/approval on the contents of the ELRA report.

## 2.4. Statement on Closure Aftercare and Management Plan

As the site was left in an unsecured condition with significant waste deposits in predominantly unlined areas by the former operator, an initial screening exercise has identified the site to be a 'Category 2 with long term issues (e.g., contaminated land)'. The licence granted to KCC will enable the remediation of the site forms the basis of the closure, restoration, and aftercare proposals for the site, supported by risk assessments (e.g., DQRA) and the Environmental Impact Assessment Report.

The Planned Programme for Improvement includes for the preparation of a Closure Restoration and Aftercare Management Plan to embrace conditions of the IEL and planning approval, taking cognisance of the proposed end-use of the site as a multi-use public park.

It is anticipated that due to the residual contaminated land issues comprising waste in unlined areas remediated with capping system, clean closure may not be achievable. Closure proposals will therefore include consideration of groundwater conditions to determine an appropriate aftercare period and approach.

A revised CRAMP for the site was provided for agreement by the EPA in September 2019 and included fully detailed and costed plan for the closure, restoration, and long-term aftercare of the site. A revised CRAMP is currently being considered and will be submitted to the EPA in Quarter 2 of 2022.

## 2.5. Statement on Environmental Liabilities

KCC are as part of the AER required to provide an annual statement as to the measures taken or adopted at the site in relation to the prevention of environmental damage, and the financial provisions in place, as appropriate in relation to the underwriting of costs for remedial actions following anticipated events (including closure) or accidents/incidents, as may be associated with the carrying on of the activity.

KCC submitted an Environmental Liabilities Risk Assessment (ELRA) on 06 September 2019. It is KCCs considered position that the contents of the ELRA as submitted remain valid. While significant progress was made during 2021 in terms of progressing the remediation works the site remains the potential risks identified remain unchanged as do the measures in place to mitigate these risks.

## 2.6. Communication Programme

### 2.6.1. Communications During 2021

Throughout 2021, Kildare County Council communicated with the public via the Kerdiffstown website (http://kildare.ie/CountyCouncil/KerdiffstownPark/). The website provided information about work ongoing at Kerdiffstown Landfill. Further information and updates were posted on the website as the remedial project progressed, to help keep residents, stakeholders, and all interested parties fully informed and up to date with progress on the project. Community updates were provided in the '*latest news'* section of the website. This section included:

- Fortnightly lookaheads were uploaded outlining planned works.
- Quarterly progress photographs (March, June, and October).

- Specific notice given of works that may cause nuisance e.g., the odour management protocols were uploaded.
- The CEMP and other management plans from WBL are uploaded with revised versions superseding older versions.
- Annual Environmental Report providing access to environmental information.

In November 2020, following the announcement of the signing of the main works contract with Wills Bros Limited a virtual Community Liaison meeting was held to ensure that all the key stakeholders were informed and also introduced to the contractor. It was agreed that these meetings would continue for the duration of the works. Due to the restrictions associated with COVID 19, community liaison meetings were not held on site as had been the case in previous years. The contractor, Wills Bros Ltd and the consulting engineers RPS Group Ltd have attended the community liaison meetings on a quarterly basis to ensure that the group can pose any queries they may have directly.

Going forward the Main Contractor, Wills Bros Limited, will continue to have a key role in ensuring that the local community are kept informed of planned works for the duration of the remediation, but all communication will be managed via the Kerdiffstown Park Project Team.

### 2.6.2. Communications Plan 2022

KCC will continue to engage with stakeholders, elected members, resident's groups, and the Community Liaison Group throughout 2022.

The following programme of communications is planned throughout 2022 and the main works:

- Monthly community Liaison Group Meetings held virtually or in person when Covid 19 restrictions allow.
- Weekly/fortnightly updates to the Kildare County Council website on the dedicated Kerdiffstown Park Page (http://kildare.ie/CountyCouncil/AllServices/KerdiffstownPark/latestnews/ )
- Quarterly attendance by Wills Bros Ltd and RPS Group Ltd

The below channels will provide a key source of information to the community of the planned works as required.

- Direct Liaison with residents who may be directly affected by the works
- Letter drops to the wider community in the vicinity of the site (1km radius)
- Social Media and press releases of further significant developments
- Presentations to local elected representatives regarding progress

All press releases, updates and relevant environmental information can be accessed via the website.

Main Remediation Works

The Main Contractor, Wills Bros Limited, will continue to have a key role in ensuring that the local community are kept informed of planned works for the duration of the

remediation, but all communication will be managed via the Kerdiffstown Park Project Team.

The above communications methods as well as a co-ordinated communication from both the KCC project team and the main contractor will keep stakeholders informed and provide the necessary outlets for any concerns or issues that may arise.

During the second half of 2022 KCC will commence publicising as to when the park may open to the public and make suitable arrangements to ensure that the park is publicised appropriately e.g., colouring competitions or similar.

## 2.7. Duty & Standby Capacities of Mitigation Measures

A number of interim 'emergency measures' were implemented by the EPA following successful extinguishing of the fire within the wastes at the site in 2011. This was to deal with the key environmental liability issues arising from leachate and landfill gas production. These measures continue to be maintained and improved upon by KCC and are summarised as follows:

Control of landfill gas through the use of gas well fields and a gas flare. Currently only one flare is required (known as the 250 flare) and operates 24 hours a day seven days a week, fed from two independent gas fields situated within the Zone 3 in the south of the site and the Zone 1 in north-western zone of the landfill.

This system also serves to deal with odours generated from the landfill as gas and odour generation is to a large degree interlinked. Wastes in the north-western zone are not capped and thus gas (and odours) will also freely vent to atmosphere.

Waste was deposited in the lined cell during the operation of the site as a landfill, during post-fire clean-up operations and as part of the waste removal activities during the Demolition and Waste Removal Contract in 2017. This waste was covered using a temporary capping system to limit the venting of landfill gases and odours. During 2021 more waste material was relocated from Zone 4 and other locally adjacent stockpiles.

Provision of leachate collection facilities from the lined cell, currently involving tankering and off-site disposal of leachate, which collects in a controlled area within the lined cell in the southern area of the site to a licenced facility on an as required basis.

Deployment of a full time site manager and project team who is involved in the daily management of the gas and leachate collection systems and who oversees a number of other key daily environmental monitoring and surveillance activities at the site, (e.g. monitoring of surface water conditions, gas concentrations in monitoring wells etc.), development of interim site management procedures (and continued refinement of such), supervision of contractors, continued liaison with interested third parties etc.

## 2.8. Incidents, Complaints and Non-compliances

All incidents and complaints are recorded on site by the KCC site management. An incident or complaints report sheet is filled out within 24 hours of an incident occurring or upon receiving a complaint and a record kept in the site incident and complaints folder. The site manager is notified of any incidents or complaints as soon as practically possible. It is the responsibility of the site manager to ensure that

all appropriate action is taken to deal with each incident or complaint as soon as possible. Senior personnel are notified of incidents or complaints at monthly team meetings.

### 2.8.1. Incidents

There were fifteen incidents reported in 2021. Each of these reports were reported to the EPA, one of which is ongoing. Appendix C provides a further detail on these incidents.

### 2.8.2. Complaints

Four complaints were received in 2021. Any complaints are recorded on site by the KCC site management. A complaints report sheet is filled out within 24 hours of receiving a complaint and a record kept in the site complaints folder. The site manager is notified of any complaints as soon as practically possible. It is the responsibility of the site manager to ensure that all appropriate action is taken to deal with each incident or complaint as soon as possible. Senior personnel are notified of incidents or complaints at monthly team meetings. Appendix C provides a further detail on these complaints.

### 2.8.3. Non-compliances

During 2021, the EPA recorded issue eight non-compliances notices in relation to the operation of the site. The non-compliances related to both noise and dust exceedances which were reported as incidents as noted above and are discussed in great detail in Section 7.5.3 Dust Monitoring and Section 7.9 Noise Monitoring.

# 3. Review of Nuisance Controls

## 3.1. Litter Control

It is the responsibility of the site management to ensure that the site is kept free from wind-blown litter. Walkovers are undertaken around the perimeter of the facility to check for litter and any fly tipping activities. All contractors working on site have been instructed to implement good hygiene practices and ensure that all litter is collected and disposed of in an appropriate manner.

There were no issues with litter noted during the reporting year.

## 3.2. Vermin Control

A pest control company was appointed by KCC to manage pest control on site. in 2021 a total of thirty bait boxes were positioned along the southern boundary fence which is close to several residential properties. An additional two bait boxes are positioned at the site offices and at the landfill gas flare. Twice-monthly maintenance checks were carried out whereby bait is replenished, and records kept of vermin activity. Overall, a low amount of vermin activity was noted by the contractor at the bait stations during the reporting year. No complaints were reported by local residents during 2021 in relation to vermin indicating that the current control methods are sufficient to deal with any vermin present on site. Pest control will continue during 2022.

## 3.3. Bird Control

Birds are no longer a nuisance on site since the facility closed in June 2010 and therefore bird control measures are not required.

## 3.4. Flying Insects

Flies and other flying insects are no longer a nuisance on site since the facility closed in June 2010.

## 3.5. Odour Control

Odour control systems have been put in place in the Zone 1 (the north-western area) and Zone 3 (the lined cell). Odour control is managed through the regular monitoring and rebalancing of the in-waste gas extraction wells, gas pipework and landfill gas flare which has a capacity of 250 m3/hr. All gas extracted from wellfields in the northwest and the lined cell is being burned at the flare. The management of the landfill gas in this way has assisted with controlling odour issues in Zone 1 and Zone 3. Both areas are in close proximity to a number of sensitive receptors and as such represent locations where active gas management was needed most.

Prior to the commencement of remediation works a total of thirty-nine gas extraction wells were installed in both areas (twenty-five wells in Zone 1 and fourteen wells in the lined cell area of Zone 3) and have been monitored and maintained on a regular basis. In May 2021, the drilling of new landfill gas extraction wells commenced in the northwestern area (Zone 1) and progressed throughout the site with a total of 86 no. wells installed. Most of the new wells in Zone 1 and a small number in Zone 3 have been connected to the existing landfill gas collection infrastructure in recent months, while all previously existing wells were decommissioned and removed on a phased

basis. Landfill gas and odour management plans have been drawn up by Wills Bros Ltd and are being followed throughout the remediation works to ensure that the flare is kept operational as far as is possible so that any potential odour emissions are minimised.

Odour surveys are conducted offsite on a monthly basis by KCC, and daily site walkovers are carried out to assess odours particularly in areas where sensitive receptors are located nearby (see section 7.6 for further details).

## 3.6. Dust Control

There were eight exceedances of the licence limit of 350 mg/m2/day for dust during 2021. Dust is monitored monthly by KCC since remediation works commenced in November 2020. Where exceedances occurred KCC engaged with the contract to ensure that corrective action was put in place and avoid reoccurrence (see section 7.5.2 for further details).

## 3.7. Noise Control

There were six exceedances of noise limits attributed to construction activities on site. Noise monitoring is conducted by both KCC and Wills Bros Ltd in order to maintain compliance with licence noise limits. Where exceedances occurred KCC engaged with the contract to ensure that corrective action was put in place and avoid reoccurrence (see section 7.9 for further details).

# 4. Emissions Management

Controlled emissions from the site are limited to landfill gas and leachate as described below.

## 4.1. Landfill Gas Management

On 22 February 2021 responsibility for the management and control of landfill gas was transferred to Wills Bros Ltd for the duration of the remediation works. This includes all gas balancing, operation of the flare, decommissioning of old landfill gas extraction wells and installation and commissioning of new gas extraction wells onsite.

Active gas extraction currently occurs in two areas of the site i.e., Zone 1 and Zone 3. Zone 3 consists of the lined cell, and prior to the commencement of remediation works the waste in this area was covered with a temporary heavy-duty membrane to assist with odour management and to reduce air from being drawn in during gas extraction operations. During remediation works in 2021 this cover was removed, and waste extracted from Zone 4 was placed in the lined cell. Final lining and capping works commenced in this area in Quarter 4 of 2021 and will be completed in Quarter 1 of 2022.

Landfill gas extraction is accomplished via a network of gas extraction wells and pipework. Gas is removed and burned in a specially manufactured stainless-steel high temperature gas flare. Formerly two flares were on the site, one with capacity 250 $m^3$/hr (known as the 250 flare), the second with capacity 500 $m^3$/hr (known as the 500 flare). The 500 flare was removed from site on 06 July 2018 to another site for operational reasons on the receiving site. It was determined that the 250 flare was capable of maintaining adequate management of the gas fields in Zone 1 and Zone 3 with all gas extracted burned in this flare at a temperature of approximately 1000°C. The 250 flare was relocated to the former 500 Flare site on 30 March 2021 due to remediation works taking place in Zone 1.

The flow of gas entering the 250 flare is controlled through the booster unit which ran at an average rate of approximately 107 $m^3$/hr during 2021 to maximize gas extraction from both areas while ensuring little or no air is drawn in across uncapped areas. The landfill gas flare is currently monitored by Wills Bros Ltd personnel on a daily basis. Emissions from the 250 flare are also monitored on a continuous basis via an in-line gas data analyser and data logger with both remote and onsite connection for data viewing to ensure a fully functional system is in place.

Prior to the commencement of the remediation works 39 no. gas extraction wells were in place on the site. Within Zone 1 there were twenty-five gas wells installed to depths between six metres and thirty-two metres (LG1 to LG10, LG25 to LG39). Within Zone 3 there were 14 gas wells, installed to depths between three metres and six metres (LG11 – LG24).

In May 2021, the drilling of new landfill gas extraction wells commenced in the north-western area (Zone 1) and progressed on to Zone 3 and throughout the site. A total of eighty six new wells have been installed and a number of the new wells in Zone 1 and Zone 3 have been connected to the existing landfill gas collection infrastructure during 2021. In tandem with these new connections the previously existing wells were decommissioned and removed on a phased basis.

Table 4.1 summarises the new gas extraction wells installed during 2021.

**Table 4.1 On site Gas Extraction Wells**

| Zone | Nomenclature | No. of Gas Wells | Approx. Depth (m) |
|---|---|---|---|
| Zone 1 | GW01 to GW39, GW86 | 40 | 12 to 33 |
| Zone 3 | GW40 to GW48 | 9 | 4 to 16 |
| Zone 2A | GW49 to GW58 | 10 | 8 to 16 |
| Zone 2B | GW59 to GW73 | 15 | 3 to 9 |
| Zone 4 | GW74 to GW85 | 12 | 2 to 13 |

Refer to Figure 3B 'Onsite Landfill Gas Monitoring Locations' for an overview of the landfill gas extraction wells that were in place as of December 2021. Not all gas wells shown were connected to the gas flare.

### 4.1.1. Flare Shutdowns

In previous years in documenting incidents in AERs for the site flare shutdowns would have been documented as minor incidents. Following receipt of the licence document P1063-01 and as per condition 3.25.7 *'the flare shall be operated at all times that there is combustible gas available'*. It has been determined that flare shutdowns will only be recorded as incidents when there is a reason other than low quality gas is the reason for the shutdown e.g., mechanical failure. Records of all incidents are kept on file in the site office.

In 2021 there were a total of seventy-three flare shutdowns of the onsite 250 flare, including periods where the flare was set to run on a 12-hour cycle rather than continuous operation due to low methane gas levels. The total flare shutdown time was recorded as approximately 1,953 hours.

Prior to the commencement of the remediation works the landfill gas flare primarily operated on a 24/7 basis extracting landfill gas from the NW area (Zone 1) and the Lined Cell (Zone 3). However, in the winter and spring months the flare tended to become more prone to unscheduled shutdowns due to low methane gas levels and a number of other factors such as unstable weather conditions (high pressure, low temperature, high winds) and increased groundwater levels, all of which can contribute to the ability of the flare to remain operational.

During 2021 the shutdowns took place for both the reasons mentioned above and also for a number of reasons which were related to the remediation works taking place onsite e.g.

- The movement of the 250 flare to a new location in late March 2021 and the subsequent adaptation of the gas field and the flare unit to these changes.
- In June 2021 some of the existing gas wells in Zone 1 deteriorated in quality due to excavation of material in that area, and some newly installed gas extraction wells were connected to the landfill gas collection infrastructure towards the end of the month. Again, the gas field was unsettled during this

transition period and time had to be allowed for the movement of gas towards the new wells for extraction.

- In order to facilitate the lining and capping works in Zone 1 during the remediation works some disconnection and reconnection of gas extraction wells to the gas collection network took place which resulted in low gas quality.
- Maintenance of the gas lines in the latter part of the year e.g., repositioning of the main gas line from Zone 1 and removal of condensate.

There was no significant impact on the environment arising from any of the flare shutdown events as landfill gas build up was retained in the waste mass of Zone 1 and Zone 3 and extracted and flared upon resumption of the flare.

Flare shutdowns are reported immediately to the site manager and to Wills Bros Ltd personnel by automatic email and text alert. While the gas management remains the responsibility of Wills Bros Ltd during the remediation works, they are responsible for investigating each shutdown and restarting the flare either directly on site during standard operational hours or remotely. When the flare shuts down it is restarted within 24 hours of when combustible gas is present.

### 4.1.2. Landfill Gas Production

In overall terms, the amount of landfill gas being produced from the Zone 1 and Zone 3 (lined cell) gas fields had been falling since flaring began in 2011, where methane concentrations had an average value of 30.4 % between June 2011 and December 2011, in comparison to 22.9% between January and December 2020.

However, gas quality and quantity has been seen to improve over 2021 due to the capping works on Zones 1 and 3 and the installation of new gas extraction wells and collection pipework. The average concentration of methane ($CH_4$) flared at the 250 flare during 2021 was 27.5%. The total amount of methane flared during 2021 based on runtime, flow rate and methane concentration was 200,865 $m^3$ or 137,210 kg [2]. Table 4.2 shows methane concentrations since 2011 and illustrates this overall observed decline up to 2020. Individual readings for methane concentrations from Zones 1 and 3 were not recorded in 2021.

**2** Source EPA Landfill Gas Survey 2020 Calculation Total CH4 (kg) based on the calculation of the density of methane at an average temperature of landfill gas of 10 degrees Celsius and the flare inlet pressure provided. The calculation also takes into account the combustion efficiency of open flares (50%) and enclosed flares (99.9%) for methane

**Table 4.2 Methane ($CH_4$ % v/v) Concentrations 2021 to 2011**

| | 2021 | | |
|---|---|---|---|
| | Avg | Max | Min |
| **250 Flare** | 27.5 | 48.3 | 15.4 |

| | 2019 | | | 2020 | | |
|---|---|---|---|---|---|---|
| | Avg | Max | Min | Avg | Max | Min |
| **250 Flare** | 23.4 | 31.6 | 19.4 | 22.9 | 34.0 | 16.2 |
| **Lined Cell** | 22.7 | 28.3 | 15.9 | 21.7 | 31.7 | 14.1 |

| | 2018 | | | 2017 | | |
|---|---|---|---|---|---|---|
| | Avg | Max | Min | Avg | Max | Min |
| **250 Flare** | 23.9 | 29.0 | 18.8 | 23.5 | 29.8 | 18.2 |
| **Lined Cell** | 24.9 | 30.2 | 18.8 | 25.3 | 35.6 | 17.5 |

| | 2016 | | | 2015 | | |
|---|---|---|---|---|---|---|
| | Avg | Max | Min | Avg | Max | Min |
| **250 Flare** | 23.6 | 34.4 | 18.5 | 21.5 | 30.2 | 16.6 |
| **Lined Cell** | 20.4 | 35 | 13.1 | 18.4 | 30.1 | 13.5 |

| | 2014 | | | 2013 | | |
|---|---|---|---|---|---|---|
| | Avg | Max | Min | Avg | Max | Min |
| **250 Flare** | 21.5 | 30.6 | 16.0 | 21.3 | 28.6 | 17.9 |
| **Lined Cell** | 18.7 | 31.3 | 15.1 | 19.0 | 26.1 | 14.6 |

| | 2012 | | | 2011 | | |
|---|---|---|---|---|---|---|
| | Avg | Max | Min | Avg | Max | Min |
| **250 Flare** | 26.4 | 37.6 | 12.0 | 31.1 | 43.0 | 14.0 |
| **Lined Cell** | 26.4 | 43.3 | 15.7 | 31.4 | 50.0 | 22.9 |

### 4.1.3. Estimated annual and cumulative quantities of landfill gas emitted from the site

The gas extraction system operated at an inlet flow rate ranging from 15$m^3$/hr to 193$m^3$/hr recorded from continuous monitoring during 2021. Table 4.3 below displays the average values as well as the range of values recorded at the 250 flare throughout 2021. The average concentration of methane ($CH_4$) flared at the 250 flare during 2021 was 27.5% v/v and the average concentration of carbon dioxide ($CO_2$) was 21.3% v/v. Corresponding values from 2020 are also provided for comparison purposes.

**Table 4.3 250 $m^3$/hr flare – Average Values 2021 vs 2020**

| | | Average | |
|---|---|---|---|
| | **Unit** | **2021** | **2020** |
| $CH_4$ | % v/v | 27.5 | 21.8 |
| $CO_2$ | % v/v | 21.3 | 20.2 |
| $O_2$ | % v/v | 1.40 | 0.41 |
| Flow | $m^3$/hr | 107.3 | 91.3 |
| Flare Exhaust Temperature | °C | 989 | 982 |
| Gas field Suction Pressure | Mbar | -10.26 | - 1.8 |

A summary graph of landfill gas quality to the flare during 2021 is provided in **Appendix D**.

## 4.2. Leachate

Only a small part of the overall site is lined i.e., the lined cell in Zone 3, located directly north of the main site entrance. Leachate is collected in this area for subsequent transportation off site for treatment and disposal.

Approximately two thirds of Zone 3 has been infilled with waste. Buildings onsite that were considered dangerous were demolished in 2016. These buildings contained waste that couldn't be accessed previously as it was unsafe. During demolition works this waste was disposed of in the lined cell.

The waste in Zone 3 has been covered with a temporary heavy-duty membrane to assist with odour management and to prevent air ingress during gas extraction. The membrane also helps to reduce the infiltration of rainwater into the waste body by redirecting surface water run-off from the waste into a series of channels which flow towards a surface water soakaway lagoon located at the lower section of the site. This cover was upgraded following the placement of waste in Zone 3. This has resulted in improved gas yield and reduced rainfall infiltration.

Although the heavy-duty membrane prevents a substantial amount of rainwater from entering the waste a certain amount of rainwater does infiltrate the waste, generating additional leachate. The generation of leachate is therefore strongly influenced by weather conditions with leachate levels noted to rise especially during heavy periods of rainfall over a number of days. The daily leachate levels are measured by the level sensors on the pumping system with reading taken at the control panel.

Leachate that collects in the lined cell drains under gravity towards the western and southwest corner where leachate sumps and associated leachate pumps are located. A fully automated pumping system was installed in March 2016 whereby level/pressure sensors were installed and a new pump and control system to help aid the filling process. A second pump was installed in 2017 in the lined cell to enable leachate extraction from both areas of the cell. Leachate is pumped from this location up to two temporary static leachate storage tanks at the top of the bank. The

tanks are used to store leachate prior to removal off site by road tanker for treatment/disposal. The two tanks hold approximately 28m$^3$ in total when filled to the maximum fill mark i.e., the black line on the level gauges. Using the existing pumping system, the tanks are filled to capacity in two hours and thirty minutes.

### 4.2.1. Volume of leachate produced and transported off-site

A total of 475 loads were transported off site by Elsatrans Ltd (NWCPO-12-11124-01) from Jan – May 2021 and by Colm Humphries Transport (NWCPO-12-11124-01) from June – Dec 2021, both delivering to Ringsend Wastewater Treatment Plant (EPA Licence: D0034-01). A summary of leachate disposal on a monthly basis is provided in **Table 4.4** below. Leachate levels within the lined cell are noted to correlate with the amount of rainfall that occurs and as a result leachate haulage frequency also increases as illustrated in **Table 4.4**. Leachate is transported from site on an 'as required' basis as determined by the Site Manager. Leachate levels in the lagoon are maintained below a maximum limit of one meter and haulage is carried out between Monday and Saturday with up to a maximum of four loads per day.

**Table 4.4 Leachate Transported Off Site 2021**

| Month | No. of Loads | Total volume (m$^3$) | Total Monthly Rainfall (mm) |
|---|---|---|---|
| January | 69 | 1,932 | 95.8 |
| February | 54 | 1,512 | 69.7 |
| March | 34 | 952 | 29.4 |
| April | 30 | 840 | 17.9 |
| May | 59 | 1652 | 111.5 |
| June | 35 | 980 | 17.8 |
| July | 48 | 1,344 | 94 |
| August | 19 | 532 | 47.2 |
| September | 7 | 196 | 42.2 |
| October | 12 | 336 | 77.2 |
| November | 34 | 952 | 16.4 |
| December | 48 | 1,344 | 76.4 |
| **Total** | **449** | **12,572** | **696** |
| Monthly Average | 37 | 1,048 | |

### 4.2.2. Minimising generation of leachate for disposal

The upgraded temporary HDPE liner (installed in Q1, 2017) on the lined cell has reduced rainfall infiltration resulting in lower rates of leachate production. This has however increased through 2020 and 2021 with higher volumes extracted from site.

**Table 4.5 Leachate vs. Rainfall Historic Comparison**

| Year | Total Leachate Volume | Total Rainfall (mm) |
|---|---|---|
| 2017 | 11,144 m$^3$ (398 loads) | 730 |
| 2018 | 9,940 m$^3$ (355 loads) | 648 |

| | | |
|---|---|---|
| 2019 | 10,724 $m^3$ (383 loads) | 865 |
| 2020 | 13,300 $m^3$ (475 loads) | 820 |
| 2021 | 12,572 $m^3$ (449 loads) | 697 |

## 4.3. Environmental Performance Reporting (EPR)

KCC has completed the Environmental Performance Report (EPR) in accordance with the Agency's guidelines. The EPR has replaced the PRTR and was submitted via EDEN by 31 March 2022. The Landfill Gas Survey was completed for submission to the EPA and is provided in **Appendix B.**

# 5. Waste Management & Resource Consumption

## 5.1. Records

Records for 2021 were maintained by the site management and have been collated and presented below in Tables 5.1 and 5.2 for the purposes of this report.

## 5.2. Waste Analysis

Waste material generated on the site is as shown in Table 5.1.

**Table 5.1 General Waste**

| Waste Type | EWC Code | Waste Description | Quantity (tonnes) | Destination |
|---|---|---|---|---|
| General Waste | 20 03 01 E | Municipal mixed dry recyclables non-household | 41.68 | Ray Whelan Ltd - W0158 |
| Paper and cardboard | 19 12 01 | Recycling from office and canteen waste collected in 1100 litre bin at site office | 2.46 | Ray Whelan Ltd - W0158 |
| Ferrous metal | 19 12 02 | Inert waste consisting of rebar removed from demolished concrete walls was removed from site | 57.82 | Wilton Waste Recycling Ltd (NWCPO-12-11001-05) |
| Septic Tank Sludge | 20 03 04 | Sewage waste removed from office toilets | 6 | Enniskerry Wastewater Treatment Works (NWCPO-15-11681-01) |
| Septic Tank Sludge | 20 03 04 | Sewage waste removed from onsite portaloos | 9.45 | Ringsend WWTP - D0034 |
| Septic Tank Sludge | 20 03 04 | Septic Tank Sewage waste | 19.62 | Upper Liffey Valley Sewerage Scheme - D0002 |
| Bulky waste non-household | 20 03 07 B | Mixed Waste | 1.96 | Starrus Eco Holdings Limited |

| Waste Type | EWC Code | Waste Description | Quantity (tonnes) | Destination |
|---|---|---|---|---|
| | | | | (Greenogue) - W0188 |
| Soil and stones containing hazardous substances | 17 05 03* | Soil and Stones containing dangerous substances | 20 | Enva Ireland Limited (Portlaoise) - W0184 |
| Mixed Metals | 17 04 07 | Existing concrete walls | 595.87 | Wilton Scrap Metals Ltd - WFP-KE-18-0091-01(T) - N0602 |
| Iron and Steel | 17 04 05 | Existing Concrete walls | 230.29 | Wilton Waste Recycling Limited - WFP-CN-15-20-0001-01 - N0052 |
| Wood | 17 02 01 | Wood | 17.60 | Ray Whelan Ltd - W0158 |
| End of Life Tyres | 16 01 03 | End of Life Tyres | 253.74 | Ecological Waste Management Ltd - WFP-LH-14-0004-01 - N0077 |
| absorbents, filter materials | 15 02 02* | Absorbents, filter materials (including oil filters not otherwise specified), wiping cloths, protective clothing contaminated by hazardous substances | 2.71 | Enva Ireland Limited (Portlaoise) - W0184 |

## 5.3. Electricity

The use of electricity on site is primarily at the site offices, the operation of the flare, leachate pumps, the two security huts as well as six freestanding exterior flood lamps for use after dark in the vicinity of the site office, flare, and security huts.

**Table 5.2 Electricity Usage**

| | Kilowatt Hours Usage 2021 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
| Day | 3,240 | 3,000 | 3,000 | 2,640 | 2,400 | 2,280 | 2,400 | 2,400 | 2,520 | 2,760 | 3,000 | 3,240 |
| Night | 1,560 | 1,440 | 1,400 | 1,320 | 1,200 | 1,080 | 1,200 | 1200 | 1,200 | 1,320 | 1,560 | 1,560 |
| **Total** | **4,800** | **4,440** | **4,400** | **3,960** | **3,600** | **3,360** | **3,600** | **3,600** | **3,720** | **4,080** | **4,560** | **4,800** |

## 5.4. Diesel

In 2021 diesel usage increased significantly on-site due to the volume of machinery required as part of the remediation works. The total quantity of diesel used by Wills Bros Ltd for construction works was 449,188 litres.

Additionally on-site KCC vehicles used approximately 202.52 litres of diesel during 2021. The total quantity of fuel used in 2021 was 449,390.52 litres.

## 5.5. Carbon Footprint

As part of the tender submission for the project, the main contractor Wills Bros Ltd, calculated a figure of 10,970 $tCO_2e$ as the total carbon footprint for the proposed remediation works.

As of 31 December 2021, the emissions relating to the project for the year was 6,625 $tCO_2e$ or 60.4 % of the total calculated figure.

# 6. Restoration Works

## 6.1. Remaining volumes of historically deposited waste

The estimate of waste volume present at the site prior to the commencement of the main remediation works has been determined, following:

- input of the Phase 2 (October 2012) ground investigation data,
- revision of the estimated base contours accordingly and,
- re-modelling the waste thickness isopachytes.

The estimate of waste volume remains at ***3.1 million cubic metres*** as determined by the Site Profile, Capping and Material Use Appraisal (EPA, 2013).

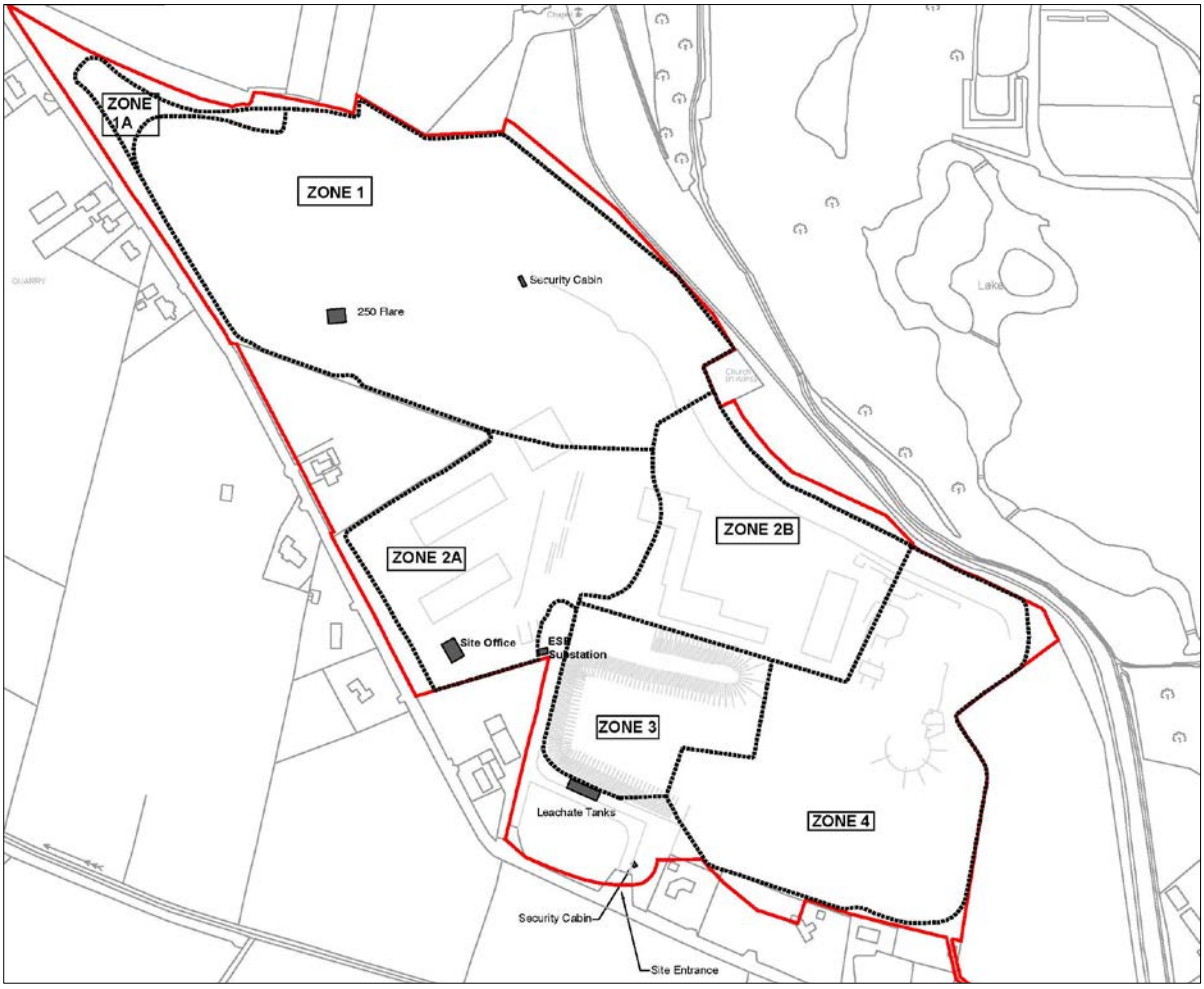
The individual volume estimates for the four zones of the site shown on the plan below are shown in **Table 6.1**. The 2017 EIAR for the site outlined the intention for waste located in Zone 4 to be moved into Zone 3 (the lined cell) which will subsequently be capped. Some re-grading of the slopes will be undertaken in Zone 1 with additional waste from Zone 2 moved to Zone 1. Zone 1 will then be capped.

Commencing in March 2021, waste material to be used as part of the remediation of the site began to be brought to site. In total 101,065m3 of waste material in the form of soil and stones was imported onto site. All material brought to site was subject to compliance with the waste acceptance procedure for the project.

**Table 6.1 Zone Descriptions and Condition as of December 2021**

| Zone | Estimated Area (plan) | Estimated Waste Volume | Basal & Side Lining | Cap Status | Comment |
|---|---|---|---|---|---|
| 1 | 100,000m$^2$ | 2,023,000m$^3$ | Unlined | Capped | Final Topsoil layer to be placed in 2022. |
| 2 | 83,000m$^2$ | 660,000m$^3$ | Unlined | 25,000m$^2$ uncapped | Capping to be completed in 2022. |
| 3 | 24,000m$^2$ | 193,000m$^3$ | Lined | 75% Capped | Remaining 25% capping to be completed in 2022. |
| 4 | 45,000m$^2$ | 227,000m$^3$ | Unlined | 33,000m$^2$ uncapped | Capping to be completed in 2022. |
| All | 252,000 | 101,065m$^3$ | - | - | Material imported for placement over capping |
| Total | 252,000m$^2$ | 3,204,065m$^3$ | | | |

**Plate 6.1 Site Zones**




## 6.2. Development / Infrastructural Works Summary

### 6.2.1. Works Completed In 2021

The below summarises the works completed in 2021 as part of the remediation of the site.

- Archaeology works (pre-construction) completed across the site.
- Perimeter fencing installed to site perimeter, along with over 160m of acoustic fencing to adjacent landowner.
- All demolition and site clearance works complete across the site.
- Earthworks before liner 95% complete across the site.
- Over 100,000 $m^3$ / 190,000t of material imported.
- Liner & capping system 95% complete in Zone 1/1A, with profiling & service install after liner 85% complete.
- Liner & capping system 20% complete in Zone 2B, with profiling & service install after liner 15% complete.
- Liner & capping system complete at three surface water attenuation ponds.

- All new gas extraction wells drilled and installed by August 2021. The installation of the permanent gas infrastructure in Zone 1(manifolds, knockout pots, pneumatic pumps) was near completion by end of 2021.
- All new perimeter gas wells drilled – headworks yet to be completed.
- 220m of new entrance road constructed. Over 1.2 kilometres of perimeter access road constructed. Overflow carpark constructed to formation level.
- Landfill infrastructure compound 75% complete, including office & leachate building.
- Changing room building up to roof level, 50% complete.

## 6.3. Works Identified for 2022

In 2022 the main works contract will involve the following Works:

- Directional drilling under N7 to facilitate access to pumping station in Johnstown.
- Completion of 2 full size sports pitches and 3 x 5 aside pitches with associated fencing and lighting.
- Gas pumping trial to inform sizing of new gas flare(s)
- Installation of new gas flare
- Construction of children's playground
- Construction of main entrance walls & gates
- Construction of main carpark, e-charge carpark & disabled carpark
- Installation of internal fencing within the site
- Installation of hoggin & tar footpaths across the site
- Commissioning of landfill infrastructure compound and associated leachate treatment infrastructure.
- Landscaping works, including planting & seeding

All works will be undertaken in compliance with the IEL P1063-01 Licence conditions along and in accordance with the Specified Engineering Works as agreed with the EPA.

# 7. Environmental Monitoring

Since February 2011, a range of environmental monitoring is undertaken to support the Kerdiffstown Park Project.

In June 2014, an environmental monitoring programme was established covering several environmental disciplines which has continued in order to support the design of the remediation and monitoring the environmental risk profile of the site.

Monitoring undertaken in 2021, exceeding requirements of and in compliance with Schedule C of IEL P1063-01 was as follows:

- Groundwater monitoring (monthly, quarterly, and bi-annual),
- Surface water monitoring (monthly, quarterly, and bi-annual),
- Leachate (weekly, quarterly, bi-annually and annually),
- Landfill gas monitoring, (on site weekly, offsite monthly),
- Stack emission testing (bi-annually),
- Dust (monthly),
- Odour (monthly),
- VOC Survey (bi-annually),
- Metrological data (monthly), and
- Noise (quarterly)

## 7.1. Groundwater

Groundwater sampling is undertaken on a monthly basis involving low specification sampling from fifteen monitoring wells for a suite of parameters. An additional five wells were included for quarterly monitoring with a slightly expanded suite of parameters. A higher specification round of monitoring was undertaken on a biannual basis at 35 monitoring wells for an expanded suite of parameters. During 2021 biannual rounds of monitoring were conducted in June and October. Figure 3A provides the location of each of the groundwater monitoring wells.

***Groundwater Monitoring Network***

Following the operator vacating the site in 2010, the EPA and KCC commissioned a number of site investigations to establish a groundwater monitoring network as summarised in **Table 7.1** with the locations of installed monitoring wells shown in Figure 3A.

**Table 7.1 Groundwater Monitoring Network and Sampling Frequency**

| Monitoring Well | Target Stratum | Orientation from the Landfill | Monthly Sampling | Quarterly Sampling | Biannual Sampling |
|---|---|---|---|---|---|
| EMW28 | Overburden | South (up hydraulic gradient) | | | |
| EMW29 | Overburden | | ✓ | ✓ | ✓ |
| EMW27D | Overburden | | ✓ | ✓ | ✓ |
| GW1D | Bedrock | | | | ✓ |
| EMW11 | Overburden | West (cross hydraulic gradient) | ✓ | ✓ | ✓ |
| EMW24 | Bedrock | | | ✓ | ✓ |
| EMW30 | Overburden | East (cross hydraulic gradient) | ✓ | ✓ | ✓ |
| DB08A | Overburden | | | | ✓ |
| EMW22 | Bedrock | North (cross hydraulic gradient) | | ✓ | ✓ |
| EMW23 | Overburden | | | ✓ | ✓ |
| DB02 | Overburden | | ✓ | ✓ | ✓ |
| DB03 | Overburden | | ✓ | ✓ | ✓ |
| EMW21 | Overburden | Northeast (down hydraulic gradient) | | ✓ | ✓ |
| BB02 | Bedrock | | ✓ | ✓ | ✓ |
| EMW04 | Overburden | | | | ✓ |
| EMW08 | Overburden | | | | |
| DB05 | Overburden | | | | ✓ |
| EMW19 | Bedrock | | ✓ | ✓ | ✓ |
| DB06 | Overburden | | | | ✓ |
| EMW18 | Overburden | | | | ✓ |
| EMW02 | Overburden | | | | ✓ |
| EMW03 | Overburden | | ✓ | ✓ | ✓ |

| Monitoring Well | Target Stratum | Orientation from the Landfill | Monthly Sampling | Quarterly Sampling | Biannual Sampling |
|---|---|---|---|---|---|
| EMW05 | Overburden | | ✓ | ✓ | ✓ |
| EMW07 | Overburden | | | | ✓ |
| EMW20 | Overburden | | ✓ | ✓ | ✓ |
| EMW31 | Overburden | | | | ✓ |
| EMW32 | Overburden | | | | |
| EMW33 | Overburden | | | | ✓ |
| EMW13 | Overburden | On site (Zone 1) | ✓ | ✓ | ✓ |
| BH26 | Overburden | | | ✓ | ✓ |
| BH36 | Overburden | | | | ✓ |
| BH68 | Bedrock | On site (Zone 3) | ✓ | ✓ | ✓ |
| DB10 | Overburden | On site | | | ✓ |
| EMW16 | Overburden | On site (Zone 4) | | | |
| EMW17 | Overburden | | ✓ | ✓ | ✓ |
| | | **Totals** | **15** | **20** | **31** |

## Groundwater Levels and Flow

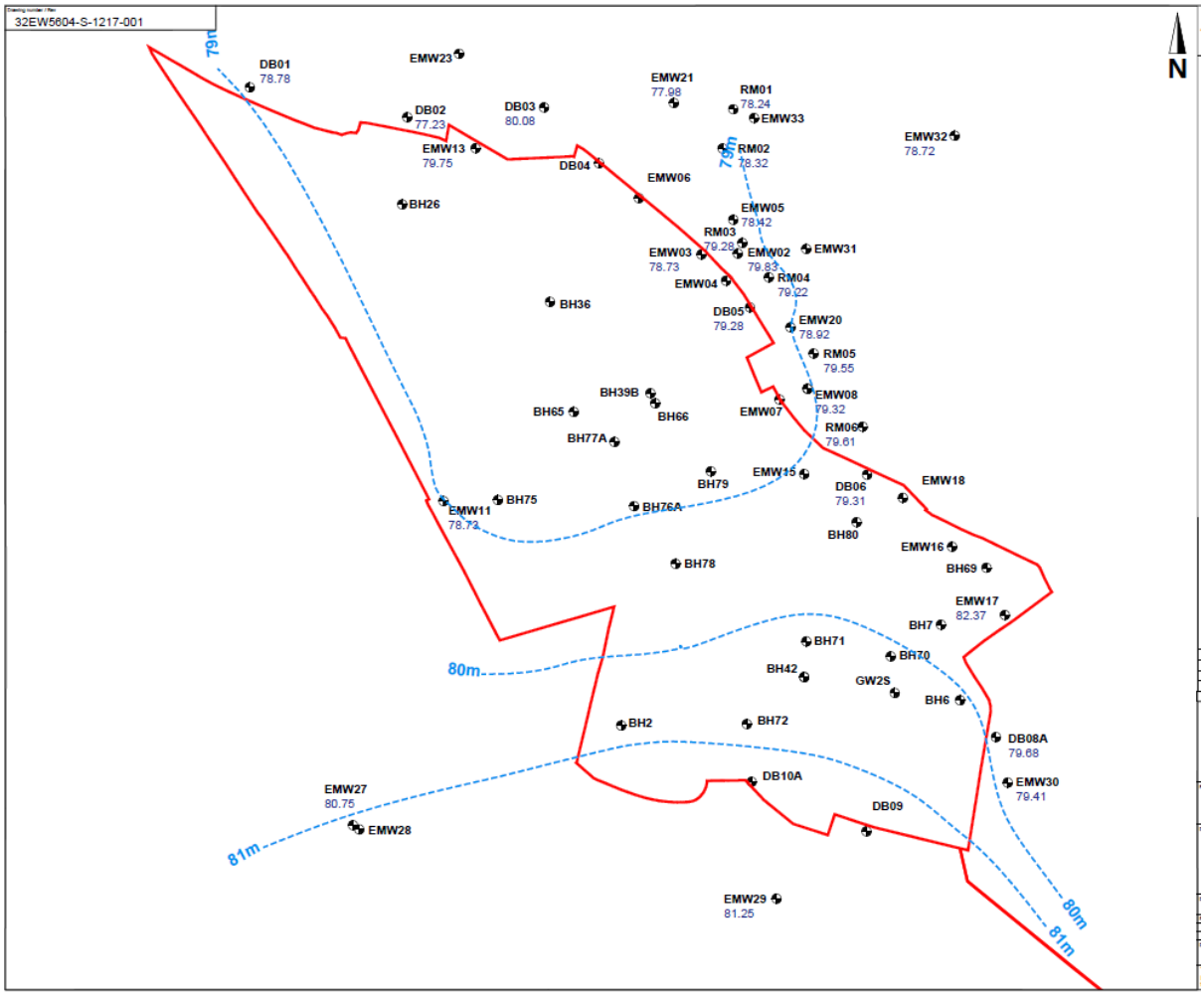
The inferred groundwater flow regime for the overburden groundwater (Plate 7.1) indicates an overall south to north movement of groundwater within the overburden and bedrock aquifer.

The conceptual model for the site shown in Figure 4 includes dilution of leachate from winter rainfall. The model also shows a general increase in groundwater levels within the overburden and bedrock aquifers in response to (likely) increased rates of infiltration. Water levels recorded in both aquifer units during 2021 show an annual trend of decreasing levels through the late spring and early summer months.

Overall flow directions within the overburden are similar to those seen previously with a complex pattern of recharge evident over the footprint of the landfill. The bedrock flow directions have also maintained the previously observed direction of flow in a north or north-easterly direction. See Appendix D for graphs of 2021 water levels in overburden and bedrock which were relatively stable throughout the year.

The only indication of offsite impacts has been to the northeast of the site. Monitoring of the new wells installed in 2016 has also indicated impacts to the north of the site.

**Plate 7.1 Shallow Groundwater Levels and Contours (December 2021)**




### *Groundwater Quality Analyses*

Groundwater quality data from January to December 2021 has remained largely consistent with results obtained during previous sampling rounds completed between 2011 and 2019. Monitoring during 2021 has shown that there is evidence of leachate impact in the north and north-eastern boundary areas of the site within the overburden aquifer beneath Zone 1 of the landfill. The highest concentrations of key indicators of leachate impact such as ammoniacal nitrogen and chloride are recorded in monitoring wells close to the northern and north-eastern boundary of Zone 1 e.g., DB02 and EMW13, rather than under the central area of this zone e.g., BH26 and BH36.

There are indications of leachate impact (primarily ammoniacal nitrogen, chloride, chemical oxygen demand (COD) and alkalinity) present in some off-site groundwater monitoring wells located between the site and the Morell River, but the concentrations of indicators in these monitoring wells are relatively low. **Table 7.2** illustrates the elevated concentrations detected onsite compared to those in near off-site boreholes along the northern and north-eastern boundary.

**Table 7.2 Summary Groundwater Concentrations**

| | | Ammoniacal nitrogen average for 2021 | Chloride average for 2021 |
|---|---|---|---|
| Area | Well Reference | mg/l | |
| **Onsite Zone 1** | EMW13 | 262.75 | 193.58 |
| | BH26 | 179 | 331.5 |
| | EMW17 | 2.15 | 26.89 |
| **Eastern boundary** | EMW03 | 19.45 | 61.68 |
| | BB02 | 0.93 | 137.43 |
| | EMW19 | 3.47 | 34.78 |
| **Northern boundary** | DB02 | 355.83 | 277.33 |
| **Offsite** | EMW05 | 0.48 | 24.67 |
| | EMW20 | 1.13 | 22.96 |

In EMW05 it was noted that the concentration of ammoniacal nitrogen ranged from below the LOD (<0.01 mg/l) in March, May, June, and September and 1.77 mg/l in October. The elevated concentrations during the middle of the year indicate possible seasonal effects influenced by the low rainfall through the latter part of the year. Aside from this seasonal change there is currently little evidence to suggest significant off-site movement of contaminated groundwater towards the Morell River based on the results obtained during 2021.

The following sections and graphs discuss the results for 2021 for the selected leachate indicator parameters ammoniacal nitrogen and chloride. For detailed analysis and interpretation refer to groundwater and surface water monitoring reports completed since June 2011 (reports available upon request).

### Ammoniacal Nitrogen

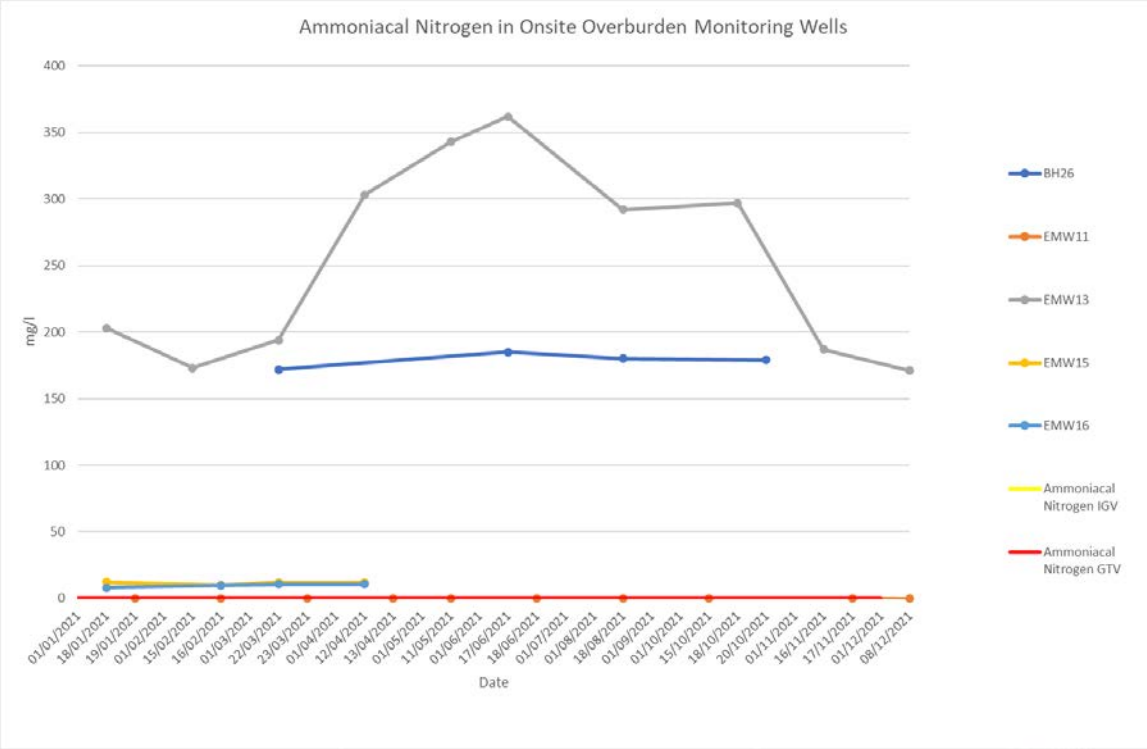
At sites such as Kerdiffstown where there is a history of disposal of municipal and commercial waste streams, ammoniacal nitrogen can typically be present at relatively high concentrations within leachate[3]. Important groundwater nitrogen species include ammoniacal nitrogen (linked to ammonia and ammonium from landfill leachate), nitrate ($NO_3$) and nitrite ($NO_2$). The latter is a transitional species and is usually present at relatively trace concentrations (as has been the case at Kerdiffstown).

[3] This is evidenced by routine chemical analysis of the leachate which is currently collected and removed from the lined cell in Zone 3 of the site where ammoniacal nitrogen is detected.

The Interim Guideline Value (IGV) for ammoniacal nitrogen in groundwater is 0.12 mg/l whereas the Groundwater Threshold Value (GTV) ranges from 0.05 to 0.14 mg/l. Graph 1 presents the gathered data from monitoring between January and December 2021 for onsite overburden wells.

Graph 1 illustrates that throughout 2021 reported ammoniacal nitrogen concentrations in onsite monitoring wells were normally elevated well above the IGV and GTV. Similarly, many of the boundary wells in the lands of Kerdiffstown House, as detailed below, recorded elevated concentrations, with a general reduction towards the Morell River. These results indicate that the leachate migration offsite is currently localised to parts of the site boundary and is not currently getting to the Morell River.

**Graph 7.1 On Site Overburden Wells – Ammoniacal Nitrogen**



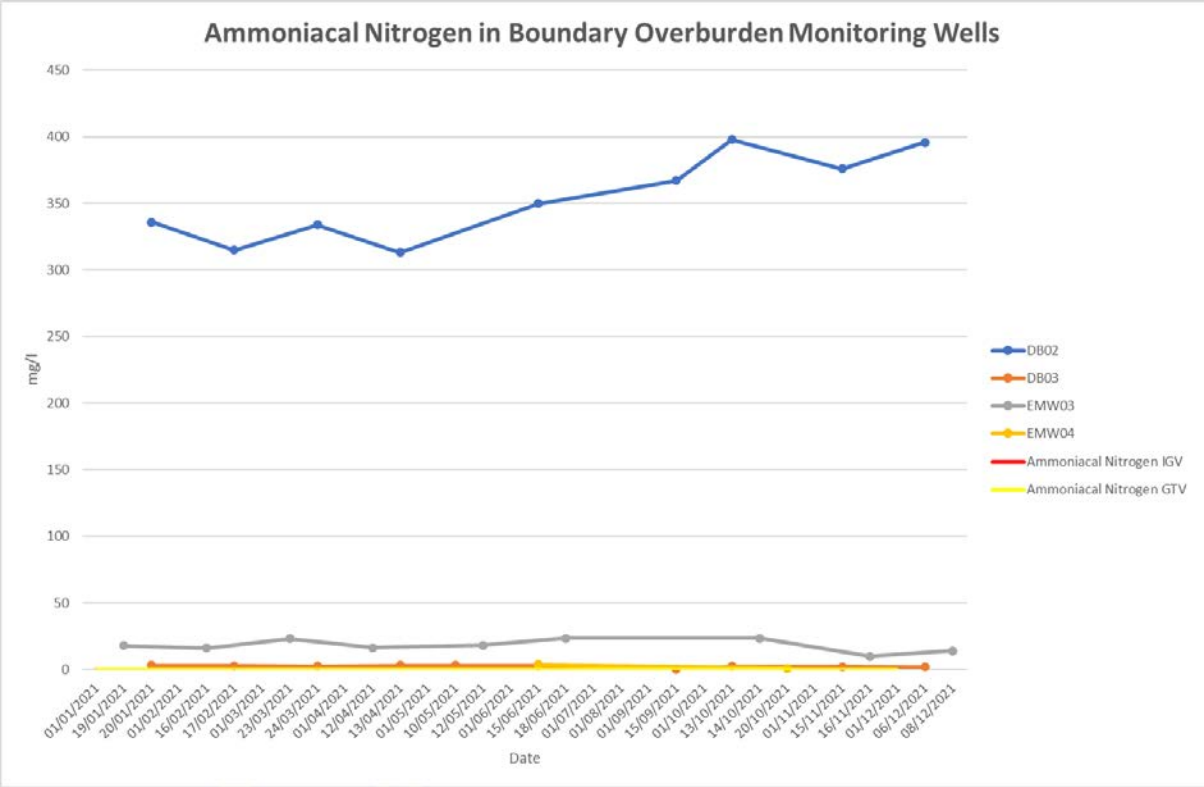

Note: Axes values are different between Graphs

### *Boundary Wells*

Throughout 2021 ammoniacal nitrogen concentrations were generally found to be elevated at monitoring boreholes along the northern and north-eastern boundary area in Zone 1 at DB02, EMW03 and EMW19. Ammoniacal nitrogen (depicted in Graph 2) coupled with the presence of other determinands such as chloride (discussed below) is indicative of the presence of landfill leachate in groundwater beneath this area. This is consistent with the results obtained during monitoring over previous years.

During 2021 concentrations of ammoniacal nitrogen in offsite boundary well DB02 and EMW03 were consistently elevated above the IGV and GTV.

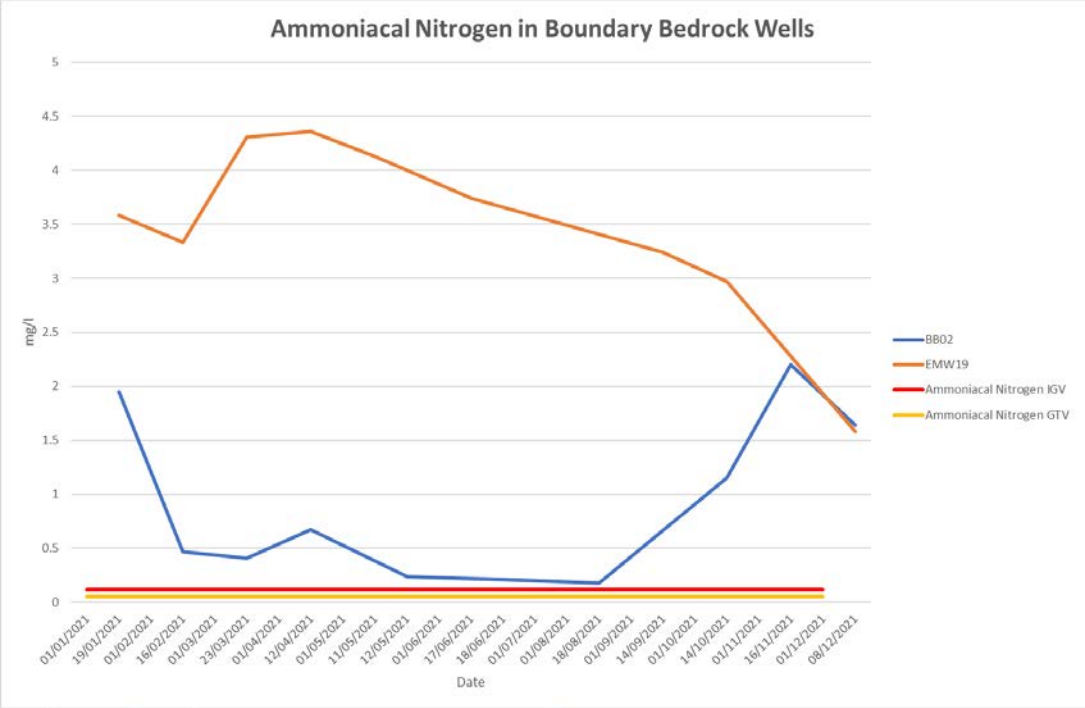
## Graph 7.2 Boundary Overburden Wells – Ammoniacal Nitrogen




Note: Axes values are different between Graphs

Concentrations of ammoniacal nitrogen in the boundary bedrock wells is at much lower concentrations as sown in graph 3 below, albeit with a trend upwards noted throughout the year.

## *Graph 7.3 Boundary Bedrock* Wells – Ammoniacal Nitrogen




Note: Axes values are different between Graphs

### *Off Site Wells*

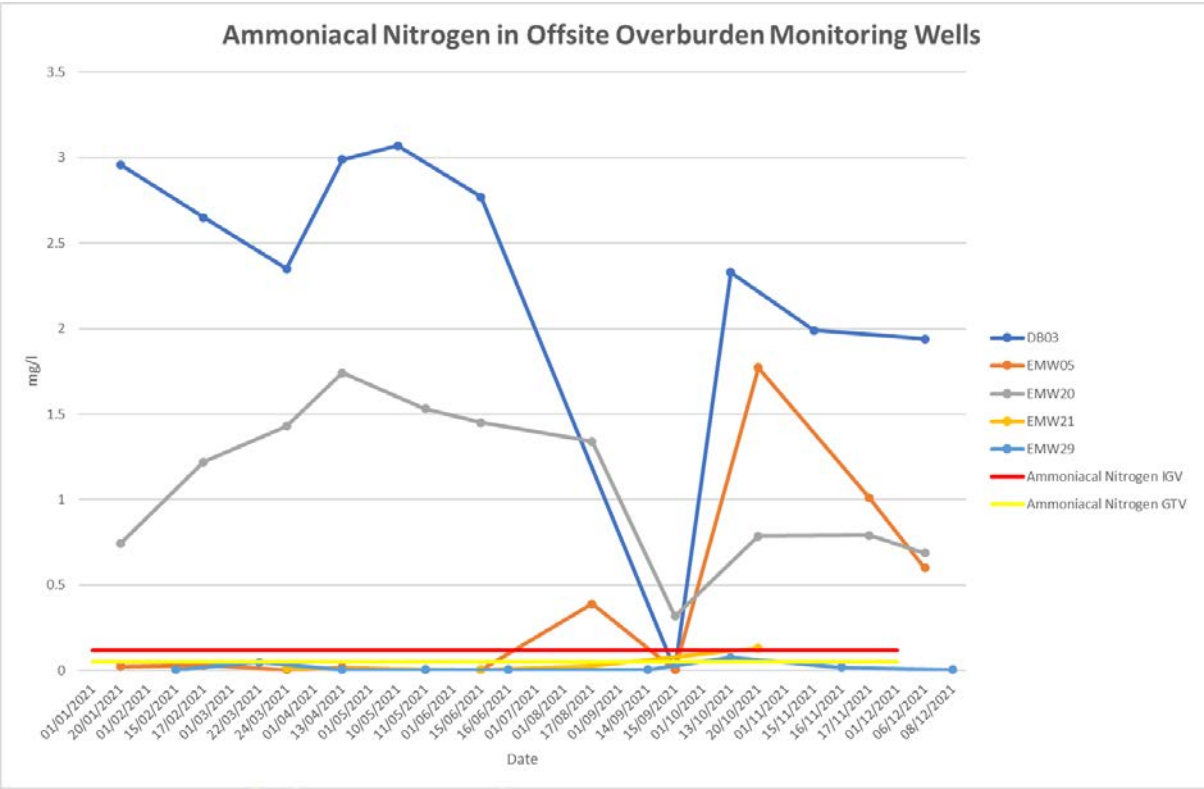
During 2021, in keeping with previous years' data concentrations of ammoniacal nitrogen in both EMW05 and EMW20, located close to the Morell River, were noted to be relatively low compared to concentrations observed in the boundary well EMW03 which is up gradient in terms of hydraulic flow.

At EMW05, situated within five metres of the Morell River, the elevated concentration during the middle of the year indicates that there may be some seasonal variation in this well. EMW05 was added to the monthly groundwater monitoring in 2015 to gather more frequent data regarding the groundwater chemistry closer to the Morell River that will be continued in 2022.

At EMW20 ammoniacal nitrogen concentrations were consistent with 2021 concentrations. Concentrations remained relatively stable with some fluctuation throughout the year.

The rest of the offsite wells located in Kerdiffstown house (EMW21, EMW22 and EMW23) were sampled quarterly in 2021 and all were typically close to or below the LOD for ammoniacal nitrogen. This continues the trend seen over the past number of years, indicating that the leachate migration offsite to the north of the site is localised close to the site boundary.

**Graph 7.4 Offsite Overburden Wells – Ammoniacal Nitrogen**




Note: Axes values are different between Graphs

### Chloride

Chloride is used as a common key indicator for the presence of landfill leachate in groundwater. The IGV for chloride is 30 mg/l whereas the GTV is between 24 mg/l and 187.5 mg/l.

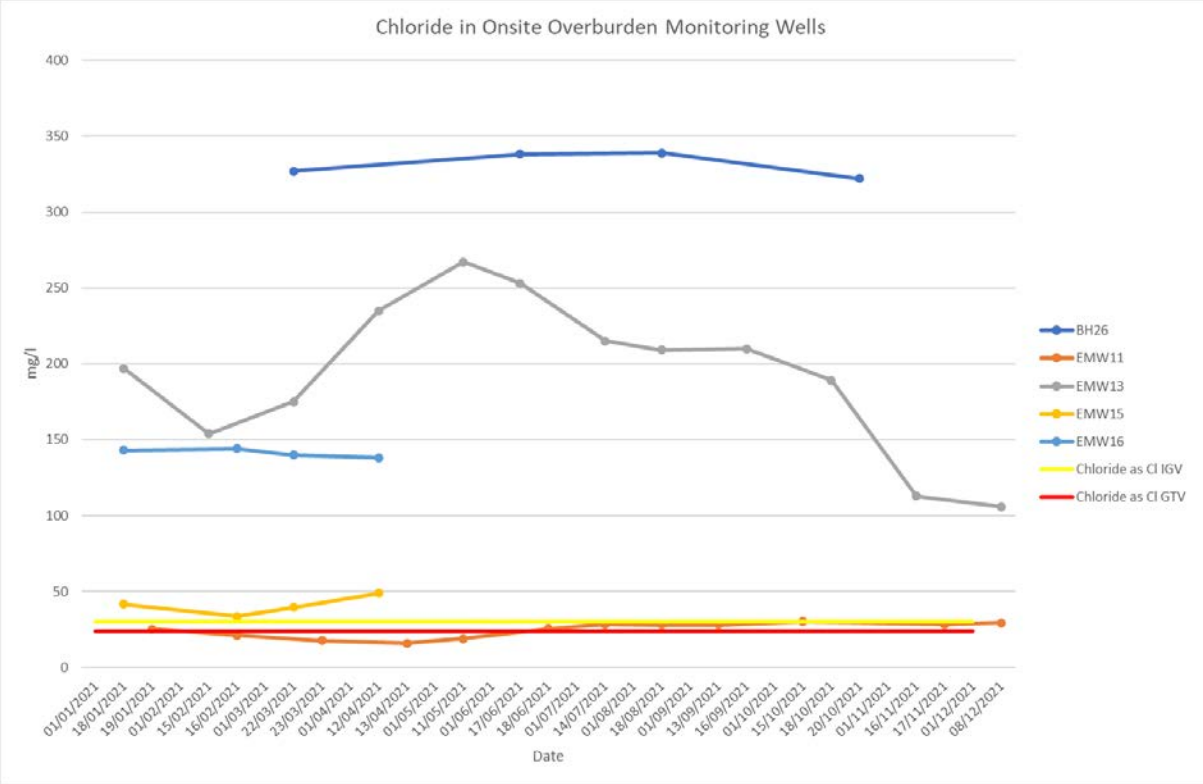
The graph below shows the variation in chloride concentrations for each of the overburden wells sampled on a monthly basis during 2021. A very similar pattern of variation is shown for electrical conductivity (EC) and ammoniacal nitrogen for the corresponding monitoring wells with decreased concentrations generally observed in those samples collected during the winter months, likely as a result of increased rainfall infiltration rates through the waste body in Zone 1 causing dilution of leachate. As with EC and ammoniacal nitrogen this is most pronounced within EMW03.

Chloride concentrations recorded within bedrock monitoring wells during 2021 are shown below also.

### *On Site Wells*

As would be expected, the highest chloride concentrations were recorded in the on-site wells. In 2021 the highest concentration of chloride was detected at on-site monitoring well BH26 located beneath Zone 1 in the northwest of the site. Monthly monitoring at this borehole started in September 2014 to gather more data regarding the groundwater chemistry beneath Zone 1. This well is now monitored quarterly. The average concentration in 2021 was calculated at 331.5 mg/l.

**Graph 7.5 Onsite Overburden Wells – Chloride**




Note: Axes values are different between Graphs

### *Boundary Wells*

Chloride concentrations in EMW03, located at the north-eastern boundary of the site, have consistently shown to be elevated relative to other nearby monitoring wells such as EMW06 and EMW04. The average concentration of chloride detected in

EMW03 during 2021 was 61.68 mg/l with the lowest concentration of 35.4 mg/l detected in November 2021, and the peak concentration of 108 mg/l detected during January 2021.

BB02 has also recorded consistently elevated chloride concentrations similar to or higher than EMW03. The average concentration of chloride detected in BB02 during 2021 was 137.43 mg/l with the lowest concentration of 95.5 mg/l detected in May 2021, and the peak concentration of 199 mg/l detected in July 2021.

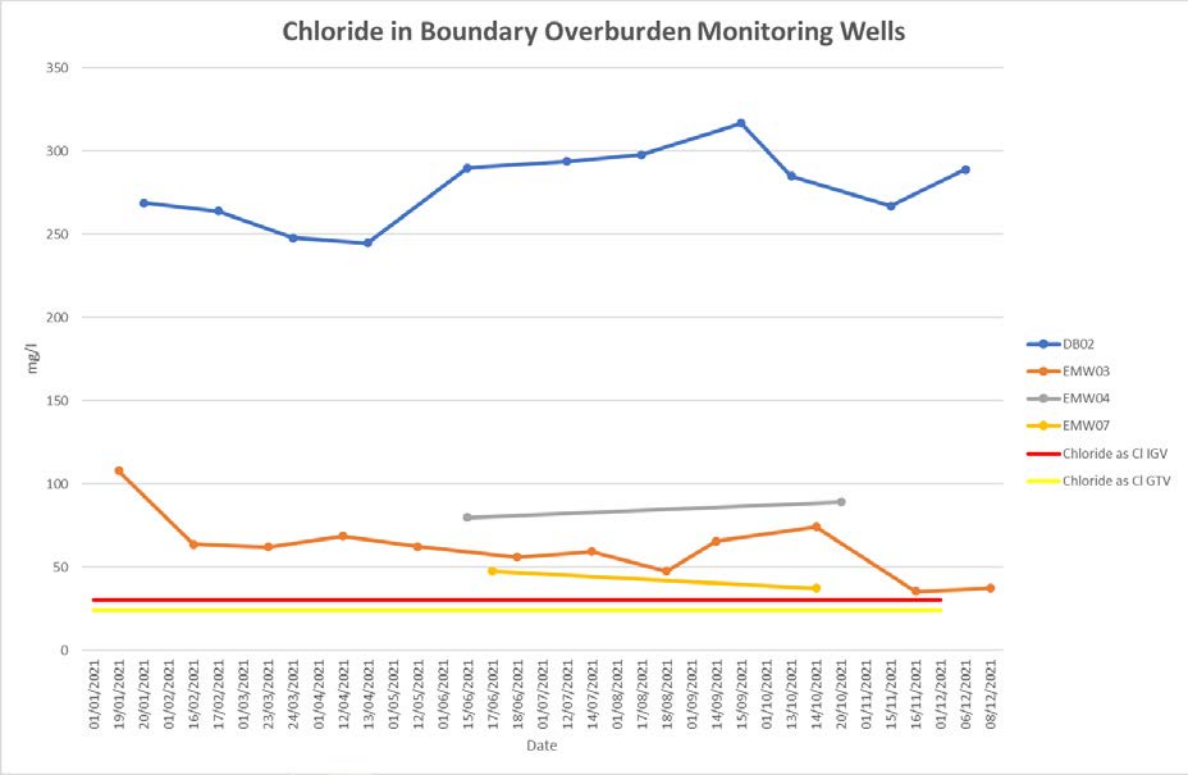
EMW04 has also shown some seasonal variability in chloride concentration, however it is only sampled on a biannual basis so there is insufficient data to confirm this.

EMW07 has shown variability in chloride since monitoring was undertaken in June 2011. This continued in 2021 with chloride concentrations of 47.6 mg/l in June and 37.4 mg/l in October.

At EMW19 (bedrock well), chloride was elevated above the IGV limit of 30mg/l throughout the year (apart from May when chloride was recorded at 29.5 mg/l). EMW19 appears to show seasonal fluctuation with lower chloride concentrations during the winter months when there is increased infiltration of rainfall.

At northern boundary, DB02 has recorded very elevated chloride concentrations since monitoring began in March 2017. The average chloride concentration for 2021 was 277.3 mg/l with the lowest concentration of 245 mg/l recorded in April 2021

**Graph 7.6 Boundary Overburden Wells - Chloride**




Note: Axes values are different between Graphs

### *Off-Site Wells*

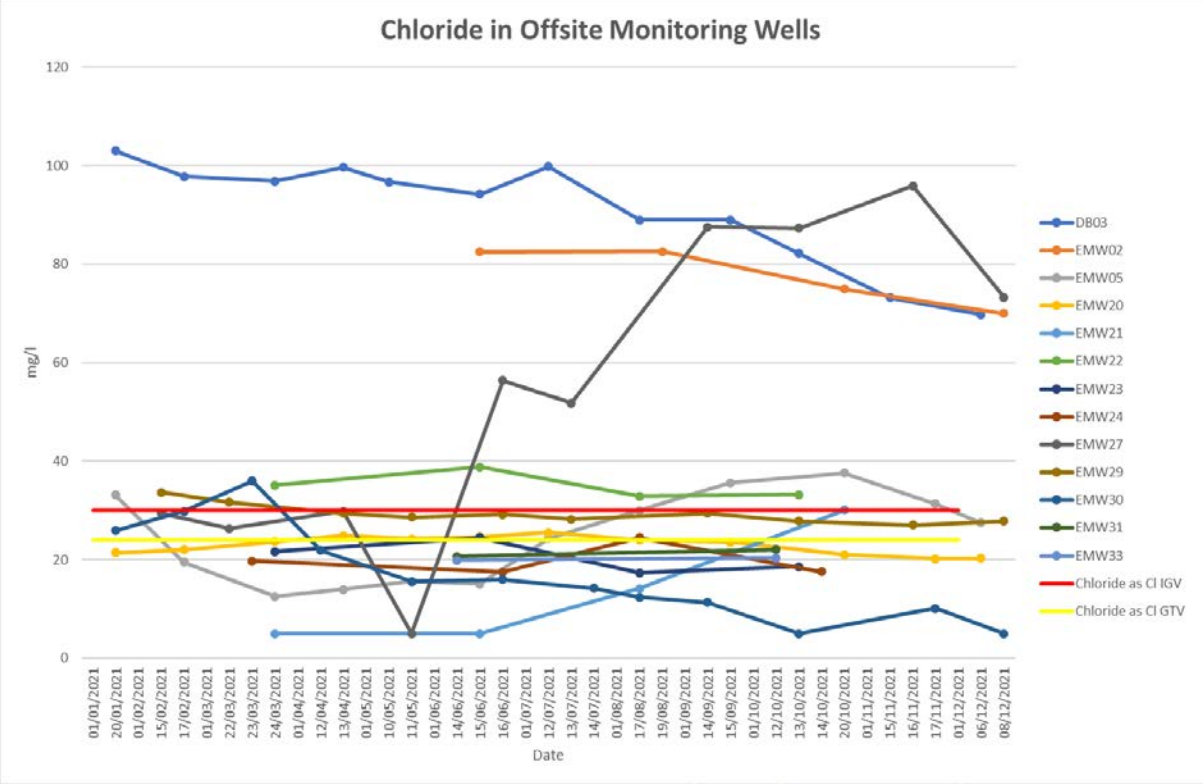
Chloride concentrations were noted to be relatively low in off-site monitoring wells to the north-east during 2021 (e.g., average value of 22.96 mg/l in EMW20 and 24.67 mg/l in EMW05).

EMW05, adjacent to the Morell River, (which may show some limited impact from leachate with elevated ammoniacal nitrogen concentrations and the presence of mecoprop) does not show a clear impact from chloride although the IGV was exceeded on four occasions during 2021 ranging from 31.4 mg/l in November to 37.6 mg/l in October (the maximum chloride concentration ever recorded in EMW05 was 61.3mg/l in September 2011). The lowest chloride concentration was recorded in March at 12.5 mg/l.

DB03, to the north off the site, recorded elevated chloride concentrations since monitoring began in February 2017. The average chloride concentration was recorded at 90.94 mg/l with the lowest concentration of 69.8 mg/l recorded in December and the peak concentration of 103 mg/l recorded in January.

Much lower chloride concentrations were noted in EMW22 and EMW23 which are to the north off DB03, both wells are monitored quarterly. In EMW22 chloride ranged from 33.2 mg/l to 38.8 mg/l. In EMW23 chloride ranged from 17.3 mg/l to 24.5 mg/l. This would indicate that chloride impacts are localised close to the northern boundary.

**Graph 7.7 Offsite Monitoring Wells Overburden and Bedrock - Chloride**




Note: Axes values are different between Graphs

## Metals

During the quarterly and biannual rounds of monitoring in 2021 additional analysis is undertaken. In certain types of wastes when the pH is low the solubility of many metal ions increases and therefore, they can become mobilised into the developing leachate. As such elevated concentrations of trace metals can be indicative of leachate contamination within groundwater.

In terms of dissolved metals, the groundwater results were broadly similar to those recorded in previous monitoring rounds carried out since 2011, both in terms of the number of exceedances against IGVs and GTVs and the location of the exceedances. In 2021 there were exceedances recorded at both on and off-site wells. The majority of exceedances were in wells on-site or on the site's eastern boundary. There were also exceedances recorded off-site to the southwest. For the most part there were no exceedances between the site boundary and the Morell River, with the exception of EMW20 which was found to have barium concentrations above the limit in June (0.13mg/l) and at the IGV in December (0.10mg/l). **Table 7.3** summarises the number of exceedances recorded during the 2021.

**Table 7.3 Dissolved Metals Exceedances of the IGVs/GTVs during 2021**

| Parameter | Lower of IGV/GTV (mg/l) | Number of exceedances | Maximum result (mg/l) | Location of maximum result |
|---|---|---|---|---|
| **Q1 2021** | | | | |
| Boron | 0.75 | 3 | 2.68 | DB02 (N boundary) |
| Cadmium | 0.00375 | 0 | 0.0031 | EMW24 (offsite) |
| Chromium | 0.03 | 0 | 0.0085 | EMW27 (offsite) |
| Copper | 0.03 | 1 | 0.0303 | EMW27 (offsite) |
| Lead | 0.01 | 4 | 0.0581 | EMW27 (offsite) |
| Mercury | 0.0001 | 0 | <0.00001 | All wells |
| Nickel | 0.015 | 4 | 0.0712 | DB02 (N boundary) |
| Zinc | 0.1 | 2 | 0.223 | EMW27 (offsite) |
| **Q2 2021** | | | | |
| Barium | 0.1 | 13 | 0.81 | BH26 (onsite) |
| Boron | 0.75 | 5 | 3.89 | DB02 (N boundary) |
| Cadmium | 0.00375 | 2 | 6.7 | EMW27 (offsite) |
| Chromium | 0.03 | 0 | 0.001 | EMW13 (onsite) & EMW27 (offsite) |
| Copper | 0.03 | 1 | 0.044 | EMW27 (offsite) |
| Lead | 0.01 | 7 | 0.069 | EMW27 (offsite) |
| Mercury | 0.0001 | 0 | <0.00001 | All wells |
| Nickel | 0.015 | 10 | 0.07 | BH26 (onsite) |
| Zinc | 0.1 | 4 | 0.255 | EMW31 (offsite) |
| **Q3 2021** | | | | |

| Parameter | Lower of IGV/GTV (mg/l) | Number of exceedances | Maximum result (mg/l) | Location of maximum result |
|---|---|---|---|---|
| Boron | 0.75 | 5 | 3.58 | DB02 (N boundary) |
| Cadmium | 0.00375 | 1 | 5.5 | EMW27 (offsite) |
| Chromium | 0.03 | 0 | 10.5 | EMW27 (offsite) |
| Copper | 0.03 | 2 | 40 | EMW22 (offsite) |
| Lead | 0.01 | 3 | 78.9 | EMW27 (offsite) |
| Mercury | 0.0001 | 3 | 0.63 | DB03 (offsite) |
| Nickel | 0.015 | 6 | 64.9 | DB02 (N boundary) |
| Zinc | 0.1 | 2 | 283 | EMW27 (offsite) |
| **Q4 2021** | | | | |
| Barium | 0.1 | 11 | 780 | DB02 (N boundary)/EMW31 (offsite) |
| Boron | 0.75 | 5 | 3.64 | DB02 (N boundary) |
| Cadmium | 0.00375 | 1 | 4.4 | EMW27 (offsite) |
| Chromium | 0.03 | 0 | 9 | EMW27 (offsite) |
| Copper | 0.03 | 1 | 39.1 | EMW27 (offsite) |
| Lead | 0.01 | 6 | 63.2 | EMW27 (offsite) |
| Mercury | 0.0001 | 14 | 0.56 | EMW07 (E boundary) |
| Nickel | 0.015 | 7 | 63.8 | BH26 (onsite) |
| Zinc | 0.1 | 1 | 216 | EMW27 (offsite) |

### Organic Compounds

Groundwater samples from all the monitoring wells during June and October 2021 were analysed for a suite of volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), polycyclic aromatic hydrocarbons (PAHs), phenols, formaldehyde, acid herbicides, organo-chlorine pesticides, and total petroleum hydrocarbons (TPH).

### Herbicides & Pesticides

The groundwater samples were analysed for a standard suite of acid herbicides and organo-chlorine pesticides.

Mecoprop is an active ingredient in many broad-leaf weed killers and has been detected in previous years in selected boreholes. Mecoprop is now monitored on a monthly basis in line with licence requirements. Ten of the fifteen wells monitored monthly have recorded mecoprop above the LOD. Of these, two monthly wells have recorded mecoprop above the IGV of 10 µg/l namely EMW13 and DB02. There were no mecoprop detections during the biannual round in June. In the October biannual round there was additional detections on mecoprop but only EMW13 exceeded the IGV.

In February two additional compounds were detected above the respective LODs.

- Dichloroprop was detected in EMW13 (10.6 µg/l) and DB02 (26.7 µg/l)
- Fenoprop was detected in EMW13 (0.43 µg/l).

In May four additional compounds were detected above the respective LODs.

- Dichloroprop was detected in EMW19 (0.07 µg/l) and BB02 (0.11 µg/l)
- MCPA was detected in EMW19 (0.42 µg/l), EMW27 (0.07 µg/l) and BB02 (0.94 µg/l).
- MCPB was detected in EMW19 (0.09 (0.42 µg/l))
- 2,4 D was detected in BB02

In June two additional compounds were detected above the respective LODs.

- Dichloroprop (0.09 µg/l) and 2,4 D (0.09 µg/l) were detected in EMW04

In November one additional compound were detected above the respective LOD.

- Dichloroprop (0.91 µg/l) was detected in EMW13

In December two additional compounds were detected above the respective LODs.

- Dichloroprop (1.76 µg/l) in EMW13 and MCPA (0.07 µg/l) in DB06.

In EMW05, adjacent to the Morell River, mecoprop was detected above the LOD on five occasions with concentrations ranging from 0.06 µg/l to 0.28 µg/l in October. The GTV of 0.075µg/l was exceeded on four occasions. Mecoprop has been detected at this monitoring point on multiple occasions since February 2013. The concentrations recorded have fluctuated between 0.05 µg/l and 1.24 µg/l in that time, the IGV has never been breached. At EMW20, also adjacent to the Morell River, mecoprop was not detected above the LOD of 0.05 µg/l during the year.

**Table 7.4 Mecoprop Detections above IGV (10 µg/l) in 2021**

| *Sample ID* | *Date* | *Result* |
|---|---|---|
| ***DB02*** | 19/01/2021 | 40.2 |
| | 17/02/2021 | 55.9 |
| | 13/04/2021 | 16.6 |
| | 10/05/2021 | 24.3 |
| | 13/07/2021 | 21.2 |
| | 15/09/2021 | 23.5 |
| | 15/11/2021 | 19.2 |
| | 06/12/2021 | 17.9 |
| ***EMW13*** | 20/01/2021 | 14.1 |
| | 12/04/2021 | 21.6 |
| | 15/07/2021 | 17.2 |

| Sample ID | Date | Result |
|---|---|---|
| | 15/09/2021 | 13.3 |
| | 19/10/2021 | 12.2 |
| | | |

### Semi Volatile Organic Compounds (SVOCs)

Excluding phenols (see below for consideration of phenolic compounds), SVOCs were absent in groundwater samples in 2021. Trace concentrations of target list compounds have been detected in past monitoring rounds in on-site boreholes; however, in all cases they have been reported close to the limit of detection and to date no compounds have been reported consistently in any of the boreholes monitored.

### Volatile Organic Compounds (VOCs)

As with SVOCs, VOCs were generally absent in groundwater samples in 2021. In the biannual round in June benzene was detected in EMW13 (1.52 µg/l). In the October biannual monitoring round formaldehyde above the LOD was recorded in 19 wells with concentrations ranging from 0.1 mg/l to 2.4 mg/l (DB02). BH36 recorded four additional compounds namely toluene (0.78 µg/l), ethylbenzene (0.14 µg/l), o-Xylene (0.22 µg/l) and trichloromethane (0.53 µg/l).

### Polycyclic Aromatic Hydrocarbons (PAHs)

There were no detections of PAHs above the LOD of 0.05 µg/l in either of the biannual monitoring rounds. Previous monitoring results have detected PAHs at low-to-trace concentrations in a small number of boreholes including on-site boreholes EMW11, EMW13, BH26, BH68 and GW1D; boundary well DB02 and off-site wells EMW30, EMW31 and EMW33. Based on the pattern of results obtained there is no evidence of significant PAH concentrations in groundwater or off-site migration of PAHs from an on-site source.

### Phenolic compounds

Phenolic compounds (principally comprising phenol) were reported above the LOD of 0.05 µg/l in many of the on-site boreholes. The highest concentrations were in Zone 1 (EMW13 & BH26). DB02 on the northern boundary of the site also recorded phenol above the LOD during 2021. Most wells were below the LOD for the year.

Phenol analysis is now undertaken monthly in line with licence requirements. Further details are presented in quarterly reports available upon request.

### Total Petroleum Hydrocarbons (TPH)

Analysed on a biannual basis (in June and October 2021) there were no detections of TPHs in any monitoring wells sampled in either biannual round.

### 7.1.1. Compliance with Groundwater Regulations[4]

The European Communities Environmental Objectives (Groundwater) Regulations 2010 (S.I. No. 9 of 2010) places a duty on public authorities to take all reasonable steps to prevent the input of hazardous substances and limit the input of non-hazardous substances to groundwater and reverse any significant and sustained upward trend in the concentration of any pollutant resulting from the impact of human activity in order to progressively reduce pollution of groundwater.

The 'prevent' objective relates to hazardous substances, whereby all necessary and reasonable measures should be taken to avoid the entry of such substances into groundwater and to avoid any significant increase in concentration in groundwater, even at a local scale. The 'limit' objective relates to non-hazardous substances, whereby all necessary measures should be taken to limit inputs into groundwater to ensure that such inputs do not cause deterioration in status of groundwater bodies, or a significant and sustained upward trends in groundwater concentrations.

Under the regulations, the EPA may issue exemptions to the 'prevent and limit' requirements of the regulations if, for example:

- Inputs are considered to be of a quantity and concentration so small as to obviate any present or future danger of deterioration in the quality of the receiving groundwater.
- Inputs are considered incapable, for technical reasons, of being prevented or limited without using:
- measures that would increase risks to human health or to the quality of the environment as a whole, or
- disproportionately costly measures to remove quantities of pollutants from or otherwise control their percolation in, contaminated ground or subsoil.

An example of where such an exemption could apply is given in Guidance on the Authorisation of Discharges to Groundwater (EPA December 2011) as an old, unlined landfill where full remediation may do more environmental harm than good.

**Determination of Compliance**

Groundwater data shows elevated concentrations compared to upstream groundwater quality and environmental quality standards for certain compounds. For the areas of the site where no basal liner is present, i.e., all zones excluding Zone 3, the requirements of the EC Environmental Objectives (Groundwater) Regulations 2010, S.I. No. 9 of 2010 cannot be achieved. The remediation works will offer mitigation to this continued release of contamination to groundwater, but hazardous substances are likely to continue to discharge to groundwater following the works.

In considering the remedial options available for the site, it was determined that the alternatives which could lead to the prevention of the discharge of hazardous substances such as excavation and removal of wastes would either present significant risks to human health and the environment as a whole or were too costly.

[4] Extracts from Environmental Impact Assessment Report (EIAR) Volume 2 of 4: Main Report

Part II of S.I. No. 9 of 2010 details the requirements of a Public Authority to ensure compliance. These include prevention, protection, and reverse of any damage to groundwater. It is deemed that the remediation work reaches these requirements, and the monitoring of the Aftercare Phase will ensure continued compliance.

**Conclusion**

Previous studies for the proposed remediation works concluded that the best solution, with the lowest environmental impact involves capping the current areas of waste, following only minimal excavating and movement of these wastes. Capping is a technology that forms a barrier between the waste and the surface, thereby protecting people and the environment from potential harmful effects and limiting the migration of pollutants including landfill gas and leachate. The movement of some wastes and material within the site is required in order to achieve stable engineered slopes and to allow for the management of surface water drainage.

Baseline data for groundwater collected over a number of years has identified that due to the historical use of the site as a landfill site, landfill leachate has locally contaminated the groundwater system. There is no evidence that this contamination is impacting adversely on local surface watercourses or groundwater abstractions.

This baseline data gathered for these determinands a will be used to assess if there is any improvement or deterioration in groundwater quality in the remediation or aftercare phases as a result of the works.

Leachate from the landfill has relevant hazardous substances associated with it including ammoniacal nitrogen, metals/metalloids (including nickel, zinc, and arsenic) and certain organic substances including phenol and mecoprop. These substances are likely to continue to be released to groundwater from the waste during the remediation works and in the aftercare period.

Given the potential impacts of the contaminants associated with leachate on water quality and ecology within the Morell River, principally through potential migration in a shallow groundwater pathway, leachate must be managed to prevent it entering water or to ensure the risk of impact is at an acceptable level. This will be achieved by installing a capping system over the predominant areas of waste in the site to reduce infiltration and managing leachate head in Zone 3 (lined cell) to an appropriate level. The assessment of viable remediation options has established that the complete prevention of leachate ingress into the groundwater system is not technically feasible and/or would be disproportionally costly, where the Groundwater Directive permits exemptions in this scenario.

The installation of engineered capping and soil cover systems across the site will reduce infiltration of water and hence the potential for leachate generation and migration to groundwater, giving a reduction to the environmental risk profile of the site to a likely acceptable level.

## 7.2. Surface Water

Monitoring of surface water samples from the Morell River (east of site) was undertaken at key strategic locations (shown in **Table 7.5**) during the monthly monitoring rounds to assess whether the landfill is having an adverse impact upon water quality.

The surface water lagoon was tested every month from January to July in 2021. In late July 2021 the surface water lagoon was filled in as part of the construction works for the main surface water retention pond onsite for Kerdiffstown Park. Sampling of the surface water lagoon has subsequently been removed from the monitoring programme.

The quarterly sampling rounds include the monthly locations and monitoring of SW08 which is located on the Hartwell River, a tributary of the Morell River, and is accessed on the Palmerstown Golf Club (PGC) estate to the east. This sample point was tested in March, June, September and October 2021.

In the biannual sampling rounds in June and October 2021, samples were obtained from all monthly monitoring locations, SW04 on the Morell River, and SW08 and SW16 which are located on the Hartwell River on Palmerstown Golf Club (PGC) estate.

Refer to Figure 3B 'Surface Water Monitoring Locations' for an overview of tall surface water monitoring locations.

**Table 7.5 Surface Water Sampling Locations and Sampling Frequency**

| Water Body | Sampling Location | Orientation from site | Monthly Sampling | Quarterly Sampling | Biannual Sampling |
|---|---|---|---|---|---|
| Morell River | SW01 | Upstream SE | ✓ | ✓ | ✓ |
| | SW02 | Upstream E | ✓ | ✓ | ✓ |
| | SW03 | Adjacent E | ✓ | ✓ | ✓ |
| | SW04 | Adjacent E | | | ✓ |
| | SW05 | Downstream NE | ✓ | ✓ | ✓ |
| Onsite Waterbody | SW Lagoon | Onsite | ✓ | | ✓ |
| Watercourse on PGC (Hartwell River) | SW08 | Upstream SE | | ✓ | ✓ |
| | SW16 | Upstream SE | | | ✓ |

### *Surface Water Quality Analysis*

Surface water sampling in 2021 consisted of collecting grab samples from the Morell River, the onsite surface water lagoon (up to July), and the Hartwell River in the

Palmerstown Golf Club estate to the east of the Morell River. During the monthly rounds, up to 5 no. surface water samples were obtained (refer to **Table 7.5**) and analysed for a suite of inorganic analytes including major ions.

In the quarterly sampling rounds in March and September 2021 a total of 5 locations upstream, adjacent and downstream of the landfill were sampled (Figure 3) in order to assess any changes in water quality linked to the site.

In the biannual sampling rounds in June and October 2021 7 no. locations upstream, adjacent and downstream of the landfill were sampled (Figure 3). The samples were analysed for an expanded suite of inorganic parameters including major ions and metals/metalloids as well as a broad suite of organic compounds including polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), speciated phenols, herbicides and pesticides. The main results for 2021 are summarised below.

### Ammoniacal Nitrogen

**Table 7.6** gives a summary of surface water ammoniacal nitrogen results during 2021. For illustrative purposes the 'good status' surface water quality standard for ammonia (as N) as stipulated in European Union Environmental Objectives (Surface Waters) Regulations 2009, as amended, is ≤0.065 mg/l (mean).

#### *Morell River*

On review of the results reported, all samples taken in the Morell River during 2021 comply with the ≤0.065 mg/l mean for "good status" surface waters.

#### *Palmerstown House Estate (Hartwell River)*

Biannual monitoring was completed for the surface waters taken from the Hartwell River in Palmerstown Golf Club in June and October 2021, and quarterly rounds of monitoring were completed in March and September 2021. In 2021, the mean Ammonia concentration recorded for SW08 (0.15 mg/l) exceeded the ≤0.065 mg/l mean for "good status" surface waters. The quality standard was not exceeded for and SW16 (0.02 mg/l) in 2021.

**Table 7.6 Ammoniacal Nitrogen in Surface Water Samples 2021**

| Water Body | Sampling Location | 2021 Range Ammoniacal Nitrogen (mg/l) | Orientation from site |
|---|---|---|---|
| Morell River | SW01 | <0.01 - 0.05 | Upstream SE |
| | SW02 | <0.01 - 0.07 | Upstream E |
| | SW03 | <0.01 - 0.07 | Adjacent E |
| | SW04 | <0.01 - 0.02 | Adjacent E |
| | SW05 | <0.01 - 0.07 | Downstream NE |
| Onsite Waterbody | SW Lagoon | <0.01 - 1.38 | Onsite |
| Watercourse on PGC (Hartwell River) | SW08 | 0.02 - 0.37 | Upstream SE |
| | SW16 | 0.01 - 0.03 | Upstream SE |

### Total Organic Carbon (TOC), Chemical Oxygen Demand (COD) & Biochemical Oxygen Demand (BOD)

Results of TOC, COD and biochemical oxygen demand (BOD) are summarised below. For illustrative purposes the “good status” surface water quality standard for BOD as stipulated in European Union Environmental Objectives (Surface Waters) Regulations 2009, as amended, is ≤1.5 mg/l (mean).

In the absence of COD limits under the above legislation, the limits for waters used for drinking water abstraction for COD is 40 mg/l (Ref: European Communities (Quality of Surface Water Intended for the Abstraction of Drinking Water) Regulations, 1989.)

#### *Morrell River*

The concentrations of TOC in the Morell River during 2021 ranged from 1.1 mg/l up to 10.0 mg/l (refer to **Table 7.7**). There was no significant difference observed in the TOC concentrations between upstream and downstream sampling points.

BOD results for surface water samples obtained from the Morell River in 2021 were close to or below the limit of detection in all instances, ranging from <2 mg/l to 6 mg/l. The trend for COD follows a similar pattern and all results were below the 40 mg/l limit for A3 waters in 2021.

#### *Palmerstown House Estate (Hartwell River)*

TOC concentrations were relatively stable on the Hartwell River (1.3 mg/l to 3.3 mg/l) during 2021 (refer to **Table 7.7**), which is broadly similar to that of the Morell River.

BOD results for surface water samples obtained in 2021 were all below the laboratory limit of detection (<2 mg/l) and COD concentrations for SW08 and SW16 were also below the LOD (8 mg/l).

**Table 7.7 Total Organic Carbon in Surface Water Samples 2021**

| Water Body | Sampling Location | 2021 Range TOC (mg/l) | Orientation from site |
|---|---|---|---|
| Morell River | SW01 | 1.1 - 5.9 | Upstream SE |
| | SW02 | 1.2 - 10.0 | Upstream E |
| | SW03 | 1.2 - 8.7 | Adjacent E |
| | SW04 | 1.8 - 2.8 | Adjacent E |
| | SW05 | 1.3 - 9.3 | Downstream NE |
| Onsite Waterbody | SW Lagoon | 5.0 - 15.0 | Onsite |
| Watercourse on PGC (Hartwell River) | SW08 | 1.3 - 3.3 | Upstream SE |
| | SW16 | 1.4 - 2.1 | Upstream SE |

**Table 7.8 COD and BOD in Surface Water Samples 2021**

| Water Body | Sampling Location | 2021 Range BOD (mg/l) | 2021 Range COD (mg/l) | Orientation from site |
|---|---|---|---|---|
| Morell River | SW01 | <2 - 6 | <8 - 10 | Upstream SE |
| | SW02 | <2 - 2 | <8 - 14 | Upstream E |
| | SW03 | <2 - 2 | <8 - 14 | Adjacent E |
| | SW04 | <2 | <8 | Adjacent E |
| | SW05 | <2 - 3 | <8 - 16 | Downstream NE |
| Onsite Waterbody | SW Lagoon | <2 - 7 | <8 - 46 | Onsite |
| Watercourse on PGC (Hartwell River) | SW08 | <2 | <8 | Upstream SE |
| | SW16 | <2 | <8 | Upstream SE |

## Chloride

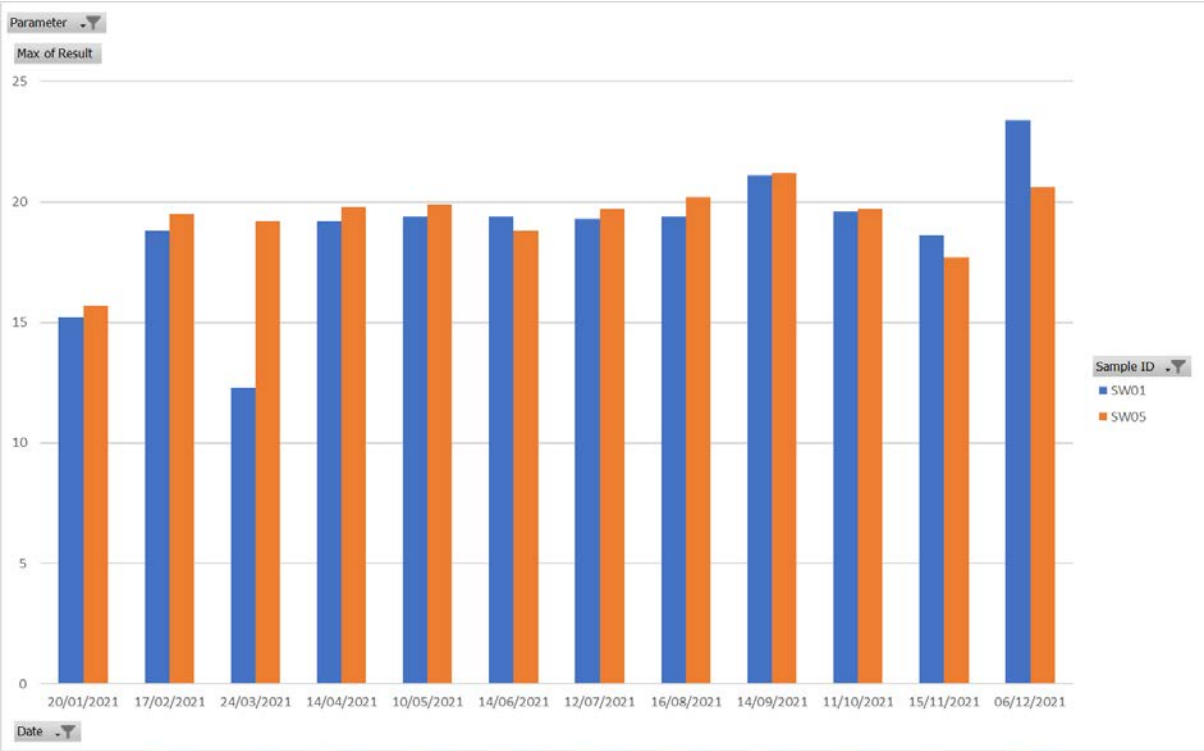
For illustrative purposes the parametric value for chloride in drinking water and water to be abstracted for drinking is 250 mg/l.

### *Morrell River*

Chloride was observed at low concentrations in the Morell River samples in 2021, with concentrations ranging between <10.0 mg/l at SW02 in March and 23.4 mg/l recorded at SW01 in December. **Graph 7.5** and **Table 7.9** shows there is little variation in chloride concentrations in the river. In 2020 levels were found to be relatively stable from month to month with SW05 being higher in concentration in five out of twelve monitoring events. In 2021, levels at SW05 are recorded as being marginally higher in nine out of 12 monitoring events with levels remaining stable throughout the year.

Given the small magnitude of the changes in concentration, it is uncertain if this could be attributable to landfill leachate discharging to the river or other sources or laboratory uncertainty. In all surface water samples taken from the Morell River the concentrations of chloride detected were below the Drinking Water and Surface Water Regulations limit of 250 mg/l.

**Graph 7.8 Chloride in Morell River – Upstream (SW01) vs downstream (SW05) 2021**




***Palmerstown House Estate (Hartwell River)***

Concentrations of chloride in samples obtained from the Hartwell River on the PGC Estate in 2021 were broadly similar to those in the Morell River with concentrations ranging from <10.0 mg/l to 18.2 mg/l at SW08 and 16.2 mg/l to 16.9 mg/l at SW16. The chloride levels recorded in 2021 are similar to previous years. All of the results from the Hartwell River were well below the drinking water limit of 250 mg/l.

**Table 7.9 Chloride in Surface Water Samples**

| Water Body | Sampling Location | 2021 Range Chloride (mg/l) | Orientation from site |
|---|---|---|---|
| Morell River | SW01 | 12.3 – 23.4 | Upstream SE |
| | SW02 | <10.0 – 21.4 | Upstream E |
| | SW03 | 15.6 – 21.0 | Adjacent E |
| | SW04 | 18.9 – 19.8 | Adjacent E |
| | SW05 | 15.7 – 21.2 | Downstream NE |
| Onsite Waterbody | SW Lagoon | <10.0 – 51.7 | Onsite |
| Watercourse on PGC (Hartwell River) | SW08 | <10.0 – 18.2 | Upstream SE |
| | SW16 | 16.2 – 16.9 | Upstream SE |

### 7.2.1. Biological Q-rating assessment

The last biological Q-rating assessment was undertaken in August 2020. Biological monitoring of the Morell River is not required until Kerdiffstown Landfill begins to discharge from the site. However, KCC have chosen to continue monitoring in advance of this date.

In September 2021 the assessment involved macroinvertebrate sampling at eighteen locations, twelve on the Morell River and six on the Hartwell. This included eleven of the sites monitored since 2018 plus one site on the Morell commonly used by the EPA for Q-value assessments (M13) added in 2020. The monitoring locations were selected to provide an indication of the water quality of the main tributaries of both rivers and were chosen to help interpret the proximity of upstream pollution sources. The Hartwell River, one of the main tributaries of the Morell River was assessed to determine its influence on the water quality of the Morell. These included six in the Morell River (M1-6); and one in its tributary, the Hartwell River (H1) and three additional site; two further upstream on the Morell (M7 & M8, 1 km upstream from M1) and one on the Hartwell (H2) above the existing monitoring site (H1). Two near the headwaters of the Hartwell (H3 & H4), three on the Morell (M9, M10 & M13) and one on the Morell tributary (M12). Two additional sites that were included in the 2018 survey, one at Arthurstown (H6), one between Arthurstown and Johnstown (H5). The macroinvertebrate data was used to derive a Q-value for each monitoring location based on the proportions of different macroinvertebrate groups.

The Q-value results are listed in Table 7.10 below. The results of the current survey indicate that the Hartwell stream further upstream is generally of good water quality (mostly Q4-5) and only deteriorates to a polluted rating at the site near Johnstown, east of the M7 motorway (H2). This site has now consistently shown polluted status in the last few years. As the further upstream site M5, located south of Kill village, has been assigned a Q4-5 it suggests that there is a significant source of pollution that occurs within this relatively short stretch between these two sites. The water quality in the Hartwell has fluctuated over the years and is probably typical of such small streams that have little dilution capacity.

The Morell in contrast varied in water quality, but the results from the surveys this year are encouraging. Stretches in the upper reaches are achieving good ecological status based on macroinvertebrate communities (both M9 and M13) although there were polluted stretches both upstream (M10) and downstream (M8) before the Morell reaches Johnstown. Another encouraging aspect is that the stretch (M3 to M6) alongside Kerdiffstown has improved to a Q4. This was verified by the presence of sensitive taxa and a good representation of generally pollution-sensitive taxa at all the sites from M3 to M6. This is despite the fact that much of the substrates at these sites are embedded leaving little space for invertebrates to live. As there were no signs of the water quality declining downstream any impact arising from the Kerdiffstown facility could not be decerned based on the survey results this year. (Full report available upon request).

**Table 7.10 2021 Q-values results for biological assessment locations**

| Monitoring Point | Location | Q-Value |
|---|---|---|
| M1 | Upstream of landfill | Q3 |
| M2 | Upstream of landfill, just upstream of tributary | Q3 |
| M3 | East of landfill, just downstream of tributary | Q4 |
| M4 | East of landfill | Q4 |
| M5 | Northeast of landfill | Q4 |
| M6 | Downstream of landfill | Q4 |
| M7 | Upstream of landfill (1km) | Q3 |
| M8 | Upstream of landfill (1km) | Q3-4 |
| M9 | Upstream of landfill (Beggar's End crossroads) | Q4 |
| M10 | Upstream of landfill (near Newtown Great) | Q3 |
| M12 | Morell Tributary (N.E. Baysland) | Q3 |
| M13 | Morell River, west of Tipper North | Q4-5 |
| H1 | Hartwell River (tributary of Morell) | Q4 |
| H2 | Hartwell River (tributary of Morell) | Q3-4 |
| H3 | Hartwell River (near Rathmore) | Q4-5 |
| H4 | Hartwell River (upstream of H3) | Q4-5 |
| H5 | Hartwell River (southeast of Kill) | Q4-5 |
| H6 | Hartwell River (adjacent to Arthurstown) | Q4-5 |

## 7.3. Leachate

Monitoring of leachate pumped from the lined cell was carried out by the site management on a weekly basis comprising a single sample taken at the leachate storage tanks and sent to the laboratory for analysis for the following parameters:

- pH, electrical conductivity, COD, chloride, and ammonia.

Analysis for an expanded suite of parameters on a quarterly, biannual, and annual basis was completed during 2021. These included dissolved methane, heavy metals, and priority substances.

A summary of the results for 2021 is provided in **Table 7.11**.

**Table 7.11 Summary Composition of Leachate**

| Parameter | Max (mg/l) | Date Observed | Min (mg/l) | Date observed | Average (mg/l) |
|---|---|---|---|---|---|
| Ammoniacal Nitrogen as N | 977 | 15 November 2021 | 156 | 9 February 2021 | 512 |
| Chloride | 933 | 15 November 2021 | 132 | 6 December 2021 | 540 |
| COD | 1550 | 13 July 2021 | 209 | 9 February 2021 | 956 |

Analysis of leachate from the lined cell area during 2021 showed a noted increase in concentration of all parameters except pH in comparison to that of 2020. In 2020 ammoniacal nitrogen results ranged from 136 mg/l to 566 mg/l, chloride results ranged from 117 mg/l to 552 mg/l, and COD ranged from 167 mg/l to 1439 mg/l.

As shown in **Table 7.11** ammoniacal nitrogen ranged from 156 mg/l recorded in February to 977 mg/l in November 2021.

Chloride ranged from 132 mg/l in December to 933 mg/l recorded in November 2021.

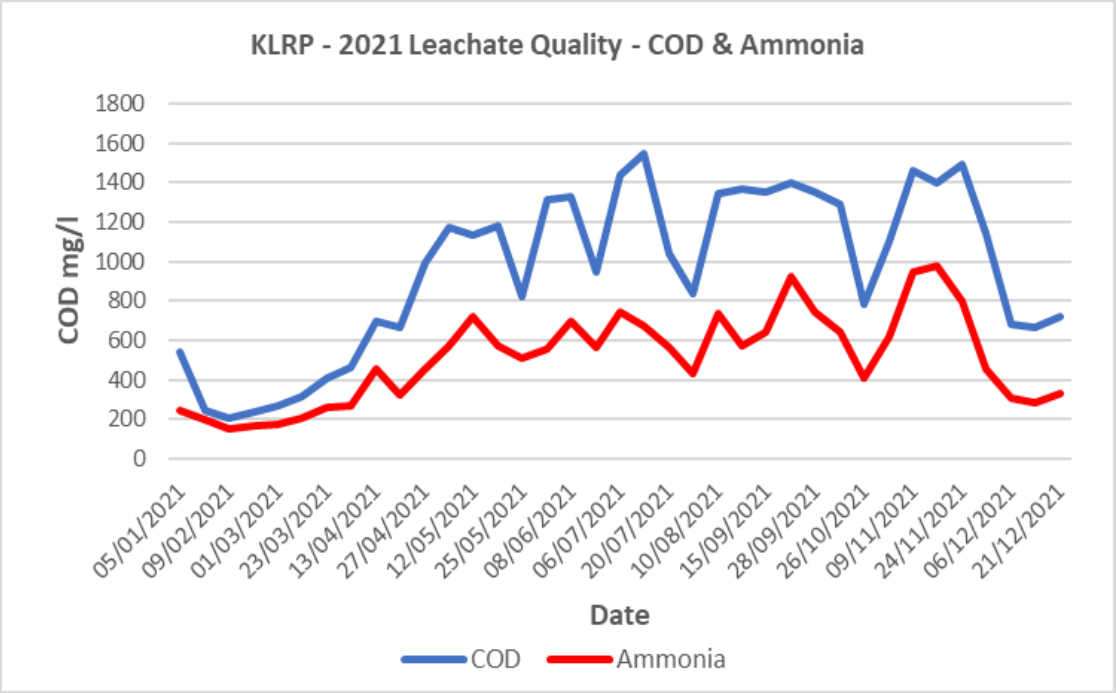
Concentrations of COD ranged from 209 mg/l recorded in February to 1550 mg/l in July 2021.

Concentrations can vary dramatically during the year as can be seen in Graphs 7.6 and 7.7. Historically this has been largely because leachate production and quality on this site is very much rainfall dependant. High rainfall levels or prolonged rainfall events lead to increased volumes of leachate, but it also dilutes the leachate meaning that the leachates produced can often contain lower concentrations of pollutants. Graphs 7.6 and 7.7 show peaks and troughs throughout 2021. The peaks generally correspond with dryer periods (in November for example), while wetter periods show decreases in pollutant concentrations (in January for example).

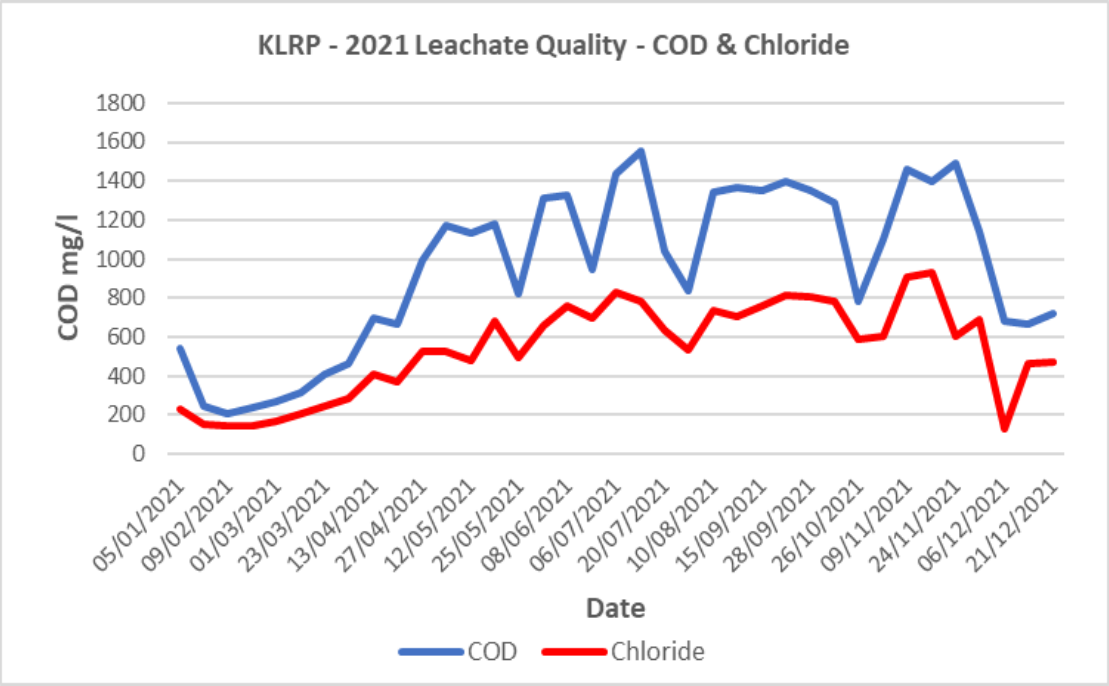
It is considered that this increase in concentration is partly due to a lack of dilution of leachate due to low levels of rainfall during 2021. With the progression of the capping works in the Lined Cell, the impact of rainfall levels on the volumes of leachate produced should reduce somewhat over the coming months.

Perhaps the most significant contributing factor during 2021 related to the remediation works is the excavation and movement of waste material from Zone 4 into the lined cell during Quarter 2 and the subsequent placement of a liner on the waste material. This would contribute significantly to the volume of leachate and increased concentration of the parameters monitored from Quarter 2 onwards. Repairs on the basal liner within the lined cell also took place during Quarter 3 which could further reduce the potential for dilution of the leachate. Capping works on the lined cell are still in progress and are projected for completion during Q1 2022.

## Graph 7.9 Leachate Composition - COD and Ammoniacal Nitrogen




## Graph 7.10 Leachate Composition - COD and Chloride



## 7.4. Landfill Gas

### 7.4.1. Perimeter/Offsite Landfill Gas Monitoring

Monthly off-site and perimeter landfill gas monitoring is undertaken by KCC (refer to Figure 3B 'Perimeter Landfill Gas Monitoring Locations' for an overview of the perimeter landfill gas wells).

A GA5000 infra-red gas analyser is used to record methane, carbon dioxide and oxygen concentrations as well as atmospheric pressure. The older wells monitored (i.e., EMW02-EMW08 and EMW10) are groundwater monitoring wells with gas taps fitted. 13 new perimeter gas monitoring wells were installed during 2019 and an additional 13 wells were installed during 2020. These wells have been included in the monthly monitoring programme as per licence conditions. Additional perimeter wells will be installed onsite as the remediation project progresses.

Tables 7.12 and 7.13 provides a summary of the results from perimeter and off-site landfill gas monitoring completed in 2021.

Methane was detected at a concentration in exceedance of the trigger level of 1.0 %v/v CH4 at GM08 during monthly perimeter gas monitoring in May, June, and September 2021. This monitoring well is located adjacent to the site entrance. It was not detected at any other monitoring well throughout the monitoring period. The exceedance was reported as an incident to the EPA in accordance with the requirements of the IEL. No odours have been detected in the vicinity of this well and only low levels of Hydrogen Sulphide (0-8ppm) have been detected in the well itself, so no odour impact is anticipated. Investigation of the source of methane this area is ongoing and weekly landfill gas monitoring of GM08 is taking place.

The concentration of carbon dioxide in a number of the perimeter wells was found to be consistently higher than the IEL limit level for carbon dioxide (1.5% $CO_2$ v/v). Tables 7.12 and 7.13 provide a summary of the results with highlighted cells indicating exceedance of the respective trigger limits for methane and carbon dioxide. These exceedances were reported as an incident to the EPA in accordance with the requirements of the IEL.

**Table 7.12 Offsite and Perimeter Landfill Gas Monitoring Results 2021 - Methane ($CH_4$)**

| | Methane ($CH_4$) % v/v | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| EMW02 | NR | NR | 0 | 0 | NR | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EMW03 | 0 | 0 | NA | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EMW04 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EMW05 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EMW06 | 0 | 0 | NA | 0 | 0 | 0 | 0 | 0 | 0 | NA | NA | - |
| EMW07 | 0 | 0 | NA | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | Methane ($CH_4$) % v/v | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| EMW08 | NR | NR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EMW10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GM05 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GM06 | NA | 0 | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GM06A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GM07 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | NA | 0 | 0 |
| GM08 | 0 | 0 | 0 | 0 | **3.9** | **1.1** | 0 | 0 | **2.6** | **0** | 0 | 0 |
| GM09 | 0 | 0 | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GM10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GM12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GM13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | NA | 0 | 0 | 0 |
| GM17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GM18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GM19 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GM20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GM21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GM22 | 0 | 0 | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GM23 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GM24 | 0 | 0 | 0 | 0 | 0 | NA | NA | 0 | 0 | 0 | 0 | 0 |
| GM25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GM26 | 0 | 0 | 0 | 0 | 0 | NA | NA | NA | NA | NA | NA | 0 |
| GM27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GM28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GM28A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | Methane ($CH_4$) % v/v | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| GM29 | 0 | 0 | 0 | 0 | 0 | NA | NA | NA | 0 | 0 | 0 | 0 |
| GM30 | 0 | 0 | 0 | 0 | 0 | 0 | NA | NA | NA | NA | 0 | 0 |
| GM31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GM35 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.8 |

**Notes:** Bold and shaded - elevated levels (i.e., levels that are greater than the trigger levels given in Schedule B.1.3 of the Waste Licence) of $CH_4$ and $CO_2$.

EMW06 was damaged during the remediation works and was decommissioned in December 2021.

NR – no result as wells were flooded at the time monitoring.

NA – not accessible

**Table 7.13 Offsite and Perimeter Landfill Gas Monitoring Results 2021 - Carbon Dioxide ($CO_2$)**.

| | Carbon Dioxide ($CO_2$) % v/v | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| EMW02 | NR | NR | **1.2** | **1.6** | NR | **2.5** | **3.8** | 0.4 | **3.6** | **2.2** | **1.2** | 0.3 |
| EMW03 | 0.1 | 0.2 | NA | 0.3 | 0.3 | 0.1 | 0.3 | 0.1 | 0.4 | 0.8 | 0.5 | 0.2 |
| EMW04 | **3.3** | 0.2 | 0.8 | 0.6 | **2.4** | 0.7 | 0.4 | 0.3 | **1.5** | 0.4 | 2.2 | 3.3 |
| EMW05 | 0.2 | 0.2 | 0.2 | 0.2 | 0.5 | 0.5 | 0.7 | 0.8 | 0.8 | 0.9 | 0.4 | 0.2 |
| EMW06 | **1.8** | 0.6 | NA | **2.5** | 0.5 | 0.3 | 0.1 | 0.6 | 0.1 | NA | NA | - |
| EMW07 | 0.4 | 0.5 | NA | 0.4 | 0.6 | 1.0 | 0.9 | 0.5 | 0.4 | 0.4 | 0.5 | 0.8 |
| EMW08 | NR | NR | 0.3 | 0.8 | 0.3 | 0.3 | 0.1 | 1.0 | 0.6 | 0.2 | 0.3 | 0.6 |
| EMW10 | **2.0** | **1.8** | **3.4** | **3.4** | **2.3** | **2.5** | **3.3** | **3.0** | 0.1 | 0.3 | 0.6 | **4.7** |
| GM05 | 0.8 | 0.2 | 0.2 | 0.4 | 0.2 | 0.2 | 0.4 | 0.7 | 0.7 | 0.7 | **1.5** | 1.2 |
| GM06 | NA | 0.2 | 0.6 | NA | NA | 0.2 | 0.2 | 0.2 | 0.3 | 0.1 | 0.3 | 0.4 |
| GM06A | 0.9 | 0.5 | 0.8 | 0.1 | 1.0 | 0.7 | 1.1 | **1.9** | **2.5** | **5.3** | **2.1** | 1.4 |
| GM07 | 0.9 | 0.8 | 0.9 | 0.9 | 1.4 | **1.7** | **2.3** | **1.9** | **2.2** | NA | 0.8 | 1.2 |
| GM08 | 0.2 | 0.2 | 0.2 | 0.4 | 1.1 | **4.1** | 0.5 | 0.7 | **6.0** | 1.0 | 0.2 | 0.3 |
| GM09 | **5.5** | **7.4** | **8.4** | NA | NA | **11.8** | **13.1** | **11.3** | **12.4** | **11.4** | **10.4** | **8.8** |
| GM10 | **11.2** | **10.7** | **10.5** | **10.1** | **11.2** | **13.6** | **14.8** | **15.1** | **15.6** | **14.5** | **14.3** | **9.7** |
| GM12 | 1.0 | 0.8 | **4.6** | **3.1** | **3.1** | **3.1** | **2.1** | **2.3** | **1.8** | **2.2** | **1.5** | **2.2** |
| GM13 | 0.3 | **2.6** | **2.6** | **2.6** | **3.4** | **5.3** | **4.9** | **3.7** | NA | 1.0 | **2.7** | **3.4** |
| GM17 | 0.1 | 0.1 | **10.1** | 0.9 | 0.1 | 0.7 | 0.5 | **2.4** | 0.9 | 0.5 | 1.1 | **3.0** |
| GM18 | 0.6 | 0.3 | **5.3** | 1.2 | 0.1 | 0.9 | 0.6 | **3.9** | 1.0 | **1.8** | 0.4 | 0.7 |
| GM19 | 0.3 | 0.2 | **3.5** | 0.5 | 0.1 | 1.2 | 1.2 | **3** | **3.4** | **2.0** | 0.5 | **2.6** |
| GM20 | 0.1 | 0.1 | **3.5** | 0.1 | 0.1 | 0.1 | 0.1 | **2.8** | **2.4** | 0.3 | 0.2 | 0.9 |
| GM21 | 1.4 | 0.1 | **7.3** | 0.6 | 0.1 | 1.0 | 0.4 | **7.3** | **8.4** | **2.7** | 0.8 | **7.0** |
| GM22 | 0.1 | 0.1 | **8.4** | NA | NA | 0.1 | 0.1 | **8.2** | **7.3** | **2.7** | 0.6 | **5.7** |

| | Carbon Dioxide ($CO_2$) % v/v | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| GM23 | **2.6** | 0.1 | **9.7** | **2.1** | 0.1 | **3.4** | **4.3** | **8.2** | **3.1** | **4.6** | **2.4** | **5.3** |
| GM24 | 0.2 | 0.1 | **11.3** | 0.3 | 0.1 | NA | NA | **6.4** | **9.1** | 0.3 | 0.7 | **10.8** |
| GM25 | **10.8** | **11.3** | **11.5** | **11.1** | **11.0** | **11.5** | **11.6** | **11.9** | **12.3** | **11.9** | **12.6** | **12** |
| GM26 | 0.1 | 0.1 | **8.7** | 0.5 | 0.1 | NA | NA | NA | NA | NA | NA | **5** |
| GM27 | 0.2 | 0.1 | **7** | 0.1 | 0.0 | 0.1 | 0.3 | 0.9 | **9.2** | **4.8** | **2.7** | **8.2** |
| GM28 | 0.4 | 0.2 | **3.3** | **2.4** | 0.2 | 0.1 | 1.1 | 0.5 | **2.7** | 0.9 | 0.8 | **2.8** |
| GM28A | 0.5 | 0.3 | **2.3** | **1.6** | 0.4 | 0.4 | 0.5 | 1.2 | **1.6** | 1.2 | 0.8 | **2** |
| GM29 | **1.6** | 0.8 | **2.1** | 0.9 | 1.0 | NA | NA | NA | 0.8 | 1.0 | 1.1 | 1.4 |
| GM30 | **2.7** | **3** | **2.9** | 0.9 | 0.1 | 0.1 | NA | NA | NA | NA | 0.6 | 1.1 |
| GM31 | 0.7 | 0.4 | **2.8** | **1.6** | 0.9 | 1.2 | **1.9** | **2.4** | **2.1** | **1.7** | 1.1 | 1.3 |
| GM35 | **3.4** | **3.8** | **3.6** | **3.5** | **4.0** | **5.2** | **7.3** | **3.0** | **8.9** | **11.0** | **12.1** | **12.8** |

Notes: Bold and shaded - elevated levels (i.e., levels that are greater than the trigger levels given in Schedule B.1.3 of the Waste Licence) of CH4 and CO2.

EMW06 was damaged during the remediation works and was decommissioned in December 2021.

NR – no result as wells were flooded at the time monitoring.

NA – not accessible due to new boundary fencing being installed on the site.

### 7.4.2. Trace Gas Analysis

Gas samples were extracted from two landfill gas extraction wells onsite (GW17 and GW46) and sent for laboratory analysis in order to measure the trace gas components as per Environment Agency document “Guidance for Monitoring Trace Components in Landfill Gas (LFTGN 04). The results are presented in **Table 7.14** overleaf.

**Table 7.14 Trace Gas Analysis of Gas Extraction Wells GW17 and GW46**

| Parameter | GW17 | GW46 |
|---|---|---|
| | Concentration (mg/m$^3$) | |
| Vinyl Chloride | 30.0 | 97.0 |
| 1,3-Butadiene | <3.1 | <5.4 |
| Methanethiol | <15 | <27 |
| Chloroethane | <3.1 | 312.0 |
| 1-Pentene | 46.0 | <11 |
| Furan | 31.0 | 65.0 |
| Ethanethiol | <15 | <27 |
| 1,1-Dichloroethene | 3.7 | 15.0 |
| Dimethylsulphide | 8.3 | 7.5 |
| DCM | <3.1 | 54.0 |
| CS2 | 307.0 | 38.0 |
| trans-1,2-Dichloroethene | <1.5 | <2.7 |
| 1,1-Dichloroethene | <1.5 | 145.0 |
| cis-1.2-Dichloroethene | 17.0 | <2.7 |
| Propanethiol | <12 | <22 |
| 1,2-Dichloroethene | <1.5 | <2.7 |
| Carbon tetrachloride | <1.5 | <2.7 |
| Benzene | 491.0 | 52.0 |
| Trichloroethylene | 3.7 | <2.7 |
| Butanethiol | <12 | <22 |
| Dimethyldisulphide | <3.1 | <5.4 |
| Butyric Acid | <3.1 | <5.4 |
| Toluene | 1412.0 | 102.0 |

| Parameter | GW17 | GW46 |
|---|---|---|
| | Concentration (mg/m$^3$) | |
| Ethylbutyrate | <3.1 | <5.4 |
| 2-Butoxyethanol | <3.1 | <5.4 |
| Styrene | 10.0 | <2.7 |
| Arsenic (as As) | <0.30 | <0.26 |
| Acetaldehyde | 5.1 | <0.054 |
| Formaldehyde | 2.4 | 0.11 |
| Hydrogen sulphide | 128.0 | 51.0 |

As part of the laboratory gas analysis conducted the Top 10 Freons were included. The results are shown in Table 2.5.

| Parameter | GW17 | GW46 |
|---|---|---|
| | Concentration (mg/m$^3$) | |
| Perfluoropropane | - | 18 |
| Norflurane | 16 | 172 |
| Ethane, 1-chloro-1,1 difluoro | 258 | 259 |
| Hexafluoropropane | - | 3070 |
| Ethane, 1-chloro-1fluoro | 491 | 862 |
| Fluorodichloromethane | 3.4 | 189 |
| 1,1-Dichloro-1-fluoroethane | 1320 | - |

## 7.5. Air Monitoring

### 7.5.1. Stack Emissions

Odour Monitoring Ireland were commissioned by Kildare County Council to carry out stack emissions testing on the Landfill Gas Flare at Kerdiffstown Landfill. Two rounds of flare stack emissions monitoring were carried out in 2021, round one was completed on the 30 April and the second round was completed on the 22 November 2021. The results are shown in Table 7.15 below. Regarding Oxides of Nitrogen and Carbon Dioxide, all concentrations were well within the Emission Limit Values as set out in Schedule B.1.1 of the licence.

**Table 7.15 Air Stack Monitoring Results 2021**

| Parameter | Units | Round 1 | Round 2 | Limit |
|---|---|---|---|---|
| **Inlet** | | | | |
| Total Sulphur | $mg/m^3$ | 63.77 | - | - |
| Total Chlorine | $mg/m^3$ | <0.14 | - | - |
| Total Fluorine | $mg/m^3$ | <0.12 | - | - |
| **Outlet** | | | | |
| Hydrogen Chloride | $mg/m^3$ | <0.5 | - | - |
| Hydrogen Fluoride | $mg/m^3$ | <0.4 | - | - |
| Sulphur Dioxide | $mg/m^3$ | 125.02 | 197.74 | - |
| Total Volatile Organic Carbon (TOC) | $mg/m^3$ | 1.73 | 2.03 | - |
| Oxides of Nitrogen (as $NO_2$) | $mg/m^3$ | 13.34 | 16.15 | **150** |
| Carbon Monoxide | $mg/m^3$ | 8.71 | 7.8 | **50** |
| Carbon Dioxide | % v/v | 10.57 | 10.69 | - |
| Oxygen | % v/v | 8.4 | 10.33 | - |
| Water Vapour | % v/v | 9.9 | 9.9 | - |

### 7.5.2. Dust Monitoring

Dust is airborne particulate matter in the size range of 1–75μm. In general dust can present a nuisance if it is present at high concentrations. Dust monitoring has been undertaken monthly since the commencement of remediation works in November 2020. Monitoring is completed using Bergerhoff gauges in accordance with the *German Standard VDI 2119*, *(Measurement of Dustfall, determination of dustfall using the Bergerhoff Instrument).* A total of seven locations situated within the site boundary and two locations off site were selected for monitoring purposes as presented in Figure 3C. A monitoring point was located in the southeast of the site to ensure all areas of the site were covered.

The gauges were left exposed to the ambient air for a period of one month during which time the dust deposition in the area passively collected in the vessels. The collected samples were sent to a laboratory for gravimetrical analysis. The sample results are expressed as mg of dust deposited per day (mg/m$^2$/day).

**Table 7.16** presents the results for the monitoring. There were eight exceedances of the licence limit of 350 mg/m$^2$/day during 2021.

- The highest dust level was detected at D1 during Feb-Mar at 1198 mg/m$^2$/day. D1 recorded another exceedance in October at 1022 mg/m$^2$/day.
- Exceedances were also recorded during the year at D7 (461 mg/m$^2$/day), D4 (732 mg/m$^2$/day), D8 (759 mg/m$^2$/day), D6 (389 & 574 mg/m$^2$/day) and D9 (527 mg/m$^2$/day).

The exceedances at all locations apart from D6 were due to remediation works onsite. There was no activity ongoing anywhere near D6 that would account for the elevated dust recorded during the monitoring period. This location is adjacent to the N7 and the boundary with Kerdiffstown House. The area may have been impacted by unrelated activities offsite. All exceedances were reported to the EPA as incidents.

**Table 7.16 Dust Monitoring Results 2021**

| Location | Dec Jan 2021 | Jan Feb 2021 | Feb Mar 2021 | Mar Apr 2021 | Apr May 2021 | May Jun 2021 |
|---|---|---|---|---|---|---|
| **D1** | 62.1 | 47.2 | **1198.3** | 9.5 | 24.4 | 32.2 |
| **D2** | 6.5 | 18.9 | 21.6 | 16.5 | 306.0 | 181.5 |
| **D3** | 7.6 | 161.4 | 7.1 | 10.9 | 18.4 | 7.4 |
| **D4** | 230.2 | 31.9 | 92.4 | 1.0 | 139.4 | 48.3 |
| **D5** | 15.7 | 9.3 | 6.2 | 72.3 | 11.1 | 16.3 |
| **D6** | 8.0 | 15.9 | 142.1 | 5.2 | 14.3 | 37.5 |
| **D7** | 9.6 | 45.8 | 4.9 | 174.3 | **461.2** | 94.0 |
| **D8** | 8.3 | 91.5 | 9.0 | 7.9 | 46.7 | 162.9 |
| **D9** | 44.1 | 13.7 | 120.7 | 7.9 | 102.2 | 27.6 |

| Location | Jun Jul 2021 | Jul Aug 2021 | Aug Sep 2021 | Sep Oct 2021 | Oct-21 | Oct Nov 2021 | Dec Jan 2022 |
|---|---|---|---|---|---|---|---|
| **D1** | 35.7 | 28.6 | 57.8 | 22.1 | **1022.2** | 14.5 | 10.4 |
| **D2** | 203.9 | 20.1 | 15.3 | 75.1 | 17.4 | 4.3 | 1.0 |
| **D3** | 53.0 | 50.0 | 11.7 | 6.8 | 9.9 | 4.5 | 6.3 |
| **D4** | **732.6** | 173.4 | 69.2 | 66.7 | 24.4 | 8.1 | 7.5 |
| **D5** | 212.7 | 22.5 | 164.8 | 28.9 | 13.2 | 7.5 | 6.6 |
| **D6** | 42.3 | 24.6 | **389.7** | 23.4 | **574.3** | 10.2 | 4.4 |
| **D7** | 151.7 | 153.7 | 12.8 | 15.4 | 12.8 | 10.9 | 3.7 |
| **D8** | 59.7 | **759.2** | 123.6 | 84.2 | 84.0 | 7.9 | 10.0 |
| **D9** | 33.0 | 4.5 | **527.3** | 4.3 | 28.1 | 18.9 | 14.0 |

## 7.6. Odour

Monthly odour monitoring has been undertaken by KCC personnel since April 2016. Prior to this, monthly odour monitoring was carried out by Jacobs' staff from August 2014 to March 2016. 10 locations are assessed comprising eight off site and two on-site areas (see Figure 3d). Odour monitoring is completed in line with the EPA AG5 'Odour Impact Assessment Guidance for EPA Licensed Sites' and carried out by suitably qualified personnel.

Particular emphasis is placed in areas where previous odour complaints have been received or where there is a history of strong odours from time to time. In line with the EPA Guidance Note (AG5), an odour intensity of 0 to 4 (most intense) is logged, and an odour persistence of between 0 and 2 (most persistent). Weather conditions and atmospheric pressure are recorded during each of the surveys to aid with the overall assessments and conclusions.

Remediation activities officially commenced on 16 November 2020 with the appointment of Wills Bros Limited. As a result of their appointment there was a significant increase in activity during 2021 with the onset of the remediation works and therefore an increase in the frequency of odour assessments carried out by both the contractor and KCC as required. Furthermore, the KCC odour management plan has been revised to align with the remediation works and the main contractor has a construction related odour management plan to deal with any potential odour related issues which may arise as a result of the works taking place e.g., movement of waste material or installation of landfill gas collection infrastructure.

3 no. odour complaints were received during 2021: one in April 2021, one in July 2021 and one in August 2021. These complaints were lodged by neighbouring residents who experienced odours arising from remediation works onsite. In each case the complaint was followed up by KCC and Wills Bros Ltd including a full review of onsite works taking place in the areas nearest to where the complainant experienced the odour. The resident was subsequently informed of the findings including details of works that are currently taking place onsite and the measures being taken by KCC and Wills Bros Ltd to ensure minimal nuisance from odours for local residents. The complainants were satisfied with the response to their concerns.

The main sources of odour from Kerdiffstown Landfill are due to diffuse gases arising from the decomposition of waste in the landfill, particularly in the NW area. The disturbance of waste during the remediation works in 2021 would have increased the likelihood of odour emissions occurring but mitigation measures are put in place during any such works to minimise the occurrence of nuisance odours offsite.

Tables 7.17a and 7.17b summarise the results of the odour assessments conducted in 2021. For further details please refer to the Monthly Odour Reports (Ref 12). It should be noted that the 250 flare was relocated to the former 500 Flare site on 30 March 2021 due to remediation works taking place in Zone 1. During the routine monthly offsite odour assessments 'earthy' type odours were detected during two monitoring events in 2021 (March and October) in the area on the top of Zone 1 i.e., the former location of the high security hut. An earthy odour was also detected around the 250 flare compound (formerly the location of 500 Flare) in March.

Also, in March 2021 a combination of earthy and landfill gas type odours were detected off site at offsite odour monitoring locations OMP6 and OMP7 which are on the grounds of Kerdiffstown House. In April 2021 a slight intermittent earthy odour was detected at monitoring location OMP3 which is located off the western site boundary. In August 2021 a moderate to strong intermittent landfill gas odour was detected at monitoring location OMP2A which is also off the western boundary. On each occasion Wills Bros Ltd were notified by KCC and measures to reduce or eliminate the odours were taken immediately by the contractor.

**Table 7.17a Summary of odour monitoring (January-June 2021)**

| | Intensity | Persistence | Intensity | Persistence | Intensity | Persistence | Intensity | Persistence | Intensity | Persistence | Intensity | Persistence |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Jan | | Feb | | Mar | | Apr | | May | | Jun | |
| Offsite | | | | | | | | | | | | |
| OMP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OMP2A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OMP3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| OMP4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OMP5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OMP6 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| OMP7 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| OMP8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Onsite | | | | | | | | | | | | |
| 250 Flare Compound | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Top of Zone 1 (former location of high security hut) | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

## Table 7.17b Summary of odour monitoring (July-December 2021)

| | Intensity | Persistence | Intensity | Persistence | Intensity | Persistence | Intensity | Persistence | Intensity | Persistence | Intensity | Persistence |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Jul | | Aug | | Sep | | Oct | | Nov | | Dec | |
| Offsite | | | | | | | | | | | | |
| OMP1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OMP2A | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OMP3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OMP4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OMP5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OMP6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OMP7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OMP8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Onsite | | | | | | | | | | | | |
| 250 Flare Compound | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Top of Zone 1 (former location of high security hut) | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |

## 7.7. VOC Survey

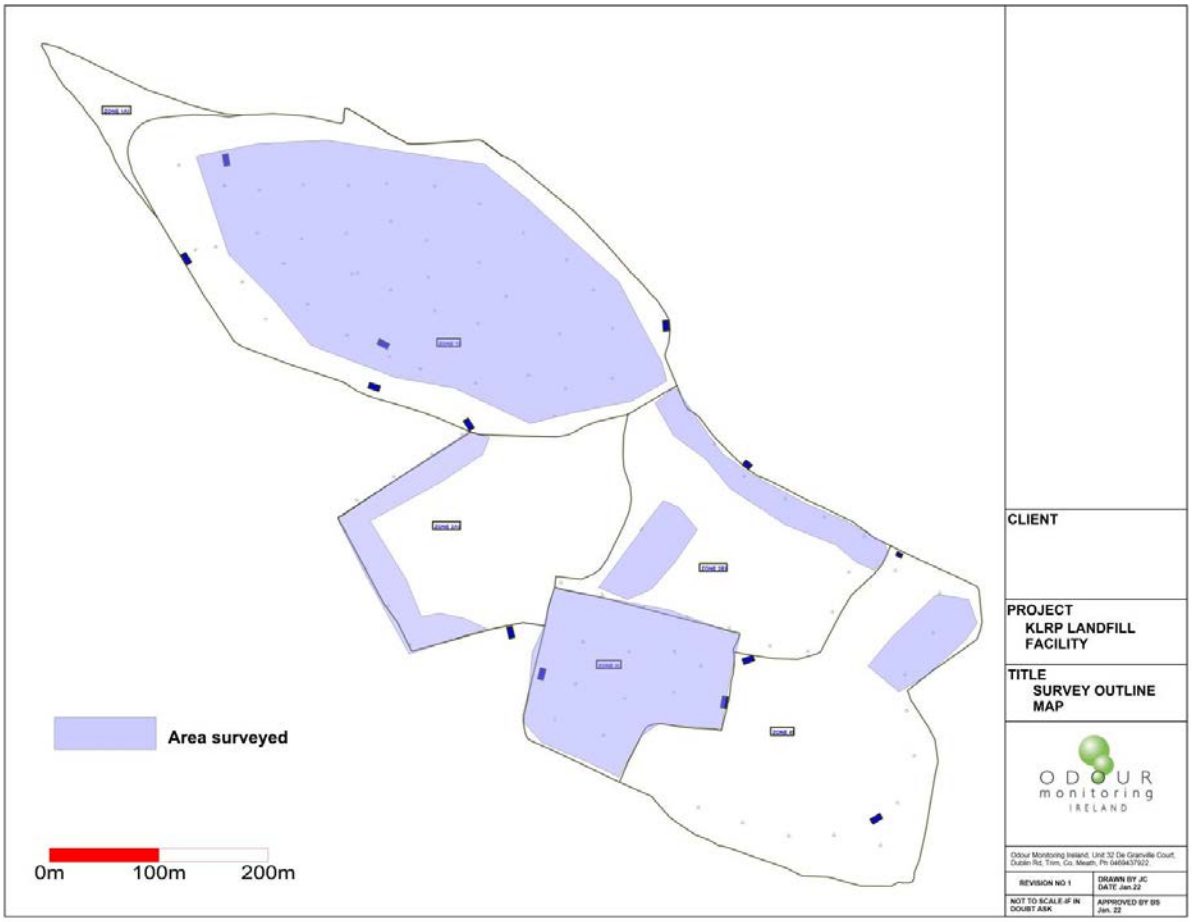
Odour Monitoring Ireland were engaged to complete a biannual independent assessment and report on surface VOC emissions. Two surveys were undertaken during 2021. The first survey was completed on the 30 April and the second round was completed on the 22 November 2021 to ascertain any areas of potential surface VOC emissions from the facility.

As shown in Plate 7.2, VOCs were measured primarily around the areas of Zone 1 & Zone 3 using an 'Odour Hog' comprising a flame ionisation detector (FID) to measure the methane fraction of emissions; and a photo ionisation detector (PID) to measure the odourous volatile compounds. The unit was calibrated before and after the surveys using reference isobutylene and methane.

The 'odour hog' has a sample response time <3.5 seconds for the FID and an integrated GPS (Magellan Professional). The capping of the facility was surveyed for potential surface emissions areas and these areas were geo-referenced

The sample response time of the MiniRAE 3000 is <3 seconds. It was operated in the 0 - 999.9 ppm range with a resolution of 0.1 ppm. The team on site walked the area in a grid formation logging any detections of gas and recording the GPS location of the detection using the Viewranger GPS accurate to 1 meter. VOC surface emission monitoring was undertaken in accordance with EPA document AG6 'Surface VOC Emissions Monitoring on Landfill Facilities' requirements.

**Plate 7.2 2021 Map of Areas Surveyed for Surface VOC Emissions**



The survey assessed VOC emission points across the main uncapped waste bodies on a grid basis and subsequently marked these emission points on a map for comparison with previous surveys completed during 2011- 2020.

Measurement of surface emissions was in accordance with of AG6 'Surface VOC Emissions Monitoring on Landfill Facilities'. The emission limits as per the licence are <50 ppm as methane average over capped areas or <100 ppm methane instantaneous reading on open surfaces within the landfill footprint; and <500 ppm as methane around identified features.

The first survey identified six individual surface emissions zones. During the second survey three individual surface emissions zones were identified. These are detailed in Plates 7.3 and 7.4 and Tables 7.18 and 7.19.

**Plate 7.3 2021 Map of Surface VOC Emissions Detected in Round 1 Survey**

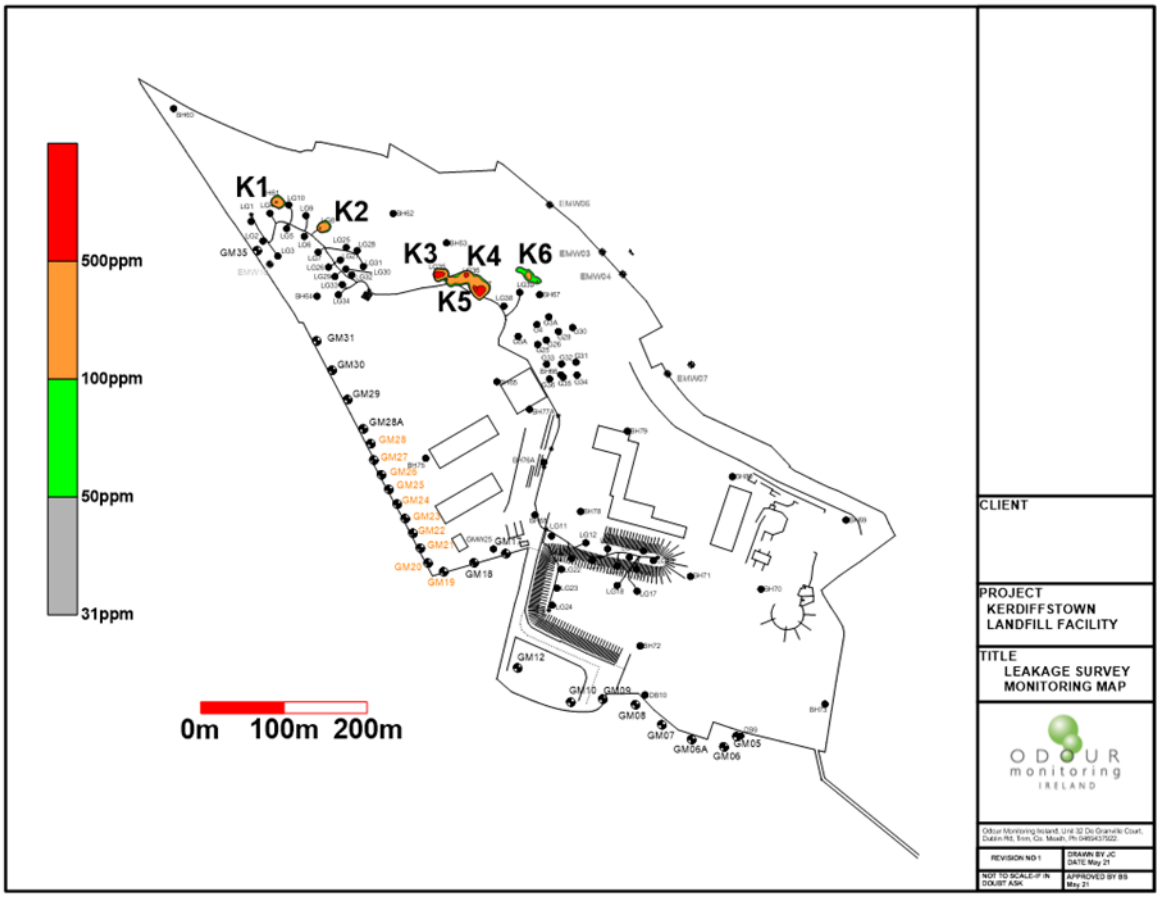



**Table 7.18: Round 1 Survey Data Table**

| Location | Map ID | VOC maximum (ppm) | Reference | Recommended Trigger Levels (ppm) |
|---|---|---|---|---|
| Zone 1 | K1 | 820 | Vertical well (BH61) | <500 ppm |
| Zone 1 | K2 | 650 | Vertical well (LG8) | <500 ppm |
| Zone 1 | K3 | 1,050 | Vertical well (LG35) | <500 ppm |
| Zone 1 | K4 | 1,100 | Surface area & vertical well LG36 | <500 & <100 ppm |

| Location | Map ID | VOC maximum (ppm) | Reference | Recommended Trigger Levels (ppm) |
|---|---|---|---|---|
| Zone 1 | K5 | 1,200 | Surface area & vertical well LG37 | <500 & <100 ppm |
| Zone 1 | K6 | 165 | Surface area | <100 ppm |

**Plate 7.4 2021 Map of Surface VOC Emissions Detected in Round 2 Survey**

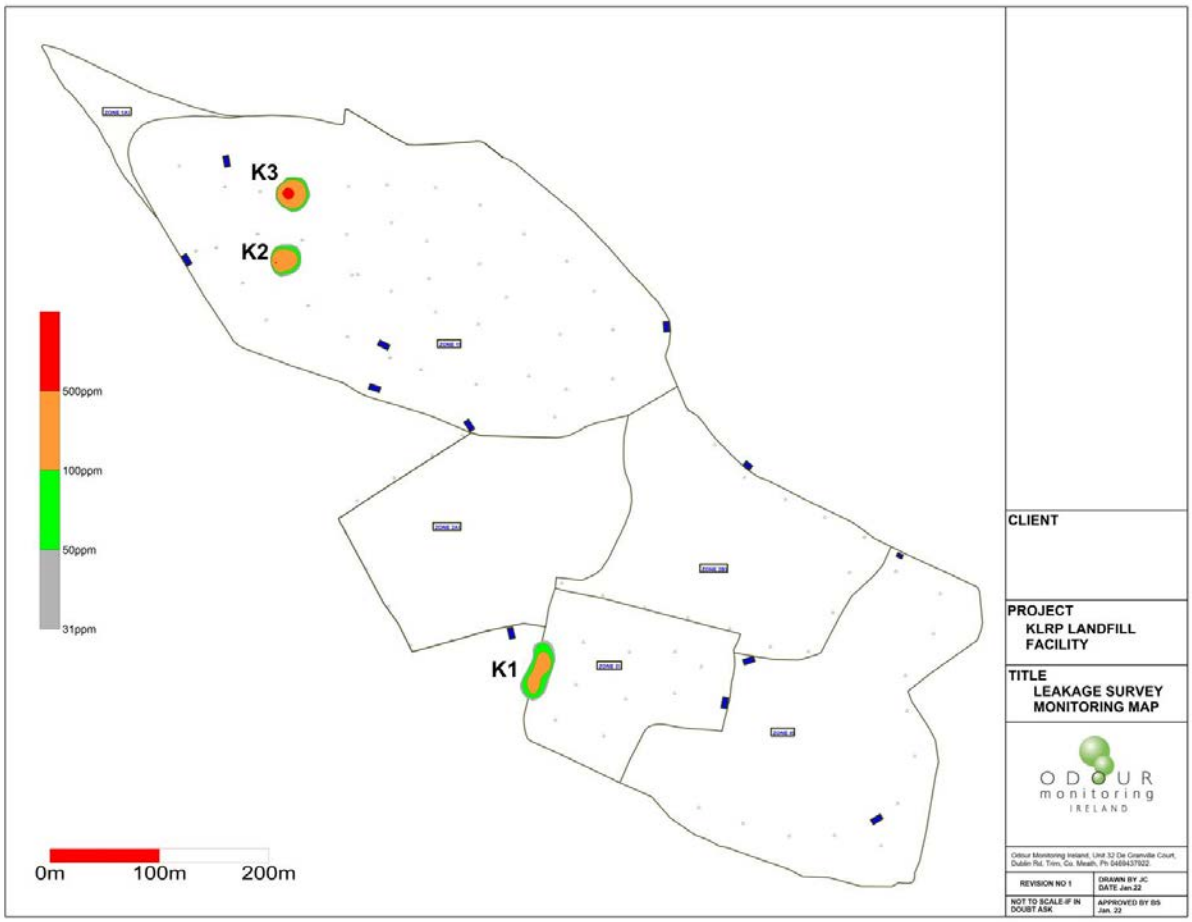



**Table 7.19: Round 2 Survey Data Table**

| Location | Map ID | VOC maximum (ppm) | Reference | Recommended Trigger Levels (ppm) |
|---|---|---|---|---|
| Zone 3 | K1 | 215 | Surface area | <100 ppm |
| Zone 1 | K2 | 650 | Vertical well (GW12) | <500 ppm |
| Zone 1 | K3 | 1,100 | Vertical well (BH26) | <500 ppm |

## 7.8. Meteorological Data

A weather station is present on site; however, for much of 2021 the wind speed and direction were not accurate and have not been used to inform the information contained in **Appendix E** Meteorological Information is obtained from the on-site weather station. Monthly information on rainfall, temperature, wind speed and direction are obtained from Met Éireann weather station at Casement Aerodrome for inclusion in reports including the monthly environmental report and the groundwater and surface water report. Meteorological information from Casement Aerodrome is also collated and presented on a monthly basis as part of the reports with graphs showing trends over time.

Overall rainfall for 2021 decreased, with total rainfall for the year at 696.9 mm compared to 814.2 mm for 2020. May was the wettest month of the year with rainfall of 112.7 mm. Appendix E presents the summary data for the weather at Casement Aerodrome for 2021.

## 7.9. Noise Monitoring

Daytime noise monitoring was carried out in March (5th & 8th), May (26th & 27th), August (30th) & September (3rd & 6th) and November (4th & 27th).

All monitoring was completed in accordance with the EPA Guidance Note for Noise in Relation to Scheduled Activities (NG4) using a Brüel and Kjær 2250 Type 1 Sound Level Meter (SLM) with an outdoor microphone unit Type 4198. A total of eight locations (N1 to N9) situated at the site boundary or close to sensitive receptors were selected for monitoring purposes. The results were compared to the noise limits set out in NG4. Emission limits specified in the licence are 55 dB LAeq,30mins for daytime. A summary of results is set out in Table 7.20.

**Table 7.20 Noise Monitoring Results**

| | Daytime (Limit: 55 dB $LA_{eq,30}$) | | | |
|---|---|---|---|---|
| | **Round 1** | **Round 2** | **Round 3** | **Round 4** |
| **N1** | 52.5 | 48.5 | 51.4 | 47.1 |
| **N2** | 51.5 | 50.5 | **59.5** | 52 |
| **N3** | 52.4 | **56.1** | **55.7** | **55.6** |
| **N4** | 55 | **55.3** | 46.7 | 47.3 |
| **N5** | **60.3** | **56.9** | 49.6 | 52.2 |
| **N6** | **59.1** | 52.2 | 48.6 | 50 |
| **N7** | **63.5** | **62.1** | **61.5** | **59.3** |
| **N9** | **67.8** | **68.7** | 54 | **61.6** |
| Note: exceedances of emission limits in bold & shaded. | | | | |

In total there were fifteen exceedances of the daytime noise limit of 55 dBA.

A single daytime exceedance was recorded at locations N2, N4 and N6 during 2021. N2 is located on the south-western boundary of the site at a sensitive receptor. There was a large increase in the noise levels recorded at this location during the third round of monitoring of 2021. The dominant noise typically observed in this area during the daytime surveys was traffic noise from the N7 and the local road L2005. The exceedance recorded in Round 3 was due to works carried out onsite including

construction of the site access road and carpark and installation of an acoustic fence.

N4 is located to the north of the site at a sensitive receptor. The dominant noise typically observed in this area during the daytime surveys was traffic noise from vehicles accessing the site, the N7 and the local road L2005. The exceedance recorded in Round 2 was due to works being carried out onsite in Zone 1 including the regrading of slopes.

N6 is located to the north-east of the site. The dominant noise typically observed in this area during the daytime surveys was traffic noise from the N7 and the local road L2005. The exceedance recorded in Round 1 was due to works being carried out onsite in Zone 1. The monitoring location was very close to the works area and was not representative of noise impacts at offsite receptors. This was relocated to the site boundary for subsequent monitoring rounds.

One location recorded two daytime exceedances namely N5. N5 is located on the western boundary of the site The dominant noise typically observed in this area during the daytime surveys was traffic noise from the local road L2005 and the N7. This was the case during the Round 1 monitoring. However, the exceedance during the Round 2 monitoring was due to plant working in Zone 1.

Two locations recorded three daytime exceedances namely N3 and N9. N3 is located on the southern boundary of the site The dominant noise typically observed in this area during the daytime surveys was traffic noise from the local road L2005 and the N7. This was the case during the Rounds 3 & 4 monitoring. However, the exceedance during the Round 2 monitoring was due to construction works ongoing in the new leachate compound. N9 is located on the north-western boundary of the site close to a sensitive receptor. The dominant noise typically observed in this area during the daytime surveys was traffic noise from the N7 and the local road L2005 as was the case for most of the monitoring in 2021. However, the exceedance in the Round 2 monitoring was due to plant working on Zone 1 of the landfill.

N7 recorded exceedances for each of the monitoring surveys. This monitoring point is located to the south-east of the site close to a sensitive receptor. The receptor is adjacent to the N7 motorway. The dominant noise observed during monitoring was traffic on the N7 motorway and on the L2005 and was consistently above the emission limit of 55 dBA.

The six works related noise exceedances recorded during the 2021 monitoring were reported to the EPA as incidents as required by Condition 11.3 (i) of the facility licence. The contractor (Wills Bros Ltd) was advised immediately of the exceedances and instructed to take measures to reduce noise in the work areas, particularly traffic movements where possible. Site management is in regular contact with local residents and regularly provide information and updates on the website and via monthly Community Liaison Group meetings. It should be noted that no complaints of noise nuisance have been received to date.

# 8. Summary

## 8.1. Management

The site is under the control of Kildare County Council with responsibility for implementing the remediation and ongoing management of the site. The statutory approvals required to undertake the remediation have been put to facilitate the remediation.

## 8.2. Incidents and Complaints

A total of four complaints were recorded in 2021 with fifteen incidents were recorded in 2021.

## 8.3. Emissions management

Controlled emissions from the facility are limited to landfill gas and leachate. Landfill gas emissions are managed by enclosed landfill gas flares. Leachate is collected from the lined cell and transported off site for treatment.

## 8.4. Waste Management and Resource Consumption

During 2021 waste was removed from the site increased compared with previous year as a direct result of the remediation works. There was also significant increase in diesel usage as a result of the remediation works. Over

## 8.5. Restoration works

During 2021, significant restoration works were undertaken with the majority of the bulk earthworks completed alongside the installation of capping and other landfill management infrastructure. Over 100,000m3 of waste material was imported to site to facilitate the remediation works.

## 8.6. Environmental Monitoring

### 8.6.1. Groundwater Results

Groundwater chemical analysis results are generally consistent with previous monitoring events completed on behalf of the EPA since 2011 and indicate elevated concentrations of key landfill leachate indicators (ammoniacal nitrogen, depleted oxygen levels, increased electrical conductivity, chloride, iron, and manganese concentrations) in on-site monitoring wells completed in the overburden deposits, also with evidence in seasonal variations in concentrations for certain parameters. Monitoring indicates limited evidence of off-site leachate impact, including elevated concentrations of certain parameters in monitoring wells located along the northern and north-eastern boundary of the site near to the unlined and uncapped area of the landfill. Furthermore, monitoring wells completed in the underlying bedrock show slight impact from landfill leachate.

### 8.6.2. Surface Water Results

The analytical results from the surface water samples collected during the January to December 2021 monitoring period indicate that water quality in both the Morell River

and the Hartwell River is good. Water quality in the downstream samples was very similar to water quality in the respective upstream samples.

While the site remediation progresses, in particular capping works in the northern part of the site (which is also unlined) there remains the potential for generation of leachate through rainfall infiltration into the waste mass and therefore increased potential for leachate migration towards the Morell River.

### 8.6.3. Biological Q-rating

A biological q-rating assessment took place in May and September 2021. The conclusions of the assessment state that the Hartwell stream further upstream is generally of good water quality (mostly Q4-5) and only deteriorates to a polluted rating at the site near Johnstown. It is likely that the good quality waters from the Hartwell help to improve the water quality of the Morell. The Morell in contrast varied in water quality, but the results from the most recent survey were encouraging. Stretches in the upper reaches are achieving good ecological status based on macroinvertebrate communities although there were polluted stretches before the Morell reaches Johnstown. Another encouraging aspect is that the stretch of the Morell alongside Kerdiffstown Landfill has improved to a Q4. There was no indication that the landfill is having any discernible impact on the Morell River as it passes the site.

### 8.6.4. Leachate

Analysis of leachate from the lined cell area during 2021 showed a noted increase in concentration of all parameters except pH in comparison to that of 2020. It is considered that this increase in concentration is partly due to a lack of dilution of leachate due to low levels of rainfall during 2021. With the progression of the capping works in the Lined Cell, the impact of rainfall levels on the volumes of leachate produced should reduce somewhat over the coming months. A significant contributing factor during 2021 related to the remediation works is the excavation and movement of waste material from Zone 4 into the lined cell during Quarter 2 and the subsequent placement of a liner on the waste material. This would contribute significantly to the volume of leachate and increased concentration of the parameters monitored from Quarter 2 onwards.

### 8.6.5. Landfill Gas

Landfill gas data from the flare emissions obtained during 2021 were noted to show an improvement in gas quality over the year, most likely due to the capping works on Zones 1 and 3 and the installation of new gas extraction wells and collection pipework. Between 2011 and 2020 there had been a gradual decline in methane and carbon dioxide concentrations over time with both well fields showing a gradual reduction in gas concentrations as landfill gas was extracted and burnt off at the 250 flare since July 2011.Monitoring of perimeter gas levels showed an exceedance of the trigger level of 1.0 % v/v Methane at GM08 during monthly perimeter gas monitoring in May, June and September 2021. The concentration of carbon dioxide in a number of the perimeter wells was found to be consistently higher than the trigger level for carbon dioxide (1.5% $CO_2$ v/v). These exceedances were reported as an incident to the EPA in accordance with the requirements of the IEL.

### 8.6.6. Dust Monitoring

Dust monitoring was completed monthly in 2021. Eight exceedances were recorded of the licence limit of 350 mg/m2/day.

### 8.6.7. Odour Monitoring

Odour monitoring has been conducted on a monthly basis since 2014. As a result of the appointment of Wills Bros Ltd as the main contractor for the landfill remediation there was a significant increase in activity during 2021 with the onset of the works and therefore an increase in the frequency of odour assessments carried out by both the contractor and KCC as required.

During the routine KCC monthly offsite odour assessments “earthy” type odours were detected during two monitoring events in 2021 (March and October) in the area on the top of Zone 1 i.e. the former location of the high security hut. An earthy odour was also detected around the 250 flare compound (formerly the location of 500 Flare) in March.

Also in March 2021 a combination of earthy and landfill gas type odours were detected off site at offsite odour monitoring locations OMP6 and OMP7 which are on the grounds of Kerdiffstown House. In April 2021 a slight intermittent earthy odour was detected at monitoring location OMP3 which is located off the western site boundary. In August 2021 a moderate to strong intermittent landfill gas odour was detected at monitoring location OMP2A which is also off the western boundary. On each occasion Wills Bros Ltd were notified by KCC and measures to reduce or eliminate the odours were taken immediately by the contractor.

### 8.6.6. VOC Surface Emissions

Two VOC surface emissions surveys were undertaken in April and November 2021 to ascertain sources of facility gas surface emissions and make recommendations regarding potential improvements to the existing landfill gas infrastructure.

### 8.6.8 Meteorological Data

Meteorological information was collated on a daily basis during 2021

### 8.6.10 Noise Monitoring

Noise monitoring was completed quarterly, and six exceedances of the licence limits were noted as a result of remediation activities undertaken on the Kerdiffstown Park Project.

# Appendices

Appendix A **AER REQUIREMENTS (FROM P1063-01)**

The below table outlines the information as per Schedule D of the Proposed Decision (P1063-01) where it can be found.

| P1063-01 Schedule D AER Requirements | Section of report / Comment |
|---|---|
| Emissions from the installation. | Chapter 4 |
| Waste Management Record. | Section 5.2 |
| Resource consumption summary. | Section 5.3 & Section 5.4 |
| Complaint summary. | Section 2.8 |
| Schedule of Environmental Objectives and Targets. | Section 2.2 |
| Environmental management programme – report for previous year. | Section 2.2 |
| Environmental management programme – proposal for current year. | Section 2.2 |
| Pollutant Release and Transfer Register – report for previous year. | Section 4.3 |
| Pollutant Release and Transfer Register – proposal for current year. | Section 4.3 |
| Noise monitoring report summary. | Section 7.9 |
| Ambient monitoring summary. | Chapter 7 |
| Tank and pipeline assessment report. | Not included in report (available upon request) |
| Reported incidents summary. | Section 2.8.1 / Appendix C |
| Energy efficiency audit report summary. | Not included in report (available upon request) |
| Report on the assessment of the efficiency of use of raw materials in processes and the reduction in waste generated. | Not currently applicable |
| Report on progress made and proposals being developed to minimise water demand and the volume of trade effluent discharges. | Not currently applicable |

| P1063-01 Schedule D AER Requirements | Section of report / Comment |
|---|---|
| A report on compliance with recommendations of the Detailed Quantitative Risk Assessment (DQRA) submitted to the Agency. | Section 7.1.1 & Separate report not included but reported to EPA under separate cover. |
| Development/Infrastructural works summary (completed in previous year or prepared for current year). | Chapter 6 |
| Reports on financial provision made under this licence, management and staffing structure of the installation, and a programme for public information. | Section 2.3 |
| Review of Closure, Restoration & Aftercare Management Plan. | Section 2.4 |
| Statement of measures in relation to prevention of environmental damage and remedial actions (Environmental Liabilities). | Section 2.5 |
| Environmental Liabilities Risk Assessment Review (every three years or more frequently as dictated by relevant on-site change including financial provisions. | Section 2.5 |
| Any other items specified by the Agency. | N/A |

Appendix B **Landfill Gas Survey 2021**

Environmental Protection Agency

# A survey of landfill sites to determine the quantity of methane flared and or recovered in utilisation plants for 2021

| | |
|---|---|
| Please choose from the drop down menu the licence number for your site | P1063 |
| Please choose from the drop down menu the name of the landfill site | Kerdiffstown Landfill |
| Please enter the number of flares operational at your site in 2021 | 1 |
| Please enter the number of engines operational at your site in 2021 | 0 |
| Total methane flared | 137,210 kg/year |
| Total methane utilised in engines | 0 kg/year |

**Please note that the closing date for receipt of completed surveys is 31/03/2022**

**Introduction**

The Office of Environmental Sustainability (OES) of the Environmental Protection Agency acts as the inventory agency in Ireland with responsibility for compiling and reporting national greenhouse gas inventories to the European Commission and the United Nations Framework Convention on Climate Change. In addition to meeting international commitments Ireland's national greenhouse gas inventory informs national agencies and Government departments as they face the challenge to curb emissions and meet Ireland's emission reduction targets under the Effort Sharing Regulation (EU) 2018/842. The national inventory also informs data suppliers, making them aware of the importance of their contributions to the inventory process and a means of identifying areas where input data may be improved.

It is on this basis that the Environmental Protection Agency is asking landfill operators to partake in this survey so that the most uptodate information on methane flaring and recovery in utilisation plants at landfills sites is used in calculating the contribution of the landfill sector to national greenhouse gas emissions

The Environmental Protection Agency wishes to thank you for partaking in this survey. If you have any questions about the survey and how to complete it please view the "Help sheet" worksheet. If however, your query is not answered by viewing the "Help sheet" worksheet please contact:
LFGProject@epa.ie

Once completed please send the completed file as an attachment clearly stating the name and or licence number of the landfill site (e.g. W000 Xanadu landfill_2021) to:
LFGProject@epa.ie

**Flare No. 1**

| | | | |
|---|---|---|---|
| **Flare type ?** | Other | **If "other" enter flare description here** | |
| **Is the flare an open or enclosed flare ?** | Enclosed | **Rated flare capacity ?** 250 | **m3/hr** |
| **Month /year comissioned ?** | July 2011 | | |
| **Month decomissioned if decomissioned in 2021 ?** | Select | | |
| **What is the function of the flare ?** | Odour control | **If "other" enter flare function here** | |

| **Monthly** | Method M/C/E | Runtime days/month | Runtime hrs/day | Downtime hrs | Total runtime hrs/month | Average Inlet Pressure (mbg) | Average Inlet Temp ◦C | Average Flow Rate ($m^3$/hr) | Average $CH_4$ %v/v | Average $CO_2$ %v/v | Average $O_2$ %v/v | Combustion efficiency (%) | Total $CH_4$ $m^3$ | Total $CH_4$ kgs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | M | 31 | 24.0 | 51.5 | 693 | -6 | 10 | 89 | 21.20 | 21.90 | 1.00 | 99.9 | 13,037 | 8,948 |
| February | M | 28 | 24.0 | 206.5 | 466 | -6 | 10 | 88 | 19.60 | 21.70 | 1.00 | 99.9 | 8,021 | 5,505 |
| March | M | 31 | 24.0 | 355.0 | 389 | -5 | 10 | 114 | 22.00 | 22.70 | 1.00 | 99.9 | 9,746 | 6,696 |
| April | M | 30 | 24.0 | 470.0 | 250 | -4 | 10 | 139 | 25.90 | 22.40 | 1.00 | 99.9 | 8,972 | 6,170 |
| May | M | 31 | 24.0 | 54.5 | 690 | -7 | 10 | 134 | 29.10 | 21.80 | 1.00 | 99.9 | 26,759 | 18,348 |
| June | M | 30 | 24.0 | 389.5 | 331 | -6 | 10 | 108 | 26.00 | 22.20 | 1.00 | 99.9 | 9,271 | 6,363 |
| July | M | 31 | 24.0 | 268.0 | 476 | -8 | 10 | 103 | 26.20 | 20.70 | 1.80 | 99.9 | 12,828 | 8,787 |
| August | M | 31 | 24.0 | 5.0 | 739 | -13 | 10 | 95 | 28.20 | 20.40 | 1.80 | 99.9 | 19,711 | 13,435 |
| September | M | 30 | 24.0 | 6.0 | 714 | -13 | 10 | 118 | 29.30 | 21.10 | 1.70 | 99.9 | 24,644 | 16,797 |
| October | M | 31 | 24.0 | 33.0 | 711 | -12 | 10 | 120 | 25.40 | 19.10 | 3.00 | 99.9 | 21,595 | 14,734 |
| November | M | 30 | 24.0 | 62.5 | 658 | -14 | 10 | 99 | 31.90 | 21.50 | 1.40 | 99.9 | 20,779 | 14,149 |
| December | M | 31 | 24.0 | 51.5 | 693 | -19 | 10 | 97 | 38.00 | 21.70 | 1.10 | 99.9 | 25,500 | 17,276 |
| Total | | | | | 6,807 | | | | | | | | 200,865 | 137,210 |

**Please note: Only fill the "Yearly" table if data is not availabe or cannot be calculated nor estimated on a monthly basis**

| **Yearly** | Method M/C/E | Runtime days/year | Runtime hrs/day | Downtime hrs | Total runtime hrs/year | Average Inlet Pressure (mbg) | Average Inlet Temp ◦C | Average Flow Rate $m^3$/hr | Average $CH_4$ %v/v | Average $CO_2$ %v/v | Average $O_2$ %v/v | Combustion efficiency (%) | Total $CH_4$ $m^3$ | Total $CH_4$ kgs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2021** | | | | | 0 | | 10 | | | | | 98.0 | 0 | 0 |

Appendix C **Incidents and Complaints Summary**

| Incidents | | | | | | |
|---|---|---|---|---|---|---|
| # | Date & Time | Type | Environmental Media | Summary | Corrective Action | Recommendation & follow up actions |
| 1 | 11/01/2021 | Minor | Groundwater | Trigger Level Reached | Ongoing Monitoring | None. Monitoring continues |
| 2 | 21/01/2021 | Minor | Landfill Gas | Trigger Level Reached | Ongoing Monitoring | None. Monitoring continues |
| 3 | 08/02/2021 | Minor | Groundwater | Trigger Level Reached | Ongoing Monitoring | None. Monitoring continues |
| 4 | 26/03/2021 | Minor | Dust | Breach of ELV | Ongoing Monitoring | None. Monitoring continues |
| 5 | 16/04/2021 | Minor | Dust | Ambient ELV Breach | Ongoing Monitoring | None. Monitoring continues |
| 6 | 30/04/2021 | Minor | VOC | Trigger Level Reached | Ongoing Monitoring | None. Monitoring continues |
| 7 | 11/05/2021 | Minor | Landfill Gas | Trigger Level Reached | Ongoing Monitoring | None. Monitoring continues |
| 8 | 24/05/2021 | Minor | Noise | Breach of ELV | Ongoing Monitoring | None. Monitoring continues |
| 9 | 10/06/2021 | Minor | Dust | Ambient ELV Breach | Ongoing Monitoring | None. Monitoring continues |
| 10 | 09/07/2021 | Minor | Dust | Ambient ELV Breach | Ongoing Monitoring | None. Monitoring continues |
| 11 | 06/08/2021 | Minor | Dust | Ambient ELV Breach | Ongoing Monitoring | None. Monitoring continues |
| 12 | 17/08/2021 | Minor | Groundwater | Trigger Level Reached | Ongoing Monitoring | None. Monitoring continues |

Incidents

| # | Date & Time | Type | Environmental Media | Summary | Corrective Action | Recommendation & follow up actions |
|---|---|---|---|---|---|---|
| 13 | 30/08/2021 | Minor | Noise | Ambient ELV Breach | Ongoing Monitoring | None. Monitoring continues |
| 14 | 31/08/2021 | Minor | Landfill Gas | Breach of ELV | Ongoing Monitoring | None. Monitoring continues |
| 15 | 01/10/2021 | Minor | Dust | Ambient ELV Breach | Ongoing Monitoring | None. Monitoring continues |

Complaints

| # | Date & Time | Type | Summary | Corrective Action | Recommendation & follow up actions |
|---|---|---|---|---|---|
| 1 | 13/04/2021 | Odour | Neighbour complaint of odour | Continue to monitor daily | Communication with neighbour and invitation to partake in future community liaison group meetings along with a tour of site |
| 2 | 20/05/2021 | Vibration | Neighbour complaint of vibration | Investigation of source of vibration | Ongoing monitoring |
| 3 | 08/07/2021 | Odour | Neighbour complaint of odour | Capping of Zone 3 as soon as practicable | Continue daily monitoring of Zone 3 |
| 4 | 30/08/2021 | Odour | Neighbour complaint of odour | Continue to monitor daily | Ongoing monitoring and odour management measures to be maintained in Zone 1A |

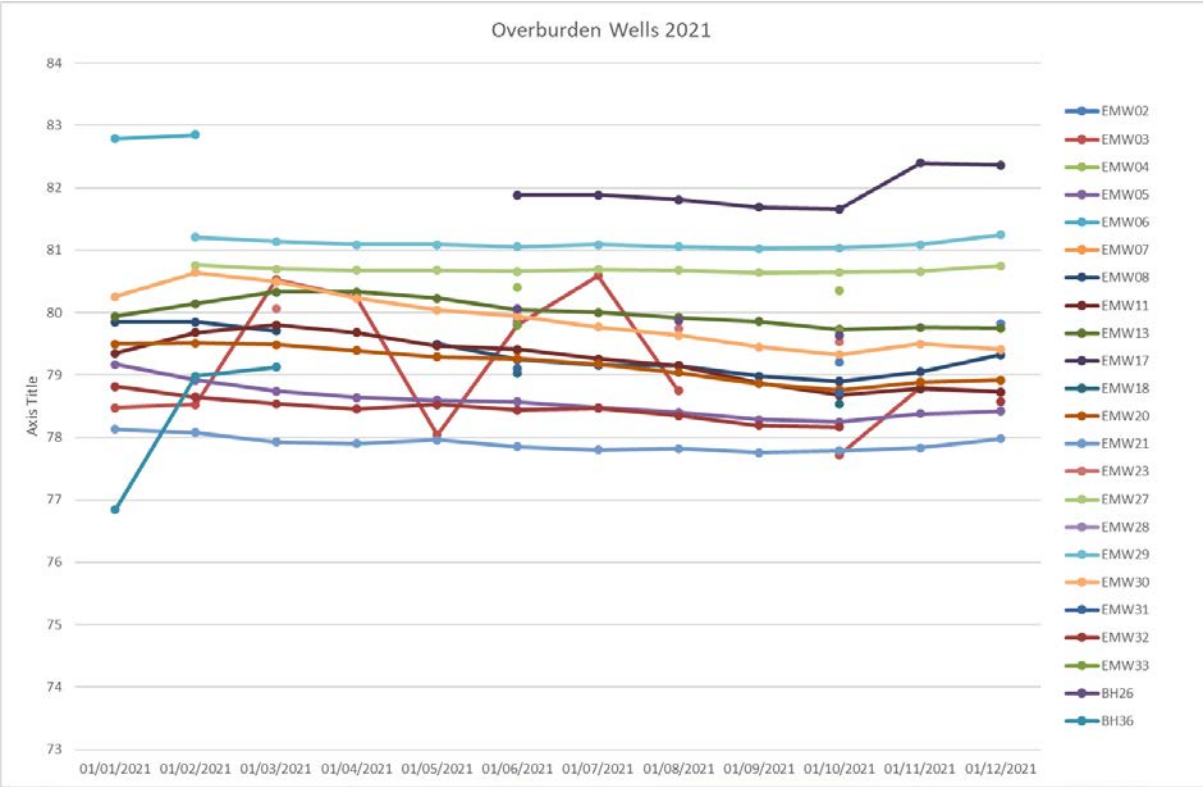
Gas and Water Time Series graphs

G1 Groundwater Dip Levels

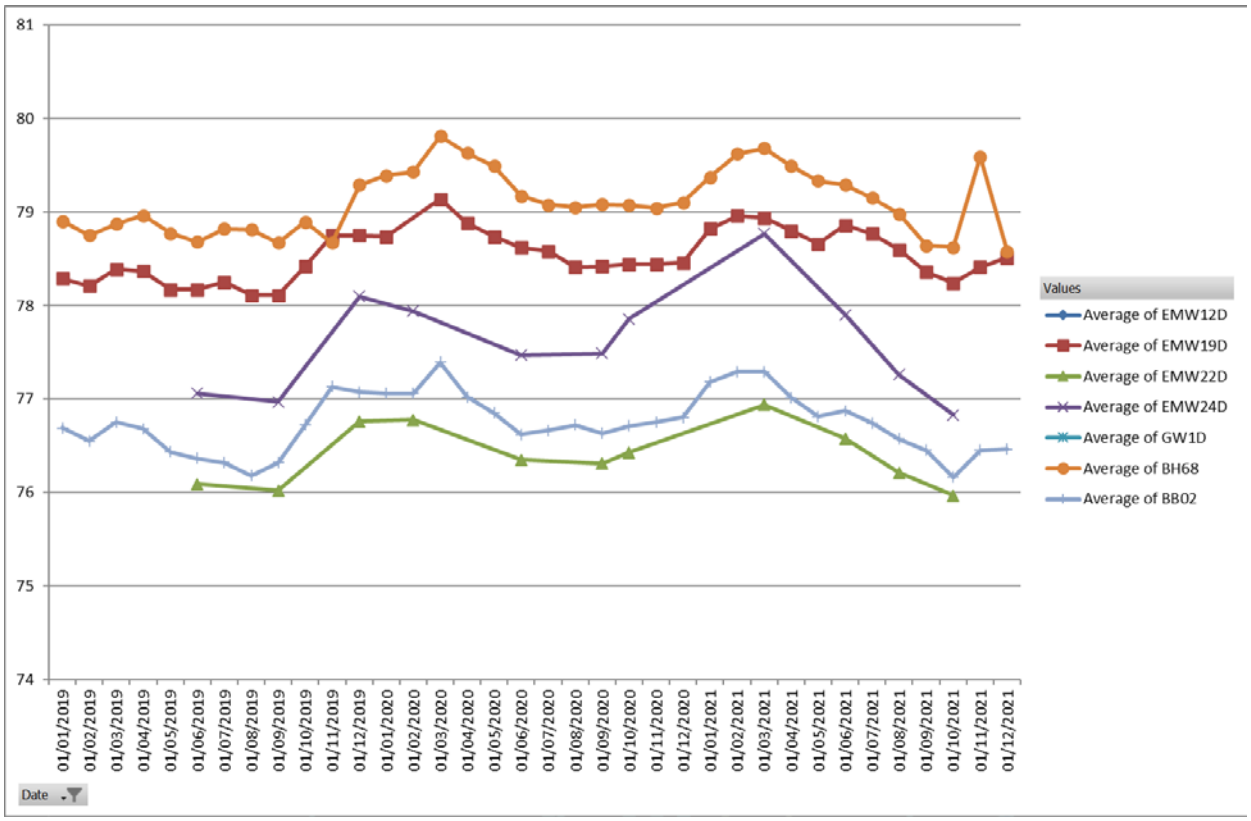
G2 Leachate Level

G3 Landfill Gas – methane in waste monitoring graphs

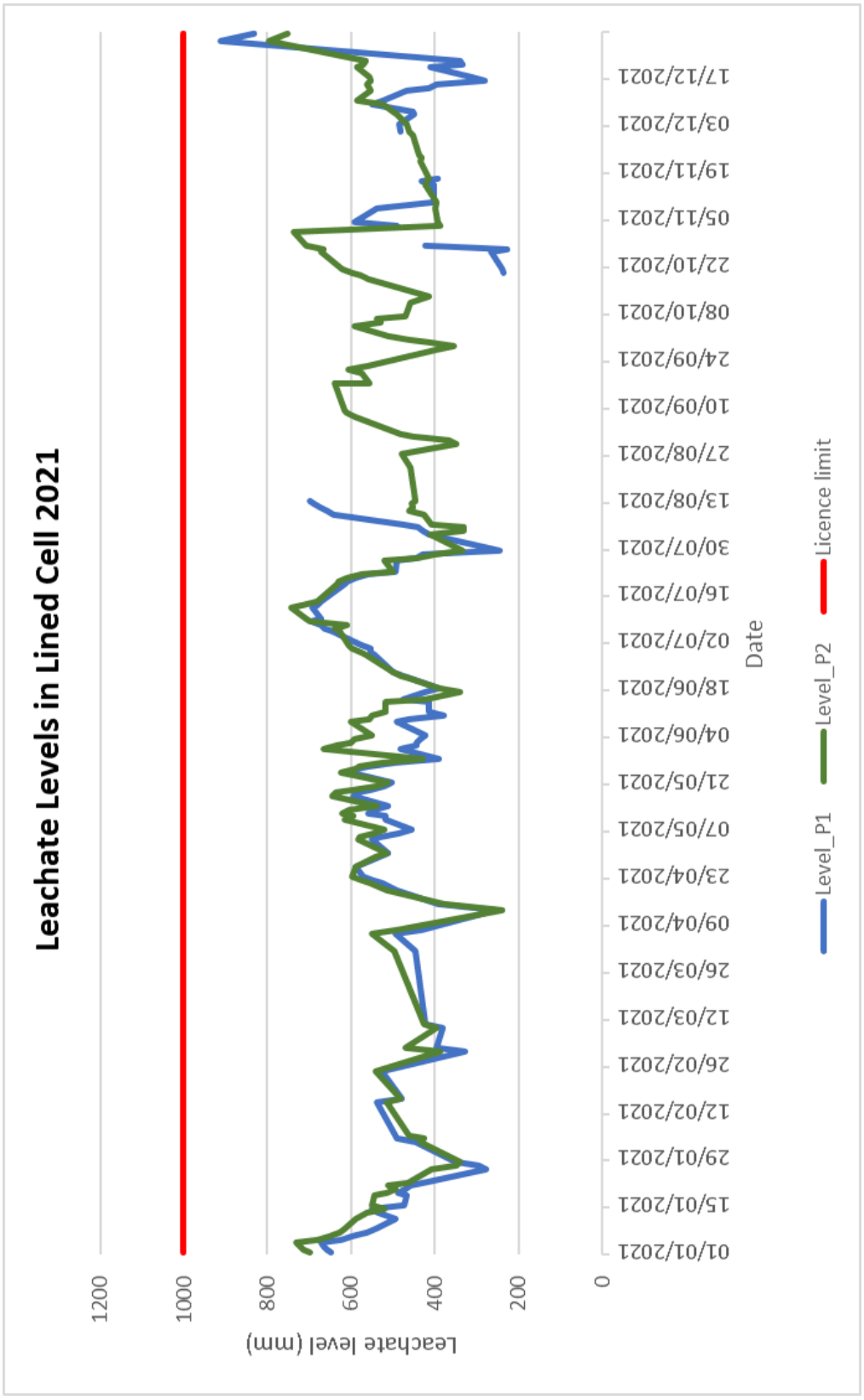
## G1: Groundwater Dip Levels 2021




## Bedrock Ground Water Levels

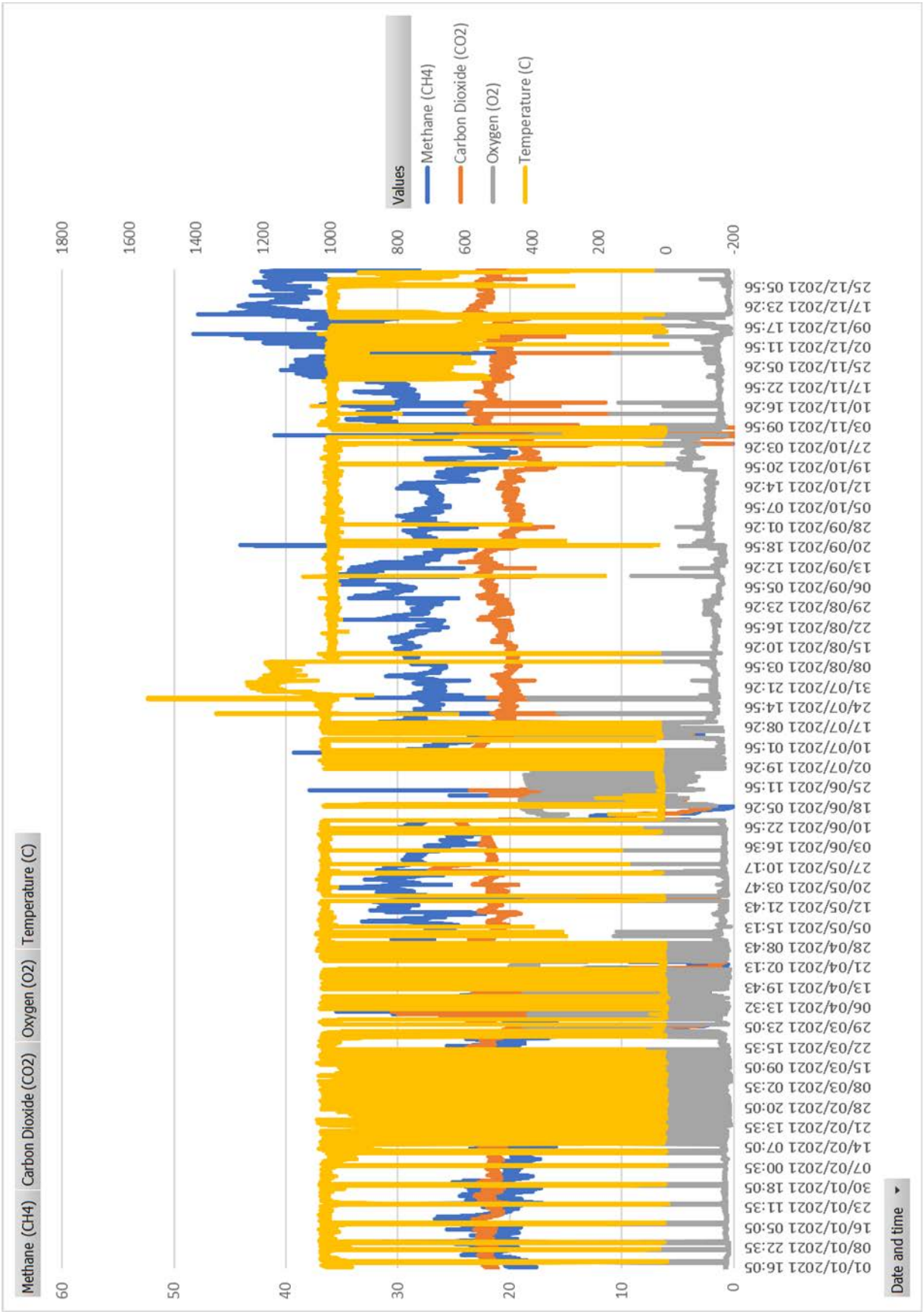


G2: Leachate Level 2021



## G3: Landfill Gas

### Landfill Gas Flare- continuous gas quality monitoring



Appendix D **Meteorological Data Graphs & Tables**

## Temperature 2021

| | Average of Daily Max Temp (°C) | Average of Daily Min Temp (°C) | Average of Daily Min Grass Temp (°C) |
|---|---|---|---|
| Jan | 6.47 | 1.06 | -1.70 |
| Feb | 8.77 | 3.48 | 0.83 |
| Mar | 10.82 | 3.72 | 1.82 |
| Apr | 11.47 | 1.34 | -1.40 |
| May | 14.46 | 4.51 | 1.53 |
| Jun | 18.90 | 9.42 | 7.02 |
| Jul | 21.35 | 12.61 | 10.57 |
| Aug | 19.09 | 11.28 | 10.30 |
| Sep | 18.73 | 11.27 | 9.71 |
| Oct | 14.85 | 8.66 | 6.87 |
| Nov | 10.52 | 4.59 | 2.80 |
| Dec | 9.46 | 3.74 | 1.50 |

## Rainfall & Potential Evapotranspiration 2

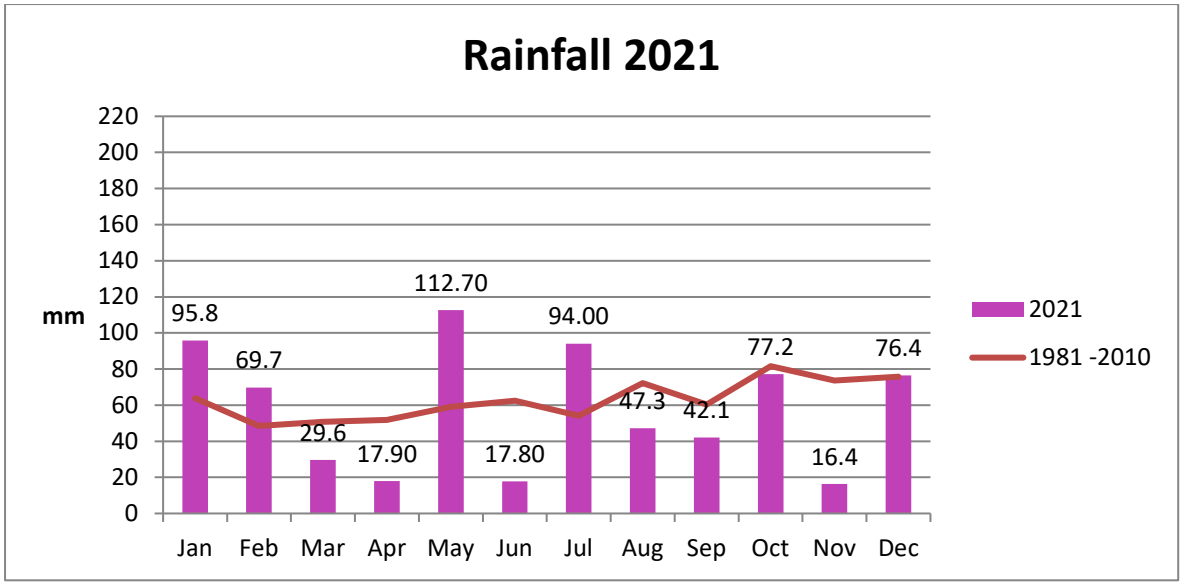
| | Dry Days | Wet Days | Max Daily Rainfall | Average Potential Evapotranspiration (mm) |
|---|---|---|---|---|
| Jan | 9 | 22 | 26.3 | 0.35 |
| Feb | 9 | 19 | 11.2 | 0.93 |
| Mar | 15 | 15 | 6.3 | 1.17 |
| Apr | 18 | 12 | 5.1 | 1.94 |
| May | 12 | 19 | 16.6 | 2.43 |
| Jun | 22 | 8 | 7.1 | 3.05 |
| Jul | 18 | 13 | 31 | 3.07 |
| Aug | 11 | 20 | 9.8 | 2.16 |
| Sep | 15 | 15 | 10.4 | 1.57 |
| Oct | 10 | 21 | 15.9 | 1.01 |
| Nov | 16 | 14 | 4.9 | 0.45 |
| Dec | 13 | 18 | 13.8 | 0.37 |

Comparison of monthly rainfall with historical average

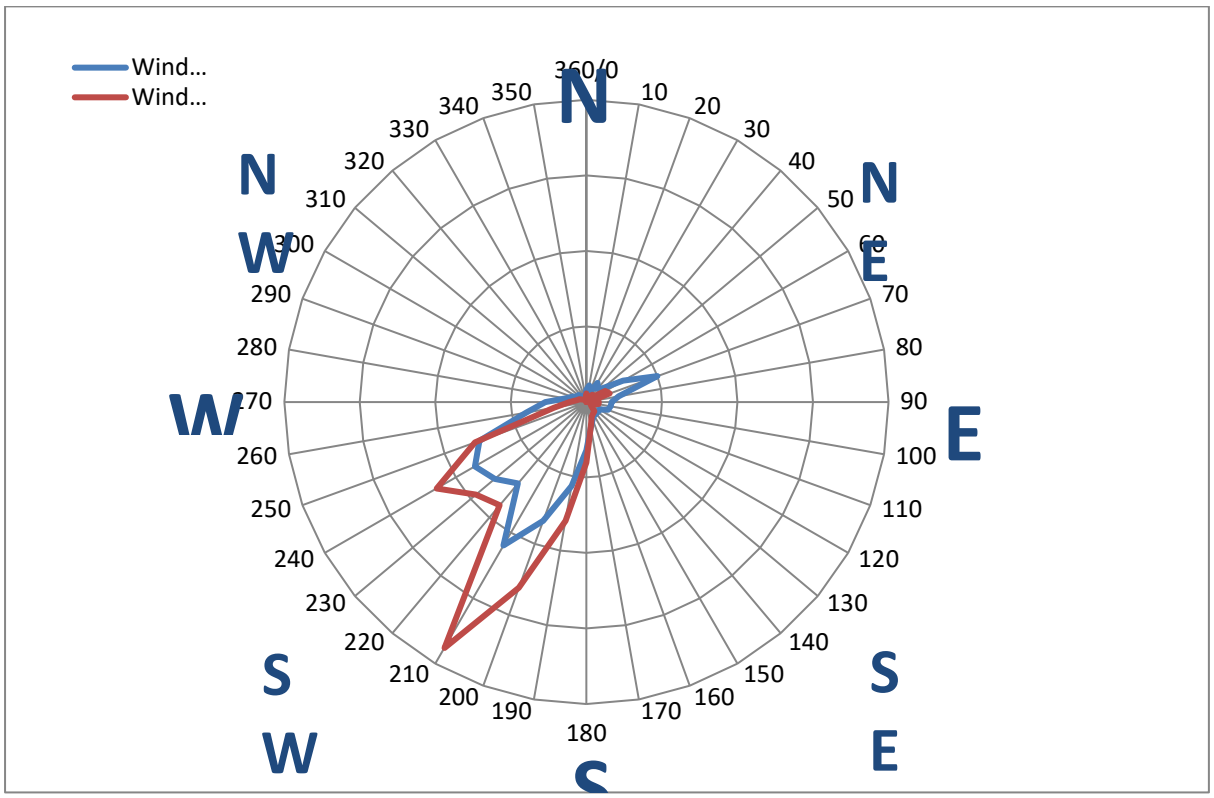
| | Monthly Rainfall 2021(mm) | Historic Average (1981 -2010) (mm) |
|---|---|---|
| Jan | 95.80 | 63.8 |
| Feb | 69.70 | 48.5 |
| Mar | 29.60 | 50.7 |
| Apr | 17.90 | 51.9 |
| May | 112.70 | 59.1 |
| Jun | 17.80 | 62.5 |
| Jul | 94.00 | 54.2 |
| Aug | 47.30 | 72.3 |
| Sep | 42.10 | 60.3 |
| Oct | 77.20 | 81.6 |
| Nov | 16.40 | 73.7 |
| Dec | 76.40 | 75.7 |
| Average | 58.08 | 62.8 |

**Wind & Sunshine 2021**

| | Average of Daily Wind speed (knots) | Wind Direction Degrees (average) | Average Pressure (hPa) | Monthly Total of Sunshine (Hours) |
|---|---|---|---|---|
| Jan | 9.35 | 203.55 | 999.34 | 40.60 |
| Feb | 13.44 | 165.00 | 997.28 | 81.10 |
| Mar | 11.11 | 212.58 | 1008.25 | 110.40 |
| Apr | 6.64 | 162.67 | 1012.51 | 209.50 |
| May | 8.17 | 208.06 | 997.10 | 213.20 |
| Jun | 7.76 | 185.33 | 1007.72 | 179.70 |
| Jul | 6.15 | 178.71 | 1003.66 | 199.70 |
| Aug | 7.73 | 174.84 | 1005.26 | 130.20 |
| Sep | 7.54 | 191.00 | 1005.58 | 99.30 |
| Oct | 10.63 | 224.52 | 999.37 | 108.30 |
| Nov | 9.80 | 229.00 | 1007.07 | 55.70 |
| Dec | 10.64 | 194.84 | 998.05 | 60.80 |



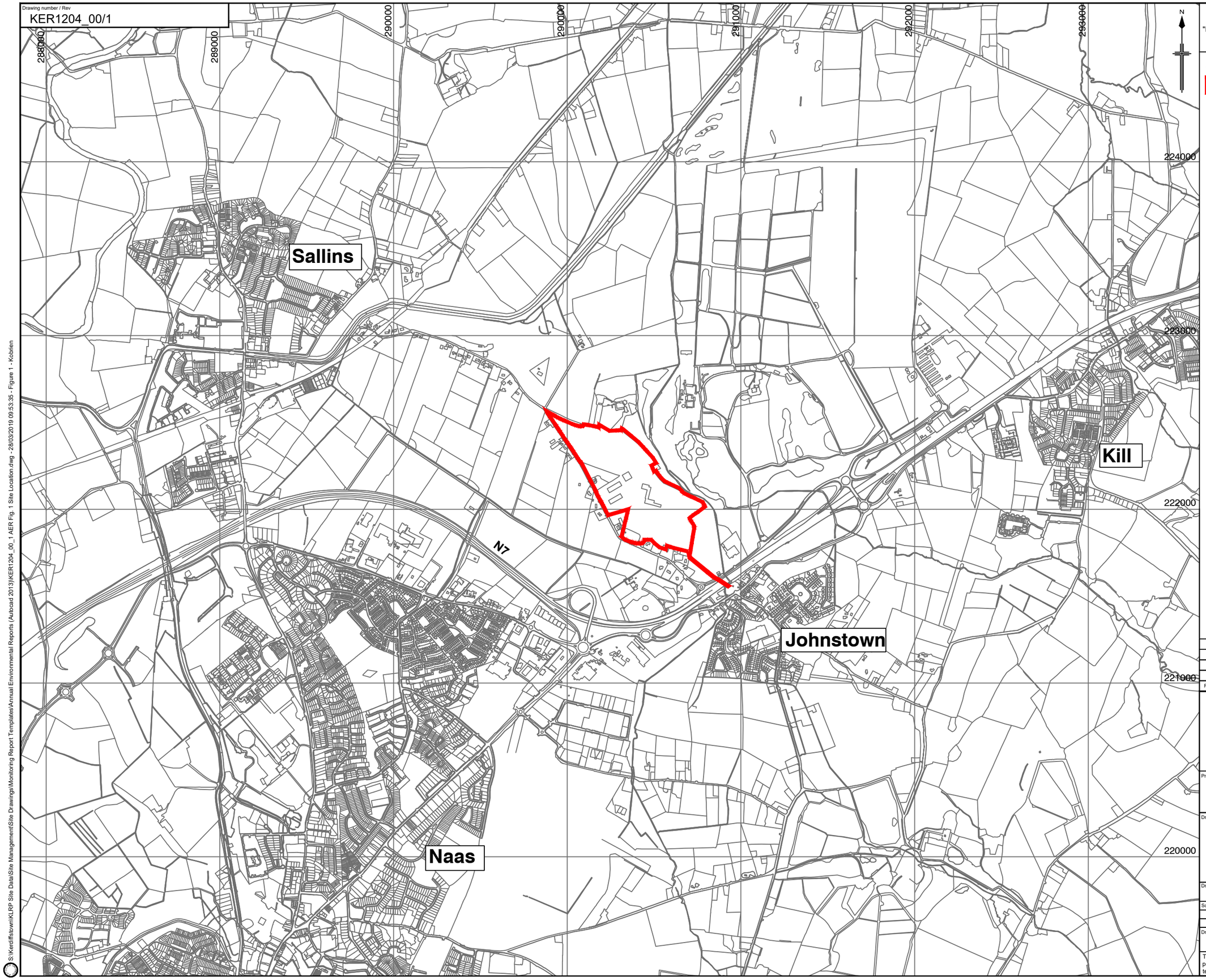

Wind rose showing wind direction for 2021 is provided below and shows that the prevailing wind direction was from a westerly or south westerly direction.



## Figures

FIGURE 1 Site Location

Drawing number / Rev
KER1204_00/1






*KEY:*

P1063-01 Licence Boundary

0 200 400 600 800
METRES

| Rev | Rev. Date | Purpose of revision | Drawn | Checkd | Rev'd | Apprv'd |
|---|---|---|---|---|---|---|
| 1 | 26/03/19 | Revised Licence Boundary | KOB | UD | | UD |
| 0 | 03/10/18 | FIRST ISSUE | KOB | UD | | UD |

KILDARE COUNTY COUNCIL
Environment Section
Áras Chill Dara
Devoy Park
Co. Kildare

Project
KERDIFFSTOWN LANDFILL
SITE REMEDIATION PROJECT

Drawing title
AER
FIGURE 1
SITE LOCATION

Drawing status
FIRST ISSUE

| Scale | 1:20,000 @ A3 | DO NOT SCALE |
|---|---|---|

Drawing number
KER1204_00

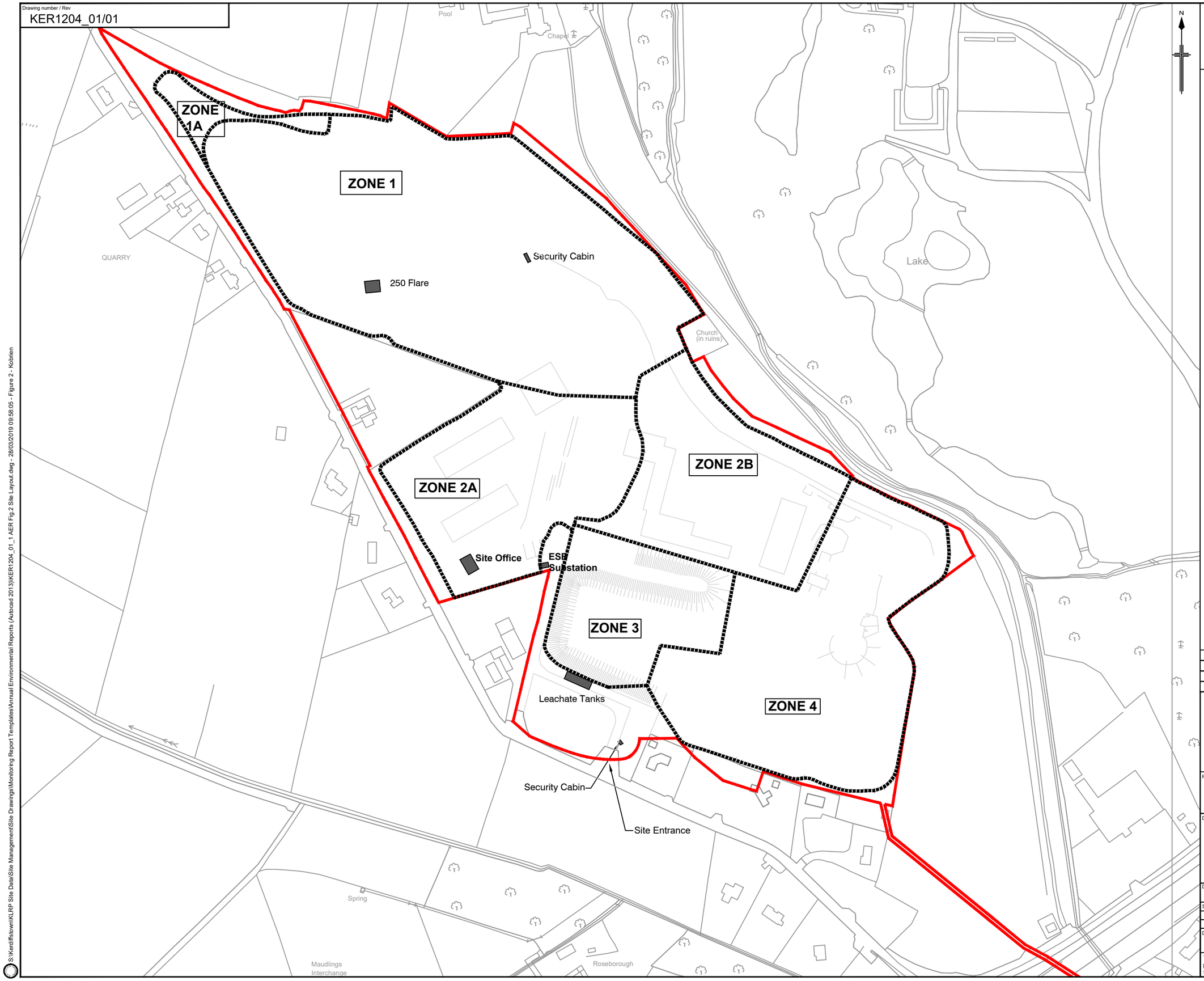
Rev
1



S:\Kerdiffstown\KLRP Site Data\Site Management\Site Drawings\Monitoring Report Templates\Annual Environmental Reports (Autocad 2013)\KER1204_00_1 AER Fig. 1 Site Location.dwg - 28/03/2019 09:53:35 - Figure 1 - Kobrien

**FIGURE 2 SITE LAYOUT**

Drawing number / Rev
KER1204_01/01

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*KEY:*

- EPA Reg No. P1063-01
- Site Infrastructure
- Zones

0 50 100 150
METRES

| Rev | Rev. Date | Purpose of revision | Drawn | Checkd | Rev'd | Apprv'd |
|---|---|---|---|---|---|---|
| 1 | 26/03/19 | Update Zones & Boundary | KOB | UD | | UD |
| 0 | 03/10/18 | FIRST ISSUE | KOB | UD | | UD |

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Project
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SITE REMEDIATION PROJECT

Drawing title
AER
FIGURE 2
SITE LAYOUT

Drawing status
FIRST ISSUE

Scale: AS SHOWN

Drawing number: KER1204-01
Rev: 1



S:\Kerdiffstown\KLRP Site Data\Site Management\Site Drawings\Monitoring Report Templates\Annual Environmental Reports (Autocad 2013)\KER1204_01_1 AER Fig 2 Site Layout.dwg - 28/03/2019 09:58:05 - Figure 2 - Kobrien

## FIGURE 3 MONITORING LOCATION REFERENCE DRAWINGS

## FIGURE 3A GROUNDWATER, SURFACE WATER AND OFFSITE LANDFILL GAS MONITORING LOCATIONS

Drawing number / Rev

KER1204_02/01

EMW24 DB1 BH60 EMW12 DB2 EMW22 EMW23 DB3 EMW13 EMW21 RM1 EMW33 SW 17 SW 05 SW 07 SW 14 EMW32 SW 04 RM2 DB4 BB2 EMW06 BH61 BH26 BH62A EMW09 EMW05 SW 15 RM3 DB15A EMW10 BH63 EMW03 EMW02 EMW31 EMW04 RM4 QUARRY BH64 BH36B BH67 DB5 SW 03 EMW20 SW 06 EMW14 RM5 DB14A BH39B BH66 EMW08 BH65 BB1 EMW07 RM6 BH48 BH77A EMW19 BH79 EMW15 DB6 EMW11 BH75 BH76A BH40B EMW18 BH80 BB4 EMW16 BH68 BH78 BH24 BH69 SW 08 SW 16 SW 02 EMW17 BH7 DB7 BB3A DB12 BH71 BH70 BH42 GW2S BH6 BH2 GW1D Site Discharge BH72 DB8A DB10A BH73 EMW30 EMW27D EMW28 DB9 SW 12 SW 10 EMW29 SW 13 SW 01 SW 11 INSET LIMERICK, CORK INSET (nts)

Pool Chapel Lake Church (in ruins) Roseborough Grave Yard

N

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*KEY:*

- EPA Reg No. P1063-01
- Groundwater Monitoring Point
- Surface Water Monitoring Point
- Monthly Wells
- Overburden
- Bedrock
- In-Waste Boreholes

0 50 100 150 METRES

| Rev | Rev. Date | Purpose of revision | Drawn | Checked | Rev'd | Apprv'd |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| 1 | 26/03/19 | | KOB | UD | | UD |
| 0 | 03/10/2018 | FIRST ISSUE | KOB | UD | | UD |

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KERDIFFSTOWN LANDFILL REMEDIATION PROJECT

Drawing title

AER
FIGURE 3a
GROUNDWATER AND SURFACE WATER MONITORING LOCATIONS

Drawing status

FIRST ISSUE

| Scale | AS SHOWN | DO NOT SCALE |
|---|---|---|

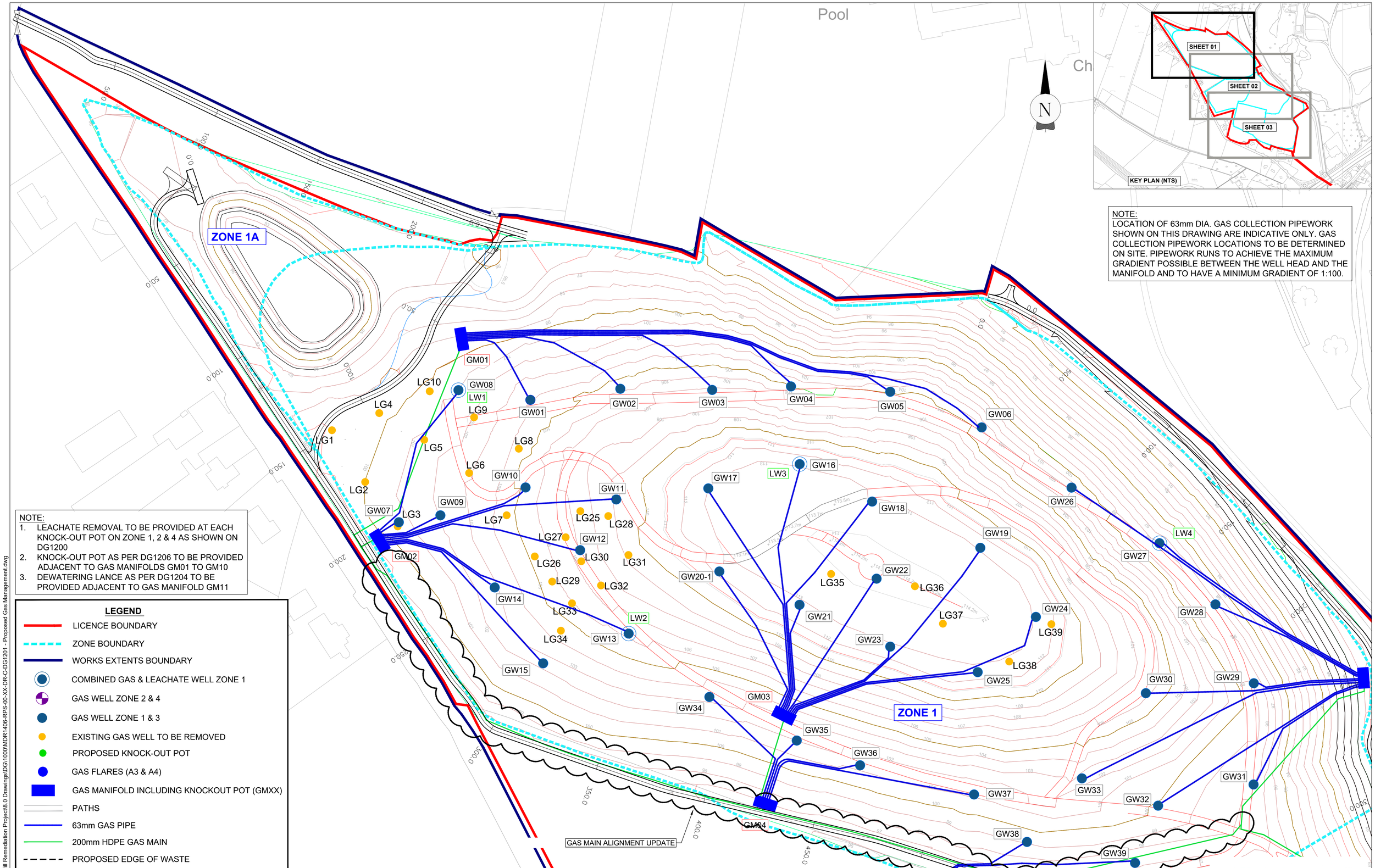
Drawing number: KER1204_02 Rev: 1



S:\Kerdiffstown\KLRP Site Data\Site Management\Site Drawings\Monitoring Report Templates\Annual Environmental Reports (Autocad 2013)\KER1204_02_1 AER Fig.3a GW, SW and Offsite LG Monitoring Locations.dwg - 28/03/2019 10:08:20 - Figure 3 - Kobrien

**FIGURE 3B ONSITE LANDFILL GAS MONITORING LOCATIONS**

*Note this drawing was provided by RPS as an interim drawing prior to the completion of the entire new landfill gas extraction network.*




NOTE:
LOCATION OF 63mm DIA. GAS COLLECTION PIPEWORK SHOWN ON THIS DRAWING ARE INDICATIVE ONLY. GAS COLLECTION PIPEWORK LOCATIONS TO BE DETERMINED ON SITE. PIPEWORK RUNS TO ACHIEVE THE MAXIMUM GRADIENT POSSIBLE BETWEEN THE WELL HEAD AND THE MANIFOLD AND TO HAVE A MINIMUM GRADIENT OF 1:100.

NOTE:
1. LEACHATE REMOVAL TO BE PROVIDED AT EACH KNOCK-OUT POT ON ZONE 1, 2 & 4 AS SHOWN ON DG1200
2. KNOCK-OUT POT AS PER DG1206 TO BE PROVIDED ADJACENT TO GAS MANIFOLDS GM01 TO GM10
3. DEWATERING LANCE AS PER DG1204 TO BE PROVIDED ADJACENT TO GAS MANIFOLD GM11

**LEGEND**

- LICENCE BOUNDARY
- ZONE BOUNDARY
- WORKS EXTENTS BOUNDARY
- COMBINED GAS & LEACHATE WELL ZONE 1
- GAS WELL ZONE 2 & 4
- GAS WELL ZONE 1 & 3
- EXISTING GAS WELL TO BE REMOVED
- PROPOSED KNOCK-OUT POT
- GAS FLARES (A3 & A4)
- GAS MANIFOLD INCLUDING KNOCKOUT POT (GMXX)
- PATHS
- 63mm GAS PIPE
- 200mm HDPE GAS MAIN
- PROPOSED EDGE OF WASTE

Client

Kildare County Council
Aras Chill Dara,
Devoy Park,
Newbridge Road,
Naas, Co. Kildare

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(v) All Levels refer to Ordnance Survey Datum, Malin Head.

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|---|---|---|---|---|---|
| A1 P05 | 04/11/21 | BC | VS | AS PER REVISION CLOUD | DC |
| A1 P04 | 12/08/21 | DN | VS | AS PER REVISION CLOUD | DC |
| A1 P03 | 27/07/21 | DN | VS | SEW APPLICATION | DC |

Model File Identifier


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West Pier Business Campus
Dun Laoghaire
Co. Dublin A96 N6T7
T +353 (0)1 4882900
W www.rpsgroup.com/ireland
E ireland@rpsgroup.com


Scale: 1:750 @ A1, 1:1500 @ A3
Created on: 05/09/18
Sheets: 01 of 03

Project: KERDIFFSTOWN LANDFILL REMEDIATION
Title: MAIN CONTRACT DRAWINGS
PROPOSED GAS MANAGEMENT

| File Identifier | Drawing No. | Status | Rev |
|---|---|---|---|
| MDR1406-RPS-00-XX-DR-C-DG1201 | DG1201-01 | A1 | P05 |

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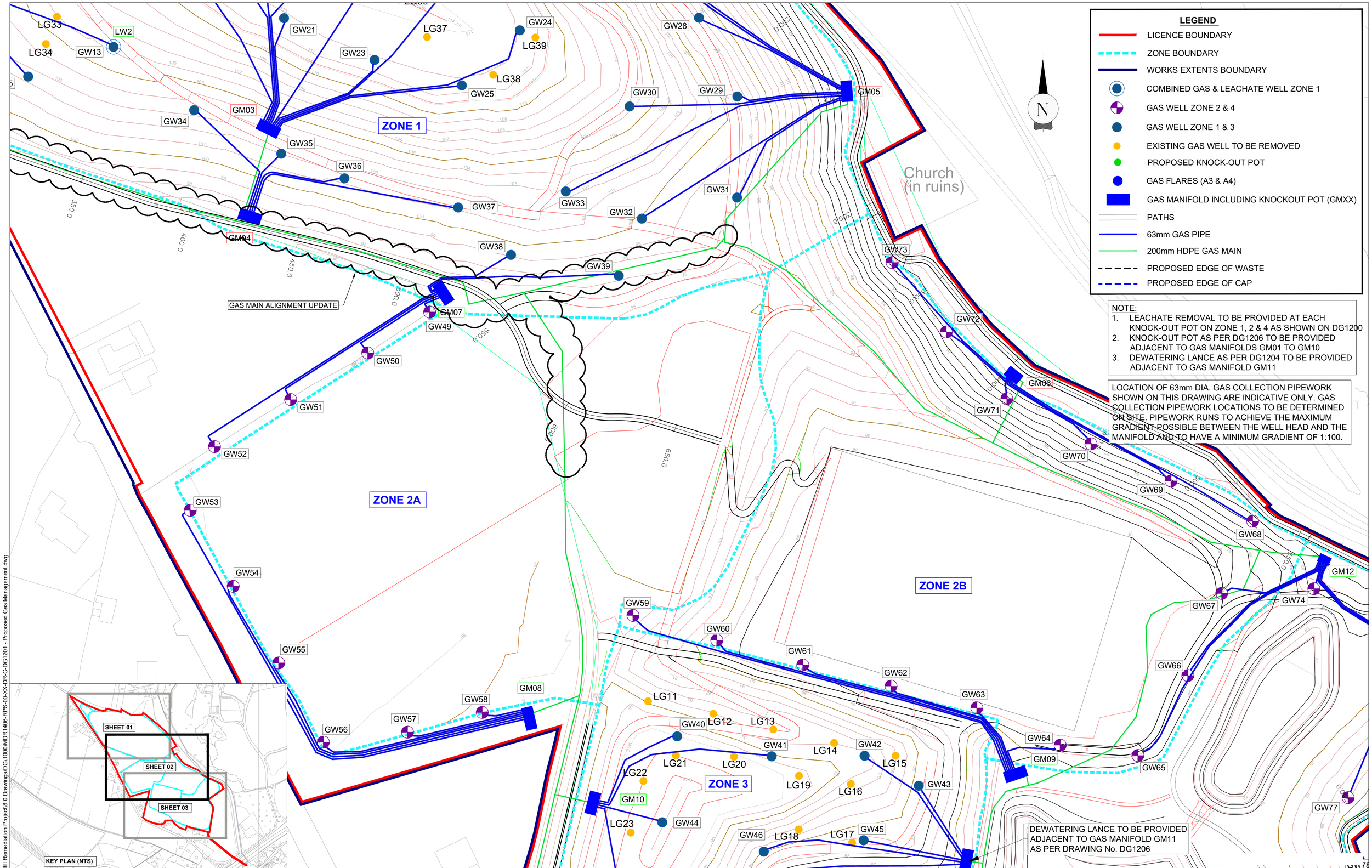


Client

Kildare County Council
Aras Chill Dara,
Devoy Park,
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Naas, Co. Kildare

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| A1 P05 | 04/11/21 | BC | JS | AS PER REVISION CLOUD | DC |
| A1 P04 | 12/08/21 | DN | JS | AS PER REVISION CLOUD | DC |
| A1 P03 | 27/07/21 | DN | JS | SEW APPLICATION | DC |

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West Pier
Business Campus
Dun Laoghaire
Co. Dublin A96 N6T7
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W www.rpsgroup.com/ireland
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|---|---|
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| Created on | 05/09/18 |
| Sheets | 02 of 03 |
| Project | KERDIFFSTOWN LANDFILL REMEDIATION |
| Title | MAIN CONTRACT DRAWINGS<br>PROPOSED GAS MANAGEMENT |
| File Identifier | MDR1406-RPS-00-XX-DR-C-DG1201 |
| Drawing No. | DG1201-02 |
| Status | A1 |
| Rev | P05 |

R:\MDR1406 - Kerdiffstown Landfill Remediation Project\8.0 Drawings\DG\1000\MDR1406-RPS-00-XX-DR-C-DG1201 - Proposed Gas Management.dwg

ZONE 2B

ZONE 3

ZONE 4

GW55 GW56 GW57 GW58 GM08 GW59 GW60 GW61 GW62 GW63 GW64 GM09 GW65 GW66 GW67 GW68 GM12 GW74 GW75 GW76 GW77 GW78 GW79 GW80 GW81 GW82 GW83 GW84 GW85 GM13

LG11 LG12 LG13 LG14 LG15 LG16 LG17 LG18 LG19 LG20 LG21 LG22 LG23 LG24

GW40 GW41 GW42 GW43 GW44 GW45 GW46 GW47 GW48 GM10 GM11

DEWATERING LANCE TO BE PROVIDED ADJACENT TO GAS MANIFOLD GM11 AS PER DRAWING No. DG1206

PROPOSED KNOCK-OUT POT

FLARES (A3 & A4)

NOTE:
LOCATION OF 63mm DIA. GAS COLLECTION PIPEWORK SHOWN ON THIS DRAWING ARE INDICATIVE ONLY. GAS COLLECTION PIPEWORK LOCATIONS TO BE DETERMINED ON SITE. PIPEWORK RUNS TO ACHIEVE THE MAXIMUM GRADIENT POSSIBLE BETWEEN THE WELL HEAD AND THE MANIFOLD AND TO HAVE A MINIMUM GRADIENT OF 1:100.

**LEGEND**

- LICENCE BOUNDARY
- ZONE BOUNDARY
- WORKS EXTENTS BOUNDARY
- COMBINED GAS & LEACHATE WELL ZONE 1
- GAS WELL ZONE 2 & 4
- GAS WELL ZONE 1 & 3
- EXISTING GAS WELL TO BE REMOVED
- PROPOSED KNOCK-OUT POT
- GAS FLARES (A3 & A4)
- GAS MANIFOLD INCLUDING KNOCKOUT POT (GMXX)
- PATHS
- 63mm GAS PIPE
- 200mm HDPE GAS MAIN
- PROPOSED EDGE OF WASTE

NOTE:
1. LEACHATE REMOVAL TO BE PROVIDED AT EACH KNOCK-OUT POT ON ZONE 1, 2 & 4 AS SHOWN ON DG1200
2. KNOCK-OUT POT AS PER DG1206 TO BE PROVIDED ADJACENT TO GAS MANIFOLDS GM01 TO GM10
3. DEWATERING LANCE AS PER DG1204 TO BE PROVIDED ADJACENT TO GAS MANIFOLD GM11

10m SCALE 1:750

SHEET 01 SHEET 02 SHEET 03

KEY PLAN (NTS)

Client

Kildare County Council
Aras Chill Dara,
Devoy Park,
Newbridge Road,
Naas, Co. Kildare

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| Rev | Date | Drn | Chk | Amendment / Issue | App |
|---|---|---|---|---|---|
| A1 P05 | 04/11/21 | BC | MF | AS PER REVISION CLOUD | DC |
| A1 P04 | 12/08/21 | BC | MF | AS PER REVISION CLOUD | DC |
| A1 P03 | 27/07/21 | BC | MF | SEW APPLICATION | DC |

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West Pier
Business Campus
Dun Laoghaire
Co. Dublin A96 N6T7
T +353 (0)1 4882900
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E ireland@rpsgroup.com

Model File Identifier

Scale 1:750 @ A1 1:1500 @ A3
Created on 05/09/18
Sheets 03 of 03

Project
**KERDIFFSTOWN LANDFILL REMEDIATION**

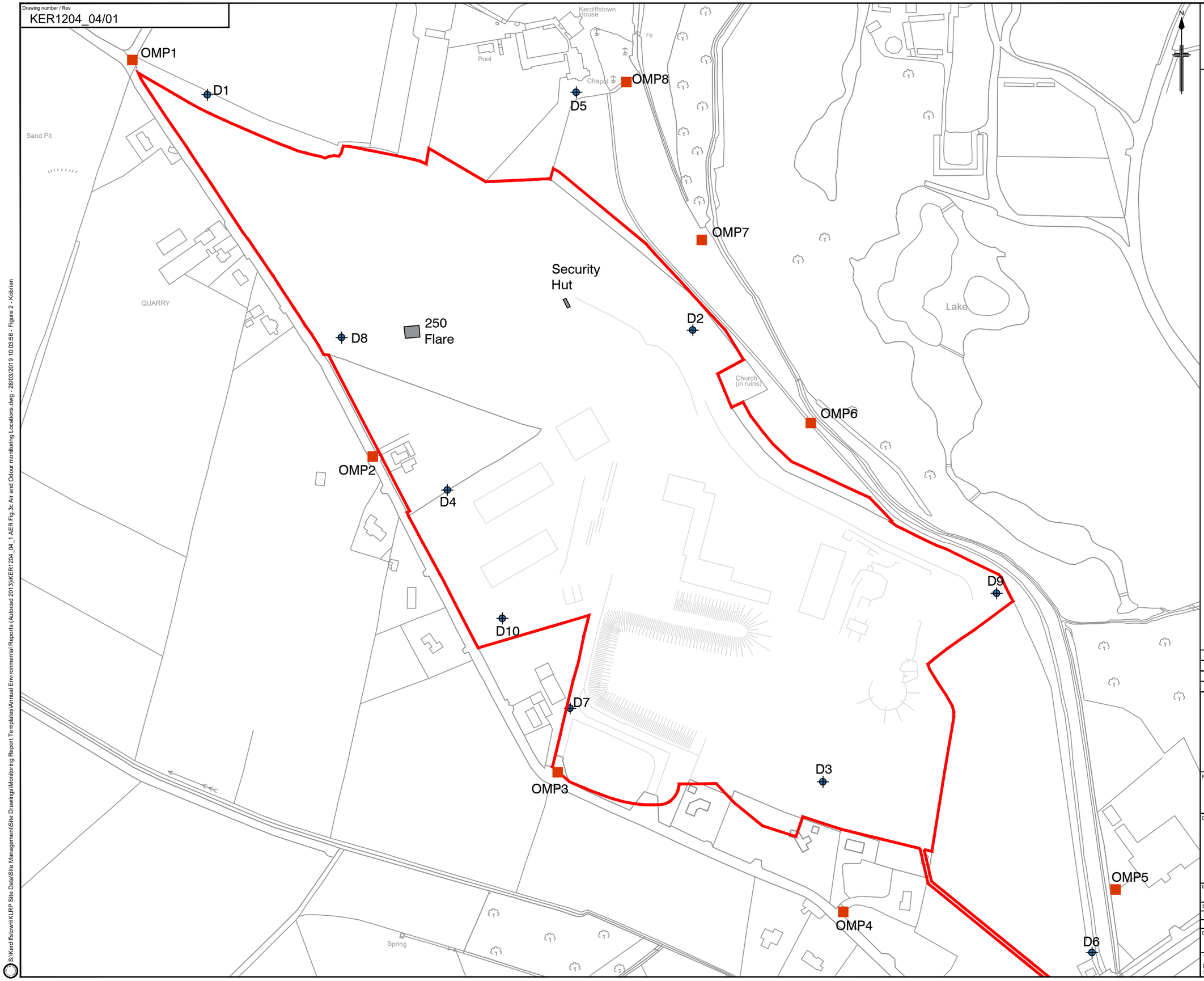
Title
**MAIN CONTRACT DRAWINGS**
PROPOSED GAS MANAGEMENT

| File Identifier | Drawing No. | Status | Rev |
|---|---|---|---|
| MDR1406-RPS-00-XX-DR-C-DG1201 | DG1201-03 | A1 | P05 |

R:\MDR1406 - Kerdiffstown Landfill Remediation Project\8.0 Drawings\DG\1000\MDR1406-RPS-00-XX-DR-C-DG1201 - Proposed Gas Management.dwg

## FIGURE 3C AIR / ODOUR / NOISE MONITORING LOCATIONS

Drawing number / Rev
KER1204_04/01

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*KEY:*

- EPA Reg No. P1063-01
- Air Quality Monitoring Locations
- Off-site Odour Monitoring Point
- Site Infrastructure

0 50 100 150
METRES

| Rev | Rev. Date | Purpose of revision | Drawn | Checkd | Rev'd | Apprv'd |
|---|---|---|---|---|---|---|
| 1 | 27/03/19 | Revised Boundary | KOB | UD | | UD |
| 0 | 03/10/18 | FIRST ISSUE | KOB | UD | | UD |


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Environment Section
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Devoy Park
Co. Kildare


Project
KERDIFFSTOWN LANDFILL
SITE REMEDIATION PROJECT

Drawing title
AER
FIGURE 3c
AIR AND ODOUR
MONITORING LOCATIONS

Drawing status
FIRST ISSUE

Scale: AS SHOWN

Drawing number: KER1204-04
Rev: 1

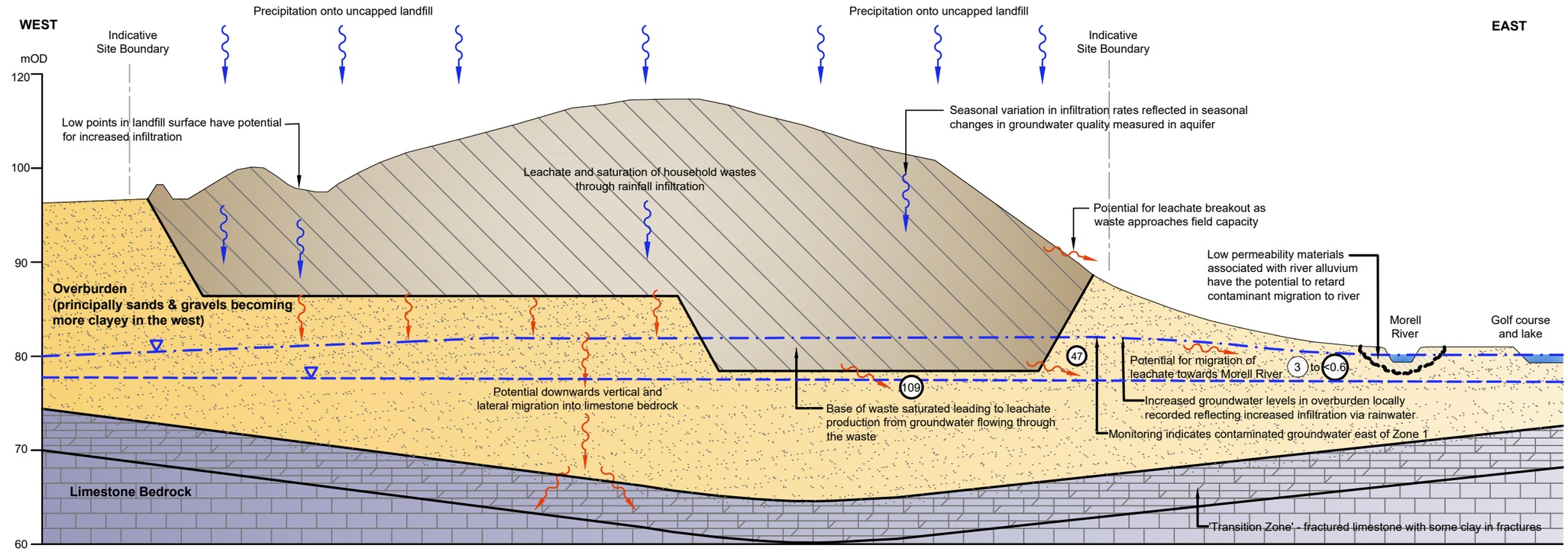


S:\Kerdiffstown\KLRP Site Data\Site Management\Site Drawings\Monitoring Report Templates\Annual Environmental Reports (Autocad 2013)\KER1204_04_1 AER Fig.3c Air and Odour monitoring Locations.dwg - 28/03/2019 10:03:56 - Figure 2 - Kobrien

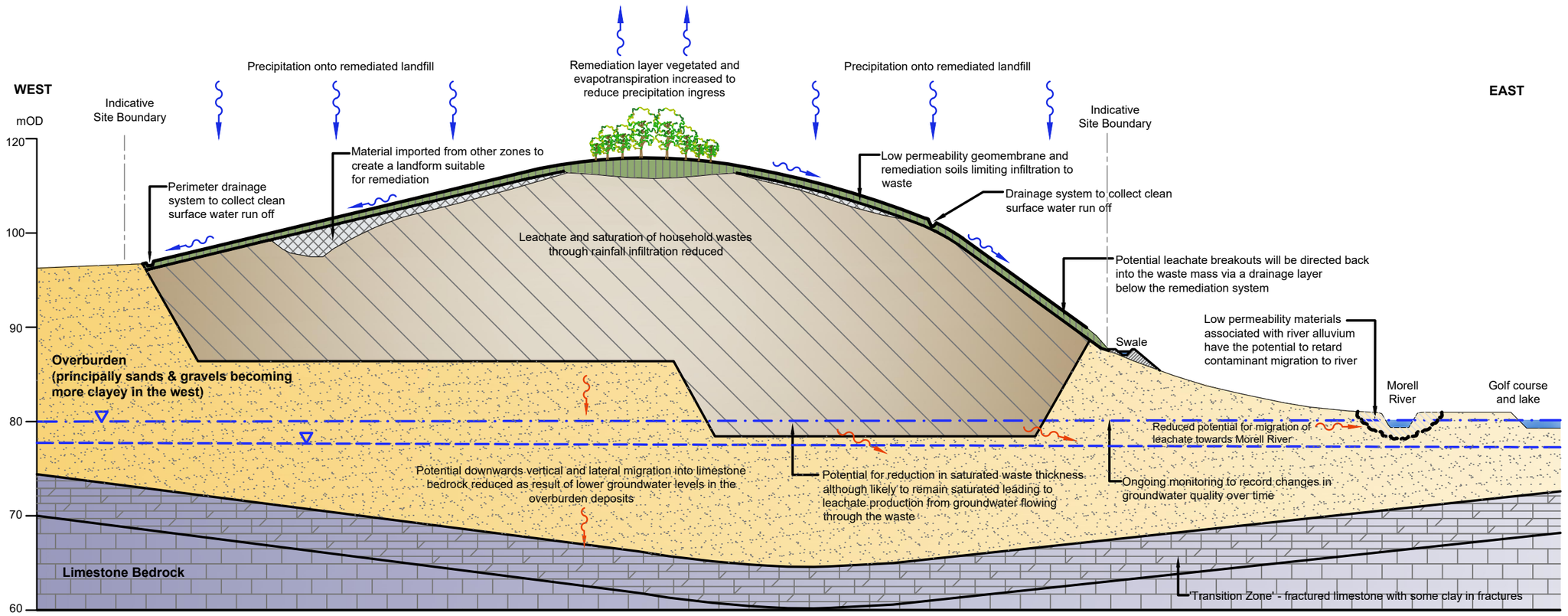
## FIGURE 4 CONCEPTUAL SITE MODELS (EIAR VERSIONS)

Hydrogeology Conceptual Site Model (Zone 1)

Drawing number / Rev
KER1204_5/0




**Groundwater Conceptual Site Model for Zone 1: Current Scenario**




**Groundwater Conceptual Site Model for Zone 1: Post Remediation**

FIGURE 4a

*KEY:*

- Groundwater Level in the Overburden
- Groundwater Head in the Limestone Bedrock
- Migrating Leachate
- (47) Ammoniacal Nitrogen Concentration July 2016 (mg/l)

| Rev | Rev. Date | Purpose of revision | Drawn | Checkd | Rev'd | Apprv'd |
|---|---|---|---|---|---|---|
| 0 | 10/10/2018 | FIRST ISSUE | KOB | UD | | UD |

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Environment Section
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Project
KERDIFFSTOWN LANDFILL REMEDIATION PROJECT

Drawing title
AER
FIGURE 4a
HYDROGEOLOGY CONCEPTUAL SITE MODEL (ZONE 1)

Drawing status
FIRST ISSUE

Scale: NTS [A3]
DETAILS SHOWN ARE NOT FOR CONSTRUCTION PURPOSES HENCE DRAWING SHOULD NOT BE SCALED

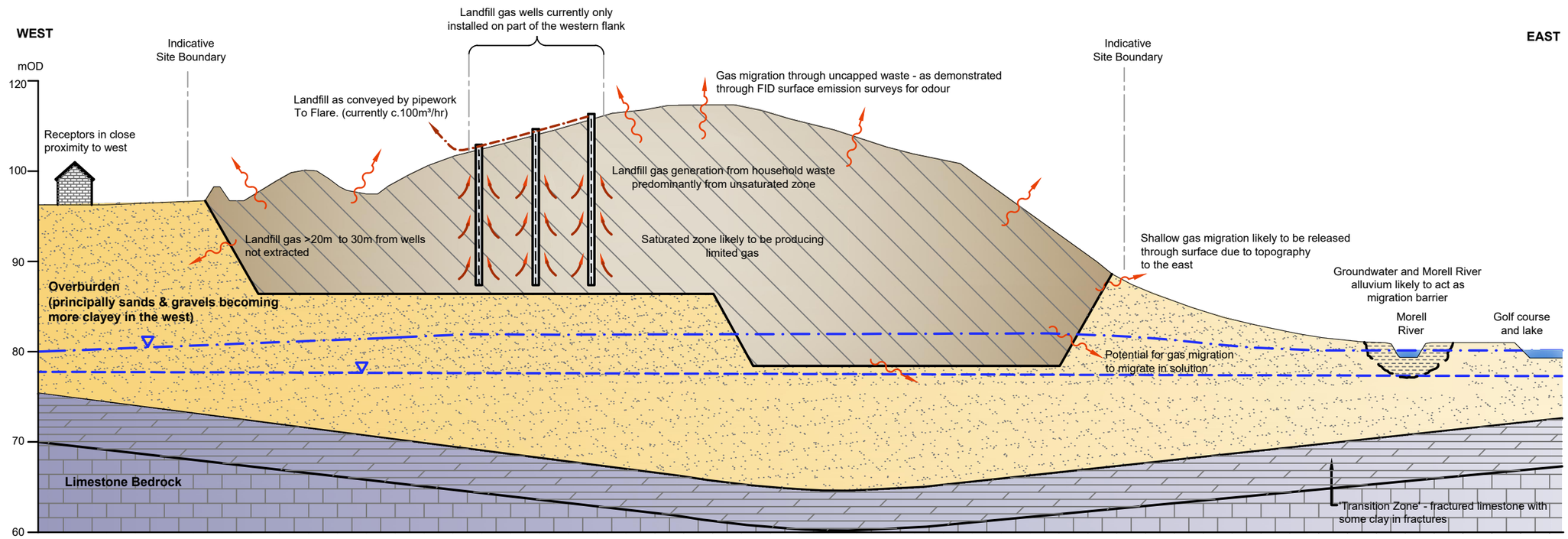
Drawing number: KER1204_5
Rev: 0



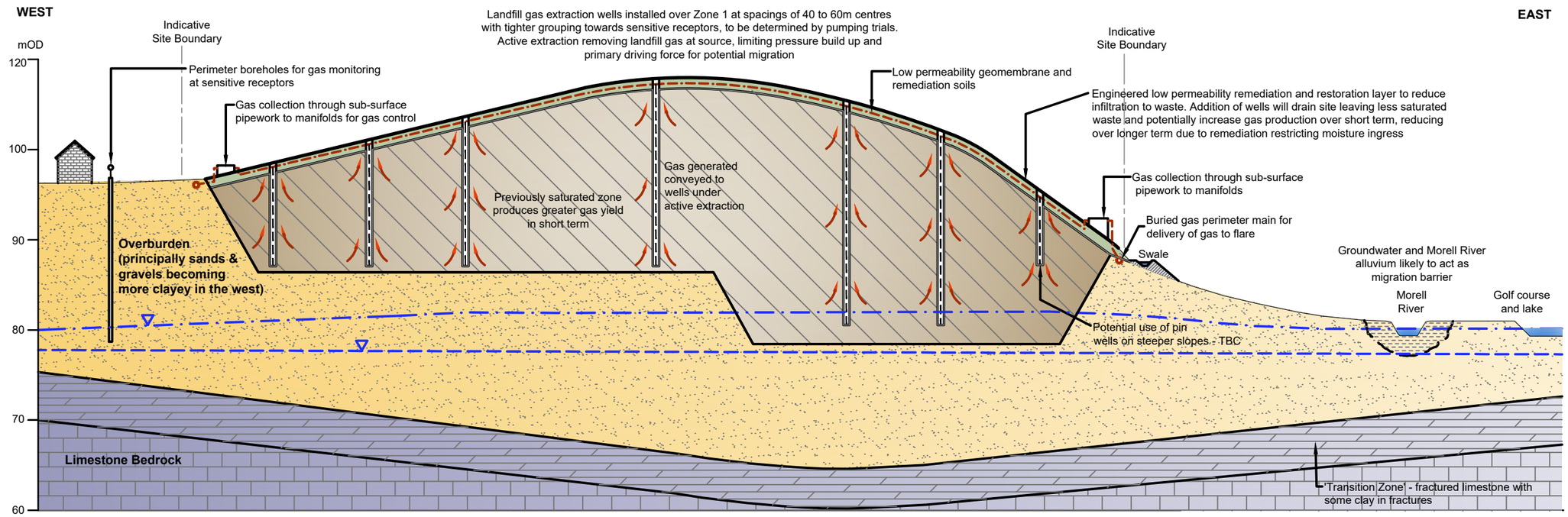
S:\Kerdiffstown\KLRP Site Data\Site Management\Site Drawings\Monitoring Report Templates\Annual Environmental Reports (Autocad 2013)\KER1204_05_0 AER Fig. 4a Hydrogeology CSM.dwg - 28/03/2019 10:09:14 - EIAR - Kobrien

Landfill Gas Management Conceptual Site Model (Zone 1)

Drawing number / Rev
KER1204_06/0




**Gas Conceptual Site Model for Zone 1: Current Scenario**




**Gas Conceptual Site Model for Zone 1: Post Remediation**

FIGURE 4b

*KEY:*

Groundwater Level in the Overburden

Groundwater Head in the Limestone Bedrock

| Rev | Rev. Date | Purpose of revision | Drawn | Checkd | Rev'd | Apprv'd |
|---|---|---|---|---|---|---|
| 0 | 10/10/2018 | FIRST ISSUE | KOB | UD | | UD |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Devoy Park
Co. Kildare


Project
KERDIFFSTOWN LANDFILL REMEDIATION PROJECT

Drawing title
AER
FIGURE 4b
LANDFILL GAS MANAGEMENT
CONCEPTUAL SITE MODEL (ZONE 1)

Drawing status
FIRST ISSUE

Scale: NTS [A3] — DETAILS SHOWN ARE NOT FOR CONSTRUCTION PURPOSES HENCE DRAWING SHOULD NOT BE SCALED

Drawing number: KER1204_06
Rev: 0



S:\Kerdiffstown\KLRP Site Data\Site Management\Site Drawings\Monitoring Report Templates\Annual Environmental Reports (Autocad 2013)\KER1204_06_0 Fig 4b LG Management CSM.dwg - 28/03/2019 09:58:52 - EIAR - Kobrien