Kerdiffstown Landfill Remediation Project

Annual Environmental Report 2018

IEL: P1063-01

Kildare County Council
Comhairle Contae Chill Dara

Report Title:	Annual Environmental Report 2018
Licence No.	P1063-01
Report Ref:	2018_AER
Status:	Final

	Name	Date	Position
Prepared by	Ultan Downes	27/03/19	Senior Executive Scientist
	Claire McLaughlin	27/03/19	Executive Scientist
	Joan McCormack	27/03/19	Executive Scientist
Approval by	Ultan Downes	28/03/19	Senior Executive Scientist

Table of Contents

Executive Summary 9
1. Introduction 11
1.1. Introduction 11
1.2. Background to Kerdiffstown Landfill Remediation Project 11
1.2.1. Site History 11
1.2.2. Current Regulatory Regime 12
1.2.3. Site Location 13
1.2.4. Current Site Layout 13
1.2.5. Conceptual Site Model (CSM) 18
1.3. Scope of Works 22
1.4. Reporting Completed During 2018 22
2. Management and Staffing Structure 24
2.1. Management and Staffing Structure of the Installation 24
2.2. Environmental Management System 24
2.3. Statement on Financial Provision 26
2.4. Statement on Closure Aftercare and Management Plan 26
2.5. Programme for Public Information 27
2.6. Duty & Standby Capacities of Mitigation Measures 27
3. Reported Incidents and Complaints Summary 29
3.1. Incidents 29
3.2. Complaints 29
3.3. Non-compliances 29
3.4. Review of Nuisance Controls 29
3.4.1. Litter Control 29
3.4.2. Vermin Control 29
3.4.3. Bird Control 30
3.4.4. Flying Insects 30
3.4.5. Odour Control 30
3.4.6. Dust Control 30
3.4.7. Noise Control 30
4. Emissions Management 31
4.1. Emissions from the facility 31

Table of Contents

4.2. Landfill Gas Management 31
4.2.1. Flare Shutdowns 32
4.2.2. Landfill Gas Production 32
4.2.3. Estimated annual and cumulative quantities of landfill gas emitted from the site 33
4.3. Leachate 34
4.3.1. Volume of leachate produced and transported off-site 35
4.3.2. Minimising generation of leachate for disposal 36
4.4. Environmental Performance Reporting (EPR) 37
4.5. Pollution Emission Register – Proposal for 2019 37
5. Waste Management & Resource Consumption 38
5.1. Records 38
5.2. Waste Analysis 38
5.3. Electricity 38
5.4. Diesel 39
6. Restoration Works 40
6.1. Remaining volumes of historically deposited waste 40
6.2. Development / Infrastructural works summary 42
6.2.1. Works Completed in 2018 42
6.2.2. Works Identified for 2019 42
7. Environmental Monitoring 44
7.1. Water 45
7.1.1. Groundwater 45
7.1.2. Surface Water 58
7.1.3. Overall Interpretation of Surface Water Monitoring Results 2018 59
7.1.4. Biological Q-rating assessment 67
7.1.5. Leachate 70
7.2. Landfill Gas 72
7.3. Air Stack Testing 74
7.4. Dust 75
7.5. Odour 76
7.6. Geotechnical 80
7.7. VOC Survey 81

Table of Contents

7.8. Meteorological Data 83
7.9. Noise Monitoring 84
8. Summary 85
8.1. Management 85
8.2. Incidents and Complaints 85
8.3. Emissions management 85
8.4. Waste Management and Resource Consumption 85
8.5. Restoration works 85
8.6. Environmental Monitoring 85
8.6.1. Groundwater Results 85
8.6.2. Surface Water Results 85
8.6.3. Biological Q-rating 86
8.6.4. Leachate 86
8.6.5. Landfill Gas 86
8.6.6. Dust 86
8.6.7. Odour Monitoring 86
8.6.8. Geotechnical 86
8.6.9. VOC Surface Emissions 86
8.6.10. Meteorological Data 87
8.6.11. Noise Monitoring 87
Appendices 89
Appendix A AER Requirements (from P1063-01) 91
Appendix B EMS Procedure summaries 95
Appendix C Landfill Gas Survey 2018 97
Appendix D Incidents and Complaints Summary 101
Appendix E Programme of Improvements 105
Appendix F Gas and Water Time Series graphs 107
Appendix G Meteorological Data Graphs & Tables 125
Appendix H Proposed 2019 Environmental Monitoring Schedule 133
Figures 137
Figure 1 Site Location 139
Figure 2 Site Layout 141
Figure 3 Monitoring Location Reference Drawings 143

Table of Contents

Figure 3a Groundwater, Surface Water And Offsite Landfill Gas Monitoring Locations 145
Figure 3b Onsite Landfill Gas Monitoring Locations 147
Figure 3C Air / Odour / Noise Monitoring Locations 149
Figure 4 Conceptual Site models (EIAR versions) 151
Figure 5a Geohazard Zonation Plan - Slope Stability Hazard Zonation Plan - South Area 153
Figure 5b Geohazard Zonation Plan - Slope Stability Hazard Zonation Plan - North Area 155

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 2018 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 restoration works.

The Kerdiffstown site occupies an area of approximately 30 ha, with an estimated 3.1 million tonnes[1] of waste present. 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).

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 2018. It also summaries proposed works at the site for 2019.

With respect to complaints, these are a rare occurrence having decreased significantly in recent years. In addition, incidents are also a rare occurrence. In 2018, 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) on a monthly basis to establish the impacts from landfill leachate on the water environment;
- Biological Q-rating assessment between May and August 2018 of the Morell River and its tributary the Hartwell River to determine the biological quality of the river and whether an impact from the landfill can be seen;
- 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;
- A surface emissions volatile organic compound (VOC) survey to determine the quantities of VOCs being discharged through the landfill surface;
- Flare stack emissions testing to inform compliance with future licence conditions;
- Noise monitoring in September 2018;
- Geotechnical risk assessment from July to November 2018 to determine slope stability and;
- Dust monitoring in May to July 2018 and August 2018 to determine the dust deposition rate.

[1] *Using conversion of 1 m^3 = 1 tonne*

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

1. Introduction

1.1. Introduction

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 2018.

Following the commencement of an intervention at the site in February 2011 the Environmental Protection Agency (EPA) and between 2015 and 2018 Kildare County Council has continued to take measures to manage activities at the site and to reduce the potential environmental impact of the site using powers under Section 56 of the Waste Management Act 1996 (as amended). From November 2019 KCC has taken ownership of the site and associated lands (See section 1.2.2 below for more details).

Table 1.1 Kerdiffstown Landfill - General Information

Kerdiffstown Landfill - General Information		
Industrial emissions register no:	P1063-01	
Name of intervening authority, name and address of facility:	Intervening Authority: Kildare County Council Áras Chill Dara, Devoy Park, Naas, Co. Kildare	Address of Facility: Kerdiffstown Landfill Johnstown Naas 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. The Kerdiffstown site occupies an area of approximately 30 ha, with an estimated 3.1 million m^3 of waste present.	

1.2. Background to Kerdiffstown Landfill Remediation Project

1.2.1. Site History

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 a number of 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 Kildare County Council (KCC).

The facility at Kerdiffstown was 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 1.2.2 below).

Although the former waste licence was no longer in effect (since September 2010) a range of environmental monitoring continued to be undertaken during 2018, as in previous years. 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 EIAR and an Industrial Emissions Licence (IEL) application to replace the former waste license. Subsequent monitoring conducted in the latter half of 2017 and throughout 2018 has been undertaken to monitor the environmental risk profile of the site and document any changes.

1.2.2. 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 and compulsory purchase. The lands associated with the Kerdiffstown facility are now in the possession of KCC effective from 12 November 2018.

In September 2017, KCC submitted an application for an Industrial Emissions Licence (IEL) to EPA the supported by an Environmental Impact Assessment Report

(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 where applicable at present.

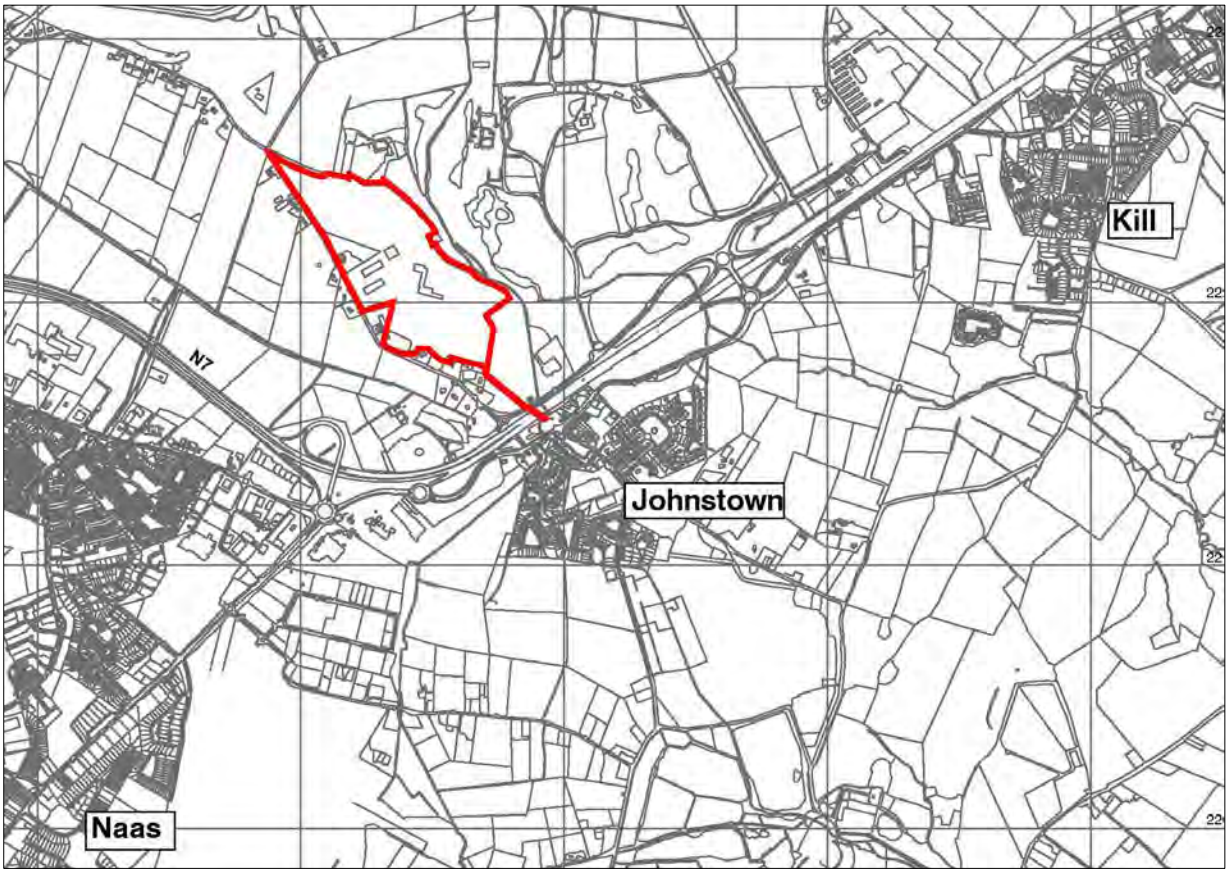
1.2.3. Site Location

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. 3.5km northeast of Naas and approximately 0.5km 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 south west and south east 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 10m 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



1.2.4. Current Site Layout

The current site layout is attached as Figure 2. Plate 1.2 below shows the site sub-divided into a number of 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

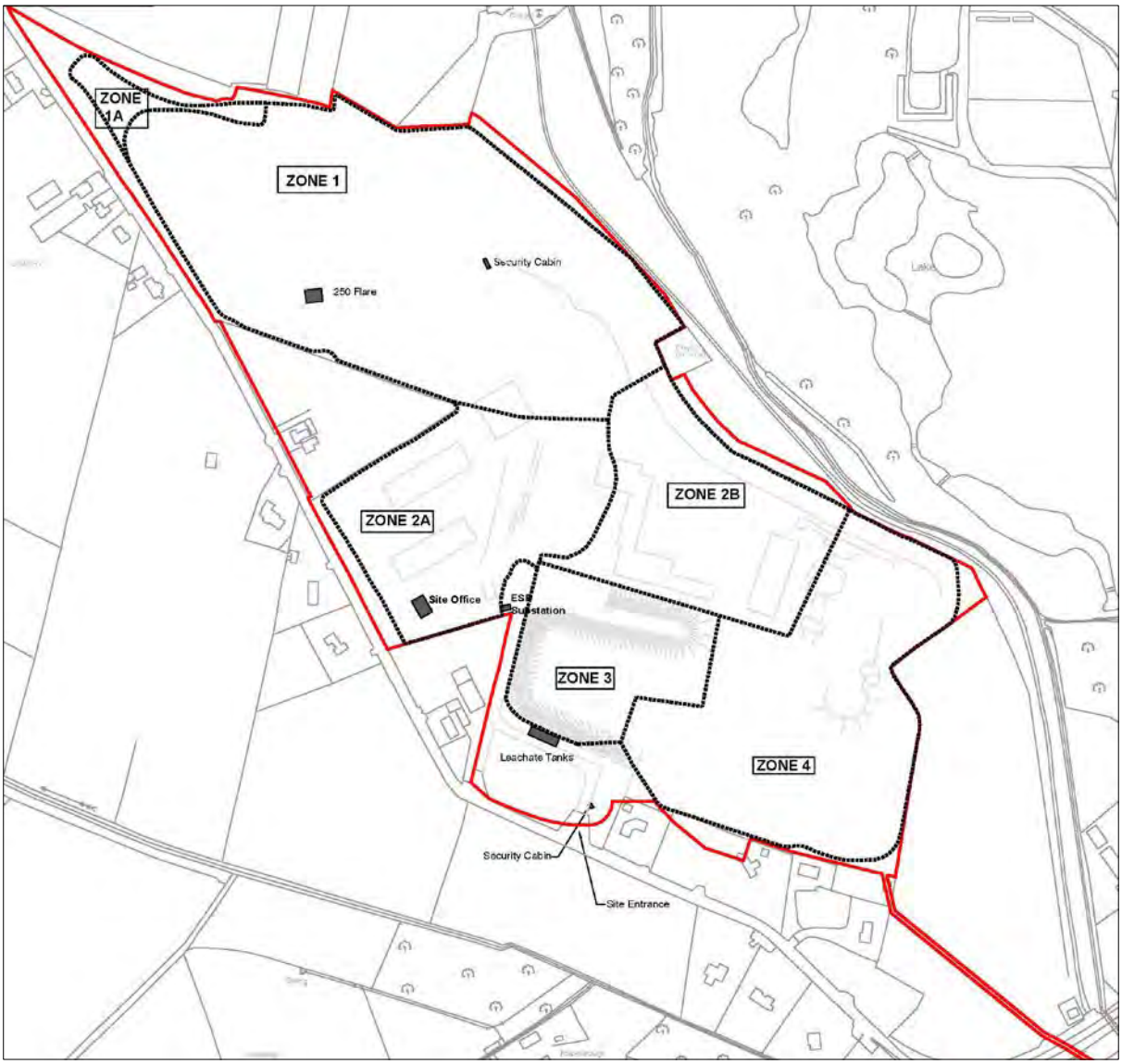


Table 1.2 Key Characteristics of the Landfill Zones

Zone Number	Zone Key Characteristics
Zone 1; comprising sub Zones 1 & 1A 	Estimated Area: 100,000m^2 Estimated Waste Volume: 2,023,000m^3 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 (e.g. borehole EMW12 and BH18). 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 (e.g. BH11, BH12) 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 1 is unlined and uncapped, with no means of limiting leachate generation or management. There are a series of landfill gas wells present across Zone 1, extracting gas to a flare. The average overall quality of gas from Zone 1, based on values recorded in the landfill gas extraction wells, is methane 23%v/v carbon dioxide 25% v/v and <1% v/v oxygen. The gas wells cover selected areas of the zone based on targeting areas of odour generation.

Zone Number	Zone Key Characteristics
Zone 2; comprising sub Zones 2A & 2B 	Estimated Area: 83,000m^2 Estimated Waste Volume: 660,000m^3 Zone 2 comprises largely flat areas with thick reinforced concrete hardstandings 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 remain. 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. 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. 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. 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. The areas beyond the hardstandings are uncapped 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 	Estimated Area: 24,000m^2 Estimated Waste Volume: 193,000m^3 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. 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. Zone 3 has a temporary cap applied over the existing waste mass. 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 	Estimated Area: 45,000m^2 Estimated Waste Volume: 227,000m^3 Zone 4 contains 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 contains a surface water soakaway lagoon which is cut into waste deposits and into which leachate from the adjacent waste stockpiles currently drains. Stockpiles comprise both processed and unprocessed non-hazardous mixed C&D waste and household waste. The majority of waste in Zone 4 is reported in borehole and trial pit logs to comprise 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. The logs (30 No.) do not generally report any MSW to be present (although the logs for BH4 to BH6 do describe the wastes as MSW. However, based on the actual description of the materials and proportion of these the materials are indicative of C&D waste rather than MSW). Where gas readings have been taken and reported in the borehole logs, it is reported that methane and carbon dioxide concentrations are largely absent from the wastes or less than 1%v/v within this zone. The bottom 1 to 2m of wastes is below the water table in this area. The areas beyond the hardstandings are uncapped. The hardstandings will limit rainwater and surface water infiltration to an extent.

1.2.5. Conceptual Site Model (CSM)

In order 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 Source-Pathway-Receptor (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.

Plate 1.3: Zone 1 Hydrogeological Conceptual Site Models 2017

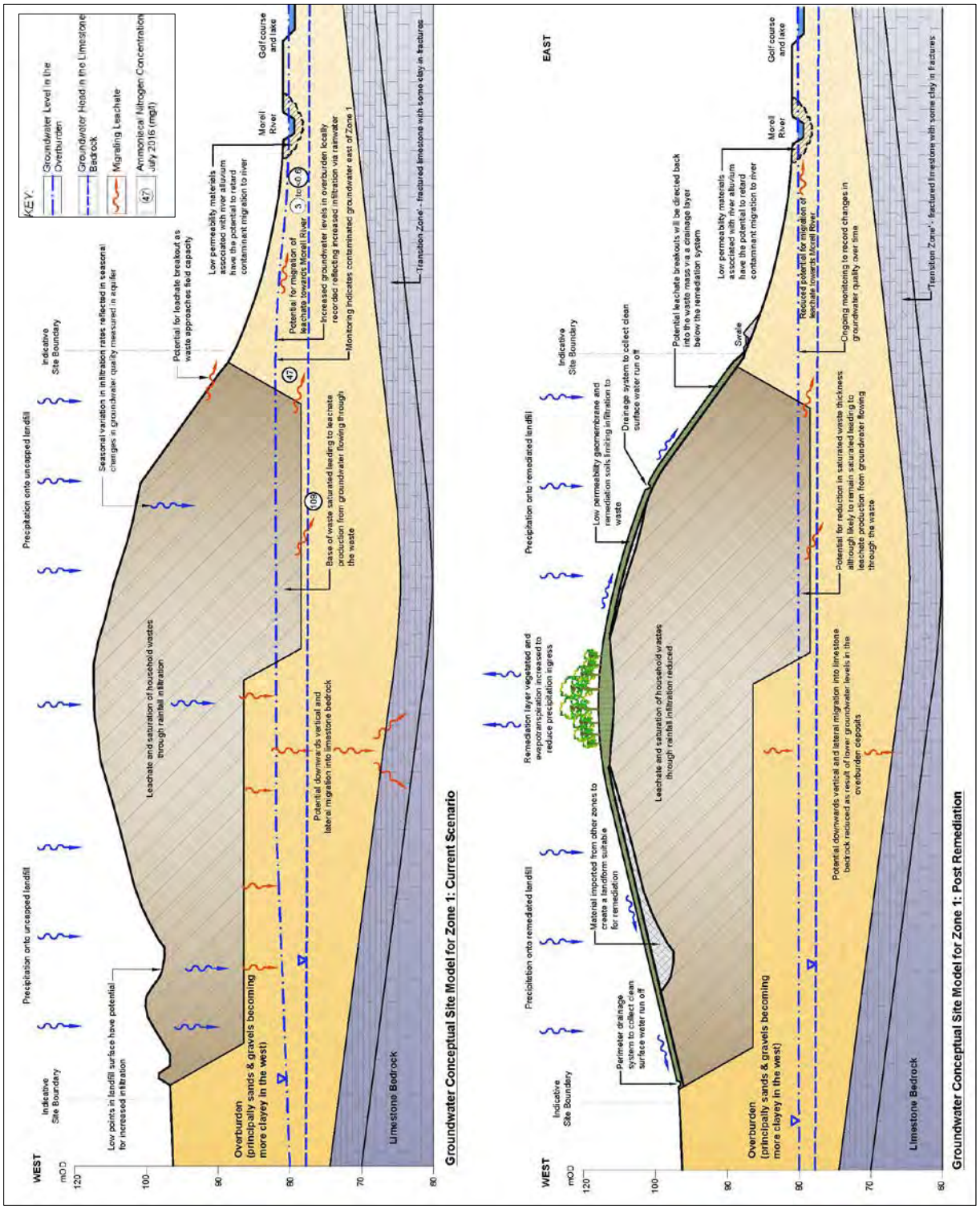
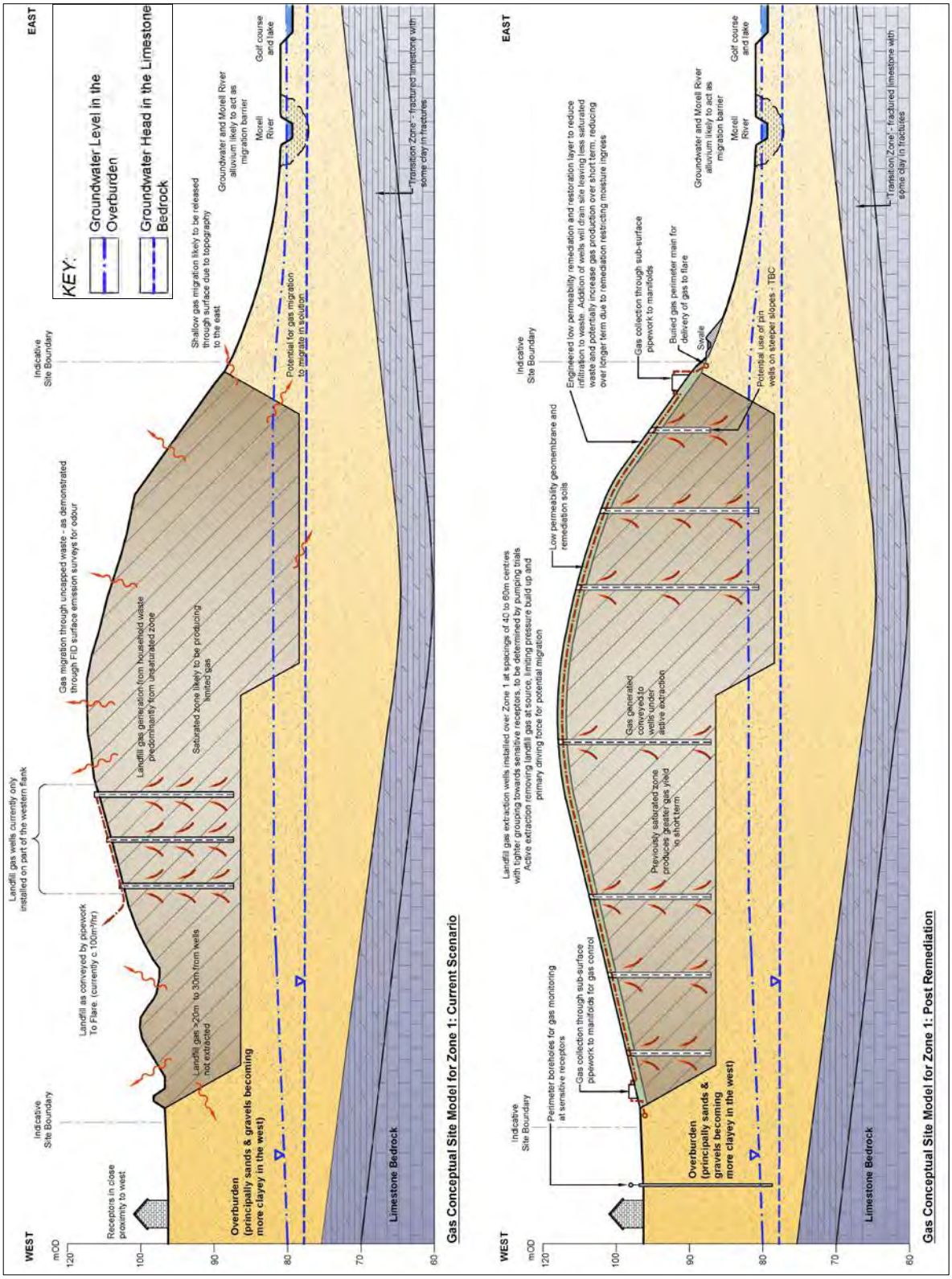


Plate 1.4: Zone 1 Landfill Gas Conceptual Site Models 2017



1.3. Scope of Works

This Annual Environmental Report (AER) was prepared by KCC for the reporting year 01 January 2018 to 31 December 2018. The scope of the AER is based on Schedule D of the proposed 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 2018.

It is noted that from January 2019, Pollutant Release and Transfer Register (PRTR) reporting of annual mass emissions and waste transfers is to be completed using the new Environmental Performance Reporting (EPR) online application, which is available through the EDEN portal. At the time of developing this document the EPR online application was not available to KCC and the need for completion of the EPR for Kerdiffstown Landfill was to be determined by the EPA[2].

1.4. Reporting Completed During 2018

Table 1.3 summarises the reports that have been undertaken as part of the environmental monitoring tasks completed during 2018. 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 2018

Discipline	Title
Groundwater and Surface water	Groundwater and Surface Water Summary Reports for Kildare County Council January to December 2018
	Groundwater and Surface Water Quarterly Monitoring Report for Kildare County Council Q1 to Q4 2018
	Biological Water Quality Assessment of the Morell and Hartwell Rivers Adjacent to the Kerdiffstown Facility in Co. Kildare
Odour Monitoring	Odour Monitoring Summaries 2018
VOC Report	Report on Surface Area Monitoring of Volatile Organic Compounds (VOCs) Emissions To Air
Flare	Stack Emissions Testing Report
Geotechnical	Slope Stability Risk Assessment and Scenario Analysis – (December 2018)

[2] *Personal Comm. between Ultan Downes and Juliet McCarthy 26.03.19.*

Discipline	Title
	Inclinometer Readings (July – November 2018)
Dust	Dust Monitoring Report May to (July 2018)
	Dust Monitoring Report (August 2018)
Noise	Noise Monitoring Summary

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 Kildare County Council 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. Michael Holligan 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 KLRP Project Team

Name	Position	Contact details
Joe Boland	Director of Services	Email: jboland@kildarecoco.ie Tel: 045 980588
Michael Holligan	Senior Engineer	Email: mholligan@kildarecoco.ie Tel: 045 980588
Ultan Downes	Site Manager (Senior Executive Scientist)	Email: udownes@kildarecoco.ie Tel: 045 980488
James Mulligan	Senior Executive Engineer	Email: jmulligan@kildarecoco.ie Tel: 045 980588
Kathleen O'Brien	Executive Engineer	Email: kobrien@kildarecoco.ie Tel: 045 980413
Claire McLaughlin	Executive Scientist	Email: cmclaughlin@kildarecoco.ie Tel: 045 980389
Joan McCormack	Executive Scientist	Email: jmccormack@kildarecoco.ie Tel: 045 980446

In 2018 KCC also had a supporting team of various contractors and consultants working on the KLRP. RPS Group is providing consultancy advice in relation to all engineering aspects of the remediation project.

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. **Appendix B** provides one page summaries of all 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 currently under review in accordance with the IEL requirements and will be revised by 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

Standard Operating Procedures	
SOP11	Emergency Preparedness and Response Procedure
SOP12	Emergency Plan
SOP13	Lone Working Procedure
SOP14	Alarm Activation Procedure

2.3. Statement on Financial Provision

In 2015, the Minister of the Environment confirmed that the Department of the Environment 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 Kildare County Council 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.

The Council 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 DCCAE 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.

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 Kildare County Council 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 (refer to **Appendix F**) 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. The management plan will include confirmation of:

- capping specifications applied in the remediation works;

- landscaping works;
- site infrastructure (landfill and non-landfill);
- maintenance requirements;
- monitoring requirements;
- inspections;
- record keeping;
- roles and responsibilities;
- closure arrangements (notifications, programme, audits, reports and certification).

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 will be provided for agreement by the Agency within six months of the grant of the licence (September 2019) and will include fully detailed and costed plan for the closure, restoration and long-term aftercare of the site or part thereof.

2.5. Programme for Public Information

At present KLRP communicates with the public via the Kerdiffstown website (http://www.kildare.ie/countycouncil/kerdiffstownpark/). The website provides information about work ongoing at Kerdiffstown Landfill. Further information and updates will be posted on the website as the remedial project progresses, to help keep local residents, stakeholders and all interested parties fully informed and up to date with progress on the project. Community updates are provided in the '*latest news'* section of the website.

Community Liaison meetings were held on site with local residents, local interest groups, Kildare County Council and local government officials to ensure all parties were kept fully informed of progress to date and any updates to the overall remediation programme. Community Liaison meetings took place during 2018 on the following dates:

- 30 May 2018
- 13 September 2018
- 17 December 2018

As the KLRP progresses consultation and/or information events will be rolled out locally. The aim of these events will be to raise awareness of the project and provide further updates on the remediation of the Landfill. These events will be advertised locally and on the Kerdiffstown website.

2.6. 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 gas flares. 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.

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 a 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.

3. Reported Incidents and Complaints Summary

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.

3.1. Incidents

There were no incidents reported in 2018.

3.2. Complaints

One complaint was received during 2018. However when investigated by the site management team it was determined that the perceived odour could not have been as a result of emissions from the site due to the prevailing wind direction during the complaint period.

A complete summary of all complaints is provided in **Appendix D**.

3.3. Non-compliances

During this reporting period the EPA did not issue any non-compliance notices in relation to the operation of the site due to the waste licence being inactive and change in the regulatory regime as detailed in Section 1.2.2 of this report.

3.4. Review of Nuisance Controls

3.4.1. 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.

3.4.2. Vermin Control

Moone Pest Control was appointed by KCC to manage pest control on site. At present a total of 30 bait boxes are positioned along the southern boundary fence which is close to a number of residential properties. An additional 2 bait boxes are positioned at the site offices and at the 250 flare. Twice-monthly maintenance checks are 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 2018 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 2019.

3.4.3. 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.

3.4.4. Flying Insects

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

3.4.5. 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 flares. In the lined cell area a heavy duty membrane has been placed over the waste material to assist with odour management and to reduce air ingress during gas extraction operations.

In all a total of 39 gas extraction wells have been installed in both areas (25 wells in Zone 1 and 14 wells in the lined cell area of Zone 3) which are monitored and maintained on a weekly basis as a minimum. Five of these gas wells were brought on-line in early 2017 having been installed during the site investigations during the last quarter of 2016. Odour surveys are conducted offsite on a monthly basis by KCC. As part of a daily site walkover the site management also assesses odours particularly in areas where sensitive receptors are located nearby.

3.4.6. Dust Control

There are currently no specific ongoing dust control measures in place at the Kerdiffstown facility. There were no issues with dust raised with facility management during 2018. Two dust deposition surveys were conducted during May to July 2018 and August 2018. There were three exceedances of the former licence limit of 350 $mg/m^2/day$. These were recorded at KLRP 6 and KLRP 9 in May-July and at KLRP 1 August 2018 (see section 7.1.6 for further details).

3.4.7. Noise Control

There were no issues noted in relation to noise during the reporting period (see section 7.1.10 for further details).

4. Emissions Management

4.1. Emissions from the facility

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

4.2. Landfill Gas Management

Active gas extraction occurs in two areas of the site; the lined cell in Zone 1 and Zone 3. Zone 3 consists of the lined cell, where the wastes have been covered with a temporary heavy duty membrane to assist with odour management and to reduce air from being drawn in during gas extraction operations. Gas extraction is accomplished via a network of gas extraction wells and pipework. Gas is removed and burnt in a specially manufactured stainless steel high temperature gas flare i.e. the 250 flare.

There were formerly are two flares on site, one with capacity 250m^3/hr (known as the 250 flare), the second with capacity 500m^3/hr (known as the 500 flare). The 500 Flare was removed from site on 06 July 2018. The 500 Flare was moved 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 is burned in the 250 flare.

The flow of gas entering the 250 flare is controlled through the booster unit which is currently set to 100 m^3/hr to maximize gas extraction from both areas while ensuring little or no air is drawn in across uncapped areas. Based on gas yields the extraction of gas from Zone 1 compared to the lined cell area is approximately 4:1.

Table 4.1 On site Gas Wells

Zone	Nomenclature	No. of Gas Wells	Approx Depth (m)
Zone 1	LG1 to LG10	10	6
	LG25 to LG34	10	20
	LG35 to LG39	5	29 to 32
Zone 3	LG11 to LG24	14	3 to 6

Table 4.1 above shows that within the Zone 3 there are 14 gas wells, installed to depths between three metres and six metres (LG11 – LG24). Within Zone 1 there are twenty five gas wells installed to depths between six metres and twenty metres. The shallow wells are labelled LG1 to LG10 while the deeper wells are labelled LG25 to LG34. Wells LG35 to LG39 vary in depth between twenty nine and thirty two metres and were installed in Zone 1 in November 2016 and were connected into the extraction system in early 2017. Refer to Figure 3B ‘Onsite Landfill Gas Monitoring Locations’ for an overview of the all landfill gas wells.

The 250 landfill gas flare is currently monitored by the site scientists on a daily basis. Continuous flare stack monitoring has been set up on site with remote access from a portable device possible through the Uniflare data logger.

4.2.1. 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 shut down e.g. mechanical failure.

In 2018 there were a total of thirteen flare shutdowns of the onsite 250 m^3 gas flare located in Zone 1. The flare shutdowns were attributed to a combination of decreasing methane concentrations, high pressure, low temperature and high winds. Records of all incidents are kept on file in the site office.

Flare shutdowns are reported immediately to the site manager, site scientist, site security and Uniflare (the flare manufacturers and service operators) by automatic email and text alert. The site manager has responsibility for investigating each incident and restarting the flare either directly on site during standard operational hours or remotely using the Uniflare Data Portal. When the flare shuts down it is restarted by the site manager within 24 hours when combustible gas is present.

Five additional gas extraction wells were installed in Zone 1 during 2016 to boost declining methane concentrations. The location of these wells was aided by a VOC survey, completed by Odour Monitoring Ireland in July 2016, which identified a number of locations where landfill gas was freely venting to air in the Zone 1 area.

There was no significant impact on the environment arising from any of the flare shutdown events.

4.2.2. Landfill Gas Production

In overall terms the amount of landfill gas being produced from both the lined cell and the Zone 1 gas fields has been falling since flaring began in 2011 where concentrations had an average value 30.4 % between June 2011 and December 2011 and 22.2% between January and December 2018.

As observed in 2017 and in contrast to Zone 1, methane concentrations in the lined cell have seen to have maintained a higher concentration during 2018. This was attributed to works that included the placing of additional waste in the Lined Cell and improvements to the membrane covering the cell. The improvement is gas quality in the lined cell resulted in gas being extracted from this area on a continuous basis.

Previously, extraction of gas was for a period of three to four days a week with the area shut off for the rest of the week, in order to allow the methane concentration build up to a sufficient level to support the operation of the flare.

Graphs 4.1 to 4.3 show the landfill gas values recorded on site in 2018, while the below table shows methane concentrations since 2011 and illustrates this overall observed decline. Summary graphs for 2018 by Zone are provided in **Appendix F**.

Table 4.2 CH4 Concentrations 2018 to 2011

	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

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

The gas extraction system operated at an inlet flow rate ranging from 81 m^3/hr and 142 m^3/hr (average 101 m^3/hr) recorded from daily inlet monitoring during 2018. Table 4.3 below displays the average values as well as the range of values recorded at the 250 flare throughout 2018. The average concentration of methane (CH_4) flared at the 250 flare during 2018 was 23.9% and the average concentration of carbon

dioxide (CO_2) was 21.6% (see Table 4.1). Corresponding values from 2017 are also **provided for comparison purposes.**

Table 4.3 250m3/hr flare - Average, Maximum and Minimum Values 2018

		Average		Max		Min	
	Unit	2018	2017	2018	2017	2018	2017
CH_4	% v/v	23.9	23.5	29.0	29.8	18.8	18.2
CO_2	% v/v	21.6	21.7	27.2	24.4	19.5	17.5
O_2	% v/v	0.3	0.3	0.9	4	0.00	0
Flow	m^3/hr	100.94	104	142.69	165	80.51	61
Flare Exhaust Temperature	°C	1003	1013	1036	1035	743.6	931
Gas field Suction Pressure	mbar	-4.52	-1.52	1.34	0.9	-9.88	-4.38
Outlet Pressure Gas Booster	mbar	8.38	9.06	12.47	11.4	5.27	7.07

The total flare shutdown time was recorded as approximately 175 hours. The total amount of methane flared based on runtime, flow rate and methane concentration was 227,997 m^3 or 157,051 kg[3]. Summary graphs of landfill gas flared during 2018 are provided in **Appendix F**.

4.3. 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 the lined cell has been infilled with waste. Buildings onsite that were considered dangerous were demolished in 2016. These building 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 the lined cell 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

3 Source EPA Landfill Gas Survey 2018 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 (98%) for methane

site. This cover was upgraded following the placement of waste in the lined cell. 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. Rain falling onto the exposed gravel area is another source of leachate generation. 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. 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. 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 the lined cell to enable leachate extraction from both areas of the cell.

4.3.1. Volume of leachate produced and transported off-site

In 2018, a total of 9,940m^3 of leachate (355 loads) was transported off site by Elsatrans Ltd (NWCPO-12-11124-01) to Ringsend waste water 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 1.0m and haulage is carried out between Monday and Friday with up to a maximum of four loads per day.

Table 4.4 Leachate Transported Off Site 2018

Month	No. of Loads	Total volume (m^3)	Total Monthly Rainfall (mm)
January	54	1512	91.5
February	20	560	25.8
March	24	672	69.1
April	53	1484	76.1
May	27	756	16.8
June	13	364	18.5
July	0	0	30.1
August	39	1092	43.1
September	18	504	37
October	25	700	56.1
November	40	1120	104.6
December	42	1176	79.1
Total	355	9,940	648
Monthly Average =	30	828	

4.3.2. 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.

In 2016, 14,168 m^3 (510 loads) of leachate were extracted from the lined cell.

In 2017 11,144 m^3 (398 loads) of leachate were extracted from the lined cell. This is a reduction of 3,024 m^3.

In 2018 9,940 m^3 (355 loads) of leachate were extracted from the lined cell. This is a reduction of 1,204 m^3.

The rainfall for 2016 and 2017 years was very similar, 732 mm compared to 730 mm in 2017, whereas 2018 saw a reduction in rainfall to 648mm.

4.4. Environmental Performance Reporting (EPR)

KCC is aware of the changes required in relation to the submission of EPR data but at the time of writing this report it was not possible to access the EPR as the site was a not fully licensed. The Landfill Gas Survey was completed for submission to the EPA and is provided in **Appendix C.**

4.5. Pollution Emission Register – Proposal for 2019

Based on current proposals for works to be completed during 2019 it is not expected that there will be any significant changes between the emissions recorded during 2018 and the emissions predicted for 2019.

5. Waste Management & Resource Consumption

5.1. Records

Records for 2018 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 at the site offices was collected by Greenstar who operate under NWCPO-13-11193-05 as shown in Table 5.1.

Table 5.1 General Waste

Waste Type	EWC Code	Waste Description	Quantity (tonnes)
General Waste	20 03 01	Office and Canteen waste collected in 1100 litre bins at site offices	0.52
Mixed Dry Recyclables	20 03 01	Recycling from office and canteen waste collected in 1100 litre bin at site office	0.29

The total volume of leachate removed off site during 2018 was 9,940 m^3. For a complete breakdown of leachate haulage records during 2018 see section 4.1.3 above.

5.3. Electricity

The use of electricity on site is primarily at the site offices, the operation of the flare(s), and the 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 compounds and security huts.

Table 5.2 Electricity Usage

	Kilowatt Hours 2018					
	Jan - Feb	Mar - Apr	May - Jun	Jul - Aug	Sep - Oct	Nov - Dec
Day	14,040	11,760	3,840	2,820	8,160	12,240
Night	8,760	8,280	3,360	2,820	5,400	6,720
Bi-monthly Total	22,800	20,040	7,200	5,640	13,560	18,960
Total Annual Usage	88,200					

5.4. Diesel

The use of diesel on site is limited to the on-site KCC 4x4 vehicles which used approximately 450 litres of diesel during 2018. Additionally site security vehicles are in use which are owned and operated by Manguard Security and therefore consumption has not been included as part of this report.

6. Restoration Works

6.1. Remaining volumes of historically deposited waste

The estimate of waste volume present at the site has been is 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 (2013). This represents an increase of 32% from the previous 2.35 million cubic metres estimate in March 2012 following the Phase 1 ground investigation and 82% above the original 2010 pre-fire estimate of 1.7 million cubic metres, which was based on desk study information only.

The significant regions of additional waste identified at this update were as follows:

in the large northern embankment adjacent to Kerdiffstown House, which had been thought previously to be re-worked overburden/natural ground (based on inspection of aerial photographs) but is now considered to be all waste;

beneath the middle yard (site offices) where Phase 1 data had suggested waste was significantly shallower in one half of the yard but Phase 2 data indicates this is not the case; and,

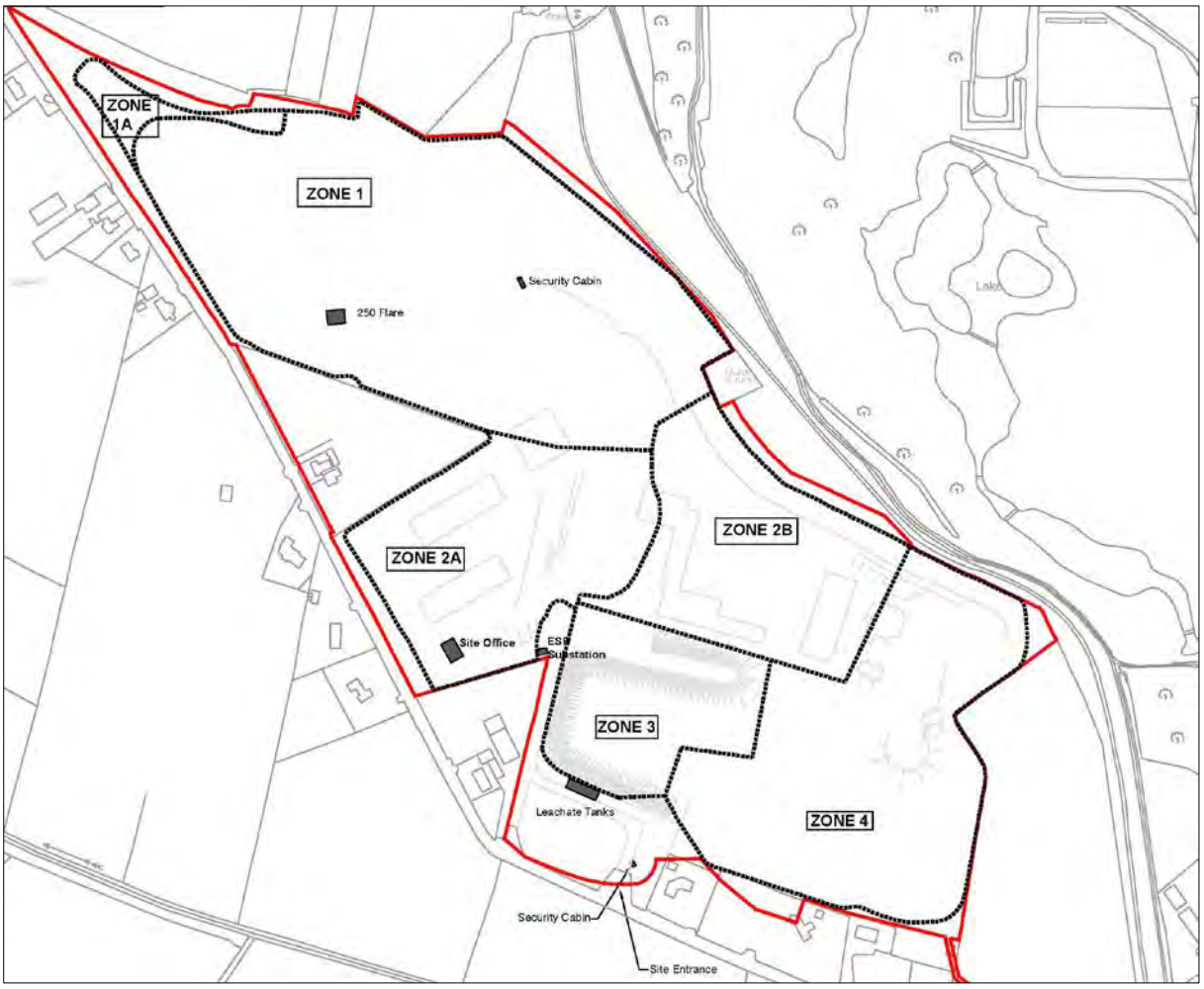
in the south east of the site beneath the sorting sheds, again where there appear to be differences between Phase 1 and Phase 2 data, where Phase 2 boreholes indicate more waste to be present.

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.

Table 6.1 Zone Descriptions and Current Condition

Zone	Estimated (plan) Area	Estimated Waste Volume	Basal & Side Lining	Cap Status	Other
1	100,000m^2	2,023,000m^3 (65.2%)	Unlined	None	-
2	83,000m^2	660,000m^3 (21.3%)	Unlined	25,000m^2 uncapped	58,000m^2 concrete hardstanding
3	24,000m^2	193,000m^3 (6.2%)	Lined	Temporary cap	-
4	45,000m^2	227,000m^3 (7.3%)	Unlined	33,000m^2 uncapped	12,000m^2 concrete hardstanding
Total	252,000m^2	3,103,000m^3			

Plate 6.1 Site Zones



6.2. Development / Infrastructural works summary

6.2.1. Works Completed in 2018

During 2018 no significant developments and infrastructural works were undertaken. Minor works included:

- Diversion of storm water drainage away from the canal feeder and into the onsite Surface water lagoon.
- Installation of CCTV and upgrades to security system on site.
- Removal of 500 Flare.
- Minor fencing improvements around boundary.

6.2.2. Works Identified for 2019

In 2019 there are several advance works contracts planned in order to facilitate to main remediation works scheduled to commence in 2020. These works include

- Site Accessibility contract – improving access to the toe of the eastern slopes.
- Surface Water Lagoon – increasing capacity.

- Advance works for L2005 – realignment and new site entrance.
    - Provision of new footpath and cycleway adjacent to realigned road extents.
- Installation of new perimeter fencing to site boundary between Kerdiffstown House and Kerdiffstown Landfill.
- Demolition of existing residential properties.
- Installation of perimeter gas monitoring boreholes along western boundary of site.
- Stormwater drainage in Kerdiffstown House
- Partial Construction of Outfall from site to the Morell River

7. Environmental Monitoring

Since February 2011 a range of environmental monitoring is undertaken to support the KLRP. Since June 2011 monthly groundwater and surface water monitoring has been.

In June 2014 a 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 2018 was as follows:

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

7.1. Water

7.1.1. Groundwater

Groundwater sampling is undertaken on a monthly basis involving low specification sampling from fifteen monitoring wells for a suite of parameters. A higher specification round of monitoring was undertaken on an annual basis at 40 monitoring wells for an expanded suite of parameters. During 2018 the annual round of monitoring was conducted in May. 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	Annual Sampling
EMW28	Overburden	South (up hydraulic gradient)		✓
EMW29	Overburden		✓	✓
EMW27D	Overburden			✓
BH2	Overburden			✓
GW1D	Bedrock			✓
EMW11	Overburden	West (cross hydraulic gradient)	✓	✓
EMW12	Bedrock			✓
EMW24	Bedrock			✓
EMW30	Overburden	East (cross hydraulic gradient)		✓
EMW22	Bedrock	North (cross hydraulic gradient)		✓
EMW23	Overburden			✓
DB02	Overburden		✓	✓
DB03	Overburden		✓	✓
EMW21	Overburden	North East (down hydraulic gradient)		✓
EMW06	Overburden			✓
BB02	Bedrock		✓	✓
EMW04	Overburden			✓
EMW08	Overburden			✓
EMW19	Bedrock		✓	✓
EMW18	Overburden			✓
EMW02	Overburden			✓
EMW03	Overburden		✓	✓
EMW05	Overburden		✓	✓

Monitoring Well	Target Stratum	Orientation from the Landfill	Monthly Sampling	Annual Sampling
EMW07	Overburden			✓
EMW20	Overburden		✓	✓
EMW31	Overburden			✓
EMW32	Overburden			✓
EMW33	Overburden			✓
EMW13	Overburden	On site (Zone 1)	✓	✓
BH26	Overburden		✓	✓
BH36	Overburden			✓
EMW14	Overburden			✓
BH39	Leachate			✓
BH40	Overburden	On site (Zone 2)		✓
EMW15	Overburden		✓	✓
BH68	**Bedrock**	On site (Zone 3)	✓	✓
BH42 / BH71*	Overburden	On site (Zone 4)	✓	✓
GW1S	Bedrock			✓
GW2D	Overburden			✓
BH6	Overburden			✓
BH7	Overburden			✓
EMW16	Overburden		✓	✓
EMW17	Overburden			✓
		Totals	**15**	**39**

*BH42 was replaced with BH71 as BH42 became blocked.

Groundwater Levels and Flow

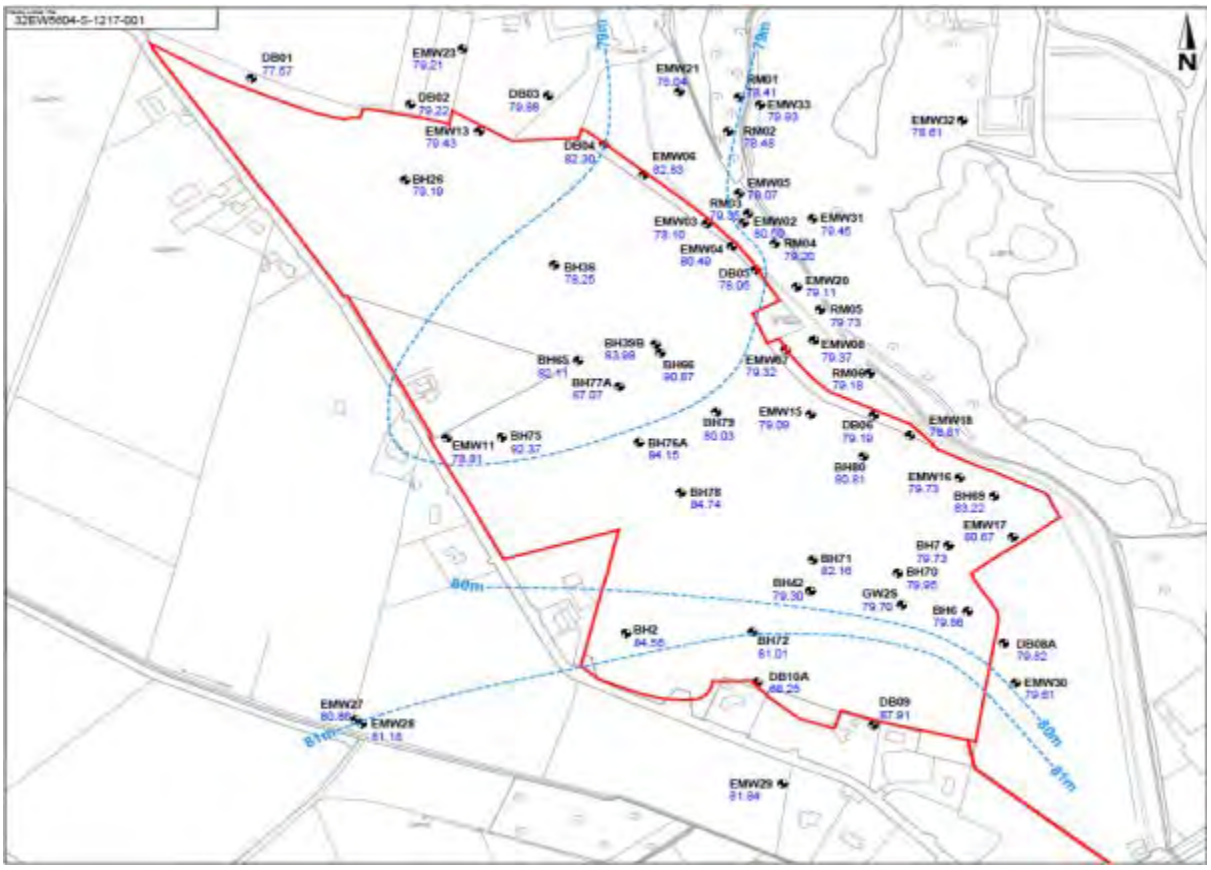
The inferred groundwater flow regime for the overburden groundwater (Plate 7.1) indicates an overall south to north movement of groundwater within the overburden and bedrock aquifer.

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 2018 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.

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. There are no indications of leachate impact from the site in other directions to the west and south of the site.

Plate 7.1 Shallow Groundwater Levels and Contours (December 2018)



Groundwater Quality Monitoring Results 2018

Groundwater quality data from January to December 2018 has remained largely consistent with results obtained during previous sampling rounds completed between 2011 and 2017. Monitoring during 2018 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 EMW03, 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 these 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 2018	Chloride average for 2018
Area	Well Reference	mg/l	
Onsite Zone 1	EMW13	223	213
	BH26	153	385
	EMW15	10	39
Eastern boundary	EMW03	17	62
	BB02	0.41	107
	EMW19	1.8	26.7
Northern boundary	DB02	263	305
Offsite	EMW05	1.2	20
	EMW20	0.6	17

In EMW05 it was noted that the concentration of ammoniacal nitrogen ranged from <0.06 mg/l in April and May to 1.80 mg/l in October. The elevated concentrations later in 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 2018.

The following sections and graphs discuss the results for 2018 for the selected leachate indicator parameters ammoniacal nitrogen and chloride. For detailed analysis and interpretation refer to groundwater and surface water monitoring reports completed and submitted to the EPA 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[4]. 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).

[4] 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 7.1 presents the gathered data from monitoring between January and December 2018. **Appendix F4** presents ammoniacal nitrogen results from June 2011 to December 2018 for comparison purposes.

Graph 7.1 illustrates that throughout 2018 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.

On Site Wells

EMW13 continues to record very elevated levels of ammoniacal nitrogen ranging from 178 mg/l (in February) to 274 mg/l (in December). Concentrations fluctuated throughout the year peaking in December. The elevated concentration recorded in December was the highest since monitoring of this well began in June 2011. The previous highest concentration was 233 mg/l in October 2017.

Ammoniacal nitrogen in BH26 also peaked in December at 167 mg/l. This is the highest concentration recorded for this well. BH26 in Zone 1 has shown a trend upwards in ammoniacal nitrogen since monitoring of this well began in October 2012 (29.7 mg/l) to a concentration peak in December 2018. Concentrations fluctuated throughout the year ranging from 139 mg/l in February to the high recorded in December.

Monthly monitoring at EMW15 has revealed variability in ammoniacal nitrogen concentrations since monitoring began in June 2011. Concentrations ranged from 5.61 mg/l in January to 12.3 mg/l in May. At EMW16 ammoniacal nitrogen concentrations remained relatively stable ranging from 7 mg/l in November to 9.83 mg/l in February.

Ammoniacal nitrogen concentrations recorded within other bedrock monitoring wells EMW22 and EMW24 (NW/N of site) were noted to be low (<0.06 mg/l) throughout 2018 (as previously recorded) indicating no discernible impact from the overlying landfill at these locations. An elevated reading in EMW22 in May at 1.22 mg/l was queried with the laboratory and sampling was repeated in July. The repeat sample was recorded as <0.06 mg/l

Boundary Wells

Throughout 2018 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 7.1) 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 2018 concentrations of ammoniacal nitrogen in offsite boundary well EMW03 were consistently elevated above the IGV and GTV. The concentration fluctuated

throughout the year ranging from 6.69 in November to 49.9 in December. This range is consistent with 2017 range of results (11.2 mg/l to 38.3 mg/l).

Ammoniacal nitrogen concentration recorded within BB02, which is also located off site and close to the north-eastern site boundary, fluctuated throughout the year. Concentrations ranged from <0.06 mg/l in April to 1.11 mg/l in December. The peak in December was the highest concentration recorded since monitoring began in February 2017. Ammoniacal nitrogen in EMW04 was recorded at 35.9 mg/l, the highest concentration recorded in this well since monitoring began in June 2011.This was notably higher than the previous peak of 19.6 mg/l recorded in July 2014. As this well is only sampled annually there is insufficient data to establish this increase as a trend.

In EMW07 an ammoniacal nitrogen concentration of 1.92 mg/l was detected in May 2018,. This was consistent with previous results for this well.

At the bedrock monitoring well EMW19 concentrations of ammoniacal nitrogen were elevated but remained stable through the year. Ammoniacal nitrogen ranged from 0.93 mg/l (Dec) to 2.44 mg/l (May). Since monitoring began in October 2012 seasonal peaks greater than 3.5 mg/l have been observed. This pattern can be seen in Graph 7.2.

At DB02, located off-site and close to the northern boundary, sampling commenced in March 2017. The well recorded very high concentrations of ammoniacal nitrogen ranging from 229 mg/l in February to 324 mg/l in November. This is higher than concentrations recorded in on-site wells and indicates leachate contamination at the northern boundary of the site.

Off Site Wells

During 2018, in keeping with previous years' data concentrations of ammoniacal nitrogen in both EMW05 (2018 average 1.2 mg/l) and EMW20 (2018 average 0.6 mg/l) close to the Morell River were noted to be relatively low compared to concentrations observed in the boundary well EMW03 (2018 average 17.5 mg/l) which is up gradient in terms of hydraulic flow.

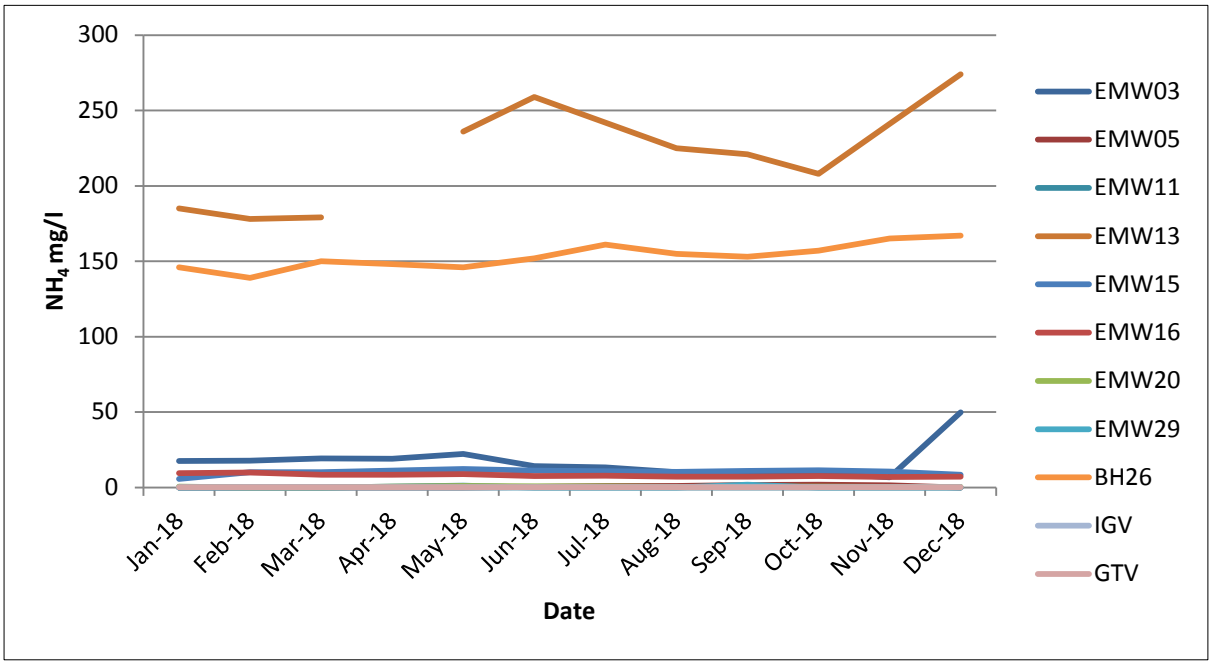
At EMW05, situated within 5m of the Morell River, nine of the twelve monthly samples exceeded the IGV of 0.12 mg/l. The decrease in ammoniacal nitrogen levels in November 2017 continued into the start of 2018 dropping to below limit of detection (LOD) in December 2018 and remaining below the LOD until it started to increase from June 2018. (It should be noted that the LOD for December 2017 to March 2018 was <0.41 but was <0.06 for the rest of the year). Concentrations peaked in October at 1.8 mg/l. There may be some indication of seasonal variation in the 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. Monthly monitoring will continue in 2019.

At EMW20 ammoniacal nitrogen concentrations were consistent with 2017 concentrations (2017 average 0.7 mg/l). Concentrations remained relatively stable throughout the year ranging from below the LOD 0.41 mg/l (Feb & Mar) to 0.95 mg/l (May). It should be noted that the LOD was changed in December from 0.06 mg/l to 0.41 mg/l. The latter is above the IGV of 0.12.

The rest of the offsite wells in Kerdiffstown house (EMW21, EMW22 and EMW23) recorded concentrations ranging from 0.11 mg/l (EMW21) to 1.22mg/l (EMW22) in

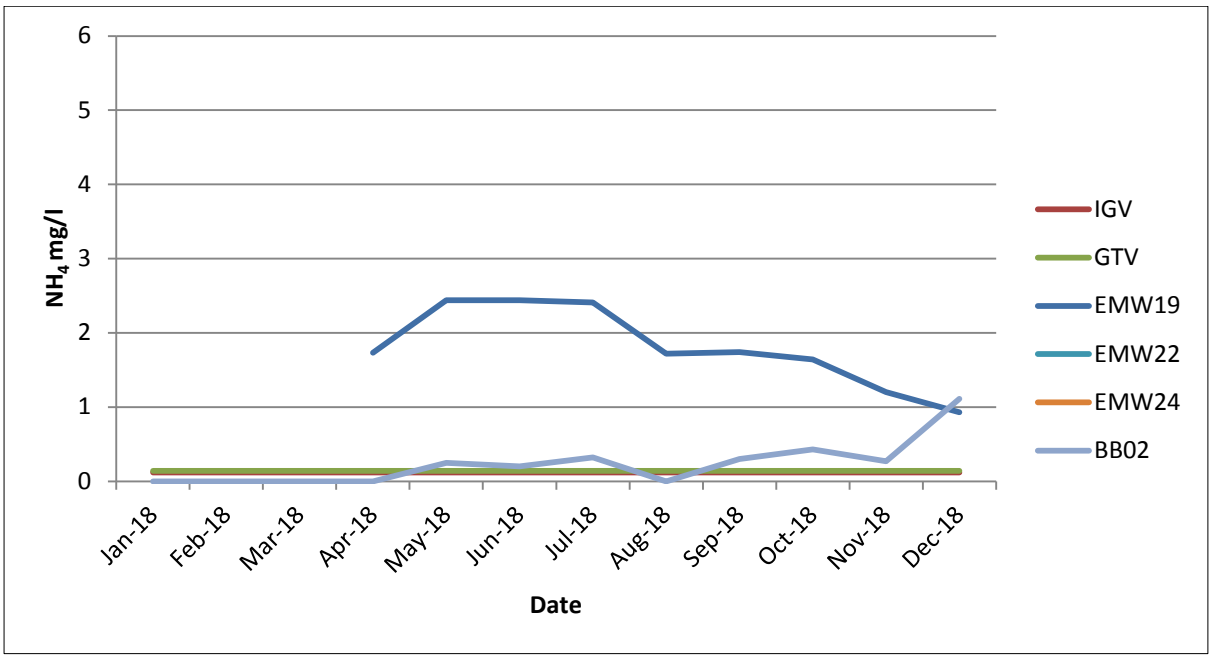
the annual round of monitoring completed in May. These wells are typically below the LOD. Sampling was repeated in July and results for all three of these wells was below the LOD of <0.06 mg/l. This continues the trend seen over the past number of years, indicating that the leachate migration offsite to the north of the site is localised close to the site boundary.

Graph 7.1 Ammoniacal Nitrogen in Selected Overburden Monitoring Wells 2018



Note: Axes values are different between Graph 7.1 and 7.2

Graph 7.2 Ammoniacal Nitrogen in Bedrock Monitoring Wells 2018



Note: Axes values are different between Graph 7.1. and 7.2

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.

Graph 7.3 shows the variation in chloride concentrations for each of the overburden wells sampled on a monthly basis during 2018. 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 2018 are shown in Graph 7.4. For comparison purposes **Appendix H5** presents chloride results from June 2011 to December 2017.

On Site Wells

As would be expected, the highest chloride concentrations were recorded in the on-site wells. In 2018 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. The average concentration in 2018 was calculated at 385 mg/l (maximum 403 mg/l, minimum 369 mg/l).

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 2018 was 62.2 mg/l with the lowest concentration of 36.1 mg/l detected in February 2018, and the peak concentration of 121 mg/l detected during December 2018.

BB02 has also recorded consistently elevated chloride concentrations similar to or higher than EMW03. The average concentration of chloride detected in BB02 during 2018 was 107.1 mg/l with the lowest concentration of 713 mg/l detected in April 2018, and the peak concentration of 163 mg/l detected in December 2018.

EMW04 has also shown some seasonal variability in chloride concentration, however it is only sampled on an annual basis so there is insufficient data to confirm this. The 2018 result was in line with the 2017 concentrations (44.3 mg/l in May 2017 2018 compared to 44.1 mg/l in May 2017 and 28.6 mg/l in Nov 2017).

EMW07 has shown variability in chloride since monitoring was undertaken in June 2011. The elevated concentrations recorded in 2016 (50.6mg/l in June and 31.1 mg/l in December) had decreased in 2017 (18.9 mg/l in May and 21.3 mg/l in Nov). The 2018 concentrations were in line with the 2017 results (22.1 mg/l in May).

At EMW19 (bedrock well), the IGV limit of 30 mg/l was exceeded four times during 2018. The borehole could not be sampled from January to March as access to the well was blocked by a fallen tree. The average chloride concentration for 2018 at 26.7 mg/l was a increase on the 2017 average for chloride at 21.1 mg/l. As with

some of the overburden boreholes, 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 recorded very elevated chloride concentrations since monitoring began in March 2017. The average chloride concentration for 2018 was 305 mg/l with the lowest concentration of 287 mg/l recorded in December and the peak concentration of 325 mg/l recorded in August. This is higher than the nearby onsite well EMW13 which recorded an average chloride concentration of 212.8 mg/l for 2018.

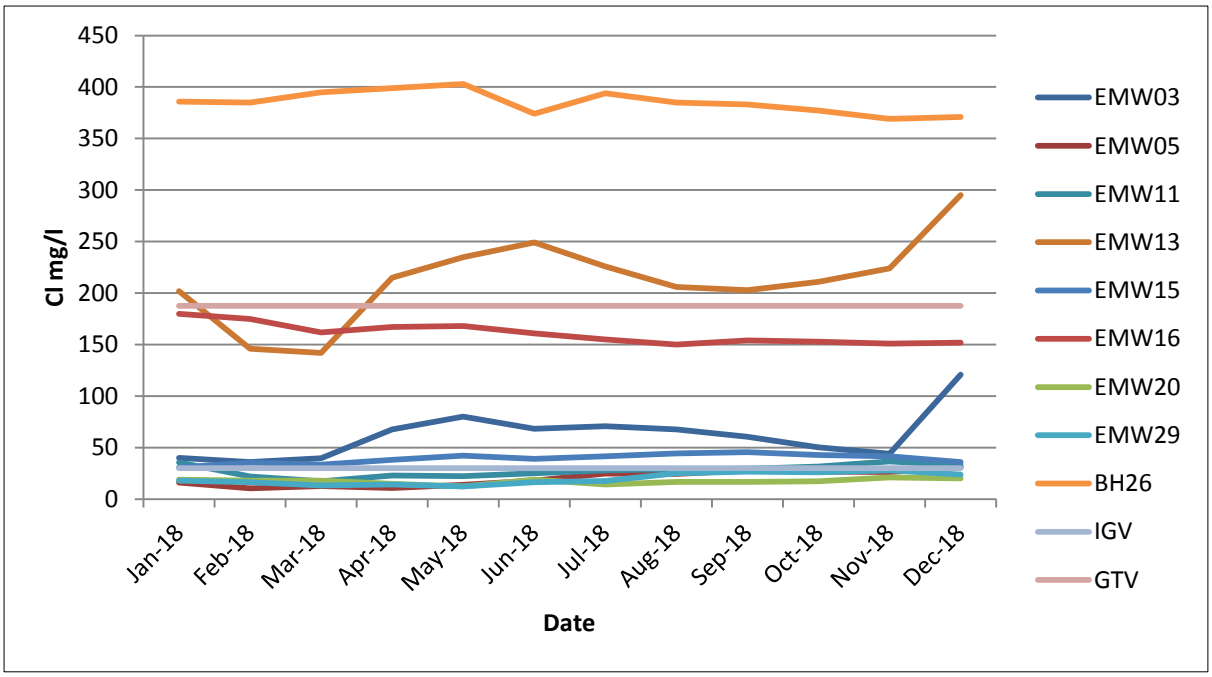
Off-Site Wells

Chloride concentrations were noted to be relatively low in off-site monitoring wells to the north-east during 2018 (e.g. average value of 17.3 mg/l in EMW20 and 20.3 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 with concentrations below the IGV every month. From July to December chloride concentrations increased with results for December exceeding the IGV for the first tim this year. Average chloride in EMW05 ranged from 10.6 mg/l in February to 30.9 mg/l in December (the maximum chloride concentration ever recorded in EMW05 was 61.3 mg/l in September 2011).

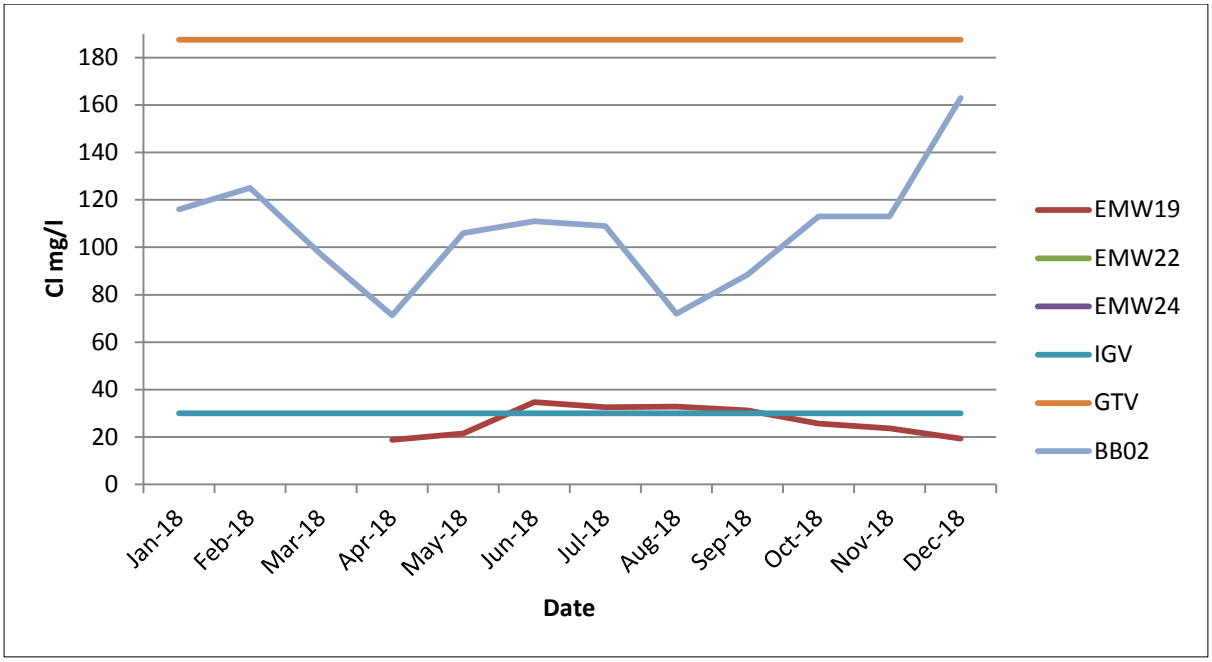
DB03, to the north off the site, recorded elevated chloride concentrations since monitoring began in February 2017. The average chloride concentration was recorded at 181.5 mg/l with the lowest concentration of 129 mg/l recorded in December and the peak concentration of 220 mg/l recorded in April. Much lower chloride concentrations were noted in EMW22 and EMW23 which are to the north off DB03. Both of these wells are monitored annually. EMW22 recorded 31.4 mg/l in May and 34.2 mg/l in July. EMW23 recorded 14.1 mg/l in May and 34.2 mg/l in July. This would indicate that chloride impacts are localised close to the northern boundary. Further monitoring is required to confirm this.

Graph 7.3 Chloride in Selected Overburden Monitoring Wells 2018



Note: Axes values are different between Graph 7.3 and 7.4

Graph 7.4 Chloride in Bedrock Monitoring Wells 2018



Note: Axes values are different between Graph 7.3 and 7.4

Metals

During the annual round of monitoring in May 2018 an extensive suite of 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 2018 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 May (0.1 mg/l) 2018. Table 7.3 summarises the number of exceedances recorded during the annual round of May 2018.

Table 7.3 Dissolved Metals Exceedances of the IGVs/GTVs during May 2018

Parameter	Lower of IGV/GTV (mg/l)	Number of exceedances	Maximum result (mg/l)	Borehole with Maximum Result	Location of maximum result
Arsenic	0.0075	9	0.058	EMW27	Off-site (Southwest)
Barium	0.1	22	1.04	DB02	Off-site (North)
Cadmium	0.00375	2	0.0189	EMW27	Off-site (Southwest)
Chromium	0.03	2	0.046	EMW27	Off-site (Southwest)
Copper	0.03	3	0.240	EMW27	Off-site (Southwest)
Lead	0.01	10	0.342	EMW27	Off-site (Southwest)
Mercury	0.0001	1	0.00024	EMW24	On-site
Nickel	0.015	18	0.363	EMW27	Off-site (Southwest)
Zinc	0.1	8	1.14	EMW27	Off-site (Southwest)

Organic Compounds

Groundwater samples from all the monitoring wells during May 2018 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. Consistent with past results, five compounds were reported above the respective laboratory detection limits in 2018 i.e. mecoprop, dichlobenil, MCPA and chlopyralid.

Mecoprop is an active ingredient in many broadleaf weed killers and has been detected in previous years in selected boreholes. Eighteen of the May 2018 groundwater samples analysed were above analysis detection limits, including off-site boreholes close to the north-east site boundary. Seventeen boreholes exceeded the GTV of 0.075 µg/l. Concentrations in excess of the IGV of 10 µg/l were reported

at three locations in May 2018, at on-site boreholes BH26 (20.4 µg/l) and EMW13 (14.9 µg/l) and at the northern boundary borehole at DB02 (17.5 µg/l).

In EMW05, adjacent to the Morell River, mecoprop was not detected above the LOD of 0.04 during May. 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 never been breached. At EMW20, also adjacent to the Morell River, mecoprop was not detected above the LOD of 0.04 during May *Semi Volatile Organic Compounds (SVOCs)*

Excluding phenols (see below for consideration of phenolic compunds), SVOCs were absent in groundwater samples in May 2018. 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 2018. Chloroform was detected in EMW24 (Zone 1) at a concentration of 1.15 µg/l in May, 2018 .Chloroform has previously been detected at EMW24 during 2013 and 2014 at concentrations ranging from1.4 µg/l to1.7 µg/l. Chloromethane was detected in BH7 at a concentration of 2.12 µg/l . No other compounds on the target list of VOCs were detected during the May 2018 rounds of sampling.

Polycyclic Aromatic Hydrocarbons (PAHs)

In common with previous monitoring results, PAHs were detected at low-to-trace concentrations in a small number of boreholes including on-site boreholes BH6, EMW13, BH36 and BH71. The highest total PAH concentration reported in on-site groundwater was 0.664 µg/l in EMW13 in Zone 1 (near the northern boundary of the site during May 2018).

PAHs were also detected in off-site boreholes EMW27 and EMW29 to EMW33. The highest total PAH concentrations was reported in off-site borehole EMW33 (located to the east of the site in Palmerstown House) was 0.309 µg/l (40% phenanthrene, 33% fluoranthene, 11% pyrene and 5% fluorine, 4% Naphthalene and less than 1% Aceanaphthene) during May 2018.

In overall terms, concentrations of PAHs detected in groundwater in on and off-site boreholes were similar to those measured in previous years. 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 analysis detection limits in many of the on-site boreholes. The highest concentrations were in Zone 1 with lower concentrations detected in boreholes in the southern part of the site. The following on-site boreholes were found to contain phenols above the IGV of 0.5 µg/l during 2018:

Table 7.4 Total Phenols exceeding IGV in Onsite Wells

Location	May 2018
EMW13	190 µg/l
EMW15	4 µg/l
EMW16	1.9 µg/l
EMW17	2.4 µg/l
BH26	28 µg/l
BH36B	40 µg/l
BH71	32 µg/l

Phenolic compounds were also detected above the IGV in off-site monitoring boreholes in May . The highest off-site concentration was recorded in the northern boundary well DB02, with all other detections at wells along the eastern boundary or between the site and the Morell. These off-site well results are outlined below:

Table 7.5 Total Phenols exceeding IGV in Off-site Wells

Location	May
EMW04	4.5 µg/l
BB02	3.4 µg/l
DB02	94 µg/l

Analysis results from earlier monitoring rounds have indicated the presence of phenol compounds in on-site monitoring boreholes at similar concentrations to those identified in December 2015. The total number (11) of monitoring wells where phenols has been detected has decreased compared to the total recorded in 2017 (13).

Formaldehyde

Formaldehyde has previously been identified in eleven boreholes located primarily along the north-eastern site boundary (both on-site and near off-site). In May 2018 formaldehyde was detected in five wells both on and offsite. Concentrations of up to 0.428 mg/l (highest in EMW13) were observed.

7.1.2. Surface Water

Monitoring of surface water samples from the Morell River (east of site) and canal feeder (south of site) was undertaken at key strategic locations (shown in Table 7.6) during the monthly monitoring rounds to assess whether the landfill is having an adverse impact upon water quality within these water bodies. The site discharge to the canal feeder was disconnected in January 2018, although monthly monitoring of the canal feeder monitoring locations SW11 and SW13 continued until July 2018. Monthly monitoring of SW04 on the Morell River recommenced in November 2018.

During the annual sampling round in May 2018, samples were obtained from water bodies located on Palmerstown Golf Club (PGC) estate to the east, beyond the Morell River.

Table 7.6 Surface Water Sampling Locations and Sampling Frequency

Water Body	Sampling Location	Orientation from site	Monthly Sampling	Annual Sampling
Morell River	SW01	Upstream SE	✓	✓
	SW02	Upstream E	✓	✓
	SW03	Adjacent E	✓	✓
	SW03A	Adjacent E	✓	✓
	SW04	Adjacent E		✓
	SW05	Downstream NE	✓	✓
Canal Feeder	SW13	Upstream S	✓	✓
	Site Discharge	Adjacent to S	✓	✓
	SW10	Downstream S		✓
	SW11	Downstream SW	✓	✓
	SW12	Downstream SW		✓
Watercourse on PGC	SW16	Upstream SE		✓

Water Body	Sampling Location	Orientation from site	Monthly Sampling	Annual Sampling
	SW08	Upstream SE		✓
	SW06	Adjacent E		✓
	SW15	Adjacent E		✓
Watercourse on PGC	SW14	Downstream NE		✓
	SW07	Downstream NE		✓

7.1.3. Overall Interpretation of Surface Water Monitoring Results 2018

Surface water sampling in 2018 consisted of collecting grab samples from the Morell River, the canal feeder and from ponds and streams in the Palmerstown Golf Club estate to the east of the Morell River. During the monthly rounds, up to 8 surface water samples were obtained and analysed for a suite of inorganic analytes including major ions (Table 7.6).

In the annual sampling round in May 2018 a total of 17 locations upstream and downstream of the landfill were sampled (Figure 3) in order to assess any changes in water quality linked to the site. The samples were analysed for the same suite of inorganic analytes as the groundwater samples including major ions and metals/metalloids. The main results for 2018 are summarised below.

Ammoniacal Nitrogen

Table 7.7 gives a summary of surface water ammoniacal nitrogen results during 2018. Graph 7.5 shows ammoniacal nitrogen levels for surface waters during 2018. This graph shows that for the majority of surface water sampling locations, the ammoniacal nitrogen levels recorded have been below the analytical limits of detection of 0.06 mg/l or 0.41 mg/l (the limit of detection changed in Quarter 1 2018 to 0.41 mg/l, but reverted to the lower LOD from April 2018). The exceptions to this are SW11 and SW13 which show greater variations and generally higher results. The results are further discussed below. For illustrative purposes the Parametric Value for ammonia in drinking water is 0.3 mg/l, and ranges from 0.2 to 4 mg/l for surface waters intending to be abstracted for drinking water.

Morell River

Ammoniacal nitrogen was below the limits of detection (<0.06/<0.41 mg/l) in all samples from the Morell River during 2018. The laboratory analysed the samples under high range ammoniacal nitrogen in error during Q1 of 2018 thereby reporting a higher limit of detection for those samples (<0.41mg/l). On review of the results reported subsequent to the higher limit of detection being used it is noted that there

was no breach of the Drinking Water Regulations limit of 0.3 mg/l in the Morell River during 2018.

Canal Feeder

Consistent with previous rounds of monitoring, ammoniacal nitrogen was detected in SW13 (upstream of site) in the Canal feeder stream during 2018 at an average concentration of 2.64 mg/l, and ranging from <0.41 mg/l to 4.99 mg/l (SW13 was sampled each month from January to July 2018). This was a decrease on the 2017 concentrations which ranged from 0.76 mg/l to 10.6 mg/l with an average of 3.6 mg/l. SW13 has consistently recorded the highest surface water concentrations of ammoniacal nitrogen since monitoring commenced in October 2013. Concentrations at this point have ranged from <0.06 mg/l up to 10.6 mg/l since October 2013, with the highest level recorded in November 2017.

SW11 was sampled each month from January to July 2018 and ammoniacal nitrogen was detected above the limit of detection for three of the monthly samples in 2018. The average concentration at this location in 2018 was 0.6 mg/l with levels ranging from <0.06 mg/l to 1.59 mg/l. This is an increase in levels from that of 2017 when the limit of detection was not exceeded on any occasion.

Ammoniacal nitrogen was below the limit of detection of 0.06 mg/l at SW12 for the annual sample in May 2018. This has been the case since sampling began in 2013. SW10 and site discharge, the other sampling points in the Canal Feeder, did not record concentrations above the limit of detection during 2018.

Palmerstown House Estate

Annual monitoring was completed for the surface waters in Palmerstown Golf Club in May 2018. Four sites were below the limit of detection (<0.06 mg/l) for this monitoring event, namely SW06, SW08, SW15 and SW16. SW07 and SW14 were sampled from the one water body and exceeded the limit of detection for the annual sampling round. SW07 recorded an ammoniacal nitrogen concentration of 0.26 mg/l and SW14 recorded a level of 0.21 mg/l. There was also no breach of the Drinking Water Regulations limit of 0.3 mg/l in the surface water bodies in Palmerstown Estate River during 2018.

Graph 7.5 Ammoniacal Nitrogen in Surface Waters 2018

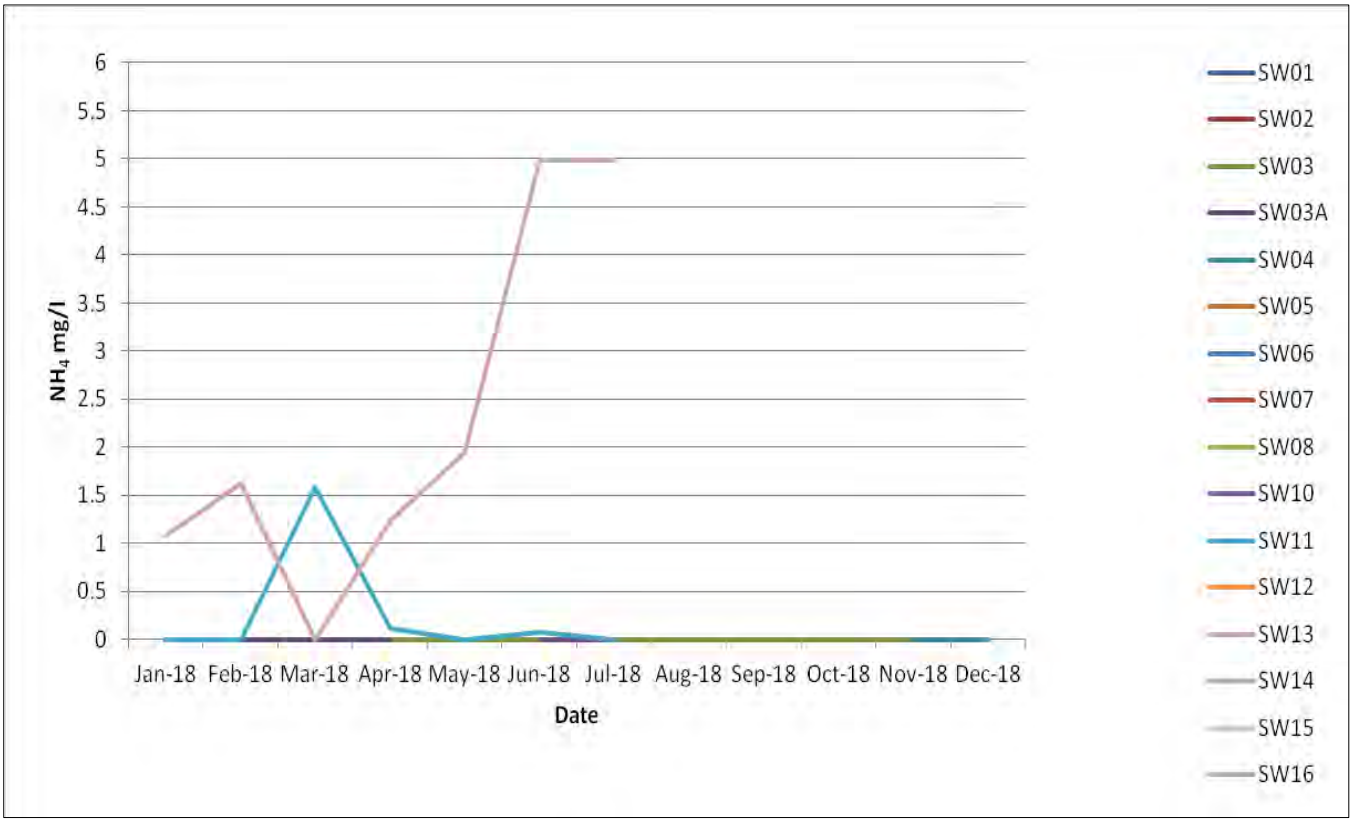


Table 7.7 Ammoniacal Nitrogen in Surface Water Samples -2018

Water Body	Sampling Location	2018 Range Ammoniacal Nitrogen (mg/l)	Orientation from site
Morell River	SW01	<0.06 - <0.41*	Upstream SE
	SW02	<0.06 - <0.41*	Upstream E
	SW03	<0.06 - <0.41*	Adjacent E
	SW03A	<0.06 - <0.41*	Adjacent E
	SW04	<0.06	Adjacent E
	SW05	<0.06 - <0.41*	Downstream NE
Canal Feeder	SW13	<0.41 – 4.99	Upstream S
	Site Discharge	<0.06 - <0.41*	Adjacent to S
	SW10	<0.06	Downstream S
	SW11	<0.06 – 1.59	Downstream SW
	SW12	<0.06	Downstream SW
Watercourse on PGC	SW16	<0.06	Upstream SE
	SW08	<0.06	Upstream SE
	SW06	<0.06	Adjacent E
	SW15	<0.06	Adjacent E
Watercourse on PGC	SW14	0.21	Downstream NE
	SW07	0.26	Downstream NE

*The laboratory analysed the samples under high range ammoniacal nitrogen in error during Q1 of 2018 thereby reporting a higher limit of detection for those samples (<0.41mg/l).

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

As discussed above, in terms of major ions, the presence of inorganic macro components which include commonly occurring cations and anions may be indicative of leachate generated from a landfill such as Kerdiffstown. The results during 2018 for major ions in surface water samples were generally consistent with those

observed since October 2013. The BOD value in rivers often increases during periods of heavy rain and high flows as organic matter is washed in from the land and farmyards. Results of total organic carbon (TOC), COD and biochemical oxygen demand (BOD) are summarised below.

The determination of TOC is complementary to the oxygen demand analyses (biochemical and chemical) discussed below and, in strict terms, it is a better indicator of organic content in that it is a direct measurement of carbon. For illustrative purposes, the limits for waters used for drinking water abstraction for COD is 40 mg/l, and for BOD is 5-7 mg/l. The Drinking Water Directive requires “no abnormal change” for TOC.

Morrell River

The concentrations of TOC in the Morell River during 2018 ranged from <0.7 mg/l up to 3.9 mg/l (Table 7.8). 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 2018 were close to or below the limit of detection in all instances, ranging from <1 mg/l to 3 mg/l.

The trend for COD as expected follows a similar pattern and all results were below the 40 mg/l limit for A3 waters in 2018. The majority of the COD results for the second half of 2018 were below the limit of detection (<11 mg/l).

Canal Feeder

TOC in the canal feeder has been found to be highest upstream of the site in SW13 (average concentration of 10.17 mg/l during 2018, with a range of 9.2 mg/l to 11.6 mg/l). This is in line with previous monitoring rounds. TOC concentrations in the other canal feeder sites ranged from 2.3 mg/l at SW11 and SW12 to 5.1 mg/l at SW10.

BOD and COD results for the Canal Feeder during 2018 were seen to peak at SW13 upstream of the site discharge point and downstream at SW11 in May 2018 (Table 7.9). The highest average concentration of BOD recorded in the canal feeder was at SW11 and SW13 (4.75 mg/l). The highest average COD concentration was also recorded at SW11 at 40 mg/l, with a range of <11 mg/l to 82 mg/l.

Palmerstown House Estate

TOC concentrations were relatively stable on the PGC Estate between 1.9 mg/l in SW08 and 3.3mg/l in SW06 and SW07 during 2018 (Table 7.8).

BOD results for surface water samples obtained from the golf course waterbodies in 2018 were close to or below the limit of detection in all instances, ranging from <1 mg/l to 3 mg/l. SW08 recorded the highest BOD result at 3 mg/l in May. COD concentrations for the Palmerstown waterbodies ranged from 23 mg/l (SW06) to 50 mg/l (SW15. This is similar to the concentrations recorded in 2017 which ranged from <11 mg/l to 59 mg/l (SW14).

Table 7.8 Total Organic Carbon in Surface Water Samples -2018

Water Body	Sampling Location	2018 Range TOC (mg/l)	Orientation from site
Morell River	SW01	<0.7 – 4.2	Upstream SE
	SW02	0.7 – 3.9	Upstream E
	SW03	<0.7 – 3.7	Adjacent E
	SW03A	0.8 – 3.0	Adjacent E
	SW04	1.7 – 3.6	Adjacent E
	SW05	0.7 – 3.1	Downstream NE
Canal Feeder	SW13	9.2 – 11.6	Upstream S
	Site Discharge	<0.7 – 2.3	Adjacent to S
	SW10	5.1	Downstream S
	SW11	2.3 – 4.2	Downstream SW
	SW12	2.3	Downstream SW
Watercourse on PGC	SW16	2	Upstream SE
	SW08	1.9	Upstream SE
	SW06	3.3	Adjacent E
	SW15	2.4	Adjacent E
Watercourse on PGC	SW14	2.9	Downstream NE
	SW07	3.3	Downstream NE

Table 7.9 COD and BOD in Surface Water Samples -2018

Water Body	Sampling Location	2018 Range BOD (mg/l)	2018 Range COD (mg/l)	Orientation from site
Morell River	SW01	<1 - 2	<11 - 21	Upstream SE
	SW02	<1 - 3	<11 - 24	Upstream E
	SW03	<1 - 3	<11 - 28	Adjacent E
	SW03A	<1 - 2	<11 - 31	Adjacent E
	SW04	<1 - 2	<11 - 31	Adjacent E
	SW05	<1 - 2	<11 - 38	Downstream NE
Canal Feeder	SW13	<1 - 7	23 - 64	Upstream S
	Site Discharge	<1 - 7	<11 – 29	Adjacent to S
	SW10	6	27	Downstream S
	SW11	<1 - 7	<11 – 82	Downstream SW
	SW12	<1	41	Downstream SW
Watercourse on PGC	SW16	2	27	Upstream SE
	SW08	3	35	Upstream SE
	SW06	1	23	Adjacent E
	SW15	<1	50	Adjacent E
Watercourse on PGC	SW14	<1	28	Downstream NE
	SW07	2	29	Downstream NE

Chloride

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

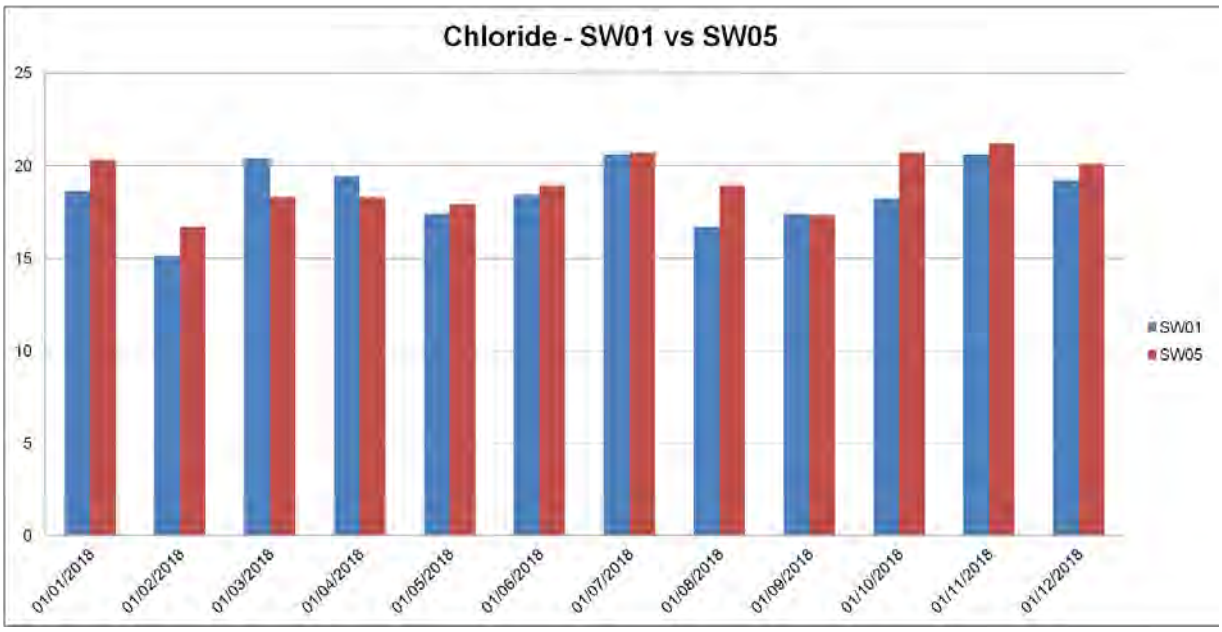
Morrell River

Chloride was observed at low concentrations in the Morell River samples in 2018 with an average concentration of between 18.5 mg/l and 19.3 mg/l. The concentrations ranged from 13.9 mg/l at SW02 to 21.3 mg/l at SW03 during 2018. Graph 7.6 and Table 7.10 shows there is little variation in chloride concentrations in the river. In 2017 there was a pattern of decreasing concentration from upstream to

downstream locations i.e. SW01 to SW05, however in 2018, there was a pattern of slight increases in chloride downstream from SW01 to SW05. **Appendix F6** shows these results since 2012 for comparison purposes.

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 for 2018.

Graph 7.6 Chloride in Morell River – Upstream (SW01) vs downstream (SW05) 2018



Canal Feeder

The site discharge to the canal feeder was disconnected in January 2018, although monthly monitoring of the canal feeder monitoring locations SW11 and SW13 continued until July 2018. In years previous to 2017, higher chloride concentrations were observed upstream in the canal feeder than those downstream. This trend reversed in 2017 and continued into 2018 with average concentrations at SW13 of 43.5 mg/l, lower than the downstream sample at SW11 of 83.8mg/l. SW12, also downstream, had a chloride concentration of 28.4 mg/l. Chloride concentrations in the canal feeder fluctuated throughout January to July 2018 with levels ranging from 26.8 mg/l to 54.1 mg/l at SW13 and 28 mg/l to 147 mg/l at SW11. SW11 recorded the highest chloride concentration in the canal feeder during 2018. All monitoring locations in the canal feeder reported concentrations of chloride that were well below the drinking water limit.

Palmerstown House Estate

Concentrations of chloride in samples obtained from watercourses on the PGC Estate in May 2018 were quite similar to those in the Morell River with concentrations ranging from 15.6 mg/l at SW15 to 19.2 mg/l at SW08. The chloride levels recorded in 2018 are similar to previous years. All of the results from PGC Estate were well below the drinking water limit of 250 mg/l.

Table 7.10 Chloride in Surface Water Samples -2018

Water Body	Sampling Location	2018 Range Chloride (mg/l)	Orientation from site
Morell River	SW01	15.1 – 20.6	Upstream SE
	SW02	13.9 – 21.2	Upstream E
	SW03	14.4 – 21.3	Adjacent E
	SW03A	17.3 – 20.6	Adjacent E
	SW04	18.1 – 20.9	Adjacent E
	SW05	16.7 – 21.2	Downstream NE
Canal Feeder	SW13	26.8 – 54.1	Upstream S
	Site Discharge	<3.7 – 8.6	Adjacent to S
	SW10	126	Downstream S
	SW11	28 – 147	Downstream SW
	SW12	28.4	Downstream SW
Watercourse on PGC	SW16	18.8	Upstream SE
	SW08	19.2	Upstream SE
	SW06	18.7	Adjacent E
	SW15	15.6	Adjacent E
Watercourse on PGC	SW14	16.2	Downstream NE
	SW07	18.2	Downstream NE

7.1.4. Biological Q-rating assessment

The biological Q-rating assessment was undertaken in May 2018. This involved macroinvertebrate sampling at nineteen locations, eleven on the Morell River and eight on the Hartwell. This included the ten locations monitored in 2016 plus the additional six locations added in the 2017 survey: 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), two on the Morell (M9 & M10) and two on the Morell tributary (M11 & M12). Four additional sites were included in the 2018 survey, one at Arthurstown (H6), one between Arthurstown and Johnstown (H5) and two on the

small tributary in Rathmore village. 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 7.9 below. This assessment found that both the Morell and Hartwell rivers are impacted. The water quality of the Morell River is moderately polluted (Q3) upstream of the landfill at both M1, approximately 300m upstream of the site at the bridge beside Johnstown Garden Centre; and M2 just upstream of the landfill and the confluence of the Morell and Hartwell. It improves to good quality (Q4) downstream of the confluence with the Hartwell River and decreases to slightly polluted Q3-4 downstream of the site. The conclusions of the assessment state that it is likely that the good quality waters from the Hartwell help to improve the water quality of the Morell. It is also possible that recharge from groundwater is helping to improve it. This most recent assessment concluded that it was difficult to determine if the site was having an impact on the water quality in the Morell due to the moderate water quality status upstream of the site.

A previous assessment completed in December 2012 found that the water quality was good along the Morell River's length with sites achieving scores of Q4 and most achieving Q4-5. The biological water quality has therefore deteriorated since the 2012 assessment. This deterioration between the two assessments are indicative of this catchment as both the Morell and its tributary the Harwell have been fluctuating in water quality over the last 30 years. It is possible that this deterioration is due to flood improvement works upstream. (Full report available upon request.)

Table 7.11 2018 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	Q3-4
M7	Upstream of landfill (1km)	Q3-4
M8	Upstream of landfill (1km)	Q3
M9	Upstream of landfill (Beggar's End crossroads)	Q3
M10	Upstream of landfill (near Newtown Great)	Q3-4
M11	Morell Tributary (near Eadestown)	Q3
M12	Morell Tributary (N.E. Baysland)	Q3-4
H1	Hartwell River (tributary of Morell)	Q4.5
H2	Hartwell River (tributary of Morell)	Q4
H3	Hartwell River (near Rathmore)	Q4
H4	Hartwell River (upstream of H3)	Q4
H5	Hartwell River (south east of Kill)	Q4-5
H6	Hartwell River (adjacent to Arthurstown)	Q4-5
H7	Hartwell Tributary	Q3
H8	Hartwell Tributary	Q3-4

7.1.5. 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 and annual basis was completed during 2018. These included dissolved methane, heavy metals and priority substances.

A summary of the results for 2018 is provided in Table 7.12.

Table 7.12 Summary Composition of Leachate

	Max (mg/l)	Date Concentration observed	Min (mg/l)	Date Concentration observed	Average (mg/l)
Ammoniacal Nitrogen as N	490	7th August	113 Note 1	5th June	241
Chloride	462	7th August	121	6th February	230
COD	866	16th April	163	6th February	360

Note 1 On 30th October 2018, an ammonia concentration of <0.41mg/l and chloride concentration of 11.3mg/l were reported for the leachate sample. This is thought to be a laboratory error. The result was queried with the lab but repeat analysis was not possible due to the sample being outside the required stability period. These results are not thought to be representative and therefore were not included in the summary data in the table above.

Analysis of leachate from the lined cell area during 2018 was noted to be broadly similar to results obtained for 2017, where ammoniacal nitrogen results ranged from 154 mg/l to 555 mg/l, chloride results ranged from 110 mg/l to 460 mg/l, and COD ranged from 174 mg/l to 927 mg/l.

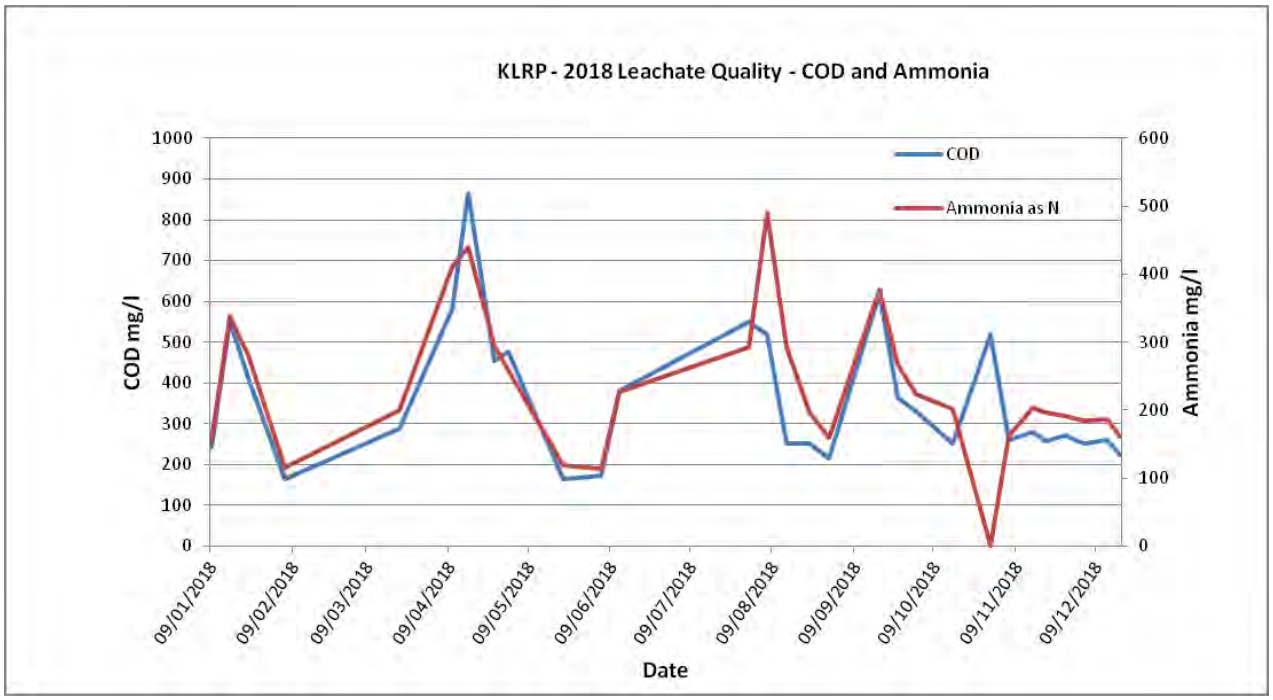
As shown in Table 7.12 concentrations of COD ranged from a maximum of 866 mg/l in April to a low of 163 mg/l recorded in February. Ammoniacal nitrogen ranged from a maximum of 490 mg/l in August to a low of 113 mg/l recorded in June. Chloride ranged from a maximum of 462 mg/l in August to a low of 11.3 mg/l recorded in October.

Concentrations can vary dramatically during the year as can be seen in Graphs 7.7 and 7.8. This is largely due to the fact that the lechate production and quality 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 7.7 and 7.8 show peaks and troughs throughout 2018. The peaks generally correspond with dryer periods (in August for example), while wetter periods show decreases in pollutant concentrations (in February for example).

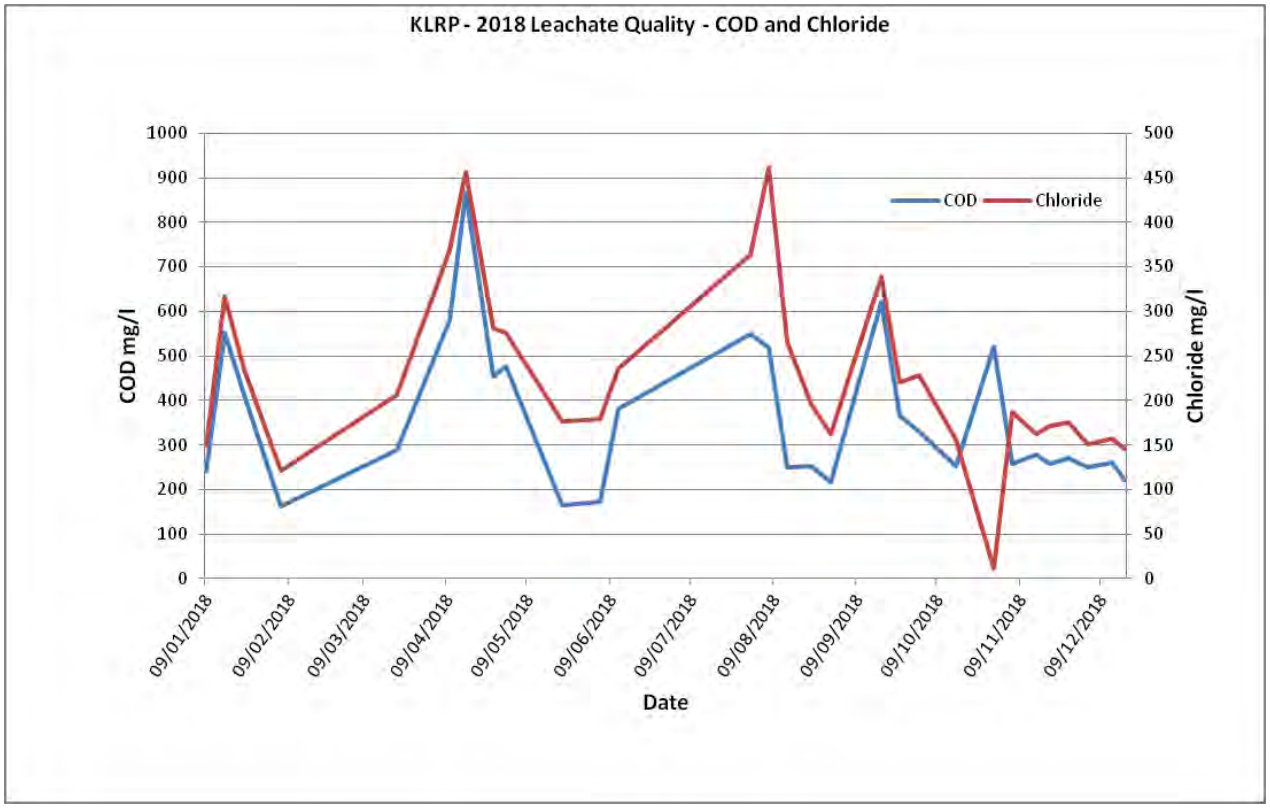
During 2011 the average concentration of ammoniacal nitrogen and COD in leachate was noted to be 505 mg/l and 1,140 mg/l respectively. Concentrations of these

parameters peaked during the summer months when the leachate was most concentrated due to a lack of rainfall to cause dilution. During the winter and spring months there was a reduction in these concentrations attributed to dilution from rainfall both directly onto the open cell area and also through the waste body itself. The averages and peaks have been reducing since 2011, with 2015's average being the lowest recorded at 224 mg/l for ammoniacal nitrogen and now 2018's average the lowest recorded at 360 mg/l for COD. The graphs in **Appendix F7** present leachate results from July 2011 to December 2018. The graphs clearly show this prevailing downward trend in those leachate pollutants since 2011.

Graph 7.7 Leachate Composition - COD and Ammoniacal Nitrogen



Graph 7.8 Leachate Composition - COD and Chloride



7.2. Landfill Gas

In-waste landfill gas monitoring in Zone 1 and the Lined Cell is undertaken by KCC on a weekly basis with results recorded in monitoring spreadsheets. Trend graphs are updated to assess gas concentrations over time and are discussed in section 4.1.2 Landfill Gas Management and provided as part of **Appendix F**.

Off-site landfill gas monitoring i.e. EMW02 – EMW10, is undertaken by KCC on a monthly basis. A GA5000 infra-red gas analyser is used to record methane, carbon dioxide and oxygen concentrations as well as atmospheric pressure. The wells monitored are groundwater monitoring wells with gas taps fitted at the top as opposed to dedicated perimeter gas monitoring wells. EMW09 was dropped from the monthly monitoring round due to concerns about safe access to the well.

Table 7.13 provides a summary of the results from off-site landfill gas monitoring completed in 2018.

No methane was detected in offsite monitoring wells during 2018.

Table 7.13 Offsite Landfill Gas Monitoring Results 2018 Methane (CH4)

	Methane (CH_4) % v/v											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug^	Sep	Oct	Nov^	Dec
EMW02	0	0	0	0	0.1	0.1	0.2		0.2	NR		0.2
EMW03	0	0	0	0	0.1	0.1	0.2		0.2	0.2		0.2
EMW04	0	0	0	0	0.1	0.1	0.2		0.2	0.2		0.2
EMW05	0	0	0	0	0.1	0.1	0.2		0.2	0.2		0.2
EMW06	0	0	0	0	0.1	0.1	0.2		0.2	0.2		0.2
EMW07	0	0	0	0	0.1	0.1	0.2		0.1	0.2		0.2
EMW08	0	0	0	0	0.1	0.1	0.2		0.2	0.2		0.2
EMW10	0	0	0	0	NR	NR	NR		0.2	0.2		0.2

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

^Monitoring was not completed in August and November 2018.

In 2018 carbon dioxide was detected in offsite monitoring wells. The concentration of carbon dioxide in EMW02, EMW03, EMW04 and EMW06 was found to be consistently higher than the W0047-02 limit level for carbon dioxide (1.5% CO2 v/v) (Table 7.14).

Table 7.14 Carbon Dioxide (CO2) EMW02 - EMW10

	Carbon Dioxide (CO_2) % v/v											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug ^	Sep	Oct	Nov ^	Dec
EMW 02	0.1	0.1	0.1	0.4	0.2	0.1	2.7		2.4	NR		0.2
EMW 03	0.1	1.1	0.2	0.8	1.1	0.6	0.9		1.9	2		2.7
EMW 04	2.3	1.2	1.8	2.1	0.3	1.8	1.0		1.4	2.9		1.5
EMW 05	0.1	0.1	0.2	0.3	0.4	0.2	0.6		0.1	0.6		0.2
EMW 06	2	1.7	2.8	0.2	1.8	3.1	0.2		1.5	0.1		1.8
EMW 07	0.6	0.4	0.8	1.5	0.6	1.5	1.6		0.5	0.6		0.7
EMW 08	0.2	0.1	0.1	0.9	1.1	0.1	0.1		0.2	0.2		0.2
EMW 10	0.4	0.8	0.7	0.7	NR	NR	NR		1.1	2.8		0.5

Shaded cells indicate exceedance of 1.5 v/v % trigger limit for CO_2.

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

^Monitoring was not completed in August and November 2018.

7.3. Air Stack Testing

Exova Catalyst Ireland were commissioned by Kerdiffstown Landfill to carry out stack emissions testing on the Landfill Flare at Johnstown Road, Naas. The monitoring was undertaken on 12th July 2018 with the results as shown in Table 7.15 below. For Total VOCs, Oxides of Nitrogen and Carbon Dioxide, all concentrations were well within the Emission Limit Values taken from Guidance Note on Landfill Flare and Engine Management and Monitoring (AG7).

Table 7.15 Air Stack Monitoring Results

Parameter	Units	Result	MU +/-	Limit
Hydrogen Chloride	mg/m^3	1.59	0.12	
Hydrogen Fluoride	mg/m^3	0.65	0.039	
Sulphur Dioxide	mg/m^3	166.4	14.0	
Total VOCs	mg/m^3	0.51	0.71	10
Oxides of Nitrogen (as NO_2)	mg/m^3	18.9	3.53	150
Carbon Monoxide	mg/m^3	1.84	1.35	50
Carbon Dioxide	% v/v	7.72	0.24	
Oxygen	% v/v	10.51	0.31	
Water Vapour	% v/v	5.33	0.23	

7.4. Dust

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.

The first deposition survey was undertaken during May and July 2018 from 28/05/18 to 18/07/18), followed by another in August 2018 from 2/08/18 to 31/08/18. They were 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 location off site were selected for monitoring purposes as presented in Figure 3C. An additional location 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 glass 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 two exceedances of the former licence limit of 350 mg/m2/day in the May to July period; and one exceedance in the August period. The highest dust level was detected at KLRP 6 during May to July. KLRP 9 also recorded elevated dust levels in this time. KLRP 6 is located offsite to the south east of the site. This location is adjacent to the N7 motorway where extensive works were ongoing during the monitoring period. Weather conditions were also very dry during this time. KLRP 9 is located onsite to

the east south eastern boundary. This was also likely to have been influenced by the road-works on the N7.

During the August monitoring period there was one exceedance recorded at KLRP 1. This is located at the northern boundary of the site near Naas Golf Club and adjacent to the L2005 County Road from Sallins to Johnstown. A quarry is located along this road and may be the source of the elevated dust levels, as KLRP 8 also recorded high dust but was within the previous licence limit.

It should be noted that there were no operations ongoing onsite during the monitoring periods that would have caused any dust generation.

Table 7.16 Dust Monitoring Results 2018

	(mg/m^2/day)		
Location	Licence Limit	Jul-Aug 2017 Result	Aug-Sep 2017 Result
D1	350	-	493
D2		42	46
D3		39	46
D4		42	69
D5		60	57
D6		2220	75
D7		39	34
D8		74	310
D9		537	57

7.5. Odour

Monthly off site and on site odour monitoring has been undertaken by KCC personnel since April 2016. Prior to this, monthly odour monitoring was carried out by Jacobs' staff since August 2014. 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.

One odour complaint was received during 2018. However when investigated by the site management team it was determined that the perceived odour could not have been as a result of emissions from the site due to the prevailing wind direction during the complaint period.

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. Since odour monitoring began in August 2014 a number of on-site odour sources have been identified. Intermittent faint odours were occasionally noted in the area around the 250 flare compound during 2018. In the area around the high security hut intermittent faint to moderate landfill gas type odours were also detected on a regular basis. Landfill gas odour was not detected off site during the monthly odour monitoring events in 2018. Tables 7.17a and 7.17b summarise the results of the odour assessments conducted in 2018. For further details please refer to the Monthly Odour Reports (Ref 12).

Table 7.17a Summary of odour monitoring (January-June 2018)

	Intensity	Persistence	Intensity	Persistence	Intensity	Persistence	Intensity	Persistence	Intensity	Persistence	Intensity	Persistence
Location \ Month	January		February		March		April		May		June	
Offsite												
OMP1	0	0	0	0	0	0	0	0	0	0	0	0
OMP2	0	0	0	0	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	2	1	1	1	0	0	1	1	0	0	1	1
Security Hut in North west (Zone 1)	2	2	2	1	2	1	2	1	2	2	2	1

Table 7.17b Summary of odour monitoring (July-December 2018)

	Intensity	Persistence	Intensity	Persistence	Intensity	Persistence	Intensity	Persistence	Intensity	Persistence	Intensity	Persistence
Location \ Month	July		August		September		October		November		December	
Offsite												
OMP1	0	0	0	0	0	0	0	0	0	0	0	0
OMP2	0	0	0	0	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	1	1	0	0	0	0	0	0	0	0	0	0
Security Hut in North west (Zone 1)	2	1	0	0	2	1	0	0	1	1	0	0

7.6. Geotechnical

A reassessment of all slopes on site in conjunction with the taking of inclinometer readings at two locations was undertaken by RPS and NVM Ltd during 2018. The slope stability assessment involved a detailed walkover of the site to assess all slopes. A review of all existing geohazard maps was also undertaken. The objectives of the walkover survey were to:

Visually assess the condition of the slopes on site by determining the presence of any indicators of slope instability and other relevant geotechnical parameters;

Categorise the site in terms of risk of instability accounting for the impact on any sensitive receptors; and

Produce of a revised slope stability risk zonation plan of the site if applicable. Inclinometer readings were compared with readings taken during 2012 to 2018 and included in the overall slope stability assessment.

An inclinometer borehole is a borehole fitted with specially designed pipe that allows for measurement of ground movements. Movements are assessed by dropping a probe into the pipe and measuring any changes in the verticality of the pipe when compared to previous readings. KLRP has two inclinometers in place on slopes that have been assessed as being at high risk. Inclinometer monitoring was undertaken in accordance with ASTM D6230 - 13 “Standard Test Method for Monitoring Ground Movement Using Probe-Type Inclinometers”. Both inclinometer boreholes were monitored monthly between July and November 2018. In July 2018, the readings from the inclinometer in BH41D showed slight movement of less than <1.11 mm on the A axis and less than <1.18 mm on the B axis whereas BH38 showed movement of less than 5.62 mm on the A axis and less than 15.35 mm on the B axis. As a result of this movement detected in BH38 a program of monthly monitoring was instigated followed by a detailed review of the slope stability across the entire site.

The detailed inspection of all slopes site was carried out in December 2018. The inspection did not reveal any significant change to slope stability across the site. However, the increasing degree of vegetation of the slopes does make a visual assessment difficult in parts of the site. Vegetation of the slopes will reduce the risk of slumping and small scale near-surface failures by ‘reinforcing’ the wastes but will make little difference to the macro stability of the higher slopes.

The slopes of most concern continue to be southern side of the lined cell in Area A and the exterior slopes of Areas I, L and N. The table below should be reviewed in conjunction with Figures 5a and 5b Geohazard Zonation Plans.

Table 7.18 Slope Stability Summary Table

Area	Likelihood	Consequence	Overall Risk	Monitoring frequency	Other
A	Medium	Low/Medium	Medium	Monthly	Annual inclinometer measurements
B	Medium	Low	Low/Medium	Quarterly	
C	Medium	Low	Low/Medium	Quarterly	
D1	Medium/High	Low	Low/Medium	Quarterly	
D2	Medium	Medium	Medium	Monthly	
E	Medium	Low	Low/Medium	Quarterly	
F	Medium	Low/Medium	Medium	Monthly	
G	Medium/High	Medium	Medium	Monthly	
H	Low/Medium	Medium/High	Medium	Monthly	
I	High	Medium	Medium/High	Weekly	
J	High	Low/Medium	Medium	Monthly	
K	Medium/High	Low	Low/Medium	Quarterly	
L	Medium/High	Medium/High	Medium/High	Weekly	Quarterly inclinometer measurements
M	Medium	Medium	Medium	Monthly	
NE (exterior)	Low	Medium	Low/Medium	Quarterly	
NE (interior)	Medium/High	Low	Low/Medium	Quarterly	
NI	Low	Medium	Low/Medium	Quarterly	
O	Low/Medium	Low/Medium	Low/Medium	Quarterly	
P	Medium	Medium	Medium	Monthly	
Q	Low	Low	Low	Annually	
R	Medium	Low/Medium	Medium	Monthly	
S	Low	Low	Low	Annually	
T	Low	Medium	Low/Medium	Quarterly	

7.7. VOC Survey

A VOC surface emissions survey was undertaken on 12th July 2018 by Exova Catalyst Ireland to ascertain any likely sources of facility gas surface emissions.

VOCs were measured around the areas of Zone 1 & Zone 3 using a MiniRAE 3000 VOC gas monitor, which measures volatile organic compounds, using a photoionization detector (PID), calibrated using isobutylene.

The sample response time of the MiniRAE 3000 is < 3 seconds. It was operated in the 0 - 999.9ppm range with a resolution of 0.1ppm. 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.

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- 2017.

During the surface emissions survey, the following tasks were performed on site:

- Identification of the key mechanisms that lead to the release of facility gas surface emissions from the site.
- Identify geographically on a site map, the locations of facility gas surface emissions in order to perform remediation of the identified surface emissions areas.

Measurement of surface emissions averaged over landfilled areas is a requirement of AG6 'Surface VOC Emissions Monitoring on Landfill Facilities'. Where a landfill has been permanently capped the limit is 50 ppm and where a temporary cap is in place a limit of 100ppm is applied.

In cases where there is no cap, such as in Zone 1 of KLRP, a trigger limit of 500ppm at identified features applies.

Results

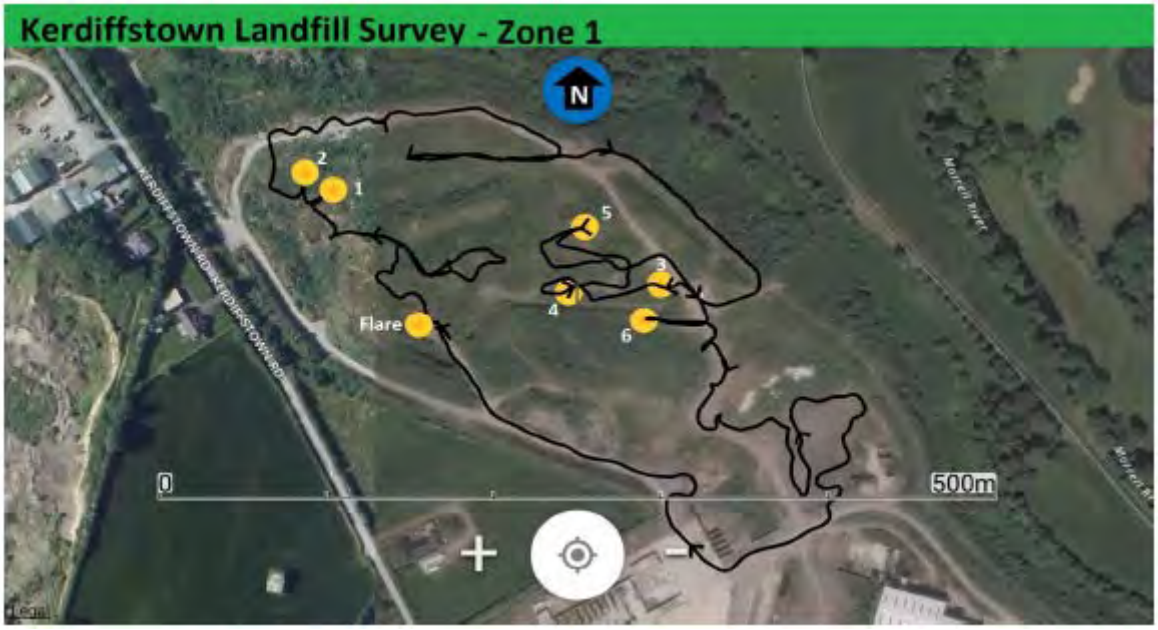
There were three positive VOC readings recorded during the survey of Zone 1 ranging from 0.3 - 5.3ppm. There were no recorded reading that were approaching the trigger levels. The area surveyed can also be seen in plate 7.4.

No surface VOC emissions were detected during the survey of Zone 3. The area surveyed can be seen in Plate 7.4.

Table 7.19 Survey Data Tables

Location	VOC average (ppm)	VOC maximum (ppm)	Map No.	Reference	Recommended Trigger Levels (ppm)
Zone 1	0 (Strong Smell)	0 (Strong Smell)	1	LG8	< 100
Zone 1	0 (Strong Smell)	0 (Strong Smell)	2	LG9	< 100
Zone 1	0 (Strong Smell)	0 (Strong Smell)	3	Security Hut	< 100
Zone 1	4.55	5.3	4	LG35	< 100
Zone 1	0.3	0.4	5	BH63	< 100
Zone 1	1.0	1.0	6	BH36B/LG 37	< 100

Plate 7.4 2018 Leakage Survey Monitoring Map



7.8. Meteorological Data

A weather station is present on site; however for much of 2018 the wind speed and direction were not accurate and have not been used to inform the information contained in **Appendix G** Meteorological Information is obtained from the on-site weather station. Monthly information on rainfall, temperature, wind speed and direction is 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 monthly report with graphs showing trends over time.

Overall rainfall for 2018 was consistent with the levels for 2017 with total rainfall for the year at 657.7 mm compared to 703.5 mm for 2017. This equated to

approximately 87% of the historical average annual rainfall. November was the wettest month of the year with rainfall of 104.6 mm, 142% of the average**. Appendix G** presents the summary data for the weather at Casement Aerodrome for 2018.

7.9. Noise Monitoring

Noise monitoring was carried out on the 7th September 2018 in accordance with the EPA Guidance Note for Noise In Relation To Scheduled Activities (NG4). Monitoring was completed at four locations, two onsite and two offsite. The results were compared to the noise limits set out in NG4. This guidance specifies a day time noise limit of 55 dB L_{Aeq}.

Table 7.20 Noise Monitoring Results

Location	L_{Aeq} (dB)	L_{A90} (dB)	L_{A10} (dB)	L_{Amax} (dB)
N1	43.4	36.6	46.3	62.6
N2	49.8	47.5	51.5	61.3
N3	51.9	48.3	52.8	76.5
N4	42.4	38.1	44.8	61.7

All sites were within the 55 dB limit. The highest L_{Aeq} was 51.9 dB_A. This was recorded at N3 which is located onsite near the southern boundary. The main source of noise at this location was traffic on the adjacent local road and traffic on the nearby N7. There were no operations ongoing onsite during the monitoring that would have contributed to noise levels.

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

There no incidents during 2018.

One ‘complaint’ was received during this reporting period but was deemed not a result of site activities or emissions.

8.3. Emissions management

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

8.4. Waste Management and Resource Consumption

Minimal amounts of waste were generated as a result of KLRP activities in 2018. During 2018 a small amount of waste was generated from the site office.

8.5. Restoration works

During 2018 no significant restoration works were undertaken.

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 2018 monitoring round indicate that water quality in both the Morell River and the canal feeder is good. Water quality in the downstream samples was very similar to water quality in the respective upstream samples.

While the site remains in its current form and in particular the wastes in the northern part of the site remain uncapped (and unlined) there remains the potential for increased 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 2018. It findings were consistent with the previous assessment in 2017. 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

Leachate analysis from the lined cell area completed during 2018 is broadly similar to those results obtained from previous sampling events in recent years. However, over the longer term, the concentration of ammoniacal nitrogen and COD has fallen from the initially recorded concentrations.

8.6.5. Landfill Gas

Landfill gas results from both the lined cell area and the north-western area obtained during 2018 were noted to be generally stable. There has 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 is extracted and burnt off at the 250 flare since July 2011. However, in 2017 there was an improvement in the quality of gas in the lined cell due to the emplacement of waste from the demolished buildings and improvements to the rain cover and these concentrations remained relatively stable in 2018.

8.6.6. Dust

Dust monitoring was completed in May and July 2018 and again in August 2018. Three exceedances were recorded of the previous licence limit of 350 mg/m^2/day.

8.6.7. Odour Monitoring

Odour monitoring has been conducted on a monthly basis since 2014. No odours were detected at off-site monitoring locations 2018. At the two on-site monitoring locations intermittent faint to strong odours were observed around the 250 flare and at the high hut. Odours are commonly detected in both these areas depending on prevailing winds.

At the present time it is considered that odour occurrences are being minimised at the site through best practice and regular monitoring. This is in line with guidance provided in the EPA Landfill Manuals, Landfill Monitoring.

8.6.8. Geotechnical

Slope stability and geo-hazard mapping was undertaken in December 2018 with no significant change to slope stability across the site noted.

8.6.9. VOC Surface Emissions

A VOC surface emissions survey was undertaken in July 2018 to ascertain sources of facility gas surface emissions and make recommendations regarding potential improvements to the existing landfill gas infrastructure.

8.6.10. Meteorological Data

Meteorological information was collated on a monthly basis during 2018.

8.6.11. Noise Monitoring

Noise monitoring was completed in September 2018. No exceedance of the L_{Aeq} 55 dB limit was recorded.

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 within this report.

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
Complaints summary.	Section 3.2
Schedule of Environmental Objectives and Targets.	Under development
Environmental management programme – report for previous year.	N/A
Environmental management programme – proposal for current year.	Under development
Pollutant Release and Transfer Register – report for previous year.	N/A
Pollutant Release and Transfer Register – proposal for current year.	N/A
Noise monitoring report summary.	Section 7.9
Ambient monitoring summary.	Chapter 7
Tank and pipeline assessment report.	Not completed in 2018
Reported incidents summary.	Section 3.1
Energy efficiency audit report summary.	Not completed in 2018
Report on the assessment of the efficiency of use of raw materials in processes and the reduction in waste generated.	Not completed in 2018
Report on progress made and proposals being developed to minimise water demand and the volume of trade effluent discharges.	Not completed in 2018
A report on compliance with recommendations of the Detailed Quantitative Risk Assessment (DQRA) submitted to the Agency.	Not completed in 2018
Development/Infrastructural works summary (completed in previous year or prepared for	Chapter 6

P1063-01 Schedule D AER Requirements	Section of report / Comment
current year).	
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).	Not completed in 2018
Environmental Liabilities Risk Assessment Review (every three years or more frequently as dictated by relevant on-site change including financial provisions.	Under development
Any other items specified by the Agency.	N/A

Appendix B **EMS PROCEDURE SUMMARIES**

Appendix C **Landfill Gas Survey 2018**

Environmental Protection Agency

A survey of landfill sites to determine the quantity of methane flared and or recovered in utilisation plants for 2018

Please choose from the drop down menu the license number for your site	Select	P1063-01
Please choose from the drop down menu the name of the landfill site	Select	Kerdiffstown Landfill
Please enter the number of flares operational at your site in 2018	1	
Please enter the number of engines operational at your site in 2018	0	
Total methane flared	157,051 kg/year	
Total methane utilised in engines	0 kg/year	

Please note that the closing date for reciept of completed surveys is 31/03/2019

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 Decision (No. 406/2009/EC). 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 license number of the landfill site (e.g. W000 Xanadu landfill_2018) to:
LFGProject@epa.ie

	to be filled in by licensee		calculated by spreadsheet	

Flare No. 1

Flare type ?	Other	**Uniflare UF10-250**	
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 2018 ?	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	C	31	24.0	42.0	702	-5	10	83	23.60	20.60	1.00	98.0	13,476	9,258
February	C	28	24.0	20.5	652	-7	10	90	23.90	21.20	1.00	98.0	13,733	9,417
March	C	31	24.0	20.0	724	-9	10	95	27.30	21.10	1.00	98.0	18,401	12,592
April	C	30	24.0	52.0	668	-3	10	103	22.60	22.80	1.00	98.0	15,239	10,490
May	C	31	24.0	0.0	744	-1	10	109	21.70	21.30	1.00	98.0	17,246	11,896
June	C	30	24.0	16.5	704	-1	10	111	24.10	21.10	1.00	98.0	18,443	12,721
July	C	31	24.0	0.0	744	-1	10	123	23.60	21.30	1.20	98.0	21,165	14,599
August	C	31	24.0	0.0	744	-1	10	136	21.40	20.10	1.70	98.0	21,220	14,637
September	C	30	24.0	0.0	720	-1	10	113	24.30	21.80	1.00	98.0	19,375	13,364
October	C	31	24.0	0.0	744	-1	10	136	23.80	21.60	1.00	98.0	23,600	16,279
November	C	30	24.0	0.0	720	-1	10	140	23.30	21.90	1.00	98.0	23,017	15,876
December	C	31	24.0	24.0	720	-1	10	141	23.20	21.80	1.00	98.0	23,082	15,921
Total					8,585								227,997	157,051

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
2018					0		10					98.0	0	0

Appendix D **Incidents and Complaints Summary**

Incidents					
#	Date & Time	Type	Summary	Corrective Action	Recommendation & Follow up actions

Complaints					
#	Date & Time	Type	Summary	Corrective Action	Recommendation & Follow up actions

Appendix E **Programme of Improvements**

Ref	Specific Goal	Modification, Upgrade, or Replacement	Timescale
IC.1	Review and update Management Plans for the installation based on IEL conditions.	Modification	Within 6 months of IEL issue date
IC.2	Develop Management Plans for the installation based on IEL conditions.	Upgrade	Within 6 months of IEL issue date
IC.3	Review and update Monitoring and Control Management Plan to develop Trigger Levels.	Modification	Within 6 months of IEL issue date
IC.4	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.	Upgrade	Within 7 years of IEL issue date
IC.5	Inspection and repair of existing concrete hardstandings (joints and cracks).	Modification	Within 7 years of IEL issue date
IC.6	Extend leachate management infrastructure to Zone 1 monitoring wells to enable monitoring and extraction of leachate (where identified).	Upgrade	Within 7 years of IEL issue date
IC.7	Construct Landfill Infrastructure Compound including leachate treatment plant and leachate transfer pipeline to Johnstown PS for treatment and discharge of leachate from the site.	Replacement	Within 1 year of IEL issue date
IC.8	Extend gas management system across Zones 1 and 3.	Upgrade	Within 7 years of IEL issue date
IC.9	Install new landfill gas flares, sized according to gas pumping trials.	Replacement	Within 7 years of IEL issue date

Ref	Specific Goal	Modification, Upgrade, or Replacement	Timescale
IC.10	Develop Construction Environmental Management Plan (CEMP) in advance of remediation works.	Upgrade	Prior to commencement of works by Appointed Main Contractor for the Remediation

Appendix F **GAS AND WATER TIME SERIES GRAPHS**

G1 Groundwater Dip Levels

G2 Leachate Level

G3 Landfill Gas – methane in waste monitoring graphs

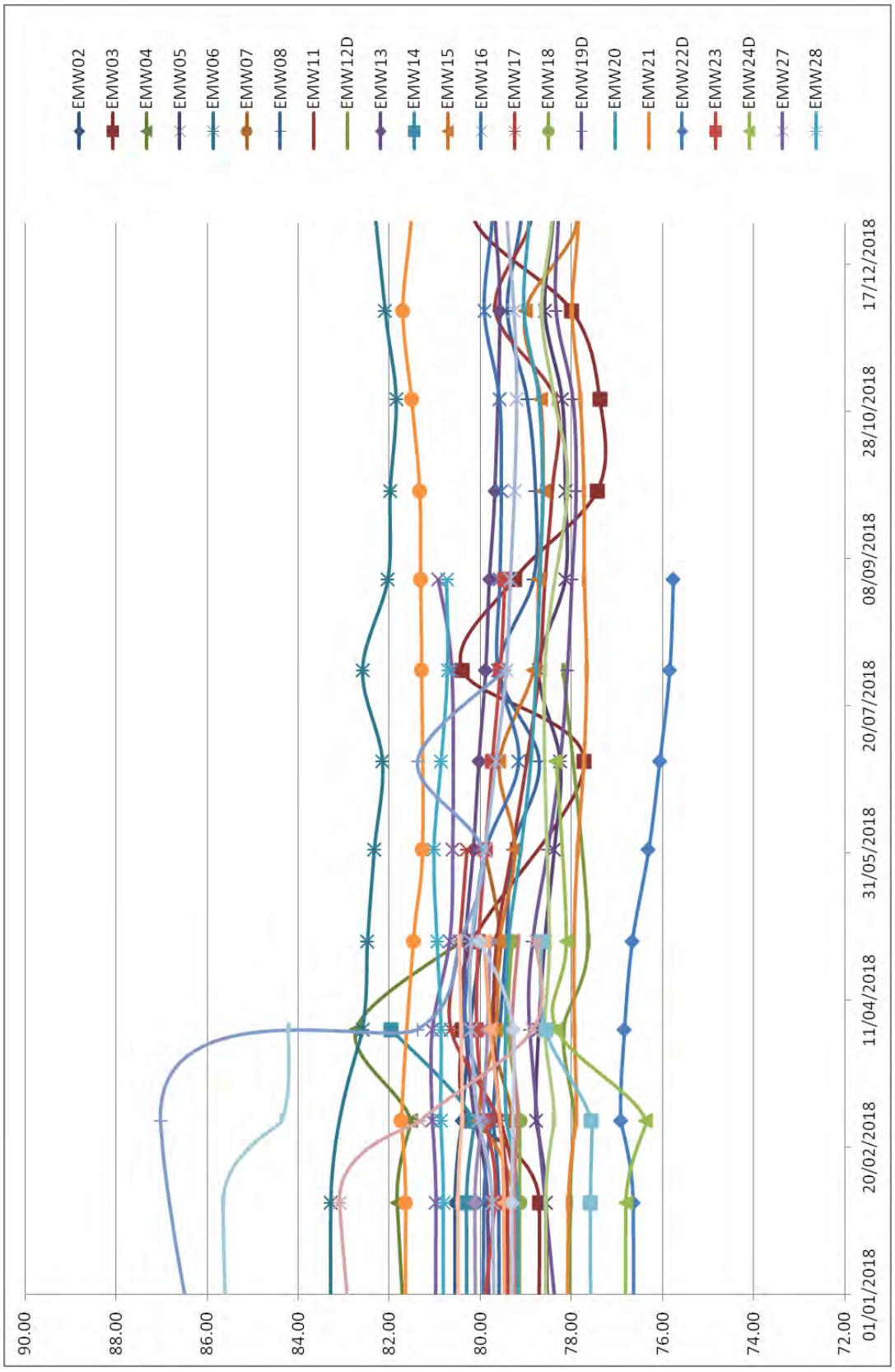
G4 Ammoniacal Nitrogen in Groundwater Monitoring Wells

G5 Chloride in Groundwater Monitoring Wells

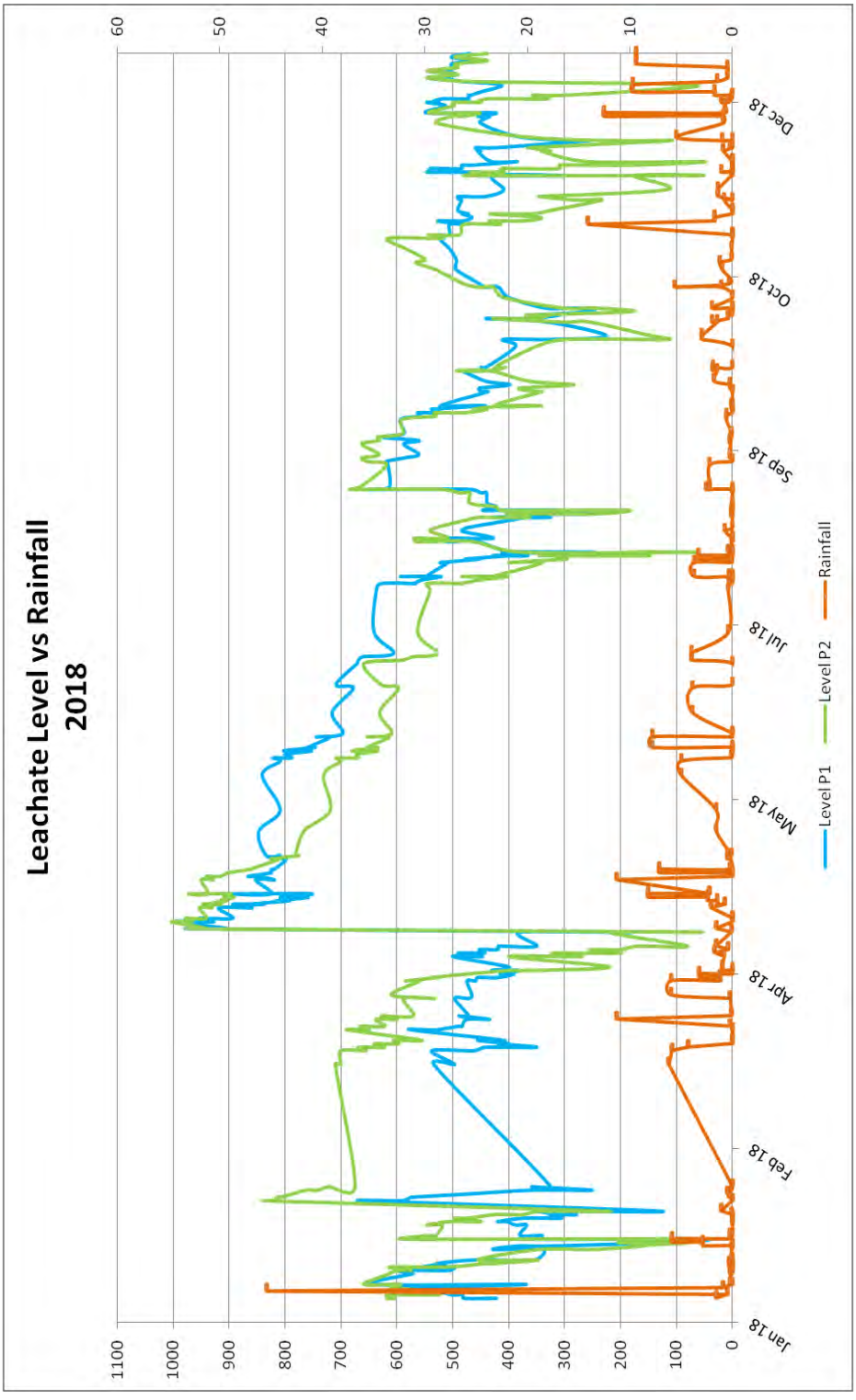
G6 Chloride in Morell River – Upstream (SW01) vs downstream (SW05)

G7 Leachate Quality

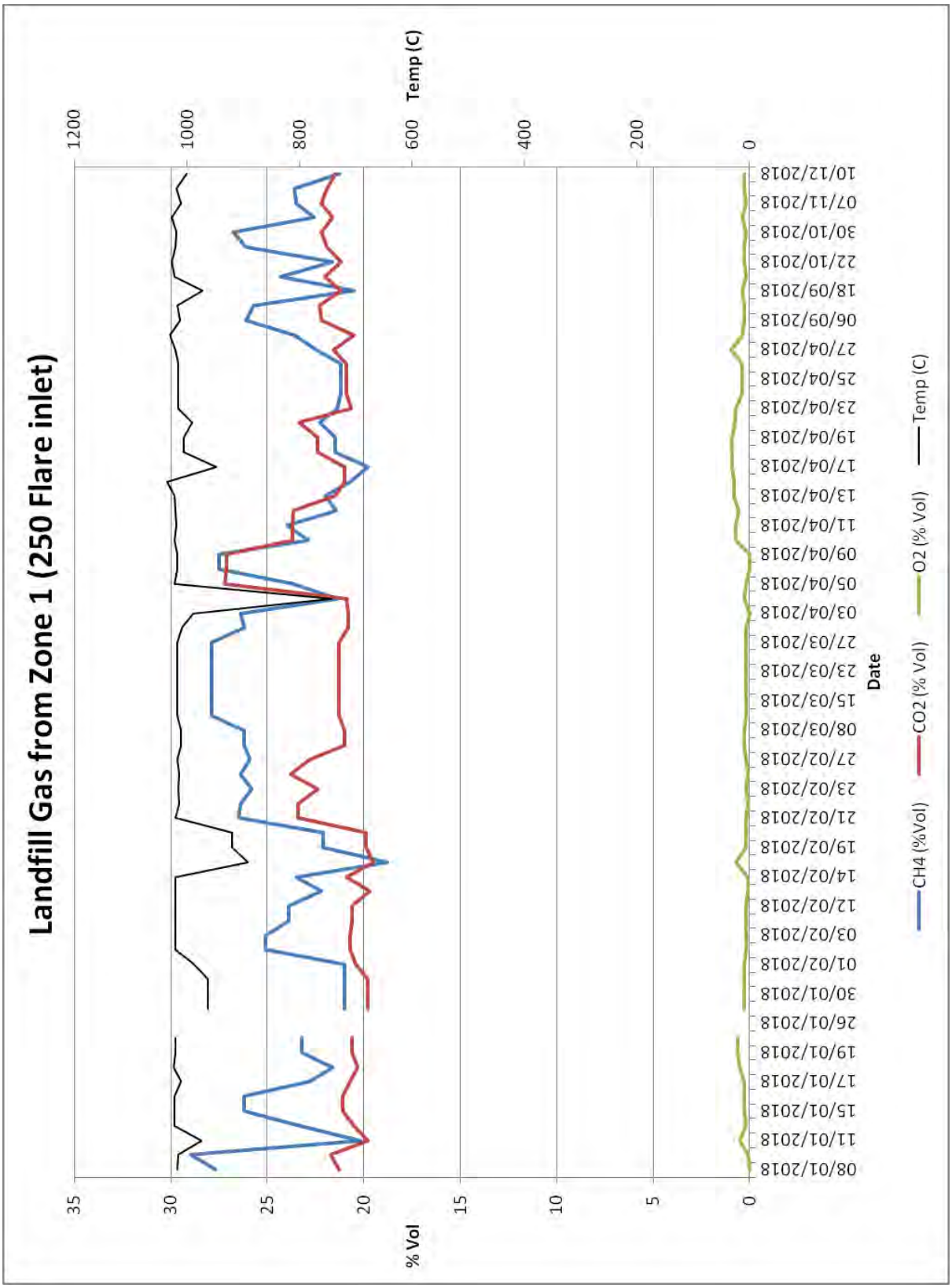
G1: Groundwater Dip Levels 2018



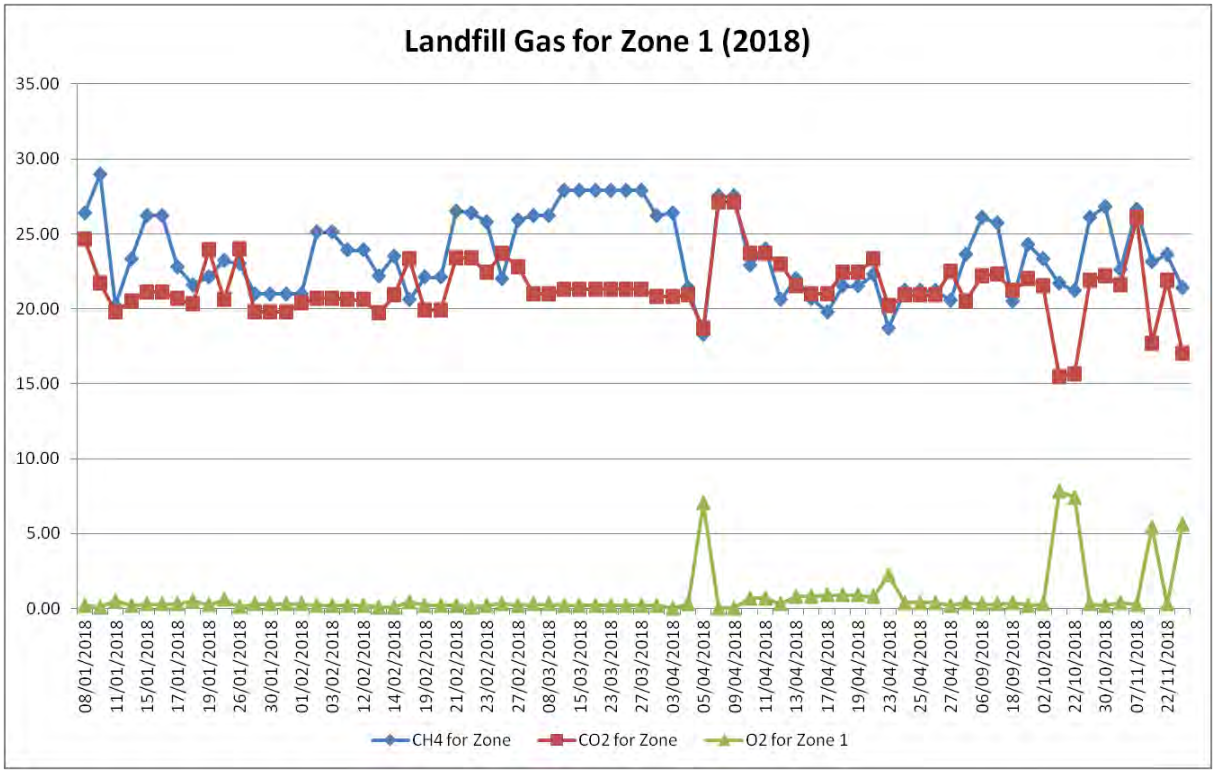
G2: Leachate Level 2018



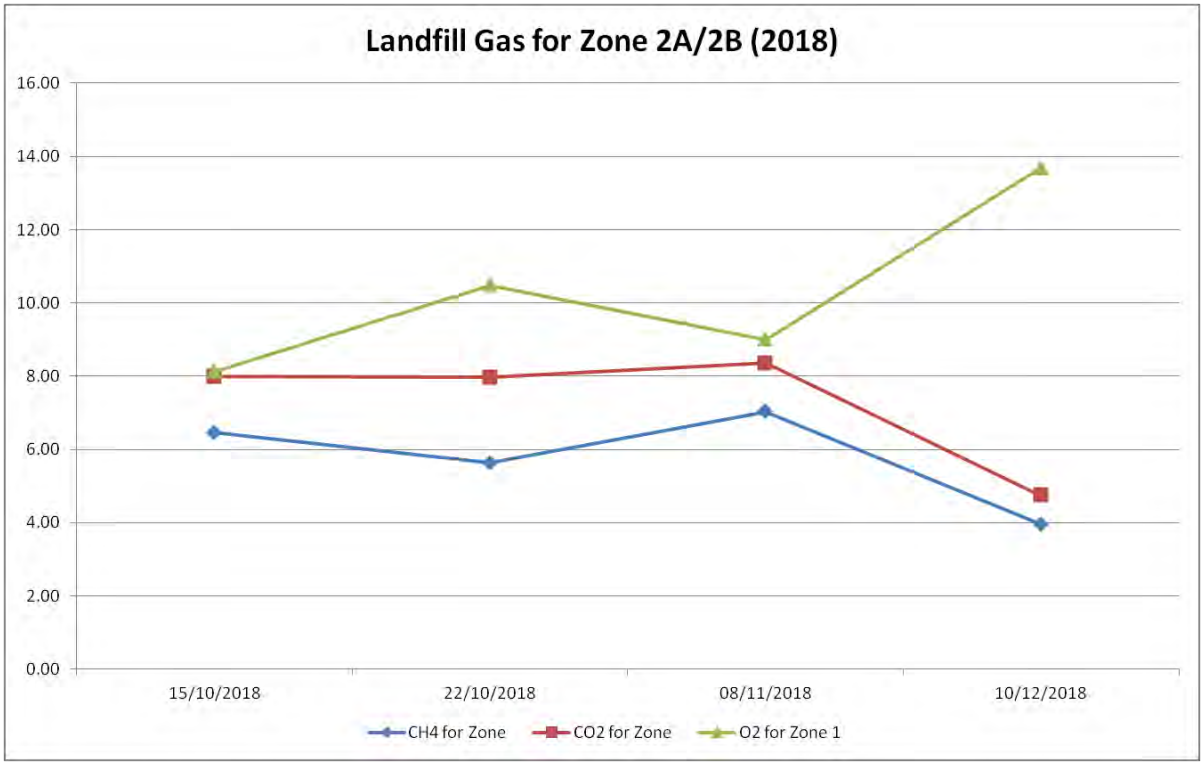
G3: Landfill Gas



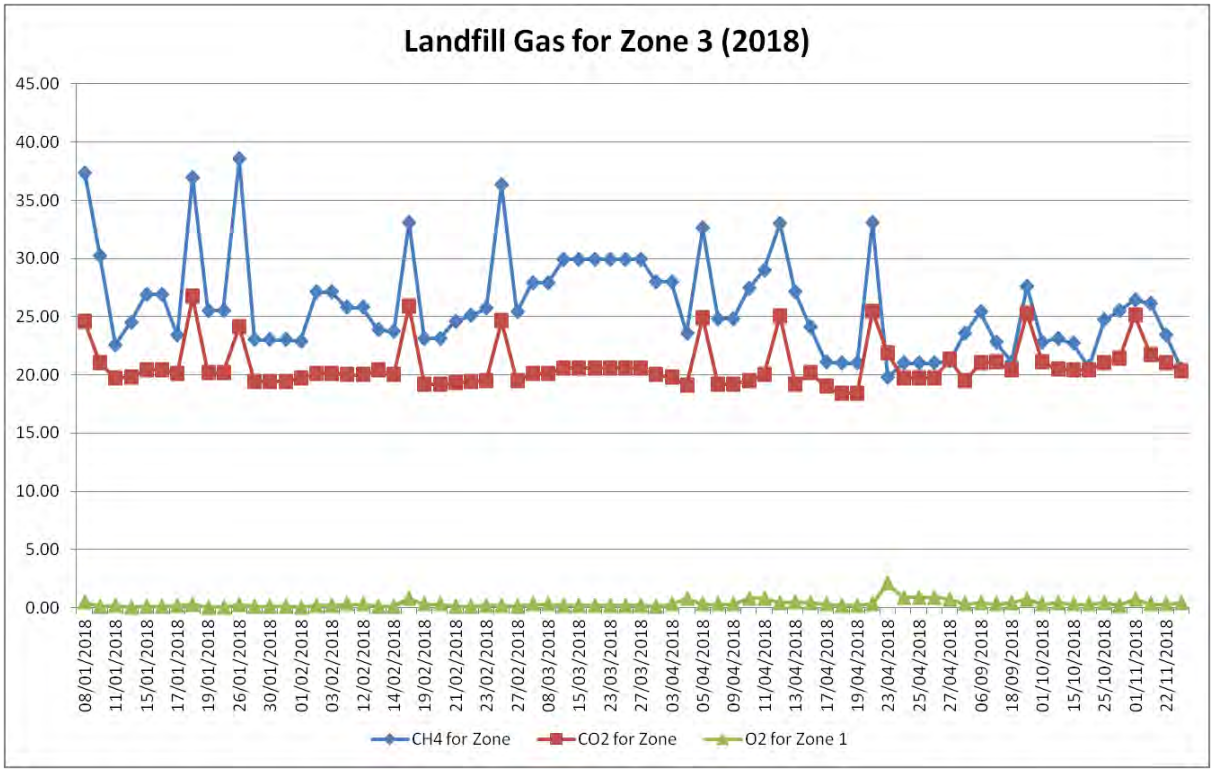
Zone 1 Landfill Gas



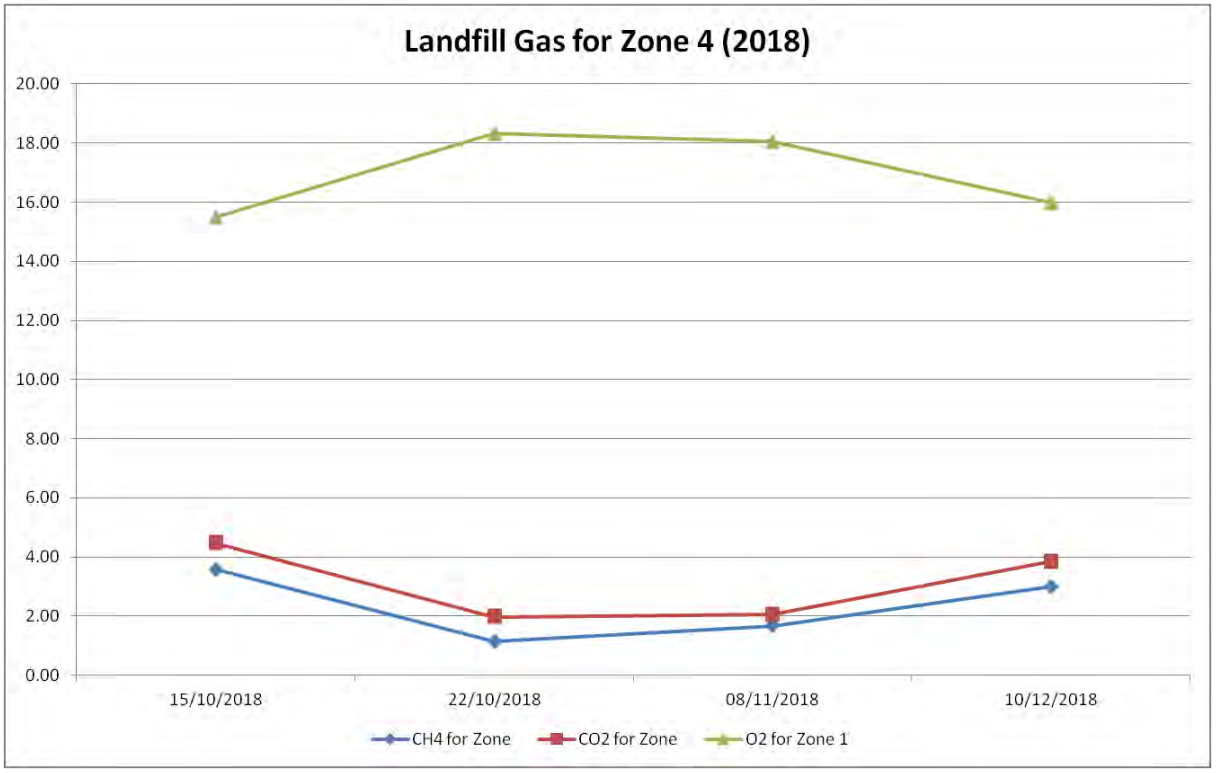
Zone 2 Landfill Gas



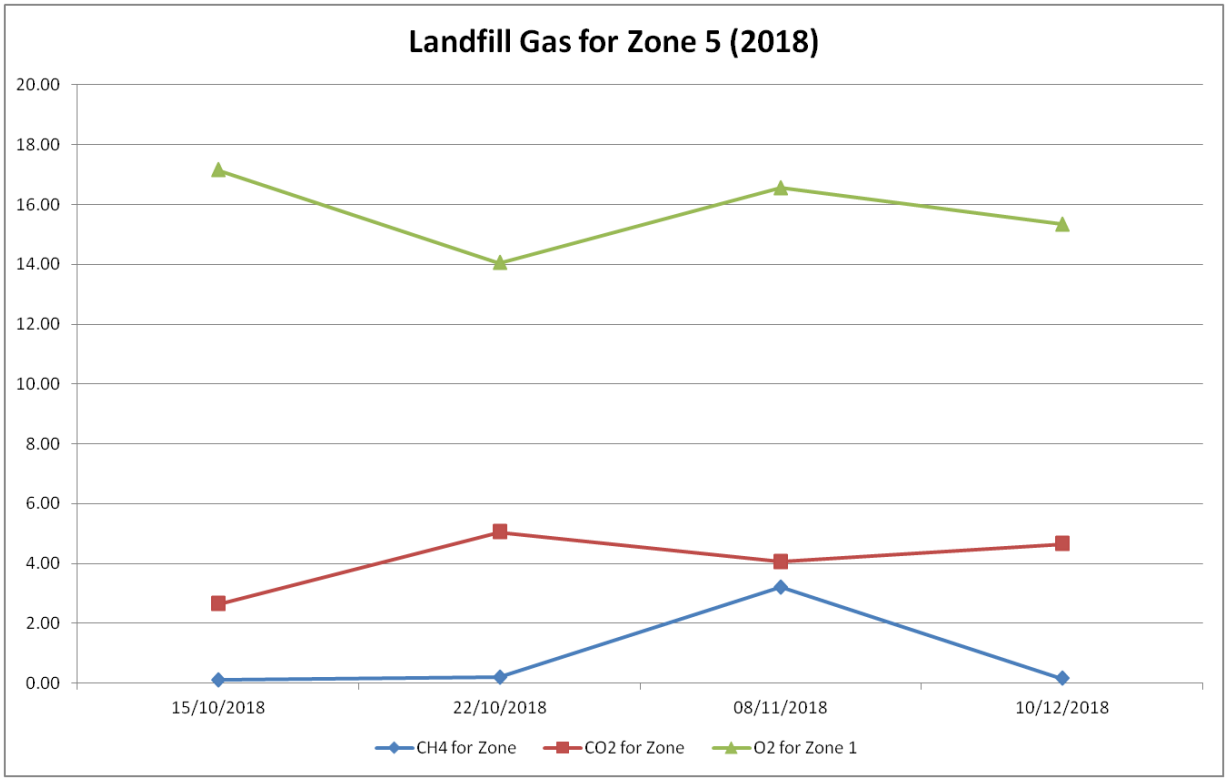
Zone 3 Landfill Gas



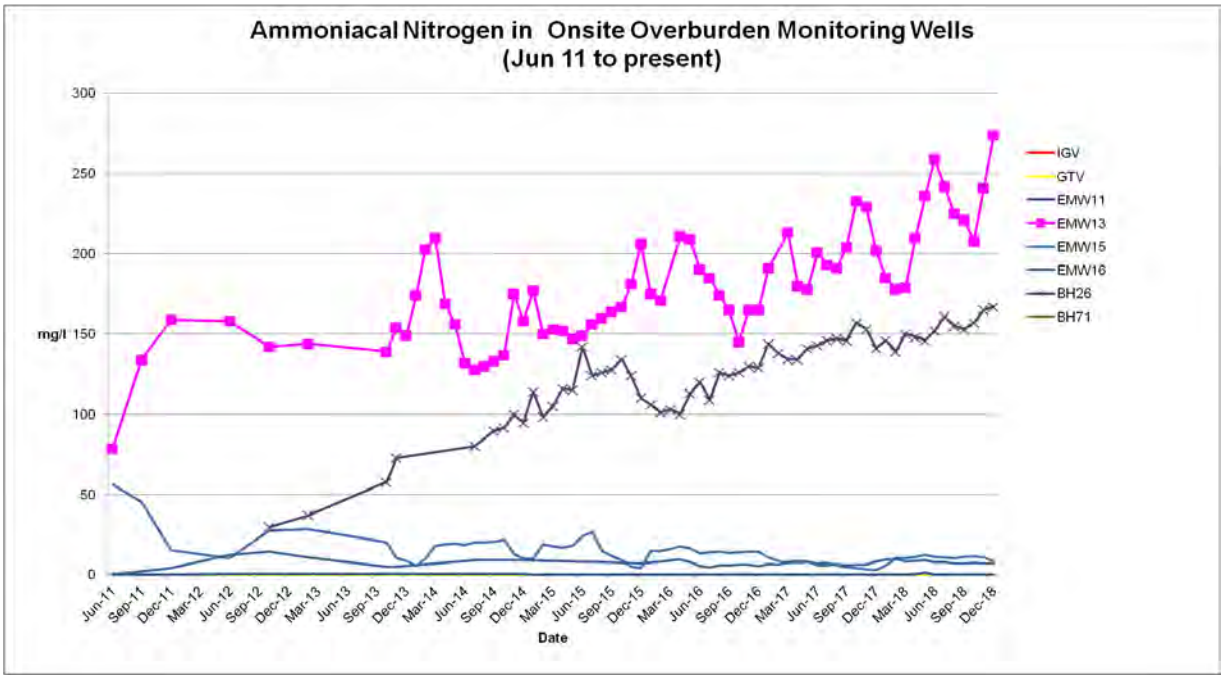
Zone 4 Landfill Gas

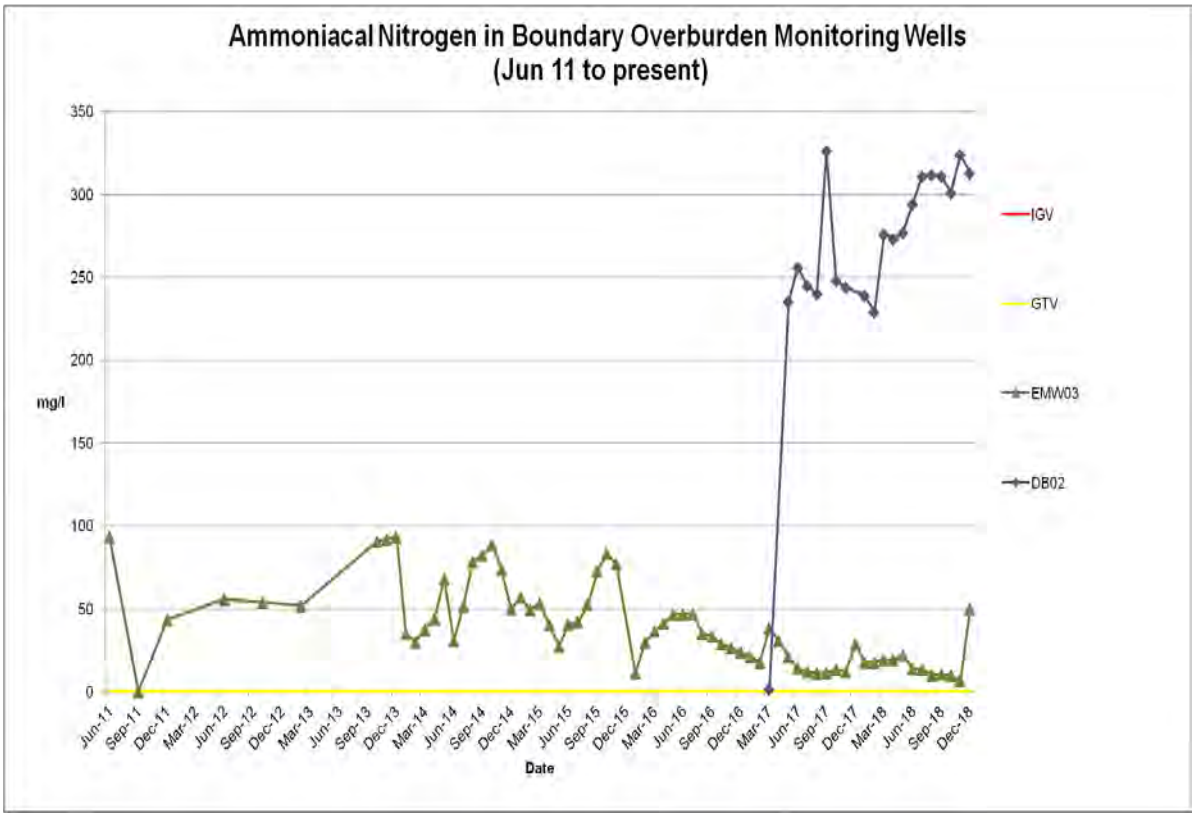


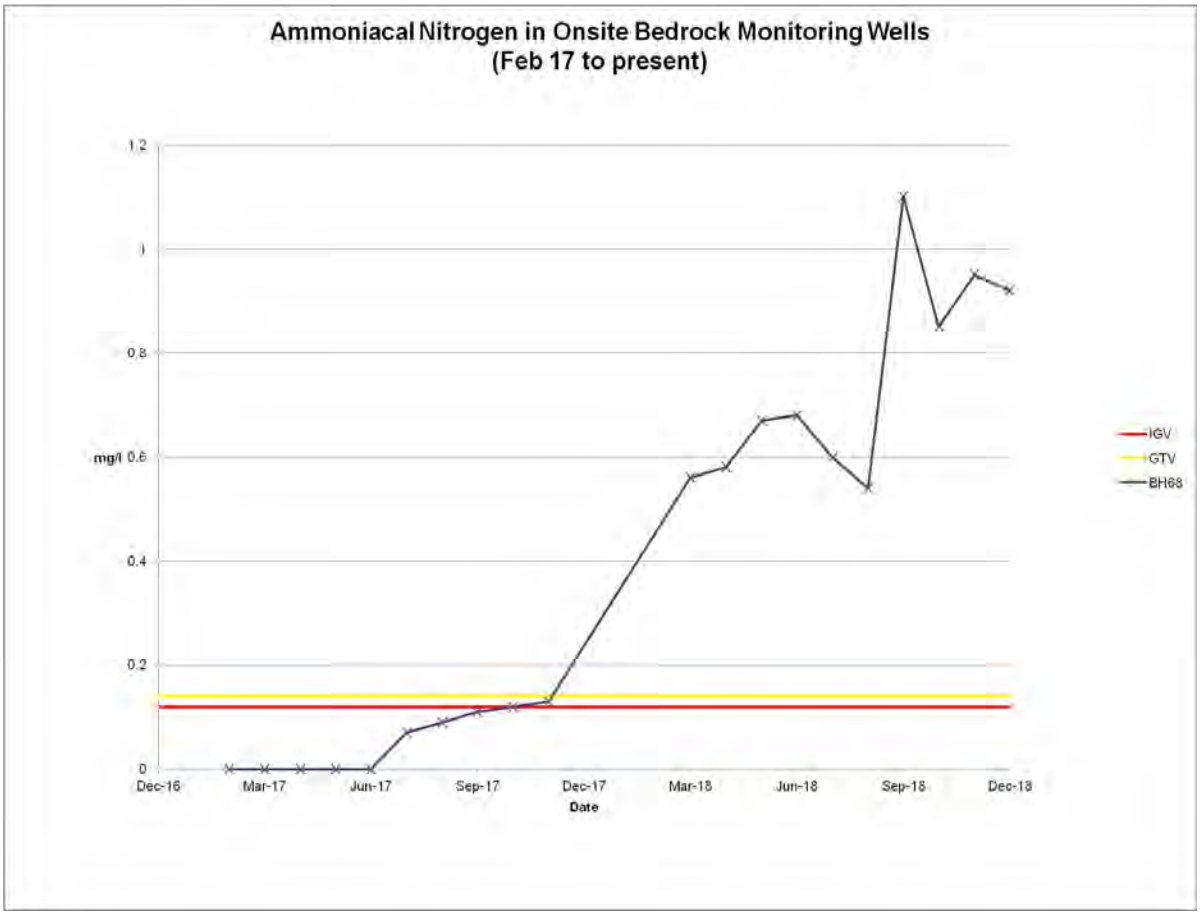
Zone 5 Landfill Gas

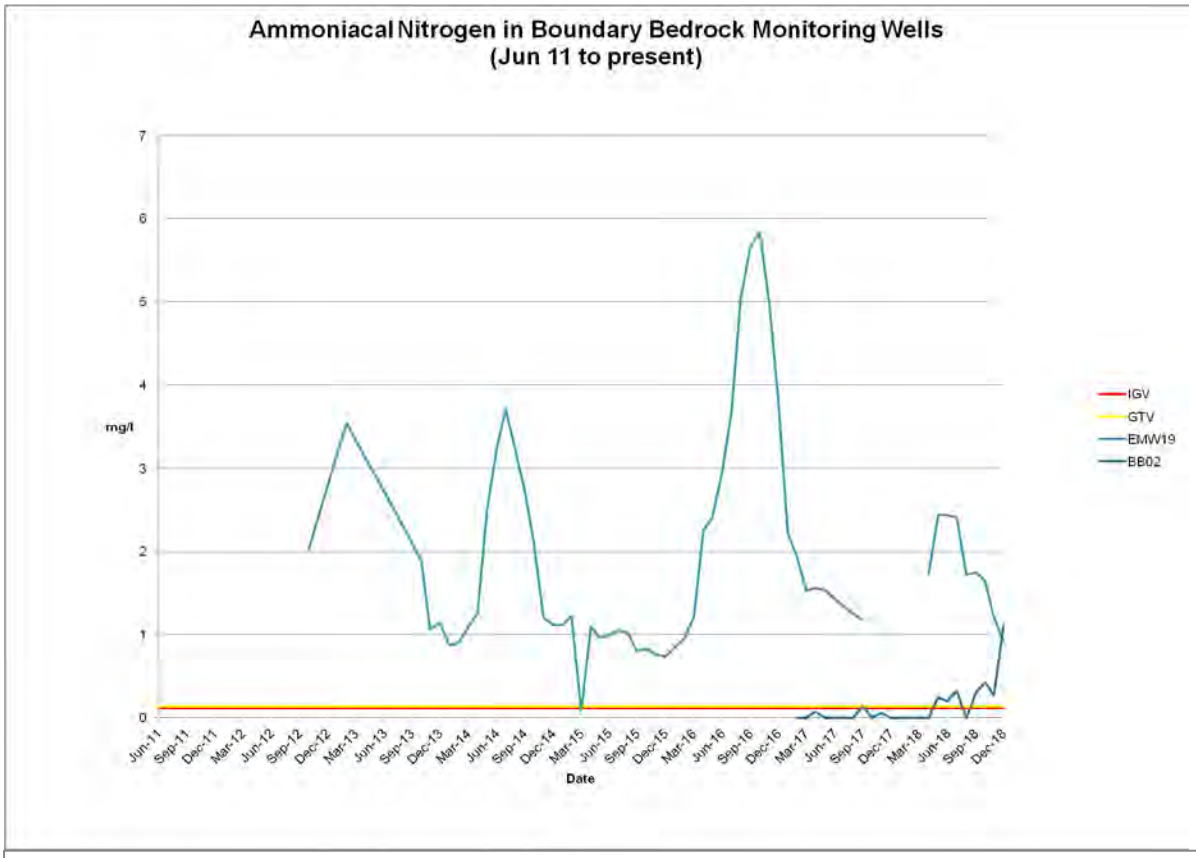


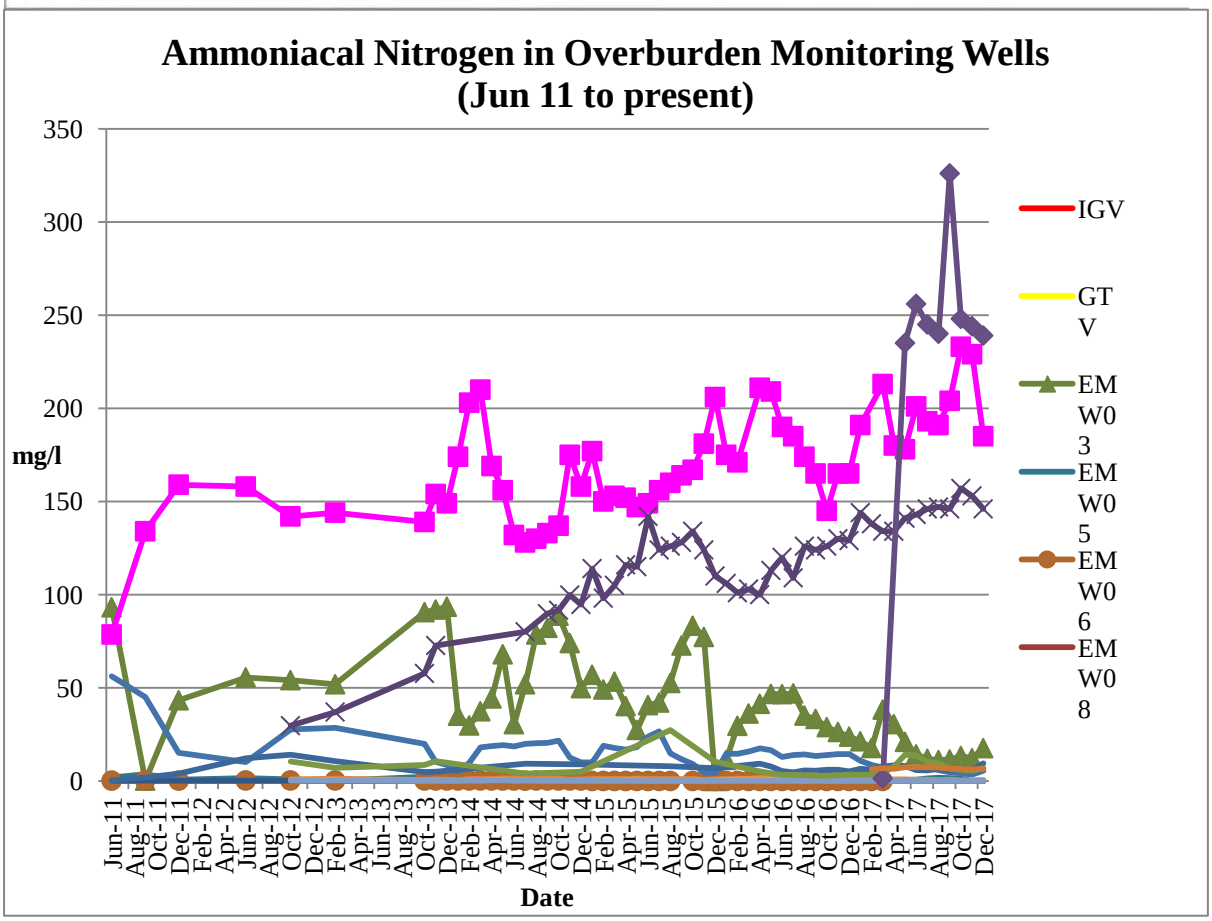
G4: Ammoniacal Nitrogen in Groundwater Monitoring Wells

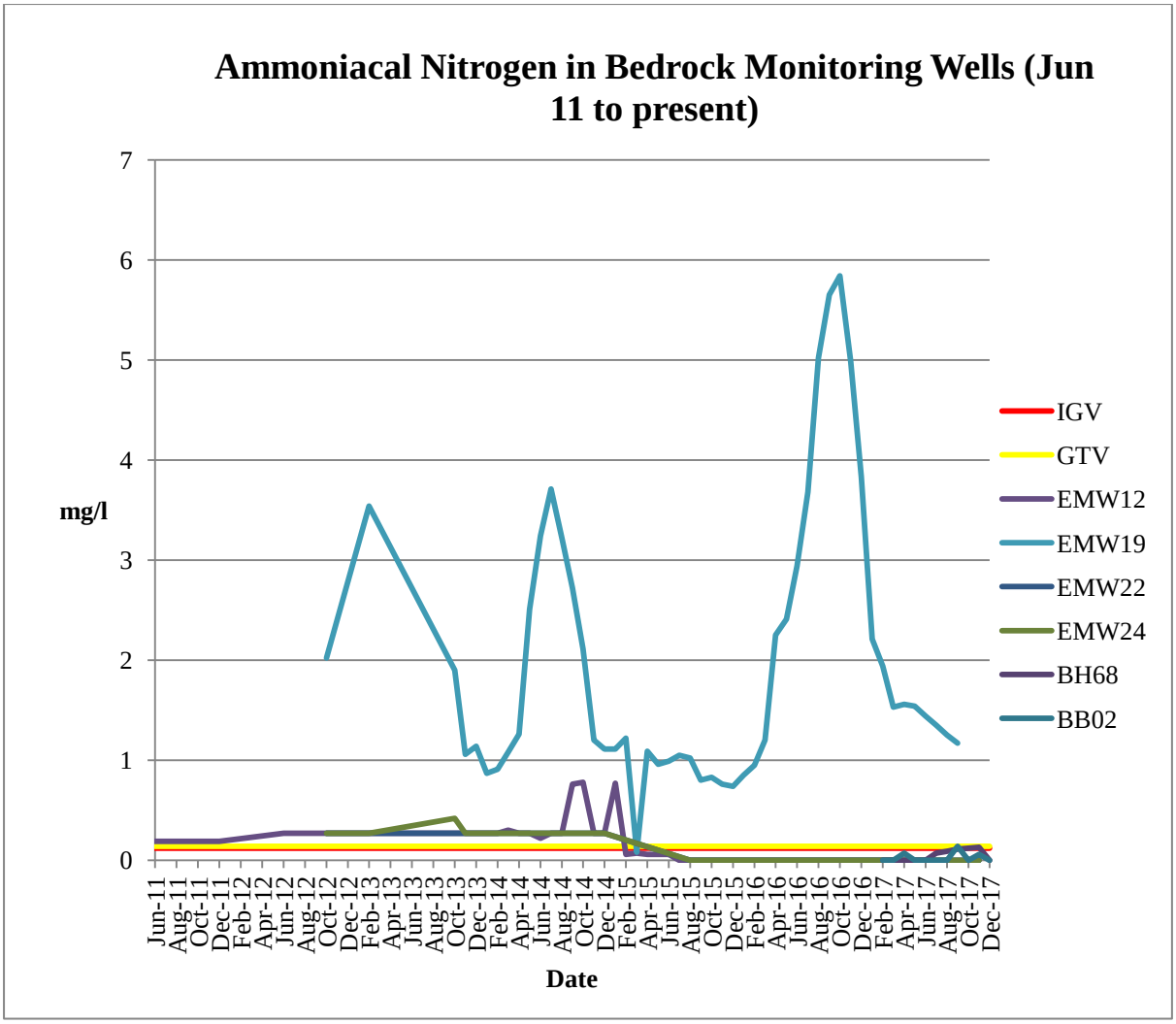




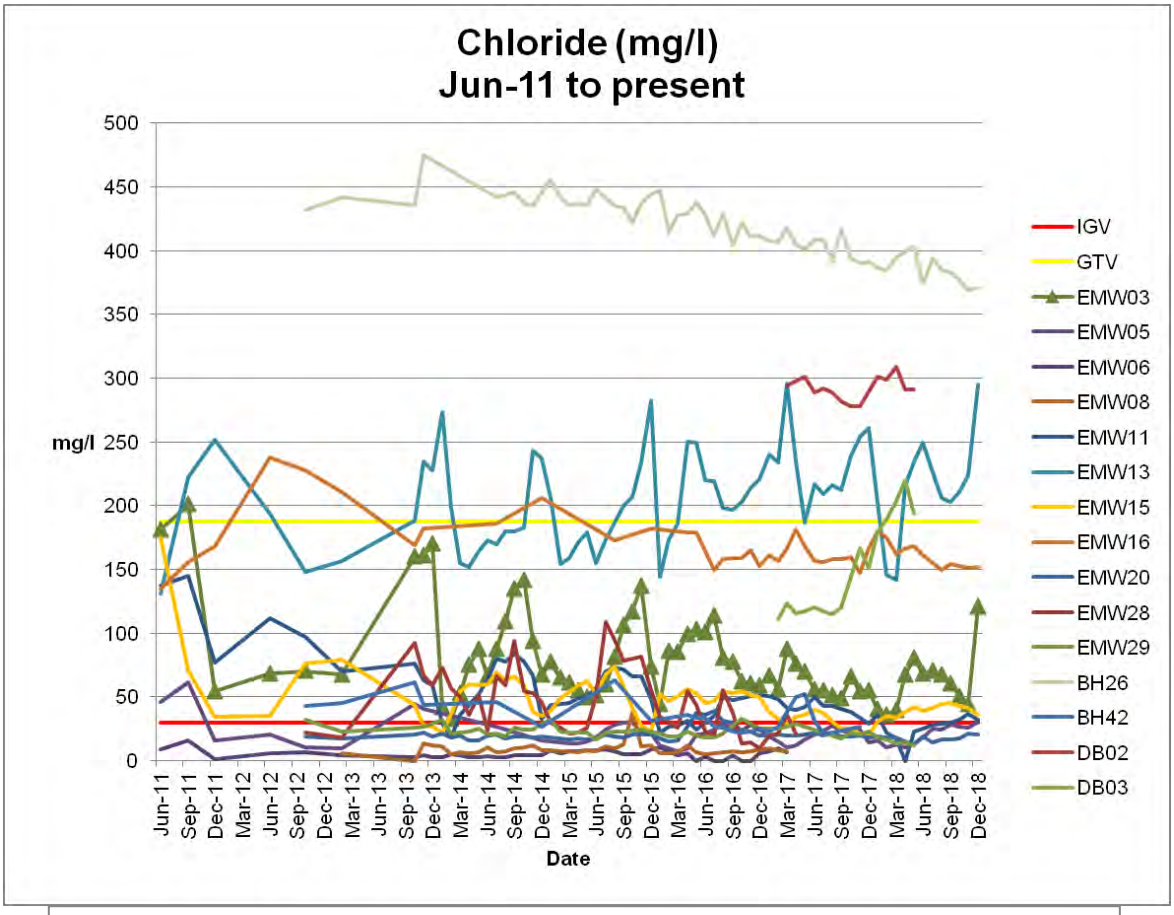

Ammoniacal Nitrogen in Onsite Bedrock Monitoring Wells
(Feb 17 to present)
1.2
1
0.8
mg/l 0.6
0.4
0.2
0
Dec-16
Mar-17
Jun-17
Sep-17
Dec-17
Mar-18
Jun-18
Sep-18
Dec-18
Date
IGV
GTV
BH68

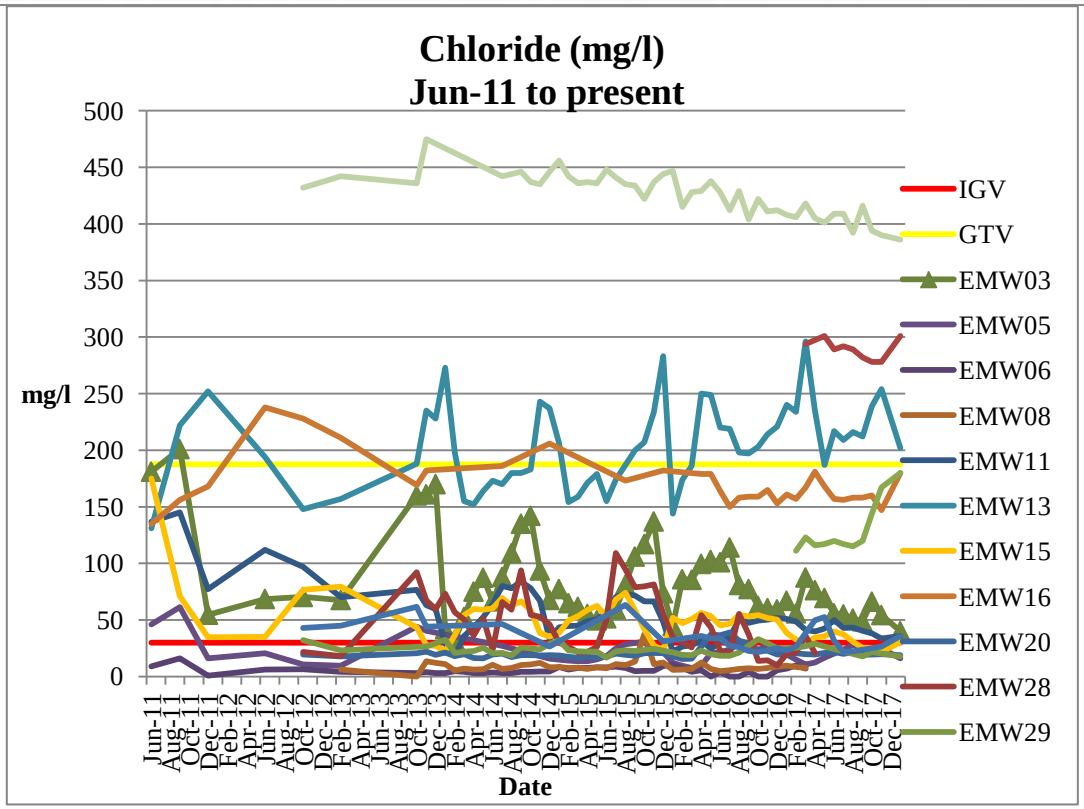

Ammoniacal Nitrogen in Boundary Bedrock Monitoring Wells
(Jun 11 to present)
mg/l
Date
IGV
GTV
EMW19
BB02

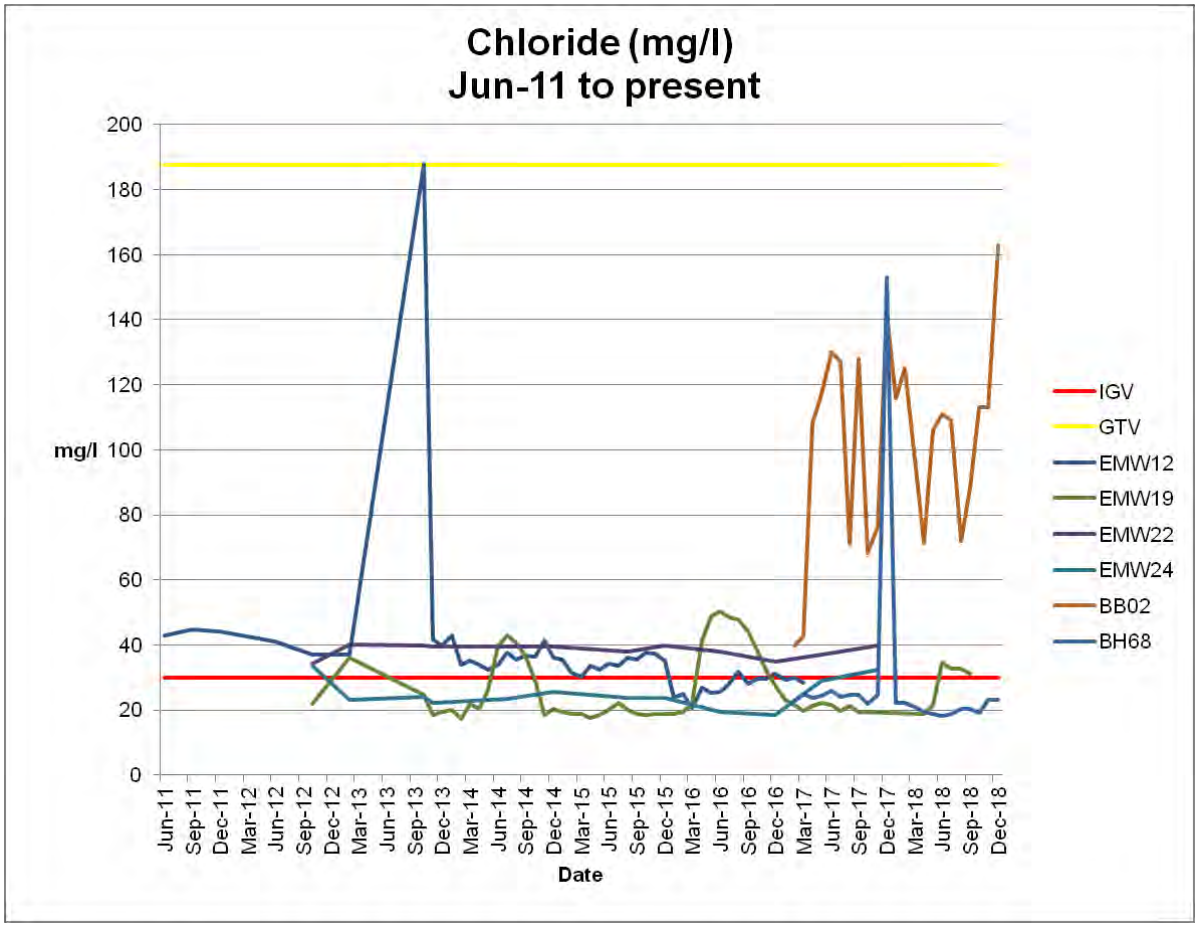

Ammoniacal Nitrogen in Overburden Monitoring Wells
(Jun 11 to present)
mg/l
Date
IGV
GTV
EMW03
EMW05
EMW06
EMW08


Ammoniacal Nitrogen in Bedrock Monitoring Wells (Jun 11 to present)
mg/l
Date
IGV
GTV
EMW12
EMW19
EMW22
EMW24
BH68
BB02

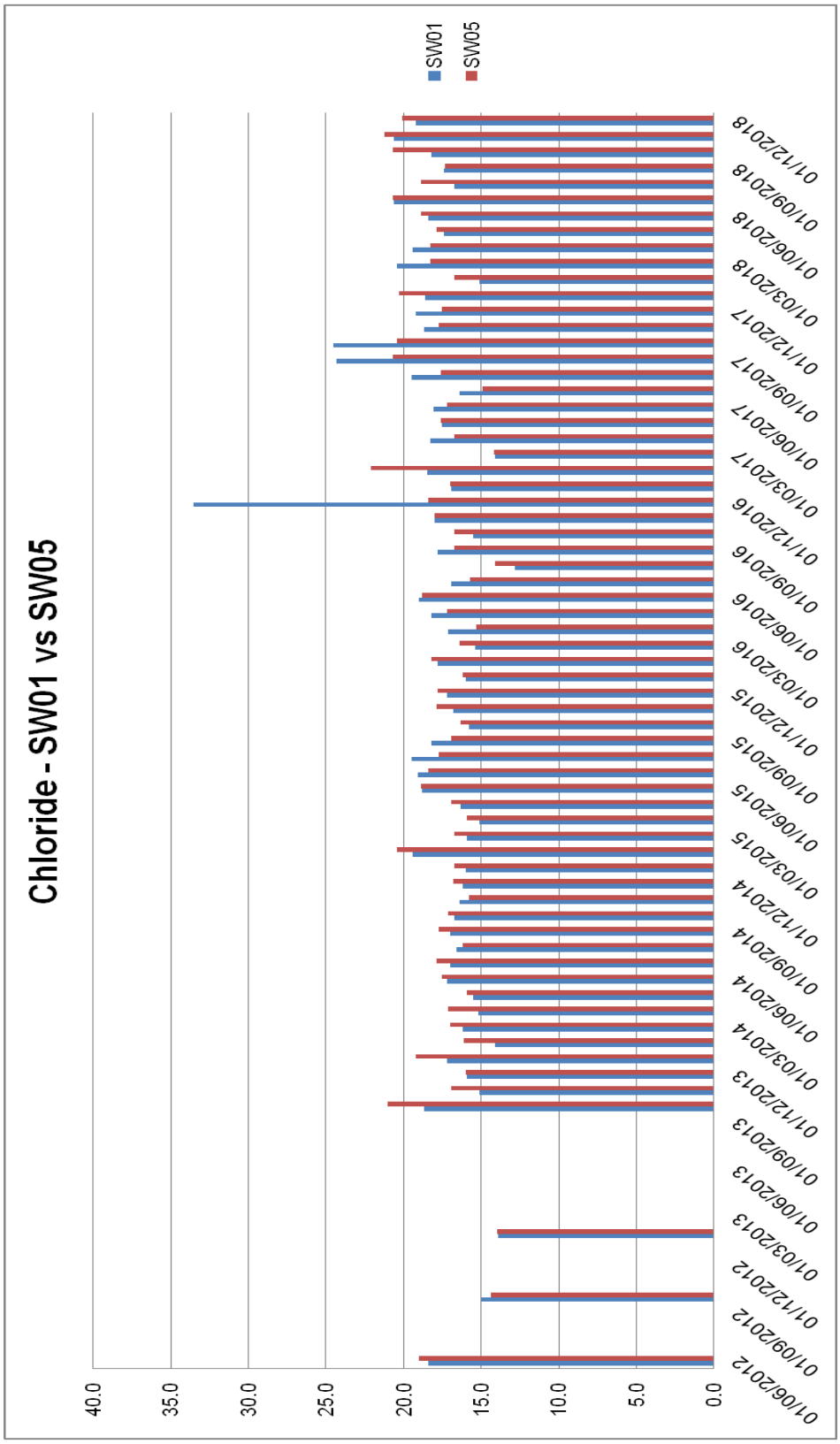
G5: Chloride in Groundwater Monitoring Wells



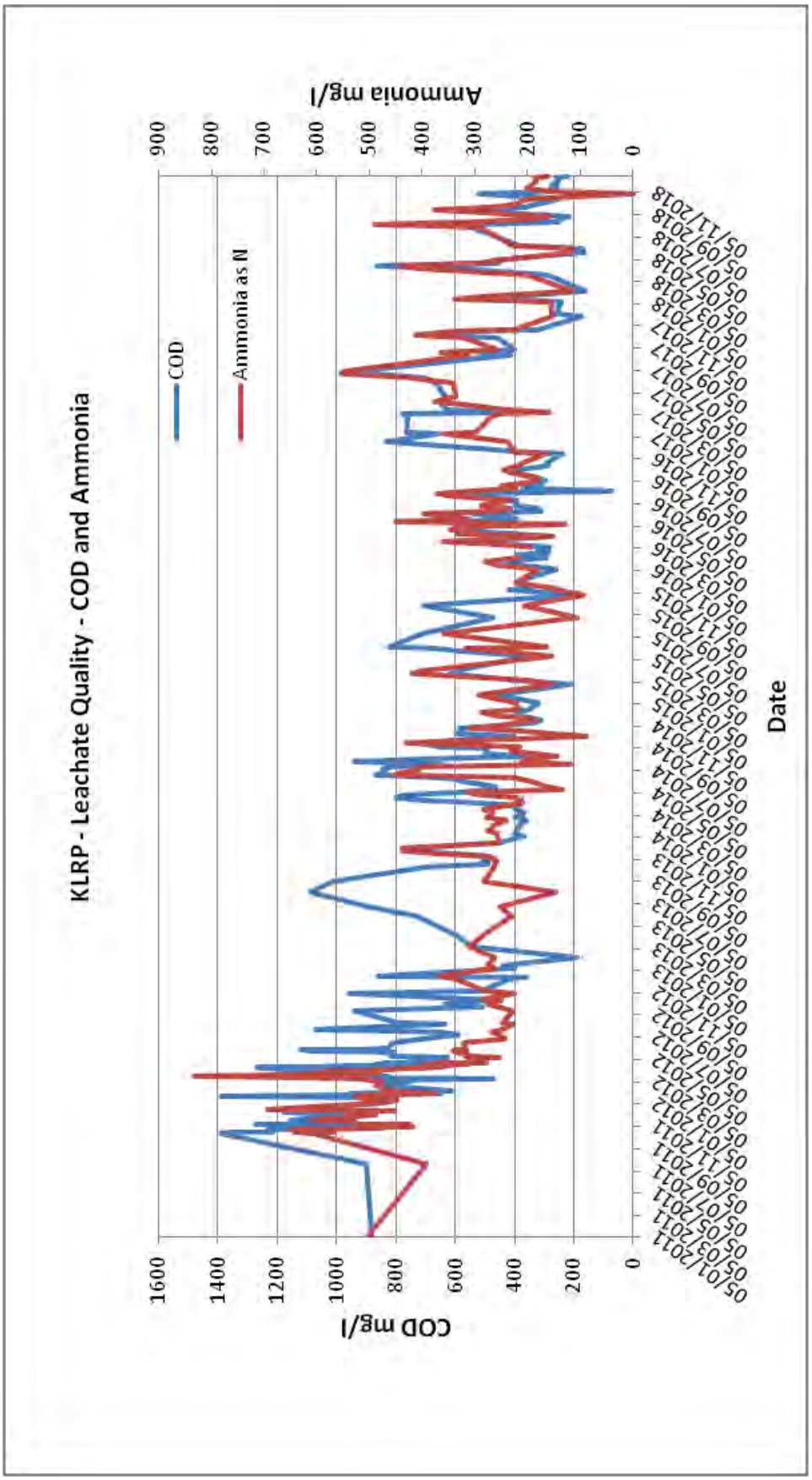


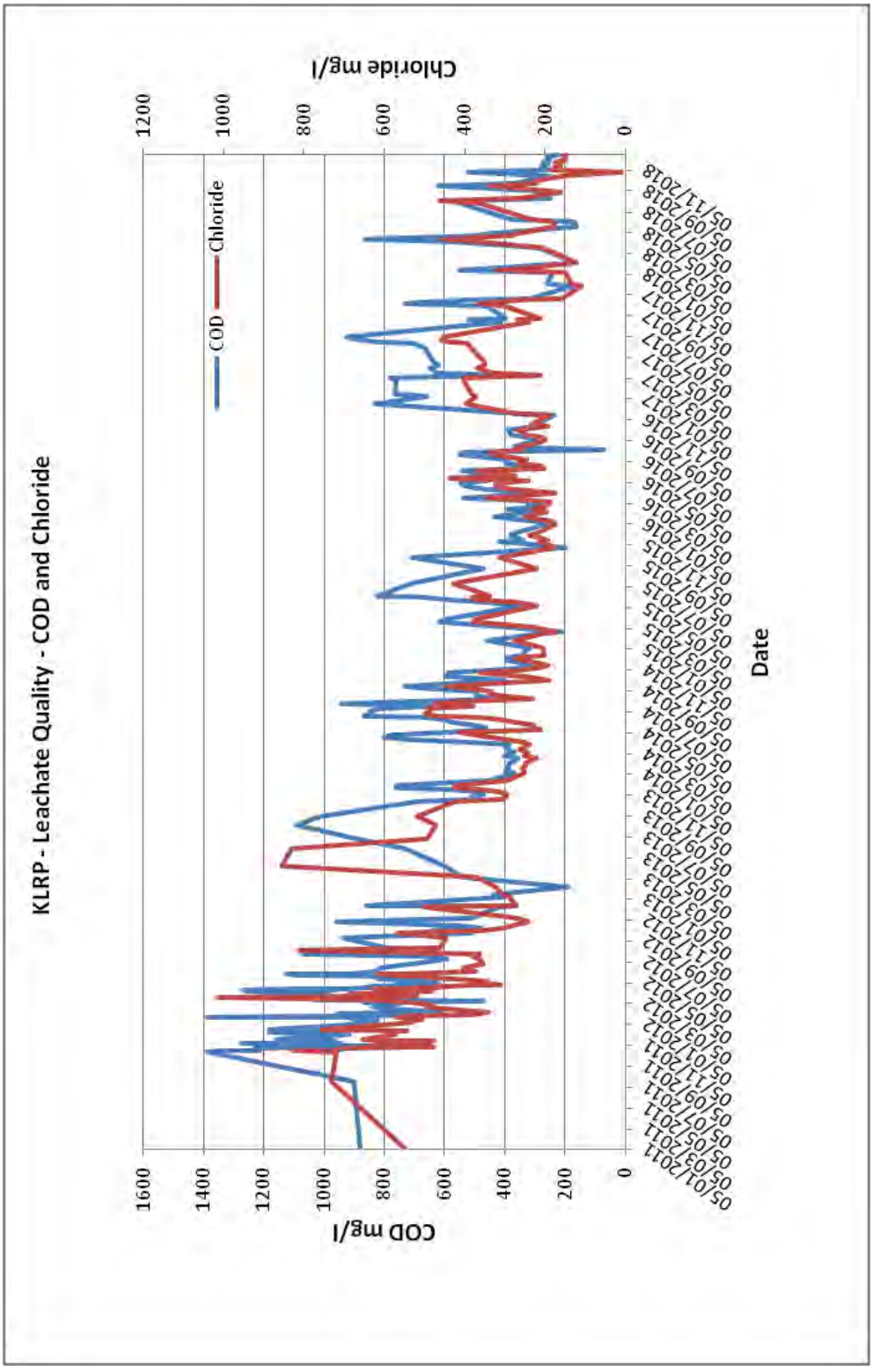

Chloride (mg/l)
Jun-11 to present
mg/l
200
180
160
140
120
100
80
60
40
20
0
Jun-11
Sep-11
Dec-11
Mar-12
Jun-12
Sep-12
Dec-12
Mar-13
Jun-13
Sep-13
Dec-13
Mar-14
Jun-14
Sep-14
Dec-14
Mar-15
Jun-15
Sep-15
Dec-15
Mar-16
Jun-16
Sep-16
Dec-16
Mar-17
Jun-17
Sep-17
Dec-17
Mar-18
Jun-18
Sep-18
Dec-18
Date
IGV
GTV
EMW12
EMW19
EMW22
EMW24
BB02
BH68

G6: Chloride in Morell River – Upstream (SW01) vs downstream (SW05)



G7: Leachate Quality




KLRP - Leachate Quality - COD and Chloride
COD mg/l
Chloride mg/l
Date
COD
Chloride
1600
1400
1200
1000
800
600
400
200
0
1200
1000
800
600
400
200
0

Appendix G **Meteorological Data Graphs & Tables**

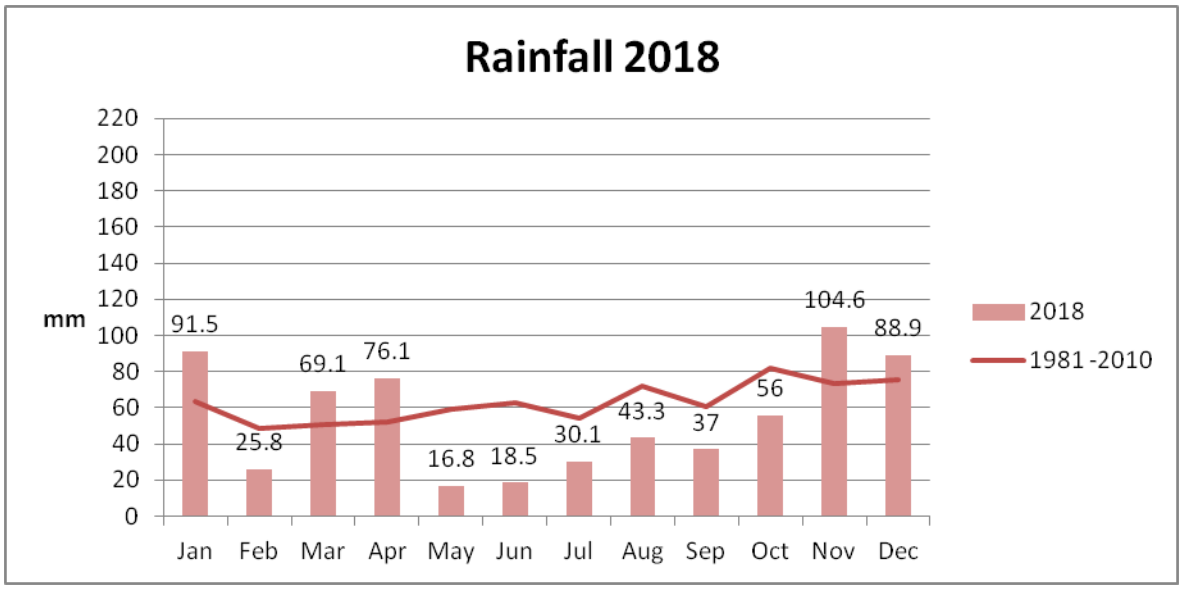
Temperature			
2018	Average of Daily Max Temp (°C)	Average of Daily Min Temp (°C)	Average of Daily Min Grass Temp (°C)
Jan	8.37	2.09	-0.48
Feb	6.62	0.15	-2.39
Mar	7.90	1.09	-0.69
Apr	12.35	4.66	2.39
May	16.93	7.02	4.10
Jun	20.80	10.19	6.82
Jul	22.34	11.34	9.00
Aug	20.08	11.12	9.41
Sep	16.82	7.86	6.14
Oct	13.36	5.07	3.46
Nov	10.75	5.75	2.89
Dec	10.08	5.77	3.94

Rainfall & Potential Evapotranspiration				
2018	Dry Days	Wet Days	Max Daily Rainfall	Average Potential Evapotranspiration (mm)
Jan	9	22	16.8	0.52
Feb	10	18	6.7	0.70
Mar	8	23	11.1	0.95
Apr	11	19	21.3	1.80
May	15	16	4	2.67
Jun	21	9	12.1	3.49
Jul	24	7	10.8	3.29
Aug	10	21	10.2	2.39
Sep	12	18	14.1	1.75
Oct	19	12	21.6	0.94
Nov	6	24	14.6	0.66
Dec	9	22	11.7	0.50

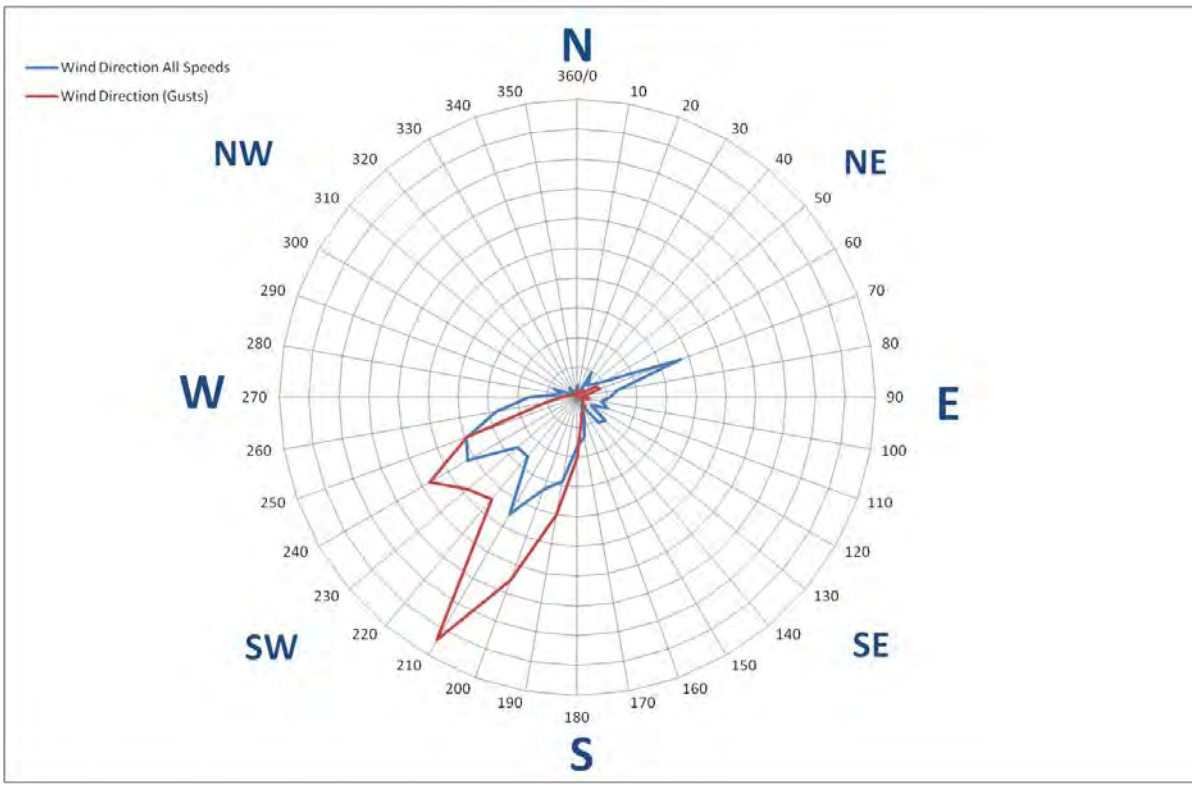
Comparison of monthly rainfall with historical average		
	Monthly Rainfall (mm)	**Historic Average (1981 -2010) (mm)**
Jan	91.50	63.8
Feb	25.80	48.5
Mar	69.10	50.7
Apr	76.10	51.9
May	16.80	59.1
Jun	18.50	62.5
Jul	30.10	54.2
Aug	43.30	72.3
Sep	37.00	60.3
Oct	56.00	81.6
Nov	104.60	73.7
Dec	88.90	75.7
Average	54.81	62.8

Wind & Sunshine

2018	Average of Daily Wind speed (knots)	Wind Direction Degrees (average)	Average Pressure (hPa)	Monthly Total of Sunshine (Hours)
Jan	13.41	215.16	995.45	56.30
Feb	10.58	206.79	1004.79	104.40
Mar	10.11	159.68	989.68	81.80
Apr	9.77	179.00	997.38	165.40
May	7.86	167.10	1006.82	220.10
Jun	7.29	154.67	1008.20	256.50
Jul	6.76	201.29	1005.15	208.30
Aug	9.25	228.71	1003.98	135.90
Sep	10.04	244.00	1007.73	136.80
Oct	9.35	201.94	1006.28	127.00
Nov	10.68	158.67	995.33	62.30
Dec	11.28	201.94	1000.41	22.10



A wind rose showing wind direction for 2018 is provided below and shows that the prevailing wind direction was from a westerly or south westerly direction.



Appendix H **Proposed 2019 Environmental Monitoring Schedule**

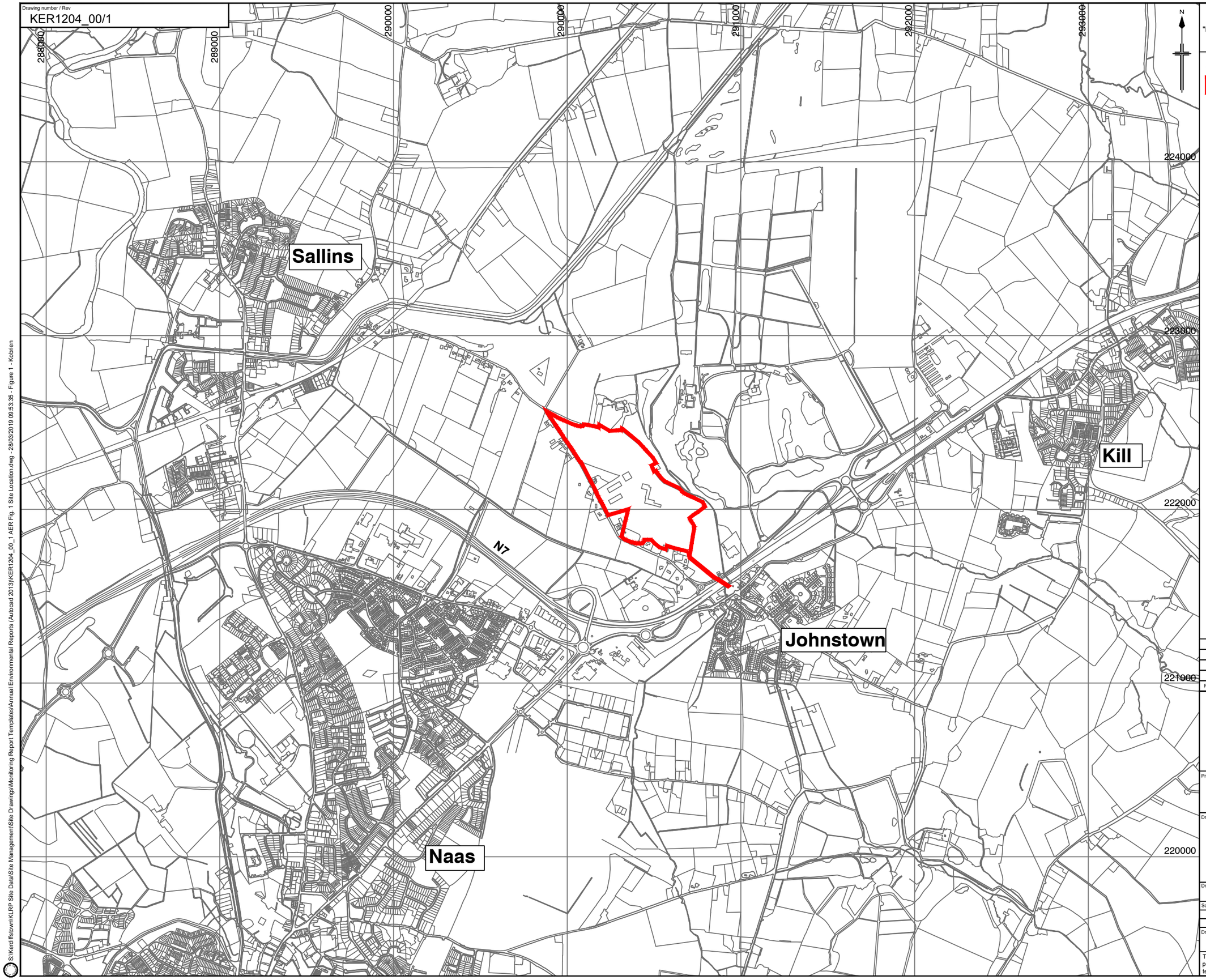
Y	2018																									
Q	Q1													Q2												
M	Jan					Feb				Mar				Apr					May				Jun			
W	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Week Starting	01-Jan	08-Jan	15-Jan	22-Jan	29-Jan	05-Feb	12-Feb	19-Feb	26-Feb	05-Mar	12-Mar	19-Mar	26-Mar	02-Apr	09-Apr	16-Apr	23-Apr	30-Apr	07-May	14-May	21-May	28-May	04-Jun	11-Jun	18-Jun	25-Jun
Landfill Gas																										
Onsite	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Flares	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Offsite	X					X				X				X					X				X			
Flare Stack																										
VOC																										
Groundwater																										
Monthly					X				X				X					X				X				X
Annual																										X
Surface Water																										
Onsite																										
Offsite	X					X				X				X					X				X			
Biological																										
Leachate																										
Weekly	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Monthly	X					X				X				X					X				X			
Quarterly										X																X
Annual																										
Geotechnical																										
Annual																										
Noise																										
Annual																										
Dust																										
Bi-annual																										
Weather																										
Continuous	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Y	2018																									
Q	Q3													Q4												
M	Jul					Aug				Sep				Oct					Nov				Dec			
W	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Week Starting	02-Jul	09-Jul	16-Jul	23-Jul	30-Jul	06-Aug	13-Aug	20-Aug	27-Aug	03-Sep	10-Sep	17-Sep	24-Sep	01-Oct	08-Oct	15-Oct	22-Oct	29-Oct	05-Nov	12-Nov	19-Nov	26-Nov	03-Dec	10-Dec	17-Dec	24-Dec
Landfill Gas																										
Onsite	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Flares	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Offsite	X					X				X				X					X				X			
Flare Stack			X																							
VOC			X																							
Groundwater																										
Monthly					X				X				X					X				X				X
Annual																										
Surface Water																										
Onsite																										
Offsite	X					X				X				X					X				X			
Biological																										
Leachate																										
Weekly	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Monthly	X					X				X				X					X				X			
Quarterly													X													X
Annual																										
Geotechnical																										
Annual					X			X				X				X					X					
Noise																										
Annual													X													
Dust																										
Bi-annual					X				X																	
Weather																										
Continuous	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

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

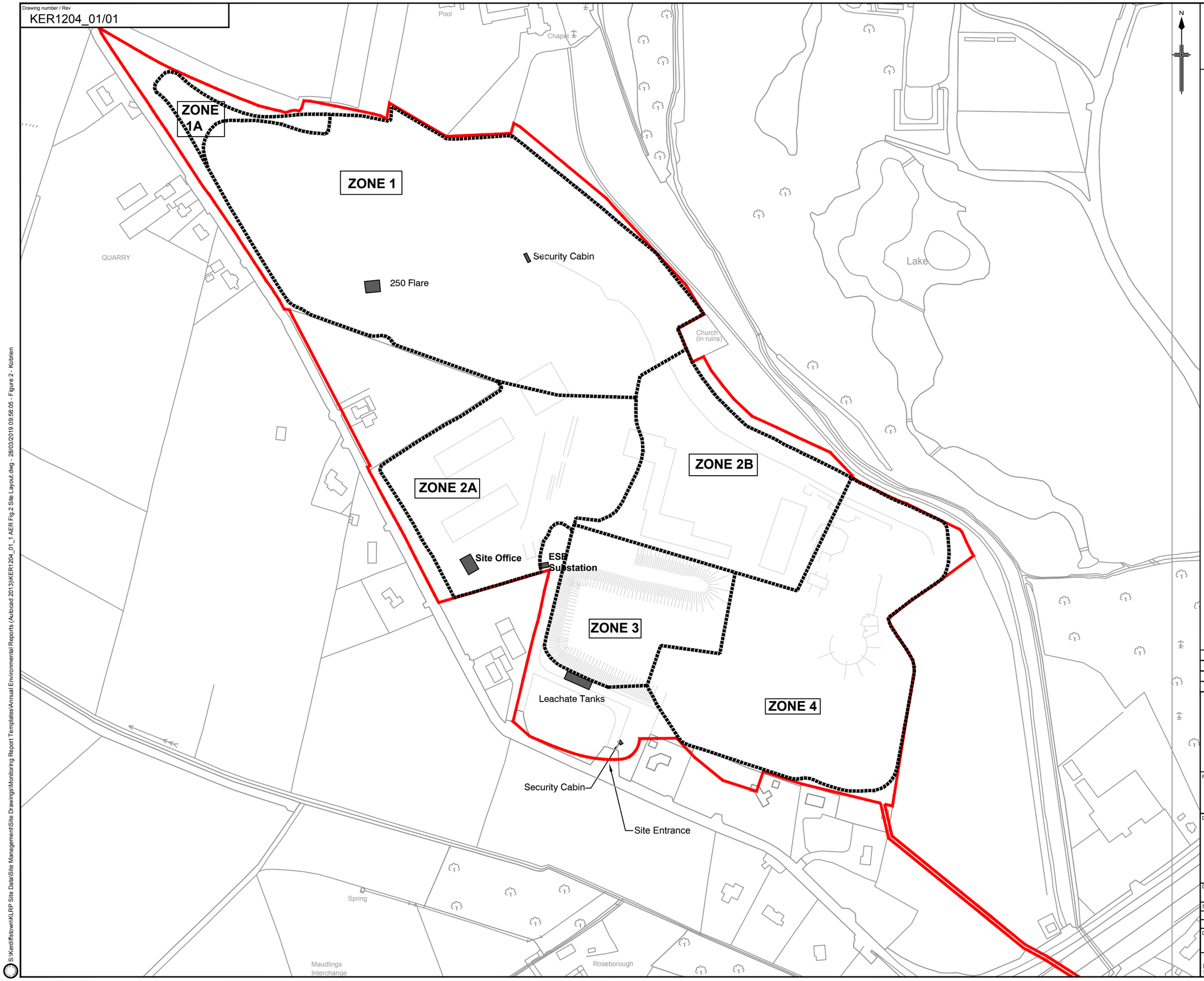
Drawing number
KER1204_00

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



N

Based on Ordnance Survey Ireland data and reproduced under Ordnance Survey Ireland Licence Number "EN0059208". Unauthorised reproduction infringes Ordnance Survey Ireland and Government of Ireland copyright.

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

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

Project
KERDIFFSTOWN LANDFILL
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
EMW22
EMW23
DB2
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
RM3
SW 15
DB15A
EMW10
BH63
EMW03
EMW02
EMW31
EMW04
RM4
QUARRY
BH64
BH36B
BH67
DB5
SW 03
EMW20
SW 06
Lake
EMW14
RM5
Church (in ruins)
DB14A
EMW08
BH39B
BH66
BH65
BB1
EMW07
RM6
BH48
BH77A
EMW19
BH79
EMW15
DB6
EMW11
BH75
EMW18
BH76A
BH40B
BH80
BB4
EMW16
BH68
BH78
BH24
BH69
SW 08
SW 16
SW 02
EMW17
BB3A
BH7
DB7
DB12
BH71
BH70
BH42
GW2S
BH6
BH2
GW1D
Site Discharge
BH72
DB8A
DB10A
BH73
EMW30
INSET
EMW27D
EMW28
DB9
SW 12
SW 10
EMW29
SW 13
SW 11
LIMERICK, CORK
INSET (nts)
Roseborough
SW 01
Grave Yard

N

Based on Ordnance Survey Ireland data and reproduced under Ordnance Survey Ireland Licence Number "EN0059208". Unauthorised reproduction infringes Ordnance Survey Ireland and Government of Ireland copyright.

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

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

Project
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

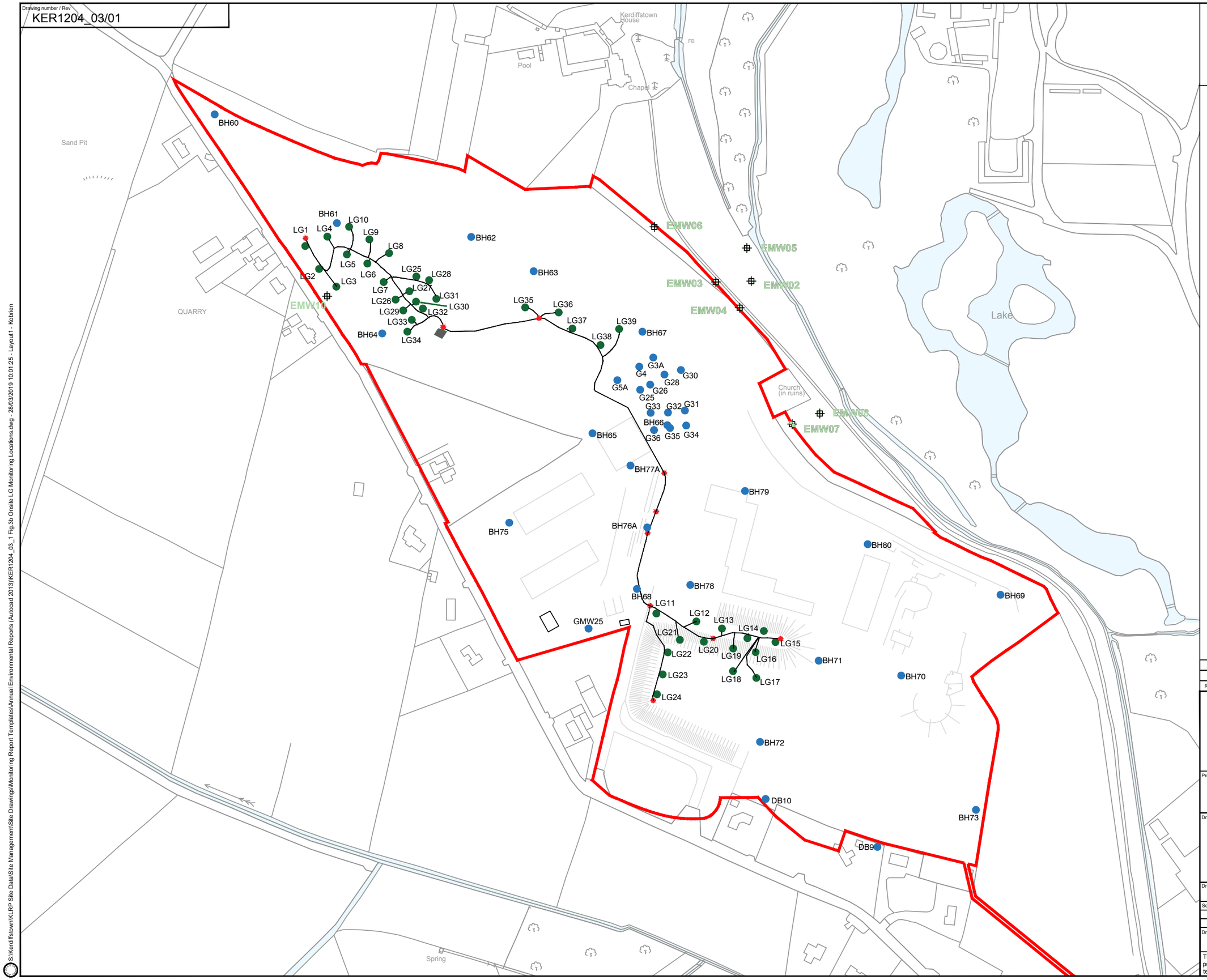
Drawing number
KER1204_02

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

Drawing number / Rev
KER1204_03/01



Based on Ordnance Survey Ireland data and reproduced under Ordnance Survey Ireland Licence Number "EN0059208". Unauthorised reproduction infringes Ordnance Survey Ireland and Government of Ireland copyright.

KEY:

- EPA Reg No. P1063-01
- Flare
- LG39 Gas Extraction Well
- G3A Gas Well
- Condensate Pot
- Groundwater/Gas Monitoring Well

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
1	26/03/19	Revised GWs	KOB	UD		UD
0	10/10/2018		KOB	UD		UD

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

Project
KERDIFFSTOWN LANDFILL REMEDIATION PROJECT

Drawing title
AER
FIGURE 3b
LANDFILL GAS EXTRACTION AND GAS MONITORING WELLS

Drawing status
FIRST ISSUE

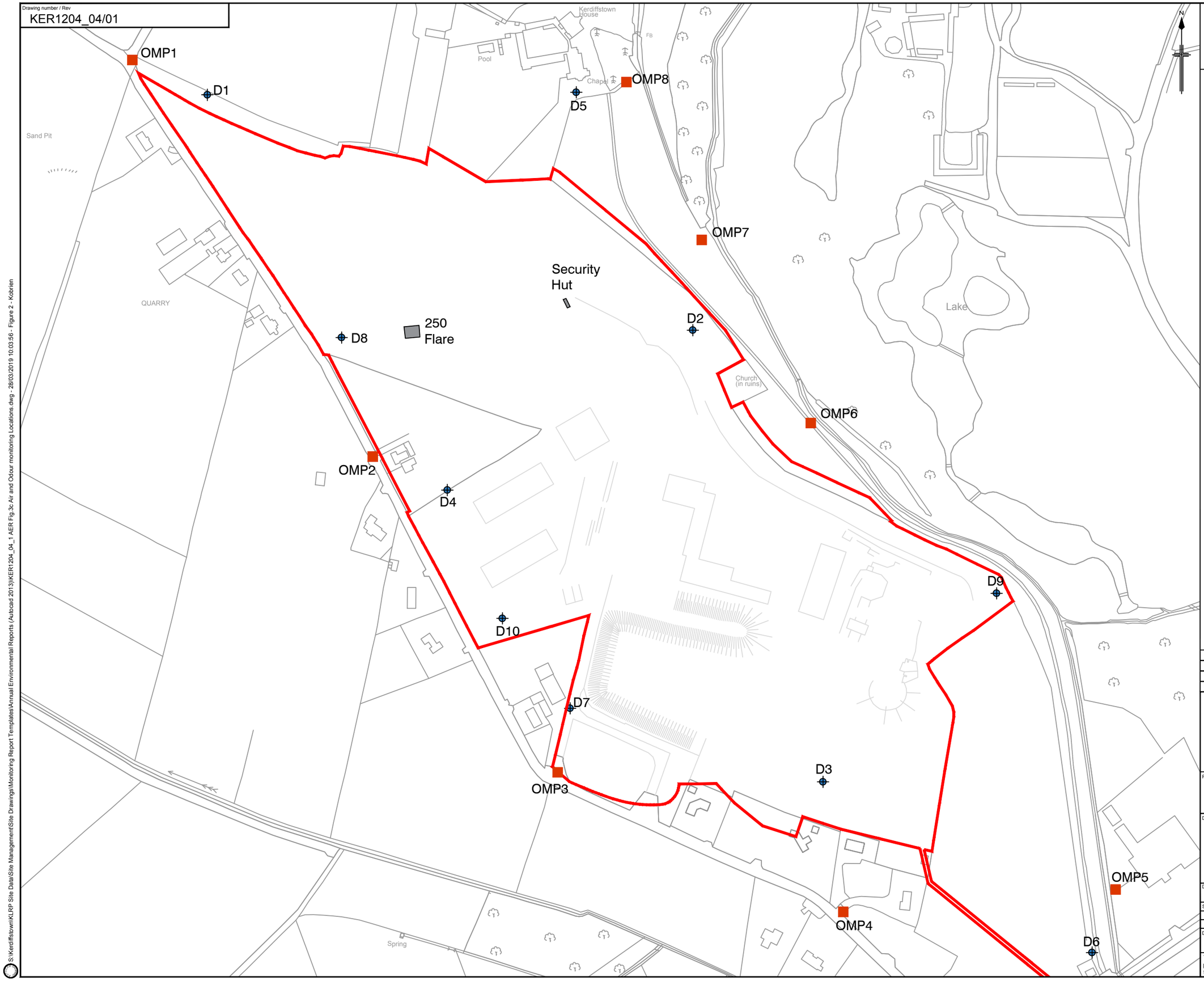
Scale: NTS — DO NOT SCALE

Drawing number: KER1204_03
Rev: 1

S:\Kerdiffstown\KLRP Site Data\Site Management\Site Drawings\Monitoring Report Templates\Annual Environmental Reports (Autocad 2013)\KER1204_03_1 Fig 3b Onsite LG Monitoring Locations.dwg - 28/03/2019 10:01:25 - Layout1 - Kobrien

FIGURE 3C AIR / ODOUR / NOISE MONITORING LOCATIONS

Drawing number / Rev
KER1204_04/01



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

KILDARE COUNTY COUNCIL
Environment Section
Áras Chill Dara
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

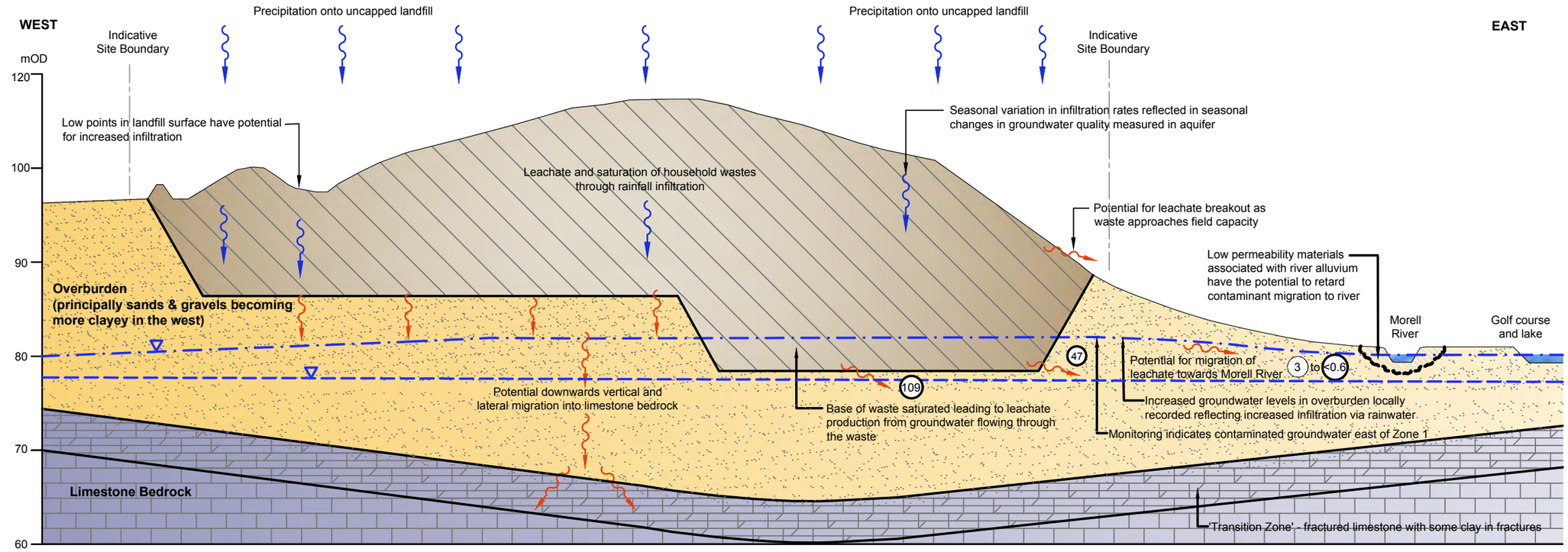
S:\Kerdiffstown\KLRP Site Data\Site Management\Site Drawings\Monitoring Report Templates\Annual Environmental Reports (Autocad 2013)\KER1204_04_1 AER Fig.3c Air and Odour monitoring Locations.dwg - 28/03/2019 10:03:56 - Figure 2 - Kobrien

FIGURE 4 CONCEPTUAL SITE MODELS (EIAR VERSIONS)

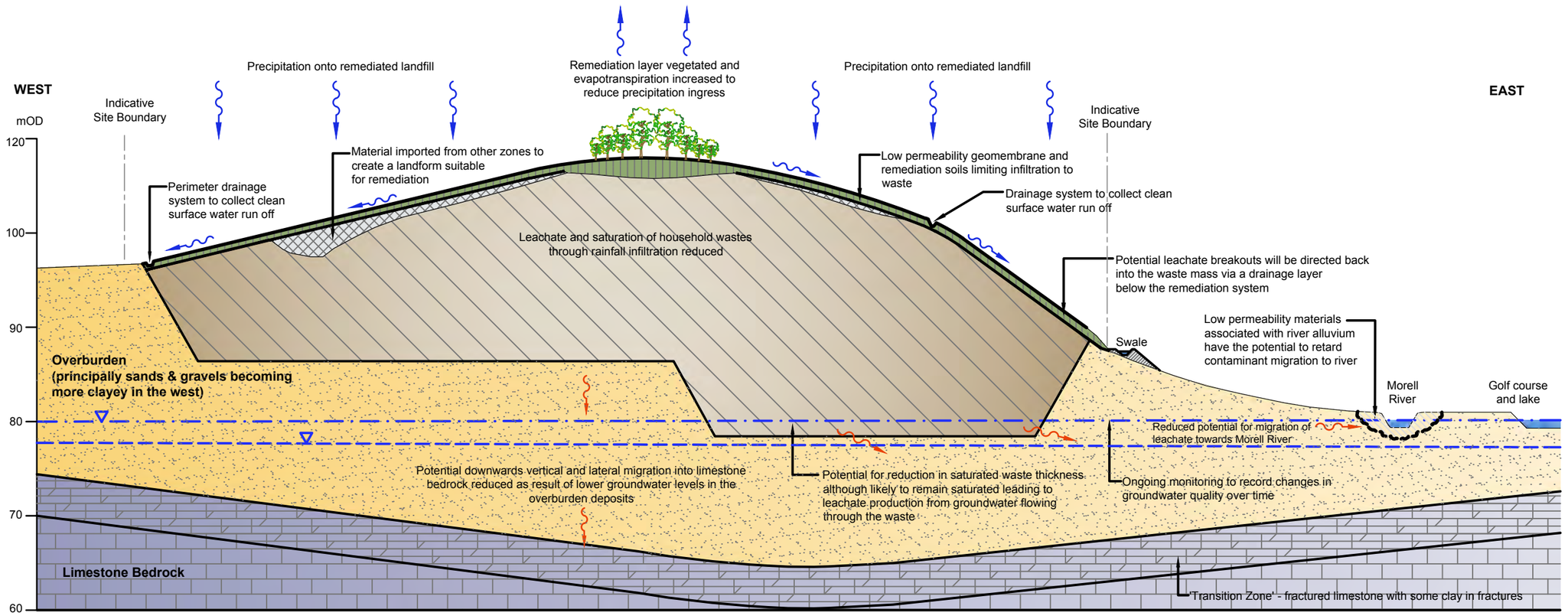
Hydrogeology Conceptual Site Model (Zone 1)

Landfill Gas Management 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

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

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

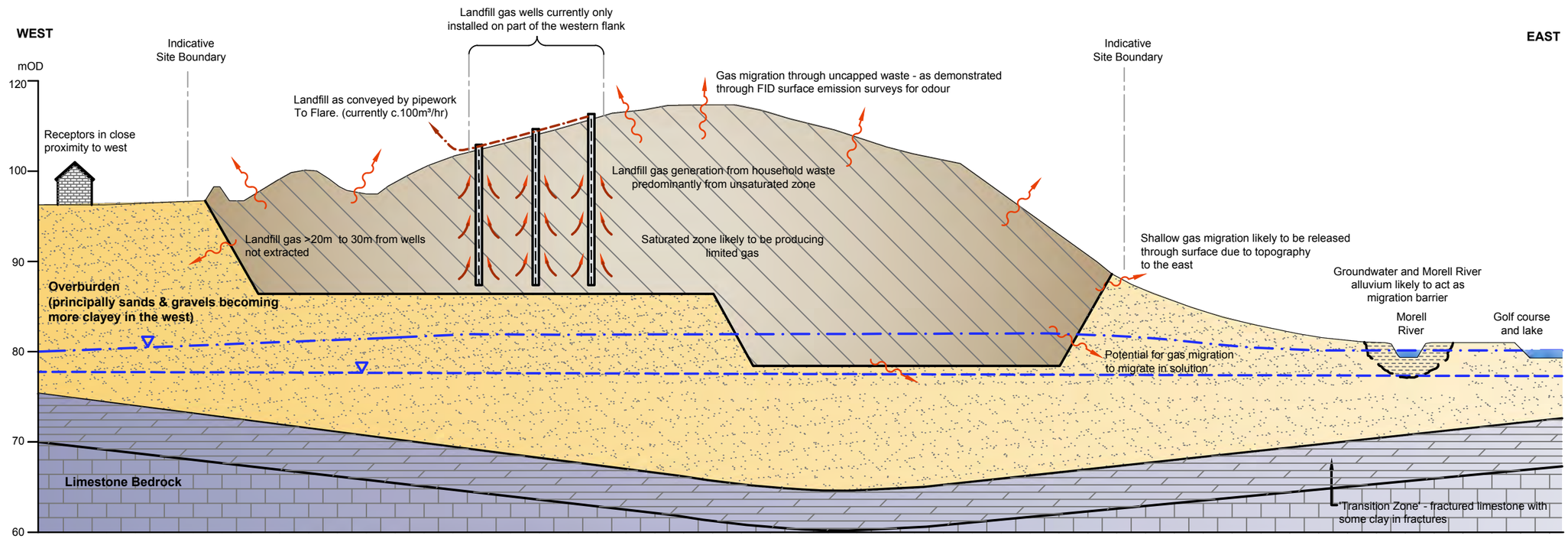
Drawing number / Rev
KER1204_06/0

FIGURE 4b

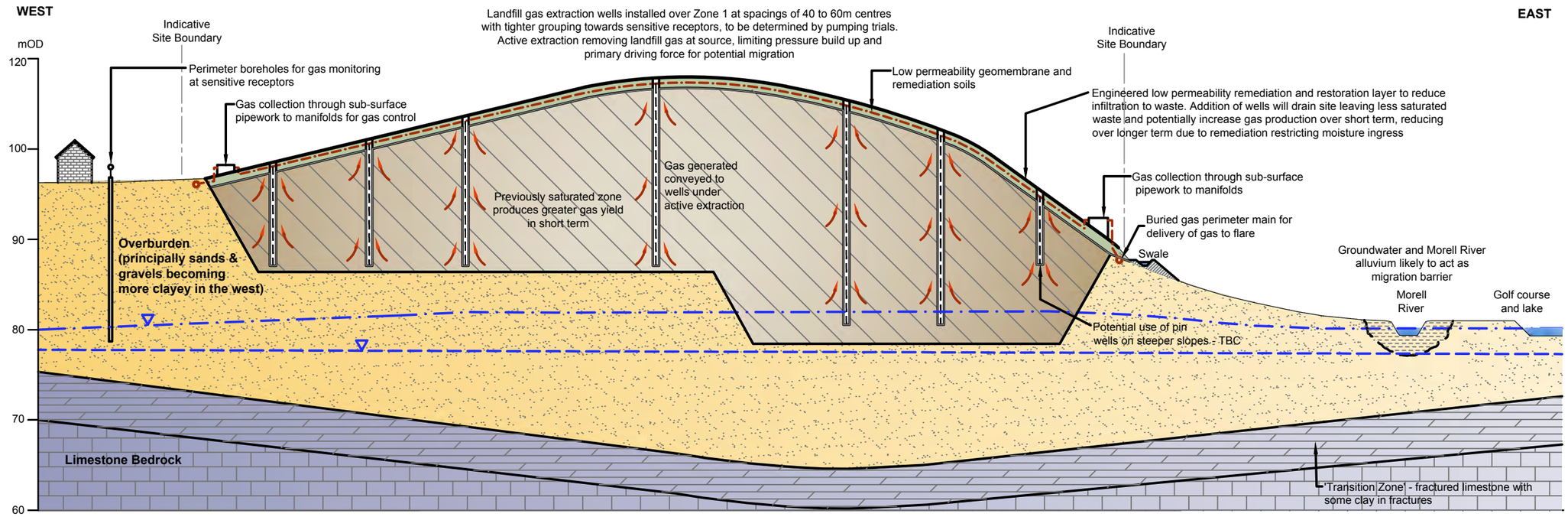
KEY:

Groundwater Level in the Overburden

Groundwater Head in the Limestone Bedrock



Gas Conceptual Site Model for Zone 1: Current Scenario



Gas Conceptual Site Model for Zone 1: Post Remediation

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

KILDARE COUNTY COUNCIL
Environment Section
Áras Chill Dara
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

FIGURE 5A GEOHAZARD ZONATION PLAN - SLOPE STABILITY HAZARD ZONATION PLAN - SOUTH AREA

LEGEND

- SITE EXTENTS (FUTURE LICENCED BOUNDARY)
- WASTE BOUNDARY
- STABILITY ASSESSMENT ZONE BOUNDARY
- INCLINOMETER

STABILITY RISK

- LOW
- LOW / MEDIUM
- MEDIUM
- MEDIUM / HIGH
- HIGH

Client

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

General Notes

(i) Hard copies, dwf and pdf will form a controlled issue of the drawing. All other formats (dwg etc.) are deemed to be an uncontrolled issue and any work carried out based on these files is at the recipients own risk. RPS will not accept any responsibility for any errors from the use of these files, either by human error by the recipient, listing of the un-dimensioned measurements, compatibility with the recipients software, and any errors arising when these files are used to aid the recipients drawing production, or setting out on site.

(ii) DO NOT SCALE, use figured dimensions only.

(iii) This drawing is the property of RPS, it is a project confidential classified document. It must not be copied used or its contents divulged without prior written consent. The needs and expectations of client and RPS must be considered when working with this drawing.

(iv) Information including topographical survey, geotechnical investigation and utility detail used in the design have been provided by others.

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

Rev	Date	Drn Chk	Amendment / Issue	App

RPS
West Pier
Business Campus
Dun Laoghaire
Co Dublin
T +353 1 4882900
W www.rpsgroup.com/ireland
E ireland@rpsgroup.com

Model File Identifier

Scale 1:1250 @ A1, 1:2500 @ A3

Created on 28.01.19

Sheets

Project **KERDIFFSTOWN LANDFILL REMEDIATION**

Title SLOPE STABILITY ZONES AND RISK ASSESSMENT

File Identifier FIGURE 1

Status

Rev

FIGURE 5B GEOHAZARD ZONATION PLAN - SLOPE STABILITY HAZARD ZONATION PLAN - NORTH AREA

Client

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

General Notes

(i) Hard copies, dwf and pdf will form a controlled issue of the drawing. All other formats (dwg etc.) are deemed to be an uncontrolled issue and any work carried out based on these files is at the recipients own risk. RPS will not accept any responsibility for any errors from the use of these files, either by human error by the recipient, listing of the un-dimensioned measurements, compatibility with the recipients software, and any errors arising when these files are used to aid the recipients drawing production, or setting out on site.

(ii) DO NOT SCALE, use figured dimensions only.

(iii) This drawing is the property of RPS, it is a project confidential classified document. It must not be copied used or its contents divulged without prior written consent. The needs and expectations of client and RPS must be considered when working with this drawing.

(iv) Information including topographical survey, geotechnical investigation and utility detail used in the design have been provided by others.

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

Rev	Date	Drn Chk	Amendment / Issue	App

RPS
West Pier
Business Campus
Dun Laoghaire
Co Dublin
T +353 1 4882900
W www.rpsgroup.com/ireland
E ireland@rpsgroup.com

Scale
1:1250 @ A1
1:2500 @ A3

Created on
28.01.19

Sheets

Project
KERDIFFSTOWN LANDFILL REMEDIATION

Title
SLOPE STABILITY ZONES AND RISK ASSESSMENT

Model File Identifier

File Identifier
FIGURE 2

Status

Rev