

Gove Peninsula Waste Management Facility

Leachate, Surface Water, Groundwater and Landfill Gas Monitoring Report 2023



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**Gove Peninsula Waste Management Facility –
Leachate, Surface Water, Groundwater and Landfill Gas Monitoring Report 2023**

Report Title:	Leachate, Surface Water, Groundwater and Landfill Gas Monitoring Report 2023
Project:	Gove Peninsula Waste Management Facility
Client:	Nhulunbuy Corporation
Report No.:	115005_REO_009_REV 1
Draft/Final:	Final

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Table of Revisions for Document No. 115005_REO_008_REV 1

Revision	Date	Description	Author	Reviewer	Approved
A	15/9/2023		B. Campbell	Shane Whitten	
1	15/9/2023	Final	B. Campbell		

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Introduction

1.1 Introduction

East Coast Environmental Pty Limited was commissioned by Nhulunbuy Corporation (NC) to prepare a Leachate, Surface Water, Groundwater and Landfill Gas Monitoring Report for the Gove Peninsula Waste Management Facility, hereafter referred to as the Water and Gas Monitoring Plan (WGMP).

The preparation of the monitoring report is required to satisfy conditions of the Northern Territory Environmental Protection Licence (EPL236) issued for the facility.

The objective of this monitoring is to identify the movement of any potential contaminants that may emanate from the landfill operations and enter pathways that could potentially affect the human and environment receptors in the local area.

This Monitoring Report provides details on the;

- location undertaken for monitoring,
- methodology for each monitoring type (Leachate, Surface water, Groundwater and Landfill gas)
- parameters monitored for each of the environmental aspects,
- results for the monitoring period.

The Monitoring report has been prepared generally in accordance with;

- Northern Territory Environment Protection Authority (2013) *Guidelines for the Siting, Design and Management of Solid Waste Disposal Sites in the Northern Territory*
- Northern Territory Environment Protection Authority (2016) *Guideline for Reporting on Environmental Monitoring*
- Northern Territory Environment Protection Authority (2013) *Guidelines for Consultants Reporting on Environmental Issues*
- East Coast Environmental (2016) *Gove Peninsula Waste Management Facility -Conceptual Site Model;*
- East Coast Environmental (2016) *Gove Peninsula Waste Management Facility - Landfill Gas Assessment*

1.2 Outline of the WGMP

The report is structured as follows:

Section 2 – Provides the site context, a description of the sites location and the operational history of the site,

Section 3 – Details the gas sampling methodology undertaken and the modelling approach used for the Landfill Gas Assessment,

Section 4 – Provides a summary of the results of the initial Landfill Gas sampling and landfill Gas generation modelling,

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Section 5 – Provides a discussion of the results, landfill gas risk and mitigation/ management measures,

Section 6 – Details the conclusions of the Landfill Gas Assessment.

1.3 Site Context

The site is located approximately 3km southeast of the Nhulunbuy Post Office, approximately 4.3km by road. The site is situated within the current Mineral Reserve R0238 and is adjacent to the Nhulunbuy Speedway on Melville Bay Road.



Figure 1: Locality plan of Gove Peninsula Waste Management Facility.

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1.3.1 Site Hydrology and Hydrogeology

Hydrology

No surface water was encountered during the 2003 or 2016 site investigations and the site lacked any natural incised drainage channels or creeks. Evidence of channelised flow was only found along road sides and constructed drainage channels emanating from table drains from the internal access roads and hardstand areas.

Water flow is expected to occur during the wet season as either sheet flow or subsurface water flow, and due to the lack of erosional features or channels is expected to slow, with high percentage of infiltration. The surface water flow direction has been inferred using recent Digital Surface Mapping (DSM) undertaken during the drilling program and baseline groundwater sampling conducted in July 2016. The inferred surface water flow direction is expected to travel in an east to west direction as shown by the direction of surface flows and the DSM is shown in **Figure 2**.

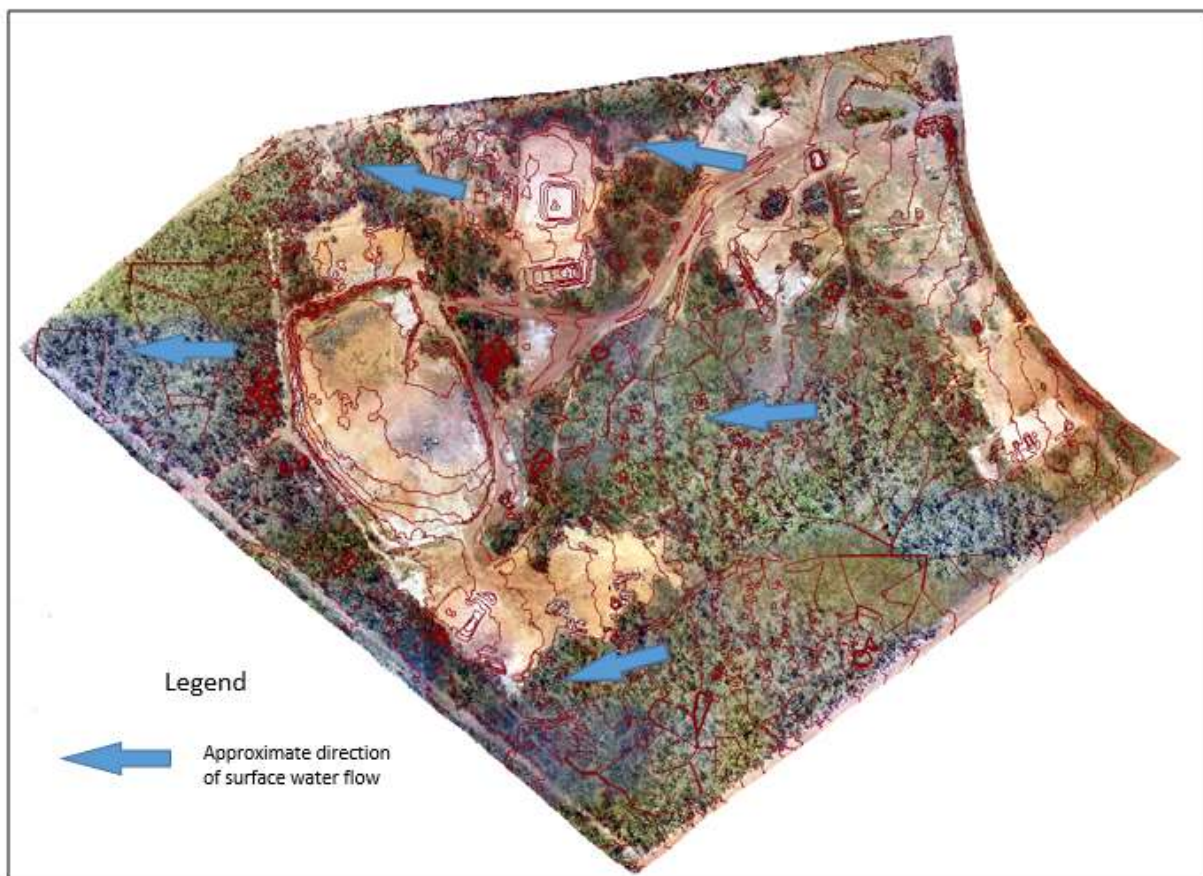


Figure 2: Inferred direction of surface flows and DSM at Gove Peninsula Waste Management Facility

Groundwater and Hydrogeology

Groundwater was encountered at boreholes deeper than 6m below ground level during the 2003 drilling program. The groundwater depth was identified by the “balling” of returned cuttings during the drilling program as standing water was only recorded in one borehole during the program and therefore a piezometric surface could not be determined across the site (GHD 2003).

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1.4 Weather and recent Climate

1.4.1 Northern Territory Wet Season (October to April 2022-23)

The wet season 2022-2023 rainfall was above average for most of the Northern Territory, with the central two-thirds of the Territory recording very much above average seasonal rainfall. Territory-wide and was the sixth-highest on record, and the wettest since 2010/11.

Mean seasonal maximum temperatures were below average for the southern two-thirds of the Territory, whilst the Arnhem and coastal Carpentaria districts saw warmer than normal mean maxima. Territory-wide, the mean maximum temperature for the season was 0.6 °C below the 1961–1990 average, the coolest since the wet season of 2010–2011. Mean seasonal minimum temperatures were above average in the north and far south of the Territory, whilst cooler than normal mean minima were observed in the Tanami district.

Territory-wide, the seasonal minimum temperature for the season was 0.16 °C above the 1961–1990 average, but it was the coolest since the wet season of 2011–2012.

In 2022, Gove Airport received 1838.8 mm of rainfall, higher than average (Annual Average 1444.7mm. 127% of Annual Average) and highest rainfall for a single day was 304.0 mm at Gove Airport Met Office on 18 Apr 2023.

The Recent Climate averages for Gove Airport are shown in Table 1 below and the Rainfall for 2022 and 2022 to date are included in Figures 3a, 3b and 3b noting that the Observations from Gove Airport Met Office (14508) continue until April but have been replaced by a new met site at Gove Airport (14412) which opened on 21 April 2023.

Table 1: Climate Averages for Recent years at Gove Airport

Years	Maximum temperatures (°C)		Minimum temperatures (°C)		Rainfall (millimetres)			
	Mean	Diff from Average	Mean	Diff from Average	Total	Annual Average Total	Rank	Fraction of Average
2018	31.6	+0.8	23.0	+0.6	1257.4	1446.4	low	87%
2019	31.2	+0.4	22.7	+0.2	1373.8	1444.5	average	95%
2020	31.7	+0.9	23.7	+1.2	933.8	1431.8	v low	65%
2021	31.7	+0.9	23.8	+1.3	1566.0	1435.1	average	109%
2022	31.6	+0.8	23.8	+1.3	1838.8	1444.7	high	127%
2023 (Jan – April 23)	31.4	+0.6	24.7	+2.3	1326	1052.1	high	126%

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Rainfall 2022

During 2022 Gove Airport weather station recorded an average rainfall, as a result of significant rainfall in December 2021. The preceding Wet season was below average however these falls in December raised annual totals for Gove (BOM 2022)

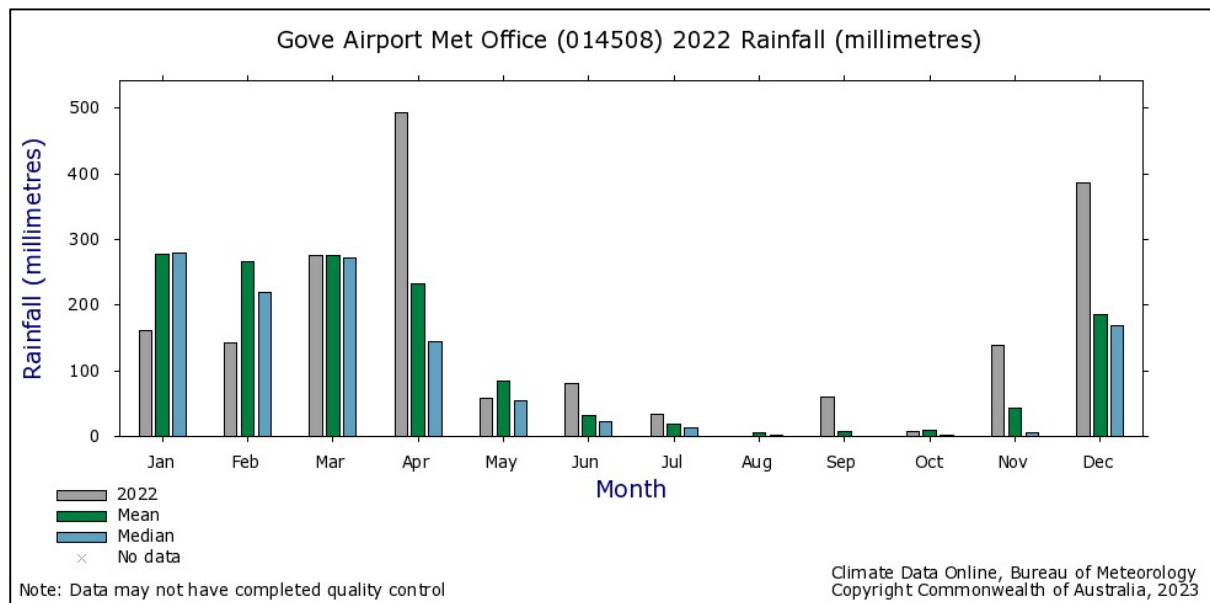


Figure 3a: Rainfall Data 2022 at Gove Airport Met office

Rainfall 2022 (Jan- August 2022)

Rainfall associated with the Monsoonal conditions were generally below average for January and February however rainfall increased in March and, rainfall in April exceeded averages by more than double.

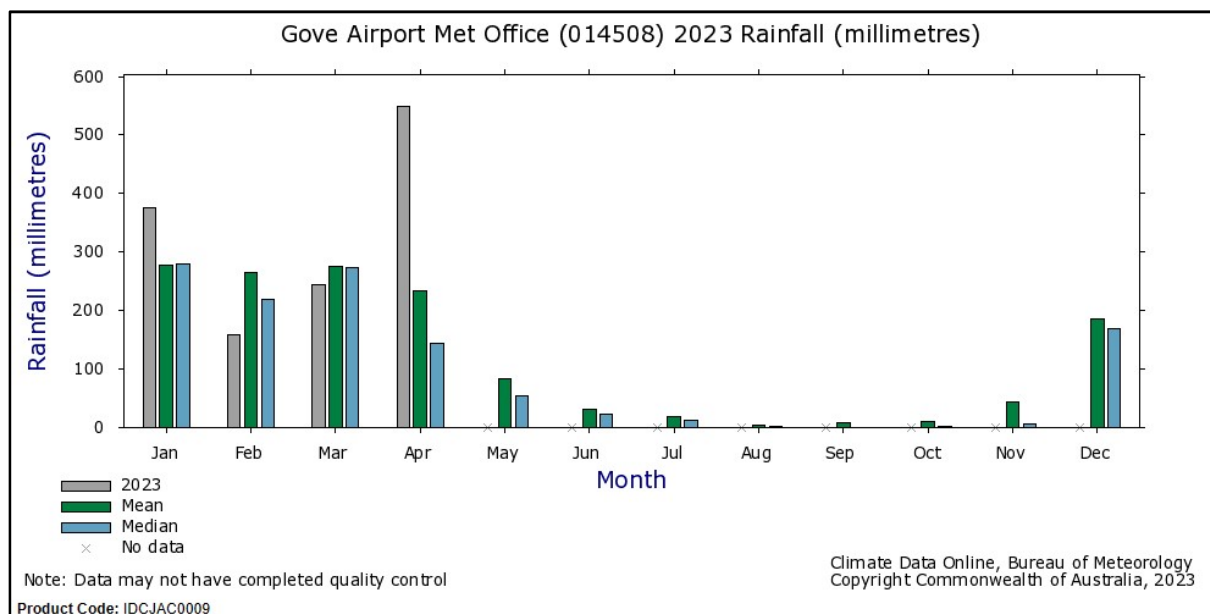


Figure 3b: Rainfall Data January to April 2023 at Gove Airport (old Met site)

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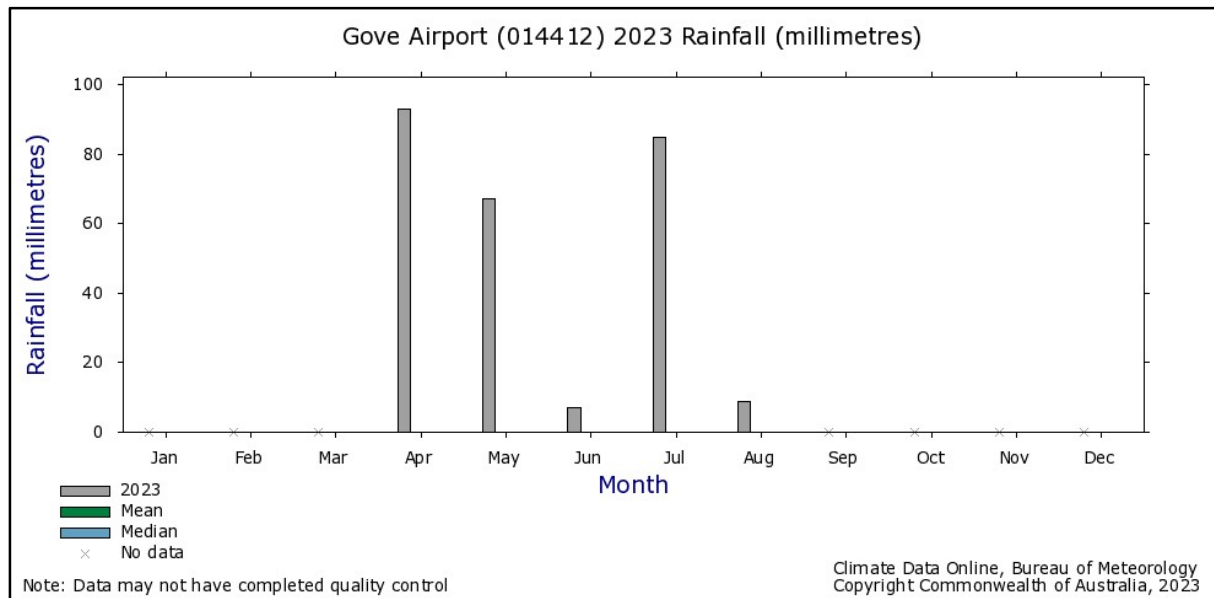


Figure 3c: Rainfall Data April to August 2023 at Gove Airport (new Met site)

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Methodology

The 2023 monitoring was undertaken over a two day period on the 22nd and 23rd August 2023. The following provides the methods employed for Leachate, Surface Water, Groundwater and Landfill Gas Monitoring.

2.1 Landfill Gas Monitoring

The Landfill Gas Monitoring sampling approach was to identify the gas concentrations within the landfill cells and whether any vertical or horizontal LFG migration could be detected. The sampling of the Leachate/LFG monitoring bores was conducted on the two new Landfill Gas boreholes, and three shallow bores (to 5.5m) installed in 2003 at the base of the landfill cells.

The dedicated Landfill Gas Monitoring was conducted at two wells was installed into the centre of each of the two capped landfill cells, to a depth of approximately 6m below ground surface within the waste mass and at 3 shallow Leachate wells to determine if any migration of Landfill gas was occurring.

All bores were fitted with an Ex Cap Vapour extraction 2" Locking Monitoring Well Expansion Plug, with Air Sampling Ports and the insitu gas composition was analysed at all five bores and the two ambient air sampling sites using the Landtec GA5000 Portable Landfill Gas Analyser. The details of each monitoring bore is shown in Table 1 and the location of each bore is provided on Figure 2.

Detailed gas composition sampling was undertaken at the two LFG bores (LFG 01 and LFG02) using soil gas canisters.



Figure 4: Landfill Gas Monitoring Bores installed at Gove Peninsula Waste Management Facility.

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Table 1: Details on Leachate and Landfill Gas Monitoring Bores

Monitoring Bore Name	Monitoring Bore Type	Depth	Notes
LL01	Leachate and Landfill Gas Migration Bore	Approximately 5.5m Below ground surface	Within 10 m of landfill, Ex -cap fitted to existing bore installed in 2003
LL02	Leachate and Landfill Gas Migration Bore	Approximately 5.5m Below ground surface	Ex -cap fitted to existing bore installed in 2003
LL03	Leachate and Landfill Gas Migration Bore	Approximately 5.5m Below ground surface	Ex -cap fitted to existing bore installed in 2003
LG01	Landfill Gas Bore	Approximately 6.0m into landfill waste	Installed during 2016 – slotted pipe grouted to surface
LG02	Landfill Gas Bore	Approximately 6.0m into landfill waste	Installed during 2016 – slotted pipe grouted to surface



Figure 5: Landfill Gas Monitoring - Gove Peninsula Waste Management Facility

2.2 Leachate Monitoring

During the August 2022 monitoring only 1 of the leachate bores contained water to enable the collection of samples for leachate monitoring.

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2.3 Surface Water Monitoring

The site has only contains ephemeral water channels and no permanent standing water bodies. During August 2023 monitoring period no surface water monitoring was undertaken as no surface waters were available for monitoring.

2.4 Groundwater Monitoring

The location of the groundwater boreholes and the relative groundwater heights are shown in **Figure 3**. The heights recorded at each of the groundwater boreholes, and the relative heights are detailed in **Table 2** below. The recent groundwater investigations determined that the groundwater gradient generally follows the terrain as shown in the DSM, in that the flow is generally from east to west.

Table 2: Groundwater Bore information from bore installation program 2016

Groundwater bore No.	Surface elevation (at top of monument)	Depth to groundwater (from monument)	Groundwater elevation (m AHD) #
GW01	17.49	7.21	10.28
GW02	17.22	7.53	9.69
GW03	26.53	10.52	16.01
GW04	28.05	11.83	16.22
GW05	25.08	7.7	17.38
GW06	24.07	11.25	12.82
GW07	17.11	8.18	8.93

Elevation currently approximate and only relative as elevation not rectified from monument.

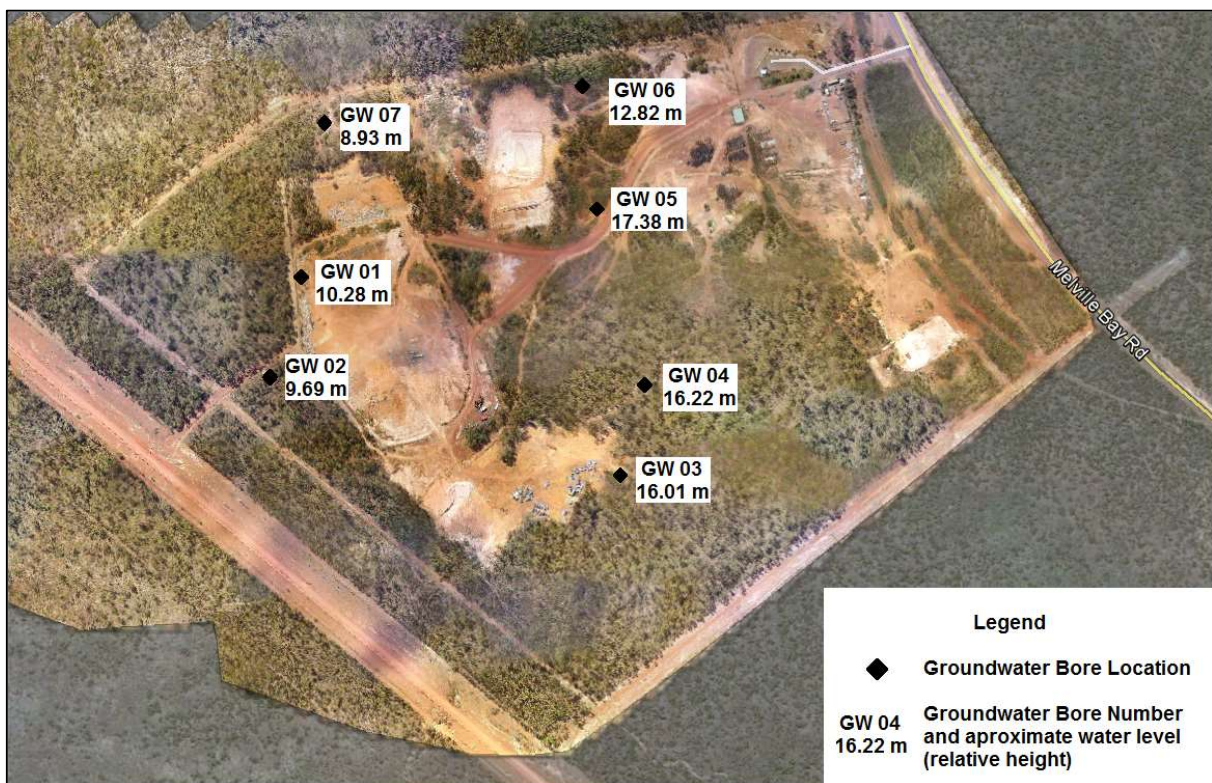


Figure 6: Groundwater boreholes and the relative groundwater heights encountered at Gove Peninsula Waste Management Facility

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Results

3.1 Landfill Gas Monitoring results

The results of the insitu field sampling undertaken in 2016 and 2023 are detailed in Tables 3 and 4 (below).

Table 3: Insitu Gas composition sampling results – Field measurements Baseline 2016

Monitoring Bore /Site	CH ₄ (%)	CO ₂ (%)	O ₂ (%)	CO (ppm)	H ₂ S (ppm)	Balance Gases (%)
LL01	0.1	3.0	18.2	45	3	78.8
LL02	0.0	4.9	16.8	1	1	78.3
LL03	0.1	6.7	13.9	66	6	79.4
LG01	49.0	15.8	0.0	182	7	35.2
LG02	64.7	31.8	0.1	303	29	3.4

Table 4: Insitu Gas composition sampling results – Field measurements August 2023

Monitoring Bore /Site	CH ₄ (%)	CO ₂ (%)	O ₂ (%)	CO (ppm)	H ₂ S (ppm)	Balance Gases (%)
LL01	0.6	0.5	19.4	1	2	76.3
LL02	0.0	0.3	19.5	0	2	79.4
LL03	3.1	6.0	13.5	1	2	79.0
LG01	68.6	13.5	0.3	3	3	17.5
LG02	84.0	37.2	0.1	14	2	0.0

The results demonstrate that the landfill continues to generate significant percentages of Methane in the closed and capped landfill cells. The gas composition recorded in 2023 however are elevated as there appeared to be an error in the equipment when sampled on the last three wells, LL03, LG 01 and LG02 as such the results are indicative only. Notwithstanding LG01/LG02 has continued to show high levels of methane however CO₂ had also increased.

The three Leachate/Landfill gas bores (LL01/LL02/LL03) situated on the edge of the landfill recorded extremely low Methane and extremely low levels of Hydrogen Sulphide (2ppm).

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3.2 Groundwater Monitoring

3.2.1 Groundwater heights (Standing Water Level SWL)

Table 5: Insitu sampling results – Field measurements

Bore No.	Surface elevation (monument)	SWL (monument Baseline 2016)	SWL (from monument 2019)	SWL (from monument 2020)	SWL (from monument 2021)	SWL (from monument 2022)	SWL (from monument 2023)	Difference between 2016 to 2023
GW01	17.49	7.21	6.98	11.72	4.23	5.39	5.09	+ 2.03
GW02	17.22	7.53	7.40	11.19	5.42	6.39	6.46	+ 1.07
GW03	26.53	10.52	11.42	13.75	13.33	11.98	10.68	-0.16
GW04	28.05	11.83	12.40	15.08	14.83	14.03	12.18	-0.35
GW05	25.08	7.7	7.01	10.27	5.23	6.19	5.86	+1.86
GW06	24.07	11.25	7.88	10.80	6.59	7.24	6.78	+4..47
GW07	17.11	8.18	5.64	9.39	4.37	5.09	4.96	+3.22

The recorded Standing Water Level heights showed an increase in height since 2022 however the variations are within ranges of fluctuations recorded in 2021. Consistent with last year all piezometers recorded heights above the baseline recorded in 2016 except, two piezometers (GW03 and GW04).

3.2.2 Groundwater Physiochemical Results August 2023

The recorded Groundwater Physiochemical results are shown in Table 6 below.

Table 6: Groundwater Field Physiochemical Results August 2023

Date	Site	pH Value (pH Units)	Electrical Conductivity $\mu\text{S}/\text{cm}$	Redox Potential mV
22/08/2023	GW01	5.5	778	150.1
22/08/2023	GW02	4.27	342	345
22/08/2023	GW03	5.48	1043	141
23/08/2023	GW04	4.87	502	271
23/08/2023	GW05	4.67	92.8	234.2
23/08/2023	GW06	4.4	175.5	318.8
23/08/2023	GW07	4.7	148	280

The following graphs demonstrate the laboratory Physiochemical Results for each Piezometer.

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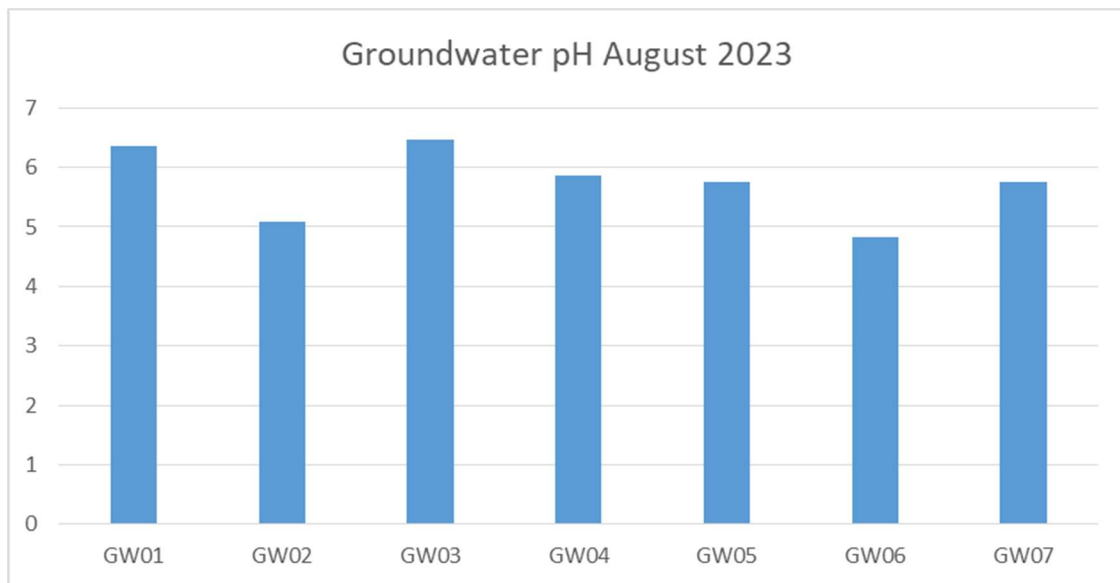


Figure 7: Groundwater pH August 2023

Groundwater pH was relatively consistent across all piezometers.

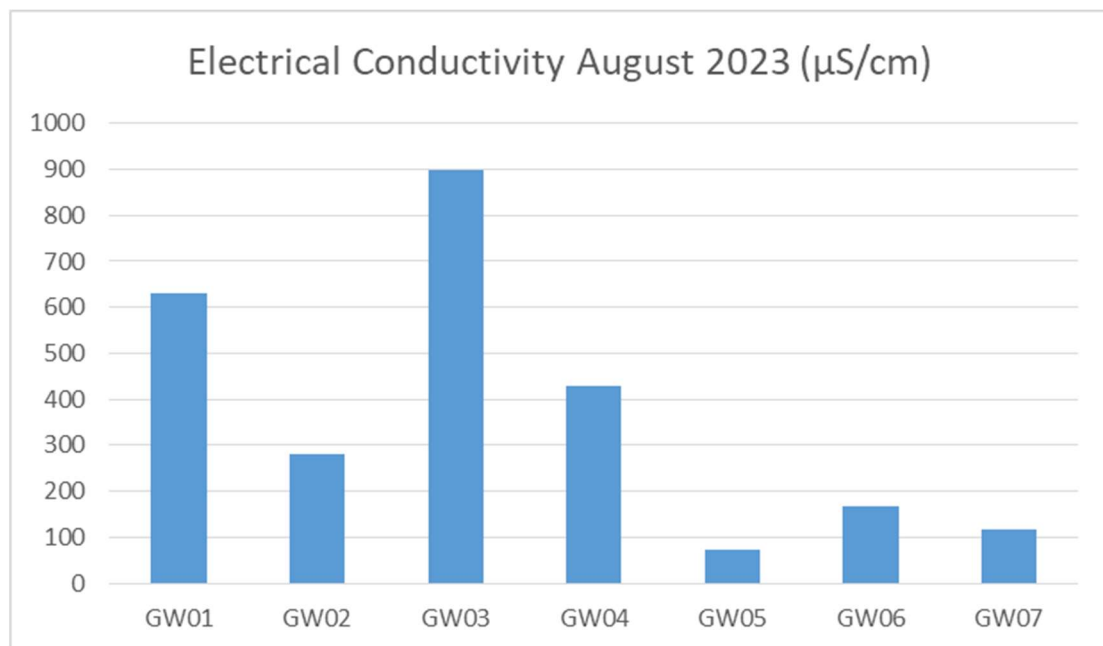


Figure 8: Electrical Conductivity (µS/cm) August 2023

The recorded Electrical Conductivity (EC) varied across piezometers however the piezometers with the highest EC recorded at GW03. This piezometer is not located near any current or former landfill cell and similar results were recorded between GW01 down gradient to the recent operational cells and the up gradient (control) piezometer at GW04, however GW01 was slightly elevated.

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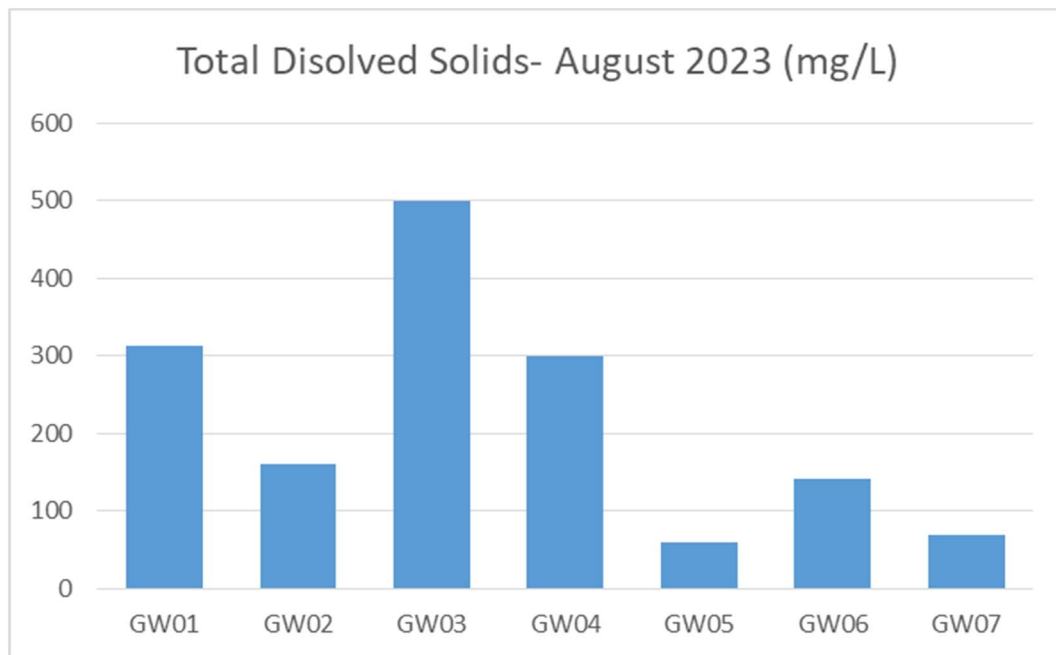


Figure 9: Total Dissolved Solid (TDS) August 2023

The recorded TDS varied across piezometers however the piezometers with the greatest variability was GW03 which is not located near any current or former landfill cell. The EC was however consistently lower at the up gradient piezometers GW04, GW05, GW06 and GW07.

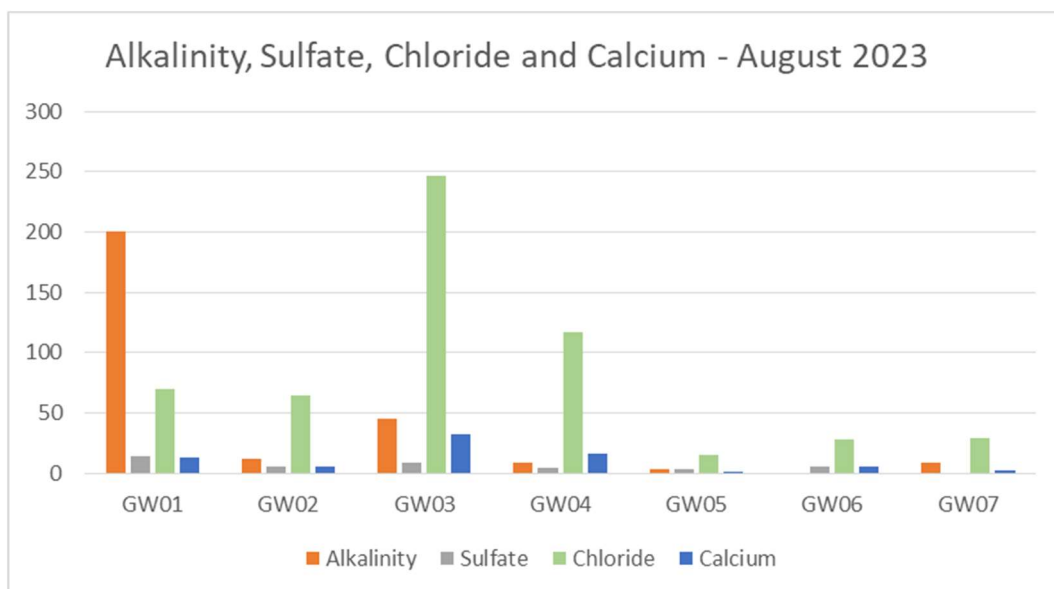


Figure 10: Alkalinity, Sulphate, Chloride and Calcium August 2023

The Alkalinity, Sulphate, Chloride and Calcium also followed the trends of the EC with again GW03 recording highest Chloride levels despite being a significant distance from any cell. GW01 down gradient to the recent operational cells also showed elevation in Alkalinity, Sulphate, Chloride and Calcium.

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3.2.3 Groundwater Metals and Metalloid Results

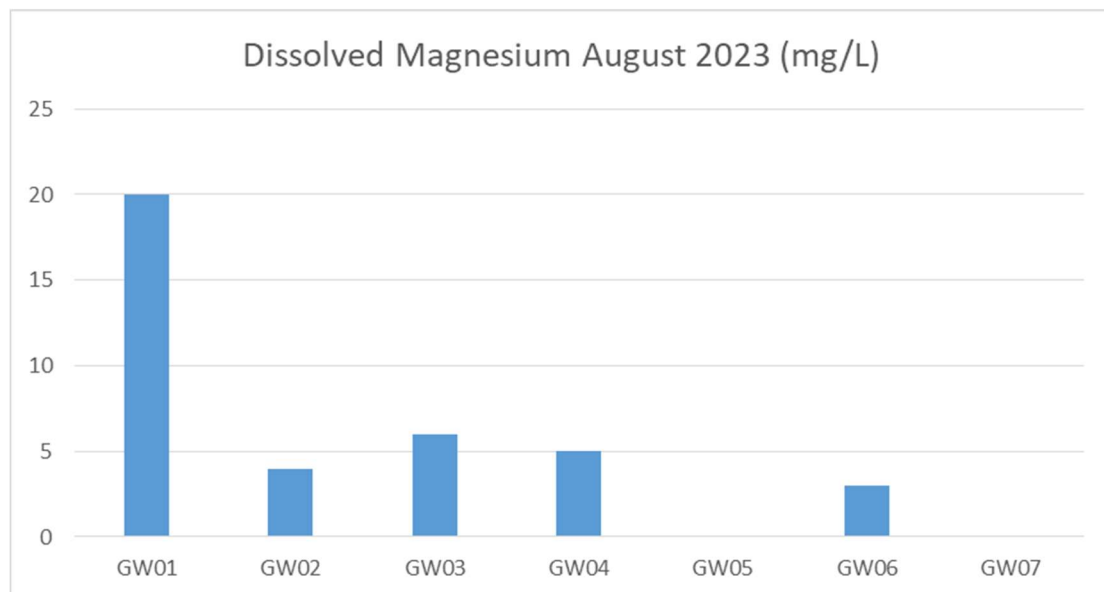


Figure 11: Dissolved Magnesium August 2023

The levels of Dissolved Magnesium were elevated at GW01 down gradient to the recent operational cells while all other piezometers recorded low or below detect concentrations.

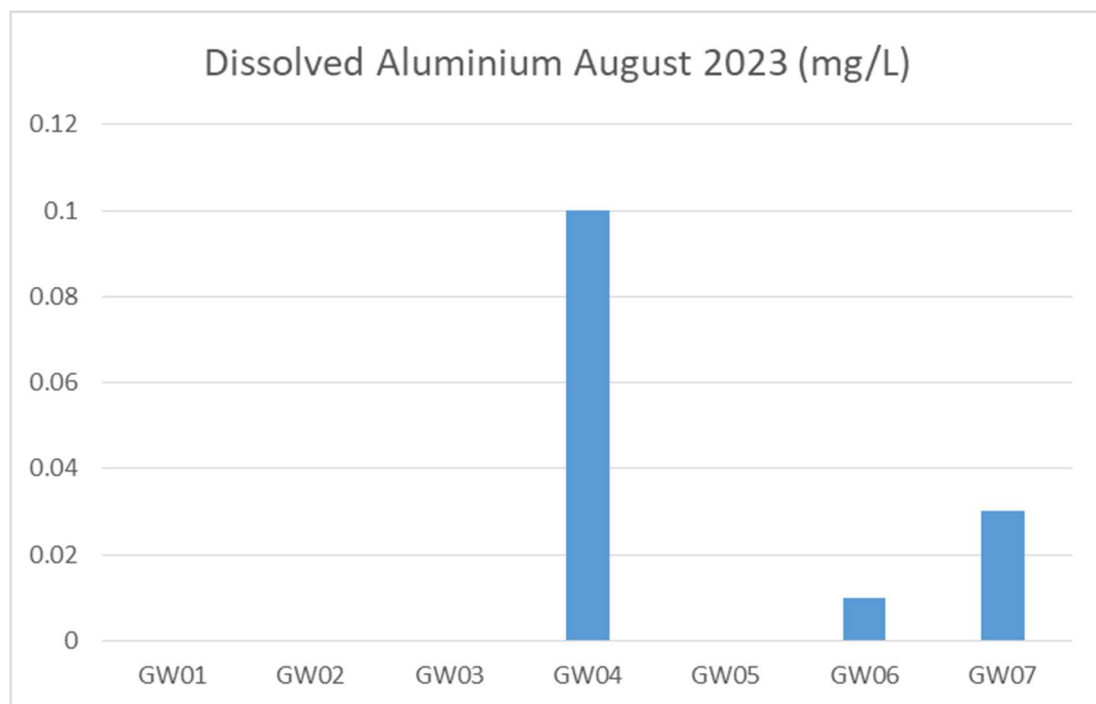


Figure 12: Dissolved Aluminium August 2023

The levels of Dissolved Aluminium were lowest (below LOR) at GW01 down gradient to the recent operational cells and GW02, GW03 and highest at GW04 a “control piezometer”, while all other piezometers recorded low concentrations.

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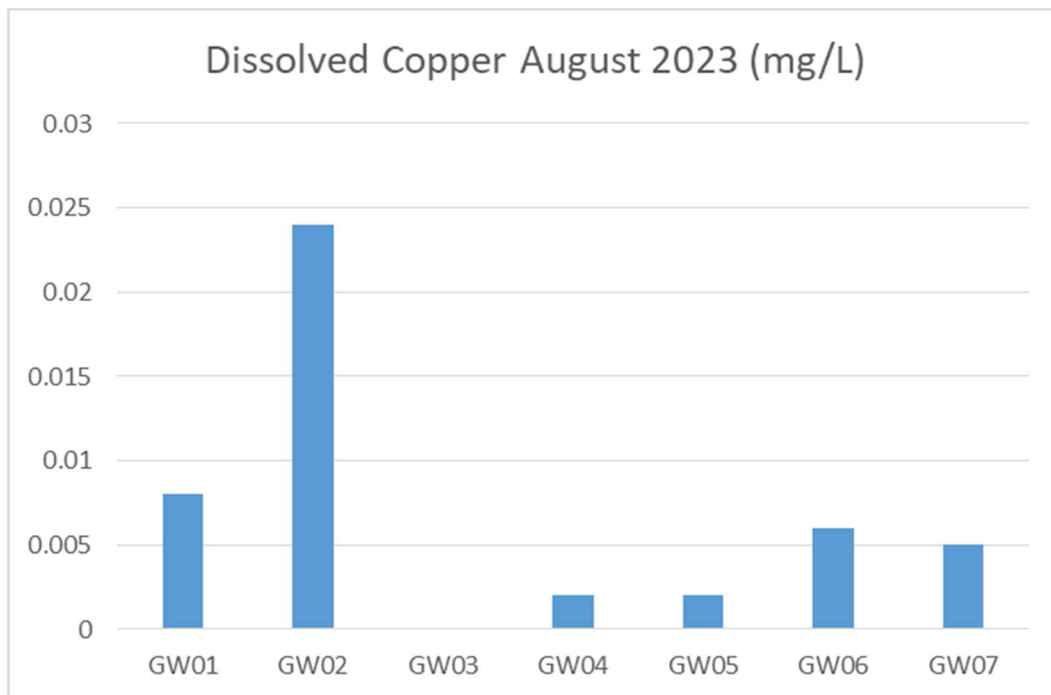


Figure 13: Dissolved Copper August 2023

The levels of Dissolved Copper were only elevated at GW02 which is near operational cells, while all other piezometers recorded low concentrations whereas last year elevated copper was recorded at GW05.

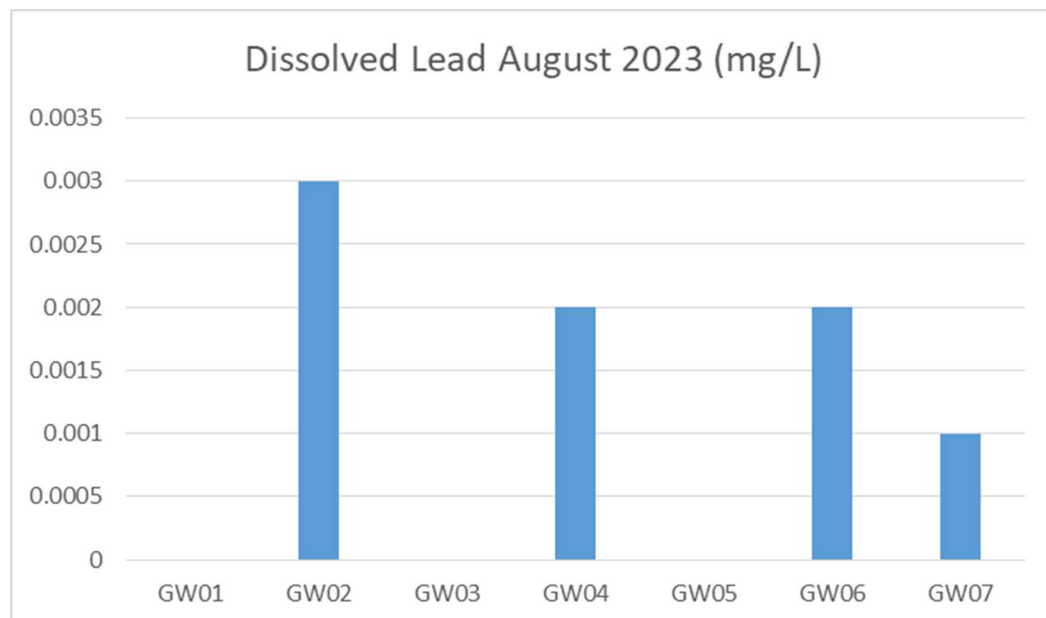


Figure 14: Dissolved Lead August 2023

In 2023 the Dissolved lead was detected at GW02, GW04, GW06 and GW07 where in 2022 levels of Dissolved Lead were detected at GW04, GW05, GW06 and GW07, while all other piezometers recorded “below detect” concentrations.

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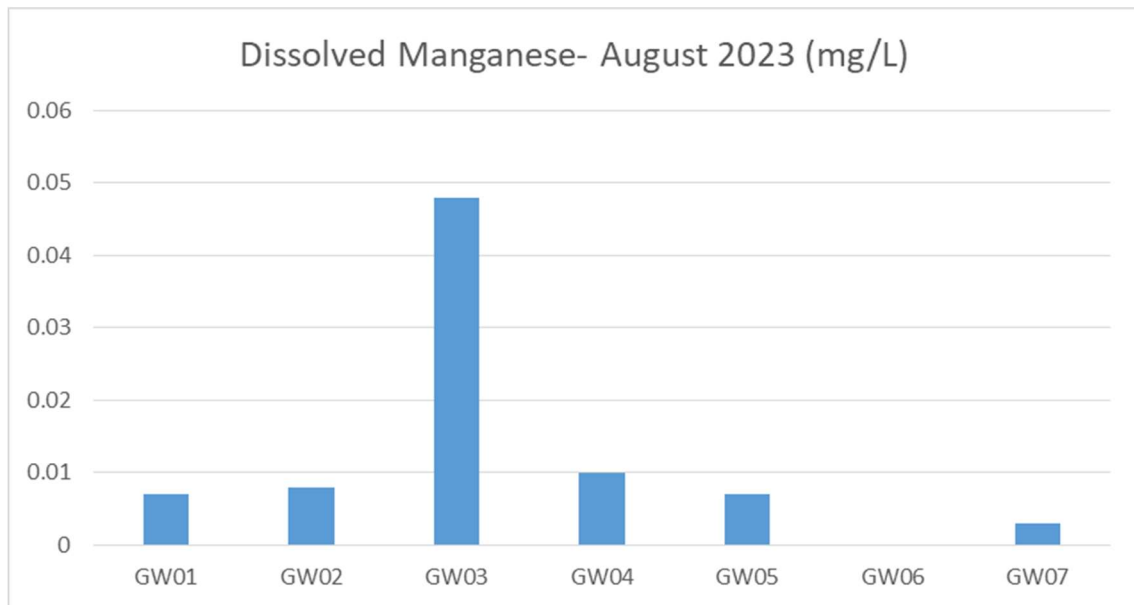


Figure 15: Dissolved Manganese August 2023

The levels of Dissolved Manganese were elevated at GW03 up gradient of operations while all other piezometers recorded low concentrations.

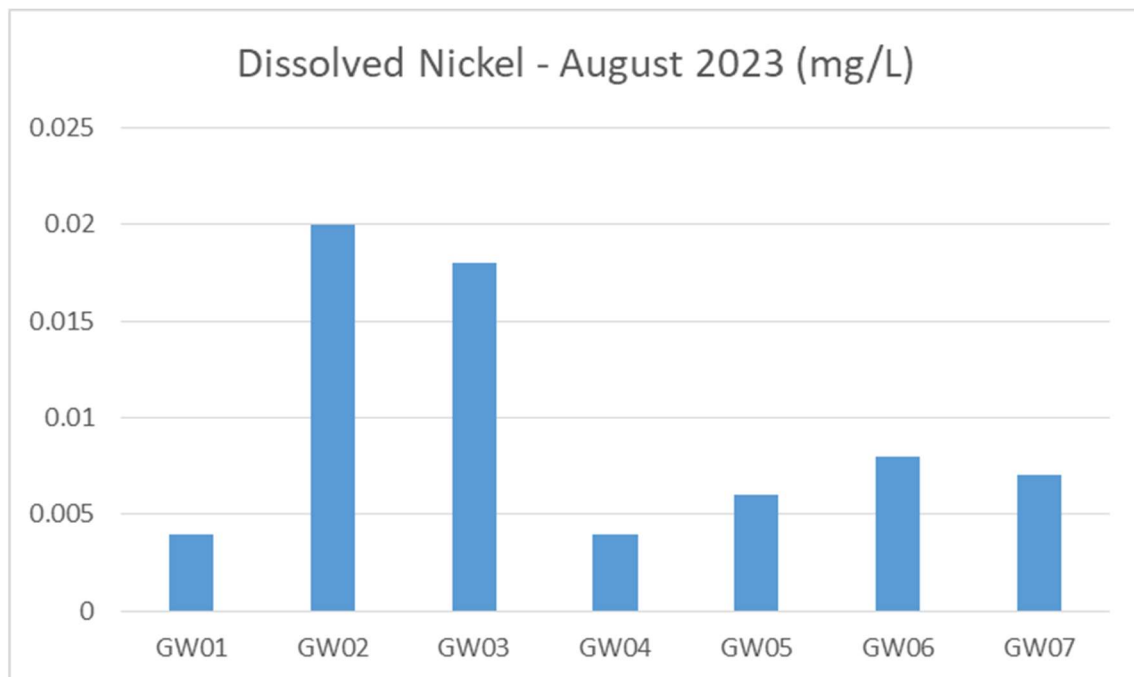


Figure 16: Dissolved Nickel August 2023

In 2023 levels of Dissolved Nickel were similar between all piezometers except at GW02 and at GW03, whereas in 2022 Dissolved Nickel was elevated at GW05.

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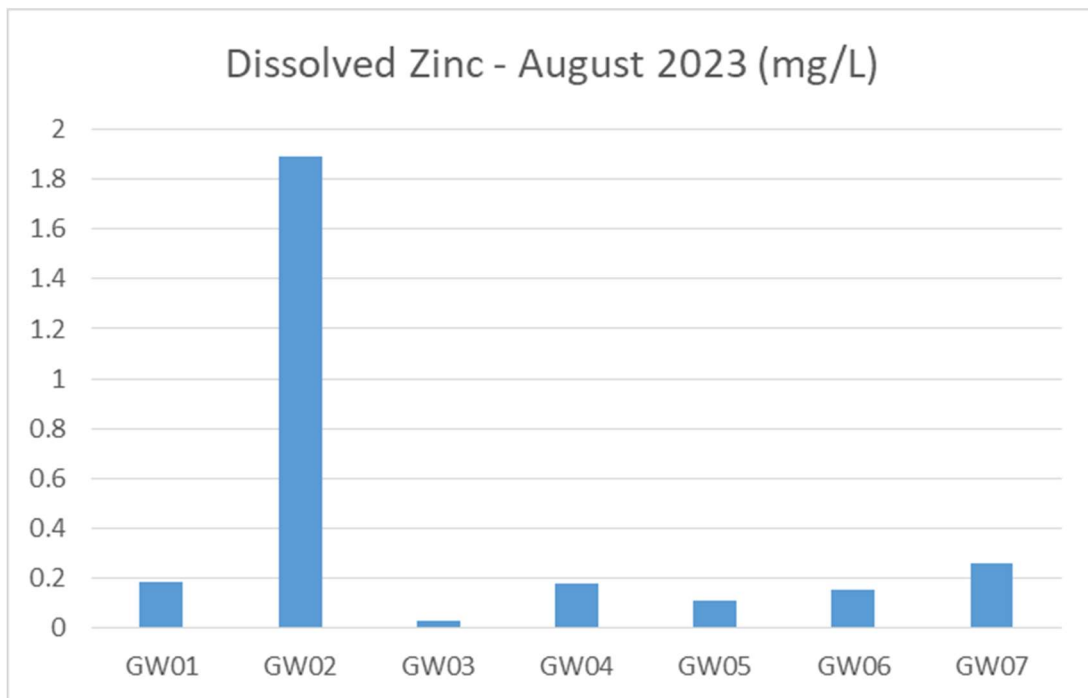


Figure 17: Dissolved Zinc August 2023

The levels of Dissolved Zinc were elevated at GW02 down gradient of the current operational landfill whereas in 2022 the GW05 recorded elevated zinc.

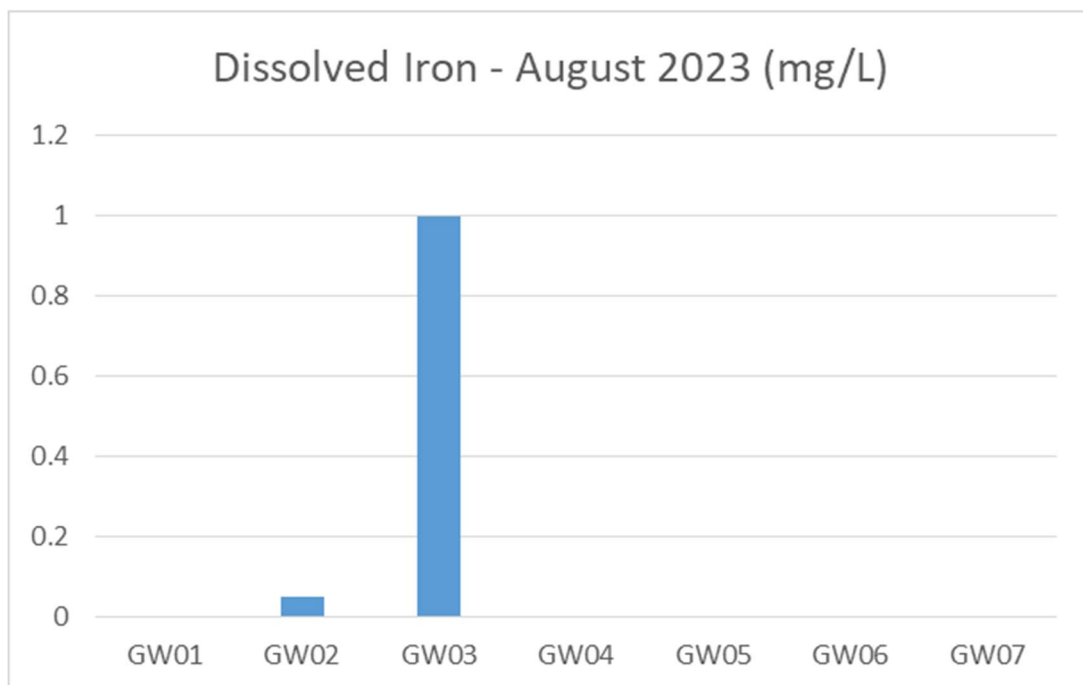


Figure 18: Dissolved Iron August 2023

The levels of Dissolved Zinc were elevated GW03 a control site which is a similar trend to 2022. .

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Where a Dissolved metal was recorded below Limit of Recording (LOR) the results were not represented graphically. Table 7 below details the Metals/Metalloids that were recorded below LOR for each site during the May2021 monitoring period.

Table 7: Groundwater Dissolved Metals below Limit of Recording (LOR) August 2023

Date	Site	Dissolved Arsenic (mg/L)	Dissolved Cadmium (mg/L)	Dissolved Chromium (mg/L)	Dissolved Selenium (mg/L)
22/08/2023	GW01	<0.001	<0.0001	<0.001	<0.01
22/08/2023	GW02	<0.001	<0.0001	<0.001	<0.01
22/08/2023	GW03	<0.001	<0.0001	<0.001	<0.01
23/08/2023	GW04	<0.001	<0.0001	<0.001	<0.01
23/08/2023	GW05	<0.001	<0.0001	<0.001	<0.01
23/08/2023	GW06	<0.001	<0.0001	<0.001	<0.01
23/08/2023	GW07	<0.001	<0.0001	<0.001	<0.01

Arsenic, Cadmium, Chromium and Selenium (Dissolved all recorded levels below the LOR at each of the seven (7) piezometers). Results in Blue designate below LOR.

The results for Metals and metalloids recorded to date (2016 -2023) for each Piezometer are tabulated in Appendix B for comparison.

3.2.4 Groundwater Ammonia, Nitrogen and Phosphorus Results August 2023
Table 8: Groundwater Ammonia, Nitrogen and Phosphorus August 2023

Date	Site	Ammonia as N (mg/L)	Total Nitrogen as N (mg/L)	Total Phosphorus as P (mg/L)
22/08/2023	GW01	7.41	14.2	0.03
22/08/2023	GW02	0.02	1	0.04
22/08/2023	GW03	0.08	2.8	0.02
23/08/2023	GW04	0.02	0.6	0.04
23/08/2023	GW05	0.11	1.8	<0.01
23/08/2023	GW06	0.11	5.5	0.01
23/08/2023	GW07	0.03	1	<0.01

The only well with elevated Ammonia and Nitrogen is GW01 which is situated extremely close to Cell 3. This result is consistent with previous years.

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3.2.5 Total Petroleum/Total Recoverable /Polynuclear Aromatic Hydrocarbons and BTEXN Results August 2023

Table 9: Groundwater Total Petroleum/Total Recoverable /Polynuclear Aromatic Hydrocarbons and BTEXN Results August 2023

Analyte	Unit	LOR	GW01	GW02	GW03	GW04	GW05	GW06	GW07
Total Petroleum Hydrocarbons									
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	180	<100	<100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50	180	<50	<50	<50	<50	<50	<50
Total Recoverable Hydrocarbons									
C6 - C10 Fraction	µg/L	20	<20	<20	<20	<20	<20	<20	<20
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	<20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100	<100	<100	<100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100	150	<100	<100	<100	<100	<100	<100
>C34 - C40 Fraction	µg/L	100	<100	<100	<100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100	150	<100	<100	<100	<100	<100	<100
>C10 - C16 Fraction minus Naphthalene	µg/L	100	<100	<100	<100	<100	<100	<100	<100

The only well that recorded Total Petroleum/Total Recoverable Hydrocarbons is GW01 which is situated extremely close to Cell 3. This result is consistent with previous years and the results are only slightly higher than LOR. .

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Polynuclear Aromatic Hydrocarbons									
Naphthalene	µg/L	1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	µg/L	1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	µg/L	1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	µg/L	1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	µg/L	1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	µg/L	1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	µg/L	1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	µg/L	1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	µg/L	1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	µg/L	1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	µg/L	1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	µg/L	1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	µg/L	1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a,h)anthracene	µg/L	1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g,h,i)perylene	µg/L	1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sum of polycyclic aromatic hydrocarbons	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ (zero)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
BTEXN									
Benzene	µg/L	1	<1	<1	<1	<1	<1	<1	<1
Toluene	µg/L	2	<2	<2	<2	<2	<2	<2	<2
Ethylbenzene	µg/L	2	<2	<2	<2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	<2	<2	<2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	<2	<2	<2	<2	<2	<2	<2
Total Xylenes	µg/L	2	<2	<2	<2	<2	<2	<2	<2
Sum of BTEX	µg/L	1	<1	<1	<1	<1	<1	<1	<1
Naphthalene	µg/L	5	<5	<5	<5	<5	<5	<5	<5

Results in Blue designate below LOR

Table g shows that the only Hydrocarbons results were detected at GWo1.

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Table 10: Groundwater PCBs and Pesticides August 2023

Table 10 shows the Total PCBs and Pesticide Results August 2023

Analyte	Unit	LOR	GW01	GW02	GW03	GW04	GW05	GW06	GW07
Polychlorinated Biphenyls (PCB)									
Total Polychlorinated biphenyls	µg/L	1	<1	<1	<1	<1	<1	<1	<1
Organochlorine Pesticides									
alpha-BHC	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Hexachlorobenzene (HCB)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
beta-BHC	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
gamma-BHC	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
delta-BHC	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Heptachlor	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Aldrin	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Heptachlor epoxide	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
trans-Chlordane	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
alpha-Endosulfan	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
cis-Chlordane	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dieldrin	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4,4'-DDE	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Endrin	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
beta-Endosulfan	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4,4'-DDD	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Endrin aldehyde	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Endosulfan sulfate	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4,4'-DDT	µg/L	2	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Endrin ketone	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Methoxychlor	µg/L	2	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Total Chlordane (sum)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Sum of DDD + DDE + DDT	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Sum of Aldrin + Dieldrin	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Organophosphate Pesticides									
Dichlorvos	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Demeton-S-methyl	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Monocrotophos	µg/L	2	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Dimethoate	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Diazinon	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

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Analyte	Unit	LOR	GW01	GW02	GW03	GW04	GW05	GW06	GW07
Chlorpyrifos-methyl	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Parathion-methyl	µg/L	2	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Malathion	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fenthion	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chlorpyrifos	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Parathion	µg/L	2	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Pirimphos-ethyl	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chlorfenvinphos	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bromophos-ethyl	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fenamiphos	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Prothiofos	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Ethion	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Carbophenothion	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Azinphos Methyl	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Polynuclear Aromatic Hydrocarbons and BTEXN, PCBs and Pesticides were below Limit of Recording at all piezometers during August 2023.

Discussion and Recommendations

4.1 Landfill Gas Monitoring

The Landfill Gas results demonstrate that the landfill continues to generate significant percentages of Methane in the closed and capped landfill cells, however due to equipment issues little comparison can be made to previous years.

4.2 Surface Water Monitoring

As detailed in the methodology, the site has only contains ephemeral water channels and no permanent standing water bodies.

4.3 Leachate Monitoring

During the August 2023 monitoring only one leachate borecontained water to enable the collection of samples for leachate monitoring. As the monsoonal weather patterns were above average for the 2021/2022/2023 periods it would be expected that if leachate migration was occurring that it would be detected at all three leachate piezometers.

4.4 Groundwater Monitoring

The recorded groundwater heights in 2023 showed slightly higher Standing water levels but similar to that recorded in May 2021 and in all but two piezometers (GW03 and GW04) the heights generally above the originals heights after installation. The lower standing water levels at GW03 and GW04 are smaller than 2022, and as these are generally at higher elevations it could reflect movement since rainfall periods.

The groundwater results are consistent with the above average rainfall described by BOM during the 2020-2021- 2022 -2023 Monsoonal periods. Previous years were affected by both the Indian Ocean Dipole and neutral to slightly positive El Niño weather patterns experienced at Gove however conditions returned to La Nina influences across the NT across the last 3 years. As the climate predictions are for a El Niño event the 2023-2024 monsoon is expected to provide a lower level of rainfall potentially, depending upon the local rainfall recorded – returning groundwater levels to lower groundwater heights in 2024.

The results of the Groundwater monitoring did not demonstrate the extreme variability in numerous analytes in previous years due to the increased rainfall in 2020/2021/2022/2023. The variance across the sites did not show clear trends between natural or background levels except at GWO1. This piezometer is an old piezometer installed greater than 15 years ago and purged during the installation program in 2016. This piezometer is located within 5-10m of a recently completed Landfill Cell and as such is more likely to represent some very localised leachate migration rather than contamination of the larger groundwater resource as discussed in the following sections.

4.4.1 Physicochemical results

The Groundwater pH was relatively consistent across all piezometers however the recorded Electrical Conductivity (EC) varied across piezometers with the highest results recorded at GW03 which is not

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located near any current or former landfill cell. This result appears to be an anomalous result in localised water chemistry as there is no defined pathway based on hydrological gradients from the landfill impacts. The second highest EC level was however at GW01, directly down gradient to the recent operational cells. Similar to the recorded Electrical Conductivity (EC), TDS varied across piezometers however the piezometers with the highest results were again GW01 and GW03.

Alkalinity Sulphate, Chloride and Calcium also followed the trends of the EC with again GW03 recording highest Chloride levels despite being a significant distance from any cell. GW01 down gradient to the recent operational cells also showed some elevation in Alkalinity, Sulphate, Chloride and Calcium.

4.4.2 Dissolved Metals

The results of dissolved metals does not show a clear trend in metals or metalloids across the piezometers installed at the landfill. Dissolved Magnesium were elevated at GW01 down gradient to the recent operational cells while all other piezometers recorded low concentrations.

The levels of Dissolved Aluminium were lowest (below LOR) at GW01, GW02 both down gradient to the landfill cells and GW03 not impacted by Landfill operations. GW04 a “control piezometer”, recorded the highest levels and all other piezometers recorded low concentrations.

The levels of Dissolved Lead were elevated at GW02, GW04, GW06 and, GW07 and while two of these are potentially impacted by landfill operations, GW04 is not and all other piezometers recorded below detect concentrations. In 2022 GW05 showed elevated lead and as such there is no clear trends identified at present. The levels of Dissolved Nickel were elevated at GW02 and GW03 while all other piezometers recorded low concentrations. In 2022 Dissolved nickel was elevated at GW95 up gradient of the landfill and similar to GW01 and as such there is also no clear trends identified at present.

Upon reviewing all data – it is clear that the down gradient piezometer GW01 has a water chemistry influenced by the Landfill as this is showing elevated results in some metals, however as this is extremely close (10m) to the landfill it does not provide a good indication of contaminants moving off site. the other ‘close’ downgradient piezometer GW02 has not recorded similar elevated results. Also where an analyte is found to be elevated at GW02 the same analyte is elevated at up gradient or “control piezometers” therefor showing natural variation in water chemistry and not significant movement of soluble metalloids as a result of the landfill.

4.4.3 Hydrocarbon, BTEX, PCB and Pesticide contamination.

The results of the 2022 monitoring program demonstrate that the landfill cells are not contributing the contamination of groundwater for Polynuclear Aromatic Hydrocarbons and BTEXN, Polychlorinated Biphenyls (PCB) Organochlorine Pesticides or Organophosphate Pesticides with all results at all piezometers returning results below LORs.

The only recorded Hydrocarbons were the detection of Total Petroleum and Total Recoverable Hydrocarbons at GW01 and as these were not recorded at GW02 it indicates that the contamination is extremely localised and not contributing to local contamination of the groundwater resource. .

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Conclusion

The Landfill Gas sampling results determined that the landfill gas is contained within the landfill cells with little migration due to the capping materials used. As such the risks of explosion and other human health or environmental impacts from the site are considered low. Notwithstanding long term passive landfill gas management measures such as Biofilters or Biocover should be investigated.

The Groundwater monitoring results demonstrate that the landfill leachate is not migrating from the site with most down gradient bores recording similar water quality levels for contaminants as those up gradient of the landfill. The monitoring to date has recorded only one piezometer GW01 recording elevated contaminants, this piezometer is within 10 m from the south western corner of a recent Landfill cell, and shows some migration of leachate but is believed to be localised and not impacting on the local groundwater resource. Consideration should be made to the installation of an additional piezometer further away from GW01 in future years and as the landfill expands additional piezometers on the boundary of the site.

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Appendix A

Analytical results of Landfill Gas composition 2016

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Analyte grouping/Analyte	Units	LOR	LFG01	LFG02
EP101-S: Reduced Sulphur Compounds in Air				
Hydrogen Sulphide	ppbv	10	<10	<10
Carbonyl Sulfide	ppbv	5	15	29
Dimethyl Sulfide	ppbv	0.5	<10.0	188
Carbon disulfide	ppbv	0.5	11.3	34.3
Methanethiol	ppbv	5	<10	<10
Ethanethiol	ppbv	5	<10	<10
EP101-S: Reduced Sulphur Compounds in Air (Calculated Concentration)				
Hydrogen Sulphide	µg/m ³	30	<600	<600
Carbonyl Sulfide	µg/m ³	10	<200	<200
Dimethyl Sulfide	µg/m ³	1	<20	477
Carbon disulfide	µg/m ³	1.8	<36	107
Methanethiol	µg/m ³	10	<200	<200
Ethanethiol	µg/m ³	10	<200	<200
EP101: VOCs by USEPA Method TO15 (Calculated Concentration)				
Freon 12	µg/m ³	2.5	<50.0	<250
Chloromethane	µg/m ³	1	<20.0	<100
Freon 114	µg/m ³	3.5	<70.0	<350
Vinyl chloride	µg/m ³	1.3	774	<130
Bromomethane	µg/m ³	1.9	<38.0	<190
Chloroethane	µg/m ³	1.3	<26.0	<130
Freon 11	µg/m ³	2.8	<56.0	<280
1.1-Dichloroethene	µg/m ³	2	<40.0	<200
Dichloromethane	µg/m ³	1.7	<34.0	<170
Freon 113	µg/m ³	3.8	<76.0	<380
1.1-Dichloroethane	µg/m ³	2	<40.0	<200
cis-1.2-Dichloroethene	µg/m ³	2	4790	693
Chloroform	µg/m ³	2.4	<48.0	<240
1.2-Dichloroethane	µg/m ³	2	<40.0	255
1.1.1-Trichloroethane	µg/m ³	2.7	<54.0	<270
Benzene	µg/m ³	1.6	540	1370
Carbon Tetrachloride	µg/m ³	3.1	<62.0	<310
1.2-Dichloropropane	µg/m ³	2.3	<46.0	<230
Trichloroethene	µg/m ³	2.7	55.8	<270
cis-1.3-Dichloropropylene	µg/m ³	2.3	<46.0	<230
trans-1.3-Dichloropropene	µg/m ³	2.3	<46.0	<230
1.1.2-Trichloroethane	µg/m ³	2.7	<54.0	<270
Toluene	µg/m ³	1.9	922	10000
1.2-Dibromoethane (EDB)	µg/m ³	3.8	<76.0	<380
Tetrachloroethene	µg/m ³	3.4	<68.0	<340
Chlorobenzene	µg/m ³	2.3	<46.0	<230
Ethylbenzene	µg/m ³	2.2	44700	186000

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Analyte grouping/Analyte	Units	LOR	LFG01	LFG02
meta- & para-Xylene	µg/m ³	4.3	143000	516000
Styrene	µg/m ³	2.1	56.6	<210
1.1.2.2-Tetrachloroethane	µg/m ³	3.4	<68.0	<340
ortho-Xylene	µg/m ³	2.2	58600	187000
4-Ethyltoluene	µg/m ³	2.4	<48.0	<240
Total Xylenes	µg/m ³	6.5	202000	703000
1.3.5-Trimethylbenzene	µg/m ³	2.4	132	265
1.2.4-Trimethylbenzene	µg/m ³	2.4	246	405
1.3-Dichlorobenzene	µg/m ³	3	<60.0	<300
Benzylchloride	µg/m ³	2.6	<52.0	<260
1.4-Dichlorobenzene	µg/m ³	3	1690	3000
1.2-Dichlorobenzene	µg/m ³	3	<60.0	<300
1.2.4-Trichlorobenzene	µg/m ³	3.7	<74.0	<370
Hexachlorobutadiene	µg/m ³	5.3	<106	<530
Acetone	µg/m ³	1.2	<24.0	<120
Bromodichloromethane	µg/m ³	3.4	<68.0	<340
1.3-Butadiene	µg/m ³	1.1	<22.0	<110
Carbon disulfide	µg/m ³	1.6	33.9	<160
2-Chlorotoluene	µg/m ³	2.6	<52.0	<260
1-Chloro-2-propene (Allyl chloride)	µg/m ³	1.6	<32.0	<160
Cyclohexane	µg/m ³	1.7	1400	1270
Dibromochloromethane	µg/m ³	4.3	<86.0	<430
1.4-Dioxane	µg/m ³	1.8	<36.0	<180
Ethylacetate	µg/m ³	1.8	<36.0	<180
trans-1.2-Dichloroethene	µg/m ³	2	46	<200
Heptane	µg/m ³	2	1160	2030
Hexane	µg/m ³	1.8	490	528
Isooctane	µg/m ³	2.3	607	1020
Isopropyl Alcohol	µg/m ³	1.2	<24.0	1530
2-Butanone (MEK)	µg/m ³	1.5	64.8	395
Methyl iso-Butyl ketone	µg/m ³	2	51.6	368
2-Hexanone (MBK)	µg/m ³	2	<40.0	<200
Propene	µg/m ³	0.9	4680	12100
Methyl tert-Butyl Ether (MTBE)	µg/m ³	1.8	<36.0	<180
Tetrahydrofuran	µg/m ³	1.5	44.8	<150
Bromoform	µg/m ³	5.2	<104	<520
Vinyl Acetate	µg/m ³	1.8	<36.0	<180
Vinyl bromide	µg/m ³	2.2	<44.0	<220
Ethanol	µg/m ³	0.9	66.3	3410
Acetonitrile	µg/m ³	0.8	<16.0	<80.0
Acrolein	µg/m ³	1.1	<22.0	<110
Acrylonitrile	µg/m ³	1.1	<22.0	<110

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Analyte grouping/Analyte	Units	LOR	LFG01	LFG02
tert-Butyl alcohol	µg/m ³	1.5	<30.0	<150
2-Chloro-1.3-butadiene	µg/m ³	1.8	<36.0	<180
Di-isopropyl Ether	µg/m ³	2.1	<42.0	<210
Ethyl tert-Butyl Ether (ETBE)	µg/m ³	2.1	<42.0	<210
tert-Amyl Methyl Ether (TAME)	µg/m ³	2.1	<42.0	<210
Methyl Methacrylate	µg/m ³	2.1	<42.0	<210
1.1.1.2-Tetrachloroethane	µg/m ³	3.4	<68.0	<340
Isopropylbenzene	µg/m ³	2.4	919	3270
n-Propylbenzene	µg/m ³	2.4	241	<240
tert-Butylbenzene	µg/m ³	2.7	<54.0	<270
sec-Butylbenzene	µg/m ³	2.7	<54.0	<270
2-isopropyltoluene	µg/m ³	2.7	<54.0	<270
n-Butylbenzene	µg/m ³	2.7	<54.0	<270
Naphthalene	µg/m ³	2.6	<52.0	<260
EP104: Light Hydrocarbons				
Methane	Mol %	0.05	51.3	62.6
EP104: Light Hydrocarbons (Calc Conc)				
Methane	mg/m ³	330	335000	409000
EP104: Permanent Gases				
Carbon Dioxide	Mol %	0.05	16.4	30
Oxygen	Mol %	0.1	<0.20	<0.20
EP104: Permanent Gases (Calc Conc)				
Carbon Dioxide	mg/m ³	900	294000	540000
Oxygen	mg/m ³	1310	<2620	<2620
Sampling Quality Assurance				
Pressure - As received	kPaa	0.1	95.9	98.2
Pressure - Laboratory Atmosphere	kPaa	0.1	103	103
Temperature as Received	°C	0.1	20	20

Appendix B

Analytical results – Dissolved Metals and Metalloids levels recorded at GW01 2016-2023

Table B1 – Dissolved Metals and Metalloids levels recorded at GW01 2016-2023

Date	Magnesium	Sodium	Potassium	Aluminium	Arsenic	Cadmium	Chromium	Copper	Lead	Manganese	Nickel	Selenium	Zinc	Iron
	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
LOR	1	1	1	0.01	0.001	0.0001	0.001	0.001	0.001	0.001	0.001	0.01	0.005	0.05
20/07/2016	-	-	-	-	<0.001	<0.0001	<0.001	0.001	<0.001	-	0.013	-	0.023	-
14/08/2017	18	59	11	<0.01	<0.001	<0.0001	0.002	0.001	<0.001	0.007	0.002	<0.01	0.02	<0.05
26/06/2018	22	68	14	<0.01	<0.001	<0.0001	<0.001	0.002	<0.001	0.009	0.007	<0.01	0.045	0.16
24/09/2019	20	75	14	<0.01	<0.001	<0.0001	<0.001	0.002	<0.001	0.008	0.003	<0.01	0.043	<0.05
9/09/2020	20	75	15	<0.01	<0.001	<0.0001	<0.001	0.001	<0.001	0.008	0.011	<0.01	0.036	<0.05
25/05/2021	22	83	17	<0.01	<0.001	<0.0001	<0.001	0.011	<0.001	0.006	0.009	<0.01	0.089	<0.05
23/08/2022	19	79	14	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	0.005	<0.001	<0.01	0.008	<0.05
22/08/2023	20	73	14	<0.01	<0.001	<0.0001	<0.001	0.008	<0.001	0.007	0.004	<0.01	0.182	<0.05

Table B2 – Dissolved Metals and Metalloids levels recorded at GW02 2016-2023

Date	Magnesium	Sodium	Potassium	Aluminium	Arsenic	Cadmium	Chromium	Copper	Lead	Manganese	Nickel	Selenium	Zinc	Iron
	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
LOR	1	1	1	0.01	0.001	0.0001	0.001	0.001	0.001	0.001	0.001	0.01	0.005	0.05
20/07/2016	-	-	-	-	<0.001	<0.0001	<0.001	<0.001	0.002	-	0.019	-	0.022	-
14/08/2017	3	31	<1	0.06	<0.001	<0.0001	0.001	0.006	0.002	0.005	0.013	<0.01	0.041	<0.05
26/06/2018	3	31	<1	0.05	<0.001	<0.0001	<0.001	0.005	0.002	0.003	0.01	<0.01	0.032	<0.05
24/09/2019	2	14	<1	0.03	<0.001	<0.0001	<0.001	0.01	0.005	0.003	0.023	<0.01	0.067	<0.05
9/09/2020	4	40	<1	0.05	<0.001	<0.0001	<0.001	0.006	0.002	0.002	0.025	<0.01	0.046	<0.05
25/05/2021	2	41	<1	<0.01	<0.001	<0.0001	<0.001	0.005	<0.001	0.002	0.007	<0.01	0.037	<0.05
23/08/2022	4	40	<1	<0.01	<0.001	<0.0001	<0.001	0.002	<0.001	0.005	0.022	<0.01	0.009	<0.05
22/08/2023	4	40	<1	<0.01	<0.001	<0.0001	<0.001	0.024	0.003	0.008	0.02	<0.01	1.89	0.05

Table B3 – Dissolved Metals and Metalloids levels recorded at GW03 2016-2023

Date	Magnesium	Sodium	Potassium	Aluminium	Arsenic	Cadmium	Chromium	Copper	Lead	Manganese	Nickel	Selenium	Zinc	Iron
	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
LOR	1	1	1	0.01	0.001	0.0001	0.001	0.001	0.001	0.001	0.001	0.01	0.005	0.05
20/07/2016	-	-	-	-	<0.001	<0.0001	<0.001	0.006	0.007	-	0.014	-	0.096	-
14/08/2017	2	188	3	0.02	<0.001	<0.0001	<0.001	0.002	<0.001	0.007	0.018	<0.01	0.015	0.06
26/06/2018	3	180	3	0.06	<0.001	<0.0001	<0.001	0.002	0.002	0.016	0.035	<0.01	0.053	0.1
24/09/2019	5	266	4	0.06	<0.001	<0.0001	<0.001	<0.001	0.001	0.036	0.025	<0.01	0.027	0.18
9/09/2020	3	174	3	0.02	<0.001	<0.0001	<0.001	0.002	<0.001	0.012	0.006	<0.01	0.052	0.26
25/05/2021	2	150	3	0.02	<0.001	<0.0001	<0.001	0.018	0.001	0.01	0.012	<0.01	0.124	0.2
24/08/2022	8	180	4	<0.01	<0.001	<0.0001	<0.001	0.002	<0.001	0.029	0.032	<0.01	0.012	0.5
22/08/2023	6	135	3	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	0.048	0.018	<0.01	0.03	1

Table B4 – Dissolved Metals and Metalloids levels recorded at GW04 2016-2023

Date	Magnesium	Sodium	Potassium	Aluminium	Arsenic	Cadmium	Chromium	Copper	Lead	Manganese	Nickel	Selenium	Zinc	Iron
	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
LOR	1	1	1	0.01	0.001	0.0001	0.001	0.001	0.001	0.001	0.001	0.01	0.005	0.05
20/07/2016	-	-	-	-	<0.001	<0.0001	0.001	0.004	0.0024	-	0.015	-	0.076	-
14/08/2017	3	15	1	0.01	<0.001	<0.0001	0.003	<0.001	0.001	0.016	0.002	<0.01	0.014	0.55
26/06/2018	3	15	1	0.02	<0.001	<0.0001	<0.001	0.001	<0.001	0.006	0.007	<0.01	0.032	0.09
24/09/2019	4	26	2	0.02	<0.001	<0.0001	<0.001	<0.001	0.002	0.006	0.006	<0.01	0.016	0.06
9/09/2020	4	36	2	0.06	<0.001	<0.0001	<0.001	0.002	0.004	0.009	0.006	<0.01	0.026	<0.05
25/05/2021	4	28	2	0.06	<0.001	<0.0001	<0.001	0.008	0.002	0.006	0.006	<0.01	0.063	<0.05
24/08/2022	5	55	2	0.11	<0.001	<0.0001	<0.001	0.008	0.005	0.01	0.026	<0.01	0.02	0.08
23/08/2023	5	56	2	0.1	<0.001	<0.0001	<0.001	0.002	0.002	0.01	0.004	<0.01	0.179	<0.05

Table B5 – Dissolved Metals and Metalloids levels recorded at GW05 2016-2023

Date	Magnesium	Sodium	Potassium	Aluminium	Arsenic	Cadmium	Chromium	Copper	Lead	Manganese	Nickel	Selenium	Zinc	Iron
	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
LOR	1	1	1	0.01	0.001	0.0001	0.001	0.001	0.001	0.001	0.001	0.01	0.005	0.05
20/07/2016	-	-	-	-	<0.001	<0.0001	<0.001	0.001	0.004	-	0.009	-	0.029	-
14/08/2017	1	13	<1	0.03	<0.001	<0.0001	0.006	0.002	0.002	0.004	0.01	<0.01	0.01	<0.05
26/06/2018	1	14	<1	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001	0.002	<0.01	<0.005	<0.05
24/09/2019	1	11	<1	0.02	<0.001	<0.0001	<0.001	0.014	<0.001	0.002	0.002	<0.01	0.03	<0.05
9/09/2020	<1	11	<1	<0.01	<0.001	<0.0001	<0.001	0.001	<0.001	<0.001	0.014	<0.01	0.011	<0.05
26/05/2021	1	10	<1	0.01	<0.001	<0.0001	<0.001	0.01	<0.001	<0.001	0.01	<0.01	0.028	<0.05
24/08/2022	1	10	<1	0.02	<0.001	<0.0001	<0.001	0.052	0.006	0.012	0.073	<0.01	0.065	0.05
23/08/2023	<1	11	<1	<0.01	<0.001	<0.0001	<0.001	0.002	<0.001	0.007	0.006	<0.01	0.111	<0.05

Table B6 – Dissolved Metals and Metalloids levels recorded at GW06 2016-2023

Date	Magnesium	Sodium	Potassium	Aluminium	Arsenic	Cadmium	Chromium	Copper	Lead	Manganese	Nickel	Selenium	Zinc	Iron
	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
LOR	1	1	1	0.01	0.001	0.0001	0.001	0.001	0.001	0.001	0.001	0.01	0.005	0.05
20/07/2016	-	-	-	-	<0.001	<0.0001	<0.001	<0.001	0.004	-	0.013	-	0.019	-
14/08/2017	3	16	<1	0.02	<0.001	<0.0001	<0.001	0.006	0.004	0.001	0.01	<0.01	0.023	<0.05
26/06/2018	4	16	<1	0.04	<0.001	<0.0001	<0.001	0.036	0.002	0.002	0.009	<0.01	0.12	<0.05
24/09/2019	3	20	<1	0.04	<0.001	<0.0001	0.005	0.005	0.002	0.005	0.02	<0.01	0.01	<0.05
9/09/2020	3	15	<1	0.02	<0.001	<0.0001	<0.001	0.003	<0.001	<0.001	0.004	<0.01	0.009	<0.05
26/05/2021	4	15	<1	0.02	<0.001	<0.0001	<0.001	0.007	<0.001	<0.001	0.005	<0.01	0.03	<0.05
24/08/2022	4	17	<1	0.03	<0.001	<0.0001	<0.001	0.022	0.006	0.002	0.033	<0.01	0.016	<0.05
23/08/2023	3	15	<1	0.01	<0.001	<0.0001	<0.001	0.006	0.002	<0.001	0.008	<0.01	0.152	<0.05

Table B7 – Dissolved Metals and Metalloids levels recorded at GW07 2016-2023

Date	Magnesium	Sodium	Potassium	Aluminium	Arsenic	Cadmium	Chromium	Copper	Lead	Manganese	Nickel	Selenium	Zinc	Iron
	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
LOR	1	1	1	0.01	0.001	0.0001	0.001	0.001	0.001	0.001	0.001	0.01	0.005	0.05
20/07/2016	-	-	-	-	<0.001	<0.0001	<0.001	<0.001	0.002	-	0.014	-	0.024	-
14/08/2017	<1	18	<1	0.04	<0.001	<0.0001	0.005	0.001	0.004	0.004	0.016	<0.01	0.012	0.09
26/06/2018	<1	19	<1	0.03	<0.001	<0.0001	<0.001	0.004	0.002	0.004	0.009	<0.01	0.085	<0.05
24/09/2019	<1	22	<1	0.04	<0.001	<0.0001	<0.001	0.001	<0.001	0.001	0.012	<0.01	0.013	<0.05
9/09/2020	<1	20	<1	0.04	<0.001	<0.0001	<0.001	0.001	<0.001	0.001	0.004	<0.01	0.018	<0.05
26/05/2021	<1	18	<1	0.05	<0.001	<0.0001	<0.001	0.008	<0.001	0.001	0.008	<0.01	0.055	0.07
24/08/2022	<1	19	<1	0.04	<0.001	<0.0001	<0.001	0.002	0.001	0.002	0.015	<0.01	0.008	0.1
23/08/2023	<1	19	<1	0.03	<0.001	<0.0001	<0.001	0.005	0.001	0.003	0.007	<0.01	0.258	<0.05

Table B8 – Dissolved Metals and Metalloids levels recorded at LL01 2017-2023

Date	Magnesium	Sodium	Potassium	Aluminium	Arsenic	Cadmium	Chromium	Copper	Lead	Manganese	Nickel	Selenium	Zinc	Iron
	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
LOR	1	1	1	0.01	0.001	0.0001	0.001	0.001	0.001	0.001	0.001	0.01	0.005	0.05
14/08/2017	21	72	13	0.04	<0.001	<0.0001	0.003	<0.001	<0.001	0.009	<0.001	<0.01	<0.005	0.36
26/06/2018	25	80	14	0.02	<0.001	<0.0001	<0.001	<0.001	<0.001	0.009	0.001	<0.01	<0.005	0.06
24/09/2019	18	71	11	0.03	<0.001	<0.0001	<0.001	<0.001	<0.001	0.004	<0.001	<0.01	<0.005	<0.05
23/08/2022	20	74	14	0.04	<0.001	<0.0001	<0.001	<0.001	<0.001	0.005	<0.001	<0.01	<0.005	<0.05
23/08/2023	19	70	14	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	0.004	<0.001	<0.01	<0.005	<0.05

Table B9 – Dissolved Metals and Metalloids levels recorded at LL02 2017-2023

Date	Magnesium	Sodium	Potassium	Aluminium	Arsenic	Cadmium	Chromium	Copper	Lead	Manganese	Nickel	Selenium	Zinc	Iron
	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
LOR	1	1	1	0.01	0.001	0.0001	0.001	0.001	0.001	0.001	0.001	0.01	0.005	0.05
14/08/2017	24	103	19	0.01	<0.001	<0.0001	<0.001	0.002	<0.001	0.005	0.001	<0.01	0.008	<0.05
26/06/2018	26	104	21	0.01	<0.001	<0.0001	<0.001	0.002	<0.001	0.024	0.002	<0.01	0.007	<0.05