TIR JOHN (PHASE 1) LANDFILL

Annual Monitoring Review January - December 2021

Enovert South Limited

Report No. 14-K6065-ENV-R008
February 2022
Revision 00

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Document Control

Document: Annual Monitoring Review January - December 2021

Project: TIR JOHN (PHASE 1) LANDFILL

Client: Enovert South Limited

Report Number: 14-K6065-ENV-R008

Document Checking:

Revision	Revision/ Review Date	Details of Issue	Authorised		
			Prepared By	Checked By	Approved By
00	February 2022	Final	Arabella Sharrock	Kathryn Wright	John Baxter
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Contents

1 Introduction

1.1 Background

This report has been prepared by Byrne Looby Partners (UK) Ltd (ByrneLooby) on behalf of Enovert South Limited who manage the Tir John Phase 1 landfill on behalf of The City and County of Swansea. Cory Environmental (Gloucestershire) Limited (Cory) were contracted by The City and County of Swansea to manage the site. Cory was subsequently rebranded as Enovert South Ltd in January 2018. This report provides a review of the environmental monitoring carried out at the closed portion of the Tir John Landfill Site by Enovert during 2021.

Tir John Landfill Site comprises an area of approximately 36ha and is situated North of Fabian Way, Port Tennant, Swansea, at National Grid Reference SS 695 936. The Site is located 3km from Swansea and approximately 1km from the coast. The site comprises two separate Permitted areas, an older landfill referred to as Phase 1 and the adjoining operational Phase 2. Phases 1 and 2 are separated by a high voltage electricity transmission line and the associated standoff distance for which passes through the site.

Phase 2 forms the eastern area of the site, incorporating Cells 5 to 17; and is operating as a non-hazardous landfill. The Permit for the operational site (Phase 2) was transferred in full to Cory Environmental (Gloucestershire) Limited on 30/09/2015. However, Phase 1 remains the responsibility of The City and County of Swansea, although daily management has been sub-contracted to Enovert.

The original planning permission for the site issued in 1985 was converted to Waste Management Licence SWW14L later in the same year. This also included permission for the development of Cells 5-14 of Phase 2. This Waste Management Licence was formally converted to EAWML 34011 on the 05/11/1996 on the transfer of ownership from Swansea City Council to Swansea City Waste Disposal Company Limited. The Permit was transferred back to the City and County of Swansea in February 2014, again with no modification to management.

The Environment Agency issued a permit variation, reference EPR/JP3395FD/V003, for Phase 1 on 15/03/2013. Phase 1 is currently regulated under Permit Number EPR/JB3597TN/V002 following the issue of a further variation by NRW on 15/08/18. This landfill no longer accepts waste and following the submission of an amended closure report in November 2019 is now progressing towards definitive closure. This report reviews the older, closed portion (Phase 1) which forms approximately a 6ha area to the west of the operational site (Phase 2).

1.2 Site History

The site was constructed within an area which was originally part of the Crymlyn Bog, believed to have been used for seasonal grazing prior to the 18th century. The north to south Glan-y-Wern canal was constructed to facilitate coal mining within the area and the exploitation of coal seams within the valley. Former coal drifts commonly surround the site, one of which coincides with a depression and forms a spring on the western boundary of the closed site. There is a similar feature 150m to the north.

The closed site is located within the footprint of a former power station which was constructed between 1932 and 1935. The power station used sea water as a coolant during the operation of this power plant. The power station was originally a coal fired station and then converted to oil during the 1960s until closure in the 1970s. However, large quantities of Pulverised Fuel Ash (PFA) from the original operational phase were deposited within the Crymlyn Bog to the east of the power station platform. A PFA platform continued to be constructed from imported PFA until the mid-1980s.

There was also a short phase of landfilling with inert waste that extends to the east of the site (under the footprint of Cells 16 and 17 of the operational site) used as a fill to create a platform above the Crymlyn Bog. Waste disposal then continued until the 1980s for a wide inventory of wastes including domestic and other mixed wastes. This terminated when the disposal operations were granted planning permission.

Phase 1 was operated for the permanent disposal of municipal, degradable commercial and industrial, inert, metal and scrap-metals, within engineered containment cells, between 1985 and the early 1990s after which operations transferred to Phase 2.

1.3 Site Setting

The site is located within the Crymlyn Bog, a lowland peaty fen which was the former estuary of the River Clydach and the River Neath. The historically placed PFA is present below much of the waste in Phase 1 where it was pushed out into the bog and overlies the natural superficial alluvial deposits, comprising interbedded peat, clay, silt, sand and gravel layers. The Carboniferous South Wales Lower Coal Measures Formation underlies the alluvium and forms the sides of the valley to the west of the site.

Topographically the ground falls from over 80mAOD to the west of the site to ~10mAOD within the Crymlyn Bog. The local hydrogeology is controlled by springs along the western edge of the valley, which discharge into the Crymlyn Bog with an easterly and south-easterly gradient towards the coast. There is a groundwater mound located at the spring monitored at GWD023, on the valley slopes at the western boundary of the closed site, which discharges into the PFA and alluvium that underlie the site.

1.4 Site Engineering

The site is fully capped and landscaping of the site was completed in 2019. The Phase 1 basal engineering comprises an early Geosynthetic Clay Liner (GCL) and a basal drainage blanket. Phase 1 was built above the platform constructed to support the original power station and there are additional layers of PFA and crushed concrete underlying the phase.

It is considered likely that the historical engineering works associated with the power station and placement of the PFA has increased the compaction of the *in-situ* peats and the low permeability clay of the alluvium.

A Hydrogeological Risk Assessment (HRA) review was produced for the site in September 2021.

1.5 Environmental Monitoring

Schedule 4 of the permit (Permit Tables S4.2 and 4.3) requires that specific performance parameters are reported. These tables are reproduced below as Table 1 and Table 2. Details are from the holistic site and are not specific to the closed site.

Table 1 – Annual Production/Treatment

Table S4.3 Performance Parameters			
Parameter	Frequency of assessment	Annual total	Unit
Potable water used	Annually	2,846	m^3/yr
Energy used (including for leachate treatment)	Annually	105.1	MWh of electricity
Non-potable water used	Annually	Nil	m^3/yr

Table 2 – Performance Parameters

Table S4.2: Annual production/treatment	
Leachate: Disposed of off-site; Disposed of to any onsite effluent treatment plant;	**Cubic metres/year** 95,990 m^3/yr (from entire site)
Surface water and/or Groundwater: Disposed of off site; Disposed of to any onsite effluent treatment plant	**Cubic metres/year** 103,523 m^3/yr (from entire site) Nil
Landfill gas: combustion in flares; combustion in gas engines; Other methods of gas utilisation	**Normalised cubic metres/year** 628,000 m^3/yr (from entire site) 3,046,196 m^3/yr (from entire site) Nil

Quantities are cumulative volumes including operational site (Phase 2) data

This site is closed and there is no remaining void space. The permanent survey pins for assessment of settlement have been installed during 2021, however we will need to survey them again before an assessment of settlement can be made.

2 Monitoring Schedule

Enovert South Limited staff carried out environmental monitoring during 2021 at the locations shown on Drawing TJ66 in accordance with the site's Environmental Permit.

3 Gas Monitoring

3.1 Surface Emissions

Surface emission surveys were undertaken in December 2021. The survey was carried out to determine gas concentrations directly above the capped and temporary capped surfaces at the site. Enovert use a data logging system with GPS to allow the direct transfer of the FID route surveyed to site plans and hence identify areas of the cap which may require remediation. Discrete features, such as abstraction wells and transfer pipework were also surveyed.

The survey was carried out according to the objectives of Environment Agency guidance LFTGN07[1]. Section 2.7 of LFTGN07 states that "providing subsequent annual walkover surveys of that area demonstrate the surface concentration limits in air are less than 100 parts per million by volume (ppmv) immediately above the surface on the main zones of the cap and less than 1,000ppmv close to any discrete feature, you do not need to carry out subsequent flux box measurements to quantify emissions".

The survey demonstrates that there is generally good gas control at the site with low emissions (*i.e.* <10ppm) occurring across the majority of the surveyed area. Emissions in the range 100–499ppm were identified adjacent to discrete features such as leachate chambers. Given that the higher readings observed occurred adjacent to a discrete feature they are not considered to be significant and no further actions are required. All other emissions were reported below the 100ppm threshold.

3.2 Perimeter Gas

The closed site has a series of eight perimeter gas monitoring points along the southern and western boundaries (Table 3).

The site is located within the Crymlyn Bog, a lowland peaty fen that contains a biologically active soil bacterial community. As a consequence of the site's location, the background soil biogeochemistry is complex and subject to a number of influences including temperature, soil saturation (including localised marsh areas) and seasonal or weather dependent transitions.

[1] Environment Agency (2010) Guidance on monitoring landfill gas surface emissions. LFTGN07 v2 2010

The data demonstrates that there are three ground gas profile types around the perimeter of the closed Tir John landfill site. These profiles can be summarised as

- ground gas approximating to atmospheric concentrations, with an absence of methane
- a ground gas enriched in carbon dioxide and significantly depleted in methane compared to landfill gas (TIRGP008)
- a marsh gas or mine gas profile, where the methane: carbon dioxide ratio is enriched compared to expected for landfill gas (TIRGP001)

Table 3 – Perimeter Ground Gas Summary 2021

Location	Methane			Carbon Dioxide		Oxygen		Balance	
	Ave	Max	Limit	Ave	Max	Ave	Max	Ave	Max
	%v/v								
TIRGP001	0.5	3.5	**20.7**	1.1	4.9	16.6	21.0	82.3	93.4
TIRGP002	0.0	0.2	**1.0**	0.3	1.2	20.4	21.5	79.2	82.2
TIRGP003	0.0	0.2	**1.0**	7.4	10.9	8.0	15.9	84.8	88.8
TIRGP004	0.0	0.3	**1.0**	1.6	5.2	17.5	21.6	79.9	81.1
TIRGP005	0.0	0.2	**1.0**	1.3	2.6	19.6	21.1	79.1	80.6
TIRGP006	0.0	0.3	**1.0**	2.0	6.7	18.4	21.7	79.8	82.2
TIRGP007	0.1	0.3	**1.0**	0.7	2.5	20.2	21.5	79.1	80.2
TIRGP008	2.1	24.8	**2.5**	11.2	22.9	9.2	17.9	77.2	82.8

Shaded cells exceed Permit Limit

Permit Limits are set for methane in all perimeter gas wells. Variation in the methane limits at TIRGP01 and TIRGP08 is recognition that natural sources of methane within the vicinity of Tir John landfill site were identified during the preparation of the site's permit. Both mine gas associated with the Coal Measures and marsh gas generation associated with saturated horizons within the Crymlyn Bog should be expected. Similarly, the absence of carbon dioxide limits within the permit is a recognition that aerobic microbial activity can also occur within unsaturated zones.

Methane has been observed above the Permit Limit in TIRGP008 (Table 3) during autumnal and winter periods since 2014 before depleting to zero during spring. This trend was repeated during 2021, with methane increasing during October to ~24%v/v, before returning to negligible concentrations during November and December. This was an isolated occurrence as methane was negligible at all other monitoring visits through 2021.

This is the same concentration range as observed in TIRGP001 from 2009-2019. TIRGP001 has a permit limit of 20.7%v/v methane to account for these background fluctuations. The Permit Limit does not reflect this background ground gas fluctuation at TIRGP008 (Figure 3.1) which has been observed annually for the past seven years.

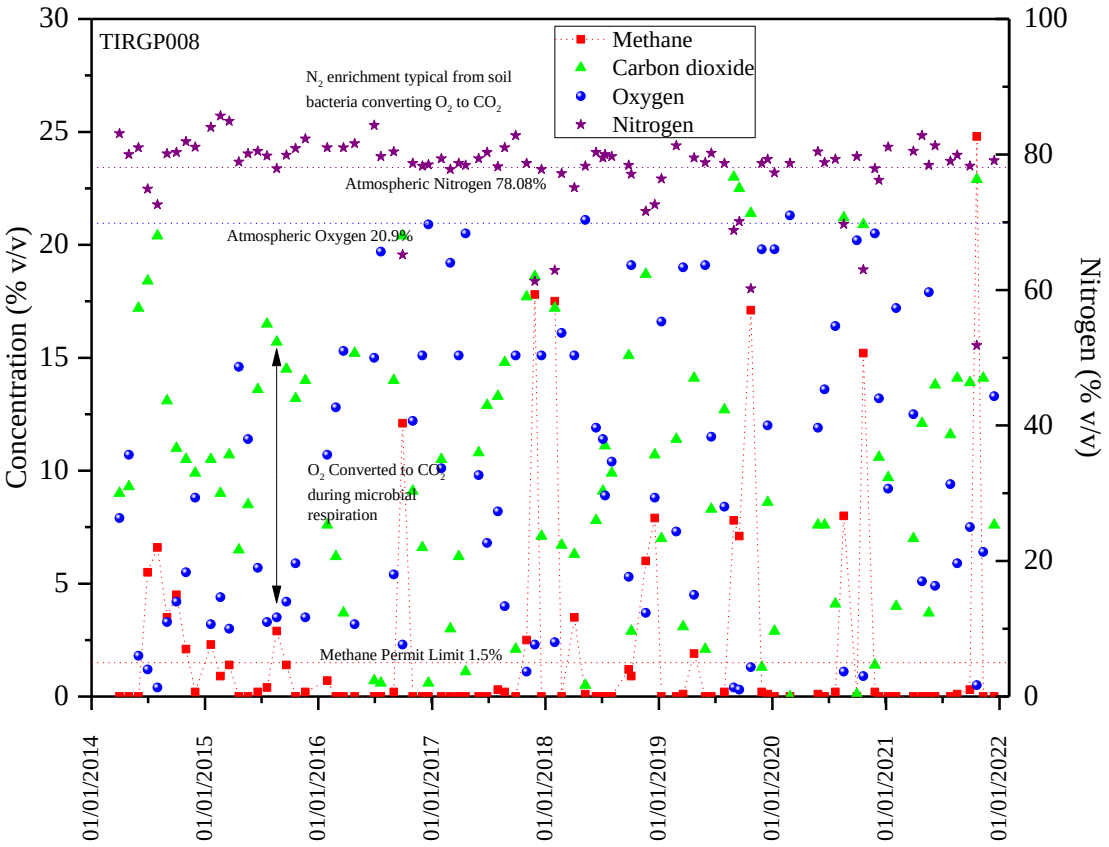

Figure 3.1 – Ground Gas Profile TIRGP008

The presence of methane is due to changes in soil moisture levels which can readily result in a cycling between aerobic and anaerobic conditions. Normal soil respiration alone cannot sustain carbon dioxide at such concentrations; therefore, it is likely that there is a continuous background methane flux derived from either marsh gas or mine gas which then forms a contributing carbon source for microbial respiration. This methane is routinely biologically oxidised within the unsaturated zone and results in the localised elevation of carbon dioxide compared with other locations. However, with short term changes in moisture content, the gas flux and other biologically relevant factors could change the relative effectiveness of the biological process. This can result in short term increases in methane as periodically observed in autumn of the previous years. The permit limit breach at TIRGP008 is therefore considered to be a consequence of *in-situ* background processes that are not related to the landfill site.

Methane recorded at TIRGP001 is similar to the periodic TIRGP008 spike in concentration, however, TIRGP001 methane was previously enriched compared to that of carbon dioxide (Figure 3.2) consistent with a marsh gas or mine gas type profile superimposed upon a background of aerobic process.

Historically this location has exhibited regular seasonal increases in methane from ~5%v/v to approximately 30%v/v with carbon dioxide stable at around 5%v/v, and oxygen typically depleted from 21%v/v to 5 – 10%v/v. Since 2016, there has been an overall reduction in the peak methane concentration compared with previous years from 20 – 30%v/v to <20%v/v. The seasonal pattern has also become more apparent and less occluded.

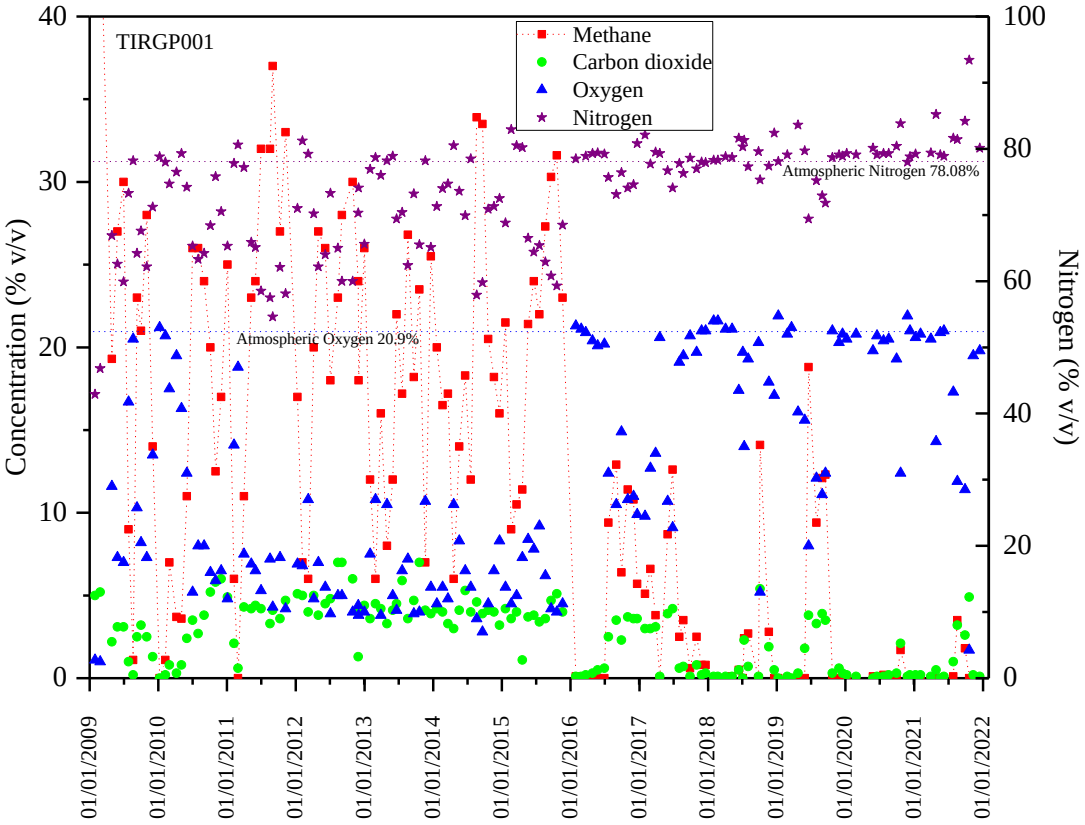

Figure 3.2 – Ground Gas Profile TIRGP001

TIRGP003 has historically displayed an atmospheric profile, however since 2016 the ground gas profile has been consistent with aerobic respiration conditions (Figure 3.3) similar to that observed in TIRGP008. When methane is not apparent in TIRGP008 there is a net ingress of nitrogen into the ground to replenish oxygen converted to carbon dioxide. There is a general similarity with adjacent monitoring point's background ground gas profile and therefore similar processes are expected to be occurring.

The change in pattern at TIRGP003 appears to shortly precede the commencement of capping works in 2016. These engineering and preceding preparatory works could have contributed to changes in ground conditions which may have triggered the change in ground gas biochemical regime to aerobic respiration conditions.

Ground gas profiles for TIRPGP002, TIRPGP004, TIRPGP005, TIRPGP006 and TIRPGP007 demonstrate no influence from landfill sources. Methane is not present in environmentally significant concentrations, a maximum of 0.3%v/v was observed during 2021.

Carbon dioxide is low at these monitoring points, and consistent with expectations for naturally biologically active soil conditions (Figure 3.4).

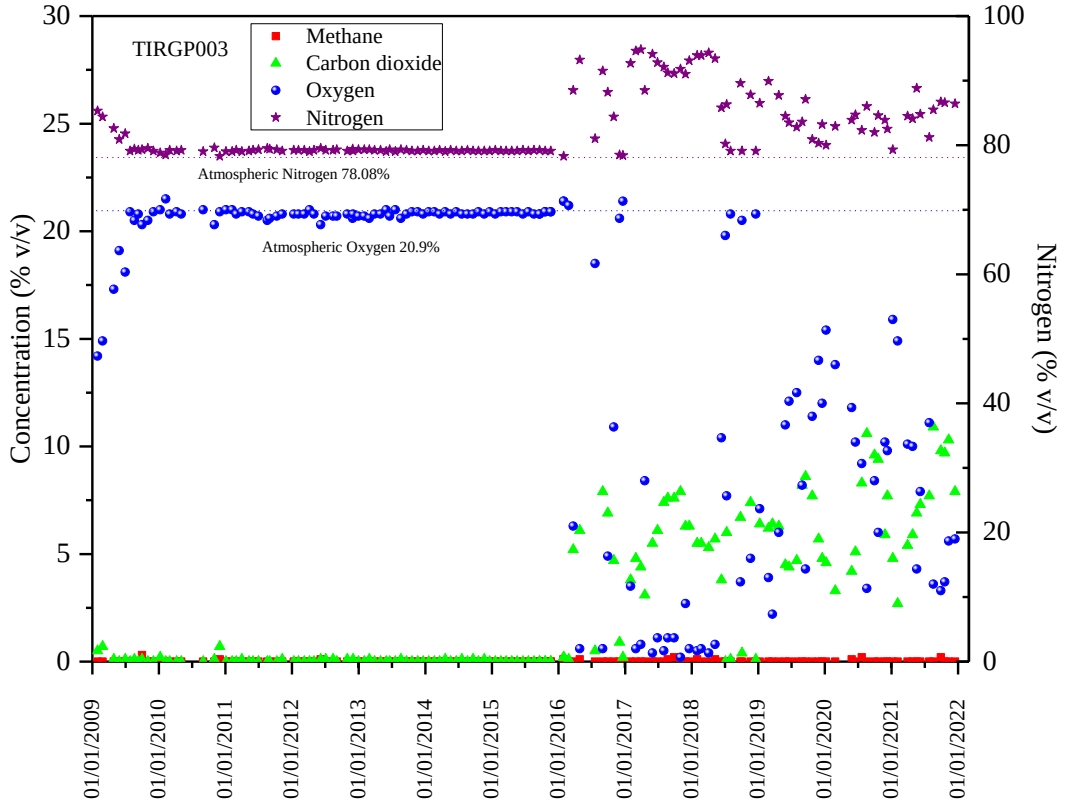

Figure 3.3 – Ground Gas Profile TIRGP003

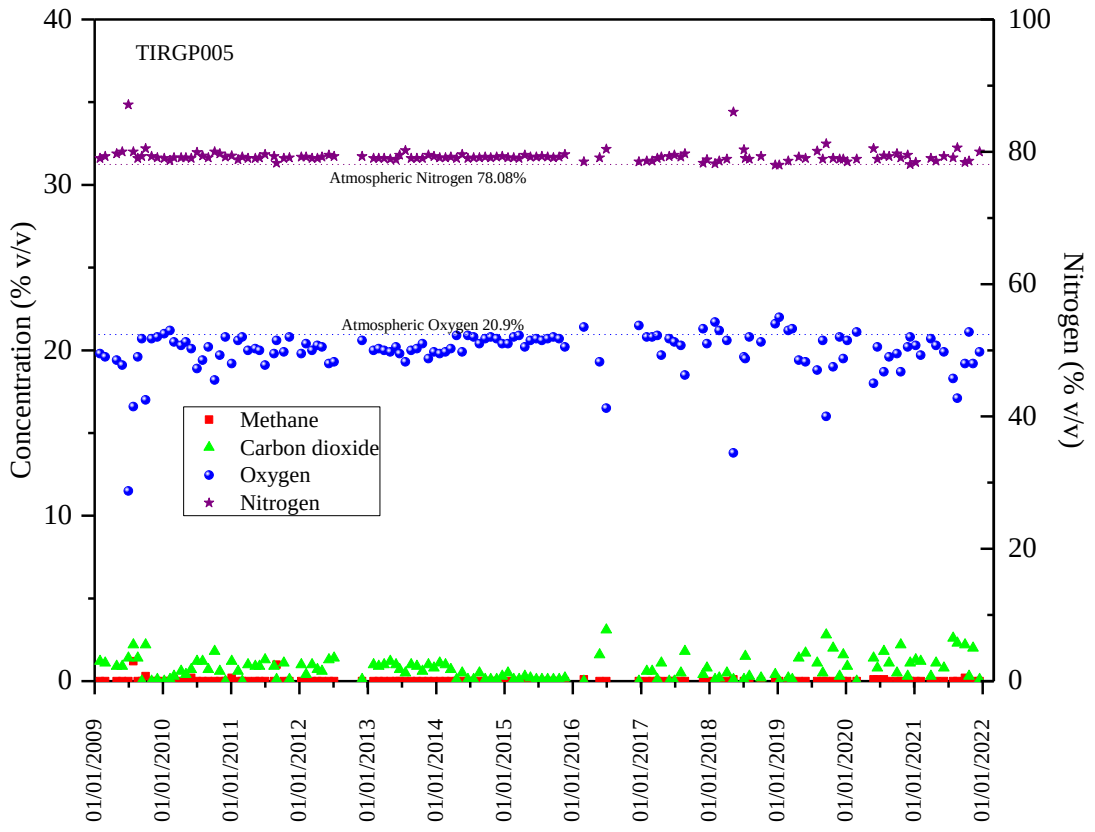

Figure 3.4 – Ground Gas Profile TIRGP005

3.3 Gas Field

Gas extraction at the site is carried out in a proportional manner to the risk posed by the site and the declining source term. Abstracted landfill gas is sent to the Phase 2 gas utilisation plant. Perimeter gas monitoring confirms that gas migration at the site is not occurring. A summary of the data collected during 2021 is provided in Appendix B.

There is negligible oxygen in the locations which are actively gassing. Where elevated oxygen is identified at up to 20%, this is indicative that the source term is depleted. Operating procedures are implemented to ensure that the system is properly balanced and optimised to prevent the ingress of air into the landfill.

Carbon monoxide and hydrogen sulphide were both low throughout 2021 and consistent with the historical dataset at a maximum of 20ppm and 179ppm respectively.

3.4 Summary

The ground gas composition was monitored in eight perimeter wells during 2021. There is an atmospheric composition in the majority of locations, with the occasional identification of carbon dioxide, consistent with *in-situ* microbial respiration. There are only two monitoring points (TIRGP008 and TIRGP001) which exhibit different ground gas systems. TIRGP008 was the only perimeter monitoring location that contained methane above the permit limit.

TIRGP008 follows a profile of aerobic respiration conditions, consistent with that observed around the wider site, with seasonal pulses of a mine gas / marsh gas type influence. This in turn causes an exceedance of the TIRGP008 methane Permit Limit, before the methane reduced to a negligible background concentration. However, TIRGP008 methane concentrations are consistent with the peak methane concentration at TIRGP001. Given the site's setting within a Marsh and above Coal Measures strata, there is no significance to the methane.

4 Water Environmental Monitoring

4.1 Leachate

Leachate within Phase 1 is managed by a gravity drained system. The leachate from both sites is then discharged to sewer. The leachate volume discharged is not differentiated into each site.

4.1.1 Leachate Levels

The leachate volume within the site is monitored in two locations for the majority of cells and one location in the smaller cells (Drawing TJ60). A number of the monitoring points are retro drilled, with the most recently installed points HMW4, HMW5 and HMW8 installed and re-instated into the monitoring schedule in January 2020 following the completion of capping and restoration works. Consequently, they were installed with an offset from the base of the site and by definition they are not in continuity with the basal drainage layer (Figure 4.2).

Leachate elevations within the site are generally between 11mAOD and 13mAOD (Figure 4.1), which equates to a leachate elevation in the 1 – 3m above basal profile range (Figure 4.2). This height range includes HWM05, where when outlier datapoints are excluded, leachate elevations fluctuate from 13.3 – 14.5mAOD, which equates to a leachate height of 1.7 – 2.9m above the base of the site.

A higher leachate elevation was reported for HMW12 in Cell 1a during January 2021 at ~15 – 16mAOD. However, following the installation of an air pump in February, leachate levels have returned to historically observed levels. It is thought that this monitoring point is intercepting a perched leachate layer which is decanting into the monitoring point however investigations are on-going. The HMW12 leachate data is not considered to be representative of the leachate head acting on the base of the site in Cell 1a or the wider landfill[2].

Leachate monitoring point HWM06A (Cell 4b) is reported to have become blocked during 2021 and is currently under investigation. The reported leachate levels during towards the end of the year (September to December) are therefore likely to be a reflection of the well integrity rather than a leachate surface. Leachate levels at HWM04 have remained low.

As the site has been fully capped with low permeability material since 2019 further stabilisation of leachate levels is expected to continue. Seasonal trends have dampened in the majority of monitoring points since the completion of capping at the site. Cell 3 continues to show some seasonal variation in leachate elevation, however as the reported leachate is above groundwater elevations then groundwater ingress is not suspected as a contributing factor.

[2] TerraConsult Limited (2021) Tir John (Closed) Landfill. Hydrogeological Risk Assessment Review. Ref. 10686-R01

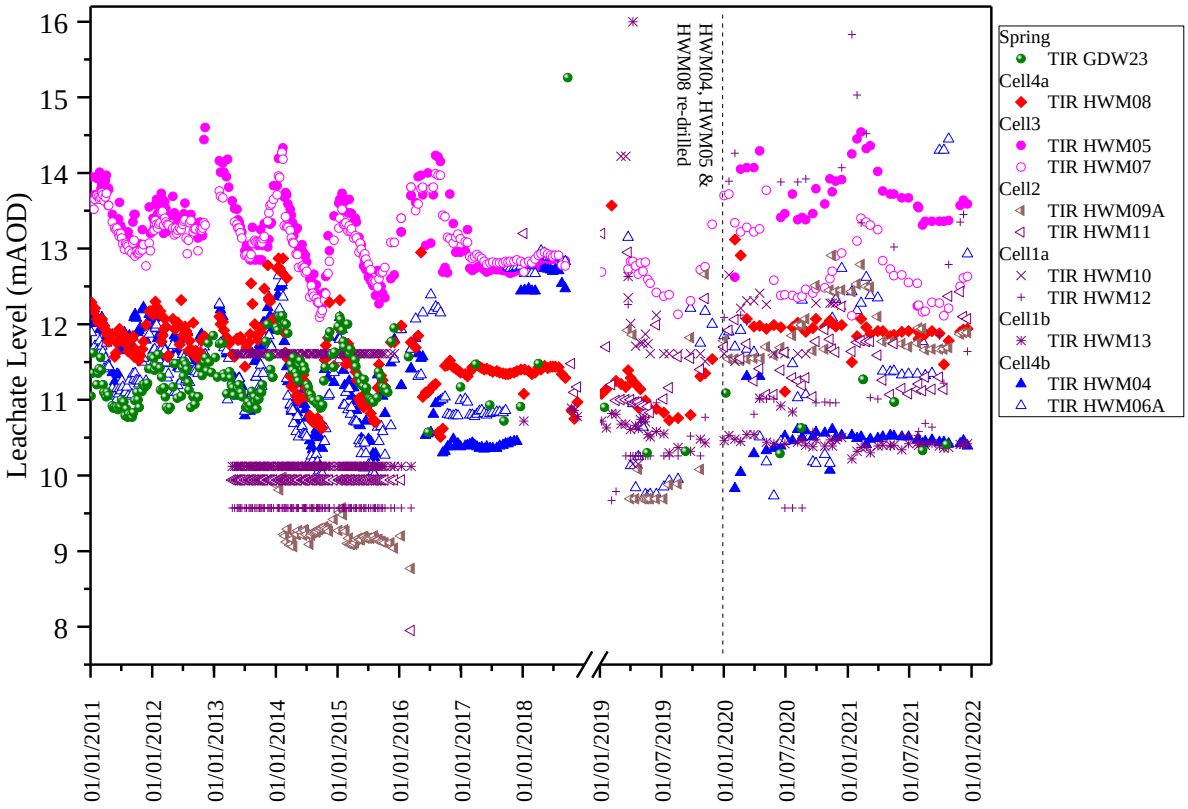

Figure 4.1 – Leachate and Groundwater Elevation

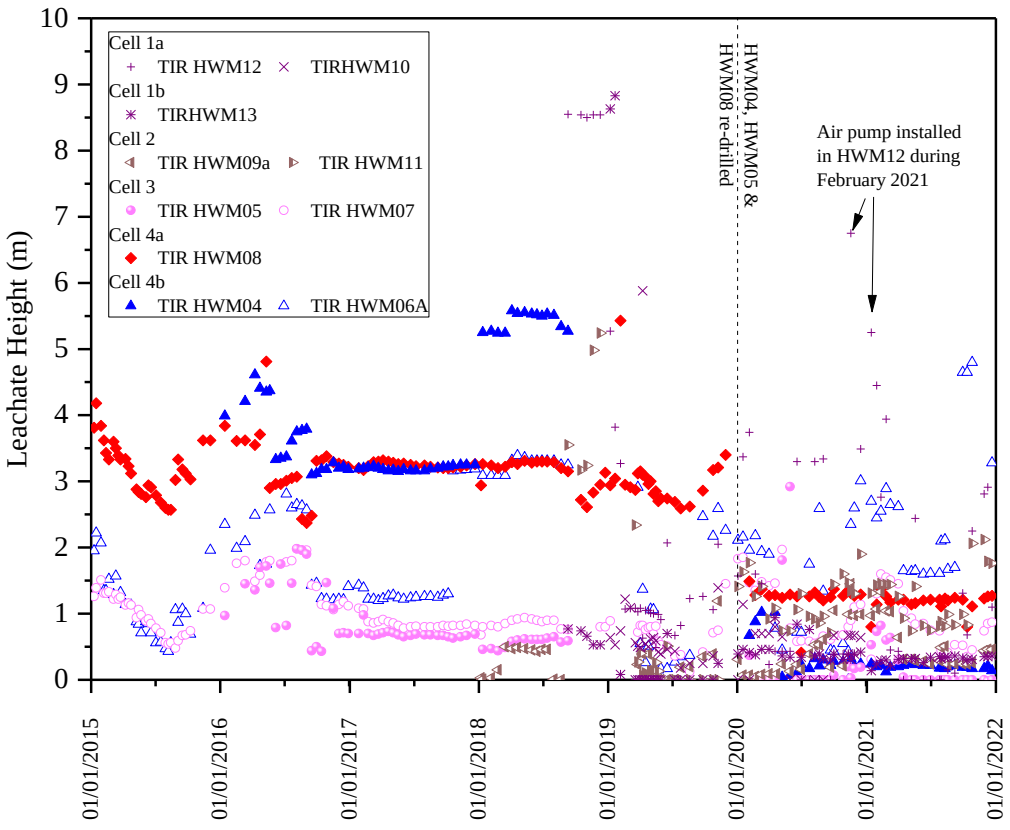

Figure 4.2 – Leachate Height Above Plumbed Base

The leachate elevation is consistent with the hydraulic response towards the passive leachate collection system which drains leachate from an elevation of 10 - 11mAOD into a central receiving lagoon, which is below the base of the landfill (with an invert height of ~9mAOD) before discharge to sewer. Leachate levels are expected to progressively decline as excess moisture within the waste mass is lost through the gravity drainage system.

4.1.2 Leachate Quality

Leachate within the Site is transitioning from a sodium-chloride bicarbonate solution with significant ammonium and potassium typical of non-hazardous leachates, to one where the majority of the sodium chloride and ammonium content has become significantly depleted. The leachate appears to have depleted to between 10% and 20% of that expected from methanogenic conditions within a municipal landfill. This is not unexpected given the age of the waste.

Table 4 – Leachate Matrix Constituents

Sample Point	Date	pH	EC	NH_4-N	COD	BOD	TOC	Ca	Mg	Na	K	Cl	SO_4	Alk
			uS/cm	mg/l										
HWM04A	26/05/21	Insufficient liquid to sample												
HWM04A	10/11/21	7.1	1800	10	4000	59	39.8	360	60	140	42	120	42	1300
HWM07	26/05/21	6.8	3100	250	880	61	66.6	150	57	140	140	180	8	1500
HWM07	10/11/21	6.6	1300	13	220	< 1	19.7	250	41	47	26	32	109	660
HWM08A	26/05/21	6.7	2000	33	150	5.1	30.7	140	40	390	33	140	9	1000
HWM08A	10/11/21	7.0	1800	19	9300	53	46.5	150	42	270	28	110	5	1100
HWM11	26/05/21	7.4	1300	0.32	96	1.8	14.8	260	30	60	17	57	467	430
HWM11	10/11/21	7.9	1100	0.29	59	1.3	15.3	260	24	51	14	31	390	330
HWM12	26/05/21	7.5	1700	0.15	100	2.3	23.4	480	38	80	18	44	608	550
HWM12	10/11/21	7.4	1700	0.13	82	1.4	36.3	510	48	110	19	55	877	510
HWM13	26/05/21	7.2	3000	99	140	28	27.9	200	130	210	160	320	458	1100
HWM13	10/11/21	7.3	2800	110	360	39	34.7	190	130	200	150	340	223	1400

Leachate metals are also typical of a non-hazardous leachate (Table 5), in which cadmium and mercury are routinely below detection limits. Cadmium and mercury are an order of magnitude below their respective Drinking Water Standard (DWS). Chromium, copper and lead were found in negligible quantities. Nickel and zinc are also low and reported within the range ~0.002 - 0.02mg/l. The most significant metalloid within the leachate is arsenic reported at 0.001 – 0.08mg/l. However, arsenic was reported below the 50µg/l EQS at the majority of locations during 2021.

Table 5 – Leachate Priority Substances

Sample Point	Date	Fe	Mn	Cd	Hg	Cr	Cu	Ni	Zn	Pb	As
		mg/l		µg/l							
HWM04A	10/11/2021	2.60	3.800	<0.02	0.006	10	2	7	10	1.6	22
HWM07	26/05/2021	19.00	2.000	<0.02	0.018	7	1	6	2	< 0.2	9
HWM07	10/11/2021	0.09	2.600	<0.02	<0.005	5	3	3	6	0.3	32
HWM08A	26/05/2021	1.60	0.900	<0.02	0.007	9	2	6	1	0.2	7
HWM08A	10/11/2021	17.00	1.400	<0.02	<0.005	10	2	9	3	0.5	80
HWM11	26/05/2021	0.04	0.004	0.05	0.006	2	6	7	3	< 0.2	1
HWM11	10/11/2021	0.03	0.004	0.04	<0.005	2	14	4	5	< 0.2	27
HWM12	26/05/2021	0.02	0.003	0.16	0.010	3	38	9	10	0.2	9
HWM12	10/11/2021	0.18	0.083	0.10	<0.005	3	19	7	9	< 0.2	39
HWM13	26/05/2021	0.07	1.100	<0.02	0.006	3	2	20	14	1.0	9
HWM13	10/11/2021	0.08	1.100	<0.02	<0.005	8	2	18	15	4.6	78

A hazardous substances screen was carried out in May 2021. However, this screen did not identify any hazardous substances above the limit of detection. The non-hazardous herbicide mecoprop was identified at 0.2 – 2.1µg/l and this is insignificant in comparison to the 18µg/l EQS.

4.2 Groundwater

Groundwater is monitored in the bedrock, the superficial deposits and the PFA platform that is present beneath the waste.

4.2.1 Groundwater Levels

Groundwater elevations during 2021 were consistent with the historic dataset. Groundwater levels and flow direction are discussed in detail within the 2021 Hydrogeological Risk Assessment Review (HRAR)[2].

GW23 is located in the vicinity of a spring which occurs when permeable / water bearing units underlain by an interbedded impermeable clay unit intersect the topography. Notwithstanding the presence of springs on the hillside above GDW23, water levels in the bedrock at the western edge of Cell 3 fluctuate seasonally typically between 11mAOD and 13mAOD.

Groundwater levels within the Made Ground (PFA) and wider Crymlyn Bog also exhibit seasonal variation and are generally between ~6.5 and 9mAOD and ~5.5 – 6mAOD respectively (Figure 4.3).

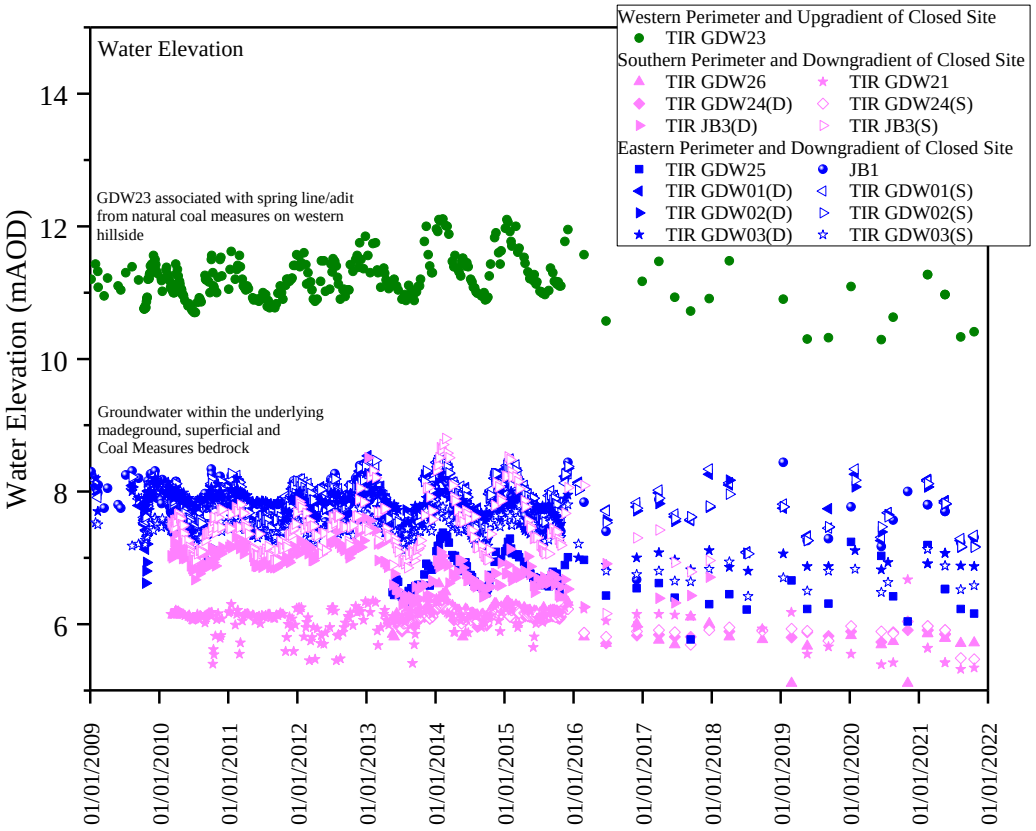

Figure 4.3 – Groundwater Elevation (2009-2021)

4.2.2 Groundwater Quality

As discussed in historical environmental monitoring reviews and the recent 2021 HRAR, interpreting the groundwater quality monitoring data with respect to identifying a potential landfill influence is complicated as the site is located on a biologically active peat bog (*i.e.* organic rich under anaerobic conditions) whilst the power station also used seawater as a coolant. Consequently, there is an expectation that ammoniacal-N, COD and chloride; three primary leachate indicators are elevated within the local groundwater system. This is further complicated by the significant quantities of PFA deposited below and adjacent to the site, which is likely to result in elevated potassium and other salts including phosphates, in addition to metals. Therefore, the groundwater cannot be compared directly to a potable water supply with respect to the primary water quality constituents usually considered when assessing water quality.

Matrix substances and 'typical' leachate indicator substances are summarised in

Table 6. A comparison with Permit Limits presented in Table 7. The data collected during 2021 is consistent with the historical dataset and no significant trends have been identified.

Table 6 – Groundwater Quality Summary (Average 2021)

Location	pH	EC	NH_4-N	COD	BOD	Ca	Mg	Na	K	Cl	SO_4
		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
North and West											
GDW23	6.8	310	0.1	59	4	24	17	16	3	20	46
TIR JB1	7.5	345	0.3	15	3	29	22	13	4	19	14
GDW03(D)	6.3	503	11	153	14	38	20	21	5	27	1
GDW03(S)	7.4	800	22	101	4	120	19	29	23	31	73
East (Between Landfill Phases)											
GDW01(D)	7.5	690	2	2615	24	89	20	58	23	49	30
GDW01(S)	7.8	583	2	1158	11	82	20	59	22	49	31
GDW02(D)	6.6	1008	8	129	28	180	41	45	25	39	171
GDW02(S)	6.9	1900	18	480	21	340	62	198	50	178	269
GDW25	7.0	2250	16	768	30	480	120	210	57	188	698
South of Site											
GDW24(D)	6.8	1475	55	33	4	130	40	125	74	120	48
GDW24(S)	6.7	1600	58	78	3	130	36	120	65	130	59
GDW26	7.0	848	10	72	7	480	120	121	42	100	701
GDW21	6.6	1425	25	1073	15	53	33	200	47	275	27

Table 7 – Ammoniacal-N comparison with Permit Limits (2021)

Location	GDW21	GDW24(D)	GDW24(S)	GDW26
Permit Limit	**51**	**85**	**75**	**25**
16/02/2021	24	49	55	10
19/05/2021	27	56	47	10
10/08/2021	25	57	80	10
12/10/2021	22	58	48	12

Shaded cells exceed the permit limit

The monitoring programme has demonstrated that ammoniacal-N is elevated around the site and this includes the monitoring points on the southern perimeter of the closed site where monitoring commenced during 2013 (GDW24(S)/(D), GDW21 and GDW26). However, this is considered to be a reflection of local baseline conditions rather than a landfill influence. As discussed within the 2021 HRAR[2], ammoniacal-N appears to increase with distance from the site.

Permit limits for ammoniacal-N are set at these downgradient monitoring points and these were generally not exceeded during 2021. There was one exception to this during August 2021 at GWD24(S) where ammoniacal-N was reported marginally in excess of the Permit limit at 80mg/l. However, the reported data is consistent with the historical dataset (Figure 4.4) and subsequent monitoring has confirmed ammoniacal-N has reduced to below the trigger limit (Table 7).

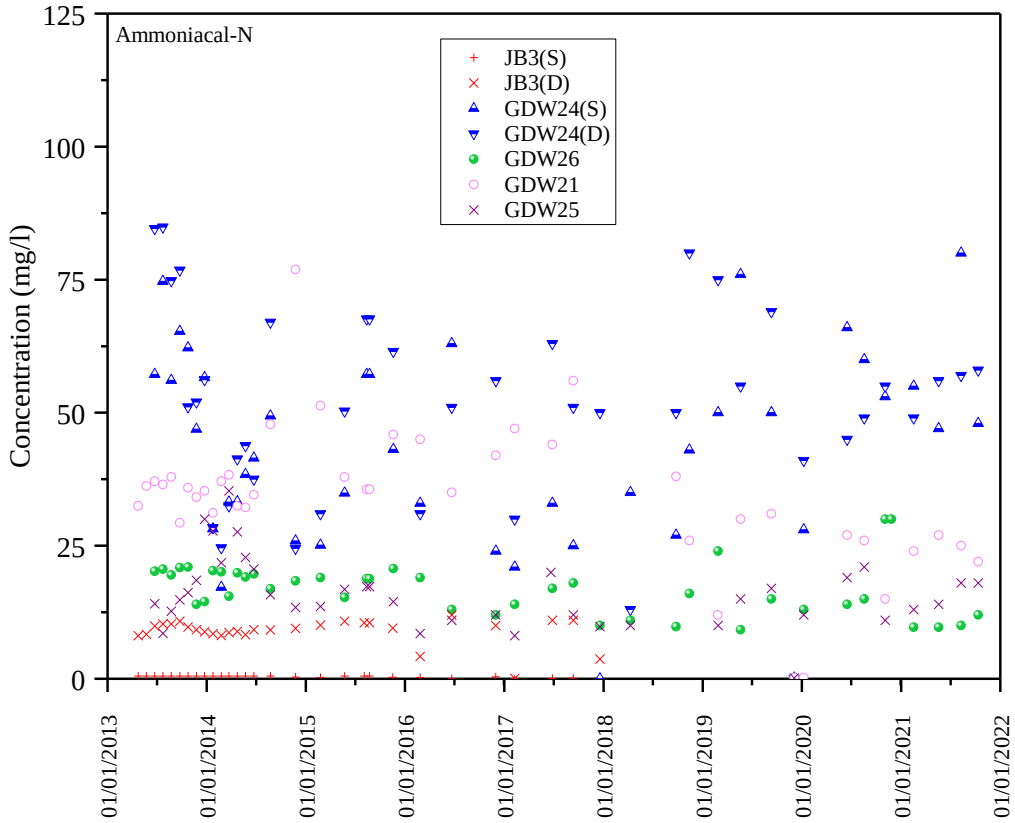

Figure 4.4 –Ammoniacal-N to the South of Phase 1

Chloride is typically reported below the 250mg/l DWS and these trends have continued during 2021. The exception to this is at GDW21 where chloride is more variable oscillating within the range 170mg/l to 450mg/l (Figure 4.5). However, chloride appears to follow a similar trend to ammoniacal-N of increasing concentration with distance from the edge of the landfill site[2]. Furthermore, chloride concentrations within the leachate are typically below that reported at GDW21 and therefore must be associated with a non-landfill source.

Sulphate continues to be reported in excess of chloride, particularly at GDW02(D), GDW02(S), GDW25 and GDW26 (

Table 6). The sulphate cannot be derived from the landfills which are under methanogenic and therefore sulphate reducing conditions. Consequently, the sulphate must be a product of the host materials, and is therefore most likely to be a product of the PFA and independent of the landfills.

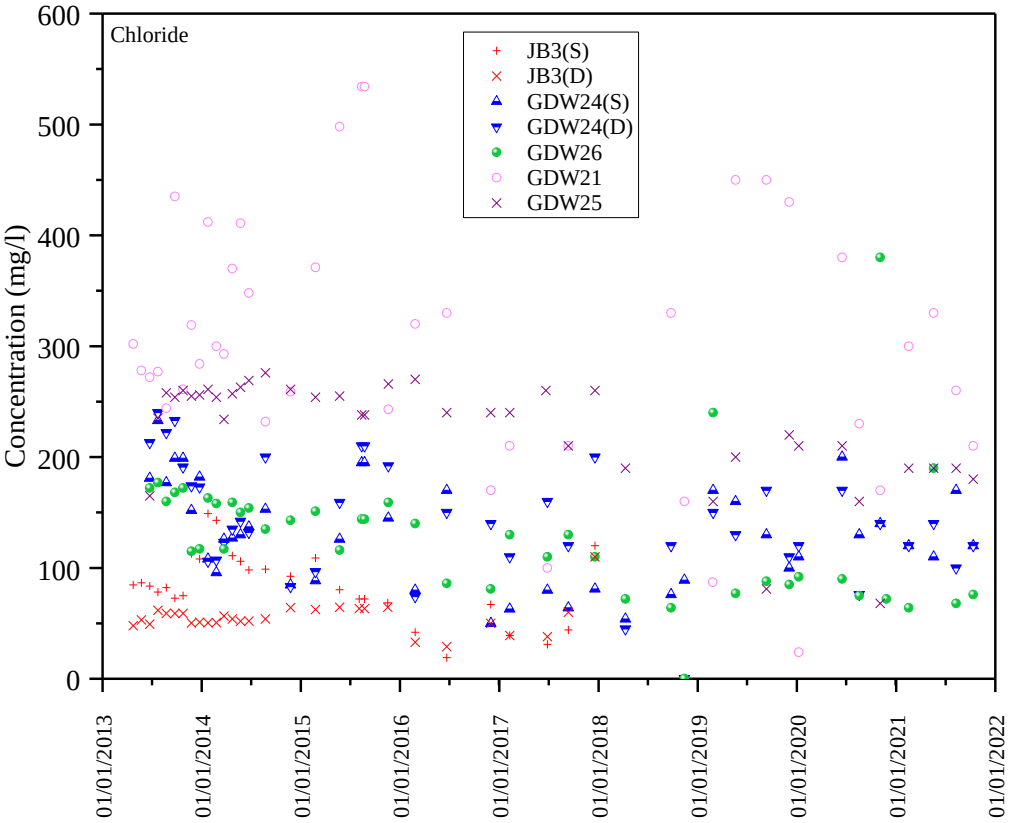

Figure 4.5 – Chloride to the South of Phase 1

The hazardous metals cadmium and mercury are typically reported at or below detection limits at the majority of groundwater locations (Table 8). Cadmium and mercury are both consistently reported below both their respective DWS and EQS and are insignificant within the groundwater.

Lead is similarly low and often reported at or close to the limit of detection of 0.3µg/l. This is below both the EQS of 1.2µg/l (bioavailable) and DWS of 10µg/l and is consistent with the historical dataset. Lead is not considered to be environmentally significant within the groundwater.

Chromium and zinc were identified in small amounts and within the 1 – 11µg/l range. Copper and nickel are also low and reported at 1 - 3µg/l. Chromium, zinc, copper and nickel are all insignificant in comparison to their respective DWS.

Arsenic is typically in the <1 - 5µg/l range, except for at GW01(S & D) where arsenic was slightly higher. At the reported concentrations, arsenic is below the EQS of 50µg/l and approximates to the DWS of 10µg/l. However, given that arsenic is a known coal constituent, it's presence may reflect local background conditions.

Table 8 – Groundwater Priority Substance Average (2021)

Sample Point	Fe	Mn	Cd	Hg	Cr	Cu	Ni	Zn	Pb	As
	mg/l		µg/l							
North and West										
GDW23	0.01	2.9	0.03	<0.005				4		0.3
TIR JB1	0.14	0.1	<0.02	<0.005				1		0.6
GDW03(D)	8.83	0.9	0.02	0.007	4	1	1.5	7	<0.2	0.5
GDW03(S)	0.09	1.6	<0.02	<0.005	4	2	1.7	5	0.3	1.4
East (Between Landfill Phases)										
GDW01(D)	0.04	0.3	0.11	0.006	3	1	0.9	4	0.3	9.4
GDW01(S)	0.02	0.1	0.07	0.007	3	1	0.7	4	<0.2	12.5
GDW02(D)	0.32	2.8	0.03	<0.005	8	2	2.9	6	<0.2	4.1
GDW02(S)	0.39	0.9	<0.02	0.007	10	2	2.9	7	0.3	2.3
GDW25	0.05	0.5	0.13	0.007				4		5.2
South of Site										
GDW21	1.63	0.3	<0.02	<0.005				6		3.9
GDW24(D)	0.12	0.5	0.03	<0.005				7		2.4
GDW24(S)	0.21	0.7	<0.02	0.007				4		2.5
GDW26	0.25	0.4	<0.02	<0.005				11		1.1

A hazardous substances suite was carried out in May 2021 for the groundwater; however no hazardous substances were identified above the limit of detection.

4.2.3 Environmental Transects

There are two monitoring transects which extend into the Crymlyn Bog from the southern edge of the closed site. The transects comprise a series of monitoring points at 2m, 4m, 8m, 16m, 32m, and 64m intervals, each of which has a shallow (1m) and deep (2m) response zone. The data from the annual screen is presented in Table 9.

Ammoniacal-N in EMT1 is typically lower in the deeper response zone and decreases with distance from the site boundary for both the shallow and deep installations (Figure 4.7). Conversely, the measured chloride increases with distance from the site boundary (Figure 4.6), at both the deep installations, *i.e.* the concentration increases towards the coast, where saline intrusion can be reasonably expected to occur.

A similar trend in ammoniacal-N is reported in EMT5 with decreasing concentrations with distance from the site (Figure 4.9). Consequently ammoniacal-N is considered to be restricted to the outer edges of the bog at the southern edge of the Made Ground. However, the inverse relationship between chloride and distance from the site is not as pronounced at EMT5 compared to EMT1. The highest chloride concentrations in EMT5 are observed at depth in the 16m to 32m distance range (Figure 4.8)

Orthophosphate is generally reported at the detectable limit in the majority of monitoring points with 0.044mg/l in EMT5(5a) being the highest concentration observed during the 2021 monitoring of EMT5. The highest concentration of orthophosphate observed in EMT1 during 2021 was 0.25mg/l at EMT1(5b). The orthophosphate does not appear to follow a specific trend along either of the transects.

Table 9 – Closed Site Transect Water Quality

Sample Point	Date	pH	NH_4-N	Cl	SO_4	DOC	BOD	Ca	NO_3	Orthophosphate as PO_4	P
			mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
ETM1 (1a)	30/03/21	7.3	26.0	110	3.2	8	14	86	0.04	0.160	1.1
ETM1 (1b)	30/03/21	7.3	17.0	220	6.8	4	11	120	0.68	0.170	1.1
ETM1 (2a)	30/03/21	7.1	29.0	130	3.0	7	16	90	0.04	0.064	0.8
ETM1 (2b)	30/03/21	7.1	15.0	140	4.5	4	22	87	0.06	<0.062	5.3
ETM1 (3a)	30/03/21	7.0	14.0	130	5.0	8	26	110	0.05	0.092	1.7
ETM1 (4a)	30/03/21	6.8	11.0	99	3.2	6	27	120	0.06	<0.062	1.7
ETM1 (4b)	30/03/21	6.7	3.0	280	1.2	11	21	230	0.09	0.064	1.1
ETM1 (5a)	30/03/21	6.9	0.8	63	2.1	5	20	140	0.04	<0.062	2.0
ETM1 (5b)	30/03/21	6.8	0.6	410	4.0	29	20	53	0.29	0.250	0.1
ETM1 (6a)	30/03/21	6.7	0.9	110	1.0	6	24	150	0.05	<0.062	2.3
ETM1 (6a)	08/06/21	6.7				5		150			
ETM1 (6a)	28/09/21	6.8				8		120			
ETM1 (6a)	06/12/21	6.8				11		40			
ETM1 (6b)	30/03/21	6.7	0.1	430	2.7	28	23	100	0.30	0.140	0.1
ETM1 (6b)	08/06/21	6.8				29		120			
ETM1 (6b)	28/09/21	6.7				41		82			
ETM1 (6b)	06/12/21	6.4				10		43			
ETM5 (1a)	30/03/21	7.1	33.0	100	5.4	8	40	96	0.19	0.098	0.97
ETM5 (1b)	30/03/21	7.3	29.0	95	3.0	4	20	62	3.61	0.320	4.60
ETM5 (2a)	30/03/21	7.1	37.0	110	6.1	11	13	150	0.15	0.089	1.50
ETM5 (2b)	30/03/21	7.1	48.0	170	3.0	4	26	130	1.72	0.300	3.80
ETM5 (3a)	30/03/21	7.1	19.0	64	15.7	8	40	100	0.14	0.200	3.50
ETM5 (3b)	30/03/21	7.2	1.0	130	1.6	6	31	130	0.13	<0.062	2.30
ETM5 (4a)	30/03/21	6.9	5.4	150	1.6	10	30	170	0.15	<0.062	2.00
ETM5 (4b)	30/03/21	7.1	0.1	540	4.2	34	7	170	0.67	<0.062	0.04
ETM5 (5a)	30/03/21	6.9	0.1	230	2.2	13	14	190	0.20	0.440	2.50
ETM5 (5b)	30/03/21	7.0	0.9	310	3.7	20	12	96	0.29	0.360	0.15
ETM5 (6a)	30/03/21	6.2	0.0	230	3.9	22	13	28	0.29	<0.062	0.17
ETM5 (6a)	08/06/21	6.4				19		49			
ETM5 (6a)	28/09/21	6.4				17		32			
ETM5 (6a)	06/12/21	5.6				2		41			
ETM5 (6b)	30/03/21	5.3	<0.015	300	3.5	27	22	14	0.29	<0.062	<0.02
ETM5 (6b)	08/06/21	5.5				30		16			
ETM5 (6b)	28/09/21	5.8				27		14			
ETM5 (6b)	06/12/21	6.8				16		31			

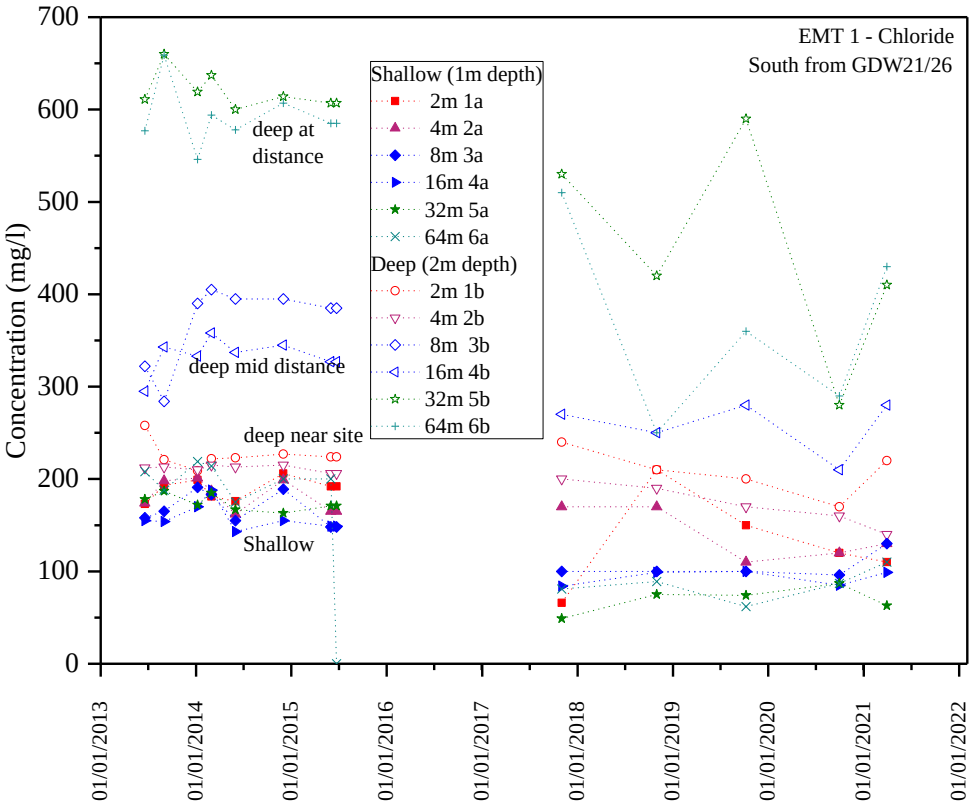

Figure 4.6 – Transect EMT1 Chloride

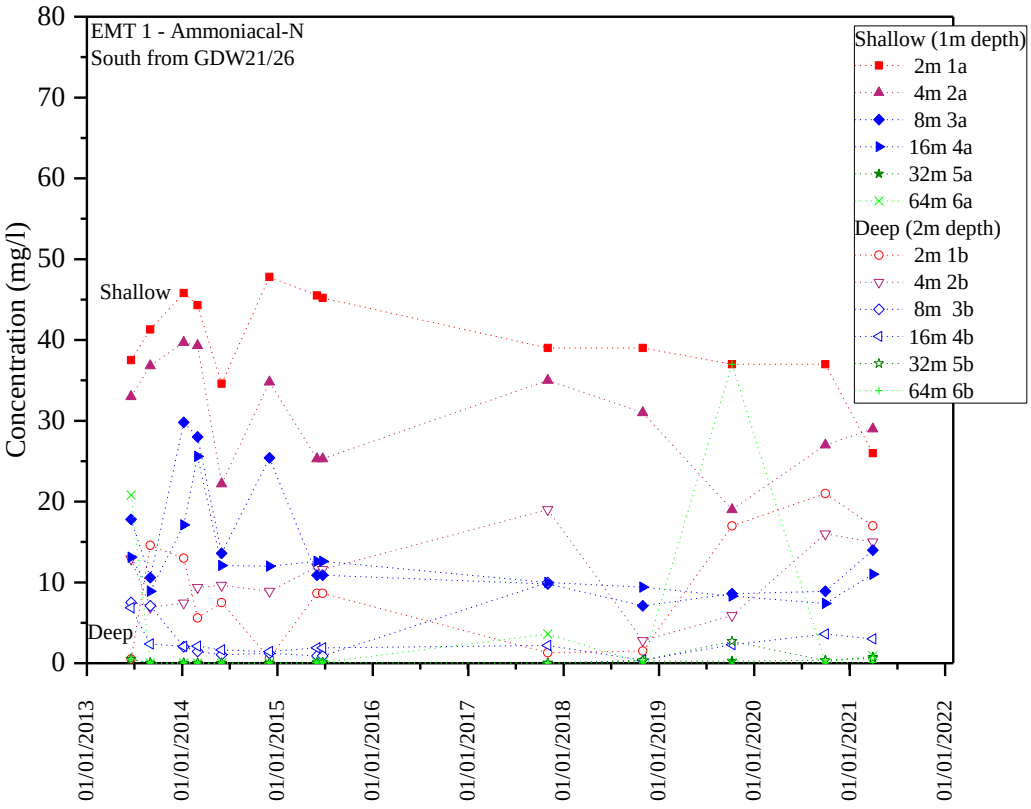

Figure 4.7 – Transect EMT1 Ammoniacal-N

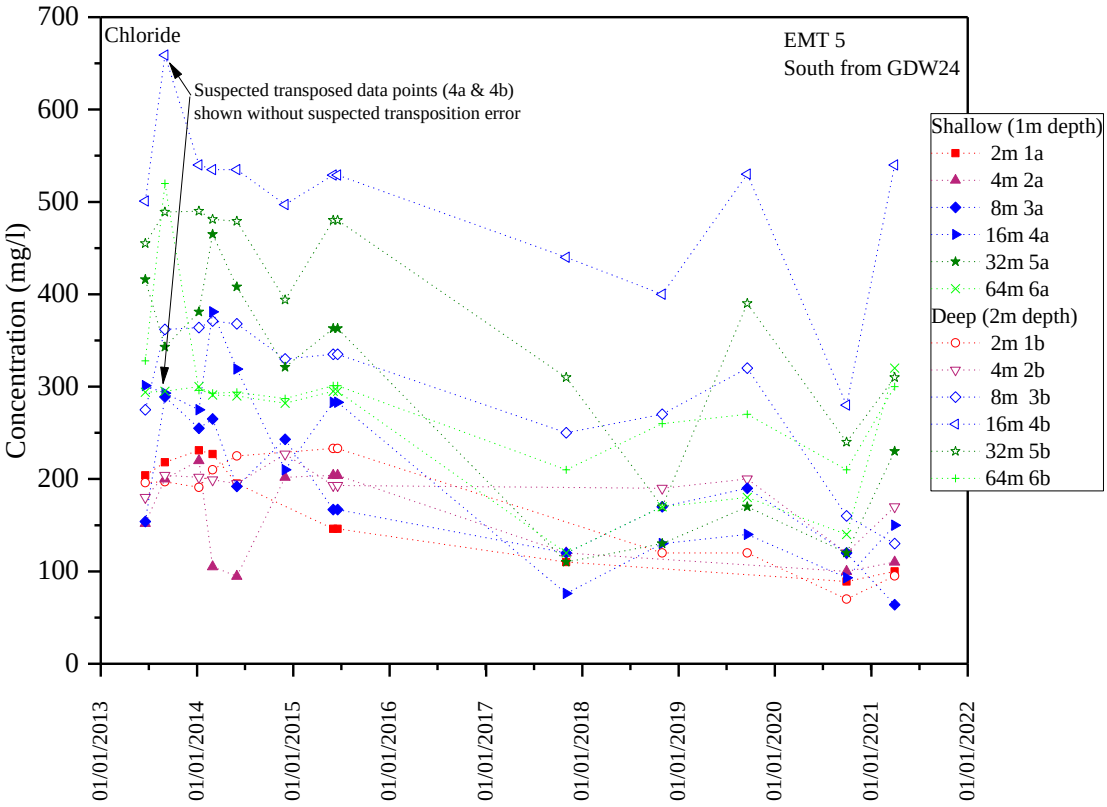

Figure 4.8 – Transect EMT5 Chloride

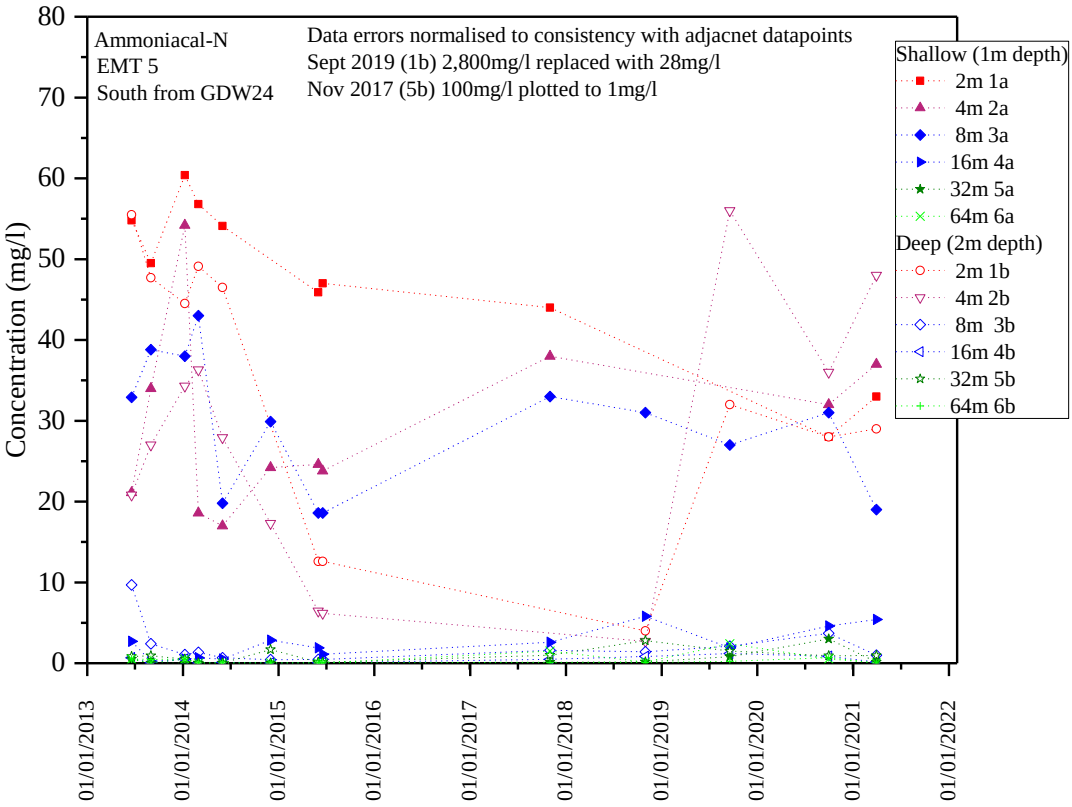

Figure 4.9 – Transect EMT5 Ammoniacal-N

4.3 Groundwater Summary

The quality of the groundwater system has generally remained consistent with previous years. Groundwater elevation within the perimeter wells follow a seasonal pattern, particularly in the east of the site. Elevated ammoniacal-N where not associated with chloride and can be attributed to high background levels from a number of sources including the underlying superficial peat deposits, the PFA platform and the mining history of the area.

Transects south of the site in Crymlyn bog demonstrate that ammoniacal-N typically decreases with distance from the site, however, any suspicion of a direct association with the landfill is disabused by the chloride data which demonstrates that chloride decreases with proximity to the site within EMT5. It is also possible that the ammoniacal-N could be a consequence of the organic rich natural host sediments, the disturbed ground, historical activities and the presence of the PFA. The PFA could also contribute to heavy metals, calcium, potassium, chloride, sodium and sulphates around the margins of the platform. Nevertheless, the data collected for the transects during 2021 is consistent with the historical dataset.

5 Amenity

5.1 Complaints

The Operator's complaints procedure is compliant to the relevant clauses of ISO14001 and involves the capture and implementation of immediate corrective action for every complaint. There are processes that review the effectiveness of the corrective action and if necessary, further preventative action is undertaken to prevent reoccurrence of the complaint.

There were no complaints received at the site during 2021.

5.2 Weather Data

Given the close association of potential nuisance emissions to weather conditions, the weather monitoring data are summarised in Table 10.

Temperature ranges were consistent with expectations for the sites location however rainfall rates were lower than historically recorded due to an error with the rain gauge. The prevailing wind direction is primarily south westerly with a minor northerly component (Figure 5.1).

Table 10 – Temperature and Rainfall Summary

Month	Temperature (2021)			Rainfall					
	Min	Max	Ave	2016	2017	2018	2019	2020	2021
	°C	°C	°C	mm	mm	mm	mm	mm	mm
January	-3	6	13	49	79	144	78	105	184
February	-3	6	13	104	70	51	62	202	104
March	-2	9	21	106	113	135	99	67	53
April	0	9	20	71	28	62	68	38	15
May	1	11	23	91	15	47	28	12	156
June	6	16	25	112	74	36	73	144	29
July	12	18	30	48	13	130	35	91	73
August	8	16	24	103	65	31	140	159	5
September	6	17	29	131	143		164	40	22
October	6	14	19	54	52	17	194	205	29
November	-1	9	15	99	83	125	142	96	4
December	1	9	14	49	121	117	180	199	2
			Total	**1,016**	**854**	**895**	**1,263**	**1,356**	**674**

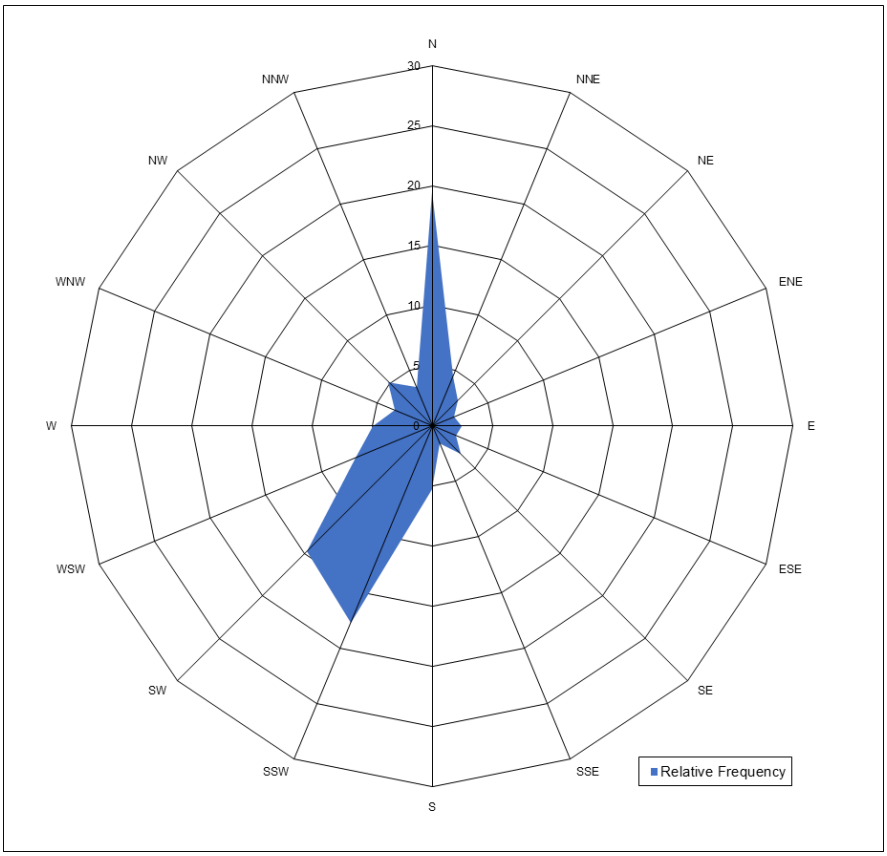

Figure 5.1 – Wind Rose Diagram 2021

6 Summary

Tir John is a capped and actively managed landfill, which ceased to accept wastes over 20 years ago. The leachate composition is consistent with the site's age and is significantly depleted compared to that of a younger non-hazardous landfill. The leachate has depleted to the extent that it no longer contains environmentally significant persistent contaminants of concern. The leachate is managed passively under gravity. Recommendations to amend the leachate monitoring programme were set out within the 2021 HRAR.

The monitoring programme at the Tir John Phase 1 Landfill site has demonstrated that landfill gas is being actively managed and that there is no evidence of uncontrolled emissions to air or land. There are seasonal fluctuations in ground gas chemistry consistent with a healthy *in-situ* microbial respiration, as well as a mine gas / marsh gas signature.

Groundwater within the area is generally of poor quality with respect to ammoniacal-N. However, there are no increasing trends and concentrations in 2021 were typically reported below Permit limits. The stable nature of the background chemistry is suggestive that a steady-state system has developed. The recent HRAR produced in September 2021 concluded that the landfill was not having an ongoing influence on groundwater quality. The data collected towards the end of 2021 is consistent with this conclusion.

Appendix A – Perimeter Gas Monitoring Data

BYRNELOOBY

Tir John Closed Landfill Site
Perimeter Gas Summary January - December 2021

Location	Methane			Carbon dioxide			Oxygen			Balance			Carbon Monoxide			Hydrogen Sulphide			Atmospheric pressure			Relative Pressure		
	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max
	%v/v			%v/v			%v/v			%v/v			ppm			ppm			mb			mb		
TIRGP001	0.0	0.5	3.5	0.0	1.1	4.9	1.7	16.6	21.0	78.9	82.3	93.4	0.0	0.0	0.0	0.0	0.6	2.0	995	1015	1031	-0.6	1.1	6.5
TIRGP002	0.0	0.0	0.2	0.1	0.3	1.2	16.6	20.4	21.5	78.3	79.2	82.2	0.0	0.0	0.0	0.0	0.5	2.0	996	1016	1032	-80.7	-11.8	7.3
TIRGP003	0.0	0.0	0.2	2.7	7.4	10.9	3.3	8.0	15.9	79.3	84.8	88.8	0.0	0.0	0.0	0.0	0.5	2.0	996	1016	1032	-0.2	0.3	0.9
TIRGP004	0.0	0.0	0.3	0.1	1.6	5.2	3.8	17.5	21.6	78.2	79.9	81.1	0.0	0.0	0.0	0.0	0.5	2.0	1007	1020	1032	-0.1	0.3	0.8
TIRGP005	0.0	0.0	0.2	0.1	1.3	2.6	17.1	19.6	21.1	78.4	79.1	80.6	0.0	0.0	0.0	0.0	0.5	2.0	995	1017	1032	-0.2	0.2	0.5
TIRGP006	0.0	0.0	0.3	0.1	2.0	6.7	12.2	18.4	21.7	78.3	79.8	82.2	0.0	0.0	0.0	0.0	0.4	2.0	995	1016	1030	-0.2	0.1	0.4
TIRGP007	0.0	0.1	0.3	0.1	0.7	2.5	17.4	20.2	21.5	78.4	79.1	80.2	0.0	0.0	0.0	0.0	0.5	2.0	995	1016	1033	-0.1	0.2	0.5
TIRGP008	0.0	2.1	24.8	3.7	11.2	22.9	0.5	9.2	17.9	51.8	77.2	82.8	0.0	0.2	1.0	0.0	0.6	2.0	995	1016	1032	-0.1	0.2	0.5

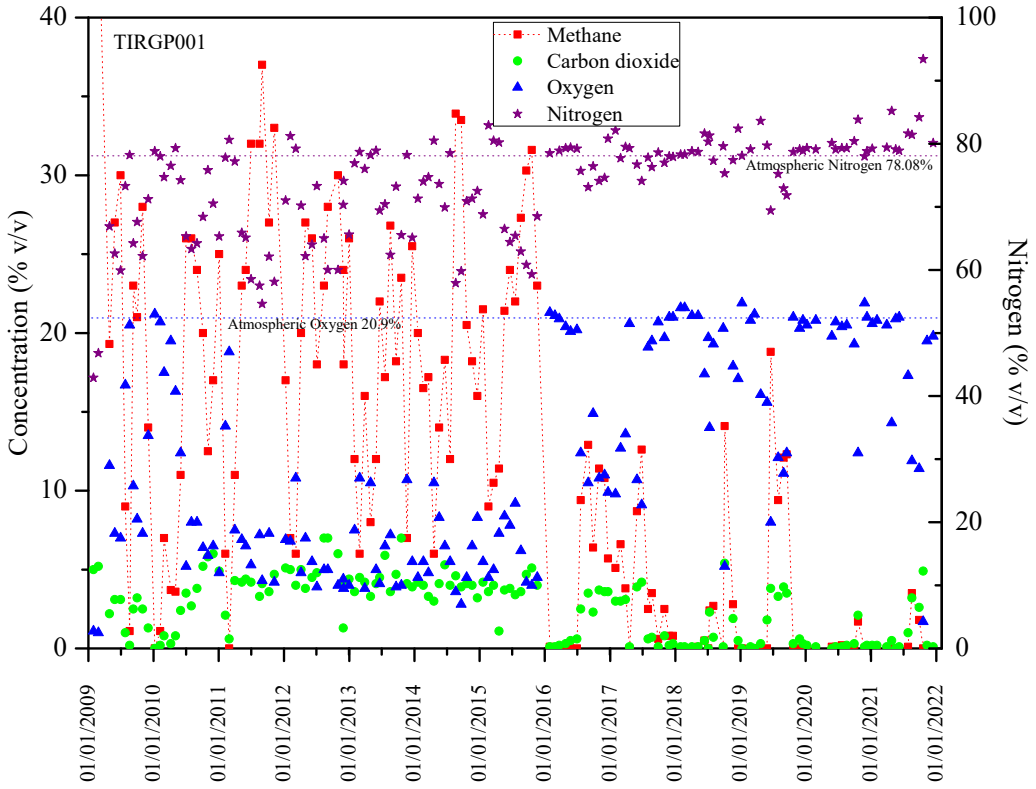

Figure A.1 – Perimeter Gas Monitoring Point TIRGP001

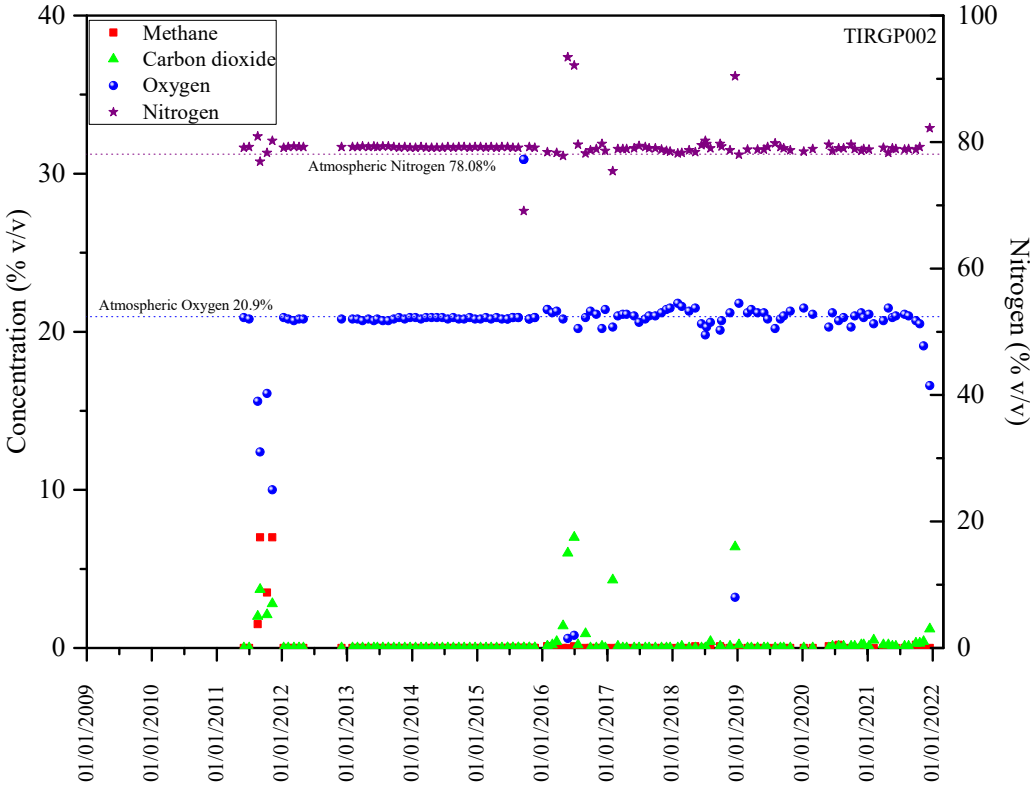

Figure A.2 – Perimeter Gas Monitoring Point TIRGP002

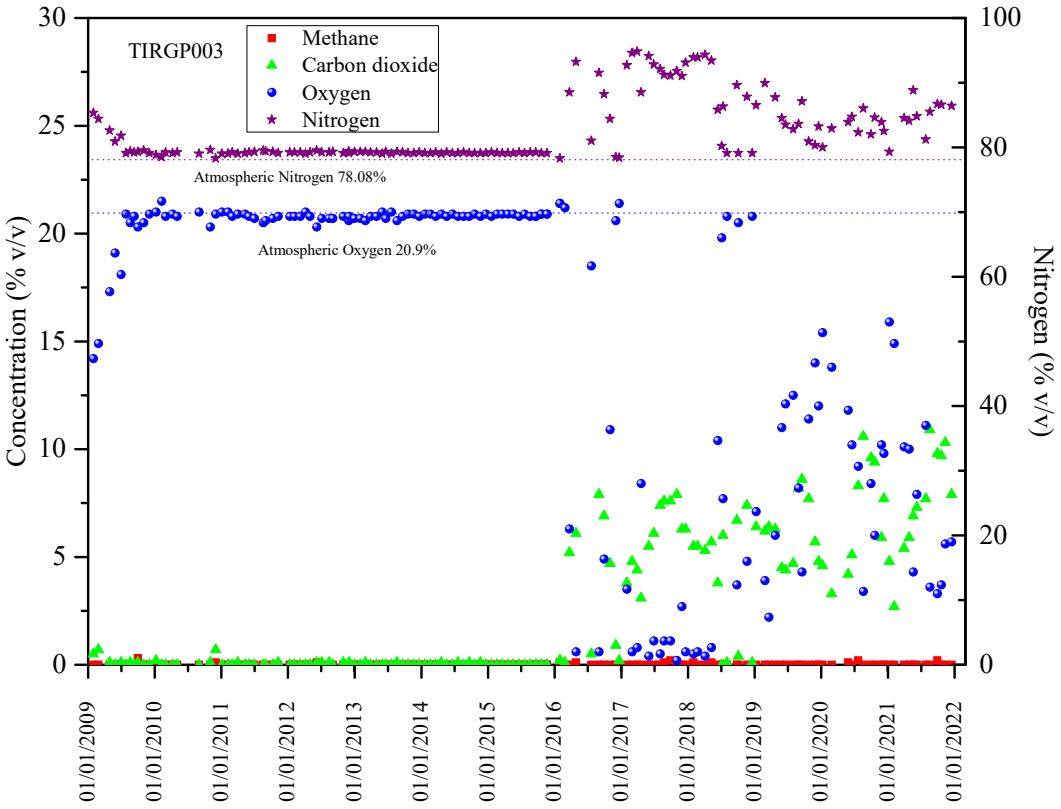

Figure A.3 – Perimeter Gas Monitoring Point TIRGP003

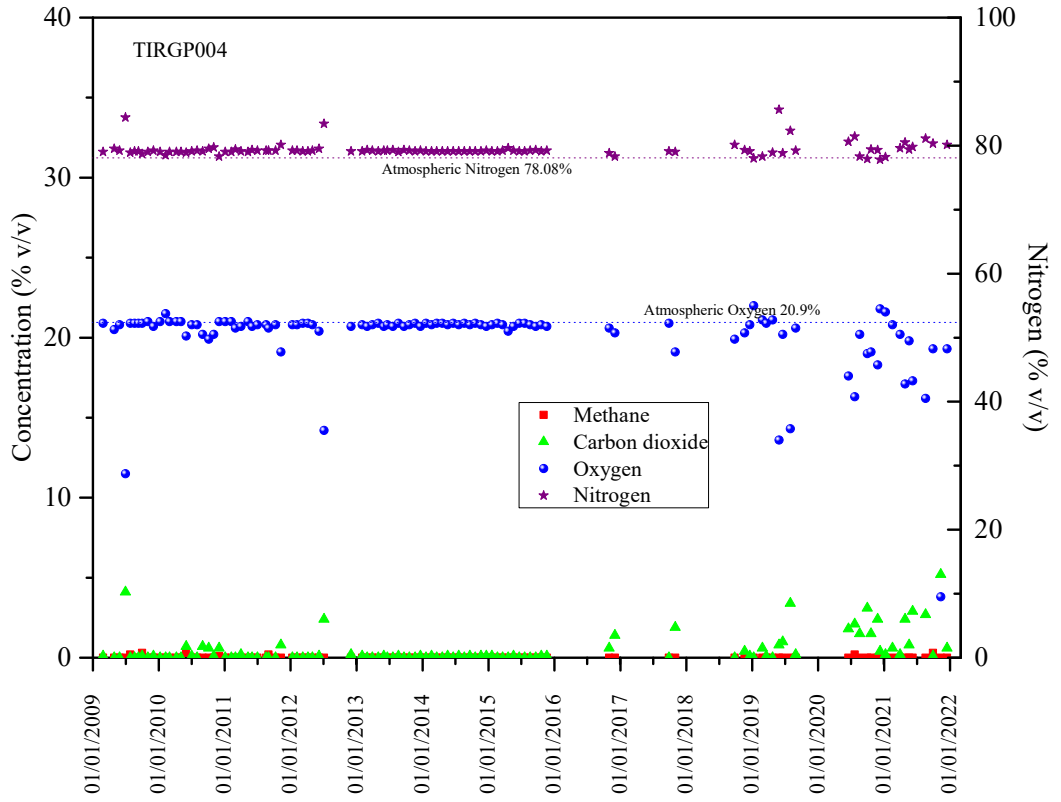

Figure A.4 – Perimeter Gas Monitoring Point TIRGP004

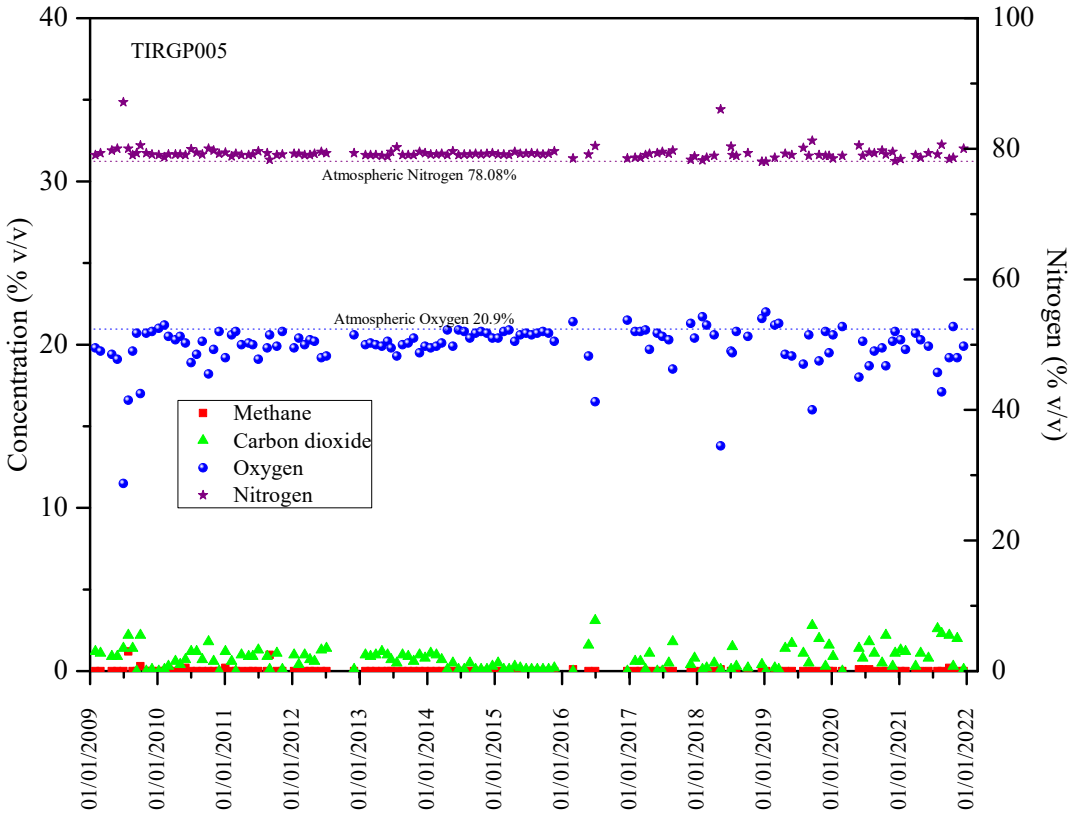

Figure A.5 – Perimeter Gas Monitoring Point TIRGP005

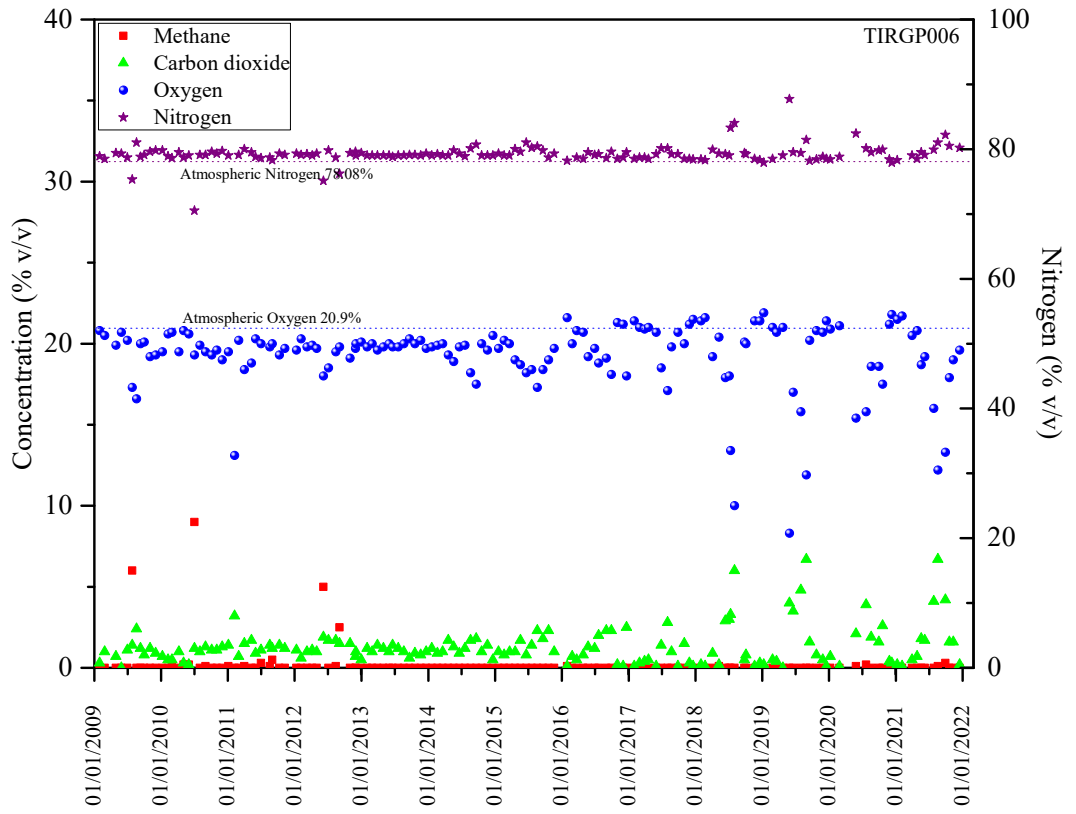

Figure A.6 – Perimeter Gas Monitoring Point TIRGP006

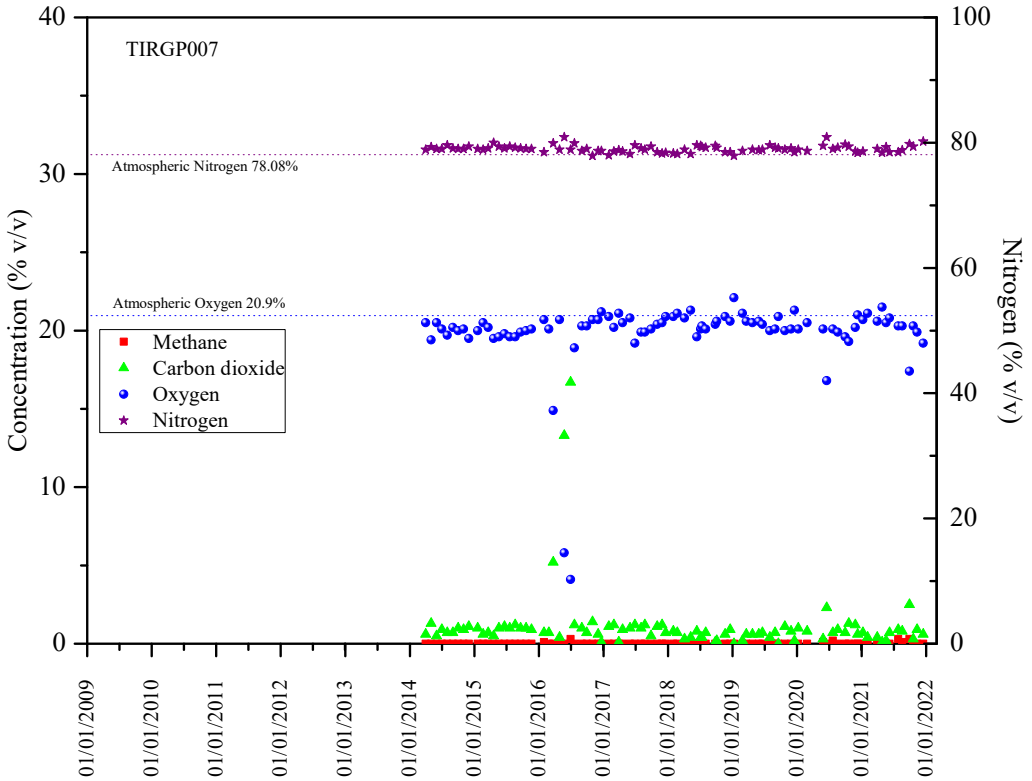

Figure A.7 – Perimeter Gas Monitoring Point TIRGP007

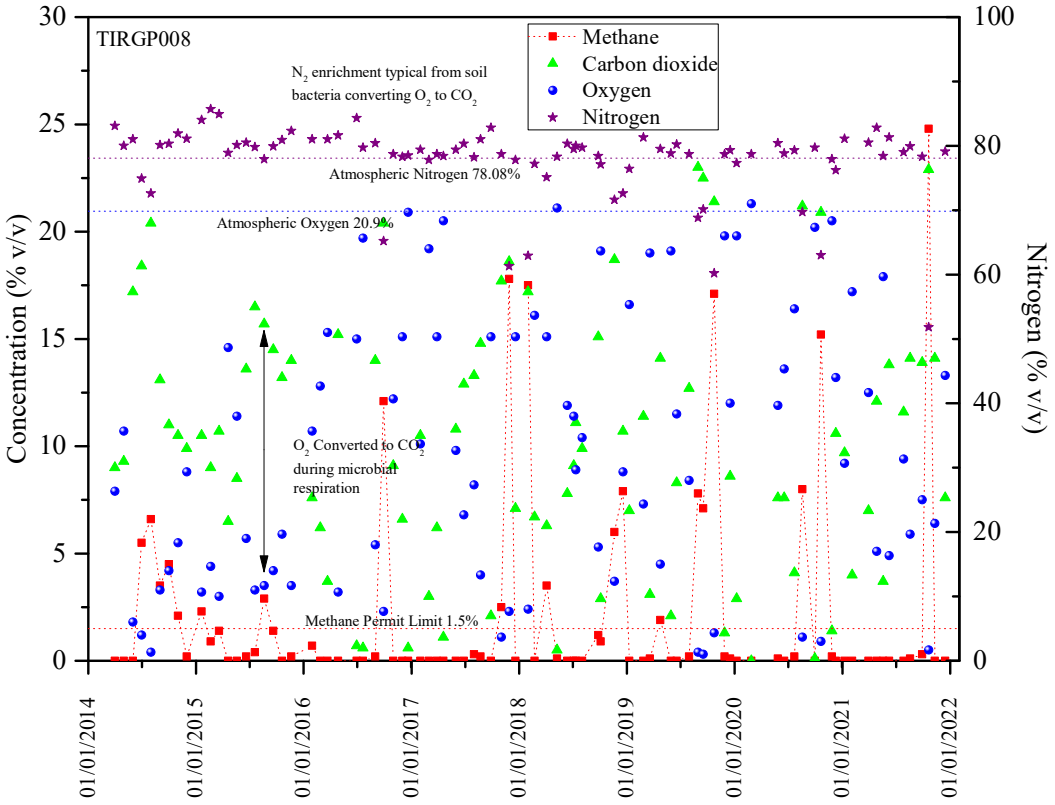

Figure A.8 – Perimeter Gas Monitoring Point TIRGP008

Appendix B – Landfill Gas Management

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Tir John Closed Landfill Site
In-Waste Gas Summary January - December 2021

Location	Methane			Carbon dioxide			Oxygen			Balance			Carbon Monoxide			Hydrogen Sulphide			Atmospheric pressure			Relative Pressure			CH4/CO2		
	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max	Min	Ave	Max
	%v/v			%v/v			%v/v			%v/v			ppm			ppm			mb			mb					
TIRW1102	0.1	0.1	0.1	0.0	0.0	0.0	19.4	19.4	19.4	80.5	80.5	80.5	1.0	1.0	1.0	0.0	0.0	0.0	999	999	999	0.5	0.5	0.5			
TIRW1104	0.1	0.1	0.1	0.0	0.0	0.0	19.4	19.4	19.4	80.5	80.5	80.5	0.0	0.0	0.0	0.0	0.0	0.0	999	999	999	0.7	0.7	0.7			
TIRW1105	0.1	0.1	0.1	0.0	0.0	0.0	19.4	19.4	19.4	80.5	80.5	80.5	1.0	1.0	1.0	0.0	0.0	0.0	999	999	999	0.4	0.4	0.4			
TIRW1201	0.1	0.1	0.1	0.0	0.0	0.0	19.3	19.3	19.3	80.6	80.6	80.6	0.0	0.0	0.0	0.0	0.0	0.0	999	999	999	0.5	0.5	0.5			
TIRW1204	0.1	0.1	0.1	0.0	0.0	0.0	19.3	19.3	19.3	80.6	80.6	80.6	1.0	1.0	1.0	0.0	0.0	0.0	999	999	999	0.5	0.5	0.5			
TIRW1205	0.1	0.1	0.1	0.0	0.0	0.0	19.3	19.3	19.3	80.6	80.6	80.6	1.0	1.0	1.0	0.0	0.0	0.0	999	999	999	0.5	0.5	0.5			
TIRW1206	0.2	0.2	0.2	0.1	0.1	0.1	19.3	19.3	19.3	80.4	80.4	80.4	1.0	1.0	1.0	0.0	0.0	0.0	1000	1000	1000	0.4	0.4	0.4	2.0	2.0	2.0
TIRW12A6	0.1	0.1	0.1	0.0	0.0	0.0	19.3	19.3	19.3	80.6	80.6	80.6	1.0	1.0	1.0	0.0	0.0	0.0	999	999	999	0.3	0.3	0.3			
TIRW12A7	0.4	14.1	40.5	5.4	14.2	31.1	0.3	10.3	20.2	28.1	61.4	82.1	3.0	5.3	7.0	0.0	0.3	1.0	998	1011	1021	-16.1	-4.5	3.6	0.1	0.5	1.3
TIRW12A8	0.1	0.1	0.1	0.0	0.0	0.0	19.3	19.3	19.3	80.6	80.6	80.6	1.0	1.0	1.0	0.0	0.0	0.0	999	999	999	0.4	0.4	0.4			

Appendix C – Water Monitoring Data

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Tir John Closed Landfill Site
Leachate Quality Summary January - December 2021

Sample Point	Date	pH	EC	NH_4-N	COD	BOD	TOC	Ca	Mg	Na	K	Cl	SO_4	Alkalinity	Fe	Mn	Cd	Hg	Cr	Cu	Ni	Zn	Pb	As
			uS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
HWM04A	10/11/2021	7.1	1800	10	4000	59	39.8	360	60	140	42	120	41.8	1300	2.60	3.800	<0.00002	0.000006	0.010	0.002	0.007	0.010	0.0016	0.022
HWM07	26/05/2021	6.8	3100	250	880	61	66.6	150	57	140	140	180	8.42	1500	19.00	2.000	<0.00002	0.0000176	0.007	0.001	0.006	0.002	< 0.0002	0.009
HWM07	10/11/2021	6.6	1300	13	220	< 1	19.7	250	41	47	26	32	109	660	0.09	2.600	<0.00002	<0.000005	0.005	0.003	0.003	0.006	0.0003	0.032
HWM08A	26/05/2021	6.7	2000	33	150	5.1	30.7	140	40	390	33	140	8.96	1000	1.60	0.900	<0.00002	0.0000069	0.009	0.002	0.006	0.001	0.0002	0.007
HWM08A	10/11/2021	7	1800	19	9300	53	46.5	150	42	270	28	110	5.16	1100	17.00	1.400	<0.00002	<0.000005	0.010	0.002	0.009	0.003	0.0005	0.080
HWM11	26/05/2021	7.4	1300	0.32	96	1.8	14.8	260	30	60	17	57	467	430	0.04	0.004	0.00005	0.0000056	0.002	0.006	0.007	0.003	< 0.0002	0.001
HWM11	10/11/2021	7.9	1100	0.29	59	1.3	15.3	260	24	51	14	31	390	330	0.03	0.004	0.00004	<0.000005	0.002	0.014	0.004	0.005	< 0.0002	0.027
HWM12	26/05/2021	7.5	1700	0.15	100	2.3	23.4	480	38	80	18	44	608	550	0.02	0.003	0.00016	0.0000101	0.003	0.038	0.009	0.010	0.0002	0.009
HWM12	10/11/2021	7.4	1700	0.13	82	1.4	36.3	510	48	110	19	55	877	510	0.18	0.083	0.00010	<0.000005	0.003	0.019	0.007	0.009	< 0.0002	0.039
HWM13	26/05/2021	7.2	3000	99	140	28	27.9	200	130	210	160	320	458	1100	0.07	1.100	<0.00002	0.0000056	0.003	0.002	0.020	0.014	0.0010	0.009
HWM13	10/11/2021	7.3	2800	110	360	39	34.7	190	130	200	150	340	223	1400	0.08	1.100	<0.00002	<0.000005	0.008	0.002	0.018	0.015	0.0046	0.078

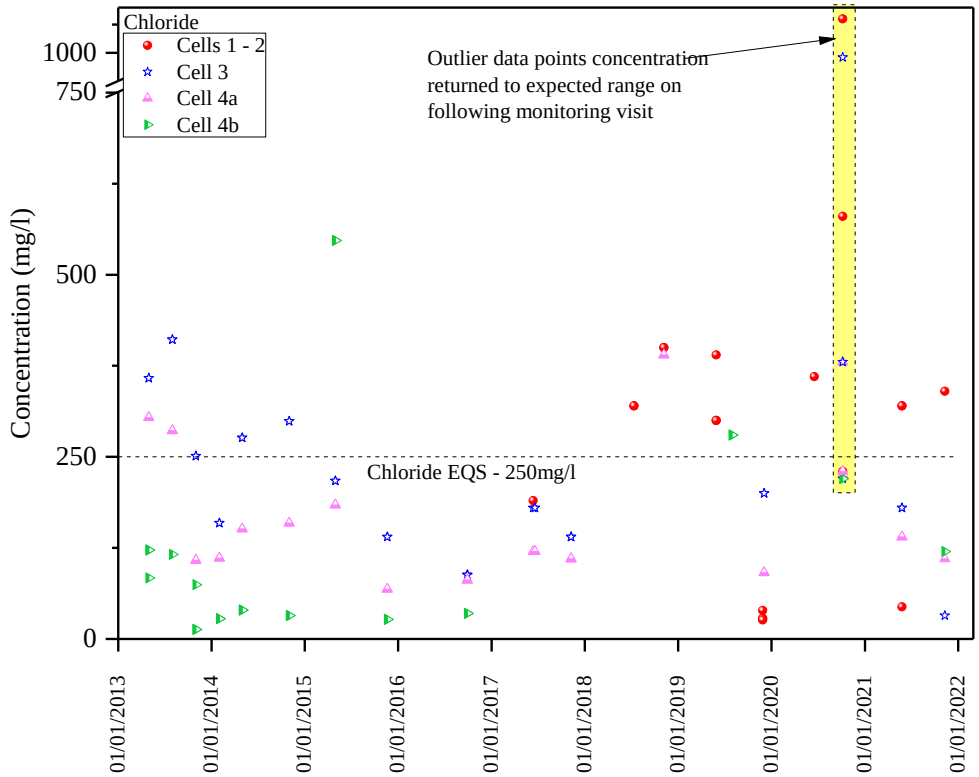

Figure C.9 – Leachate Chloride

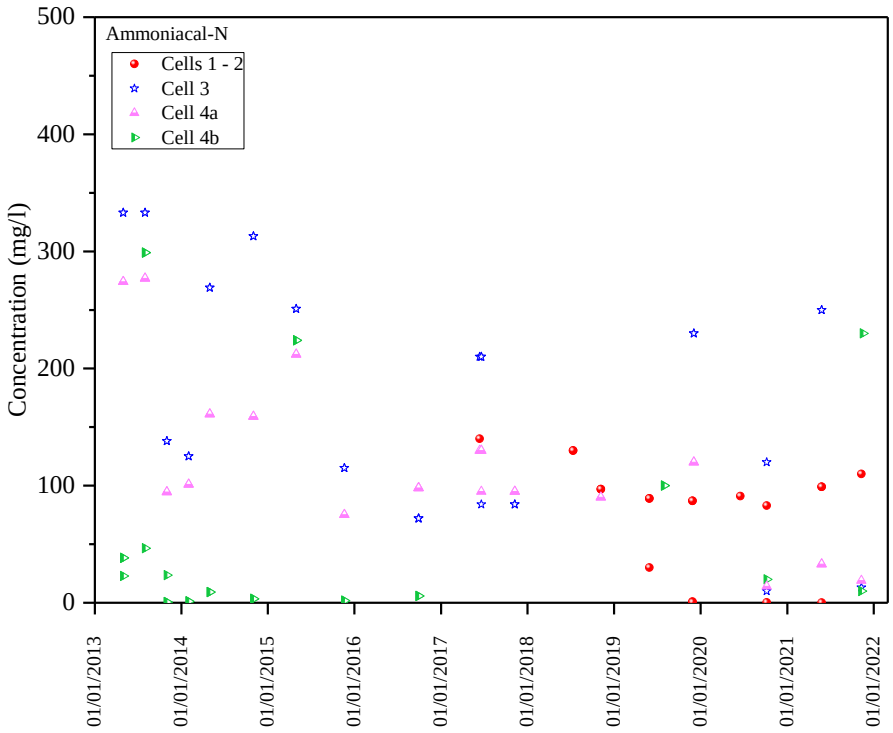

Figure C.10 – Leachate Ammoniacal-N

BYRNELOOBY

Tir John Closed Landfill Site
Groundwater Quality Summary January - December 2021

Sample Point	Date	pH	EC	NH_4-N	COD	BOD	TOC	Ca	Mg	Na	K	Cl	SO_4	Alkalinity	Fe	Mn	Cd	Hg	Cr	Cu	Ni	Zn	Pb	As	MCPP
			uS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	ug/l
GDW01(D)	16/02/2021	7.4	800	2.2	850	19	6			64	25	60			0.01	0.3	0.00010	< 0.0001	0.004	0.0008		0.005	0.0005	0.0099	<0.02
	19/05/2021	7.4	700	2.7	610	< 1	5	89	20	58	23	54	30	330	0.06	0.2	<0.00002	<0.000005	0.003	0.0011	0.0009	0.001	< 0.0002	0.0053	< 0.02
	10/08/2021	7.6	670	1.6	4700	11	6			49	22	39			0.01	0.5	0.00018	<0.000005	0.004	0.0015		0.007	0.0003	0.0227	< 0.02
	12/10/2021	7.6	590	1.1	4300	43	6			60	23	44			0.08	0.4	0.00012	0.0000145	0.003	0.0011		0.003	< 0.0002	0.0097	< 0.02
GDW01(S)	16/02/2021	8.5	440	0.7	800	7	3			53	21	46			0.01	0.1	0.00010	< 0.0001	0.002	0.0006		0.001	<0.0002	0.0250	<0.02
	19/05/2021	7.5	650	2.0	230	3	2	82	20	58	23	51	31	310	0.08	0.1	<0.00002	<0.000005	0.003	0.0008	0.0007	0.001	< 0.0002	0.0200	< 0.02
	10/08/2021	7.4	710	2.9	700	10	6			54	22	54			0.01	0.3	0.00010	<0.000005	0.004	0.0022		0.009	< 0.0002	0.0144	< 0.02
	12/10/2021	7.8	530	1.5	2900	25	1			69	23	45			< 0.004	0.2	0.00008	0.0000169	0.003	0.0011		0.003	< 0.0002	0.0156	< 0.02
GDW02(D)	16/02/2021	6.6	1100	6.0	95	33	2			32	28	30			0.06	2.8	0.00004	< 0.0001	0.007	0.0016		0.007	0.0002	0.0087	<0.02
	19/05/2021	6.5	980	6.4	70	41	8	180	41	42	26	34	171	510	0.82	4.1	0.00004	<0.000005	0.007	0.0016	0.0029	0.004	< 0.0002	0.0105	< 0.02
	10/08/2021	6.6	970	11.0	59	19	5			48	21	50			0.02	4.2	<0.00002	<0.000005	0.009	0.0029		0.009	< 0.0002	0.0014	< 0.02
	12/10/2021	6.5	980	8.9	290	20	13			58	26	43			0.40	3.7	<0.00002	0.0000084	0.009	0.0009		0.004	< 0.0002	0.0044	< 0.02
GDW02(S)	16/02/2021	6.8	2300	19.0	700	40	3			180	49	170			0.20	0.9	0.00004	< 0.0001	0.014	0.0026		0.006	0.0004	0.0037	<0.02
	19/05/2021	7.0	1900	17.0	460	17	6	340	62	180	51	180	269	970	1.10	0.9	<0.00002	0.0000095	0.008	0.0029	0.0029	0.003	< 0.0002	0.0054	< 0.02
	10/08/2021	6.9	1900	18.0	240	21	6			190	47	180			0.05	0.8	<0.00002	<0.000005	0.007	0.0024		0.008	< 0.0002	0.0020	< 0.02
	12/10/2021	6.9	1500	17.0	520	6	5			240	52	180			0.20	0.8	<0.00002	0.0000137	0.012	0.0015		0.011	< 0.0002	0.0017	< 0.02
GDW03(D)	16/02/2021	6.3	500	11.0	150	10	4			22	4	27			0.12	0.9	<0.00002	< 0.0001	0.005	0.0005		0.004	<0.0002	0.0006	<0.02
	19/05/2021	6.3	460	11.0	140	11	10	38	20	20	4	26	1	250	0.14	0.8	<0.00002	0.0000107	0.004	0.0007	0.0015	0.006	< 0.0002	0.0010	< 0.02
	10/08/2021	6.4	500	11.0	190	3	14			20	4	27			0.05	0.7	<0.00002	<0.000005	0.005	0.0019		0.007	< 0.0002	0.0007	< 0.02
	12/10/2021	6.3	550	11.0	130	33	10			22	6	27			35.00	0.6	<0.00002	0.0000129	0.005	0.0014		0.009	< 0.0002	0.0006	< 0.02
GDW03(S)	16/02/2021	7.2	830	25.0	81	6	4			33	22	30			0.25	1.6	<0.00002	< 0.0001	0.005	0.0013		0.004	<0.0002	0.0014	<0.02
	19/05/2021	7.4	820	23.0	190	2	4	120	19	33	25	34	73	460	0.05	1.7	<0.00002	<0.000005	0.003	0.0011	0.0017	0.003	< 0.0002	0.0013	< 0.02
	10/08/2021	7.4	740	17.0	120	5	5			23	20	30			0.02	1.3	<0.00002	<0.000005	0.005	0.0030		0.009	0.0005	0.0025	< 0.02
	12/10/2021	7.4	810	23.0	14	< 1	5			27	24	29			0.04	2.1	<0.00002	0.0000103	0.004	0.0019		0.004	< 0.0002	0.0018	< 0.02
GDW21	16/02/2021	6.5	1600	24.0	590	11	10			200	47	300			0.18	0.3		< 0.0001						0.0042	
	19/05/2021	6.7	1400	27.0	1200	26	21	53	33	230	46	330	27	450	0.08			0.0000058				0.006		0.0069	< 0.02
	10/08/2021	6.6	1500	25.0	1400	17	19			200	44	260			0.46			<0.000005						0.0050	
	12/10/2021	6.6	1200	22.0	1100	5	8			170	52	210			5.80			0.0000106						0.0037	
GDW23	16/02/2021	6.6	320	0.2	31	<1	1			16	3	20			<0.004	2.9		< 0.0001						0.0003	
	19/05/2021	7.0	280	0.1	83	4	1	24	17	15	3	19	46	95	0.01			<0.000005				0.004		0.0002	< 0.02
	10/08/2021	6.7	320	0.1	60	< 1	7			16	3	20			0.02			<0.000005						0.0003	
	12/10/2021	6.7	320	0.1	61	< 1	2			15	3	20			0.01			0.0000089						0.0007	
GDW24(D)	16/02/2021	6.8	1600	49.0	21	10	3			130	74	120			0.01	0.5		< 0.0001						0.0028	
	19/05/2021	6.7	1500	56.0	16	1	4	130	40	130	69	140	48	770	0.28			<0.000005				0.007		0.0042	< 0.02
	10/08/2021	6.9	1400	57.0	37	< 1	5			100	74	100			0.12			<0.000005						0.0041	
	12/10/2021	6.8	1400	58.0	57	2	17			140	78	120			0.07									0.0014	
GDW24(S)	16/02/2021	6.7	1700	55.0	56	6	3			110	60	120			0.43	0.7		< 0.0001						0.0056	
	19/05/2021	6.7	1400	47.0	15	1	9	130	36	99	56	110	59	690	0.07			<0.000005				0.004		0.0026	< 0.02
	10/08/2021	6.6	1900	80.0	200	2	7			150	77	170			0.25			<0.000005						0.0040	
	12/10/2021	6.8	1400	48.0	39	< 1	3			120	67	120			0.09			0.0000174						0.0034	
GDW25	16/02/2021	6.9	2700	13.0	760	22	3			250	72	190			0.02	0.5		< 0.0001						0.0130	
	19/05/2021	6.9	2200	14.0	1100	41	8	480	120	200	59	190	698	1200	0.10			0.0000096				0.004		0.0098	< 0.02
	10/08/2021	7.0	2400	18.0	650	27	7			190	43	190			0.03			<0.000005						0.0072	
	12/10/2021	7.1	1700	18.0	560	< 1	6			200	53	180			0.04			0.0000123						0.0038	
GDW26	16/02/2021	6.9	860	9.7	16	8	2			110	35	64			0.20	0.4		< 0.0001						0.0006	
	19/05/2021	6.9	860	9.7	85	11	4	480	120	200	58	190	701	1100	0.01			<0.000005				0.011		0.0006	< 0.02
	10/08/2021	7.0	860	10.0	45	7	4			74	32	68			0.73			<0.000005						0.0021	
	12/10/2021	7.0	810	12.0	140	4	8			100	44	76			0.05			0.0000109						0.0016	
TIR JB1	16/02/2021	7.5	350	0.5	9.4	8	1			13	3	19			0.01	0.1		< 0.0001						0.0007	
	19/05/2021	7.5	330	0.2	5.5	2	1	29	22	12	4	18	14	160	0.48							0.001			< 0.02
	10/08/2021	7.4	350	0.2	30	2	2			12	3	18			0.03										
	12/10/2021	7.5	350	0.3	15	1	3			13	4	19			0.04										

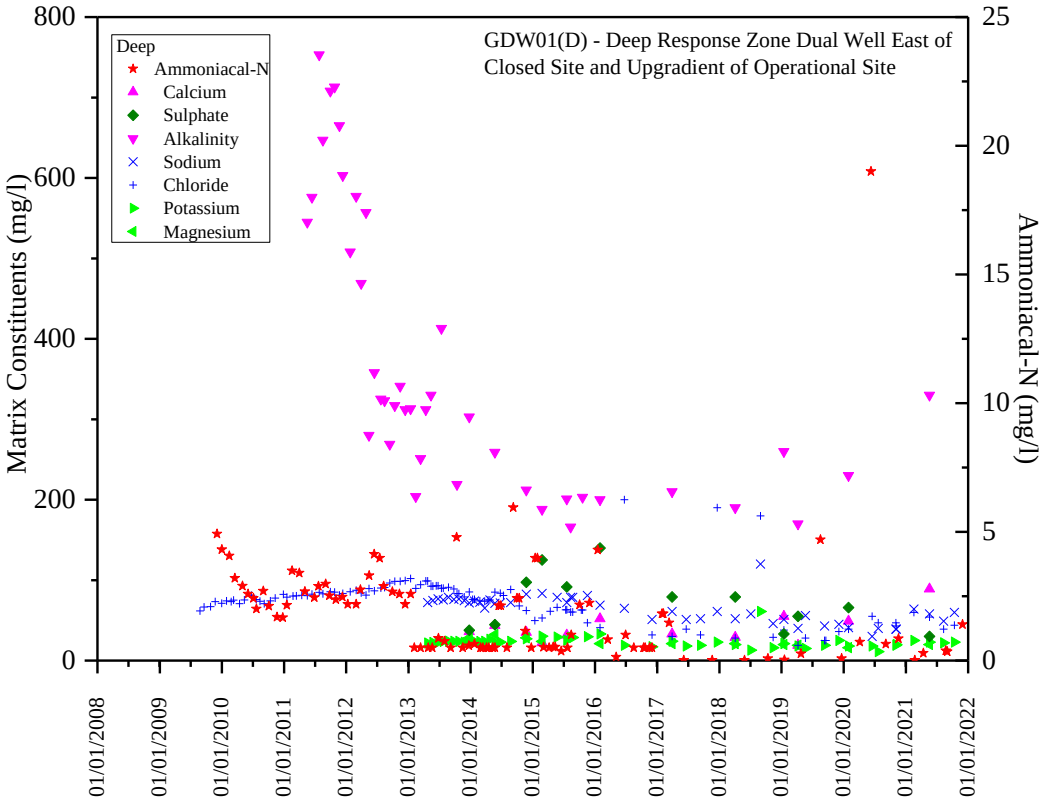

Figure C.11 – Groundwater Monitoring Point GDW01D

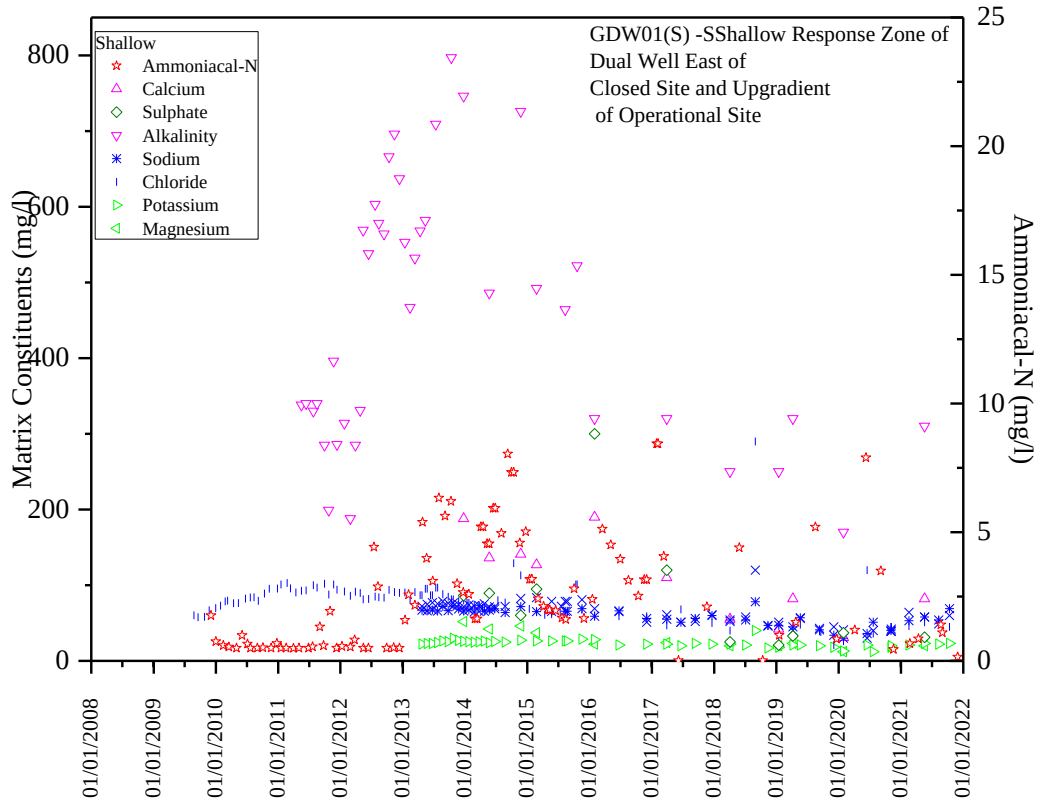

Figure C.12 – Groundwater Monitoring Point GDW01S

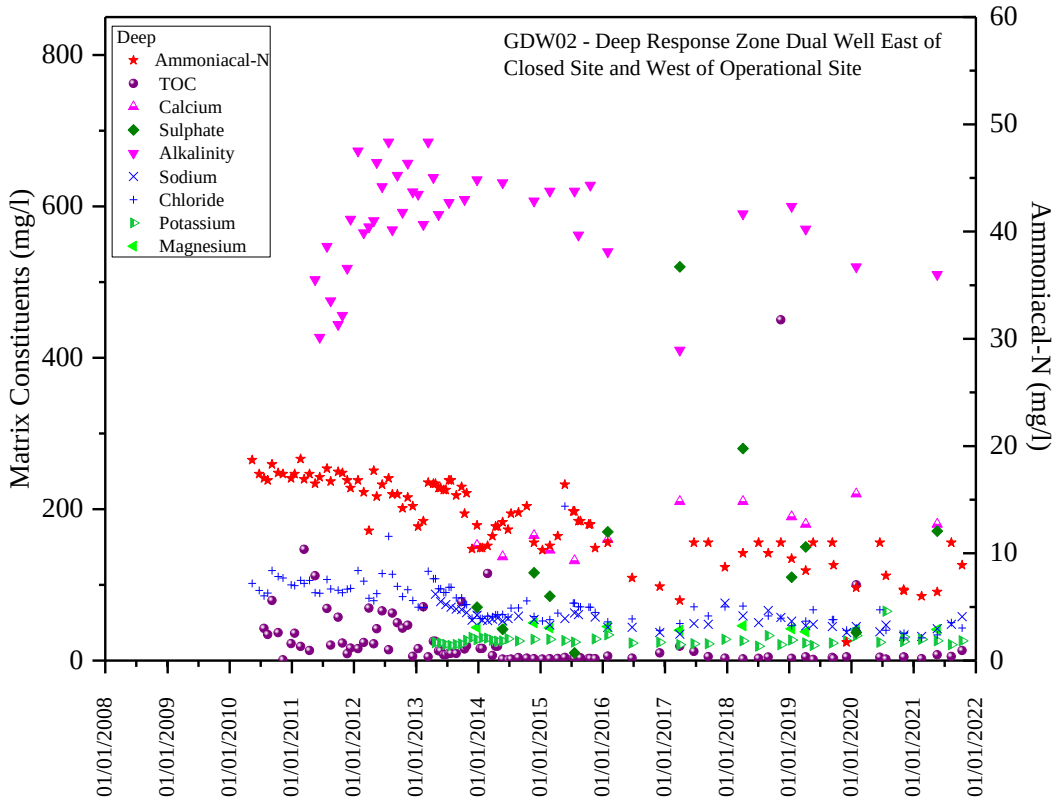

Figure C.13 – Groundwater Monitoring Point GDW02D

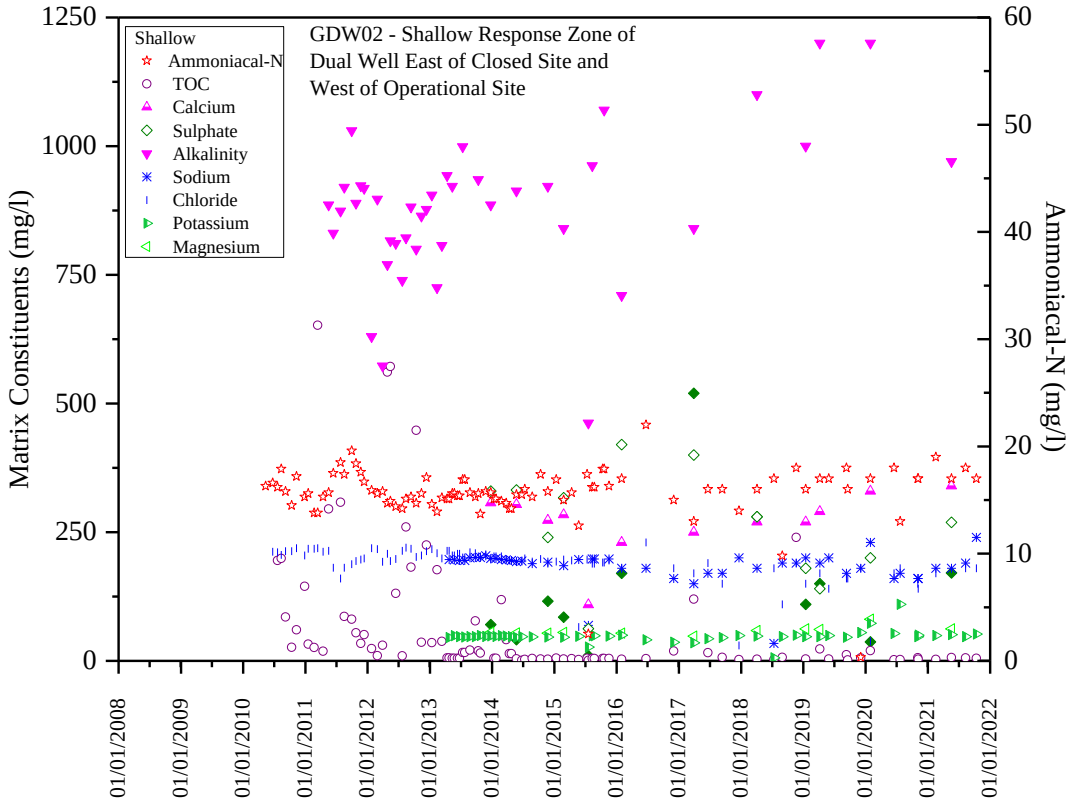

Figure C.14 – Groundwater Monitoring Point GDW02S

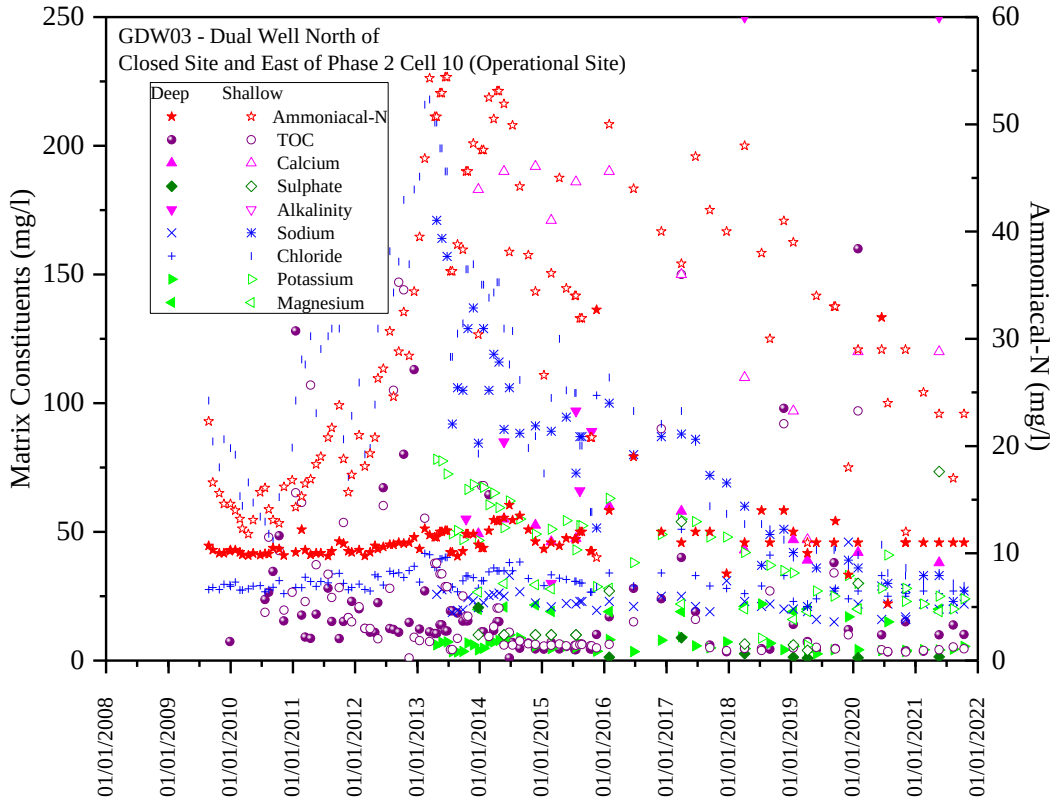

Figure C.15 – Groundwater Monitoring Point GDW03

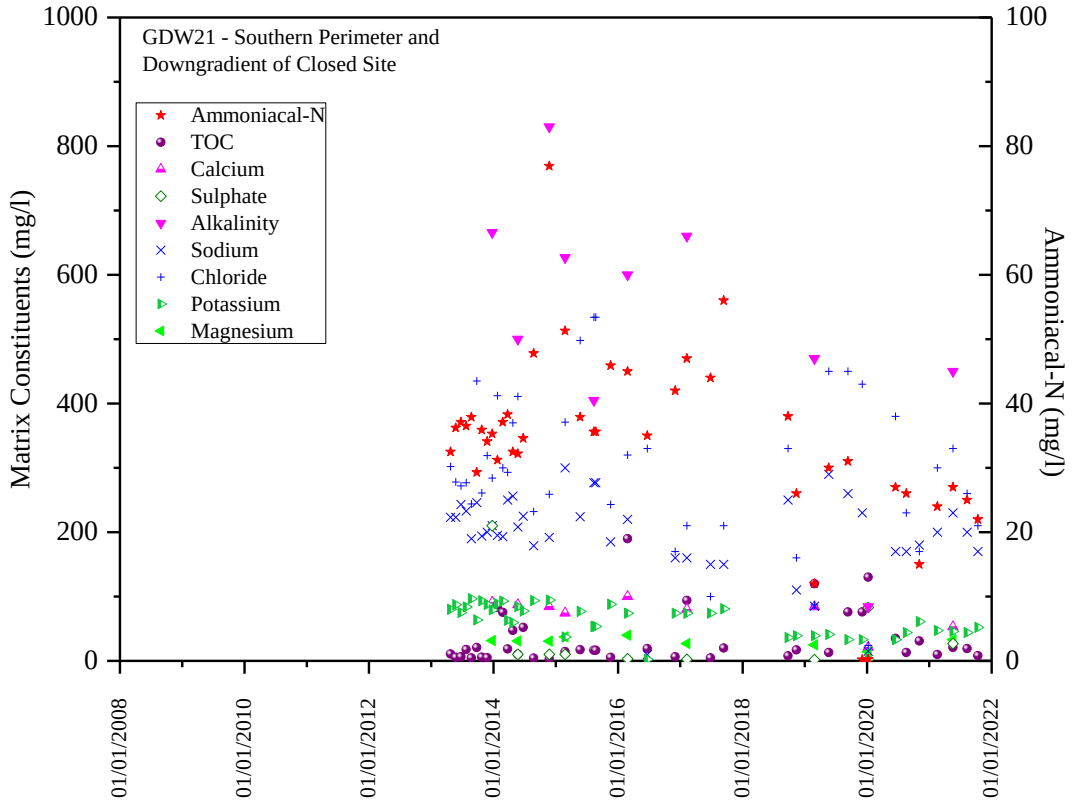

Figure C.16 – Groundwater Monitoring Point GDW21

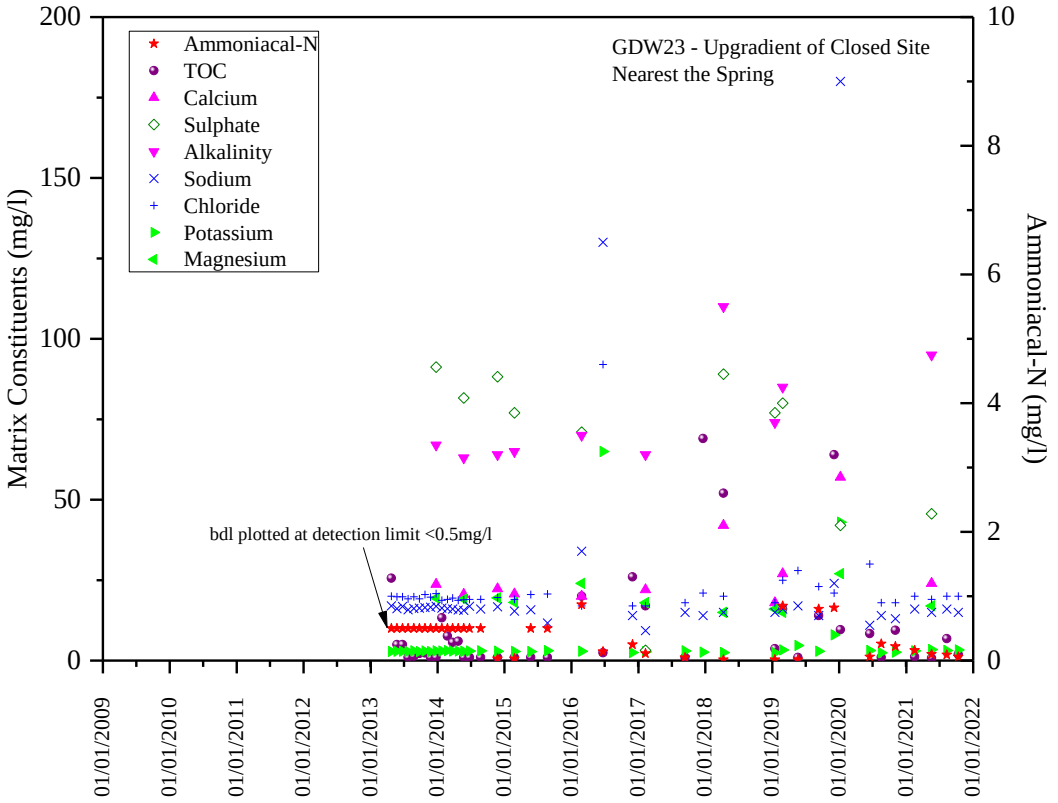

Figure C.17 – Groundwater Monitoring Point GDW23

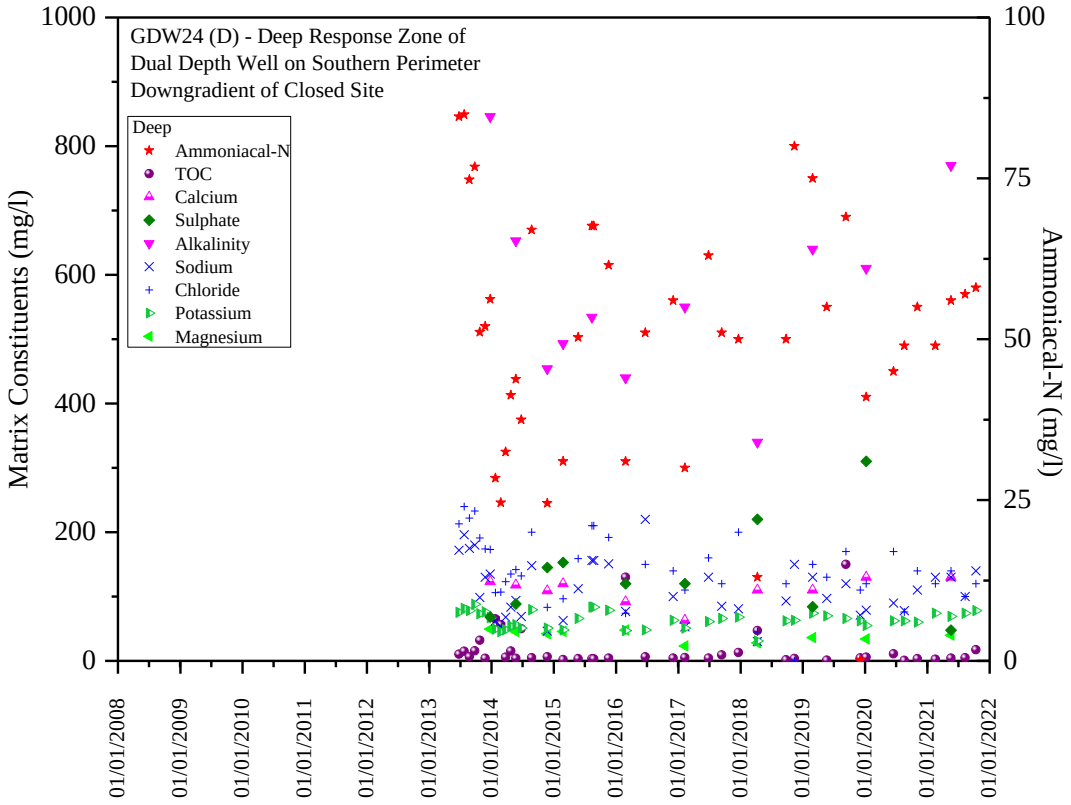

Figure C.18 – Groundwater Monitoring Point GDW24D

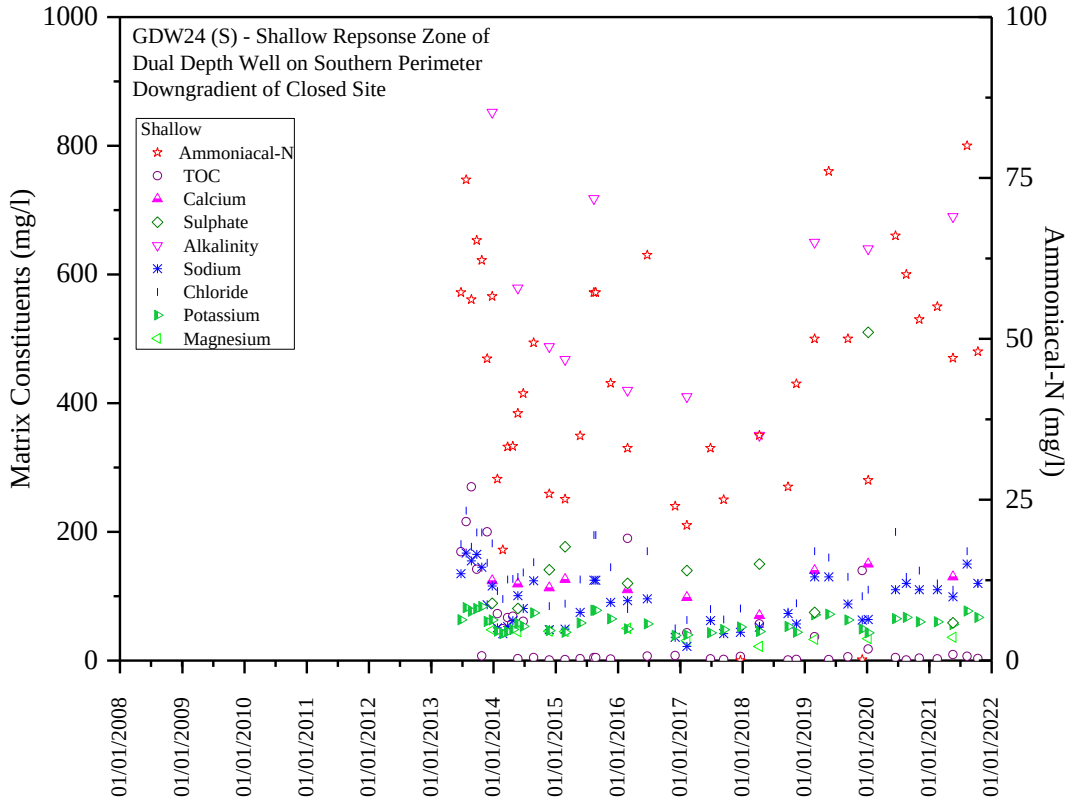

Figure C.19 – Groundwater Monitoring Point GDW24S

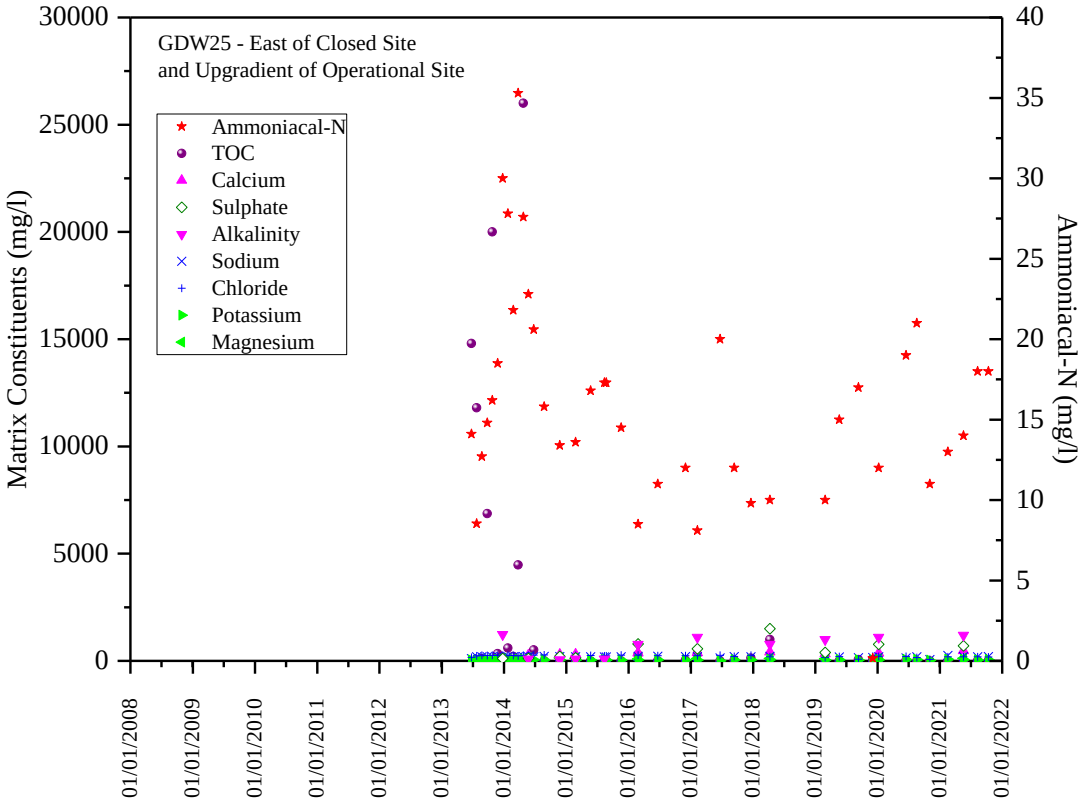

Figure C.20 – Groundwater Monitoring Point GDW25

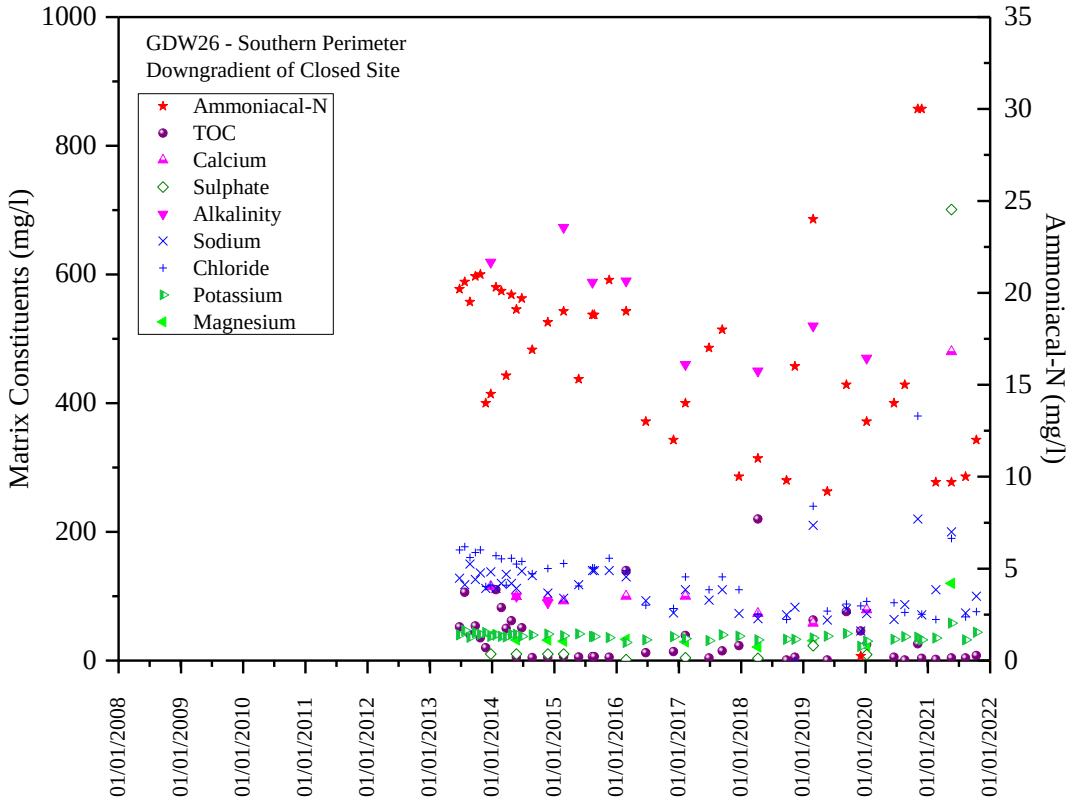

Figure C.21 – Groundwater Monitoring Point GDW26

Drawings

N

Key

- Permit Boundary
- Leachate extraction sump
- Leachate monitoring well
- Surface water monitoring point
- Ground water monitoring borehole
- Gas monitoring borehole
- Drainage sump
- ( ) Not in use

EMT7
GDW4
SW2
GDW5
GDW6
GDW7
LFG15
LFG16
LFG17
GDW8
GDW9
LFG18
SW3
LFG19
GDW10
Cell 14
Cell 13
LFG14
LFG20
GDW11
PCS (North)
LFG13
JB5
LEW28
LEW13A
LEW29
LEW14A
LEW30
LEW14
LEW31
LEW32
Cell 15
LEW27
LEW15
GDW12
LEW12A
Cell 15E
LEW13
LEW11A
Cell 12
LEW33
LEW11(PPC4)
Cell 11
LEW26
LEW16
LEW09B
Cell 16
(Operational)
GDW13
BH16A/PCS
PCS (MID)
LFG24
JB1
LEW34
BH16B/PCS
LEW10
Cell 9
LEW24
EMT2N
GDW3 (S)
GDW3 (D)
LEW9A
SW5
GDW14 (R)
SW1
IPDS
LEW10A
Cell 10
PCS (South)
Cell 4a
HWM8R
LEW8
Cell 8
LEW23
LEW25
GDW15(R)
BH5W
GDW23
LEW 5 (PPC2)
Cell 3
GDW2 (S)
GDW2 (D)
LEW22
Cell 7
HWM7
LEW7
GDW16
EMT6
HWM5R
GDW1 (S)
GDW1 (D)
LEW5A
HWM4R
LEW6
Cell 5
LEW20
Cell 4b
LFG8
GDW17
LEW21
HWM9A
Cell 6
HWM6A
Cell 2
SW4
HWM11
Cell 1b
LFG7
LFG21
GDW25
HWM10
Cell 1a
HWM12
HWM13
(JB3)
GDW18
LFG6
LFG22
LFG5
LFG4
LFG3
LFG23
LFG2
LFG1
GDW21
GDW26
GDW24
Walkway
Wheelwash
Weighbridge
Site Car Park
Walkway
EMT1N
EMT5
Crymlyn Bog
Tennant Canal (disused)
Sewer Discharge Sample Point
Outdoor Centre
DINAM ROAD
Cwmbach
Cae-merch Einon
Pen-y-graig Isaf
TERRACE
TIR JOHN NORTH ROAD
Car Park
Playing Fields
MARCROFT ROAD
RUSTON ROAD
Pav
Playing Fields
Gelli'r-

Enovert
Units 3-5 Greyfriars Business Park,
Frank Foley Way, Stafford, ST16 2ST
Tel: 01785 251555

Revision	Details

Site: **TIR JOHN**

Title: **Environmental Monitoring Locations**

Drawn:	Date:	Scale @A1:
TJG	18-1-22	1:2000

Drawing number **TJ66**

Key

- Permit Boundary
- Settlement Calculation Location
- 5m contour line
- 1m contour line

Tir John Settlement Dec 20 to Feb 22

			Dec-20	Feb-22				
Point	E	N	10/02/2020	11/02/2022	Basal	**Settlement**	Depth of Waste	**Settlement**
	(m)	(m)	(mAOD)	(mAOD)	(mAOD)	**(m)**	(m)	**(%)**
1	269161.6	193897.6	38.661	38.286	10.983	0.375	27.678	1.4%
2	269131.8	193977.9	37.543	37.31	10.367	0.233	27.176	0.9%
3	269225.9	194055.8	32.783	32.574	10.507	0.209	22.276	0.9%

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Tel: 01785 251555

Revision:	Details:

Site: **TIR JOHN**

Title: **Site Survey**

Drawn	Date:	Scale @A4:
TJG	23-2-22	1:5000

Drawing number **TJ67**

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