Appendix C Annual Monitoring Reports

Appendix C1 Annual Monitoring Report 2023

Annual Monitoring Review 2022 – 2023

Shoal Bay Waste Management Facility – Water Monitoring Program

Prepared for City of Darwin

Revision Schedule

Rev No	Date	Description	Signature of Typed Name (documentation on file)			
			Prepared by	**Checked by**	**Reviewed by**	**Approved by**
V0.1	31/07/2023	Preliminary Draft	JB	MJ	DJ	DJ
V1.0	04/08/2023	Report for Client Review	JB	JB	DJ	DJ
V1.1	18/08/2023	Final	JB	CoD	DJ	DJ

This document was prepared by Stantec Australia ("Stantec") for the account of City of Darwin (the "Client" / "CoD"). The conclusions in the Report titled *Annual Monitoring Review 2022 – 2023* are Stantec's professional opinion, as of the time of the Report, and concerning the scope described in the Report. The opinions in the document are based on conditions and information existing at the time the document was published and do not take into account any subsequent changes. The Report relates solely to the specific project for which Stantec was retained and the stated purpose for which the Report was prepared. The Report is not to be used or relied on for any variation or extension of the project, or for any other project or purpose, and any unauthorized use or reliance is at the recipient's own risk.

Stantec has assumed all information received from the Client and third parties in the preparation of the Report to be correct. While Stantec has exercised a customary level of judgment or due diligence in the use of such information, Stantec assumes no responsibility for the consequences of any error or omission contained therein.

This Report is intended solely for use by the Client in accordance with Stantec's contract with the Client. While the Report may be provided to applicable authorities having jurisdiction and others for whom the Client is responsible, Stantec does not warrant the services to any third party. The report may not be relied upon by any other party without the express written consent of Stantec, which may be withheld at Stantec's discretion.

Quality statement

Project manager	**Project technical lead**
David James	Mike Jorgensen

PREPARED BY Julian Brown	Julian Brown	31/07/2023
CHECKED BY Mike Jorgensen ***Senior Principal Scientist***	Michael	17/08/2023
REVIEWED BY David James		18/08/2023
APPROVED FOR ISSUE BY David James		18/08/2023

Level 6, 93 Mitchell Street, Darwin, Northern Territory, 0800
Tel +61 08 89428200
STATUS REV 1.0 | Project No 304701188

Summary

This document – *Annual Monitoring Review 2022 – 2023* summarises the findings of Stantec's monitoring activities for the period 1 July 2022 to 30 June 2023 to address the Environmental Protection Licence (EPL)188-03 Environment Protection Objectives (Part 4 of the WMPC Act), and Water Quality Standards (section 73 of the Water Act); which requires the implementation Soil and Water Monitoring Plan (SWMP) (EcOz, 2021a).

The intent is to summarise the performance of the monitoring activities against the Environmental Protection Authority's (EPA) Environmental Quality Objectives (EQO), which in turn are assessed against Environmental Quality Criteria (EQC), comprising Environmental Quality Guidelines (EQG) and Environmental Quality Standards (EQS).

Under the SWMP, sampling is conducted across groundwater, surface water. Sampling is conducted monthly with varying sampling programs and analysis suites between dry season (May to September) and wet season (October to April)

During this monitoring period SBMWF experienced insufficient leachate storage capacity, which resulted in SW14 accommodating the surplus leachate overflow in accordance with the site's Emergency Leachate Management Procedure (ELMP). As such the receiving dam (SW14) was considered a temporary leachate storage pond and monitoring was reported independently of this report by CoD in line with the ELMP.

Together, analytical results and the hydraulic gradient of the Site detailed in Section 3.3 of this report indicate that the migration of leachate-impacted surface water flowing from the Site is occurring most consistently between the Stage 3, 4 and 5 landfills, the water sump receiving from the green waste processing area and in stormwater runoff from water from the Stage 1, 2 and 6 landfills.

Based on source, source, pathway and receptor review and the groundwater and surface water chemistry it is considered that some shallow groundwater at the site has been impacted by leachate. While the high concentrations of contaminants, such as nutrients, metals, and PFAS, are evident in the leachate samples, the concentrations reported for the surface water and ground water samples are significantly lower.

None of the data sets for the sampling locations exhibited significant trends. Spikes of high concentrations occurred, but these elevated concentrations did not typically persist. However, some of the shallow wells, such as GW2-3, are exhibiting higher concentrations that will need to be reviewed to evaluate whether an increasing trend is developing.

The location and distance to potential receptors is considerable, which will require significant travel time for the groundwater and allow attenuation through degradation and dilution of CoPC, reducing the potential risk of contaminated groundwater transporting off site.

Contents

List of Tables

List of Figures

1 Introduction

1.1 Background

Stantec has been commissioned by the City of Darwin (CoD) to undertake groundwater, surface water, leachate, soil and dust deposition monitoring at the Shoal Bay Waste Management Facility (the 'Site') operated by City of Darwin (CoD) in accordance with the Site's environmental protection license (EPL) EPL 188 – 03 pursuant to the *NT Waste Management and Pollution Control Act* (WMPC Act). Soil and dust monitoring has been discontinued since Stantec's engagement.

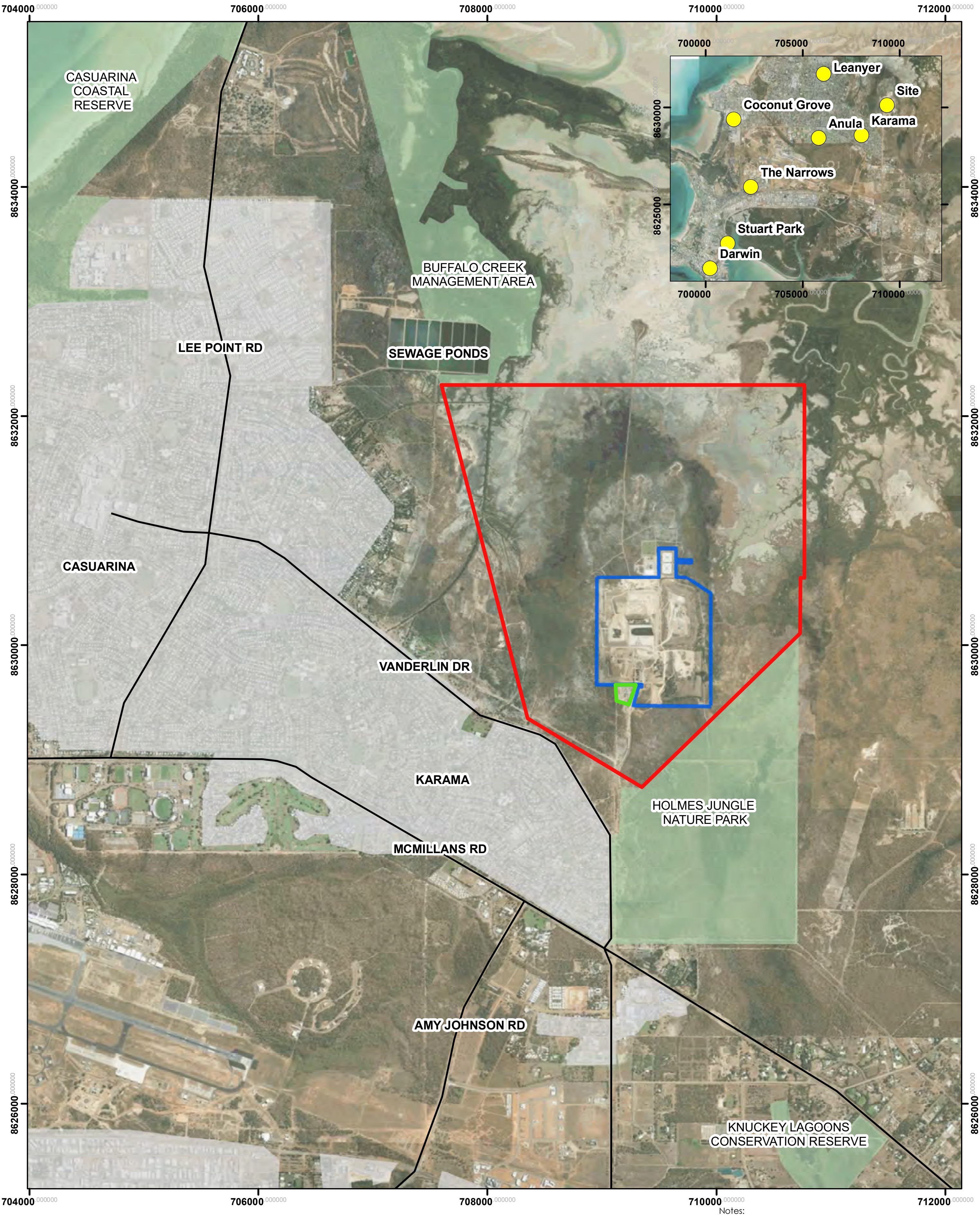
The Site is located 13 km north-east of Darwin City in the suburb of Holmes where CoD lease the entire property from the Commonwealth Department of Defence. Under the terms and conditions of the lease, only a portion of the property is designated as a Waste Management Project Area in which CoD is authorised to conduct waste management and ancillary activities. The remainder of the site consists of an uncleared unexploded ordinance (UXO).

The operational area of the SBWMF is located in the southern part of the property, bound by floodplains, wetlands, and mangroves of Leanyer Swamp to the north/north east, to the south by Holmes Jungle Nature Reserve and to the west by bushland. This bushland separates the Site from the nearest residential area, the suburb of Karama found approximately 800 m to the south-west.

During this annual monitoring period, environmental sampling activities for the Site have been conducted in line with methodologies laid out in the Soil and Water Monitoring Plan (SWMP) (EcOz, 2021a) in order to comply with EPL188-03 also relevant to the new water treatment facilities and monitoring bores adjacent to the western side of the existing leachate treatment ponds previously monitored under licence EPA304-01.

1.2 Site Location

The Site (**Figure 1-1**) is located at Lot 03952 Town of Sanderson Plan S 79/149a, Vanderlin Drive, Holmes, Northern Territory (NT).



Notes:
1. Coordinate System: GDA 1994 MGA Zone 52

References:
1. {Basemap source credits}

STIE LOCALITY AND SURROUNDING LAND USE

CITY OF DARWIN

Project Code: 304701188
Drawn By: LT, Checked By: JB
Figure No: 1-1 | Rev: 1.1
Date: 2023-03-14

Stantec

Legend

- Main Roads
- City of Darwin Lease Area
- Resource Recycling Centre
- 🟩 Protected Reserves
- ⬜ Urban Footprint
- Landfill Operation Area

0 500 1,000 1,500 2,000 Meters

Scale at A3 1:30,000

2 Purpose of this Document

The purpose of this Quarterly Monitoring Review is to provide a summary of all of Stantec's monitoring activities for the period 1 July 2022 to 30 June 2023, including analytical results and assessment against adopted criteria in accordance with the Site's EPL conditions.

This review has been prepared in accordance with the requirements of the NT EPA *Guideline for Reporting on Environmental Monitoring* and SWMP to include the following:

- Summary of all surface water, groundwater, leachate, air emissions, undertaken during the monitoring review period.
- Graphical and tabulated interpretation of all monitoring data for the monitoring period;
- Comparison of results with respect to the adopted quality criteria and/or action levels;
- Discussion of results with respect to long term monitoring data over a three year period and temporal and spatial trends;
- Assess compliance with regulatory guidelines and standards including notifying the regulator; and
- Provide recommendations for remediation where impacts are identified during monitoring and reporting activities.
- Noting that analytical data has also been provided to CoD separately in Microsoft Excel format outside of this report.

3 Site Identification

3.1 Site Use

The ‘Site’ lies within Lot 3952, Town of Sanderson (see **Figure 3-1**) described in EPL 188-03 as a municipal waste resource recovery and disposal site operated by the CoD which services both domestic and commercial customers in the Darwin area. Under the terms and conditions of the lease, the property is designated as a Waste Management Project Area in which CoD is authorised to conduct the following scheduled activities:

- Operating premises for the disposal of waste by burial that service, or are designed to service, the waste disposal requirements of more than 1,000 persons;
- Collecting, transporting, storing, re-cycling, treating or disposing of a listed waste (see **Table 3-1**) on a commercial or fee for service basis, other than in or for the purpose of a sewage treatment plant; and
- Operating premises, other than a sewage treatment plant, associated with collecting, transporting, storing, re-cycling, treating or disposing of a listed waste (see **Table 3-1**) on a commercial or fee for service basis.

Table 3-1 Listed Wastes Authorised to be Held

Listed Waste	Collection	Transport	Storage	Treatment	Recycling	Disposal
Acidic solutions or acids in solid form	✗	✗	✓	✗	✗	✗
Animal effluent and residues	✗	✗	✗	✗	✗	✓
Asbestos	✗	✗	✗	✗	✗	✓
Clinical and related wastes	✗	✗	✗	✗	✗	✓
Lead, lead compounds	✗	✗	✓	✗	✗	✗
Sewerage sludge and residues including nightsoil and septic tank sludge	✗	✗	✗	✗	✗	✓
Soils contaminated with a listed waste	✗	✗	✗	✗	✗	✓
Tyres	✗	✗	✗	✗	✗	✓
Waste from the production, formulation and use of inks, dyes, pigments, paints, lacquers and varnish	✗	✗	✓	✗	✗	✗
Waste mineral oils unfit for their original intended use	✗	✗	✓	✗	✗	✗

✓ Activity authorised by EPL 188 ✗ Activity not authorised by EPL 188

3.2 Site Layout

At the end of this monitoring period the Site included putrescible waste landfill cell (Stage 5, Stage 6), inert waste landfill cell (Stage 2), waste transfer station, recycle shop, mulching/processing facility for green waste, leachate management systems, and landfill gas management systems.

- The Stage 3 and 4 putrescible waste landfill cells reached capacity and were capped during 2016 and 2017, with the waste accepted by the Stage 5 cell currently approaching capacity, where waste has started being diverted to the recently constructed Stage 6 landfill cell.
- The Stage 3, 4, and 5 landfill cells are lined and have a leachate collection system. The leachate collected is irrigated back onto the cells, when possible. Leachate storage ponds store excess leachate until it can be applied back onto the landfill cells.
- The Stage 2 landfill cell located in the north-eastern portion of the Site is unlined and accepts inert waste (construction and demolition including asbestos). The Stage 1 landfill cell is located in the southeast is an historic unlined landfill, which is capped and not in use. Leachate from the unlined Stage 1 and 2 landfill cells is collected in an underground drain running north-south along the eastern edge of the cells. This then drains into a collection chamber ‘LMP02’, where it is pumped out and irrigated onto the capped Stage 1 cell.
- Newly prescribed Stage 6 landfill lies adjacent and immediately south east of the Stage 5 landfill providing further capacity and has been integrated into the same leachate collection systems as the Stage 3, 4, and 5 landfill cells;
- Green waste storage and mulching is undertaken on a pad south of Stage 5.
- A facility for the short-term storage of chemicals is located in the southern portion of the Site.
- Renewable energy is generated on Site using landfill gas (methane) and provided to Darwin’s power grid. The landfill gas management system involves capturing methane gas emissions from the landfill via a gas extraction system comprising vertical and horizontal wells drilled into the waste cells connected to a reticulation system. Condensate from the gas extraction system is pumped to disposal trenches within the Stage 2 landfill.

For more details on the disposal, storage and handling of different waste types refer to the SBWMF *Environmental Management Plan* (EMP), (CoD, 2023), Sections 2.1 and 2.4, and for more details on landfill leachate management and gas management, refer to the EMP’s appended, supporting documents listed below:

- Water Balance, Leachate and Stormwater Management Strategies
- Environmental Management Plan Leachate Treatment and Irrigation
- Landfill Gas Monitoring Plan

3.3 Environmental Setting

3.3.1 Climate

The regional climate is tropical monsoonal with a distinct wet season (November to April) and dry season (May to October). Average yearly rainfall is 1,723.3 mm, 80% of which occurs between December and March (Darwin Airport, BoM Station Site Number 014015).

3.3.2 Hydrology

Surface water from the eastern portions of the Site flows towards the Meckitt Creek floodplain (see **Figure 3-1**) Flows from the western portion of the Site are towards the Leanyer Swamp and Buffalo Creek. Both Meckitt Creek and Buffalo Creek are mangrove-lined tidal inlets of Shoal Bay, a coastal embayment with extensive sand and mud flats.

Surface water often records concentrations of nutrients such as ammonia, as well as metals including lead above guideline values, with the majority of other parameters measured within guideline limits. Groundwater and leachate water frequently record elevated ammonia, copper, lead and zinc concentrations above guideline values. The migration of leachate into the surface and groundwaters at the Site is evident through chemistry analysis though the transportation of these contaminants around and offsite is not yet fully understood.

Historically groundwater quality at SBWMF has been highly variable in terms of salinity, pH, metals and nutrients (CDM Smith 2019). Groundwater down gradient of the SBWMF is saline due to its close proximity to Shoal Bay and it’s aforementioned estuaries Buffalo and Mickett Creek. There are no groundwater bores or groundwater uses down gradient of SBWMF other than that potentially associated with environmental supply of groundwater seepage into wetlands and tidal inlets (CoD, 2023).

3.3.3 Hydrogeology

Geology and groundwater aquifers beneath the Site are described in detail in the *Shoal Bay Waste Disposal Site, Hydrogeological Investigation* (URS 2015).

The lithology encountered during groundwater bore drilling for the investigation comprised topsoils (silts and clays), generally underlain by weathered (lateralised) siltstone over most of the Site, and claystone east of Stage 1. Beneath this, sandstone was encountered at depths of 9.0 to 20 m below the surface across most of the Site.

Groundwater exists within the unconsolidated overlying sediments and fractured and weathered underlying bedrock. Bore yields are generally very poor; less than 5.0 L/sec. Seasonal groundwater levels measured as part of the SBWMF water monitoring plan are greater than 12 meters below ground level (mbgl) at the end of the dry season and usually within 2.0 m of the ground surface during the peak of the wet season.

Groundwater down-gradient of the SBWMF is saline due to its close proximity to the coast and tidal saline intrusion; see *the Groundwater Resources of the Darwin Area Map* (DIPE 2003). There are no groundwater bores or groundwater uses down-gradient of SBWMF other than that potentially associated with environmental supply of groundwater seepage into wetlands and tidal inlets.

Higher yielding weathered and fractured carbonate rock aquifers occur in the wider region, with yields commonly greater than 5.0 L/sec. *The Groundwater Supply Prospects and Hydrogeology of the Cox Peninsula Region Map* (NRETA 2008) identifies a high yielding carbonate aquifer south-east of the SBWMF, trending in a northerly direction. Groundwater from this aquifer discharges to the surface within the Holmes Jungle Nature Park and maintains streamflow through the dry season. This spring and associated shallow groundwater support the Holmes Jungle rainforest. Further to the southeast around the Knuckey Lagoon area, a large number of bores draw groundwater from this carbonate aquifer for domestic and agricultural purposes.

The carbonate rock aquifer and associated springs, Holmes Jungle rainforest and groundwater users are all located upgradient of the SBWMF. No significant areas of carbonate rock aquifer are located down-gradient of the SBWMF, and no carbonate rocks were encountered during the installation of the 32 groundwater bores, to depths of up to 30 mbgl, across the Site for the hydrogeological investigation (URS 2016).

For detailed analysis of potential contamination pathways for leachate and other pollutants from the SBWMF towards potential human health and environmental receptors, refer to the EMP Section 3, *Conceptual Site Model* (CoD, 2023) and **Section 7** of this report.

3.3.4 Environmental Values

EPL188-03 lists the following 'Environment Protection Objectives' (Part 4 of the WMPC Act), 'Beneficial Uses and Water Quality Standards' (section 73 of the NT Water Act) and 'environmental interests' that apply to the Site and immediate surrounds:

- An Environment Protection Objective (EPO) is a statutory instrument to establish principles on which:

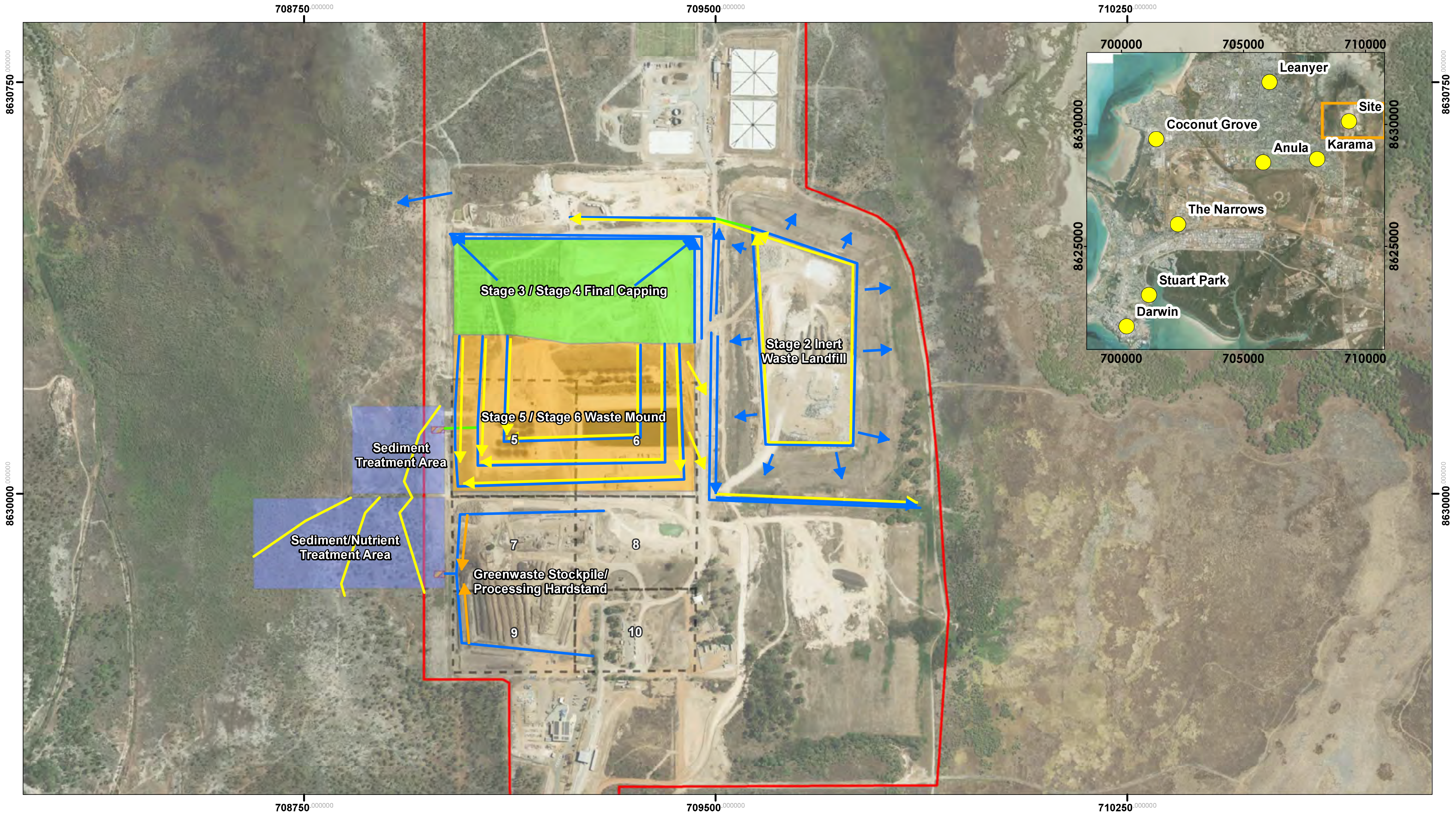
a) environmental quality is to be maintained, enhanced, managed or protected;

b) pollution, or environmental harm resulting from pollution, is to be assessed, prevented, reduced, controlled, rectified or cleaned up; and

c) effective waste management is to be implemented or evaluated.

- In accordance with section 18 of the WMPC Act a beneficial use, quality standard, criteria or objective declared under section 73 of the Water Act and in force is an environment protection objective for the purposes of the WMPC Act.
- Declared Beneficial Uses for the Darwin Harbour Area: Water Quality Objectives, NTG Gazette 29, June 2010; these include the beneficial uses of: environment, agriculture, cultural and rural stock and domestic. Of these, the 'environmental' beneficial use is the most stringent in regard to water quality requirements given aquatic organisms are the most sensitive of these beneficial uses to water quality changes.
- Darwin Harbour Site of Conservation Significance (SOC 6)

The SBWMF also lies within the Shoal Bay Site of Conservation Significance (SOC 8); see Factsheet available on the NT Government information and services website:
https://nt.gov.au/environment/environment-data-maps/important-biodiversity-conservation-sites/conservation-significance-list



Site Layout and Surface Water Flows

City of Darwin

Project Code: 304701188
Drawn By: LT, Checked By: JB
Figure No: 3-1 | Rev: 1
Date: 2023-08-18

Legend

- ➔ First flush water
- ➔ Clean water
- ➔ Sediment water
- — Catch Drain
- — Chutes
- — Level spreader
- ▨ Sediment traps
- ■ Sediment treatment area
- ■ Stage 3 / Stage 4 Final Capping
- ■ Stage 5 / Stage 6 Waste Mound
- ☐ Future landfill stages
- ☐ Perimeter fence

Notes:
1. Coordinate System: GCS GDA 1994

References:
1. {Basemap source credits}

Scale at A3 1:6500

Stantec

4 Methods and Approach

Groundwater, surface water, and leachate water quality monitoring have been undertaken at the SBWMF as per the URS monitoring plan (2016) and subsequent EcOz monitoring plan since July 2016, when EPL188 was issued. Throughout this time, CoD initially commissioned EcOz Environmental Consultants (EcOz), assisted by Larrakia Nation Rangers, to carry out the monitoring, prior to engaging Cardno now, Stantec to undertake the monitoring activities.

Stantec has developed a specific safe work method statement (SWMS) and standard operating procedures (SOP) for soil, groundwater and surface water (applicable to leachate), which are always adhered to.

4.1 Management Framework

Stantec's suitably qualified scientist undertook groundwater, surface water and leachate sampling detailed below, consistent with procedures laid out in the SWMP and in accordance with the following best practice industry standards and guidelines:

- NT EPA 'Guideline for Reporting on Environmental Monitoring'
- AS 4482.1-2005 "Guide to the investigation and sampling of sites with potentially contaminated soil, Part 1: Non-volatile and semi-volatile compounds".
- AS 4482.2-1999 "Guide to the sampling and investigation of potentially contaminated soil, Part 2: Volatile substances".
- AS 5667.1 "Water Quality-Sampling: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples".
- AS 5667.11-1998 "Water Quality-Sampling: Guidance on sampling of groundwater".
- Department of Environment and Regulation (DER), 2014, "Assessment and Management of Contaminated Sites".
- AS/NZS 5667.4:1998 "Water Quality Sampling - Part 4: Guidance on sampling from lakes, natural and man-made".
- AS/NZS 5667.6:1998 "Water Quality Sampling – Part 6: Guidance on sampling of rivers and streams".
- AN/NZS 5667.10:1998 "Water Quality Sampling – Part 10: Guidance on sampling of waste waters".
- DoH, 2014, Contaminated Sites Ground and Surface Water Chemical Screening Guidelines.
- National Environment Protection Council (NEPC), 1999, National Environmental Protection (Assessment of Site Contamination) Measure (as amended), registered May 2013.
- NEPC Schedule B (1): Guideline on the Investigation Levels for Soil and Groundwater.

4.2 Methodologies

4.2.1 Overall Monitoring Approach

During each monitoring round a team of two of Stantec's suitably qualified environmental scientists and hydrologists undertook groundwater and surface water monitoring in line with the aforementioned standards and SWMP. On each monitoring event, surveys were undertaken for up to 3 consecutive days. The monitoring procedures for groundwater and surface water monitoring were carried out concurrently and consisted of the following preliminaries:

- Prior to attendance to site preparation/update the Site Works Method Statement (SWMS) that includes details of health and safety procedures, map showing location of sacred sites likely to have restrictions to access, and identification of required PPE for site conditions/requirements.
- At start of each field day and prior to each survey commencing, conduct a safety start meeting identifying potential hazards. Liaise with site manager to identify no-go zones regarding site's operations and other relevant safety information.
- Scope specific sampling procedures, data collection, and analysis are discussed in their respective sections below.

4.2.2 Ground Water Monitoring

During this monitoring period the following groundwater monitoring procedures were carried out by Stantec's suitably qualified personnel at each ground water monitoring location where no-purge (Hydrasleeve) was the predominant sampling technique prior to the new SWMP:

- HydraSleeves are deployed with top weight for sample collection to begin at the lowest point. HydraSleeve sampling devices are left in wells for a minimum of 4 hours to allow restabilisation of the well following the slight disturbance caused by sampler deployment.
- Samples are then collected via continuous pull method at a rate allowing the water to pass through the check value into the sample sleeve.
- Samples are discharged immediately (minimise changes in chemistry) via discharge tube.
- Low Flow Purging and sampling:
- Groundwater is purged utilising the "continue flow" technique using a low flow bladder pump.
- Purging of each monitoring bore continues until groundwater field parameters [including pH, electrical conductivity (EC), oxidation reduction potential (ORP), dissolved oxygen (DO), turbidity and temperature] stabilise (as indicated by at least three consecutive measurements falling within +/- 5% of each other) and a sustainable sampling flow rate (i.e., minimal draw down) has been established to confirm that a representative sample of the Superficial Aquifer is collected.
- In situ temperature, pH, dissolved oxygen (DO), turbidity (NTU), electrical conductivity and redox (mV) is measured using a YSI Pro Plus Multiparameter Instrument.
- Groundwater sampling can commence once the physiochemical parameters have stabilised, indicating that they represent natural groundwater in the aquifer.
- Samples collected for dissolved heavy metal analysis are filtered in the field using an in-line 0.45 micron (µm) filter to remove suspended solids and most colloids.
- Use of dedicated pump tubing at each groundwater well; and thorough washing of all re-usable sampling equipment (i.e., pumps) and with detergent (Liquinox), then double rinsing with clean water and drying before the collection of each sample.
- Samples are collected directly in into appropriately labelled and preserved laboratory supplied bottles and packed in chilled containers for delivery to the laboratory under Chain-of-custody documentation.
- Sample containers, preservation procedures, sample storage requirements and holding times are undertaken in accordance with those recommended by Standards Australia (AS/NZS 5667.1:1998 and AS 4482.1 as appropriate). All holding times comply with the requirements set out in "Australian Standard AS/NZS 5567.1:1998 and AS 4482.1".

4.2.3 Storm / Surface Water and Leachate Monitoring Procedures

The following surface water sampling procedures were carried out by Stantec's suitably qualified personnel at each surface and stormwater sampling location:

- In situ temperature, pH, dissolved oxygen (DO), turbidity (NTU), electrical conductivity and redox (mV) shall be measured using a YSI Pro Plus Multiparameter Instrument or equivalent.
- The specific method of sampling adhered to those specified in and SWMP.
- Samples are collected directly in into appropriately labelled and preserved laboratory supplied bottles and packed in chilled containers for delivery to the laboratory under Chain of Custody documentation.
- Surface water samples collected for dissolved heavy metal analysis are filtered in the field using an in-line 0.45 micron (µm) filter to remove suspended solids and most colloids.
- Sample containers, preservation procedures, sample storage requirements and holding times are undertaken in accordance with those recommended by Standards Australia (AS/NZS 5667.1:1998 and AS 4482.1 as appropriate). All holding times comply with the requirements set out in "Australian Standard AS/NZS 5567.1:1998 and AS 4482.1".
- Use of dedicated disposable sampling equipment at each surface water location; and, thorough washing of all re-usable sampling equipment with detergent (Liquinox), then double rinsing with clean water and drying before the collection of each sample.

4.2.4 Quality Assurance / Quality Control

QA/QC samples are collected at the frequency detailed in the SWMP and analysed for the same analytes as the primary samples:

Water sampling

- Field duplicate (intra-laboratory) at 1 per 10 primary water samples.
- Field triplicate (inter-laboratory) at 1 per 10 primary water samples.
- Field blank (one per event).

4.2.5 Emissions Monitoring

Emissions testing methodologies associated with the evapoconcentrators, BeneVap (BV300) and BeneVap (BV150) are discussed in detail in the following reports, also provided in **Appendix A**:

- Source Emissions Monitoring – Shoal Bay BeneVap300, Report Ref. 14326_BV300_Aug 2022 (Assured Environmental, 2022).
- Source Emissions Monitoring – Shoal Bay BeneVap300, Report Ref. 14621_BV300_Oct 2022 (Assured Environmental, 2022).
- Source Emissions Monitoring – Shoal Bay BeneVap300, Report Ref. 14714_BV300_Feb 2023 (Assured Environmental, 2022).
- Source Emissions Monitoring – Shoal Bay BeneVap150, Report Ref. 14326_BV150_Aug 2022 (Assured Environmental, 2022).
- Source Emissions Monitoring – Shoal Bay BeneVap150, Report Ref. 14621_BV300_Oct 2022 (Assured Environmental, 2022).
- Source Emissions Monitoring – Shoal Bay BeneVap150, Report Ref. 14714_BV300_Feb 2023 (Assured Environmental, 2022).

4.3 Monitoring Sites

The current network of monitoring sites relevant to this review period includes 11 leachate sites, 43 groundwater sites, and 9 surface water and stormwater sampling sites. Each monitoring network is described in detail in their respective sections below and illustrated on **Figure 4-1.**

4.3.1 Leachate Monitoring Network

Leachate sampling sites allow for the characterisation of contaminant concentrations in landfill leachate to allow for comparison with groundwater and surface water samples. The leachate sampling locations are detailed in **Table 4-1** and include:

- Deleaching Well (DW) DW2 - collects leachate from the south-west corner of the Stage 3/4 landfill.
- DW3 - collects leachate from the north-west corner of the Stage 3/4 landfill.
- Stage 3 leachate sump (TC Sump) - collects leachate from the eastern side of the Stage 3/4 landfill.
- DW5 - collects leachate from the western side of the Stage 5 landfill.
- DW6 - collects leachate from the south-west corner of the Stage 5 landfill.
- DW7 - collects leachate from the northern portion of the Stage 6 landfill.
- DW8 - collects leachate from the southern portion of the Stage 6 landfill.
- Leachate Pond (LP) LP01 - Northern leachate storage pond.
- LP02 - Southern leachate storage pond.
- LMP02 - Sump at the end of a trench that runs along the western side of the Stage 1 and Stage 2 landfills and collects leachate from these landfills.
- Newly installed ‘LTP wetland’ – is open wetland treatment pond receiving treated leachate from the new leachate treatment facilities.

Table 4-1 Leachate Sampling Locations

Site ID	Easting (m)	Northing (m)	Location	Source
DW2	709029	8630459	Deleaching well on noththwest corner of Stage 3/4 landfill	Represents leachate from Stage 3/4 landfill cells
DW3	709038	8630216	Deleaching well on southwest corner of Stage 3/4 landfill	Represents leachate from Stage 3/4 landfill cells
DW5	709023	8630122	Deleaching well on west side of Stage 5 landfill	Represents leachate from Stage 5 landfill cell
DW6	709041	8630039	Deleaching well on southwest corner of Stage 5 landfill	Represents leachate from Stage 5 landfill cell
DW7	709450	8630121	Deleaching well on northeast corner of stage 6 landfill	Represents leachate from the norther portion of the Stage 6 landfill cell
DW8	709459	8630042	Deleaching well on central east boundary of stage 6	Represents leachate from the southern portion of the Stage 6 landfill cell
TC Sump	709465	8630233	Sump on southeast corner of Stage 3/4 landfill	Represents leachate from Stage 3/4 landfill cells
LMP02	709938	8629759	East of Stage 1	Sump that receives leachate from Stage 1 and 2 landfills via an interception trench that runs north-south along the eastern edge of the Stage 1 and 2 landfills.
LP01	709534	8630726	Northern leachate storage pond	Represents leachate in northern storage pond
LP02	709531	8630713	Southern leachate storage pond	Represents leachate in southern storage pond
LTP Wetland	709458	8630643	Leachate treatment pond	Receives treated leachate from the newly installed treatment facilities

4.3.2 Groundwater Monitoring Network

Ground water monitoring bores provide an indication of landfill leachate and/or other contaminants associated with SBWMF operations migrating from site in groundwater down gradient. The 43 groundwater monitoring bores to be monitored under EPL188-03 and bores previously monitored in line with the URS WMP are detailed in **Table 4-2**, and comprise:

- A total 43 bores at 22 locations across the Site, with up to 3 bores (nested) at some locations. Installation of this monitoring network began in 2015 to inform a hydrogeological investigation (URS 2015) and development of a CSM (URS 2016). Since then, additional clustered have been installed in 2019 and 2021 to inform groundwater impacts from newly constructed Stage 6 landfill and future leachate treatment infrastructure. Generally, each of the 22 locations includes a shallow bore screened between 1.5 and 3 m below ground level (mbgl), and a deeper bore screened between 9 and 12 mbgl. Three of the locations have a third bore screened at 30 mbgl. The IDs for these bores are prefixed with a 'GW' and suffixed with a -3, -12 or -30 to indicate bore screening depth.
- Four bores of the current monitoring network installed prior to the URS (2015) hydrogeological investigation prefixed with a 'WW' with varying screened intervals; all less than 10 m deep.
- The most recent installation includes GW19 and GW20 (renamed from GWI5 and GWI6), from which groundwater from underneath the two landfill stages (Stage 5/6 and Stage 2) can be sampled. These monitoring sites are technically interception points that have not been installed with a well monument and complete monitoring well infrastructure. They therefore do not have TOC elevations and other bore-related information.

Table 4-2 Monitoring Bore Locations and Construction Details

Bore	Easting (m)	Northing (m)	Monument Elevation (m AHD)	PVC Elevation (m AHD)	Ground Elevation (m AHD)	Screened Interval (m bgl)	Screened Interval Lithology
GW1-3	709564	8631004	8.71	8.63	8.02	1.5-3	Siltstone
GW1-12	709566	8631004	8.71	8.59	8.00	9-12	Siltstone

Bore	Easting (m)	Northing (m)	Monument Elevation (m AHD)	PVC Elevation (m AHD)	Ground Elevation (m AHD)	Screened Interval (m bgl)	Screened Interval Lithology
GW2-3	709629	8630835	8.06	7.94	7.33	1.5-3	Siltstone
GW2-12	709631	8630835	8.08	7.94	7.28	9-12	Siltstone
GW3-3	709652	8630746	9.94	9.80	9.12	1.5-3	Siltstone
GW3-12	709654	8630746	9.87	9.82	9.10	9-12	Siltstone
GW4-3	709775	8630634	5.65	5.49	4.88	1.5-3	Siltstone
GW4-12	709776	8630633	5.61	5.44	5.36	9-12	Siltstone
GW4-30	709777	8630631	5.50	5.20	5.33	15-21	Gravelly sand, Sandstone
GW5-3	709880	8630224	5.51	5.41	4.70	1.5-3	Siltstone
GW5-12	709880	8630226	5.48	5.33	4.70	9-12	Siltstone, Gravelly Clay
GW7-3	709900	8629992	5.18	5.03	4.33	1.5-3	Siltstone
GW7-12	709900	8629994	5.16	5.08	4.33	9-12	Siltstone, Sandy Silt
GW8-3	709896	8629708	5.42	5.28	4.65	1.5-3	Claystone
GW8-12	709896	8629708	5.37	5.22	4.62	9.1-12.1	Claystone, Sandstone
GW9-12	709660	8629469	16.18	15.93	15.44	9-12	Siltstone
GW10-3	709147	8629507	18.12	18.06	17.32	1.5-3	Siltstone
GW10-12	709149	8629507	18.13	17.98	17.37	9.1-12.1	Siltstone
GW11-3	709040	8629671	13.50	13.38	12.72	1.5-3	Siltstone
GW11-12	709042	8629671	13.52	13.38	12.84	9-12	Siltstone, Sandstone
GW12-3	709024	8629881	12.20	12.07	11.44	1.5-3	Siltstone
GW12-12	709024	8629883	12.22	12.04	11.50	9-12	Siltstone
GW12-30	709024	8629885	12.21	12.05	11.55	24-30	Sandstone
GW13-3	709017	8630175	12.93	12.88	12.32	3-4.5	Siltstone
GW13-12	709016	8630174	12.91	12.86	12.25	10-13.5	Siltstone
GW14-3	709013	8630423	6.78	6.73	6.09	1.5-3	Siltstone
GW14-12	709013	8630424	6.77	6.64	6.08	9-12	Siltstone
GW15-3	709230	8630599	11.27	11.06	10.44	1.5-3	Siltstone
GW15-12	709233	8630599	11.20	11.04	10.44	9-12	Siltstone
GW16-3	709493	8630030	TBC	TBC	TBC	1.5-3	Sandy Claystone
GW16-12	709494	8630025	TBC	TBC	TBC	9-12	Siltstone
GW16-30	709495	8630021	TBC	TBC	TBC	30	Siltstone
GW17-3	709418	8630692	TBC	TBC	TBC	3	-
GW17-12	709418	8630691	TBC	TBC	TBC	12	-
GW17-30	709418	8630691	TBC	TBC	TBC	30	-
GW18-3	709464	8630729	TBC	TBC	TBC	3	-
GW18-12	709464	8630728	TBC	TBC	TBC		-
GW19	708952	8630107	-	-	-	-	-
GW20	709811	8629975	-	-	-	-	-
WW1	709471	8630255	-	16.60	15.90	0-6.3	-
WW6	709047	8630478	-	7.46	6.76	0-20.4	-
WW9	709016	8630598	-	7.09	6.39	1-9.8	Siltstone

Bore	Easting (m)	Northing (m)	Monument Elevation (m AHD)	PVC Elevation (m AHD)	Ground Elevation (m AHD)	Screened Interval (m bgl)	Screened Interval Lithology
WW13	709457	8630598	+0.8	+0.7	Not available	1-10	Siltstone

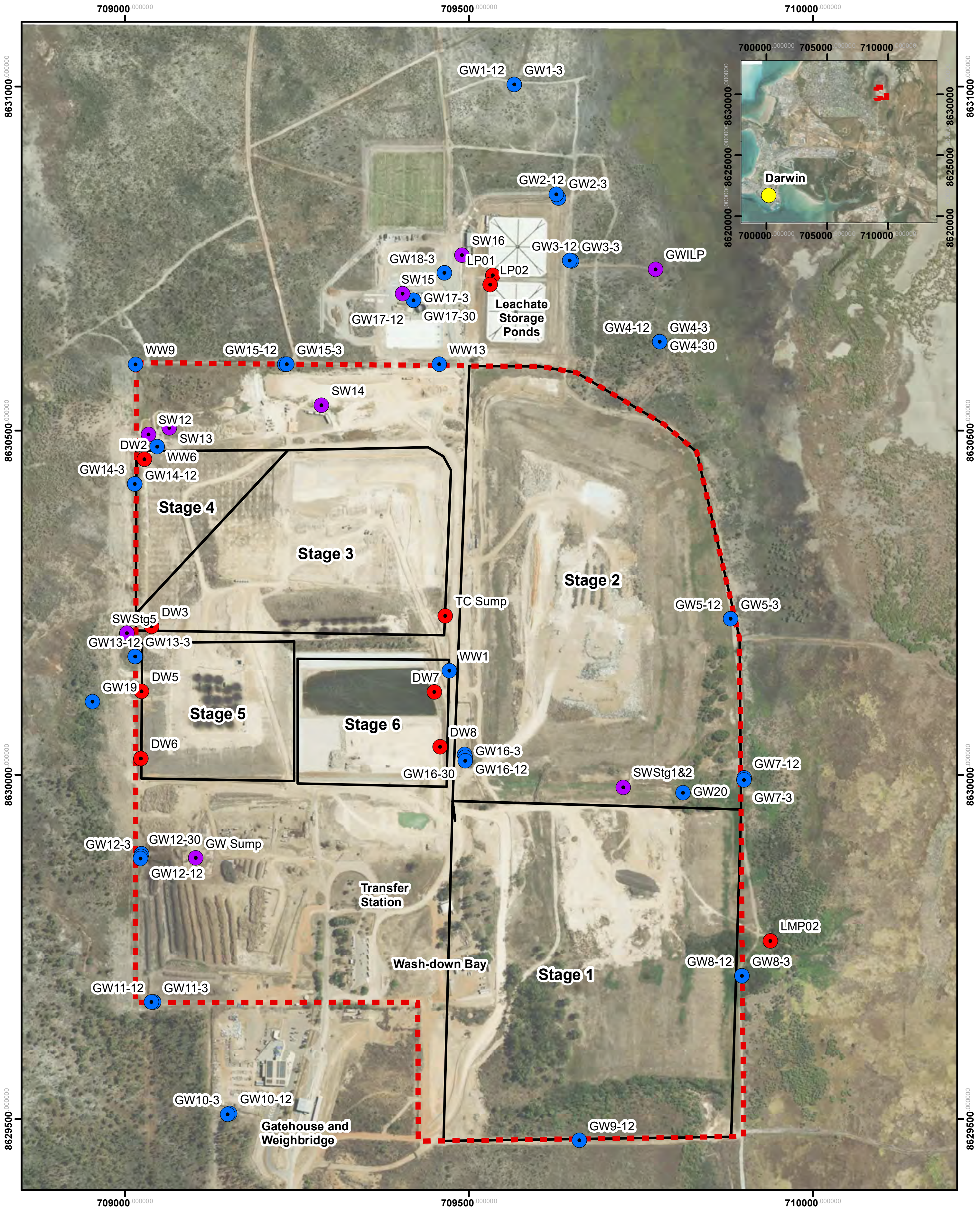
4.3.3 Stormwater and Surface Water Monitoring Network

Surface water sampling locations provide an indication of landfill leachate and/or other contaminants associated with SBWMF operations that have the potential flow downstream and offsite affecting surrounding receptors. The surface water monitoring sites are detailed in **Table 4-3** and include:

- Wheel Wash Sump - collects the wash-down water from the bunded area used to wash commercial waste disposal vehicles.
- Water outfall from Stage 1 and Stage 2 landfills (STG1 & 2) - surface water drain along the western edge of the Stage 1 and Stage 2 landfills.
- Water outfall from Stage 3 and Stage 5 landfills (SWStg5) - surface water drain along the western edge of the Stage 3 and Stage 5 landfills.
- Green waste (GW) Sump - collects surface water drainage from the green waste processing area.
- SW12, SW13 and SW14 - receive surface water runoff (and potentially seepage) from the Stage 3 and 4 landfill cells.
- SW15 and SW16 - receive surface water runoff from the newly installed leachate treatment facilities west of the leachate treatment ponds.
- GWILP - Receives intercepted water runoff from the existing leachate pond.

Table 4-3 Stormwater and Surface Water Monitoring Locations

Site ID	Easting (m)	Northing (m)	Location	Source
SWStg1&2 (formerly STG1&2)	709448	8629979	Surface drain between Stage 1 and Stage 2	Receives surface water runoff from central SBWMF areas
SWStg5	709003	8630206	Northwest of Stage 5	Receives surface water runoff from central Stage 3 and Stage 5 landfills.
GW Sump	709102	8629880	Sump within green waste processing and storage area	Receives surface water runoff from green waste processing and storage area. Possibly also surface runoff from the Stage 3 and 5 landfills.
GWILP	709771	8630733	East of the leachate ponds	Receives surface runoff from the existing leachate pond.
SW12	709035	8630495	Catchment dam at base of northwest corner of Stage 3/4 landfill	Receives surface water runoff (and potentially seepage) from the northern and western sides of the Stage 3/4 landfill cells
SW13	709065	8630504	Catchment dam at base of northwest corner of Stage 3/4 landfill	Receives surface water runoff (and potentially seepage) from the northern and western sides of the Stage 3/4 landfill cells
SW14	709287	8630536	Catchment dam north of Stage 3/4 landfill	Receives surface water runoff (and potentially seepage) from the western landfill cells
SW15	709405	8630699	North of leachate treatment	Receives runoff from the new leachate treatment plant
SW16	709490	8630756	West of leachate treatment plant	Receives runoff from the new leachate treatment plant



Site Layout & Water Mointoring Site Locations

City of Darwin

Legend

- ● Leachate Sampling
- ● Surface Water Sampling
- ● Ground Water Sampling Sites
- ▨ Lot Boundary
- ☐ Stage Areas

Notes:
1. Coordinate System: GDA 1994 MGA Zone 52

References:
1. {Basemap source credits}

0 100 200 300 400 500 Metres

Scale at A3 1:5,000

Project Code: 304701188
Drawn By: LT, Checked By: JB
Figure No: 4-1 | Rev: 1.1
Date: 2023-07-05

Stantec

4.4 Sampling Frequency

EPL188-03 stipulates sampling frequencies and analysis for each sampling location provided in **Appendix B**. The specific sites sampled each month vary concurrent with seasonal changes in rainfall, surface water flows and groundwater levels. The availability of sites for sampling throughout the year (i.e., availability of water to sample) confirmed in previous annual reviews (Cardno, 2020, Cardno, 2021, Cardno 2022) is summarised as follows:

> All leachate sites can be sampled throughout the year.

> The GW Sump can usually be sampled throughout the wet season, between the months of September and May.

> The surface water sites SW12, SW13 and SW14 are sediment dams that hold water throughout the wet season and well into the dry season i.e., is usually only dry from June to September.

> The surface water sites SW15, SW16, SWStg1&2 and SWStg5 only have water and can be sampled immediately after heavy rainfall at the peak of the wet season i.e., January and February.

> During the dry season, most of the shallow 3.0 m deep bores, and a large number of the 12 m deep bores are dry i.e., groundwater levels drop below the bottom of the bore.

> The established deep bores GW4-30, GW17-30, GW16-30 and GW12-30 are known to contain water throughout the year, with standing water levels (SWLs) of up to 12 m bgl at the end of the dry season (at GW12-30) and within 6.0 m of the ground surface during the wet season. GW4-30, located close to the floodplains northeast of the SBWMF, is often artesian throughout the wet season and only drops to a maximum 3.0 m bgl during the dry season.

> In addition to the three deep bores mentioned above, the following bores also contain groundwater throughout the dry season and can be sampled:

> GW-5-12;

> GW6-12;

> GW7-12;

> GW8-12;

> GW16-12; and

> GW17-12.

> Sampling is undertaken during the first week of every month, representative of water quality for the previous month, e.g., sampling during the first week of November represents October.

4.5 Parameters Measured

Analysis suites prescribed by EPL-188-03 and laid out in SWMP are provided in **Appendix B**. **Table 4-4** provides which parameter suite was analysed during each monitoring round during this annual monitoring period.

Table 4-4 Water Quality Analysis Schedule January – March 2023

Monitoring Event	Monitoring Schedule	Analysis Suite	Analysis Group
July 2023	EPL188-03	Quarterly	▪ Leachate ▪ Surface Water (in situ parameters only) ▪ Groundwater
August 2023	EPL188-03	Monthly	▪ Surface Water (in situ parameters only) ▪ Groundwater (SWLs only)
September 2023	EPL188-03	Monthly	▪ Surface Water (in situ parameters only) ▪ Groundwater (SWLs only)
October 2023	EPL188-03	Quarterly	▪ Leachate ▪ Surface Water ▪ Groundwater
November 2023	EPL188-03	Monthly	▪ Surface Water ▪ Groundwater (SWLs only)
December 2023	EPL188-03	Monthly	▪ Surface Water

Monitoring Event	Monitoring Schedule	Analysis Suite	Analysis Group
			Groundwater (SWLs only)
January 2023	EPL188-03	Annual	Leachate Surface Water Groundwater
February 2023	EPL188-03	Monthly	Surface Water Groundwater (SWLs only)
March 2023	EPL188-03	Monthly	Surface Water Groundwater (SWLs only)
April 2023	EPL188-03	Quarterly	Leachate Surface Water Groundwater
May 2023	EPL188-03	Monthly	Surface Water (in situ parameters only) Groundwater (SWLs only)
June 2023	EPL188-03	Monthly	Surface Water (in situ parameters only) Groundwater (SWLs only)

4.6 Assessment Criteria

Assessment Criteria relevant to water and leachate have remained consistent with the below details during this monitoring review period.

4.6.1 Water Quality

Surface water trigger values prescribed by Attachment 3 of EPL188-03 (**Appendix B**) have been informed by the following guidelines:

> Darwin Harbour Water Objectives (Shoal Bay upper area marine ambient water quality) trigger values;

> *Australian and New Zealand Guidelines (ANZG) for Fresh and Marine Water Quality* (2018) default guideline values (DGVs) for protection of 90% of marine ecosystems. These criteria aim to better assess the potential risk to surrounding environmental receptors; and

> *PFAS National Environmental Management Plan v2.0* (HEPA, 2020), 90% species protection – highly disturbed systems in interim marine water (PFOS – 2 µg/L and PFOA – 632 µg/L)

The aforementioned guidelines currently reference freshwater values in lieu of interim marine guidelines, using the nationally agreed process under the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* where PFOS and PFOA are the only PFAS species with guidelines values for aquatic ecosystems.

Pursuant to EPL 188-03, if at the time of review storm and surface water quality issues have been identified (i.e., trigger levels are exceeded) then these issues will be raised formally with the CEO and NT EPA, provided that:

> Trigger levels have been exceeded over three consecutive monitoring events;

> A trigger level is exceeded greater than or equal to two times the trigger value; or

> A trigger level is exceeded at a median value over six consecutive monitoring events.

4.6.2 Emissions

Emission values have been compared against the emission limits stipulated in Attachment 7 of EPL188-03.

5 Results

5.1 Rainfall and Site Conditions

The availability of water for sampling at a number of groundwater and surface water sites is dependent on rainfall described in Section 3.3. Surface water only flows in stormwater drains across the site during and immediately after rainfall although surface water catchments such as ‘SW12,13,14’ and ‘GW Sump’ hold water for longer periods.

Stormwater sampling sites SW15, SW16, SWStg1&2 and SWStg5 have only provided for sampling sporadically during the wet season since their introduction to the monitoring program.

Figure 5-1 illustrates monthly rainfalls from July 2022 to June 2023, collected from the nearest BoM station with consistent, reliable rainfall data (Darwin Airport Station No. 014015). The average annual rainfall for this station is 1,723.1 mm.

Based on historical data and *SBWMF Annual Monitoring Review, 1 July 2021 – 30 June 2022* (Cardno 2022) it is evident that this monitoring period has experienced more typical periods of high rainfall consistent with the previous wet season. However, more peak periods were experienced exceeding 500ml/month during December and February, where 400ml/month was not exceeded on any occasion during the previous wet season.

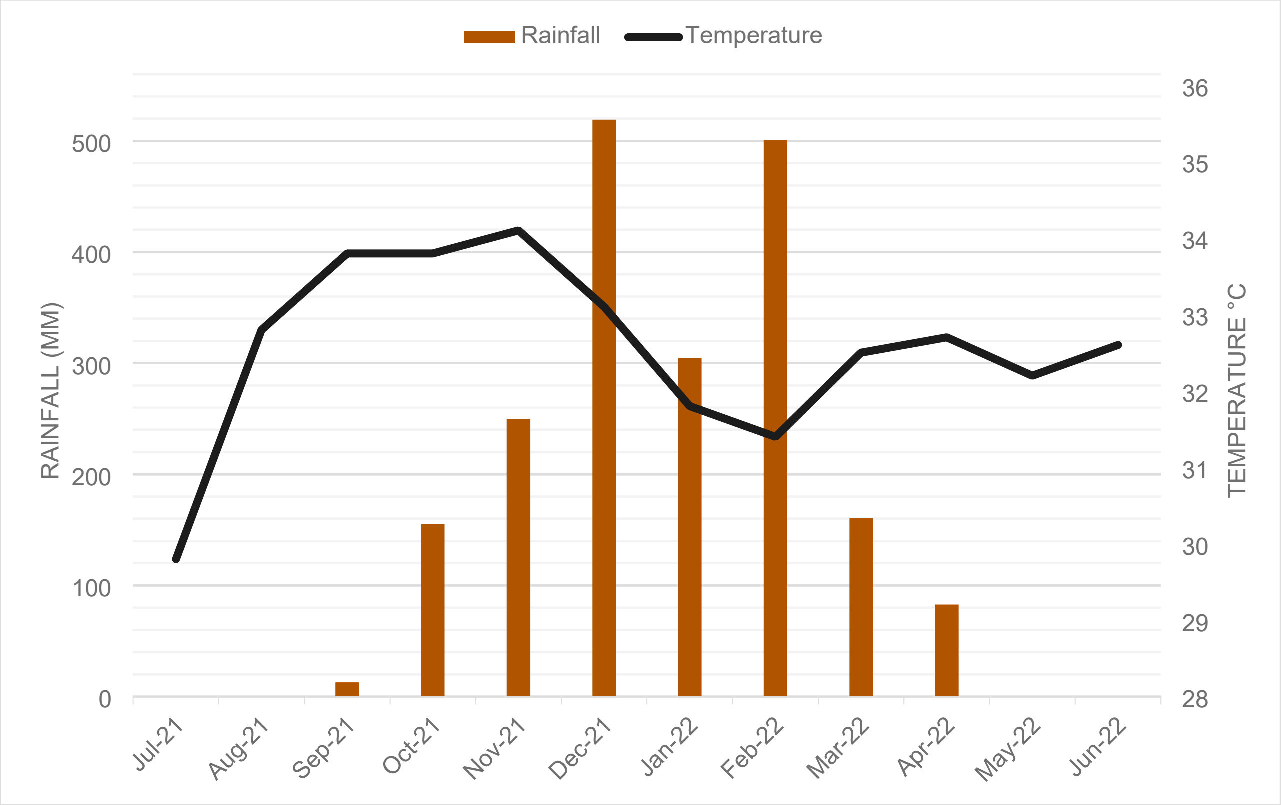


Figure 5-1 Average Monthly Rainfall, July 2022 – June 2023 (Source: Darwin Airport BoM Station, Site Number 014015)

5.2 Field Observations

5.2.1 Surface Water and Leachate

Surface water flows in stormwater drains across the site only during and immediately after rainfall although surface water catchments such as ‘SW12,13,14’ and ‘GW Sump’ hold water for long periods.

Surface water and leachate sites sampled during this reporting are provided below in **Table 5-1**. Noting that that sites not included were either not required by EPL188-03 sampling frequencies, dry, or inaccessible during that month.

Due to insufficient leachate storage capacity at the site, during this monitoring period sampling location SW14 accommodated leachate overflow and was sampled in accordance with the site's Emergency Leachate Management Procedure (ELMP) provided in **Appendix E**. For the purpose of this assessment SW14 has not been discussed further as it was considered a temporary leachate storage pond where monitoring has reported independently by CoD in line with the ELMP. It is also noted that during this time leaching pumping systems were offline to prevent oversupply to the leachate treatment ponds and therefore associated deleaching well (DW) sampling sites were unable to provide for sampling.

Table 5-1 Surface Water and Leachate Locations Sampled

Monitoring Event	Surface Water Sites Sampled	Leachate Sites Sampled
July 2022	SW12, SW13, SW14	DW3, LP01, LP02, TC Sump
August 2022	SW12, SW13, SW14,	*
September 2022	SW12, SW13, SW14, GWILP	*
October 2022	GWILP, GWILPS, SW12, SW13, SW14	LP01, LP02
November 2022	GW Sump, SW12, SW13. SW14, SWStg5	*
December 2022	GW SUMP, SW12, SW13, SW14, SW15, SW16, SWStg1&2, SWStg5,	*
January 2023	GW SUMP, GWILP, GWILPS, SW12, SW13, SW15. SWStg1&2, SWStg5,	DW3, LP01, LP02, LMP02, TC Sump
February 2023	GW SUMP, SW12, SW13, SW15, SWStg1&2, SWStg5	LTP Wetland
March 2023	GW SUMP, SW12, SW13, SWStg1&2	LTP Wetland
April 2023	GW SUMP, SW12, SW13, GWILP	LP02
May 2023	SW12, SW13, SW14	*
June 2023	SW12, SW14	*
*Not required during monthly sampling		

5.2.2 Groundwater

Groundwater at SBWMF is recharged via direct infiltration of rainfall and/or runoff making groundwater levels in the shallow aquifer highly reactive to rainfall totals.

Dry or inaccessible wells and SWLs of groundwater bores sampled during each monitoring event of this reporting period are provided below in **Table 5-2**.

Table 5-2 Standing Water Levels of Bores

Monitoring Event	Dry or Inaccessible Groundwater Bore	Standing Water Levels (mbgl)
July 2022	GW1-3, GW11-3, GW12-3, GW12-12, GW13-2, GW15-3, GW16-3, GW17-3, GW18-3, GW2-3, GW3-3, GW5-3, GW4-3, GW4-12, GW4-30, WW1, WW13, GW19, GW20	Min: 0.94 at GW7-12 Max: 13.04 at GW13-12
August 2022	GW10-12, GW10-3, GW11-12, GW1-12, GW11-3, GW12-12, GW12-3, GW1-3, GW13-12, GW15-12, GW15-3, GW16-12, GW16-3, GW2-3, GW3-12, GW3-3, GW4-3, GW5-12, GW5-3, GW7-3, GW9-12, WW9, GW19, GW20	Min: 1.97 at GW7-12 Max: 13.7 at GW12-30
September 2022	GW10-12, GW10-3, GW11-12, GW1-12, GW11-3, GW12-12, GW12-3, GW1-3, GW13-12, GW15-12, GW15-3, GW16-12, GW16-3, GW16-30, GW17-3, GW2-3, GW3-12, GW3-3, GW4-3, GW5-12, GW5-3, GW7-3, GW9-12, WW9, GW19	Min: 1.48 at GW7-12 Max: 12.68 at GW13-12

Monitoring Event	Dry or Inaccessible Groundwater Bore	Standing Water Levels (mbgl)
October 2022	GW1-3, GW1-12, GW2-3, GW2-12, GW3-3, GW4-3, GW4-12, GW5-3, GW9-12, GW10-3, GW10-12, GW11-3, GW12-3, GW13-3, GW13-12, GW14-3, GW14-12, GW15-3, GW15-12, GW17-3, GW18-3, GW19, GW20, WW1, WW13	Min: 1.00 at GW4-30 Max: 11.03 at GW13-12
November 2022	WW9, GW4-3, GW4-12, GW4-30, GW7-3, GW7-12, GW5-3, GW5-12, GW1-3, GW1-12, GW19	Min: 0.67 at GW8-3 Max: 9.87 at GW9-12
December 2022	WW9, GW2-3, GW2-12, GW4-3, GW4-12, GW4-30, GW7-3, GW7-12, GW5-3, GW5-12, GW1-3, GW1-12, GW19	Min: 0.27 at GW8-3 Max: 8.73 at GW13-12
January 2023	GW2-3, GW2-12, GW4-3, GW4-12, GW4-30, GW5-3, GW5-12, GW7-3, GW7-12, WW9, GW19	Min: -0.03 at GW8-12 Max: 11.03 at GW13-12
February 2023	GW2-3, GW2-12, GW5-3, GW5-12, GW7-3, GW7-12, WW9, GW19, GW20	Min: ~7L/hr flow at GW4-30 Max: 9.67 at GW9-12
March 2023	WW9, GW2-3, GW2-12, GW7-3, GW7-12, GW5-3, GW5-12, GW1-3, GW1-12, GW19, GW20	Min: ~6.4L/hr flow at GW4-30 Max: 7.78 at GW13-12
April 2023	GW11-3, GW10-3, GW13-3, GW19	Min: ~7L/hr flow at GW4-30 Max: 7.36 at GW13-12
May 2023	GW1-3, GW1-12, GW10-3, GW11-3, GW12-3, GW17-3, GW18-3, GW19, GW20	Min: ~3.6L/hr flow at GW4-30 Max: 11.01 at GW13-12
June 2023	GW1-3, GW1-12, GW5-3,GW10-3, GW10-12, GW11-3, GW12-3, GW13-3, GW17-3, GW18-3, GW19, GW20, WW1	Min: ~2.4L/hr flow at GW4-30 Max: 10.97 at GW13-12

5.3 Chemistry Analysis

Tabulated water quality results (groundwater, surface water, and leachate samples) obtained during the reporting period July 2022 – June 2023 have been provided in **Appendix C**. Laboratory analysis reports produced during Stantec's most recent quarterly sampling activities are provided in **Appendix D**. Other laboratory analysis reports have been provided during their respective quarterly reporting periods.

5.4 Quality Assurance / Quality Control

All quality control/quality assurance procedures outlined in Section 4 and respective SOPs were followed during field sampling as part of each monitoring event while all analyses were completed within holding times.

At each monitoring event relative percent difference (RPD) was calculated for primary and duplicate samples where 30% RPD values infer precise data. Where the RPD was above 30%, the primary result was only used in further assessment if RPD was within 5 times the LOR and therefore remained acceptable (**Appendix C**).

The QA/QC review concluded that there are no significant systematic errors in the data collection process and therefore, the dataset used for the assessment is considered valid and complete.

6 Discussion of Results

As the adopted trigger levels only apply to surface water analysis, the basis of discussion has been based around these sampling locations in particular.

SBWMF experienced above average rainfall highlighted by peak periods exceeding 500ml/month during December and February, where 400ml/month was not exceeded on any occasion during the previous wet season. Typical for SBWMF, these periods of heavy rainfall correlate with higher nutrient loads in surface water and therefore the highest number of trigger level exceedances which may indicate overflow and/or direct infiltration of leachate surface water catchments at the Site.

Due to insufficient leachate storage capacity at the site, during this monitoring period sampling location SW14 accommodated leachate overflow and was sampled in accordance with the site's Emergency Leachate Management Procedure (ELMP). For the purpose of this assessment SW14 has not been discussed further as it was considered a temporary leachate storage pond where monitoring has been reported independently by CoD in line with the ELMP.

The EPL188-03 trigger value range of 6-8.5 for pH was most often exceeded in surface water sampling sites during the wet season months were predominantly alkaline (basic). A waterbody is considered to have a high pH if pH exceeds 9 for prolonged periods or with high frequency (USEPA, 2023). Known sources and activities of high pH include: industrial discharges, alkaline geology and soils, asphalt production or disposal, oil and gas brines and industrial landfills.

Exceedances in the dissolved oxygen trigger value range of 80-100 % saturation occurred sporadically where only the water sump receiving run off from the green waste processing area and surface water run off from the Stage 1,2 and 6 landfills exceeded the trigger value on three consecutive occasions as per Condition 56.1 and 56.2 of EPL188-03. These areas also experienced high levels of Ammonia which leads to increased oxygen consumption as ammonia is oxidized (nitrification). In turn low oxygen levels can also increase ammonia levels by inhibiting nitrification.

Nutrients including ammonia, total nitrogen, and reactive phosphorus continue to exceeded surface and storm water trigger values by magnitudes more than double the respective trigger level and on three consecutive occasions across the Site. Municipal landfills and waste disposal sites are a known source of nutrient loading in surface water run off, however the highest concentrations and frequencies of exceedances occurred in sediment catchment dams which were not discharging further into the environment.

Trigger value exceedances in metal concentrations were isolated for the Site. Copper, lead and zinc only exceeded trigger values more than once at the green waste processing area water sump (GW SUMP). On each occasion copper, lead and zinc exceeded the trigger value by more than twice the trigger level and copper and zinc were in exceedance over three consecutive sampling events.

Sampling sites which receive runoff from the new leachate newly installed leachate treatment facilities west of the leachate treatment ponds rarely provide for sampling due to the fast run off and highly evaporative nature of the open drainage. These sites produced among the highest concentrations of nutrients when sampled during this monitoring period.

Based on the results of contaminant exceedances measured in surface and storm water during the reporting period (in particular nutrients), impacts from the migration of leachate in surface water flowing from the Site are occurring to the west and northwest of the Stage 3, 4 and 5 landfills (SW12, SW13, SW STG5) and in stormwater runoff from water from the Stage 1, 2 and 6 landfills (SWStg1&2, SWStg5). GW SUMP which collects drainage from the green waste processing area presents the highest concentrations of contaminants and at the highest frequencies compared to other sampling sites.

6.1.1 Leachate

To characterise the quality of leachate the maximum concentrations of nutrients, key metals, and PFAS were evaluated. These results provide an indication of the degree of impact on surface water and groundwater by leachate.

6.1.1.1 Nutrients

Table 6-1 presents the maximum reported concentrations of nutrients and associated ANZG 2018 guidelines. The maximum reported concentration for each of these nutrients exceeded the respective guideline value.

Table 6-1 Leachate maximum concentrations & ANZG 2018 guidelines for nutrients

	Reactive Phosphorus as P	Ammonia as N	Nitrate & Nitrite (NOx)	Nitrogen (Total)
	mg/L	**mg/L**	**mg/L**	**mg/L**
ANZG 2018	0.01	0.01	0.05	0.2
Maximum Result	16	1,700	16	8,700

6.1.1.2 Dissolved Metals

Table 6-2 shows the ANZG (2018) guideline values for metals, which were used to generally characterise the concentrations of metals in leachate. The maximum concentrations of metals reported for leachate samples were compared to the guideline values. Of the guideline values evaluated, the maximum values exceeded the respective guideline values except for cadmium. Note that the LOR for chromium (VI) and mercury were above the respective guideline values.

Table 6-2 Leachate maximum concentrations & ANZG 2018 guidelines for metals

	Cd	Cr (III)	Cr (VI)	Co	Cu	Pb	Hg	Ni	V	Zn
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ANZG 2018	0.014	0.04286	0.02	0.014	0.003	0.0066	0.0007	0.2	0.16	0.023
Maximum Result	0.0008	0.38	<0.05	0.15	0.081	0.075	<0.001	0.43	0.26	0.32

6.1.1.3 PFAS

The maximum reported concentration of PFOS (3.1 µg/L) exceeded the PFAS NEMP 2020 Interim Marine 90% guideline of 2 µg/L. However, the maximum reported concentration of PFOA (8.6 µg/L) did not exceed the guideline value of 632 µg/L.

6.1.2 Surface Water Trigger Value Exceedances

Table 6-3 through to **Table 6-7** present all exceedances of the adopted trigger values described in **Section 4.6 "Assessment Criteria".** The results highlighted in yellow indicate when the surface water trigger value was exceeded on three or more consecutive occasions as per EPL188-03 Condition 56.1. Results with an asterisk (*) indicate when the results are greater than or equal to two times the trigger value as per Condition 56.2.

Noting that only trigger value exceedances are listed in the tables below. Where a concentration is not listed for a site or month and does not appear in the table, either the concentration was below the trigger value, the Site was not sampled because it was dry or limited suites of analytes were assessed during that month. Refer to **Section 5.2.1** above for the sites that were sampled during the reporting period.

6.1.2.1 pH Units

Surface water sites GW Sump, SW12, SW13, SW15 and SWStg5 exceeded the EPL188-03 trigger value range of 6-8.5 for pH during November, January, April and May, where exceedances were predominantly alkaline (basic) seen in chemistry summary tables provided in **Appendix C**. None of which exceeded the trigger value on three consecutive occasions as per Condition 56.1 and 56.2 of EPL188-03.

6.1.2.2 Dissolved Oxygen

The below sampling sites exceeded the EPL188-03 dissolved oxygen trigger value range of 80-100 % saturation during this monitoring period. Sampling location GW SUMP and SWStg1&2 exceeded trigger value range of 80-100 % saturation on three consecutive occasions in line with 56.1 of EPL188-03:

GWILP
SW15
SW16
SWStg1&2
SWStg5
GW Sump

6.1.2.3 Ammonia

Ammonia continues to record elevated concentrations across the site in both groundwater and surface water most notably far exceeding trigger values in dams north of Stage 4 and 5, run off from Stage 1 and 2 and ground water interception from the leachate treatment ponds.

Ammonia concentrations above adopted assessment criteria (20 µg/L) are provided in **Table 6-3**. Findings are summarised as follows:

> Exceedances of ammonia occurred in the sediment dams receiving runoff from the Stage 3, 4 and 5 landfills (SW12, SW13), the water sump receiving from the green waste processing area GW SUMP), storm water runoff from the new processing area west of the existing treatment ponds (SW15) and the storm water runoff from water from the Stage 1, 2 and 6 landfills (SWStg1&2, SWStg5).

> The intercepted water runoff from the existing leachate ponds (GWILP) experienced the highest concentration of ammonia (190,000 µg/L) during October monitoring indicating that water being captured via GWILP was being directly impacted by leachate.

> Surface water and stormwater runoff impacts from leachate are prevalent during these periods of high rainfall indicated by consistently elevated ammonia concentrations far exceeding the trigger value in sediment dams north of the site and run off from the central SBWMF areas including Stages 1, 2 and 6 (SWStg1&2).

> Sediment dam SW12 experienced highly elevated concentrations of ammonia (17,000 µg/L) during February which may indicate direct infiltration of leachate during periods of high rainfall.

> Surface water run off from the Stage 1,2 and 6 landfills (SWStg1&2) produced consistent high ammonia concentrations up to 7,000 µg/L which may indicate overflow of contaminated surface water from these landfills.

Table 6-3 Exceedances of Ammonia above 20 µg/L

Location	Ammonia concentration (µg/L)						
	Oct	Nov	Dec	Jan	Feb	Mar	Apr
GW SUMP		7,800*	6,000*	720*	3,400*	640*	840*
SW12	30	70*	30	310*	17,000*	100*	810*
SW13	30	30		70*	80*	30	30
SW14		190*			30		
SW15							
GWILP	190,000*						
SW STG1&2			2,500*	820*	7,000*	3,300*	1,400*
SW STG5		320*	530*	210*			

Notes

- The results highlighted in yellow indicate when the trigger value was exceeded on three or more consecutive occasions as per Condition 56.1 of EPL188-03.
- Results with an asterisk (*) indicate when the surface water results are greater than or equal to two times the trigger value as per Condition 56.2 of EPL188-03.

6.1.2.4 Total Nitrogen

Total Nitrogen (TN) concentrations above adopted assessment criteria (300 µg/L) were observed at all available surface water sampling locations during this monitoring period, illustrated in **Consistent with** other nutrients, exceedances of TN occurred in the sediment dams receiving runoff from the Stage 3, 4 and 5 landfills (SW12, SW13), the water sump receiving from the green waste processing area (GW SUMP), storm water runoff from the new processing area west of the existing treatment ponds (SW15) and the storm water runoff from water from the Stage 1, 2 and 6 landfills (SWStg1&2, SWStg5).

GW SUMP experienced the highest concentration of TN (29,000 µg/L) during November which may indicate direct infiltration of leachate.

Surface water runoff from the new leachate processing areas (SW15, SW16) experienced high levels of nitrogen during December, both in excess of 20,000 µg/L. This may be attributed to overflow from the leachate treatment pond wetland (LTP Wetland) during high rainfall.

Surface water run off from the Stage 1,2 and 6 landfills (SWStg1&2) produced consistently high ammonia concentrations up to 12,400 µg/L which would indicate overflow of contaminated surface water from these landfills.

Table 6-4. Findings are summarised as follows:

> Consistent with other nutrients, exceedances of TN occurred in the sediment dams receiving runoff from the Stage 3, 4 and 5 landfills (SW12, SW13), the water sump receiving from the green waste processing area (GW SUMP), storm water runoff from the new processing area west of the existing treatment ponds (SW15) and the storm water runoff from water from the Stage 1, 2 and 6 landfills (SWStg1&2, SWStg5).

- GW SUMP experienced the highest concentration of TN (29,000 µg/L) during November which may indicate direct infiltration of leachate.
- Surface water runoff from the new leachate processing areas (SW15, SW16) experienced high levels of nitrogen during December, both in excess of 20,000 µg/L. This may be attributed to overflow from the leachate treatment pond wetland (LTP Wetland) during high rainfall.
- Surface water run off from the Stage 1,2 and 6 landfills (SWStg1&2) produced consistently high ammonia concentrations up to 12,400 µg/L which would indicate overflow of contaminated surface water from these landfills.

Table 6-4 Exceedances of Nitrogen (Total) above 300 µg/L

Location	Nitrogen concentration (µg/L)						
	Oct	Nov	Dec	Jan	Feb	Mar	Apr
GW SUMP		29,000*	11,000*	4,140*	6,480*	13,000*	15,000*
SW12	630*	3,600*	4,200*	5,300*	19,000*	1,550*	2,470*
SW13	1,600*	3,300*	4,000*	1,100*	830*	3,400*	3,690*
SW14	860*	11,590*	5,500*	5,500*	1,240*		
SW15			21,870*				
SW16			20,200*				
GWILP	200,000*						
SW STG1&2	2,870*		3,700*	550*	8,830*	12,400*	2,400*
SW STG5		10,000*	2,170*	660*	730*		

Notes

- The results highlighted in yellow indicate when the trigger value was exceeded on three or more consecutive occasions as per Condition 56.1 of EPL188-03.
- Results with an asterisk (*) indicate when the surface water results are greater than or equal to two times the trigger value as per Condition 56.2 of EPL188-03.

6.1.2.5 Oxides of Nitrogen

It is noted that in some instances the LOR for Oxides of Nitrogen (NO_X) was raised due to matrix inferences, bringing it above the adopted assessment criteria (20 µg/L). For the purpose of this data analysis, concentrations reported <LOR will be assessed as half the LOR. However, concentrations were observed above the LOR, at generally the same frequencies and sampling locations as other nutrients, seen below in **Table 6-5**. Findings are summarised as follows:

- Consistent with other nutrients, exceedances of NO_x occurred in the sediment dams receiving runoff from the Stage 3, 4 and 5 landfills (SW12, SW13), the water sump receiving from the green waste processing area GW SUMP), storm water runoff from the new processing area west of the existing treatment ponds (SW15) and the storm water runoff from water from the Stage 1, 2 and 6 landfills (SWStg1&2, SWStg5).
- Consistent with Nitrogen SW16) experienced high levels of nitrogen during December (20,000 µg/L) potentially attributed to overflow from the leachate treatment pond wetland (LTP Wetland) during high rainfall.

Table 6-5 Exceedances of NO_X concentrations above 20 µg/L

Location	NOx concentration (µg/L)						
	Oct	Nov	Dec	Jan	Feb	Mar	Apr
GW SUMP		125*	125*	340*	80*	25	
SW12	630*	2,700*	2,600*	1,100*	125*	50*	170*
SW13	1,300*	2,300*	2,300*	1,100*	230*	25	90*
SW14	860*	590*	1,300*				
SW15			870*	3,900*	840*		
SW16			20,000*				
GWILP	125*						
SW STG1&2			25*	250*	230*	2,400*	
SW STG5		125*	270*	660*	330*		

Notes

- The results highlighted in yellow indicate when the trigger value was exceeded on three or more consecutive occasions as per Condition 56.1 of EPL188-03.
- Results with an asterisk (*) indicate when the surface water results are greater than or equal to two times the trigger value as per Condition 56.2 of EPL188-03.

6.1.2.6 Reactive Phosphorus

Filterable Reactive Phosphorus (FRP) concentrations above adopted assessment criteria (10 µg/L) were observed at generally the same surface water sampling area as other nutrients during the same periods of high rainfall, although at less prevalence. **Table 6-6** shows locations and months these exceedances occurred and is summarised as follows:

> The water sump receiving from the green waste processing area (GW SUMP) and surface water run off from the central Site areas (SWStg1&20 were the only sampling location to exceed the FRO trigger value of 10 µg/L on three consecutive occasions during this monitoring period.

> The highest concentration (5,400 µg/L) was observed in the sediment dam receiving runoff from the Stage 3 and 4 landfill (SW12) during December which may indicate direct infiltration of leachate during periods of high rainfall.

Table 6-6 Exceedances of FRP concentrations above 10 µg/L

Location	FRP concentration (µg/L)						
	Oct	Nov	Dec	Jan	Feb	Mar	Apr
GW SUMP	180*			430*	1,500*	260*	80*
SW12		1,500*	5,400*		40*		20*
SW13			20*		20*		20*
SW14			30*				
SW15		200*					
SW16			20*				
GWILP	180*						20*
SW STG1&2			60*		30*		
SW STG5			110*	20*	20*		

Notes

- The results highlighted in yellow indicate when the trigger value was exceeded on three or more consecutive occasions as per Condition 56.1 of EPL188-03.
- Results with an asterisk (*) indicate when the surface water results are greater than or equal to two times the trigger value as per Condition 56.2 of EPL188-03.

6.1.2.7 Total Suspended Solids

Total Suspended Solids (TSS) concentrations exceeded the adopted assessment criteria (10 mg/L) at three surface water sampling locations provided in **Table 6-7**. Findings are summarised as follows:

> TSS concentrations in exceedance of the adopted trigger value occurred consistently in water sump receiving from the green waste processing area (GW SUMP) and sediment dams receiving runoff from the Stage 3, 4 and 5 landfills (SW12, SW13)

> Elevated TSS levels in surface water is likely due to inclusions of inorganic materials such as gravel, silt, and sand from topsoils across the site as they are occurring in highly disturbed, unvegetated and exposed processing areas following the first onset of heavy rainfall events. Algae can also contribute to the TSS concentration.

Table 6-7 Exceedances of TSS above 10 mg/L

Location	Total Suspended Solids (mg/L)						
	Oct	Nov	Dec	Jan	Feb	Mar	Apr
GW SUMP		280*	290*	39*	49*	220*	270*
SW12	13*	21*	110*		19		
SW13	150*		22*		28*		11
SW14	40*	25*	220*				
SW15							
GWILP	22*						
SW STG5		24*					

Notes

- The results highlighted in yellow indicate when the trigger value was exceeded on three or more consecutive occasions as per Condition 56.1 of EPL188-03.
- Results with an asterisk (*) indicate when the surface water results are greater than or equal to two times the trigger value as per Condition 56.2 of EPL188-03.

1.1.1.1 Copper

Copper concentrations exceeding the adopted assessment criteria of 3 µg/L for 90% species protection during this annual monitoring period are highlighted in the tabulated chemistry results provided in **Appendix C** and summarised as follows:

- Copper trigger value occurred in the sump collecting drainage from the green waste processing area (GW SUMP) on consecutive occasions during November, December, January, February, March and April as per Condition 56.1 EPL188-03. These trigger value exceedances were greater than or equal to two times the trigger value during November, December, January, February and April as per Condition 56.2 of EPL188-03.
- SWStg5 exceeded the copper trigger value by greater than or equal to two times the trigger value during November sampling as per Condition 56.2 of EPL188-03.
- No other sampling sites exceeded the trigger value during this monitoring period.

6.1.2.8 Lead

GW SUMP which collects drainage from the green waste processing area was the only sampling site to record a concentration above the adopted assessment criteria of 6.6 µg/L during the November, January and April sampling events

The exceedance occurring in January (15 µg/L) recorded was also greater than or equal to two times the trigger value as per Condition 56.2 of EPL188-03.

- No other sampling sites exceeded the trigger value during this monitoring period.

6.1.2.9 Zinc

Zinc concentrations recorded above adopted assessment criteria of 23 µg/L for 90% species protection during this annual monitoring period are highlighted in the tabulated chemistry results provided in **Appendix C** and summarised as follows:

- In breach of Condition 56.1 EPL188-03, Zinc concentrations exceeding the trigger value were observed on consecutive occasions at GW SUMP which collects drainage from the green waste processing area during November, December, January, February, March and April. These trigger value exceedances were greater than or equal to two times the trigger value during November, December, January and April as per Condition 56.2 of EPL188-03.
- The sampling location representing intercepted water run off from the treatment ponds (GWILP) exceeded the trigger value for Zinc once during October sampling activities and was not greater than or equal to two times the trigger value of 23 µg/L.
- SW16, which receives run off from the leachate processing area west of the leachate ponds exceeded the trigger value for Zinc once during December sampling activities and was greater than or equal to two times the trigger value during November sampling as per Condition 56.2 of EPL188-03.

No other sampling sites exceeded the trigger value during this monitoring period.

6.1.2.10 PFAS Assessment

During this annual monitoring period, no stormwater and surface water monitoring locations exceeded the HEPA (2020) guideline value for 90% species protection for highly disturbed systems in interim marine water (PFOS – 2 µg/L and PFOA – 632 µg/L), though some species did marginally exceed the LOR (**Appendix C**). PFAS analysis was only required during January's annual monitoring event as per the Sampling frequencies stipulated in EPL188-03 (**Appendix B**)

6.1.3 Groundwater

To evaluate of groundwater quality the maximum concentrations of nutrients, key metals, and PFAS were compiled. These results provide an indication of the degree of impact on surface water and groundwater by leachate.

6.1.3.1 Nutrients

Table 6-8 presents the maximum reported concentrations of nutrients and associated ANZG 2018 guidelines. The maximum reported concentration for each of these nutrients exceeded the respective guideline value.

Table 6-8 Groundwater maximum concentrations & ANZG 2018 guidelines for nutrients

	Reactive Phosphorus as P)	Ammonia as N	Nitrate & Nitrite (NOx)	Nitrogen (Total)
	mg/L	**mg/L**	**mg/L**	**mg/L**
ANZG 2018	0.01	0.01	0.05	0.2
Maximum Result	0.51	40	93	106

6.1.3.2 Dissolved Metals

Table 6-9 shows the ANZG (2018) guideline values for metals in sampled groundwater. The maximum concentrations of metals reported for groundwater samples were compared to the guideline values. Of the guideline values evaluated, the maximum values exceeded the respective guideline values except for cadmium and vanadium. Note that the LOR for mercury was above the respective guideline values.

Table 6-9 Groundwater maximum concentrations & ANZG 2018 guidelines for metals

	Cd	Cr (III)	Cr (VI)	Co	Cu	Pb	Hg	Ni	V	Zn
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ANZG 2018	0.014	0.04286	0.02	0.014	0.003	0.0066	0.0007	0.2	0.16	0.023
Maximum Result	0.005	0.067	0.081	1.2	0.15	0.046	<0.001	0.82	0.064	1.3

6.1.3.3 PFAS

The maximum reported concentration of PFOS (0.76 µg/L) did not exceed the PFAS NEMP 2020 Interim Marine 90% guideline of 2 µg/L. The maximum reported concentration of PFOA (0.33 µg/L) did not exceed the guideline value of 632 µg/L.

6.2 Groundwater Historical Water Quality Trends

Key exceedances reported during this reporting period discussed above in Section 5 are overall consistent with previous data sets and historical water quality trends. The long-term trends of contaminants in groundwater has been illustrated in their respective sections below for each of the following source areas:

- Green waste processing area;
- Western perimeter landfills;
- Eastern perimeter landfills; and
- Leachate Treatment areas.

6.2.1 Green waste processing area

6.2.1.1 Ammonia

As shown on **Figure 6-1,** long-term reported ammonia concentrations generally ranged between LOR and 3 mg/L with spikes in concentration reported for GW12-3 and GW10-12. Spikes in ammonia concentrations do not conform to a long-term increasing trend of the contaminant.

6.2.1.2 Total Nitrogen & Nitrite + Nitrate (Nox)

Figure 6-2 and **Figure 6-3** shows reported concentrations of total nitrogen have ranged between LOR and approximately 8 mg/L; while concentrations of Nox ranged between LOR and approximately 3.5 mg/L.. Concentrations of total nitrogen and Nox reported for GW11-12 and GW12-30 have increased since 2021, but have reduced since peaking in February 2023.

6.2.1.3 Reactive Phosphorus

Figure 6-4 presents reported concentrations of reactive phosphorus, which ranged between LOR and 0.2 mg/L. Concentrations of reactive phosphorus reported for GW12-12 and GW12-30 have increased since 2018; while concentrations have reduced in GW12-3.

6.2.1.4 Metals

Figure 6-5 through **Figure 6-7** present concentrations of copper, lead, and zinc. No trend in reported concentrations is evident with fluctuations that probably reflect seasonal variations.

As shown on **Figure 6-6** and **Figure 6-** 7, lead and zinc experienced spikes in concentration varying between sampling locations. These spikes do not provide for a long-term increasing trend in increased lead or zinc concentrations.

6.2.1.5 PFAS

As shown on **Figure 6-8**, PFAS concentrations have ranged between LOR and approximately 1.5 µg/L. However, concentrations have not exhibited any significant trend.

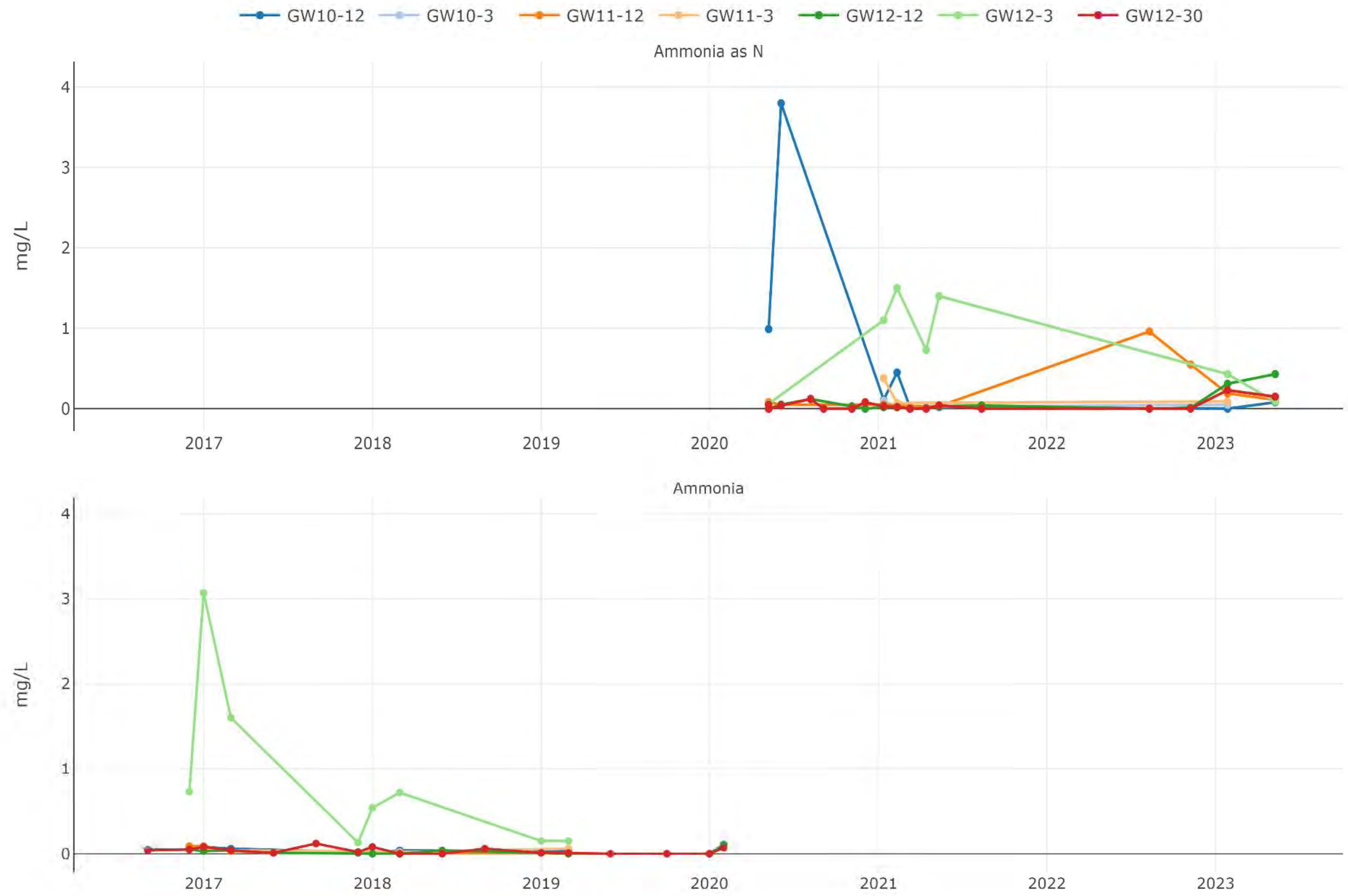


Figure 6-1 Historical ammonia concentrations in groundwater within the green waste processing area

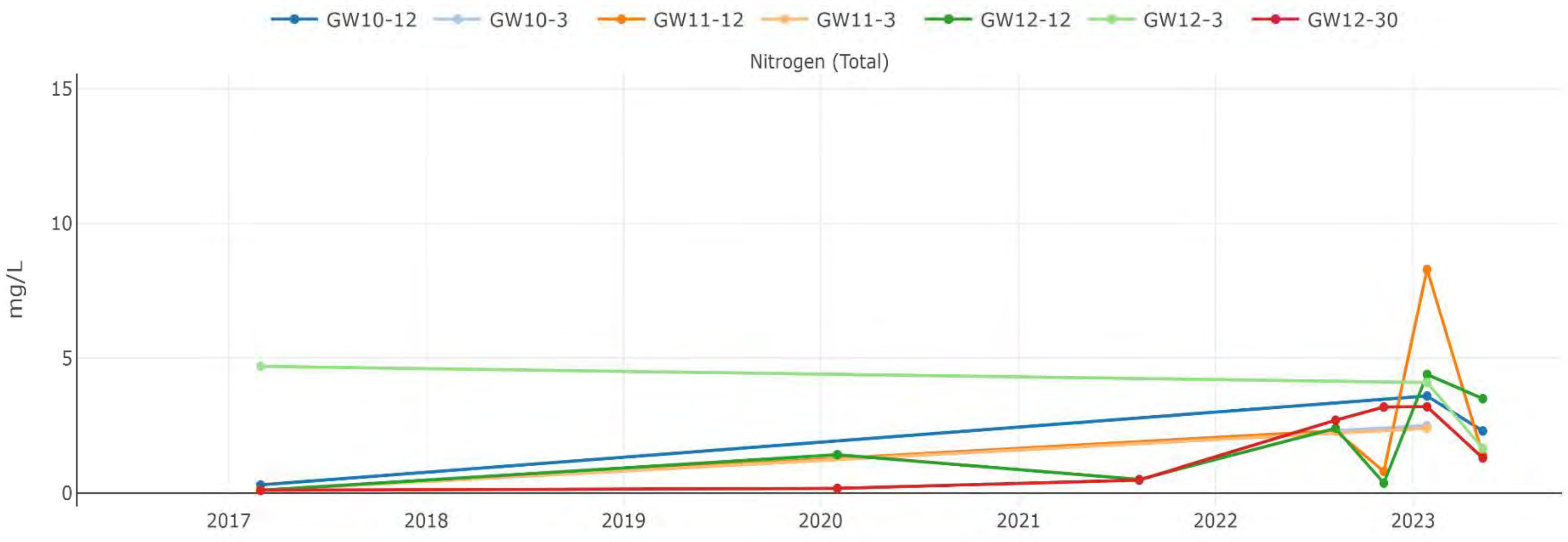


Figure 6-2 Historical Total Nitrogen concentrations in groundwater within the green waste processing area

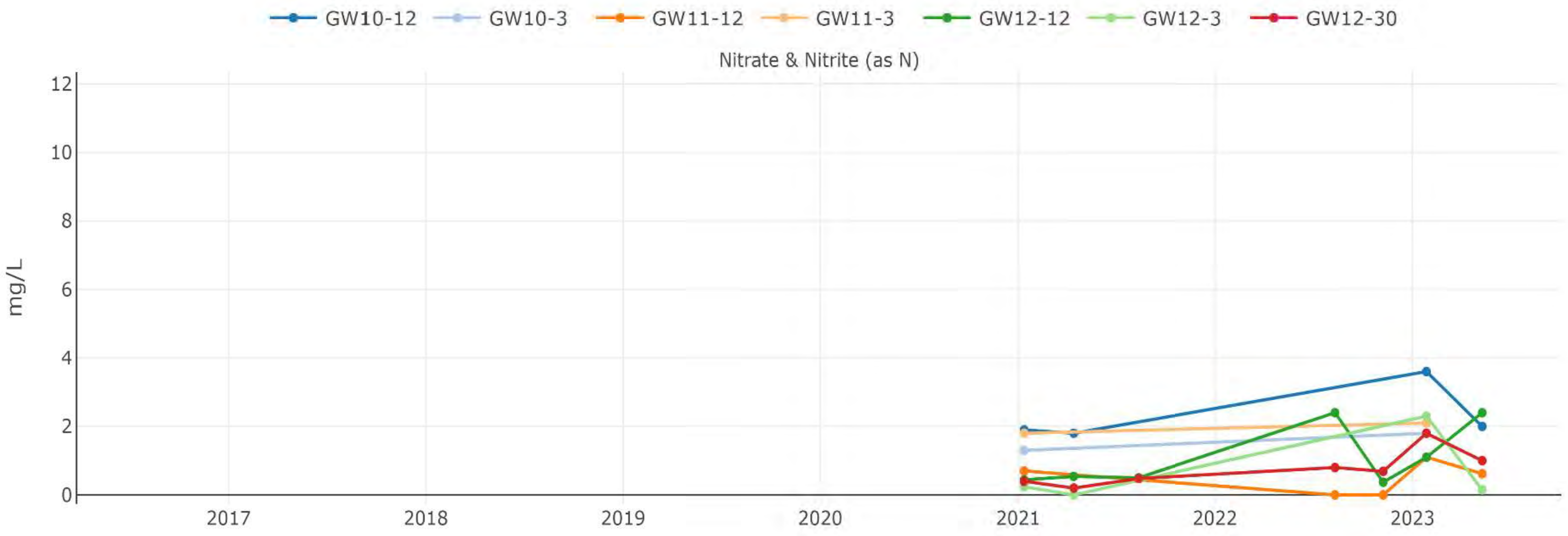


Figure 6-3 Historical Nox concentrations in groundwater within the green waste processing area

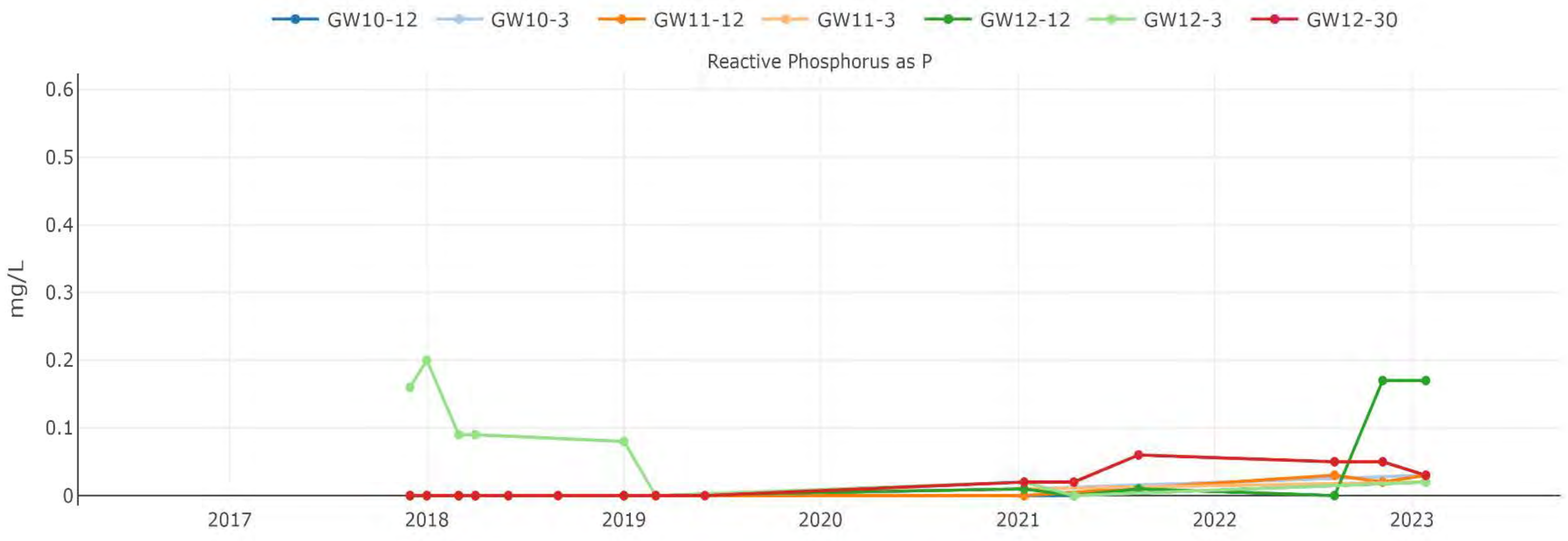


Figure 6-4 Historical reactive phosphorus concentrations in groundwater within the green waste processing area

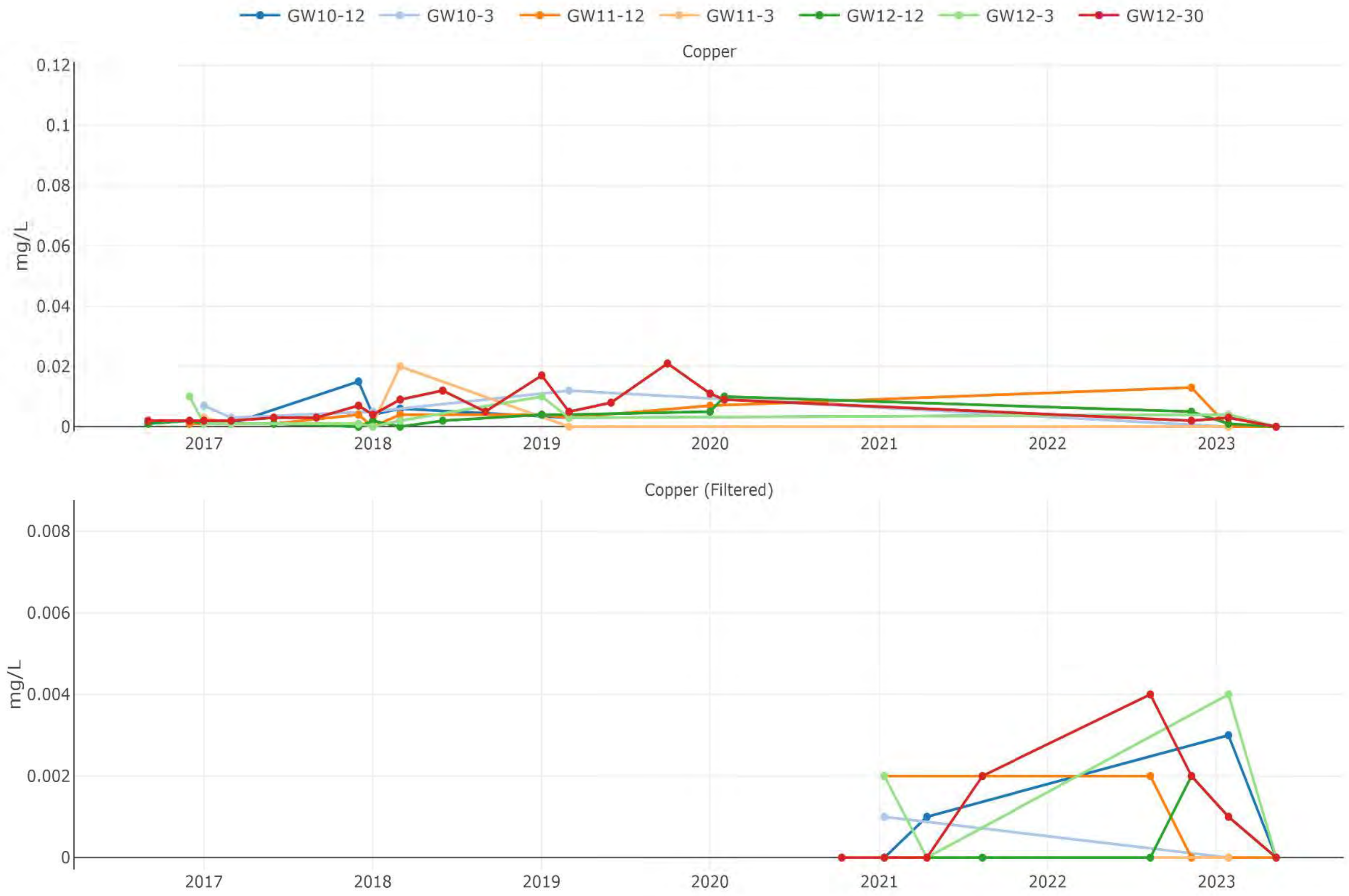


Figure 6-5 Historical copper concentrations in groundwater within the green waste processing area

Figure 6-6 Historical lead concentrations in groundwater within the green waste processing area

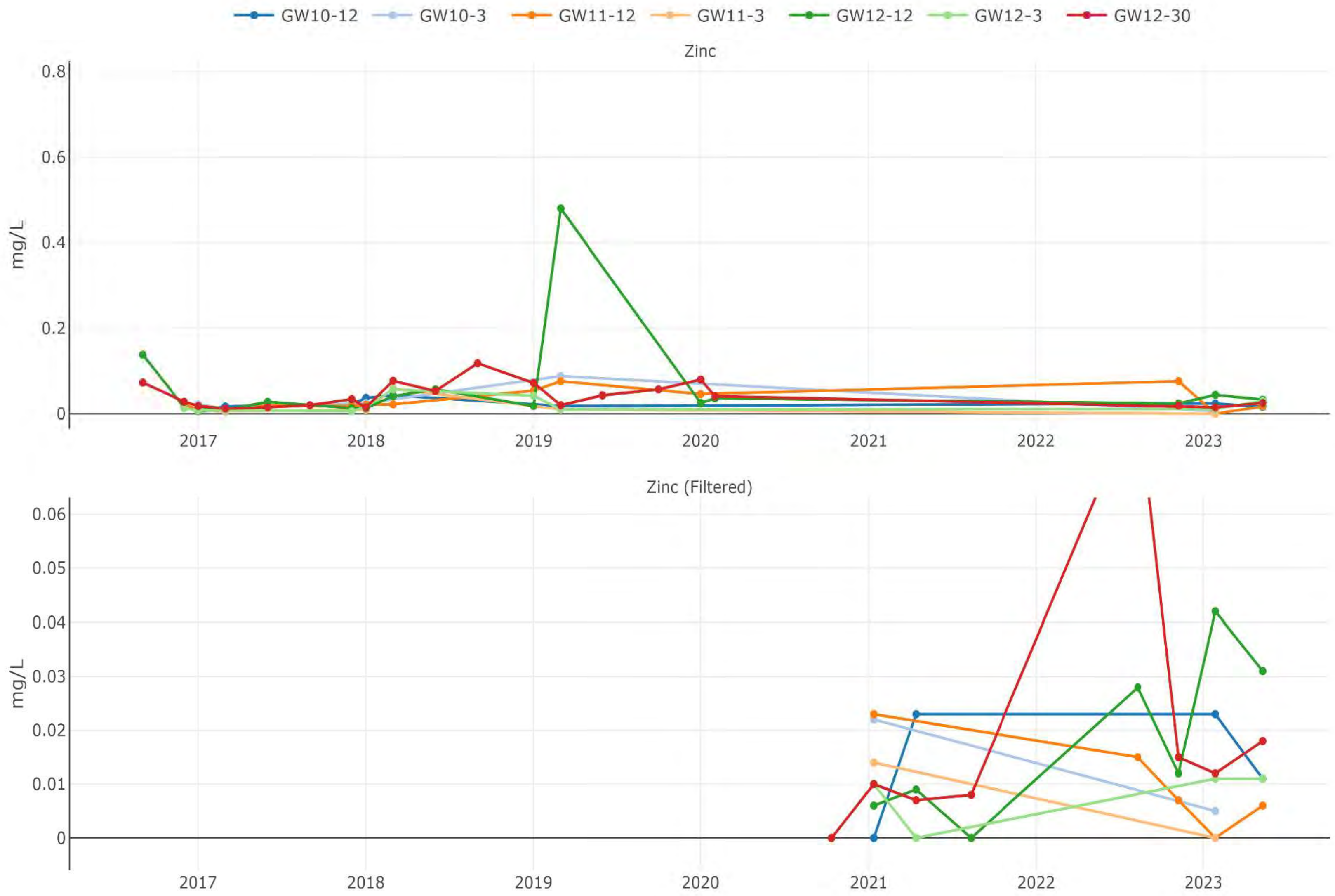


Figure 6-7 Historical Zinc concentrations in groundwater within the green waste processing area

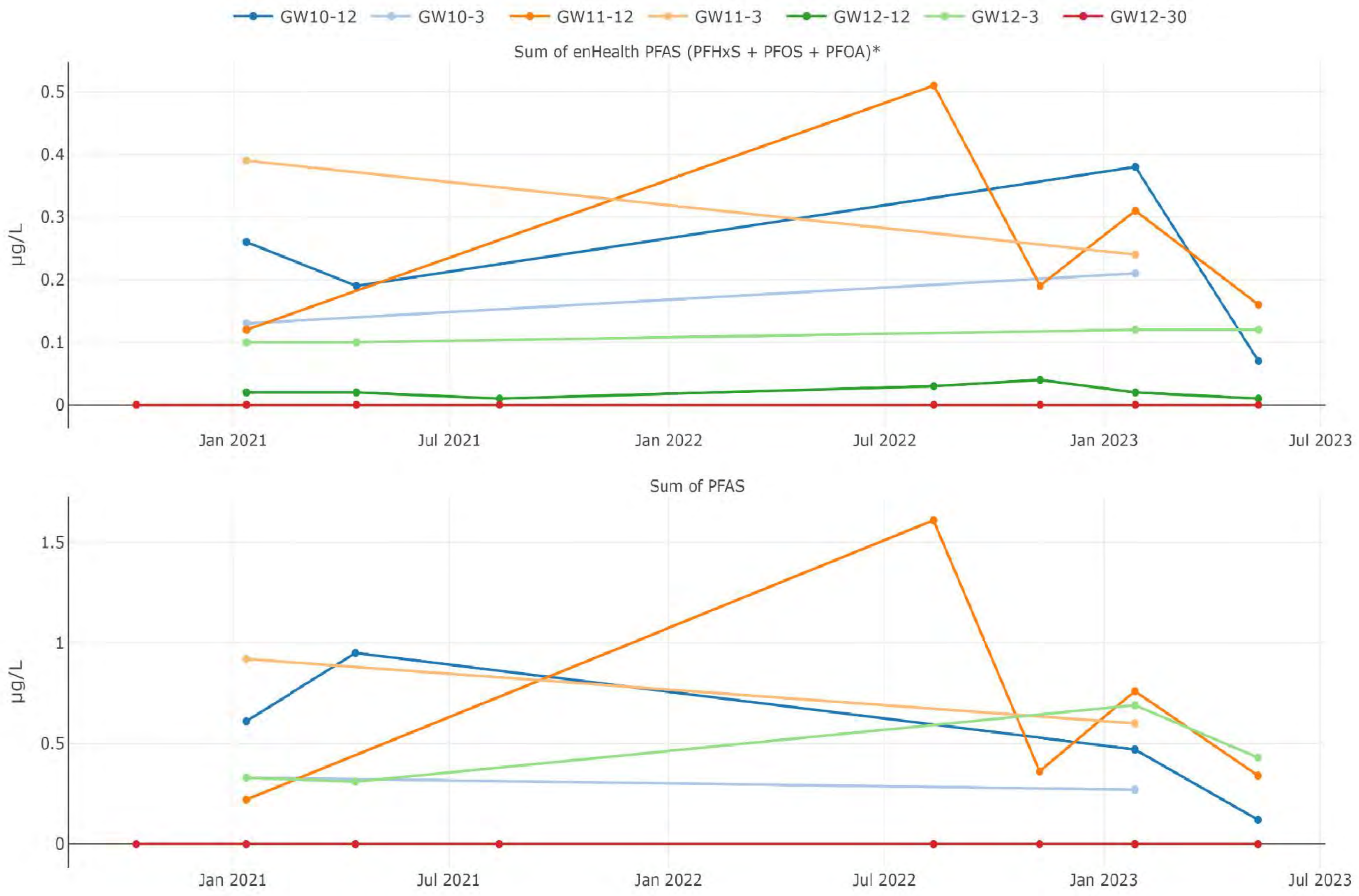


Figure 6-8 Historical PFAS concentrations in groundwater within the green waste processing area

6.2.2 Western perimeter landfills

6.2.2.1 Ammonia

As shown on **Figure 6-9,** long-term reported ammonia concentrations generally ranged between LOR and 5 mg/L with spikes in concentration reported for WW7 of approximately 80 mg/L. Overall, no trends were evident.

6.2.2.2 Total Nitrogen & Nitrite + Nitrate (Nox)

Figure 6-10 and Figure 6-11 show reported concentrations of total nitrogen have ranged between LOR and approximately 15 mg/L; while concentrations of Nox ranged between LOR and approximately 6 mg/L. No long-term trends are evident.

6.2.2.3 Reactive Phosphorus

Figure 6-12 presents reported concentrations of reactive phosphorus, which ranged between LOR and approximately 0.9 mg/L. Concentrations of reactive phosphorus reported for WW6 had increased between 2021 and 2022, but have dropped back to historical concentrations in 2023. No other trends are evident for the other wells.

6.2.2.4 Metals

Figure 6-13 through Figure 6-15 present concentrations of copper, lead, and zinc. No trend in reported concentrations is evident with fluctuations that probably reflect seasonal variations except for WW6, which may be exhibiting an overall increasing trend for copper and zinc.

6.2.2.5 PFAS

As shown on **Figure 6-16**, PFAS concentrations have ranged between LOR and approximately 4 µg/L. However, concentrations have not exhibited any significant trend.

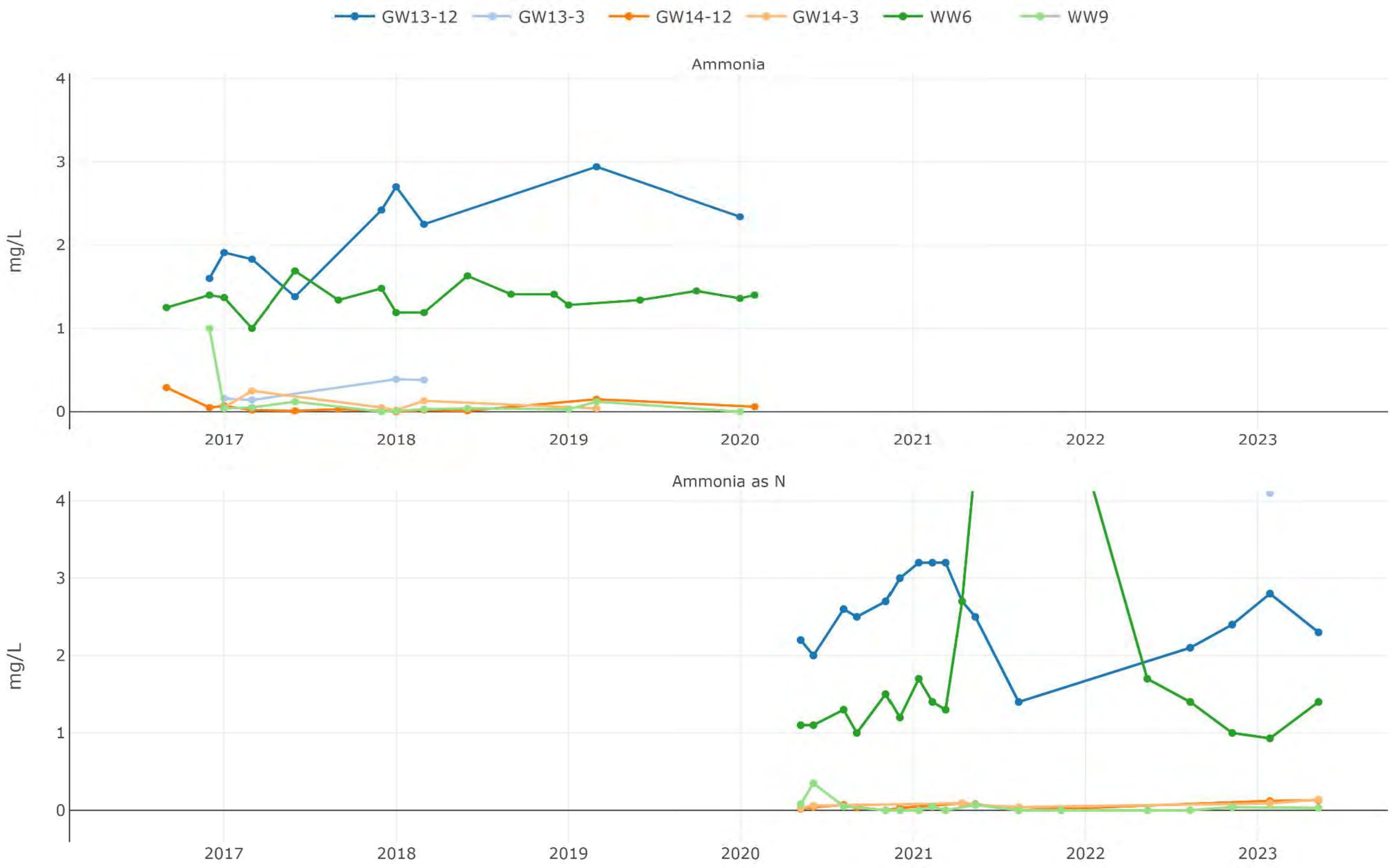


Figure 6-9 Historical ammonia concentrations in groundwater on the western perimeter of the Site landfill cells

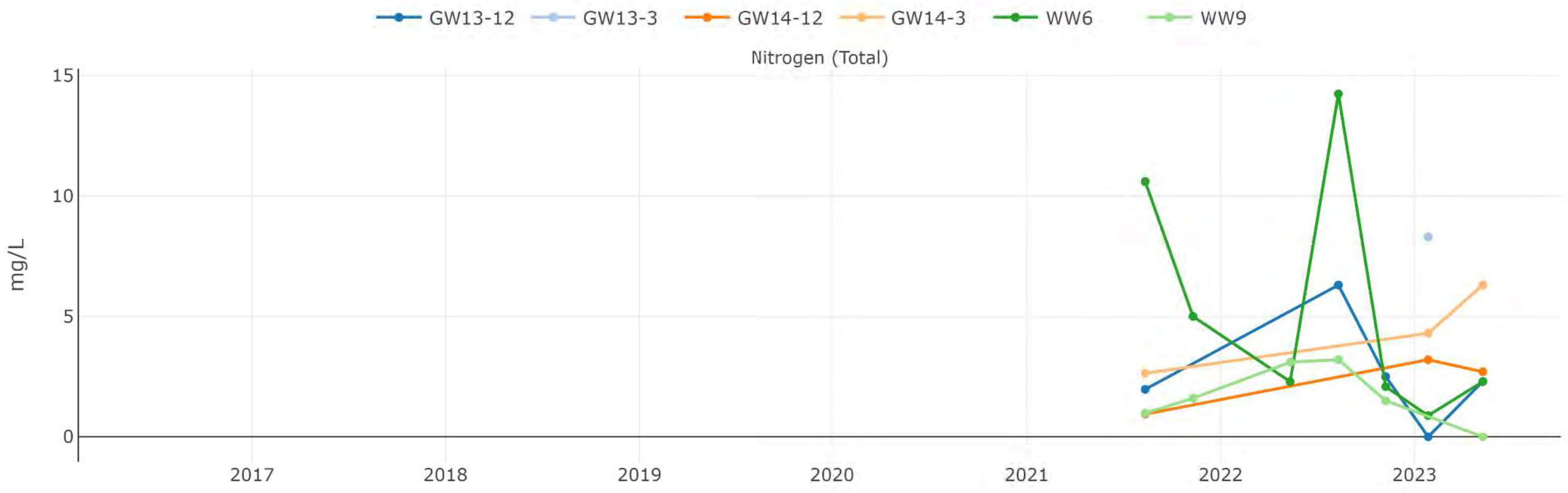


Figure 6-10 Historical Total Nitrogen concentrations in groundwater on the western perimeter of the Site landfill cells

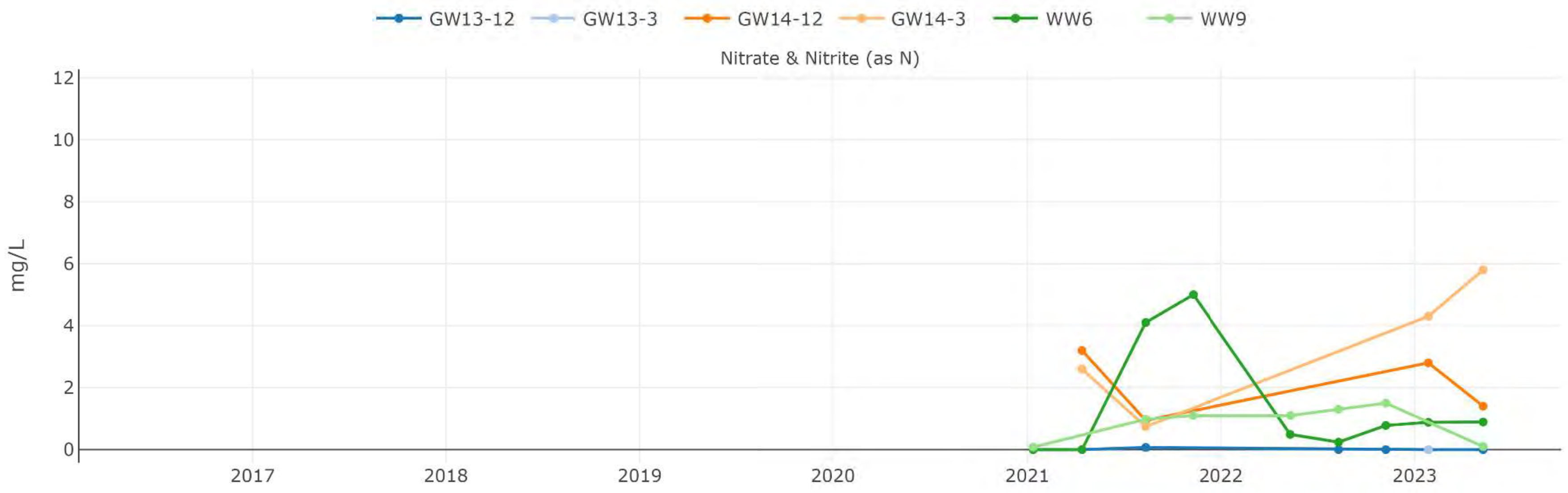


Figure 6-11 Historical Nox concentrations in groundwater on the western perimeter of the Site landfill cells

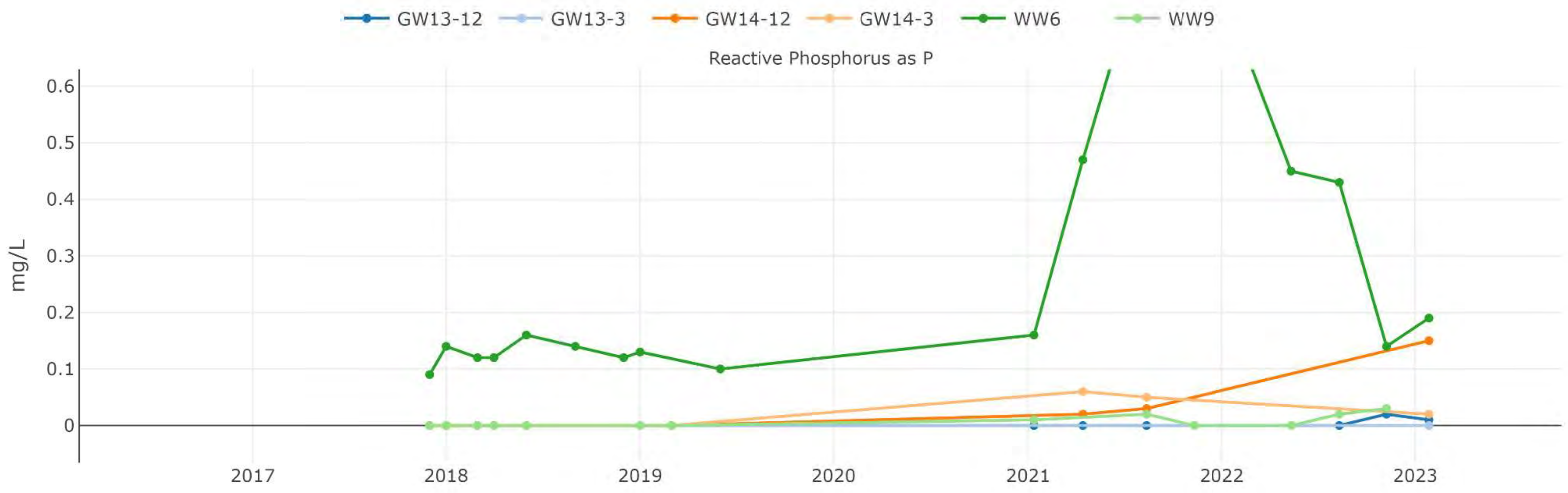


Figure 6-12 Historical reactive phosphorus concentrations in groundwater on the western perimeter of the Site landfill cells

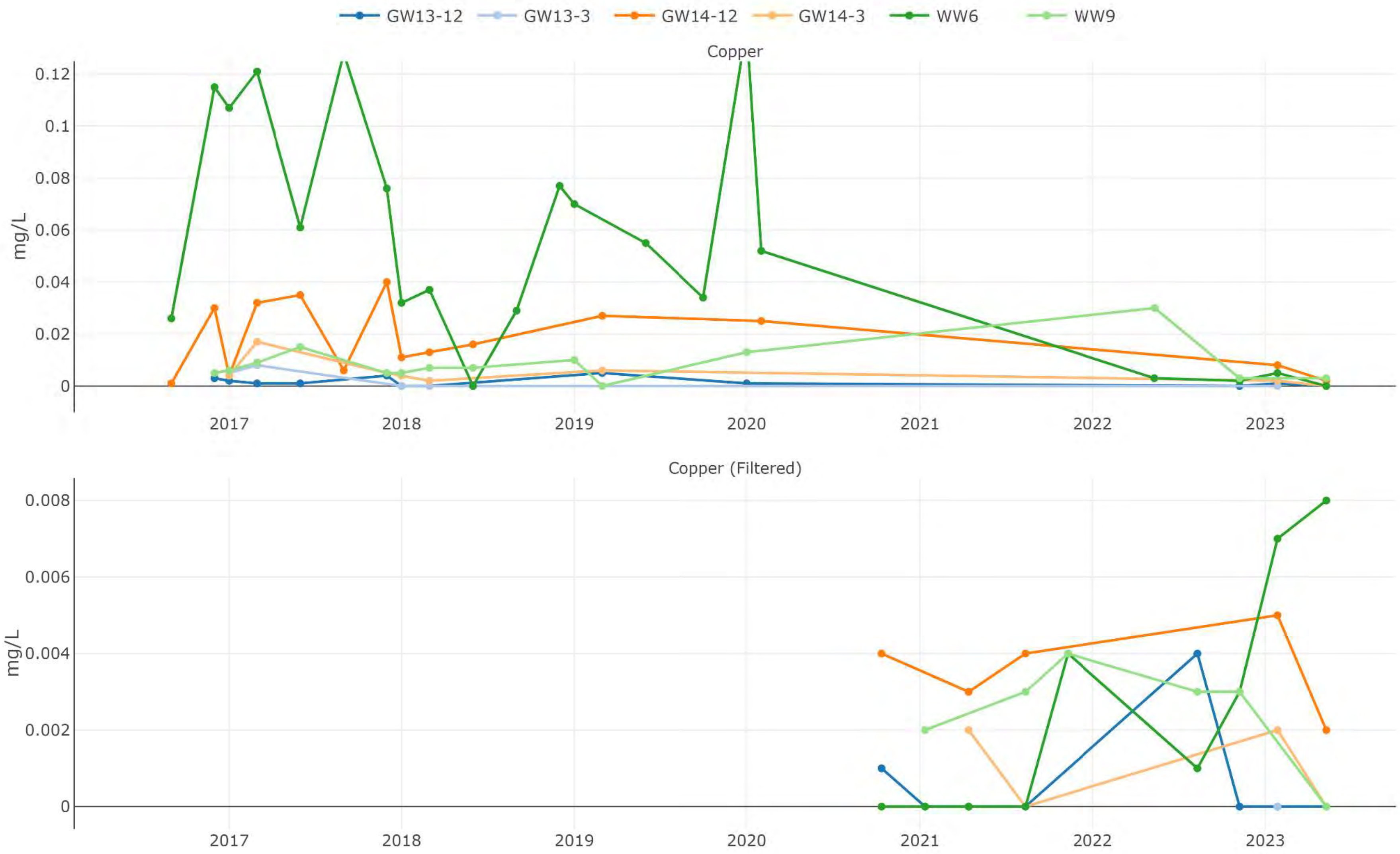


Figure 6-13 Historical copper concentrations in groundwater on the western perimeter of the Site landfill cells

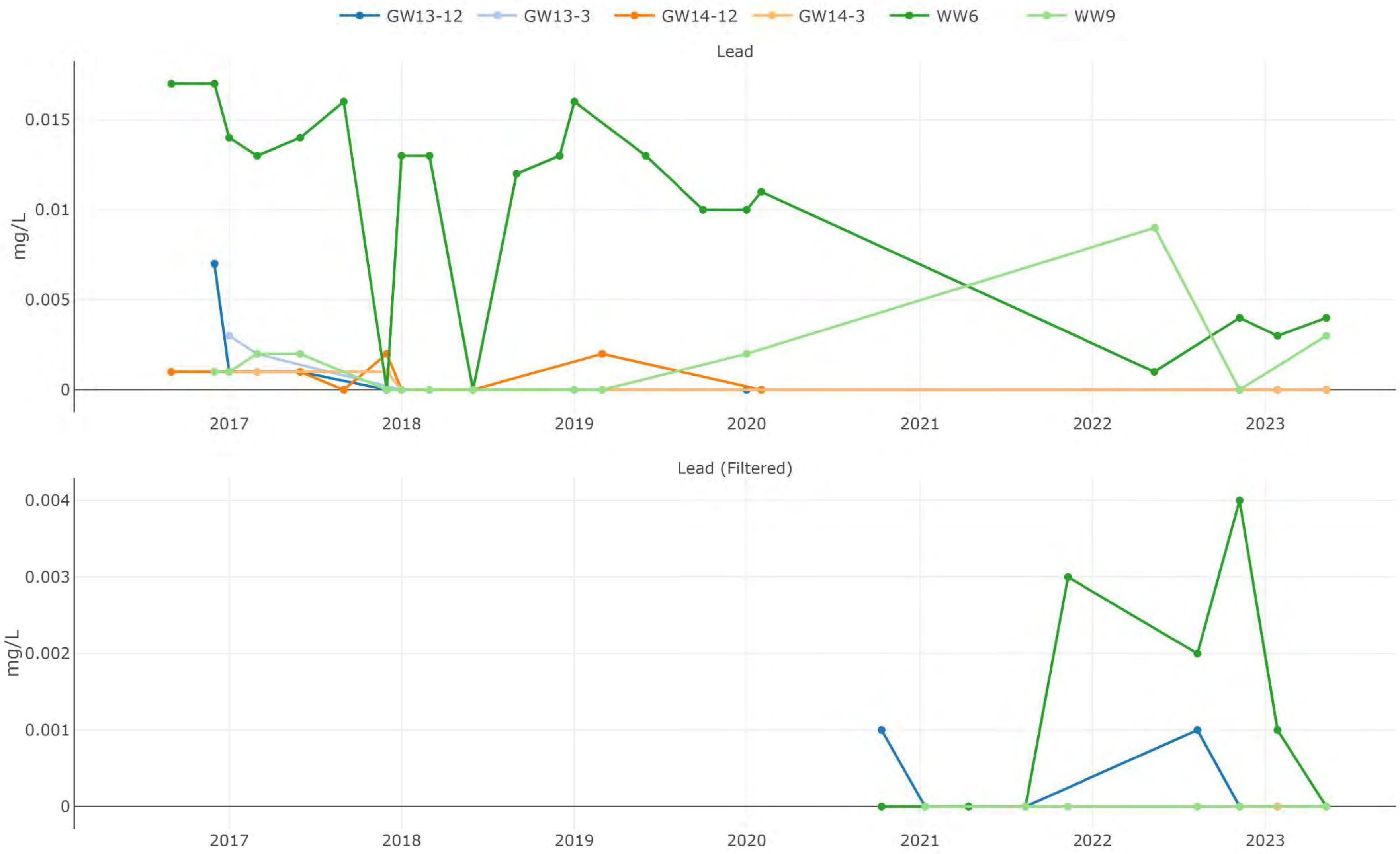


Figure 6-14 Historical lead concentrations in groundwater on the western perimeter of the Site landfill cells

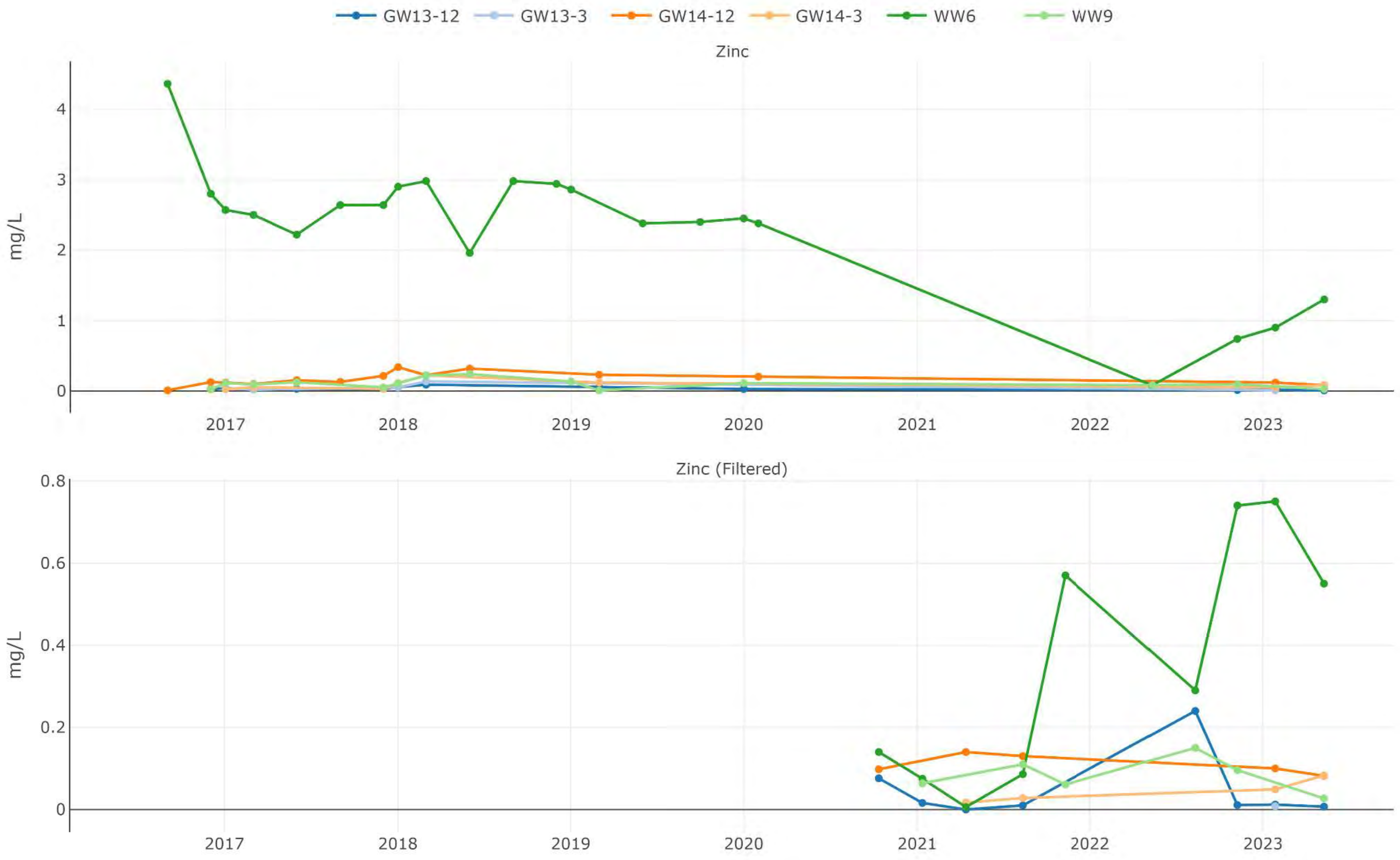


Figure 6-15 Historical Zinc concentrations in groundwater on the western perimeter of the Site landfill cells

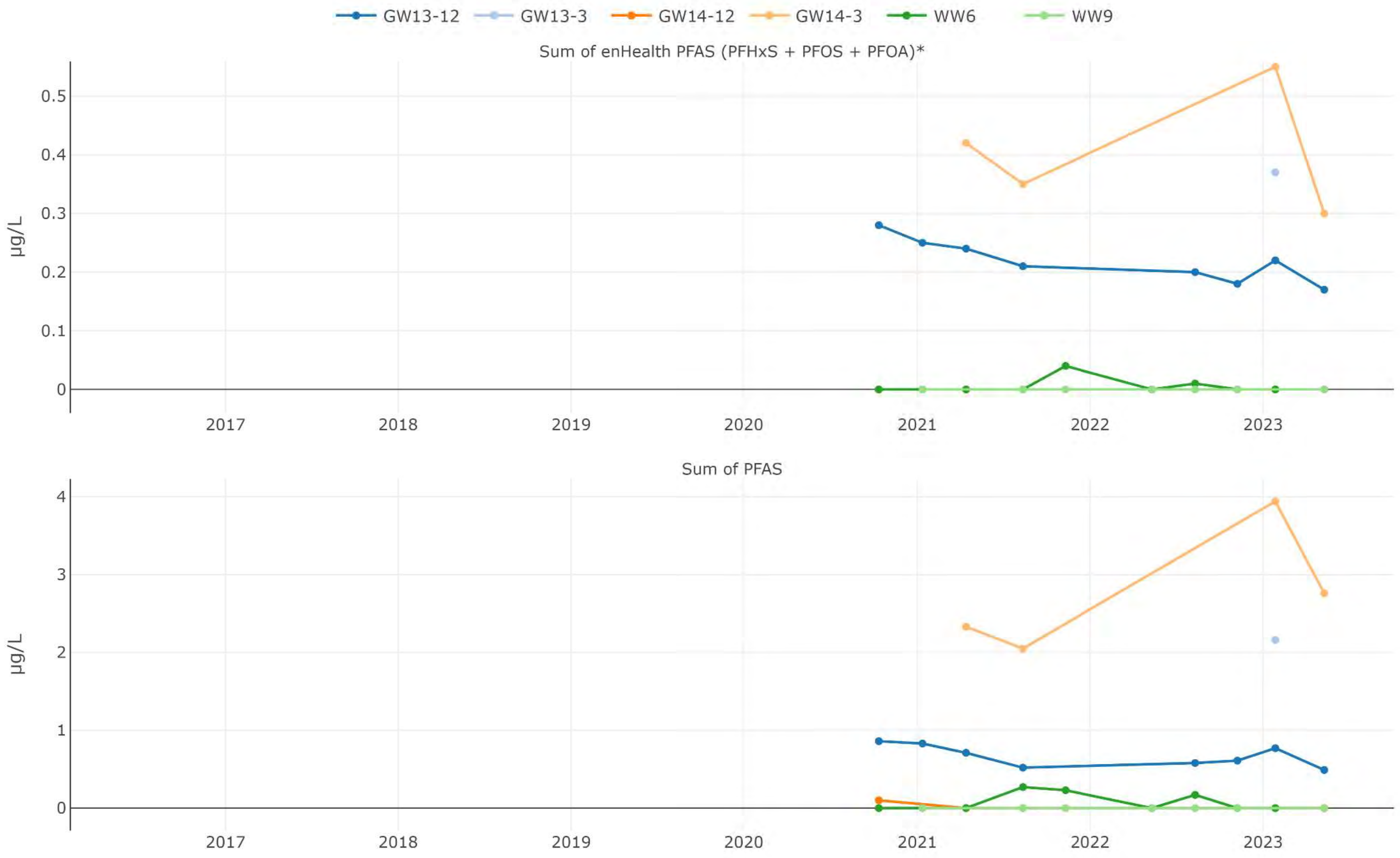


Figure 6-16 Historical PFAS concentrations in groundwater on the western perimeter of the Site landfill cells

6.2.3 Eastern perimeter landfills

6.2.3.1 Ammonia

As shown on **,** long-term reported ammonia concentrations generally ranged between LOR and 10 mg/L with spikes in concentrations reported up to approximately 70 mg/L for GW8-3. None of the results exhibit long-term trends.

6.2.3.2 Total Nitrogen & Nitrite + Nitrate (Nox)

Figure 6-18 and **Figure 6-19** show reported concentrations of total nitrogen and Nox have ranged between LOR and approximately 30 mg/L; while concentrations of Nox ranged between LOR and approximately 30 mg/L. Concentrations of total nitrogen and Nox reported for GW8-3 have increased since 2022, but have reduced since peaking in March 2023. Overall, none of the results for the wells exhibit significant trends.

6.2.3.3 Reactive Phosphorus

Figure 6-20 presents reported concentrations of reactive phosphorus, which ranged between LOR and approximately 0.5 mg/L. Concentrations of reactive phosphorus reported for GW8-3 and GW7-3 exhibited spikes in early 2021, but have reduced back to typical concentrations since 2022. None of the results for any of wells exhibit significant trends.

6.2.3.4 Metals

Figure 6-21 through **Figure 6-23** present concentrations of copper, lead, and zinc. No trend in reported concentrations is evident with fluctuations that probably reflect seasonal variations.

6.2.3.5 PFAS

As shown on **Figure 6-24**, PFAS concentrations have ranged between LOR and approximately 2 µg/L. However, concentrations have not exhibited any significant trend.

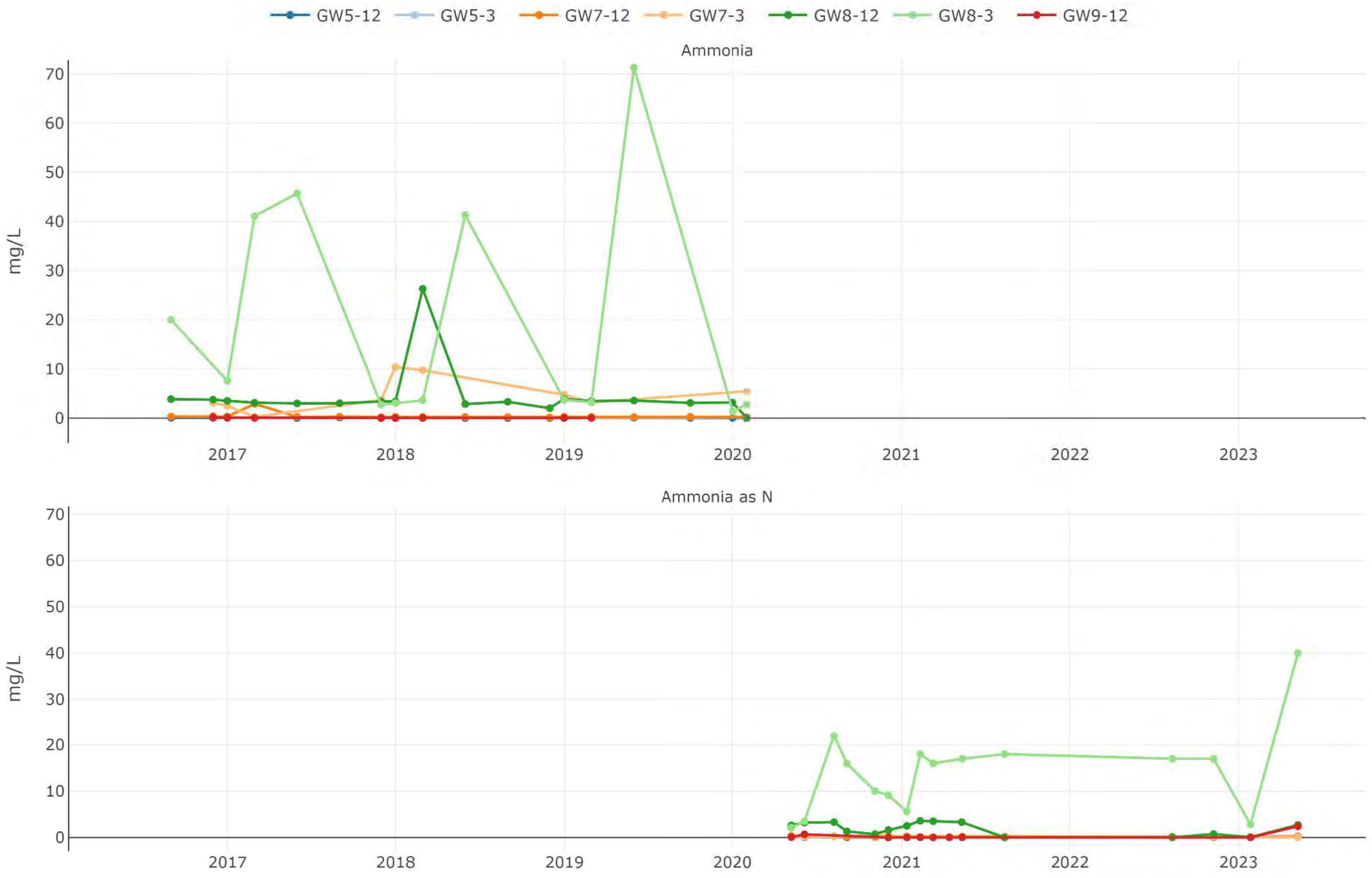


Figure 6-17 Historical ammonia concentrations in groundwater on the eastern perimeter of the Site landfill cells

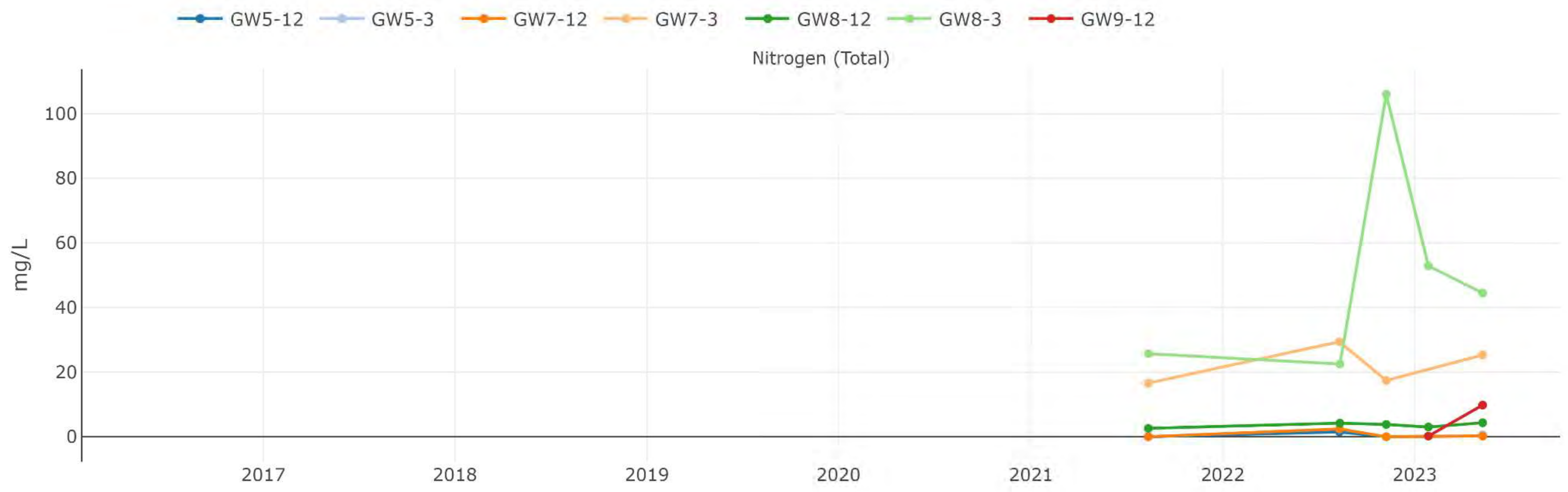


Figure 6-18 Historical Total Nitrogen concentrations in groundwater on the eastern perimeter of the Site landfill cells

Figure 6-19 Historical Nox concentrations in groundwater on the eastern perimeter of the Site landfill cells

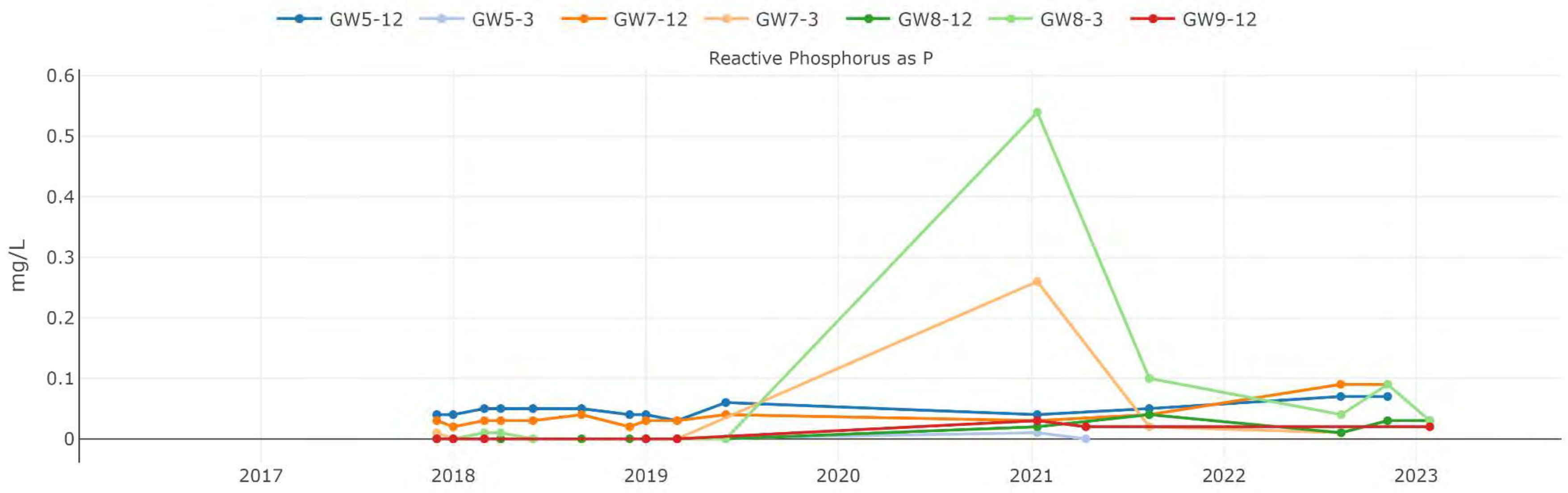


Figure 6-20 Historical reactive phosphorus concentrations in groundwater on the eastern perimeter of the Site landfill cells

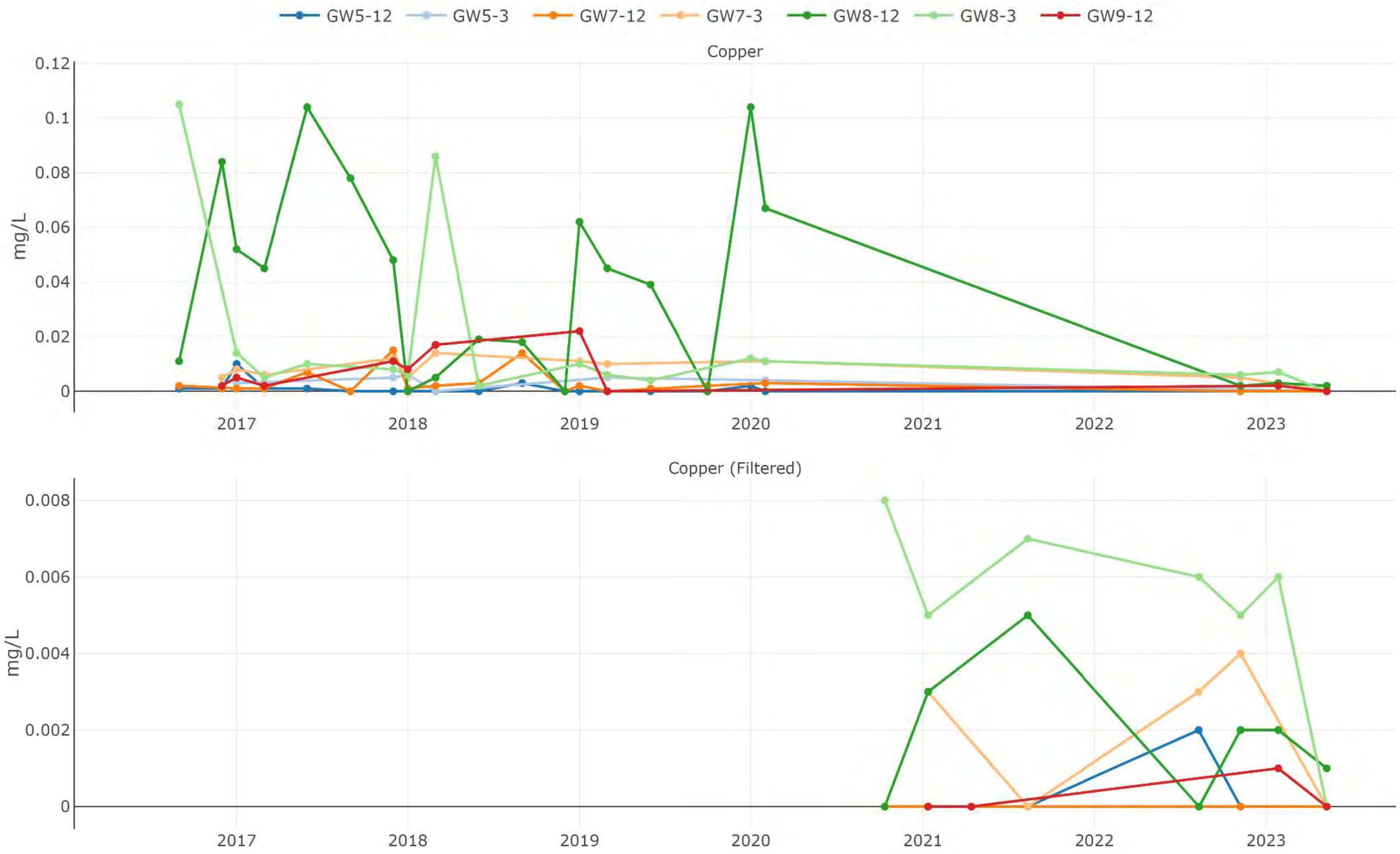


Figure 6-21 Historical copper concentrations in groundwater on the eastern perimeter of the Site landfill cells

Figure 6-22 Historical lead concentrations in groundwater on the eastern perimeter of the Site landfill cells

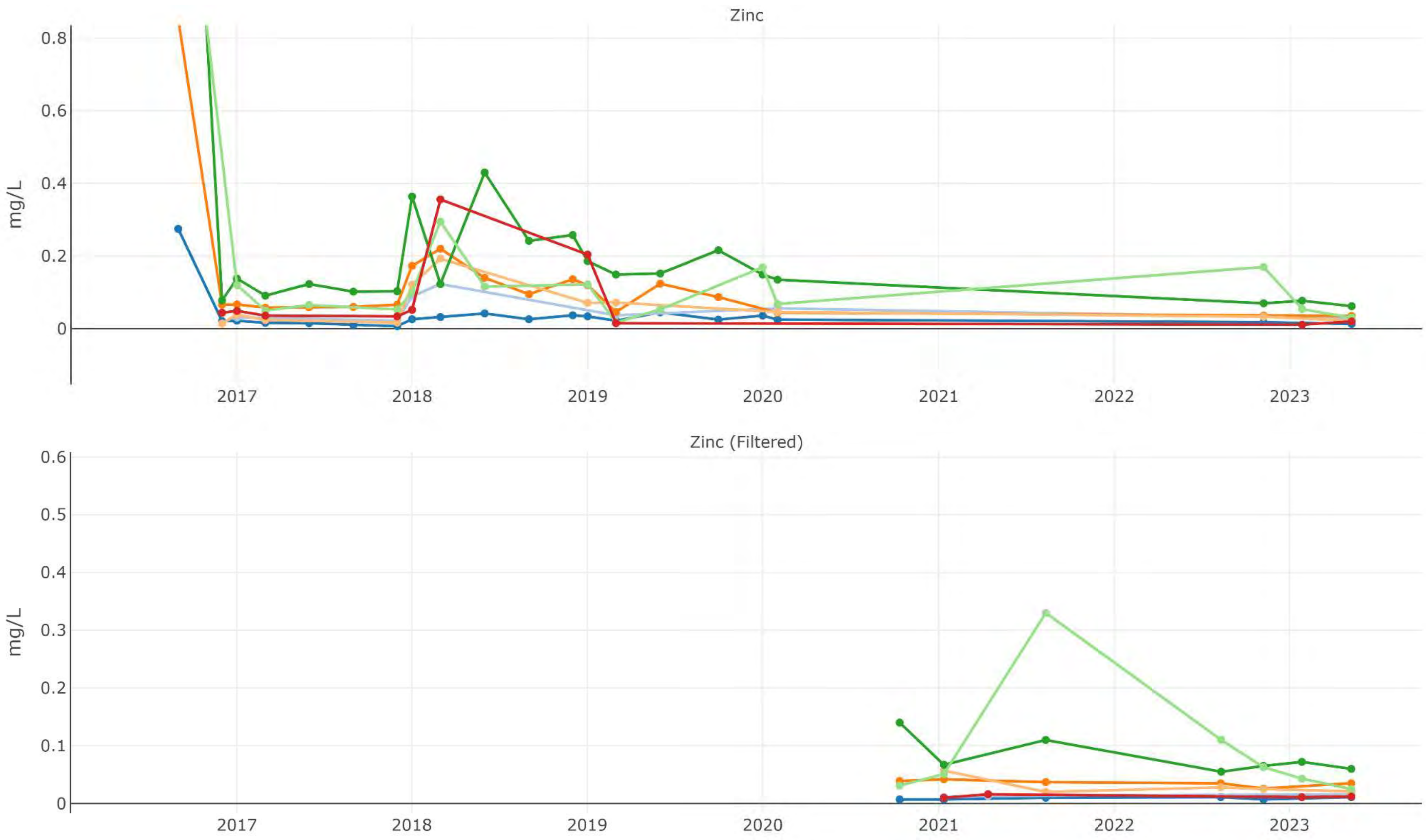


Figure 6-23 Historical Zinc concentrations in groundwater on the eastern perimeter of the Site landfill cells

Figure 6-24 Historical PFAS concentrations in groundwater on the eastern perimeter of the Site landfill cells

6.2.4 Leachate Treatment areas.

6.2.4.1 Ammonia

As shown on **Figure 6-25,** long-term reported ammonia concentrations generally ranged between LOR and 2 mg/L with concentrations reported for GW2-3 increasing 2023 concentrations significantly higher than pre-2022. For the other wells, no significant long-term trend is evident.

6.2.4.2 Total Nitrogen & Nitrite + Nitrate (Nox)

Figure 6-26 and **Figure 6-27** shows reported concentrations of total nitrogen have generally ranged between LOR and approximately 2 mg/L; while concentrations of Nox ranged between LOR and approximately 10 mg/L. Concentrations of total nitrogen and Nox reported for GW15-3 have increased since 2022. The other wells are not exhibiting any long-term trends.

6.2.4.3 Reactive Phosphorus

Figure 6-28 presents reported concentrations of reactive phosphorus, which ranged between LOR and 0.4 mg/L. Concentrations of reactive phosphorus reported for GW2-12 have increased since 2021; while concentrations in the remaining wells have not exhibited any trend.

6.2.4.4 Metals

Figure 6-29 through **Figure 6-31** present concentrations of copper, lead, and zinc. No significant trend in reported concentrations is evident with fluctuations that probably reflect seasonal variations, except for filtered copper reported for GW15-12, which increased since 2021 from 0.005 mg/L to approximately 0.02 mg/L.

6.2.4.5 PFAS

As shown on **Figure 6-32**, PFAS concentrations have ranged between LOR and approximately 0.5 µg/L. However, except for GW15-3, none of the concentrations have not exhibited any significant trend. GW15-3 concentrations increased from approximately below LOR to 0.4 µg/L.

Figure 6-25 Historical ammonia concentrations in groundwater surrounding the leachate treatment areas

Figure 6-26 Historical Total Nitrogen concentrations in groundwater surrounding the leachate treatment areas

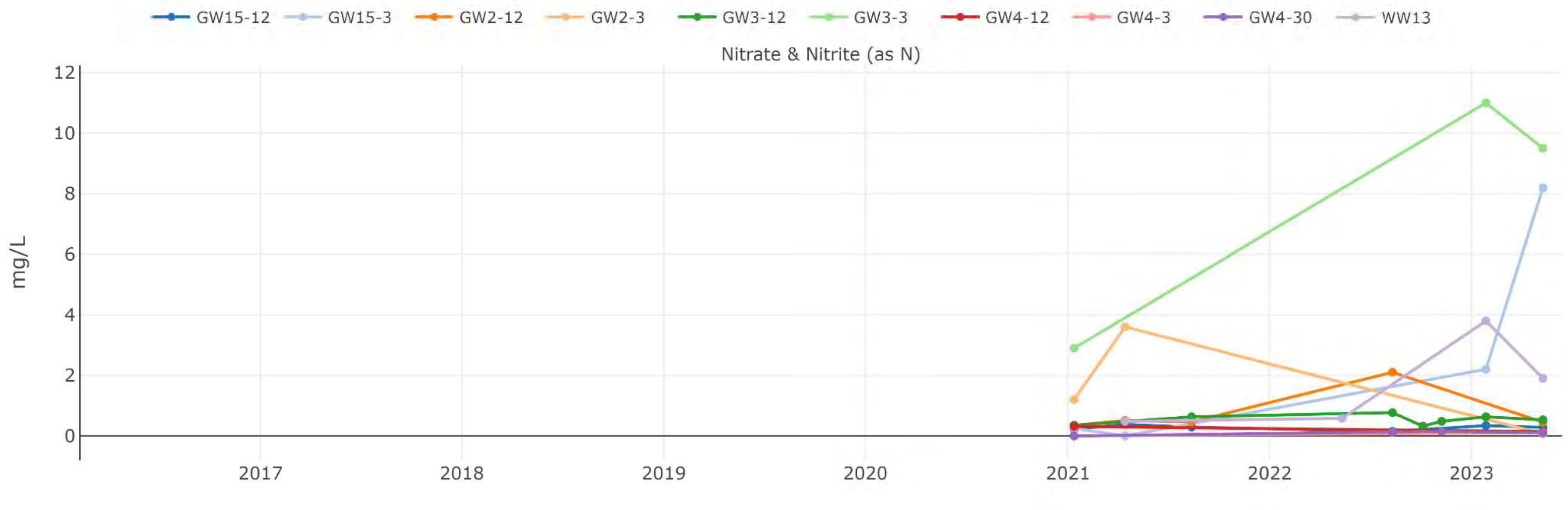


Figure 6-27 Historical Nox concentrations in groundwater surrounding the leachate treatment areas

Figure 6-28 Historical reactive phosphorus concentrations in groundwater surrounding the leachate treatment areas

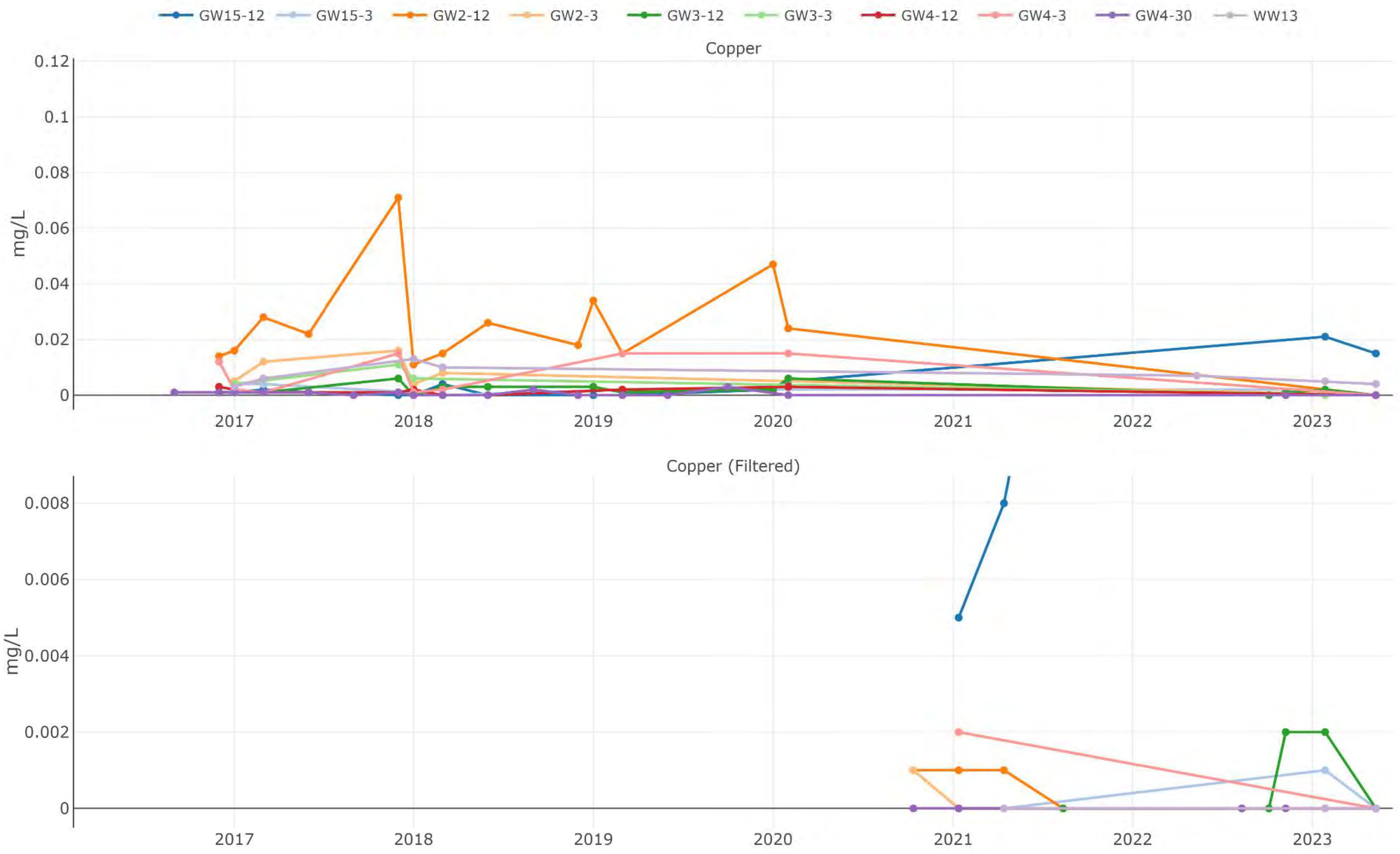


Figure 6-29 Historical copper concentrations in groundwater surrounding the leachate treatment areas

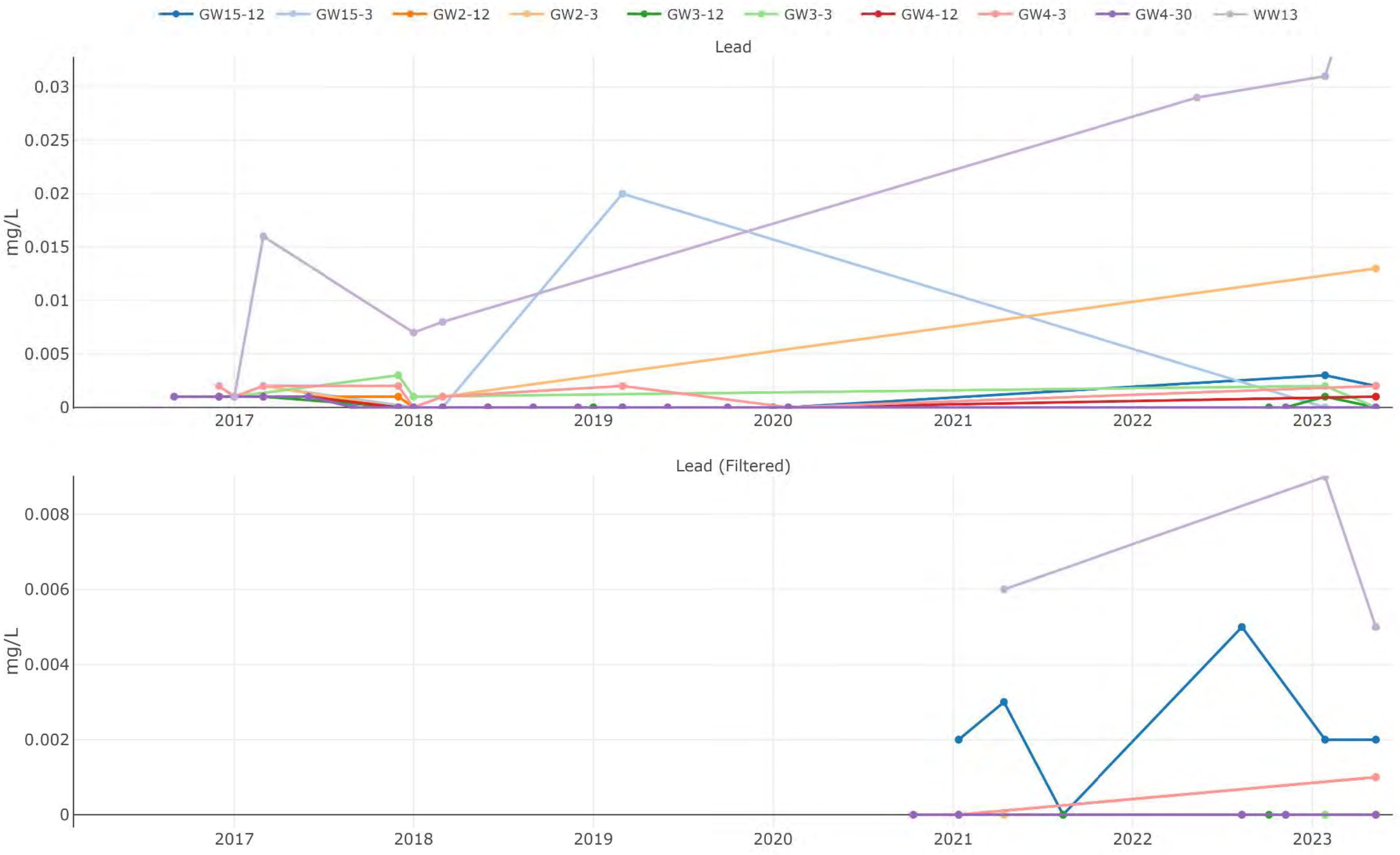


Figure 6-30 Historical lead concentrations in groundwater surrounding the leachate treatment areas

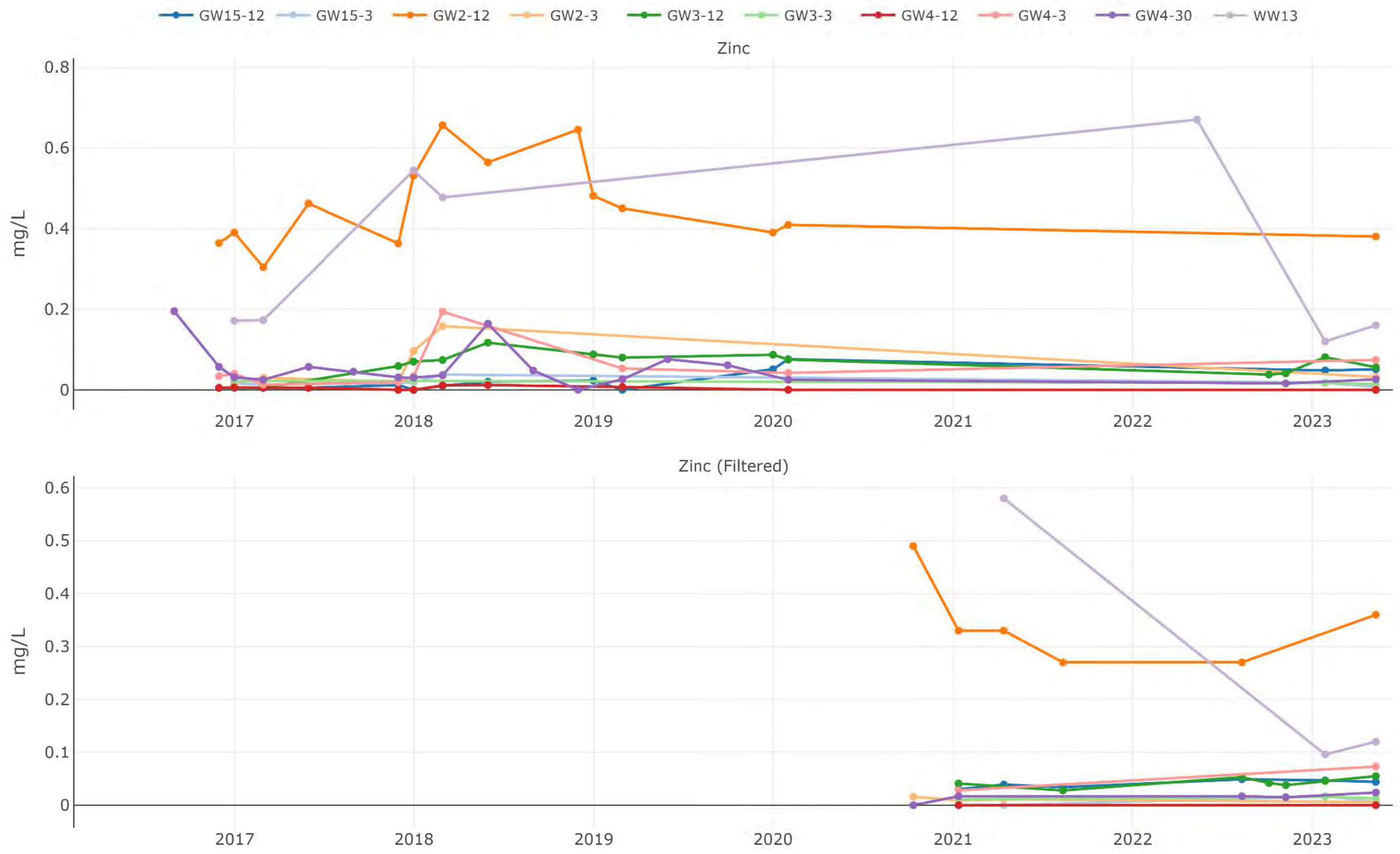


Figure 6-31 Historical Zinc concentrations in groundwater surrounding the leachate treatment areas

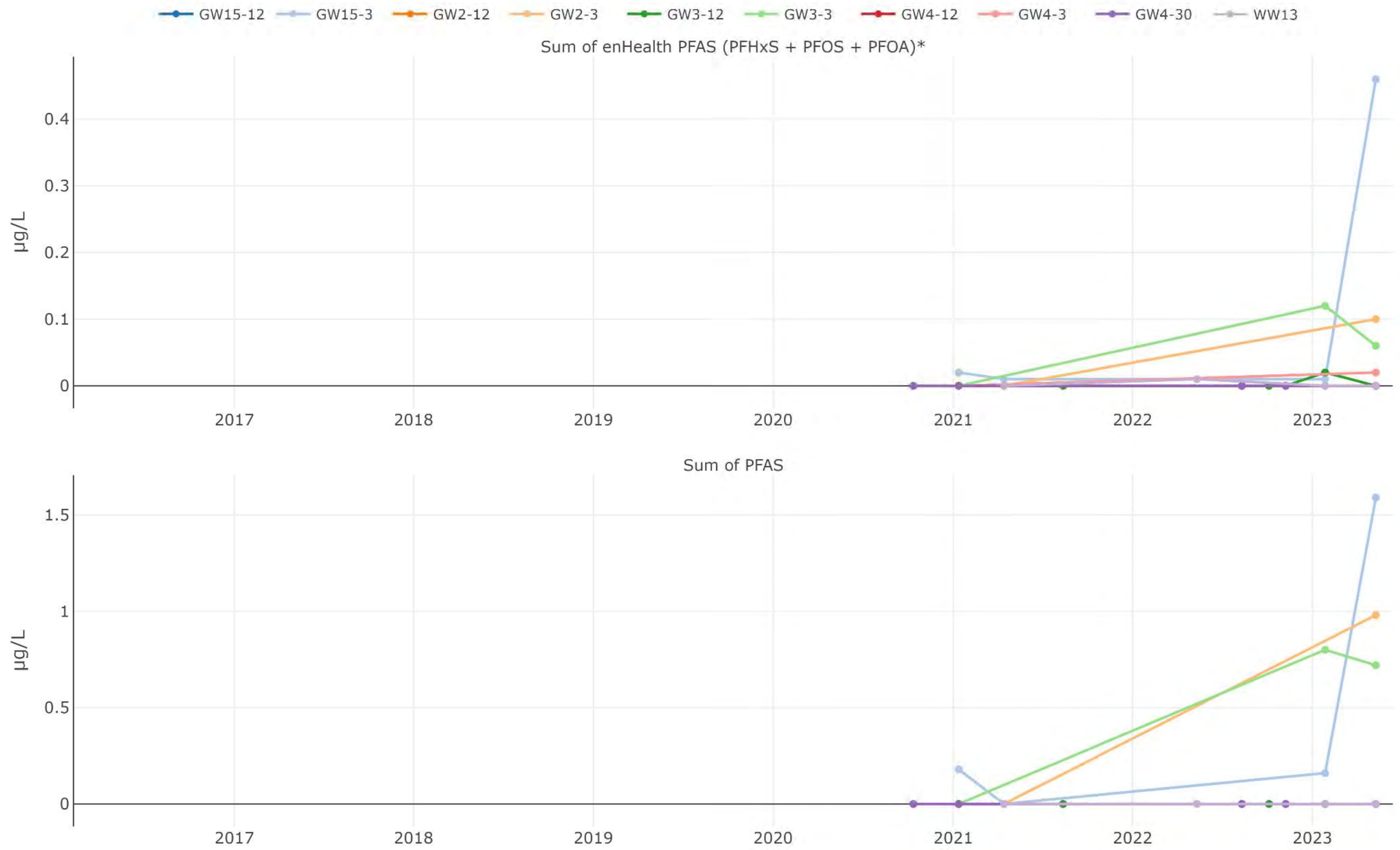


Figure 6-32 Historical PFAS concentrations in groundwater surrounding the leachate treatment areas

7 Conceptual Site Model

The CSM identifies potential contamination sources, pathways, and receptors with a view to identifying potential and significant pollution linkages to inform an appropriate intrusive investigation and provide for and informed assessment of the potential risk to site users.

Changed land use scenarios provide different contamination risk profiles depending on the exposure mechanisms and sensitivity of receptors. For the purpose of this assessment this CSM assumes continued commercial/industrial land use for the site as a commercial landfill and residential land use for the immediate surrounding properties.

7.1 Primary Contaminant Sources

Potential sources of contamination and associated CoPC are presented in **Table 7-1**.

Table 7-1 Sources of Contamination and Potential Contaminants

Source	CoPC	Rationale
On-site		
Leachate generated from current and future landfill material within the landfill cells	PFAS, Total Recoverable Hydrocarbons (TRH), Monocyclic Aromatic Hydrocarbons (MAH) including BTEX) and Polycyclic Aromatic Hydrocarbons (PAH), VOCs, metals and Organochlorine pesticides and Organophosphates pesticides (OCP/OPP).	Long term municipal waste resource recovery and disposal operations at the site CoPC have been detected in leachate, surface and groundwater chemistry analysis historically at the site.
Leachate contained in lined leachate treatment ponds and wetland area		
Chemical release due to spillage at the refuelling and wash down area and other trafficable areas around the site	Hydrocarbons, oil and grease, PAHs	
Seepage from the stormwater dams	As above	
Fire-fighting response	PFAS	PFAS has been detected in leachate, surface and groundwater chemistry analysis
Off-site		
Contaminated groundwater up gradient from the site	As above	Upgradient from the Site lies medium density residential and commercial land use areas which have potential to impact groundwater before reaching the Site

7.2 Transport Pathways and Exposure Mechanisms

For the purpose of this assessment, possible exposure pathways are identified as natural and/or man-made pathways for the preferential migration of CoPC in the liquid and/or gaseous state. Potential contaminant migration pathways for the CoPC are summarised below:

> Leaching in the unsaturated zone and into groundwater from landfill cells, leachate treatment ponds and/stormwater ponds.

> Stormwater runoff and pond overflows during high rainfall.

> Horizontal groundwater flow in the aquifer.

> Movement of soil-gas through volatilisation from impacted soils and groundwater.

> Vapour migration.

Potential exposure routes for the CoPC include:

- Direct contact (dermal and ingestion)
- Inhalation of dust and/or emissions

7.3 Potential Receptors and Exposure Routes

7.3.1 Potential Receptors

The site is located in a highly modified commercial/industrial setting surrounded medium density residential zones. Key potential human health and ecological receptors, at or down-gradient of the site, and relevant to the identified sources and associated CoPC include:

- **Onsite workers and visitors** (impacted soils and groundwater);
- **Onsite construction / maintenance workers** (associated ongoing maintenance, including subsurface works);
- **Offsite users** (public, and workers at adjacent properties);
- **Groundwater users** down-gradient (Mickett and Buffalo Creek wetlands);
- **Surface Waters** (fresh water / marine ecosystem, water quality, recreational users); and
- **Modified Ecosystems** (terrestrial flora and fauna).

7.3.2 Preferential Pathways

The potential preferential pathways that could link the identified potential sources of contamination with the identified potential receptors include:

- Dust / fibre migration through air via wind or mechanical agitation;
- Direct handling of contaminated soil and/or groundwater;
- Vertical migration of contamination (downward – assisted by rainfall infiltration) through the soil profile and into groundwater;
- Migration of contamination via subsurface trenches for underground utilities.
- Lateral migration of contamination in groundwater via advection (and dispersion);
- Vertical (upward) migration of volatile contaminants from the soil profile and/or groundwater; and
- Surface water runoff and stormwater drainage offsite.

7.3.3 Exposure Routes

Exposure Routes The potential routes that could cause the identified potential receptors to be exposed to contamination (i.e. exposure routes) include:

- Inhalation of soil / fibres through dust;
- Ingestion of soil and/or groundwater through direct handling;
- Dermal absorption of soil and/or groundwater through direct handling;
- Inhalation of vapours that may accumulate within enclosed and confined spaces; and
- Uptake by vegetation and further bioaccumulation through larger terrestrial and marine fauna consuming soil organisms, micro marine organisms and plant matter impacted by CoPC.

7.3.4 Source-Pathway-Receptor Linkage Assessment

The CSM provided in **Table 7-2** presents the possible Source-Pathway-Receptor (SPR) Linkages that may be present at the site.

Table 7-2 CSM – potential pollution linkages

Potential Source	Migration Pathway	Exposure Pathway	Receptor	SPR Linkage	Discussion	Data Gap
Human Health						
Site Operation and infrastructure, including: ▪ Leachate from within landfill cells and/or treatment ponds ▪ Chemicals storage ▪ Washdown bays ▪ Drainage alignments (surface water run off)	Direct contact to contaminated soil (surface/near surface)	Dermal contact	▪ Site users ▪ Waste processing / Construction / Maintenance workers	Incomplete linkage – all workers adhere to industry safe work practices administered via onsite HSEQ processes and documentation Insufficient data / characterisation of current site condition	▪ Due to the historical and current land use (landfill) and onsite operation (e.g. perpetual waste processing) there is a potential for contamination at the site. Limited recent soil quality investigation has been completed and is not sufficient to characterise the nature and extent of the potential soil contamination at the site.	Insufficient data / characterisation of current site surface soils condition
	Dust/fibre migration through air via wind or mechanical agitation. Inhalation of soil through dust	Incidental ingestion or inhalation of surface/near-surface soils/dust	▪ Site users ▪ Waste processing / Construction / Maintenance workers ▪ Off-site users (neighbouring properties and POS)	Potentially complete – exposed soil areas across site though dust mitigation practices including water trucks, and revegetation are in use across the site Historical dust depositional data detected no CoPC	▪ Concentration in surface soils and dust (Cardno, 2020) were below the LOR and assessment criteria for human health impacts.	Previous dust and soil sampling regimes were too localised and small scaled to adequately characterise whole of site
	Leaching in the unsaturated zone and into groundwater, horizontal groundwater flow in the aquifer	Ingestion of groundwater through direct handling	▪ Off-site users ▪ Groundwater users ▪ Recreational users ▪ Off-site users (neighbouring properties)	Insufficient data / characterisation of current hydrogeological site condition Reference bores are required to confirm groundwater flow is not flowing towards residential areas.	▪ A robust understanding of the spatial extent and magnitude of site-derived groundwater flow has not been established. ▪ There are no groundwater bores immediately adjacent/offsite currently in the sampling schedule. ▪ The quality and characteristics of groundwater beneath the site is understood including conditions of groundwater migrating to beneath the site however there is no recent data to infer conditions of groundwater migrating off-site.	Groundwater condition adjacent/offsite has not been fully assessed. Community groundwater usage immediately adjacent is not understood.
	Direct contact with potentially contaminated surface water.	Dermal and ingestion contact or ingestion.	▪ Site users ▪ Waste processing / Construction / Maintenance workers ▪ Off-site users (neighbouring properties) ▪ Recreational users	Potentially Complete Insufficient data / characterisation of current site condition	▪ Surface waters distributed further offsite via onsite stormwater drainage observed during monitoring is a potential pathway. ▪ Surface water pathways linking to the Mickett and Buffalo Creek wetland and marine environments could potentially occur though is data deficient and not able to be delineated	Insufficient data / characterisation of current offsite (receiving environment) conditions
Regional groundwater conditions	Groundwater migration with hydraulic gradient.	Ingestion of groundwater through direct handling	▪ Off-site users ▪ Groundwater users ▪ Recreational users ▪ Off-site users (neighbouring properties)	Potentially Complete Insufficient data / characterisation of current site condition	▪ There are no groundwater bores immediately adjacent/offsite currently in the sampling schedule. ▪ The quality and characteristics of groundwater beneath the site is understood including conditions of groundwater migrating to beneath the site however there is no recent data to infer conditions of groundwater migrating onto site from surrounding areas.	Groundwater condition adjacent/offsite has not been fully assessed. Community groundwater usage immediately adjacent is not understood.
	Migration of contaminated groundwater to surface water receptors.					
	Vertical migration (upwards) of volatile contaminants from the groundwater.					
Environment						
Site Operation and infrastructure, including: ▪ Leachate from within landfill cells and/or treatment ponds ▪ Chemicals storage ▪ Washdown bays ▪ Drainage alignments (surface water run off)	Direct contact to contaminated soil (surface/near surface).	Dermal contact, incidental ingestion or inhalation of surface/near-surface soils/dust	Modified Ecosystems (flora & fauna). Mickett and Buffalo Creek wetlands and marine ecosystems Holmes Jungle Nature Park and Leanyer Swamp and their ecosystems	Low Risk Insufficient data / characterisation of current site condition	▪ Potential risks to vegetation and bioaccumulation are considered to be low given their sporadic and limited (highly modified) flora and fauna distribution on the site and associated land use compared to the regional representation of flora and fauna ▪ Nature reserves are located 1 km downgradient of the site where attenuation is likely to occur.	Insufficient data / characterisation
	Dust/fibre migration through air via wind or mechanical agitation. Inhalation of soil through dust.	Dermal contact, incidental ingestion or inhalation of surface/near-surface soils/dust		Low Risk Insufficient data / characterisation of current site condition		
	Vertical migration of contaminants from the soil profile into groundwater	Ingestion of groundwater through direct handling.	Modified Ecosystems (flora & fauna).	Insufficient data / characterisation of current site condition		

8 Conclusions and Recommendations

Stantec has been conducting groundwater, surface water and leachate monitoring at the Shoal Bay Waste Management Facility operated by City of Darwin and reviewed all monitoring activities for the period 1 July 2022 to 30 June 2023, in accordance with the Site's environmental protection license EPL 188 – 03 pursuant to the *NT Waste Management and Pollution Control Act* (WMPC Act).

During this reporting period analysis suites and sampling frequencies have been implemented that comply with the EPL188-03 and Soil & Water Monitoring Plan developed by EcOz (EcOz, 2021). As per the licence all analytical results for samples of surface water have been assessed against the adopted criteria in accordance with the Site's Licence conditions.

During this monitoring period SBMWF experienced insufficient leachate storage capacity, which resulted in the pond associated with sampling location SW14 accommodating the surplus leachate overflow in accordance with the site's Emergency Leachate Management Procedure (ELMP). As such the receiving dam (SW14) was considered a temporary leachate storage pond and monitoring was reported independently of this report by CoD in line with the ELMP.

Seasonal variation in rainfall restricted access and/or dried up sampling locations precluded all required sites from being sampled and varying month to month.

Together, analytical results and the hydraulic gradient of the Site detailed in Section 3.3 of this report indicate that the migration of leachate-impacted surface water flowing from the Site is occurring most consistently between the Stage 3, 4 and 5 landfills, the water sump receiving from the green waste processing area and in stormwater runoff from water from the Stage 1, 2 and 6 landfills.

There were trigger value exceedances in several nutrients and metals from the storm and surface water sampling locations that would trigger formal notification to the EPA. Therefore, Stantec recommends that the EPA be notified in writing of these exceedances.

However, because trigger values have been derived from the Darwin Harbour Water Quality Objective, the assessment criteria may be considered too conservative to apply to SBWMF inland surface water monitoring locations and more suitable to sampling locations to be implemented as part of the off-site impact assessment to be implemented during the second half of 2023. Stantec has begun baseline sampling of these sites which will inform these results further over the coming wet season and recommend they be compared to elevated concentrations of contaminants on site to provide a basis to assess any correlations and review trigger levels for the SMWMF if required.

The locations of surface water sampling sites that do not accommodate sampling frequently enough due to rapid runoff, evaporation and/or infiltration should be reconsidered and moved further downstream in areas retaining the runoff for longer.

Based on the above source, pathway and receptor review and the groundwater and surface water chemistry it is considered that some shallow groundwater at the site has been impacted by leachate. While the high concentrations of contaminants, such as nutrients, metals, and PFAS, are evident in the leachate samples, the concentrations reported for the surface water and ground water samples are significantly lower.

None of the data sets for the sampling locations exhibited significant trends. Spikes of high concentrations occurred, but these elevated concentrations did not typically persist. However, some of the shallow wells, such as GW2-3, are exhibiting higher concentrations that will need to be reviewed to evaluate whether an increasing trend is developing.

The location and distance to potential receptors is considerable, which will require significant travel time for the groundwater and allow attenuation through degradation and dilution of CoPC, reducing the potential risk of contaminated groundwater transporting off site.

9 References

1. ANZG 2018, Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines
2. ANZECC ,2000), Australian and New Zealand guidelines for fresh and marine water quality. Volume 1, The guidelines, October 2000, National Water Quality Management Strategy, Paper No. 4, Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.
3. Australian Government Department of the Environment and Energy (DoEE) (2018). PFAS National Environmental Management Plan. January 2018, Report prepared by the Heads of EPAs Australia and New Zealand (HEPA), Australia.
4. BoM 2019, Climate Data Online. [online] Available at Bureau of Meteorology (BoM). Available at http://www.bom.gov.au/climate/data/index.shtml?bookmark=200 (Accessed, July 2020)
5. Cardno 2022, *Annual Monitoring Review, Shoal Bay Waste Management Facility Water Quality Monitoring 1 July 2021 – 30 June 2022,* Report prepared by Cardno for City of Darwin.
6. Cardno 2022, *Annual Monitoring Review, Shoal Bay Waste Management Facility Water Quality Monitoring 1 July 2021 – 30 June 2022,* Report prepared by Cardno for City of Darwin.
7. CoD 2023, Shoal Bay Waste Management Facility Environmental Management Plan, 2023, City of Darwin (CoD), Darwin.
8. EcOz 2021, *Soil and Water Monitoring Plan - Shoal Bay Waste Management Facility*, 7 April 2021, Prepared for City of Darwin.
9. HEPA, 2020, *PFAS National Environmental Management Plan v2.0*
10. URS 2015, Shoal Bay Waste Disposal Site, Hydrogeological Investigation, November 2015, Report prepared by URS Australia Pty Ltd for John Holland Pty Ltd, Darwin.
11. URS 2016, Shoal Bay Waste Disposal Site, Conceptual Site Model, February 2016, Report prepared by URS Australia Pty Ltd for John Holland Pty Ltd, Darwin.
12. United States Environmental Protection Agency 2023, *CADDIS Vol. 2 Stressors-pH Overview*. Available at https://www.epa.gov/caddis-vol2/ph (Accessed July 2023)

Appendices

Appendix A Emissions Monitoring Reports

ASSURED ENVIRONMENTAL PTY LTD

Your environmental compliance partner

AUGUST 2022

SOURCE EMISSIONS MONITORING – SHOAL BAY BENEVAP 150

CLIENT: BENETERRA
PROJECT ID: 14326
DATE: 6/10/2022 RELEASE: R_0

DOCUMENT CONTROL PAGE

Project Title: Source Emissions Monitoring – Shoal Bay Benevap 150

Project Reference ID: 14326

Report Prepared by:

Assured Environmental
Unit 7, 142 Tennyson Memorial Avenue
Tennyson, QLD, 4105
ABN: 87 604 851 078

Report Prepared for:

BeneTerra
Shoal Bay Access Road
Karama NT 0812

Report Author: Timon Berger

Report Reviewer: Adam Dixon

Table 1: History of Revisions

Revision	Date	Issued to	Changes
R_0	6/10/2022	N. Sharma	Formal report release
DRAFT_0	23/09/2022	N. Sharma	Draft release for comment.

ACCREDITED FOR COMPLIANCE TO ISO/IEC 17025 (TESTING)

The results of the tests, calibrations and/or measurements included in this document is traceable to Australian/national standards.

Accreditation number: 19703

NATA
WORLD RECOGNISED
ACCREDITATION
NATA ID: 19703

DISCLAIMER

Assured Environmental acts in all professional matters as a faithful advisor to the Client and exercises all reasonable skill and care in the provision of its professional services.

Reports are commissioned by and prepared for the exclusive use of the Client. They are subject to and issued in accordance with the agreement between the Client and Assured Environmental. Assured Environmental is not responsible for any liability and accepts no responsibility whatsoever arising from the misapplication or misinterpretation by third parties of the contents of its reports.

Except where expressly stated, Assured Environmental does not attempt to verify the accuracy, validity or comprehensiveness of any information supplied to Assured Environmental for its reports.

Reports cannot be copied or reproduced in whole or part for any purpose without the prior written agreement of Assured Environmental.

Where site inspections, testing or fieldwork have taken place, the report is based on the information made available by the client or their nominees during the visit, visual observations and any subsequent discussions with regulatory authorities. The validity and comprehensiveness of supplied information has not been independently verified and, for the purposes of this report, it is assumed that the information provided to Assured Environmental is both complete and accurate. It is further assumed that normal activities were being undertaken at the site on the day of the site visit(s), unless explicitly stated otherwise.

EXECUTIVE SUMMARY

Assured Environmental (AE) conducted source emissions monitoring from the mobile BeneVap Leachate Treatment Facility (BV150) located at the Shoal Bay Waste Facility in Darwin, Northern Territory from 8th to 10th August 2022.

A summary of results and comparison against compliance levels is presented in Table 2 below from the testing conducted on the single release point on the BV150 unit.

In comparison to the emission limits outlined in EPL188-03 – Attachment 7, all measured parameters were within those limits specified. Results are reported at dry, 273.15°K and 101.325 kPa (STP).

Table 2: Summary of measured parameters

Parameter		Result BV150	Emission limit	Unit	Reference
Average source temperature		80	-	°C	-
Flue gas water vapour content		48	-	vol-%	-
Carbon dioxide concentration		7.1	-	vol-%	STP - dry
Oxygen concentration		11.1	-	vol-%	STP - dry
Flue gas molecular weight - dry		1.3	-	kg/Nm^3	STP - dry
Flue gas velocity		3.2	-	m/sec	STP - dry
Flue gas volume flow		21.7	-	Nm^3/min	STP - dry
Oxides of nitrogen (as NO_2)		52	350	mg/Nm^3	STP - dry
- emission rate		1.1	-	g/min	
Carbon monoxide		49	125	mg/Nm^3	STP - dry
- emission rate		1.01	-	g/min	
Total heavy metals		0.177	1.0	mg/Nm^3	STP - dry
- emission rate		0.0047	-	g/min	
Cadmium		0.00061	0.2	mg/Nm^3	STP - dry
- emission rate		1.6E-05	-	g/min	
Mercury		0.00012	0.2	mg/Nm^3	STP - dry
- emission rate		3.2E-06	-	g/min	
Fluorine (as HF)	<	2.2	50	mg/Nm^3	STP - dry
- emission rate	<	0.043	-	g/min	
Hydrogen chloride	<	1.6	100	mg/Nm^3	STP - dry
- emission rate	<	0.039	-	g/min	
Chlorine	<	1.6	200	mg/Nm^3	STP - dry
- emission rate	<	0.039	-	g/min	
Ammonia (NH_3) - total		1,251	-	mg/Nm^3	STP - dry
- emission rate		24	-	g/min	
Ammonia (NH_3) - in condensate		1,117	-	mg/Nm^3	STP - dry
- emission rate		22	-	g/min	
Ammonia (NH_3) - gaseous		134	-	mg/Nm^3	STP - dry
- emission rate		2.6	-	g/min	
Hydrogen sulfide	<	1.1	5	mg/Nm^3	STP - dry
- emission rate	<	0.03	-	g/min	
Sulfur dioxide	<	2.2	-	mg/Nm^3	STP - dry
- emission rate	<	0.04	-	g/min	
Sulfuric acid mist (as H_2SO_4)	<	2.2	100	mg/Nm^3	STP - dry
- emission rate	<	0.04	-	g/min	
Total VOCs (as n-propane)	<	0.8	40	mg/Nm^3	STP - dry
- emission rate	<	0.02	-	g/min	
Average odour		8,450	-	ou	STP - wet
- emission rate		411,005	-	ou-m^3/min	
Dioxins & Furans (i-TEQ)		0.0025	0.1	ng/Nm^3	STP - dry
- emission rate		4.8E-11	-	g/min	
PCBs (i-TEQ)		0.0020	-	ng/Nm^3	STP - dry
- emission rate		3.8E-11	-	g/min	

Table 3: Summary of PFAS results

Parameter		Result ng/Nm^3		Emission Rate g/min	Reference
Per- and polyfluoroalkyl substances					
Perfluorobutanesulfonic acid		**239**		**4.8E-06**	**STP**
Perfluoropentanesulfonic acid		**3.5**		**7.0E-08**	**STP**
Perfluorohexanesulfonic acid		**44**		**8.9E-07**	**STP**
Perfluoroheptanesulfonic acid		**1.8**		**3.6E-08**	**STP**
Perfluorooctanesulfonic acid PFOS		**43**		**8.7E-07**	**STP**
Perfluorodecanesulfonic acid	<	2.7	<	5.4E-08	STP
Perfluorobutanoic acid		**5.9**		**1.2E-07**	**STP**
Perfluoropentanoic acid		**60**		**1.2E-06**	**STP**
Perfluorohexanoic acid		**96**		**1.9E-06**	**STP**
Perfluoroheptanoic acid		**23**		**4.7E-07**	**STP**
Perfluorooctanoic acid PFOA		**94**		**1.9E-06**	**STP**
Perfluorononanoic acid		**4.6**		**9.2E-08**	**STP**
Perfluorodecanoic acid		**6.2**		**1.3E-07**	**STP**
Perfluoroundecanoic acid	<	6.8	<	1.4E-07	STP
Perfluorododecanoic acid	<	6.7	<	1.3E-07	STP
Perfluorotridecanoic acid	<	6.7	<	1.3E-07	STP
Perfluorotetradecanoic acid	<	33	<	6.7E-07	STP
4:2 FTS	<	1.3	<	2.7E-08	STP
6:2 FTS		**37**		**7.5E-07**	**STP**
8:2 FTS		**3.7**		**7.4E-08**	**STP**
10:2 FTS	<	2.7	<	5.4E-08	STP
Perfluorooctane sulfonamide	<	6.7	<	1.3E-07	STP
N-Methyl perfluorooctane sulfonamide	<	6.7	<	1.3E-07	STP
N-Ethyl perfluorooctanesulfonamide	<	6.7	<	1.3E-07	STP
N-Me perfluorooctanesulfonamidoethanol		**16**		**3.2E-07**	**STP**
N-Et perfluorooctanesulfonamidoethanol	<	81	<	1.6E-06	STP
MePerfluorooctanesulf-amido acetic acid		**5.7**		**1.1E-07**	**STP**
EtPerfluorooctanesulf-amido acetic acid		**4.4**		**8.8E-08**	**STP**

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

Assured Environmental (AE) was appointed by BeneTerra to sample and analyse source emissions from the BeneVap Leachate Treatment system. Sampling was conducted by AE from 8th to 10th August 2022 during typical site operations.

AE was responsible for the collection and analysis of samples, unless otherwise indicated. The samples were recovered and stored in the appropriate manner until their return to the laboratory where the samples were prepared and analysed according to the methodologies listed below in this report.

2 METHODOLGY & EQUIPMENT

2.1 Sampling methodology

All sampling and analysis was carried out in accordance with the listed requirements in Table 4. Any specific comments about the sampling and analysis have been documented where required.

Table 4: Test methods

Parameter	Reference Test Method	Test Method (NSW)	NATA accreditation	Analysis by
Sample location	AS4323.1	TM-1	Yes	1
Velocity & flow rate	USEPA Method 2	TM-2	Yes	1
Stack gas density	USEPA Method 3	TM-23	Yes	1
Oxygen	USEPA Method 3A	TM-25	Yes	1
Carbon dioxide	USEPA Method 3A	TM-24	Yes	1
Water vapour content	USEPA Method 4	TM-22	Yes	1
Sulphur dioxide	USEPA Method 6	TM-4	Yes	1
Oxides of nitrogen (as NO_2)	USEPA Method 7E	TM-11	Yes	1
Sulfuric acid mists	USEPA Method 8	TM-3[a]	Yes	1
Carbon monoxide	USEPA Method 10	TM-32	Yes	1
Hydrogen sulfide	USEPA Method 15	TM-5	Yes	1
Total VOCs	USEPA Method 18	TM-34	Yes	2
Hydrogen chloride	USEPA Method 26A	TM-8	Yes	2
Chlorine	USEPA Method 26A	TM-7	Yes	2
Fluoride (as HF)	USEPA Method 13B	TM-9	Yes	2
Heavy metals	USEPA Method 29	TM-12/13/14	Yes	2
PFAS – suite	USEPA SW846 Method 0010	Mod TM-18	No	2
Dioxins & furans	USEPA SW846 Method 0010	TM-18	Yes	3
Polychlorinated biphenyls	USEPA SW846 Method 0010	TM-18	Yes	3
Ammonia	Modified USEPA Method 26	Mod TM-4[b]	Yes	2
Odour	AS4323.3	OM-7	Yes	1

Table 5: Analysis performed by

Note	Company	Work performed	NATA ID	Report Number
1	Assured Environmental	Sampling & analysis	19703	14326
2	Envirolab Services	Sample analysis	2901	303554
3	National Measurement Inst.	PCDD/F & PCB analysis	198	DAU22_217

---

[a] EPL188-03 lists the test method for sulfuric acid mists as TM-13, this does not correspond to the *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales* listed method (TM-3).

[b] EPL188-03 lists the test method for ammonia as TM-3. A closer representation of the sampling technique is a Modified TM-4 sample train. See the description of the sampling technique in Table 6 below.

Table 6: Sampling comments

Note	Comment
Sample location	Sample location is compliant but non ideal as per AS4323.1. The sample location is greater than two, but less than six diameters downstream from a disturbance. The temperature and velocity survey showed that the sample position was in compliance to items (a) to (f) as per AS4323.1.
Calibrations	Analyser calibration performed in the laboratory prior to conducting field work and post field work in AE lab.
H_2S	A sample of exhaust gas was passed through a buffer solution to remove any potential SO_2 present before being captured in a specialised gas sampling bag. Analysis for H_2S was performed using GC-FPD within 30 hours of collection.
Heavy metals	Type 1 substances: Antimony, Arsenic, Cadmium, Lead Mercury. Type 2 substances: Beryllium, Chromium, Cobalt, Manganese, Nickel, Selenium, Tin, Vanadium.
PFAS	A modified version of the USEPA SW846 Method 0010 sample train was employed to sample for Per- and poly-fluoroalkyl substances (PFAS) material in the flue gas emission. Refer to section 2.2 for further information.
Ammonia	The ammonia sampling was performed using a modified constant flow sampling train. A condensate removal trap was placed in front of the collection trap containing the absorbing solution to separate condensing ammonia from gaseous ammonia passing through the initial dropout and into the collection solution (0.1N H_2SO_4). Both the condensate captured in the trap and the sorbent solution are analysed for ammonia individually. Ammonia results are reported in the condensate and gaseous phase separately and as total NH_3. Samples are analysed using a Discrete Analyser.
Odour	Due to the high levels of moisture in the emission the odour samples bags were diluted beyond the suggested limit in AS4323.3. This is required to avoid condensation forming in the sample bags.

2.2 Per- and poly-fluoroalkyl substances sample methodology

Suitable sampling methods for Per- and poly-fluoroalkyl substances (PFAS) in air have received considerably less attention than in other media such as water and soil matrices. As such Assured Environmental has developed a sampling method based on modifications of the promulgated USEPA SW846 Method 0010 sample train. This method includes consideration for both semi-volatile and particulate bound PFAS. It is recognised that the US EPA has recently introduced Other Test Method (OTM) – 45 and although many of the elements included in this method are consistent with the method developed by AE. It is also noted that posting of an OTM by USEPA is neither an endorsement by EPA regarding the validity of the test method nor a regulatory approval of the test method, rather to promote discussion of developing emerging methodologies prior to full endorsement. In this case the AE method was employed, which is summarised below.

The basis of the sample train is;

- Gaseous and particulate pollutants are withdrawn from an emission source at an isokinetic sampling rate and are collected in a multi-component sampling train. The sample train contains a high-efficiency glass fibre filter and a packed bed of porous adsorbent resin. The filter is used to collect organic-laden particulate materials and the porous polymeric resin to adsorb semi-volatile organic species. Semi-volatile species are defined as compounds with boiling points greater than 100°C. The impingers downstream of the resin trap are loaded with water to knock-out any water vapour prior to metering the gas. These impingers are not routinely analysed for S-VOCs.

The modifications made to this sample train in order to target PFAS materials included;

- Sorbent material is XAD-2 and XAD-4.
- The resin traps are spiked with a surrogate standard to test for retention. A known quantity of standard is injected into the trap during preparation, the trap is then shipped, sampled and returned to the laboratory for analysis. The analysis includes detecting the injected standard, which provides a measure of the recovery efficiency. Factors that may affect the recovery efficiency include, sample transport and handling procedures, sampling temperatures (the resin must be chilled during sampling and maintained below 20°C) and sample preparation at the laboratory, including the extraction of the sample from the resin.
- Condensate remove trap prior to resin traps.
- Impingers downstream of the resin trap are loaded with a sodium solution and is intended to be a breakthrough detector. Following the sampling, the impinger contents are measured and placed in a sample bottle for shipment to the laboratory. The final impinger of the sample train is then analysed separately to the filter, resin trap and front half methanol rinse so as to provide a measure of possible breakthrough. The intent of this sample train component is to provide a measure of breakthrough from the primary sampling components. Where no detections of PFAS material is made in this sample component, the limit of detection is not added to the sample result.
- Following the sampling onsite, all sample train components that have been in contact with the sample are rinsed thoroughly with methanol and stored in a sample container to be analysed as part of the sample.
- Sample train component material. According to documented water and soil PFAS sampling procedures, the use of glass, Teflon and stainless steel should be avoided and the use of polypropylene (PE) is recommended. PE is not considered to be conducive to source emissions sampling due to the temperatures of the flue gas. PE or HDPE cannot be used in the probe or filter box due to its low melting point, instead, all sampling components upstream of the resin trap was constructed of glass. Following sampling, all glassware was thoroughly rinsed with methanol at least three times to quantitatively recovery any possible PFAS material deposited on this surface.

For the analysis, the samples are extracted using a solvent desorption technique, with the filter and front half methanol rinse extract combined prior to analysis for the PFAS species. The XAD resin trap is then analysed in isolation as is the condensate downstream of the trap to gain an understanding of where the PFAS is captured within the sample train. The analysis is performed using LC/MS/MS instruments, with each analysis performed using the surrogate spikes to determine sample specific recoveries.

2.2.1 PFAS blank corrections

A full field blank sample has not been performed for this round of sampling. The stock reagents are largely unchanged from the previous round of sampling (13633), therefore the results of this previous blank are utilised for this round. A field blank is performed by the sample train being constructed as normal, however no sample is passed through it. It is then cleaned and recovered following the standard recovery procedures and the filter, resin trap and rinsate kept and analysed along with the sample.

The following details the procedures used to correct for detections of PFAS species in the blank samples.

- Where the blank result is a non-detection, no adjustment to the sample result is made.
- Where the blank result returns a positive detection, but is less than half of the sample result, the blank value is subtracted from the sample result and reported as a positive detection.
- Where the blank value returns a positive detection, and is exceeding half of the sample result, no adjustments are made to the sample result, but it is reported as a non-detection.

2.3 Sample Location

The images and figures below show the sample location and site details.

Figure 1: BeneVap treatment system stack

Table 7: Sample location summary

AS4323.1	Sample location	BV150
	Stack Shape	CIRCULAR
	Ideal Sampling Plane Assessment	
	Stack Diameter (m)	0.6
	Stack Cross Section Area (m^2)	0.28
	Distance to upstream disturbance (m) (from disturbance)	0.7
	Upstream Diameters (D)	1.1
	Distance to downstream disturbance (m) (from disturbance)	1.3
	Downstream diameters (D)	2.2
4.2.2 Table 1	Meets Requirements AS4323.1 Table 1	No
	Non-deal Sampling Plane Assessment	
	Assessment required?	No
	Total traverse point factors	1.21
	Non-conforming Sampling Plane Assessment	
4.2.2(a)	Gas flow in same direction	Yes
4.2.2(b)	Gas flow steady & evenly distributed (cyclonic or swirl <15º)	Yes
4.2.2(c)	Temperature difference between points <10%, and each point <10% of average	Yes
4.2.2(d)	Ratio of highest to lowest differential pressure & ratio highest to lowest velocity	6.5 2.6
4.2.2(e)	Minimum differential pressure	0.20
	Gas temperature above dewpoint	No
	Samling Plane Type	
4.2.2, 4.2.3, 4.2.4	Samling plane type	Non-conforming
	Alternative sampling plane available?	No
	Number of Sample Points Adopted	
	Port size (mm)	100
	Port Thread Type	BSP
	Number of traverses	2
	Number of points per traverse	6
	Total number of traverse points	12
	Flow & temperature compliance check	No

2.4 Test equipment

The sampling equipment was transported to site and specifically setup at the test location. Sampling was performed using heated probes and filters, with a constant flow and isokinetic sample console.

Equipment used during the course of the testing is sourced from Apex Instruments and Testo, industry leaders in the supply of source testing equipment.

Figure 2: Manual sample equipment

Figure 3: Combustion gas analyser

3 MEASUREMENT UNCERTAINTY

There is an inherent uncertainty associated with any scientific measurement, including stack emissions monitoring. The measurement uncertainty can be controlled with strict adherence to the reference methodology along with utilising appropriate calibration standards with corresponding acceptable uncertainty reports.

Many source sampling methods do not outline exact procedures for establishing direct measurement uncertainty. In the absence of a defined procedure, the uncertainty budgets presented are based on estimations using ISO-GUM method.

Each individual source and test may have a unique associated uncertainty, due largely to the stack sample location in relation to the positioning requirements of AS4323.1.

Table 8: Sample specific uncertainty budgets

Parameter	Reference method	Limit of measurement	Unit of measure	Uncertainty ± %
Flue gas velocity	USEPA Method 2	3	m/sec	20
Oxygen	USEPA Method 3A	0.3	%-vol	5.0
Carbon dioxide	USEPA Method 3A	0.3	%-vol	10
Water vapour content	USEPA Method 4	0.5	%-vol	5.0
Sulphur dioxide	USEPA Method 6	2.0	mg/sample	15
Oxides of nitrogen (as NO_2)	USEPA Method 7E	2.1	mg/sample	15
Sulfuric acid mists	USEPA Method 8	2.0	mg/sample	15
Carbon monoxide	USEPA Method 10	1.5	mg/sample	15
Hydrogen sulfide	USEPA Method 15	1.0	mg/sample	20
Total VOCs	USEPA Method 18	1.0	mg/sample	20
Hydrogen chloride	USEPA Method 26A	1.0	mg/sample	15
Chlorine	USEPA Method 26A	1.0	mg/sample	15
Fluoride (as HF)	USEPA Method 13B	1.0	mg/sample	15
Heavy metals	USEPA Method 29	0.3 to 50	µg/sample	20
PFAS – suite	USEPA SW846 Method 0010	1 to 50	ng/sample	25
Dioxins & furans	USEPA SW846 Method 0010	1	pg/sample	15
Polychlorinated biphenyls	USEPA SW846 Method 0010	20	pg/sample	15
Ammonia	Modified USEPA Method 26	1	mg/sample	25
Odour	AS4323.3	100	ou	40

4 QUALITY ASSURANCE & QUALITY CONTROL (QA/QC)

AE operates within a quality system based upon the requirements of ISO17025. Our quality system defines specific procedures and methodologies to ensure any project undertaken by AE is conducted with the highest level of quality given the specific confines of each project. The overall objective of our QA/QC procedures is to representatively sample and accurately analyse components in the gas streams and therefore report valid measurements of emission concentrations.

To ensure <u>representativeness of field work</u>, our quality procedures target:

1. Correct sampling locations
2. Sample time
3. Frequency of samples and
4. Method selection & adherence

To ensure <u>representativeness of lab work</u>, our quality procedures target:

1. Sample preservation
2. Chain of custody (COC)
3. Sample preparation and
4. Analytical techniques

AE maintains strict quality assurance throughout all its sampling programs, covering on-site 'field work' and the analytical phase of our projects. Our QA program covers the calibration of all sampling and analytical apparatus where applicable and the use of spikes, replicate sample and reference standards. The test methodologies used for this project are outlined in section 2 of this document. Field test data has been recorded and calculated using direct entry into Microsoft Excel spreadsheets following the procedures of the appropriate test methods. Determination of emission concentrations has been performed using the same Microsoft Excel spreadsheets which are partially supplied as an attachment to this report. More detailed information can be supplied upon request.

QA/QC checks for this project will use validation techniques and criteria appropriate to the type of data and the purpose of the measurement to approve the test report. Records of all data will be maintained. Complete chain of custody (COC) procedures have been followed to document the entire custodial history of each sample. The COC forms also served as a laboratory sheet detailing sample ID and analysis requirements.

Table 9: Sampling data QA/QC checklist

Sampling Data QA/QC Checklist	Comment
Use of appropriate test methods	Yes
'Normal' operation of the process being tested	Yes – as instructed by client
Use of properly operating and calibrated test equipment	Yes
Use of high purity reagents	Yes
Performance of leak checks post sample (at least)	Yes

Table 10: Laboratory data QA/QC checklist

Laboratory Data QA/QC Checklist	Comment
Use of appropriate analytical methods	Yes
Use of properly operating and calibrated analytical equipment	Yes
Precision and accuracy comparable to that achieved in similar projects	Yes
Accurate reporting	Yes

Table 11: Olfactometer QA data

Item	Comment
Methodology	AS/NZ4323.3:2001 "determination of odour concentration by dynamic olfactometry".
Sample Media	Odour samples collected into Nalophan™ sample bags
Sample identification	All samples are labelled uniquely immediately following collection according to Assured Environmental identification procedure. Each sample has the following recorded: project ID, sample number, location, date, time, dilution and any deviations to AS/NZ4323.3.
Timing	All measurements were conducted within 30 hours of sampling as specified by AS/NZ4323.3
Traceability	All panel results are traceable to reference standards held by Assured Environmental
Analysis conditions	Room temperature maintained at 22 °C ± 3 °C
Odour panel location	7/142 Tennyson Memorial Avenue Tennyson, Qld. 4105
Reference odourant	40 ppm n-butanol
Odour panel threshold	100 ou

4.1 PFAS quality control

The recoveries of surrogate standards from the sampling and analysis are presented in the table below. The expected QC recovery for measurements in the ppb to ppt levels is in the range of 60 to 120%. The results are not corrected for the recovery efficiency.

Table 12: PFAS surrogate recovery (%)

Surrogate	PFAS	
	Filter	Trap
Field surrogate		
Surrogate $^{13}C_8$ PFOS	97	65
Surrogate $^{13}C_2$ PFOA	102	115

Analysis of the final bubbler containing a sodium borate solution was performed separately to the front of the sampling train in order to assess the potential for breakthrough. The results of this analysis are provided below.

Table 13: Breakthrough analysis

Perfluorinated surfactants	Abbreviation	Breakthrough analysis (ng/Nm^3)	
Perfluorobutanesulfonic acid	PFBS	<	0.1
Perfluoropentanesulfonic acid	PFPeS	<	0.1
Perfluorohexanesulfonic acid	PFHxS	<	0.1
Perfluoroheptanesulfonic acid	PFHpS	<	0.1
Perfluorooctanesulfonic acid PFOS	PFOS	<	0.3
Perfluorodecanesulfonic acid	PFDS	<	0.3
Perfluorobutanoic acid	PFBA	<	0.3
Perfluoropentanoic acid	PFPeA	<	0.3
Perfluorohexanoic acid	PFHxA	<	0.1
Perfluoroheptanoic acid	PFHpA	<	0.1
Perfluorooctanoic acid PFOA	PFOA	<	0.1
Perfluorononanoic acid	PFNA		0.7
Perfluorodecanoic acid	PFDA	<	0.7
Perfluoroundecanoic acid	PFUdA	<	1.3
Perfluorododecanoic acid	PFDoA	<	0.7
Perfluorotridecanoic acid	PFTrDA	<	0.7
Perfluorotetradecanoic acid	PFTeDA	<	3.3
4:2 FTS	4:2 FTS	<	0.1
6:2 FTS	6:2 FTS	<	0.1
8:2 FTS	8:2 FTS	<	0.3
10:2 FTS	10:2 FTS	<	0.3
Perfluorooctane sulfonamide	FOSA	<	0.7
N-Methyl perfluorooctanesulfonamide	N-MeFOSA	<	0.7
N-Ethyl perfluorooctanesulfonamide	n-EtFOSA	<	0.7
N-Me perfluorooctanesulfonamidoethanol	n-MeFOSE	<	0.7
N-Et perfluorooctanesulfonamidoethanol	n-EtFOSE	<	33
MePerfluorooctanesulf-amidoacetic acid	N-MeFOSAA	<	0.3
EtPerfluorooctanesulf-amidoacetic acid	N-EtFOSAA	<	0.3

The breakthrough analysis showed PFNA present at low levels (0.7 ng/Nm^3 or 17%) in the sample.

Analysis of the field sample blank (project 13633) showed that only a small amount of PFOA was detectable in the methanol/XAD resin. The table below shows the results of the blank analysis.

Table 14: Field blank analysis

Perfluorinated surfactants - PFAS suite	Blank analysis Front half ng/sample	Resin Traps ng/sample	Breakthrough ng/sample
Perfluorobutanesulfonic acid	< 0.2	< 0.2	< 0.2
Perfluoropentane sulfonic acid (PFPeS)	< 0.2	< 0.2	< 0.2
Perfluorohexane sulfonate (PFHxS)	< 0.2	< 0.2	< 0.2
Perfluoroheptane sulfonate (PFHpS)	< 0.2	< 0.2	< 0.2
Perfluorooctane sulfonate (PFOS)	< 0.2	< 0.2	< 0.2
Perfluorodecanesulfonic acid (PFDS)	< 0.4	< 0.4	< 0.4
Perfluorobutanoic acid	< 0.4	< 0.4	< 0.4
Perfluoropentanoic acid (PFPeA)	< 0.4	< 0.4	< 0.4
Perfluorohexanoic acid (PFHxA)	< 0.2	< 0.2	< 0.2
Perfluoroheptanoic acid (PFHpA)	< 0.2	< 0.2	< 0.2
Perfluorooctanoic acid (PFOA)	< 0.2	**2.3**	< 0.2
Perfluorononanoic acid (PFNA)	< 0.2	< 0.2	< 0.2
Perfluorodecanoic acid	< 1.0	< 1.0	< 1.0
Perfluoroundecanoic acid (PFUnA)	< 1.0	< 1.0	< 1.0
Perfluorododecanoic acid (PFDoA)	< 1.0	< 1.0	< 1.0
Perfluorotridecanoic acid (PFTrDA)	< 1.0	< 1.0	< 1.0
Perfluorotetradecanoic acid (PFTeDA)	< 5.0	< 5.0	< 5.0
4:2 Flurotelomersulphonate	< 0.2	< 0.2	< 0.2
6:2 Fluorotelomersulphonate	< 0.2	< 0.2	< 0.2
8:2 Fluorotelomersulphonate	< 0.4	< 0.4	< 0.4
10:2 Fluorotelomersulphonate	< 0.4	< 0.4	< 0.4
Perfluorooctane sulfonamide	< 1.0	< 1.0	< 1.0
N-Methyl-heptadecafluorooctane sulphonamide	< 1.0	< 1.0	< 1.0
N-Ethyl-heptadecafluorooctane sulphonamide	< 1.0	< 1.0	< 1.0
N-Me perfluorooctanesulfonamid oethanol	< 1.0	< 1.0	< 1.0
N-Et perfluorooctanesulfonamid oethanol	< 50	< 50	< 50
N-Methylperfluorooctane sulphonamidoacetic acid	< 0.4	< 0.4	< 0.4
N-Ethyl-perfluorooctane sulphonamidoacetic acid	< 0.4	< 0.4	< 0.4

4.2 Dioxins and furans QA

During sample analysis, the laboratory uses $^{13}C_{12}$ labelled dioxin, furan and PCB surrogates to test sample recovery efficiency and possible sample matrix interference.

During this analysis, the laboratory surrogate recovery for all dioxin, furan and PCB congeners was within acceptable ranges.

5 DEFINITIONS

The following terms and abbreviations may be used in this report:

Table 15: Definitions

Symbol	Definition
<	The analytes tested for was not detected; the value stated is the reportable limit of detection
Am^3	Gas volume in cubic metres at measured conditions
AS	Australian Standard
BH	Back half of sample train (filter holder and impingers) (referred to during sample recovery)
ºC	Degrees Celsius
CARB	California Air Resources Board methods
dscm	dry standard cubic meters
FH	Front half of sample train (probe and filter holder) (referred to during sample recovery)
g	Grams
Heavy metals	Sum of Antimony, Arsenic, Beryllium, Cadmium, Chromium, Cobalt, Lead, Manganese, Nickle, Selenium, Tin, Vanadium & Mercury. Also known as Type 1 and Type 2 hazardous substances. Total heavy metals refers only to those metals found in the sample and does not include limit of detection values.
kg	Kilograms
Lower range	The sum of a list of a particular group of compounds, where only those individual congeners/compounds that are detectable in the sample have been included in the total. Results below the limit of detection have not been included. Unless otherwise indicated, the lower range is reported for dioxins & furans, PCBs, heavy metals and PFAS analysis suites.
m	Metres
m^3	actual gas volume in cubic metres as measured
mbar	Millibars
mg	Milligrams (10^{-3} grams)
min	Minute
ml	Millilitres
mmH_2O	Millimetres of water
Mole	SI unit that measures the amount of substance
N/A	Not applicable
ng	Nanograms (10^{-9} grams)
Nm^3	Gas volume in dry cubic metres at standard temperature and pressure (0°C and 101.3 kPa)
NMI	National Measurement Institute
NM VOC	Non methane volatile organic compound
NR	Not required on this occasion
ou	Odour unit
PM	Particulate matter
ppb	Parts per billion
ppm	Parts per million
sec	Second
Sm^3	Gas volume in dry cubic metres at standard temperature and pressure (0°C and 101.3 kPa) and corrected to a standardised value (e.g. 15% O_2)
STP	Standard temperature and pressure (0°C and 101.3 kPa) & dry
USEPA	United States Environmental Protection Authority

6 RESULTS

Table 16: Sample information – PFAS

Site		Shaolbay Landfill	
Sample Location		BV150	
Reference Method		USEPA Method 0010 - ISOKINETIC	
Run ID		8	
Test Parameter		PFAS	
Test Date	dd/mm/yyyy	9/08/2022	
Start Time	hh:mm	8:39	
End Time	hh:mm	11:41	
Average Stack Temperature	°C	81	
Absolute Stack Pressure	mb	1012	
Moisture Content	% v/v	47.9	
Dry Gas Density	kg/Nm^3	1.32	
Dry Gas Molecular Weight	g/g-mole	29.6	
Sample Volume (dry gas meter)	Nm^3	1.51	
Stack Gas Velocity	m/sec	2.9	
Actual Stack Flow Rate	m^3/min	50	
Dry Standard Stack Flow Rate	Nm^3/min	20	
Percent Isokinetic Rate	%	90	
Pollutant PFAS species	Licence limit ng/Nm^3	standard conditions Concentration ng/Nm^3	Emission Rate g/min
Perfluorobutanesulfonic acid	-	239	4.81E-06
Perfluoropentanesulfonic acid	-	3.5	6.97E-08
Perfluorohexanesulfonic acid	-	44	8.86E-07
Perfluoroheptanesulfonic acid	-	1.8	3.64E-08
Perfluorooctanesulfonic acid PFOS	-	43	8.74E-07
Perfluorodecanesulfonic acid	-	< 2.7	< 5.39E-08
Perfluorobutanoic acid	-	6	1.20E-07
Perfluoropentanoic acid	-	60	1.21E-06
Perfluorohexanoic acid	-	96	1.92E-06
Perfluoroheptanoic acid	-	23	4.69E-07
Perfluorooctanoic acid PFOA	-	94	1.88E-06
Perfluorononanoic acid	-	4.6	9.20E-08
Perfluorodecanoic acid	-	6.2	1.26E-07
Perfluoroundecanoic acid	-	< 6.8	< 1.37E-07
Perfluorododecanoic acid	-	< 6.7	< 1.35E-07
Perfluorotridecanoic acid	-	< 6.7	< 1.35E-07
Perfluorotetradecanoic acid	-	< 33	< 6.73E-07
4:2 FTS	-	< 1.3	< 2.69E-08
6:2 FTS	-	37	7.48E-07
8:2 FTS	-	3.7	7.42E-08
10:2 FTS	-	< 2.7	< 5.39E-08
Perfluorooctane sulfonamide	-	< 6.7	< 1.35E-07
N-Methyl perfluorooctane sulfonamide	-	< 6.7	< 1.35E-07
N-Ethyl perfluorooctanesulfonamide	-	< 6.7	< 1.35E-07
N-Me perfluorooctanesulfonamidoethanol	-	16	3.21E-07
N-Et perfluorooctanesulfonamidoethanol	-	< 81	< 1.63E-06
MePerfluorooctanesulf-amido acetic acid	-	5.7	1.14E-07
EtPerfluorooctanesulf-amido acetic acid	-	4.4	8.75E-08
TOTAL			
Sum of positive detections	-	689	1.38E-05

Table 17: Sample information – Odour

Site		Shaolbay Landfill	
Sample Location		BV150	
Reference Method		AS4323.3 - CONSTANT FLOW	
Run ID		9	
Test Parameter		Odour	
Test Date	dd/mm/yyyy	10/08/2022	
Start Time	hh:mm	8:00	
End Time	hh:mm	8:10	
Average Stack Temperature	°C	80	
Absolute Stack Pressure	mb	1012	
Moisture Content	% v/v	45.8	
Dry Gas Density	kg/Nm^3	1.33	
Dry Gas Molecular Weight	g/g-mole	29.8	
Sample Volume (dry gas meter)	Nm^3	-	
Stack Gas Velocity	m/sec	3.7	
Actual Stack Flow Rate	m^3/min	63	
Dry Standard Stack Flow Rate	Nm^3/min	26	
Percent Isokinetic Rate	%	N/A	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
Odour	ou	ou	ou.m^3/min
Odour Sample 1	-	7,962	387,262
Odour Sample 2	-	8,939	434,749
Average Odour	-	8,450	411,005

Table 18: Sample information – Hydrogen sulfide

Site		Shaolbay Landfill	
Sample Location		BV150	
Reference Method		AS4323.3 - CONSTANT FLOW	
Run ID		10	
Test Parameter		H_2S	
Test Date	dd/mm/yyyy	10/08/2022	
Start Time	hh:mm	8:20	
End Time	hh:mm	8:25	
Average Stack Temperature	°C	80	
Absolute Stack Pressure	mb	1012	
Moisture Content	% v/v	45.8	
Dry Gas Density	kg/Nm^3	1.33	
Dry Gas Molecular Weight	g/g-mole	29.8	
Sample Volume (dry gas meter)	Nm^3	-	
Stack Gas Velocity	m/sec	3.7	
Actual Stack Flow Rate	m^3/min	63	
Dry Standard Stack Flow Rate	Nm^3/min	26	
Percent Isokinetic Rate	%	N/A	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
Odour	mg/Nm^3	mg/Nm^3	g/min
Hydrogen sulfide	5	< 1.6	< 0.03

Table 19: Sample information – Oxides of Sulfur

Site		Shaolbay Landfill	
Sample Location		BV150	
Reference Method		USEPA Method 8 - ISOKINETIC	
Run ID		5	
Test Parameter		SOx	
Test Date	dd/mm/yyyy	8/08/2022	
Start Time	hh:mm	13:48	
End Time	hh:mm	14:51	
Average Stack Temperature	°C	80	
Absolute Stack Pressure	mb	1011	
Moisture Content	% v/v	46.9	
Dry Gas Density	kg/Nm^3	1.32	
Dry Gas Molecular Weight	g/g-mole	29.6	
Sample Volume (dry gas meter)	Nm^3	0.46	
Stack Gas Velocity	m/sec	2.7	
Actual Stack Flow Rate	m^3/min	47	
Dry Standard Stack Flow Rate	Nm^3/min	19	
Percent Isokinetic Rate	%	92	
Pollutant SOx	Licence limit mg/Nm^3	standard conditions Concentration mg/Nm^3	Emission Rate g/min
SO_2	-	< 2.2	< 0.04
SO_3 (as H_2SO_4)	100	< 2.2	< 0.04

Table 20: Sample information – Acid gases

Site		Shaolbay Landfill	
Sample Location		BV150	
Reference Method		USEPA Method 26A - ISOKINETIC	
Run ID		3	
Test Parameter		Acid Gases	
Test Date	dd/mm/yyyy	9/08/2022	
Start Time	hh:mm	13:33	
End Time	hh:mm	14:35	
Average Stack Temperature	°C	81	
Absolute Stack Pressure	mb	1012	
Moisture Content	% v/v	50.4	
Dry Gas Density	kg/Nm^3	1.32	
Dry Gas Molecular Weight	g/g-mole	29.6	
Sample Volume (dry gas meter)	Nm^3	0.62	
Stack Gas Velocity	m/sec	3.8	
Actual Stack Flow Rate	m^3/min	64	
Dry Standard Stack Flow Rate	Nm^3/min	24	
Percent Isokinetic Rate	%	97	
Pollutant Acid Gases	Licence limit mg/Nm^3	standard conditions Concentration mg/Nm^3	Emission Rate g/min
HCl	100	< 1.6	< 0.04
Cl_2	200	< 1.6	< 0.04

Table 21: Sample information – Heavy metals

Site		Shaolbay Landfill	
Sample Location		BV150	
Reference Method		USEPA Method 29 - ISOKINETIC	
Run ID		2	
Test Parameter		Metals	
Test Date	dd/mm/yyyy	9/08/2022	
Start Time	hh:mm	13:31	
End Time	hh:mm	15:33	
Average Stack Temperature	°C	80	
Absolute Stack Pressure	mb	1012	
Moisture Content	% v/v	45.8	
Dry Gas Density	kg/Nm^3	1.32	
Dry Gas Molecular Weight	g/g-mole	29.6	
Sample Volume (dry gas meter)	Nm^3	1.32	
Stack Gas Velocity	m/sec	3.7	
Actual Stack Flow Rate	m^3/min	63	
Dry Standard Stack Flow Rate	Nm^3/min	26	
Percent Isokinetic Rate	%	90	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
Metals	µg/Nm^3	µg/Nm^3	g/min
Antimony	-	< 4.3	< 1.1E-04
Arsenic	-	< 4.3	< 1.1E-04
Beryllium	-	< 0.3	< 8.5E-06
Cadmium	200	0.6	1.6E-05
Chromium	-	3.2	8.4E-05
Cobalt	-	< 0.3	< 8.5E-06
Lead	-	161	4.3E-03
Manganese	-	3.5	9.2E-05
Nickel	-	9	2.4E-04
Selenium	-	< 4.3	< 1.1E-04
Tin	-	< 11	< 2.8E-04
Vanadium	-	< 5.4	< 1.4E-04
Mercury	200	0.1	3.2E-06
Total Heavy Metals (lower bound)	1,000	177	4.7E-03

Table 22: Sample information – Volatile organic compounds

Site		Shaolbay Landfill
Sample Location		BV150
Reference Method		USEPA Method 18 - CONSTANT FLOW
Run ID		6
Test Parameter		VOCs
Test Date	dd/mm/yyyy	9/08/2022
Start Time	hh:mm	10:44
End Time	hh:mm	11:44
Average Stack Temperature	°C	81
Absolute Stack Pressure	mb	1012
Moisture Content	% v/v	48.9
Dry Gas Density	kg/Nm^3	1.32
Dry Gas Molecular Weight	g/g-mole	29.6
Sample Volume (dry gas meter)	Nm^3	0.03
Stack Gas Velocity	m/sec	2.9
Actual Stack Flow Rate	m^3/min	49
Dry Standard Stack Flow Rate	Nm^3/min	19
Percent Isokinetic Rate	%	N/A

		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
Total (non-methane) VOCs	mg/Nm^3	mg/Nm^3	g/min
Total VOCs - as n-hexane	-	< 1.7	< 0.03
Total VOCs - as n-propane	40	< 0.8	< 0.02

Table 23: Sample information – Ammonia

Site		Shaolbay Landfill
Sample Location		BV150
Reference Method		USEPA Method Mod 6 - CONSTANT FLOW
Run ID		7
Test Parameter		NH_3
Test Date	dd/mm/yyyy	9/08/2022
Start Time	hh:mm	9:20
End Time	hh:mm	10:20
Average Stack Temperature	°C	81
Absolute Stack Pressure	mb	1012
Moisture Content	% v/v	48.9
Dry Gas Density	kg/Nm^3	1.32
Dry Gas Molecular Weight	g/g-mole	29.5
Sample Volume (dry gas meter)	Nm^3	0.05
Stack Gas Velocity	m/sec	2.9
Actual Stack Flow Rate	m^3/min	49
Dry Standard Stack Flow Rate	Nm^3/min	19
Percent Isokinetic Rate	%	N/A

		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
NH3	mg/Nm^3	mg/Nm^3	g/min
Ammonia (NH_3) - in condensate	-	1,117	21.6
Ammonia (NH_3) - gaseous	-	134	2.6
Total Ammonia (as NH_3)	-	1,251	24.1

Table 24: Sample information – Fluoride

Site		Shaolbay Landfill	
Sample Location		BV150	
Reference Method		USEPA Method 13B - ISOKINETIC	
Run ID		4	
Test Parameter		F	
Test Date	dd/mm/yyyy	8/08/2022	
Start Time	hh:mm	13:47	
End Time	hh:mm	14:50	
Average Stack Temperature	°C	80	
Absolute Stack Pressure	mb	1011	
Moisture Content	% v/v	45.8	
Dry Gas Density	kg/Nm^3	1.32	
Dry Gas Molecular Weight	g/g-mole	29.6	
Sample Volume (dry gas meter)	Nm^3	0.48	
Stack Gas Velocity	m/sec	2.7	
Actual Stack Flow Rate	m^3/min	46	
Dry Standard Stack Flow Rate	Nm^3/min	19	
Percent Isokinetic Rate	%	89	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
F	mg/Nm^3	mg/Nm^3	g/min
Fluorine - (as total HF)	50	< 2.2	< 0.04

Table 25: Sample information – Combustion gases

Site		Shaolbay Landfill
Sample Location		BV150
Reference Method		USEPA Method 3A, 7E & 10
Run ID		Various
Test Parameter		O_2, CO_2, NOx, CO
Test Date	dd/mm/yyyy	8/08/2022
Start Time	hh:mm	13:48
End Time	hh:mm	14:35
Average Stack Temperature	°C	80
Absolute Stack Pressure	mb	1011
Moisture Content	% v/v	47.6
Dry Gas Density	kg/Nm^3	1.32
Dry Gas Molecular Weight	g/g-mole	29.6
Stack Gas Velocity	m/sec	3.2
Actual Stack Flow Rate	m^3/min	54
Dry Standard Stack Flow Rate	Nm^3/min	22

		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
O_2, CO_2, NOx, CO	STP	STP	g/min
Oxygen (% v/v)	-	11.1	-
Carbon dioxide (% v/v)	-	7.1	-
Carbon monoxide (mg/m^3)	125	49	1.0
Oxides of nitrogen (mg/m^3)	350	52	1.1

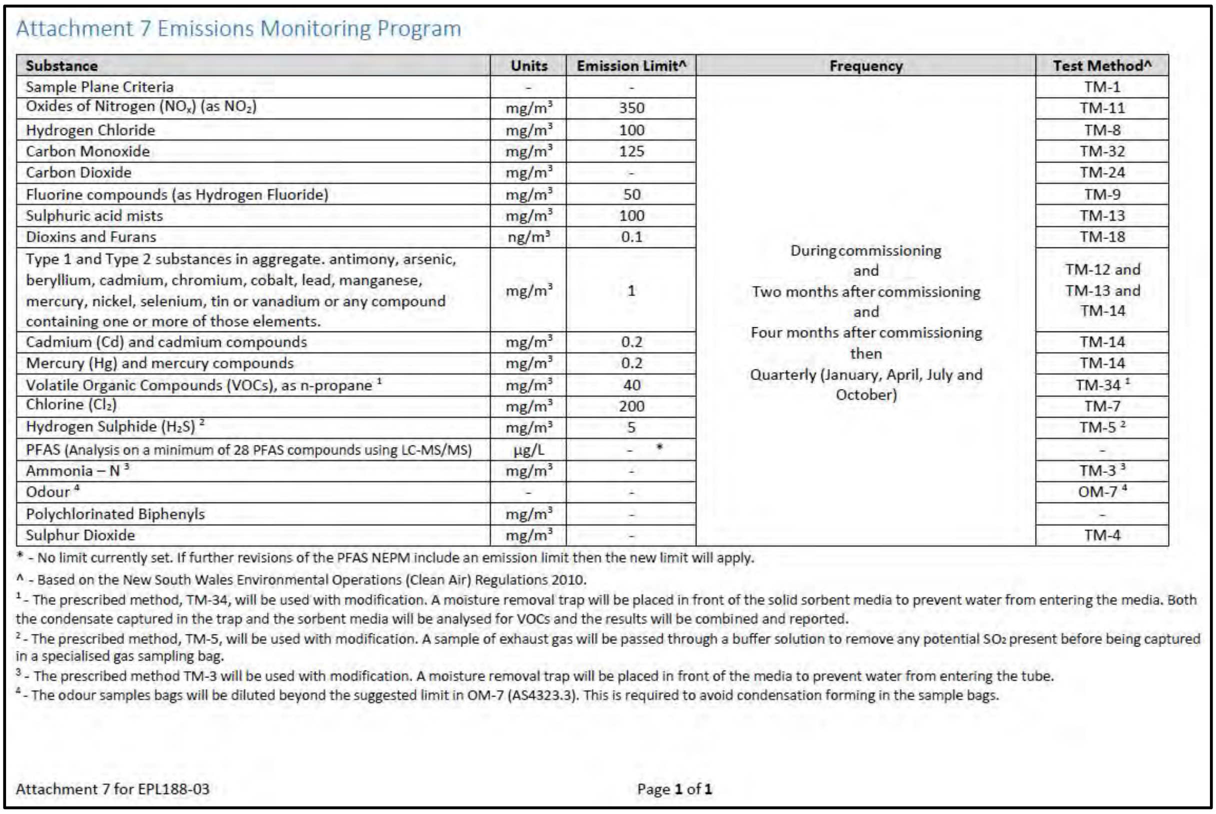
Table 26: Sample information – Dioxins & furans

Site		Shaolbay Landfill	
Sample Location		BV150	
Reference Method		USEPA Method 23 - ISOKINETIC	
Run ID		1	
Test Parameter		DF & PCB	
Test Date	dd/mm/yyyy	9/08/2022	
Start Time	hh:mm	8:41	
End Time	hh:mm	11:43	
Average Stack Temperature	°C	81	
Absolute Stack Pressure	mb	1012	
Moisture Content	% v/v	48.9	
Dry Gas Density	kg/Nm^3	1.32	
Dry Gas Molecular Weight	g/g-mole	29.6	
Sample Volume (dry gas meter)	Nm^3	1.37	
Stack Gas Velocity	m/sec	2.9	
Actual Stack Flow Rate	m^3/min	49	
Dry Standard Stack Flow Rate	Nm^3/min	19	
Percent Isokinetic Rate	%	90	
Pollutant DF & PCB	Licence limit ng/Nm^3	standard conditions Concentration ng/Nm^3	Emission Rate g/min
2378 TCDF	-	0.0044	8.6E-11
Total TCDF isomers	-	0.044	8.6E-10
2378 TCDD	-	< 0.0015	< 2.8E-11
Total TCDD isomers	-	0.010	2.0E-10
12378 PeCDF	-	< 0.0015	< 2.8E-11
23478 PeCDF	-	0.0028	5.5E-11
Total PeCDF isomers	-	0.020	3.9E-10
12378 PeCDD	-	< 0.0015	< 2.8E-11
Total PeCDD isomers	-	0.0069	1.3E-10
123478 HxCDF	-	< 0.0015	< 2.8E-11
123678 HxCDF	-	0.0018	3.4E-11
234678 HxCDF	-	0.0021	4.1E-11
123789 HxCDF	-	< 0.0015	< 2.8E-11
Total HxCDF isomers	-	0.012	2.4E-10
123478 HxCDD	-	< 0.0015	< 2.8E-11
123678 HxCDD	-	< 0.0015	< 2.8E-11
123789 HxCDD	-	< 0.0015	< 2.8E-11
Total HxCDD isomers	-	0.011	2.1E-10
1234678 HpCDF	-	0.0036	7.0E-11
1234789 HpCDF	-	< 0.00073	< 1.4E-11
Total HpCDF isomers	-	0.0063	1.2E-10
1234678 HpCDD	-	0.014	2.7E-10
Total HpCDD isomers	-	0.025	4.8E-10
OCDF	-	0.0025	4.8E-11
OCDD	-	0.046	8.9E-10
Sum of congeners			
Sum of positive detections	-	0.18	3.6E-09
Total I-TEQ			
Sum of positive detections	0.1	0.0025	4.8E-11

Table 27: Sample information – PCBs

PCBs (USEPA Method 23)					
		standard conditions			
PCBs	Licence limit		Concentration		Emission Rate
	ng/Nm^3		ng/Nm^3		g/min
PCB#77	-		0.51		9.9E-09
PCB#81	-		0.020		3.9E-10
PCB#126	-		0.018		3.4E-10
PCB#169	-	<	0.0015	<	2.8E-11
PCB#105	-		1.5		3.0E-08
PCB#114	-		0.11		2.1E-09
PCB#118	-		3.7		7.2E-08
PCB#123	-		0.059		1.1E-09
PCB#156	-		0.39		7.6E-09
PCB#157	-		0.080		1.5E-09
PCB#167	-		0.14		2.7E-09
PCB#189	-		0.013		2.5E-10
Sum of PCB Congeners					
Sum of positive detections	-		6.6		1.3E-07
Total TEQ					
Sum of positive detections	-		0.0020		3.8E-11

7 APPENDIX



Attachment 7 Emissions Monitoring Program

Substance	Units	Emission Limit^	Frequency	Test Method^
Sample Plane Criteria	-	-	During commissioning and Two months after commissioning and Four months after commissioning then Quarterly (January, April, July and October)	TM-1
Oxides of Nitrogen (NO_x) (as NO_2)	mg/m^3	350		TM-11
Hydrogen Chloride	mg/m^3	100		TM-8
Carbon Monoxide	mg/m^3	125		TM-32
Carbon Dioxide	mg/m^3	-		TM-24
Fluorine compounds (as Hydrogen Fluoride)	mg/m^3	50		TM-9
Sulphuric acid mists	mg/m^3	100		TM-13
Dioxins and Furans	ng/m^3	0.1		TM-18
Type 1 and Type 2 substances in aggregate. antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, manganese, mercury, nickel, selenium, tin or vanadium or any compound containing one or more of those elements.	mg/m^3	1		TM-12 and TM-13 and TM-14
Cadmium (Cd) and cadmium compounds	mg/m^3	0.2		TM-14
Mercury (Hg) and mercury compounds	mg/m^3	0.2		TM-14
Volatile Organic Compounds (VOCs), as n-propane [1]	mg/m^3	40		TM-34 [1]
Chlorine (Cl_2)	mg/m^3	200		TM-7
Hydrogen Sulphide (H_2S) [2]	mg/m^3	5		TM-5 [2]
PFAS (Analysis on a minimum of 28 PFAS compounds using LC-MS/MS)	µg/L	- *		-
Ammonia – N [3]	mg/m^3	-		TM-3 [3]
Odour [4]	-	-		OM-7 [4]
Polychlorinated Biphenyls	mg/m^3	-		-
Sulphur Dioxide	mg/m^3	-		TM-4

* - No limit currently set. If further revisions of the PFAS NEPM include an emission limit then the new limit will apply.

^ - Based on the New South Wales Environmental Operations (Clean Air) Regulations 2010.

[1] - The prescribed method, TM-34, will be used with modification. A moisture removal trap will be placed in front of the solid sorbent media to prevent water from entering the media. Both the condensate captured in the trap and the sorbent media will be analysed for VOCs and the results will be combined and reported.

[2] - The prescribed method, TM-5, will be used with modification. A sample of exhaust gas will be passed through a buffer solution to remove any potential SO_2 present before being captured in a specialised gas sampling bag.

[3] - The prescribed method TM-3 will be used with modification. A moisture removal trap will be placed in front of the media to prevent water from entering the tube.

[4] - The odour samples bags will be diluted beyond the suggested limit in OM-7 (AS4323.3). This is required to avoid condensation forming in the sample bags.

Attachment 7 for EPL188-03 Page **1** of **1**

Figure 4: Excerpt from EPL188-03 – Attachment 7

ASSURED ENVIRONMENTAL PTY LTD

Your environmental compliance partner

AUGUST 2022

SOURCE EMISSIONS MONITORING – SHOAL BAY BENEVAP 300

CLIENT: BENETERRA
PROJECT ID: 14326
DATE: 6/10/2022 RELEASE: R_0

DOCUMENT CONTROL PAGE

Project Title: Source Emissions Monitoring – Shoal Bay BeneVap 300

Project Reference ID: 14326

Report Prepared by:

Assured Environmental
Unit 7, 142 Tennyson Memorial Avenue
Tennyson, QLD, 4105
ABN: 87 604 851 078

Report Prepared for:

BeneTerra
Shoal Bay Access Road
Karama NT 0812

Report Author: Timon Berger

Report Reviewer: Adam Dixon

Table 1: History of Revisions

Revision	Date	Issued to	Changes
R_0	6/10/2022	N. Sharma	Formal report release
DRAFT_0	23/09/2022	N. Sharma	Draft release for comment.

ACCREDITED FOR COMPLIANCE TO ISO/IEC 17025 (TESTING)

The results of the tests, calibrations and/or measurements included in this document is traceable to Australian/national standards.

Accreditation number: 19703

NATA
WORLD RECOGNISED
ACCREDITATION
NATA ID: 19703

DISCLAIMER

Assured Environmental acts in all professional matters as a faithful advisor to the Client and exercises all reasonable skill and care in the provision of its professional services.

Reports are commissioned by and prepared for the exclusive use of the Client. They are subject to and issued in accordance with the agreement between the Client and Assured Environmental. Assured Environmental is not responsible for any liability and accepts no responsibility whatsoever arising from the misapplication or misinterpretation by third parties of the contents of its reports.

Except where expressly stated, Assured Environmental does not attempt to verify the accuracy, validity or comprehensiveness of any information supplied to Assured Environmental for its reports.

Reports cannot be copied or reproduced in whole or part for any purpose without the prior written agreement of Assured Environmental.

Where site inspections, testing or fieldwork have taken place, the report is based on the information made available by the client or their nominees during the visit, visual observations and any subsequent discussions with regulatory authorities. The validity and comprehensiveness of supplied information has not been independently verified and, for the purposes of this report, it is assumed that the information provided to Assured Environmental is both complete and accurate. It is further assumed that normal activities were being undertaken at the site on the day of the site visit(s), unless explicitly stated otherwise.

EXECUTIVE SUMMARY

Assured Environmental (AE) conducted source emissions monitoring from the mobile BeneVap Leachate Treatment Facility (BV300) located at the Shoal Bay Waste Facility in Darwin, Northern Territory from 6th to 10th August 2022.

A summary of results and comparison against compliance levels is presented in Table 2 and Table 3 below from the testing conducted on both release points of the BV300 unit.

In comparison to the emission limits outlined in EPL188-03 – Attachment 7, all measured concentrations were within those limits specified. Results are reported at dry, 273.15°K and 101.325 kPa (STP).

Table 2: Summary of measured parameters – Stack 1

Parameter		Result BV300_1	Emission limit	Unit	Reference
Average source temperature		86	-	°C	-
Flue gas water vapour content		62	-	vol-%	-
Carbon dioxide concentration		13.0	-	vol-%	STP - dry
Oxygen concentration		3.8	-	vol-%	STP - dry
Flue gas molecular weight - dry		1.3	-	kg/Nm^3	STP - dry
Flue gas velocity		3.1	-	m/sec	STP - dry
Flue gas volume flow		14.4	-	Nm^3/min	STP - dry
Oxides of nitrogen (as NO_2)		180	350	mg/Nm^3	STP - dry
- emission rate		2.6	-	g/min	
Carbon monoxide		61.5	125	mg/Nm^3	STP - dry
- emission rate		0.88	-	g/min	
Total heavy metals		0.258	1.0	mg/Nm^3	STP - dry
- emission rate		0.0034	-	g/min	
Cadmium		0.0035	0.2	mg/Nm^3	STP - dry
- emission rate		4.7E-05	-	g/min	
Mercury		0.00078	0.2	mg/Nm^3	STP - dry
- emission rate		1.0E-05	-	g/min	
Fluorine (as HF)	<	2.7	50	mg/Nm^3	STP - dry
- emission rate	<	0.034	-	g/min	
Hydrogen chloride	<	2.3	100	mg/Nm^3	STP - dry
- emission rate	<	0.037	-	g/min	
Chlorine	<	2.3	200	mg/Nm^3	STP - dry
- emission rate	<	0.037	-	g/min	
Ammonia (total)		2,317	-	mg/Nm^3	STP - dry
- emission rate		36	-	g/min	
Ammonia (NH3) - in condensate		2,036	-	mg/Nm^3	STP - dry
- emission rate		31	-	g/min	
Ammonia (NH3) - gaseous		281	-	mg/Nm^3	STP - dry
- emission rate		4.3	-	g/min	
Hydrogen sulfide	<	1.1	5	mg/Nm^3	STP - dry
- emission rate	<	0.02	-	g/min	
Sulfur dioxide	<	2.9	-	mg/Nm^3	STP - dry
- emission rate	<	0.04	-	g/min	
Sulfuric acid mist (as H_2SO_4)		2.9	100	mg/Nm^3	STP - dry
- emission rate		0.04	-	g/min	
Total VOCs (as n-propane)	<	0.8	40	mg/Nm^3	STP - dry
- emission rate	<	0.01	-	g/min	
Average odour		9,190	-	ou	STP - wet
- emission rate		364,470	-	ou-m^3/min	
Dioxins & Furans (i-TEQ)		0.0044	0.1	ng/Nm^3	STP - dry
- emission rate		6.8E-11	-	g/min	
PCBs (i-TEQ)		0.0055	-	ng/Nm^3	STP - dry
- emission rate		8.4E-11	-	g/min	

Table 3: Summary of measured parameters – Stack 2

Parameter		Result BV300_2	Emission limit	Unit	Reference
Average source temperature		88	-	°C	-
Flue gas water vapour content		63	-	vol-%	-
Carbon dioxide concentration		13.0	-	vol-%	STP - dry
Oxygen concentration		3.8	-	vol-%	STP - dry
Flue gas molecular weight - dry		1.3	-	kg/Nm^3	STP - dry
Flue gas velocity		2.9	-	m/sec	STP - dry
Flue gas volume flow		13.2	-	Nm^3/min	STP - dry
Oxides of nitrogen (as NO$_2$)		180	350	mg/Nm^3	STP - dry
- emission rate		2.4	-	g/min	
Carbon monoxide		61.1	125	mg/Nm^3	STP - dry
- emission rate		0.9	-	g/min	
Total heavy metals		0.380	1.0	mg/Nm^3	STP - dry
- emission rate		4.9E-03	-	g/min	
Cadmium		0.0032	0.2	mg/Nm^3	STP - dry
- emission rate		4.1E-05	-	g/min	
Mercury		0.00165	0.2	mg/Nm^3	STP - dry
- emission rate		2.1E-05	-	g/min	
Fluorine (as HF)	<	3.0	50	mg/Nm^3	STP - dry
- emission rate	<	0.036	-	g/min	
Hydrogen chloride	<	2.3	100	mg/Nm^3	STP - dry
- emission rate	<	0.035	-	g/min	
Chlorine	<	2.3	200	mg/Nm^3	STP - dry
- emission rate	<	0.035	-	g/min	
Ammonia (total)		2,348	-	mg/Nm^3	STP - dry
- emission rate		32	-	g/min	
Ammonia (NH3) - in condensate		2,205	-	mg/Nm^3	STP - dry
- emission rate		30	-	g/min	
Ammonia (NH3) - gaseous		144	-	mg/Nm^3	STP - dry
- emission rate		1.9	-	g/min	
Hydrogen sulfide	<	1.1	5	mg/Nm^3	STP - dry
- emission rate	<	0.014	-	g/min	
Sulfur dioxide	<	3.4	-	mg/Nm^3	STP - dry
- emission rate	<	0.043	-	g/min	
Sulfuric acid mist (as H$_2$SO$_4$)	<	1.7	100	mg/Nm^3	STP - dry
- emission rate	<	0.022	-	g/min	
Total VOCs (as n-propane)	<	1.1	40	mg/Nm^3	STP - dry
- emission rate	<	0.015	-	g/min	
Average odour		7,759	-	ou	STP - wet
- emission rate		278,282	-	ou-m^3/min	
Dioxins & Furans (i-TEQ)		0.0052	0.1	ng/Nm^3	STP - dry
- emission rate		7.0E-11	-	g/min	
PCBs (i-TEQ)		0.0041	-	ng/Nm^3	STP - dry
- emission rate		5.6E-11	-	g/min	

Table 4: Summary of PFAS results – Stack 1

Parameter		Result ng/Nm^3		Emission Rate g/min	Reference
Per- and polyfluoroalkyl substances				**BV300_1**	
Perfluorobutanesulfonic acid		**1,238**		**1.8E-05**	**STP**
Perfluoropentanesulfonic acid		**13**		**1.9E-07**	**STP**
Perfluorohexanesulfonic acid		**132**		**1.9E-06**	**STP**
Perfluoroheptanesulfonic acid		**6.1**		**8.7E-08**	**STP**
Perfluorooctanesulfonic acid PFOS		**116**		**1.7E-06**	**STP**
Perfluorodecanesulfonic acid	<	3.1	<	4.4E-08	STP
Perfluorobutanoic acid		**30**		**4.2E-07**	**STP**
Perfluoropentanoic acid		**104**		**1.5E-06**	**STP**
Perfluorohexanoic acid		**201**		**2.9E-06**	**STP**
Perfluoroheptanoic acid		**42**		**6.0E-07**	**STP**
Perfluorooctanoic acid PFOA		**155**		**2.2E-06**	**STP**
Perfluorononanoic acid		**6.7**		**9.4E-08**	**STP**
Perfluorodecanoic acid		**14**		**2.0E-07**	**STP**
Perfluoroundecanoic acid	<	9.3	<	1.3E-07	STP
Perfluorododecanoic acid		**8.5**		**1.2E-07**	**STP**
Perfluorotridecanoic acid	<	7.8	<	1.1E-07	STP
Perfluorotetradecanoic acid	<	39.1	<	5.5E-07	STP
4:2 FTS	<	1.6	<	2.2E-08	STP
6:2 FTS		**66**		**9.4E-07**	**STP**
8:2 FTS		**6.4**		**9.1E-08**	**STP**
10:2 FTS	<	3.1	<	4.4E-08	STP
Perfluorooctane sulfonamide	<	7.8	<	1.1E-07	STP
N-Methyl perfluorooctane sulfonamide	<	7.8	<	1.1E-07	STP
N-Ethyl perfluorooctane sulfonamide	<	7.8	<	1.1E-07	STP
N-Me perfluorooctanesulfonamido ethanol		**16**		**2.2E-07**	**STP**
N-Et perfluorooctanesulfonamido ethanol	<	95	<	1.3E-06	STP
MePerfluorooctanesulf-amido acetic acid		**16**		**2.3E-07**	**STP**
EtPerfluorooctanesulf-amido acetic acid		**10**		**1.5E-07**	**STP**

Table 5: Summary of PFAS results – Stack 2

Parameter		Result ng/Nm^3		Emission Rate g/min	Reference
Per- and polyfluoroalkyl substances				**BV300_2**	
Perfluorobutanesulfonic acid		**1,230**		**1.7E-05**	**STP**
Perfluoropentanesulfonic acid		**13**		**1.8E-07**	**STP**
Perfluorohexanesulfonic acid		**132**		**1.8E-06**	**STP**
Perfluoroheptanesulfonic acid		**5.7**		**7.8E-08**	**STP**
Perfluorooctanesulfonic acid PFOS		**132**		**1.8E-06**	**STP**
Perfluorodecanesulfonic acid	<	3.5	<	4.8E-08	STP
Perfluorobutanoic acid		**33**		**4.5E-07**	STP
Perfluoropentanoic acid		**80**		**1.1E-06**	**STP**
Perfluorohexanoic acid		**199**		**2.7E-06**	**STP**
Perfluoroheptanoic acid		**40**		**5.4E-07**	**STP**
Perfluorooctanoic acid PFOA		**180**		**2.4E-06**	**STP**
Perfluorononanoic acid		**5.6**		**7.6E-08**	**STP**
Perfluorodecanoic acid		**16**		**2.2E-07**	**STP**
Perfluoroundecanoic acid	<	8.9	<	1.2E-07	STP
Perfluorododecanoic acid	<	8.9	<	1.2E-07	STP
Perfluorotridecanoic acid	<	9.0	<	1.2E-07	STP
Perfluorotetradecanoic acid	<	44.3	<	6.0E-07	STP
4:2 FTS	<	1.8	<	2.4E-08	STP
6:2 FTS		**72**		**9.8E-07**	**STP**
8:2 FTS		**7.5**		**1.0E-07**	**STP**
10:2 FTS	<	3.5	<	4.8E-08	STP
Perfluorooctane sulfonamide	<	8.9	<	1.2E-07	STP
N-Methyl perfluorooctane sulfonamide	<	8.9	<	1.2E-07	STP
N-Ethyl perfluorooctane sulfonamide	<	8.9	<	1.2E-07	STP
N-Me perfluorooctanesulfonamido ethanol		**19**		**2.6E-07**	**STP**
N-Et perfluorooctanesulfonamido ethanol	<	108	<	1.5E-06	STP
MePerfluorooctanesulf-amido acetic acid		**17**		**2.3E-07**	**STP**
EtPerfluorooctanesulf-amido acetic acid		**14**		**1.9E-07**	**STP**

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

Assured Environmental (AE) was appointed by BeneTerra to sample and analyse source emissions from the BV300 BeneVap Leachate Treatment system. Sampling was conducted by AE from 6th to 10th August 2022 during typical site operations.

AE was responsible for the collection and analysis of samples, unless otherwise indicated. The samples were recovered and stored in the appropriate manner until their return to the laboratory where the samples were prepared and analysed according to the methodologies listed below in this report.

2 METHODOLGY & EQUIPMENT

2.1 Sampling methodology

All sampling and analysis was carried out in accordance with the listed requirements in Table 6. Any specific comments about the sampling and analysis have been documented where required.

Table 6: Test methods

Parameter	Reference Test Method	Test Method (NSW)	NATA accreditation	Analysis by
Sample location	AS4323.1	TM-1	Yes	1
Velocity & flow rate	USEPA Method 2	TM-2	Yes	1
Stack gas density	USEPA Method 3	TM-23	Yes	1
Oxygen	USEPA Method 3A	TM-25	Yes	1
Carbon dioxide	USEPA Method 3A	TM-24	Yes	1
Water vapour content	USEPA Method 4	TM-22	Yes	1
Sulphur dioxide	USEPA Method 6	TM-4	Yes	1
Oxides of nitrogen (as NO_2)	USEPA Method 7E	TM-11	Yes	1
Sulfuric acid mists	USEPA Method 8	TM-3[a]	Yes	1
Carbon monoxide	USEPA Method 10	TM-32	Yes	1
Hydrogen sulfide	USEPA Method 15	TM-5	Yes	1
Total VOCs	USEPA Method 18	TM-34	Yes	2
Hydrogen chloride	USEPA Method 26A	TM-8	Yes	2
Chlorine	USEPA Method 26A	TM-7	Yes	2
Fluoride (as HF)	USEPA Method 13B	TM-9	Yes	2
Heavy metals	USEPA Method 29	TM-12/13/14	Yes	2
PFAS – suite	USEPA SW846 Method 0010	Mod TM-18	No	2
Dioxins & furans	USEPA SW846 Method 0010	TM-18	Yes	3
Polychlorinated biphenyls	USEPA SW846 Method 0010	TM-18	Yes	3
Ammonia	Modified USEPA Method 26	Mod TM-4[b]	Yes	2
Odour	AS4323.3	OM-7	Yes	1

Table 7: Analysis performed by

Note	Company	Work performed	NATA ID	Report Number
1	Assured Environmental	Sampling & analysis	19703	14326
2	Envirolab Services	Sample analysis	2901	303554
3	National Measurement Inst.	PCDD/F & PCB analysis	198	DAU22_217

---

[a] EPL188-03 lists the test method for sulfuric acid mists as TM-13, this does not correspond to the *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales* listed method (TM-3).

[b] EPL188-03 lists the test method for ammonia as TM-3. A closer representation of the sampling technique is a Modified TM-4 sample train. See the description of the sampling technique in Table 8 below.

Table 8: Sampling comments

Note	Comment
Sample location	Sample location is compliant but non ideal as per AS4323.1. The sample location is greater than two, but less than six diameters downstream from a disturbance. The temperature and velocity survey showed that the sample position was in compliance to items (a) to (f) as per AS4323.1.
Calibrations	Analyser calibration performed in the laboratory prior to conducting field work and post field work in AE lab.
H_2S	A sample of exhaust gas was passed through a buffer solution to remove any potential SO_2 present before being captured in a specialised gas sampling bag. Analysis for H_2S was performed using GC-FPD within 30 hours of collection.
Heavy metals	Type 1 substances: Antimony, Arsenic, Cadmium, Lead Mercury. Type 2 substances: Beryllium, Chromium, Cobalt, Manganese, Nickel, Selenium, Tin, Vanadium.
PFAS	A modified version of the USEPA SW846 Method 0010 sample train was employed to sample for Per- and poly-fluoroalkyl substances (PFAS) material in the flue gas emission. Refer to section 2.2 for further information.
Ammonia	The ammonia sampling was performed using a modified constant flow sampling train. A condensate removal trap was placed in front of the collection trap containing the absorbing solution to separate condensing ammonia from gaseous ammonia passing through the initial dropout and into the collection solution (0.1N H_2SO_4). Both the condensate captured in the trap and the sorbent solution are analysed for ammonia individually. Ammonia results are reported in the condensate and gaseous phase separately and as total NH_3. Samples are analysed using a Discrete Analyser.
Odour	Due to the high levels of moisture in the emission the odour samples bags were diluted beyond the suggested limit in AS4323.3. This is required to avoid condensation forming in the sample bags.

2.2 Per- and poly-fluoroalkyl substances sample methodology

Suitable sampling methods for Per- and poly-fluoroalkyl substances (PFAS) in air have received considerably less attention than in other media such as water and soil matrices. As such Assured Environmental has developed a sampling method based on modifications of the promulgated USEPA SW846 Method 0010 sample train. This method includes consideration for both semi-volatile and particulate bound PFAS. It is recognised that the US EPA has recently introduced Other Test Method (OTM) – 45 and although many of the elements included in this method are consistent with the method developed by AE. It is also noted that posting of an OTM by USEPA is neither an endorsement by EPA regarding the validity of the test method nor a regulatory approval of the test method, rather to promote discussion of developing emerging methodologies prior to full endorsement. In this case the AE method was employed, which is summarised below.

The basis of the sample train is;

- Gaseous and particulate pollutants are withdrawn from an emission source at an isokinetic sampling rate and are collected in a multi-component sampling train. The sample train contains a high-efficiency glass fibre filter and a packed bed of porous adsorbent resin. The filter is used to collect organic-laden particulate materials and the porous polymeric resin to adsorb semi-volatile organic species. Semi-volatile species are defined as compounds with boiling points greater than 100°C. The impingers downstream of the resin trap are loaded with water to knock-out any water vapour prior to metering the gas. These impingers are not routinely analysed for S-VOCs.

The modifications made to this sample train in order to target PFAS materials included;

- Sorbent material is XAD-2 and XAD-4.
- The resin traps are spiked with a surrogate standard to test for retention. A known quantity of standard is injected into the trap during preparation, the trap is then shipped, sampled and returned to the laboratory for analysis. The analysis includes detecting the injected standard, which provides a measure of the recovery efficiency. Factors that may affect the recovery efficiency include, sample transport and handling procedures, sampling temperatures (the resin must be chilled during sampling and maintained below 20°C) and sample preparation at the laboratory, including the extraction of the sample from the resin.
- Condensate remove trap prior to resin traps.
- Impingers downstream of the resin trap are loaded with a sodium solution and is intended to be a breakthrough detector. Following the sampling, the impinger contents are measured and placed in a sample bottle for shipment to the laboratory. The final impinger of the sample train is then analysed separately to the filter, resin trap and front half methanol rinse so as to provide a measure of possible breakthrough. The intent of this sample train component is to provide a measure of breakthrough from the primary sampling components. Where no detections of PFAS material is made in this sample component, the limit of detection is not added to the sample result.
- Following the sampling onsite, all sample train components that have been in contact with the sample are rinsed thoroughly with methanol and stored in a sample container to be analysed as part of the sample.
- Sample train component material. According to documented water and soil PFAS sampling procedures, the use of glass, Teflon and stainless steel should be avoided and the use of polypropylene (PE) is recommended. PE is not considered to be conducive to source emissions sampling due to the temperatures of the flue gas. PE or HDPE cannot be used in the probe or filter box due to its low melting point, instead, all sampling components upstream of the resin trap was constructed of glass. Following sampling, all glassware was thoroughly rinsed with methanol at least three times to quantitatively recovery any possible PFAS material deposited on this surface.

For the analysis, the samples are extracted using a solvent desorption technique, with the filter and front half methanol rinse extract combined prior to analysis for the PFAS species. The XAD resin trap is then analysed in isolation as is the condensate downstream of the trap to gain an understanding of where the PFAS is captured within the sample train. The analysis is performed using LC/MS/MS instruments, with each analysis performed using the surrogate spikes to determine sample specific recoveries.

2.2.1 PFAS blank corrections

A full field blank sample has not been performed for this round of sampling. The stock reagents are largely unchanged from the previous round of sampling (13633), therefore the results of this previous blank are utilised for this round. A field blank is performed by the sample train being constructed as normal, however no sample is passed through it. It is then cleaned and recovered following the standard recovery procedures and the filter, resin trap and rinsate kept and analysed along with the sample.

The following details the procedures used to correct for detections of PFAS species in the blank samples.

- Where the blank result is a non-detection, no adjustment to the sample result is made.
- Where the blank result returns a positive detection, but is less than half of the sample result, the blank value is subtracted from the sample result and reported as a positive detection.
- Where the blank value returns a positive detection, and is exceeding half of the sample result, no adjustments are made to the sample result, but it is reported as a non-detection.

2.3 Sample Location

The images and figures below show the sample location and site details.

Figure 1: BeneVap treatment system stacks

Table 9: Sample location summary

AS4323.1	Sample location	BV300
	Stack Shape	CIRCULAR
	Ideal Sampling Plane Assessment	
	Stack Diameter (m)	0.59
	Stack Cross Section Area (m^2)	0.27
	Distance to upstream disturbance (m) (from disturbance)	0.7
	Upstream Diameters (D)	1.2
	Distance to downstream disturbance (m) (from disturbance)	1.4
	Downstream diameters (D)	2.4
4.2.2 Table 1	Meets Requirements AS4323.1 Table 1	No
	Non-deal Sampling Plane Assessment	
	Assessment required?	No
	Total traverse point factors	1.2
	Non-conforming Sampling Plane Assessment	
4.2.2(a)	Gas flow in same direction	Yes
4.2.2(b)	Gas flow steady & evenly distributed (cyclonic or swirl <15º)	Yes
4.2.2(c)	Temperature difference between points <10%, and each point <10% of average	Yes
4.2.2(d)	Ratio of highest to lowest differential pressure & ratio highest to lowest velocity	4.5 2.1
4.2.2(e)	Minimum differential pressure	0.20
	Gas temperature above dewpoint	No
	Samling Plane Type	
4.2.2, 4.2.3, 4.2.4	Samling plane type	Non-conforming
	Alternative sampling plane available?	No
	Number of Sample Points Adopted	
	Port size (mm)	100
	Port Thread Type	BSP
	Number of traverses	2
	Number of points per traverse	6
	Total number of traverse points	12
	Flow & temperature compliance check	No

2.4 Test equipment

The sampling equipment was transported to site and specifically setup at the test location. Sampling was performed using heated probes and filters, with a constant flow and isokinetic sample console.

Equipment used during the course of the testing is sourced from Apex Instruments and Testo, industry leaders in the supply of source testing equipment.

Figure 2: Manual sampling equipment

Figure 3: Combustion gas analyser

3 MEASUREMENT UNCERTAINTY

There is an inherent uncertainty associated with any scientific measurement, including stack emissions monitoring. The measurement uncertainty can be controlled with strict adherence to the reference methodology along with utilising appropriate calibration standards with corresponding acceptable uncertainty reports.

Many source sampling methods do not outline exact procedures for establishing direct measurement uncertainty. In the absence of a defined procedure, the uncertainty budgets presented are based on estimations using ISO-GUM method.

Each individual source and test may have a unique associated uncertainty, due largely to the stack sample location in relation to the positioning requirements of AS4323.1.

Table 10: Sample specific uncertainty budgets

Parameter	Reference method	Limit of measurement	Unit of measure	Uncertainty ± %
Flue gas velocity	USEPA Method 2	3	m/sec	20
Oxygen	USEPA Method 3A	0.3	%-vol	5.0
Carbon dioxide	USEPA Method 3A	0.3	%-vol	10
Water vapour content	USEPA Method 4	0.5	%-vol	5.0
Sulphur dioxide	USEPA Method 6	2.0	mg/sample	15
Oxides of nitrogen (as NO_2)	USEPA Method 7E	2.1	mg/sample	15
Sulfuric acid mists	USEPA Method 8	2.0	mg/sample	15
Carbon monoxide	USEPA Method 10	1.5	mg/sample	15
Hydrogen sulfide	USEPA Method 15	1.0	mg/sample	20
Total VOCs	USEPA Method 18	1.0	mg/sample	20
Hydrogen chloride	USEPA Method 26A	1.0	mg/sample	15
Chlorine	USEPA Method 26A	1.0	mg/sample	15
Fluoride (as HF)	USEPA Method 13B	1.0	mg/sample	15
Heavy metals	USEPA Method 29	0.3 to 50	µg/sample	20
PFAS – suite	USEPA SW846 Method 0010	1 to 50	ng/sample	25
Dioxins & furans	USEPA SW846 Method 0010	1	pg/sample	15
Polychlorinated biphenyls	USEPA SW846 Method 0010	20	pg/sample	15
Ammonia	Modified USEPA Method 26	1	mg/sample	25
Odour	AS4323.3	100	ou	40

4 QUALITY ASSURANCE & QUALITY CONTROL (QA/QC)

AE operates within a quality system based upon the requirements of ISO17025. Our quality system defines specific procedures and methodologies to ensure any project undertaken by AE is conducted with the highest level of quality given the specific confines of each project. The overall objective of our QA/QC procedures is to representatively sample and accurately analyse components in the gas streams and therefore report valid measurements of emission concentrations.

To ensure representativeness of field work, our quality procedures target:

1. Correct sampling locations
2. Sample time
3. Frequency of samples and
4. Method selection & adherence

To ensure representativeness of lab work, our quality procedures target:

1. Sample preservation
2. Chain of custody (COC)
3. Sample preparation and
4. Analytical techniques

AE maintains strict quality assurance throughout all its sampling programs, covering on-site 'field work' and the analytical phase of our projects. Our QA program covers the calibration of all sampling and analytical apparatus where applicable and the use of spikes, replicate sample and reference standards. The test methodologies used for this project are outlined in section 2 of this document. Field test data has been recorded and calculated using direct entry into Microsoft Excel spreadsheets following the procedures of the appropriate test methods. Determination of emission concentrations has been performed using the same Microsoft Excel spreadsheets which are partially supplied as an attachment to this report. More detailed information can be supplied upon request.

QA/QC checks for this project will use validation techniques and criteria appropriate to the type of data and the purpose of the measurement to approve the test report. Records of all data will be maintained. Complete chain of custody (COC) procedures have been followed to document the entire custodial history of each sample. The COC forms also served as a laboratory sheet detailing sample ID and analysis requirements.

Table 11: Sampling data QA/QC checklist

Sampling Data QA/QC Checklist	Comment
Use of appropriate test methods	Yes
'Normal' operation of the process being tested	Yes – as instructed by client
Use of properly operating and calibrated test equipment	Yes
Use of high purity reagents	Yes
Performance of leak checks post sample (at least)	Yes

Table 12: Laboratory data QA/QC checklist

Laboratory Data QA/QC Checklist	Comment
Use of appropriate analytical methods	Yes
Use of properly operating and calibrated analytical equipment	Yes
Precision and accuracy comparable to that achieved in similar projects	Yes
Accurate reporting	Yes

Table 13: Olfactometer QA data

Item	Comment
Methodology	AS/NZ4323.3:2001 "determination of odour concentration by dynamic olfactometry".
Sample Media	Odour samples collected into Nalophan™ sample bags
Sample identification	All samples are labelled uniquely immediately following collection according to Assured Environmental identification procedure. Each sample has the following recorded: project ID, sample number, location, date, time, dilution and any deviations to AS/NZ4323.3.
Timing	All measurements were conducted within 30 hours of sampling as specified by AS/NZ4323.3
Traceability	All panel results are traceable to reference standards held by Assured Environmental
Analysis conditions	Room temperature maintained at 22 °C ± 3 °C
Odour panel location	7/142 Tennyson Memorial Avenue Tennyson, Qld. 4105
Reference odourant	40 ppm n-butanol
Odour panel threshold	100 ou

4.1 PFAS quality control

The recoveries of surrogate standards from the sampling and analysis are presented in the table below. The expected QC recovery for measurements in the ppb to ppt levels is in the range of 60 to 120%. The results are not corrected for the recovery efficiency.

Table 14: PFAS surrogate recovery (%)

Surrogate	PFAS	
	BV300_1	BV300_2
Field surrogate		
Surrogate $^{13}C_8$ PFOS	75	85
Surrogate $^{13}C_2$ PFOA	140	125

Analysis of the final bubbler containing a sodium borate solution was performed separately to the front of the sampling train in order to assess the potential for breakthrough. The results of this analysis are provided below.

Table 15: Breakthrough analysis

Perfluorinated surfactants	Abbreviation	Breakthrough analysis (ng/Nm^3)	
		BV300_1	BV300_2
Perfluorobutanesulfonic acid	PFBS	< 0.2	< 0.2
Perfluoropentanesulfonic acid	PFPeS	< 0.2	< 0.2
Perfluorohexanesulfonic acid	PFHxS	< 0.2	< 0.2
Perfluoroheptanesulfonic acid	PFHpS	< 0.2	< 0.2
Perfluorooctanesulfonic acid PFOS	PFOS	< 0.2	< 0.2
Perfluorodecanesulfonic acid	PFDS	< 0.3	< 0.4
Perfluorobutanoic acid	PFBA	< 0.3	< 0.4
Perfluoropentanoic acid	PFPeA	< 0.3	< 0.4
Perfluorohexanoic acid	**PFHxA**	< 0.2	**0.3**
Perfluoroheptanoic acid	PFHpA	< 0.2	< 0.2
Perfluorooctanoic acid PFOA	PFOA	< 0.2	< 0.2
Perfluorononanoic acid	PFNA	< 0.2	< 0.2
Perfluorodecanoic acid	PFDA	< 0.8	< 0.9
Perfluoroundecanoic acid	PFUdA	< 0.8	< 0.9
Perfluorododecanoic acid	PFDoA	< 0.8	< 0.9
Perfluorotridecanoic acid	PFTrDA	< 0.8	< 1.8
Perfluorotetradecanoic acid	PFTeDA	< 3.9	< 4.4
4:2 FTS	4:2 FTS	< 0.2	< 0.2
6:2 FTS	6:2 FTS	< 0.2	< 0.2
8:2 FTS	8:2 FTS	< 0.3	< 0.4
10:2 FTS	10:2 FTS	< 0.3	< 0.4
Perfluorooctane sulfonamide	FOSA	< 0.8	< 0.9
N-Methyl perfluorooctanesulfonamide	N-MeFOSA	< 0.8	< 0.9
N-Ethyl perfluorooctanesulfonamide	n-EtFOSA	< 0.8	< 0.9
N-Me perfluorooctanesulfonamidoethanol	n-MeFOSE	< 0.8	< 8.8
N-Et perfluorooctanesulfonamidoethanol	n-EtFOSE	< 39	< 44
MePerfluorooctanesulf-amidoacetic acid	N-MeFOSAA	< 0.3	< 0.4
EtPerfluorooctanesulf-amidoacetic acid	N-EtFOSAA	< 0.3	< 0.4

The breakthrough analysis showed no detectable PFAS compounds were present in the BV300_1 sample and PFHxA was present at low levels (0.3 ng/Nm^3, or 0.1% of the sample total) for the BV300_2 sample.

Analysis of the field sample blank (project 13633) showed that only a small amount of PFOA was detectable in the methanol/XAD resin. The table below shows the results of the blank analysis.

Table 16: Field blank analysis

	Blank analysis		
Perfluorinated surfactants - PFAS suite	**Front half ng/sample**	**Resin Traps ng/sample**	**Breakthrough ng/sample**
Perfluorobutanesulfonic acid	< 0.2	< 0.2	< 0.2
Perfluoropentane sulfonic acid (PFPeS)	< 0.2	< 0.2	< 0.2
Perfluorohexane sulfonate (PFHxS)	< 0.2	< 0.2	< 0.2
Perfluoroheptane sulfonate (PFHpS)	< 0.2	< 0.2	< 0.2
Perfluorooctane sulfonate (PFOS)	< 0.2	< 0.2	< 0.2
Perfluorodecanesulfonic acid (PFDS)	< 0.4	< 0.4	< 0.4
Perfluorobutanoic acid	< 0.4	< 0.4	< 0.4
Perfluoropentanoic acid (PFPeA)	< 0.4	< 0.4	< 0.4
Perfluorohexanoic acid (PFHxA)	< 0.2	< 0.2	< 0.2
Perfluoroheptanoic acid (PFHpA)	< 0.2	< 0.2	< 0.2
Perfluorooctanoic acid (PFOA)	< 0.2	**2.3**	< 0.2
Perfluorononanoic acid (PFNA)	< 0.2	< 0.2	< 0.2
Perfluorodecanoic acid	< 1.0	< 1.0	< 1.0
Perfluoroundecanoic acid (PFUnA)	< 1.0	< 1.0	< 1.0
Perfluorododecanoic acid (PFDoA)	< 1.0	< 1.0	< 1.0
Perfluorotridecanoic acid (PFTrDA)	< 1.0	< 1.0	< 1.0
Perfluorotetradecanoic acid (PFTeDA)	< 5.0	< 5.0	< 5.0
4:2 Flurotelomersulphonate	< 0.2	< 0.2	< 0.2
6:2 Fluorotelomersulphonate	< 0.2	< 0.2	< 0.2
8:2 Fluorotelomersulphonate	< 0.4	< 0.4	< 0.4
10:2 Fluorotelomersulphonate	< 0.4	< 0.4	< 0.4
Perfluorooctane sulfonamide	< 1.0	< 1.0	< 1.0
N-Methyl-heptadecafluorooctane sulphonamide	< 1.0	< 1.0	< 1.0
N-Ethyl-heptadecafluorooctane sulphonamide	< 1.0	< 1.0	< 1.0
N-Me perfluorooctanesulfonamid oethanol	< 1.0	< 1.0	< 1.0
N-Et perfluorooctanesulfonamid oethanol	< 50	< 50	< 50
N-Methylperfluorooctane sulphonamidoacetic acid	< 0.4	< 0.4	< 0.4
N-Ethyl-perfluorooctane sulphonamidoacetic acid	< 0.4	< 0.4	< 0.4

4.2 Dioxins and furans QA

During sample analysis, the laboratory uses $^{13}C_{12}$ labelled dioxin, furan and PCB surrogates to test sample recovery efficiency and possible sample matrix interference.

During this analysis, the laboratory surrogate recovery for dioxin, furan and PCB congeners all fell within method tolerances.

5 DEFINITIONS

The following terms and abbreviations may be used in this report:

Table 17: Definitions

Symbol	Definition
<	The analytes tested for was not detected; the value stated is the reportable limit of detection
Am^3	Gas volume in cubic metres at measured conditions
AS	Australian Standard
BH	Back half of sample train (filter holder and impingers) (referred to during sample recovery)
°C	Degrees Celsius
CARB	California Air Resources Board methods
dscm	dry standard cubic meters
FH	Front half of sample train (probe and filter holder) (referred to during sample recovery)
g	Grams
Heavy metals	Sum of Antimony, Arsenic, Beryllium, Cadmium, Chromium, Cobalt, Lead, Manganese, Nickle, Selenium, Tin, Vanadium & Mercury. Also known as Type 1 and Type 2 hazardous substances. Total heavy metals refers only to those metals found in the sample and does not include limit of detection values.
kg	Kilograms
Lower range	The sum of a list of a particular group of compounds, where only those individual congeners/compounds that are detectable in the sample have been included in the total. Results below the limit of detection have not been included. Unless otherwise indicated, the lower range is reported for dioxins & furans, PCBs, heavy metals and PFAS analysis suites.
m	Metres
m^3	actual gas volume in cubic metres as measured
mbar	Millibars
mg	Milligrams (10^{-3} grams)
min	Minute
ml	Millilitres
mmH_2O	Millimetres of water
Mole	SI unit that measures the amount of substance
N/A	Not applicable
ng	Nanograms (10^{-9} grams)
Nm^3	Gas volume in dry cubic metres at standard temperature and pressure (0°C and 101.3 kPa)
NMI	National Measurement Institute
NM VOC	Non methane volatile organic compound
NR	Not required on this occasion
ou	Odour unit
ppb	Parts per billion
ppm	Parts per million
sec	Second
Sm^3	Gas volume in dry cubic metres at standard temperature and pressure (0°C and 101.3 kPa) and corrected to a standardised value (e.g. 15% O_2)
STP	Standard temperature and pressure (0°C and 101.3 kPa) & dry
USEPA	United States Environmental Protection Authority

6 RESULTS

6.1 Stack 1 Results

Table 18: Sample information – PFAS

Site		Shaolbay Landfill	
Sample Location		BV300_1	
Reference Method		USEPA Method 0010 - ISOKINETIC	
Run ID		19	
Test Parameter		PFAS	
Test Date	dd/mm/yyyy	7/08/2022	
Start Time	hh:mm	8:10	
End Time	hh:mm	11:10	
Average Stack Temperature	°C	87	
Absolute Stack Pressure	mb	1008	
Moisture Content	% v/v	63.2	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.3	
Sample Volume (dry gas meter)	Nm^3	1.29	
Stack Gas Velocity	m/sec	3.1	
Actual Stack Flow Rate	m^3/min	51	
Dry Standard Stack Flow Rate	Nm^3/min	14	
Percent Isokinetic Rate	%	106	
		standard conditions	
Pollutant PFAS species	Licence limit ng/Nm^3	Concentration ng/Nm^3	Emission Rate g/min
Perfluorobutanesulfonic acid	-	1,238	1.76E-05
Perfluoropentanesulfonic acid	-	13.3	1.89E-07
Perfluorohexanesulfonic acid	-	132	1.88E-06
Perfluoroheptanesulfonic acid	-	6.1	8.66E-08
Perfluorooctanesulfonic acid PFOS	-	116	1.65E-06
Perfluorodecanesulfonic acid	-	< 3.1	< 4.44E-08
Perfluorobutanoic acid	-	29.7	4.22E-07
Perfluoropentanoic acid	-	104	1.47E-06
Perfluorohexanoic acid	-	201	2.86E-06
Perfluoroheptanoic acid	-	42	6.00E-07
Perfluorooctanoic acid PFOA	-	155	2.20E-06
Perfluorononanoic acid	-	7	9.45E-08
Perfluorodecanoic acid	-	14	1.95E-07
Perfluoroundecanoic acid	-	< 9.3	< 1.32E-07
Perfluorododecanoic acid	-	8.5	1.21E-07
Perfluorotridecanoic acid	-	< 7.8	< 1.11E-07
Perfluorotetradecanoic acid	-	< 39.1	< 5.55E-07
4:2 FTS	-	< 1.6	< 2.22E-08
6:2 FTS	-	66	9.41E-07
8:2 FTS	-	6.4	9.08E-08
10:2 FTS	-	< 3.1	< 4.44E-08
Perfluorooctane sulfonamide	-	< 7.8	< 1.11E-07
N-Methyl perfluorooctane sulfonamide	-	< 7.8	< 1.11E-07
N-Ethyl perfluorooctane sulfonamide	-	< 7.8	< 1.11E-07
N-Me perfluorooctanesulfonamido ethanol	-	16	2.20E-07
N-Et perfluorooctanesulfonamido ethanol	-	< 95	< 1.35E-06
MePerfluorooctanesulf-amido acetic acid	-	16	2.26E-07
EtPerfluorooctanesulf-amido acetic acid	-	10.5	1.49E-07
TOTAL			
Sum of positive detections	-	2,181	3.10E-05

Table 19: Sample information – Odour

Site		Shaolbay Landfill	
Sample Location		BV300_1	
Reference Method		AS4323.3 - CONSTANT FLOW	
Run ID		20	
Test Parameter		Odour	
Test Date	dd/mm/yyyy	10/08/2022	
Start Time	hh:mm	7:15	
End Time	hh:mm	7:27	
Average Stack Temperature	°C	87	
Absolute Stack Pressure	mb	1009	
Moisture Content	% v/v	61.1	
Dry Gas Density	kg/Nm^3	1.33	
Dry Gas Molecular Weight	g/g-mole	29.9	
Sample Volume (dry gas meter)	Nm^3	-	
Stack Gas Velocity	m/sec	3.2	
Actual Stack Flow Rate	m^3/min	52	
Dry Standard Stack Flow Rate	Nm^3/min	15	
Percent Isokinetic Rate	%	N/A	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
Odour	ou	ou	ou.m^3/min
Odour Sample 1	-	8,920	353,762
Odour Sample 2	-	9,460	375,178
Average Odour	-	9,190	364,470

Table 20: Sample information – Hydrogen sulfide

Site		Shaolbay Landfill	
Sample Location		BV300_1	
Reference Method		USEPA Method 15 - CONSTANT FLOW	
Run ID		20	
Test Parameter		H_2S	
Test Date	dd/mm/yyyy	10/08/2022	
Start Time	hh:mm	7:10	
End Time	hh:mm	7:15	
Average Stack Temperature	°C	87	
Absolute Stack Pressure	mb	1009	
Moisture Content	% v/v	61.1	
Dry Gas Density	kg/Nm^3	1.33	
Dry Gas Molecular Weight	g/g-mole	29.9	
Sample Volume (dry gas meter)	Nm^3	-	
Stack Gas Velocity	m/sec	3.2	
Actual Stack Flow Rate	m^3/min	52	
Dry Standard Stack Flow Rate	Nm^3/min	15	
Percent Isokinetic Rate	%	N/A	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
H_2S	mg/Nm^3	mg/Nm^3	g/min
Hydrogen sulfide	5	< 1.1	< 0.02

Table 21: Sample information – Oxides of Sulfur

Site		Shaolbay Landfill	
Sample Location		BV300_1	
Reference Method		USEPA Method 8 - ISOKINETIC	
Run ID		16	
Test Parameter		SOx	
Test Date	dd/mm/yyyy	6/08/2022	
Start Time	hh:mm	9:06	
End Time	hh:mm	10:06	
Average Stack Temperature	°C	87	
Absolute Stack Pressure	mb	1009	
Moisture Content	% v/v	62.5	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.2	
Sample Volume (dry gas meter)	Nm^3	0.48	
Stack Gas Velocity	m/sec	3.2	
Actual Stack Flow Rate	m^3/min	52	
Dry Standard Stack Flow Rate	Nm^3/min	15	
Percent Isokinetic Rate	%	115	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
SOx	mg/Nm^3	mg/Nm^3	g/min
SO$_2$	-	< 2.9	< 0.04
SO$_3$ (as H$_2$SO$_4$)	100	2.9	0.04

Table 22: Sample information – Acid gases

Site		Shaolbay Landfill	
Sample Location		BV300_1	
Reference Method		USEPA Method 26A - ISOKINETIC	
Run ID		14	
Test Parameter		HCl / Cl2	
Test Date	dd/mm/yyyy	6/08/2022	
Start Time	hh:mm	11:43	
End Time	hh:mm	12:43	
Average Stack Temperature	°C	86	
Absolute Stack Pressure	mb	1009	
Moisture Content	% v/v	58.6	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.2	
Sample Volume (dry gas meter)	Nm^3	0.44	
Stack Gas Velocity	m/sec	3.1	
Actual Stack Flow Rate	m^3/min	51	
Dry Standard Stack Flow Rate	Nm^3/min	16	
Percent Isokinetic Rate	%	95	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
HCl / Cl2	mg/Nm^3	mg/Nm^3	g/min
HCl	100	< 2.3	< 0.04
Cl$_2$	200	< 2.3	< 0.04

Table 23: Sample information – Heavy metals

Site		Shaolbay Landfill
Sample Location		BV300_1
Reference Method		USEPA Method 29 - ISOKINETIC
Run ID		13
Test Parameter		Metals
Test Date	dd/mm/yyyy	6/08/2022
Start Time	hh:mm	14:21
End Time	hh:mm	16:21
Average Stack Temperature	°C	87
Absolute Stack Pressure	mb	1009
Moisture Content	% v/v	65.0
Dry Gas Density	kg/Nm^3	1.35
Dry Gas Molecular Weight	g/g-mole	30.3
Sample Volume (dry gas meter)	Nm^3	0.82
Stack Gas Velocity	m/sec	3.0
Actual Stack Flow Rate	m^3/min	50
Dry Standard Stack Flow Rate	Nm^3/min	13
Percent Isokinetic Rate	%	109

		standard conditions			
Pollutant	Licence limit		Concentration		Emission Rate
Metals	µg/Nm^3		µg/Nm^3		g/min
Antimony	-	<	6.9	<	9.1E-05
Arsenic	-	<	6.9	<	9.1E-05
Beryllium	-	<	0.5	<	6.8E-06
Cadmium	200		3.5		4.7E-05
Chromium	-		8.4		1.1E-04
Cobalt	-		1.2		1.6E-05
Lead	-		213		2.8E-03
Manganese	-		11		1.4E-04
Nickel	-		21		2.7E-04
Selenium	-	<	8.8	<	1.2E-04
Tin	-	<	17	<	2.3E-04
Vanadium	-	<	8.6	<	1.1E-04
Mercury	200		0.8		1.0E-05
Total Heavy Metals (lower bound)	1,000		258		3.4E-03

Table 24: Sample information – Volatile organic compounds

Site		Shaolbay Landfill	
Sample Location		BV300_1	
Reference Method		USEPA Method 18 - CONSTANT FLOW	
Run ID		17	
Test Parameter		VOC	
Test Date	dd/mm/yyyy	7/08/2022	
Start Time	hh:mm	13:55	
End Time	hh:mm	14:55	
Average Stack Temperature	°C	87	
Absolute Stack Pressure	mb	1009	
Moisture Content	% v/v	58.6	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.2	
Sample Volume (dry gas meter)	Nm^3	0.03	
Stack Gas Velocity	m/sec	2.6	
Actual Stack Flow Rate	m^3/min	43	
Dry Standard Stack Flow Rate	Nm^3/min	14	
Percent Isokinetic Rate	%	N/A	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
Total (non-methane) VOCs	mg/Nm^3	mg/Nm^3	g/min
Total VOCs - as n-hexane	-	< 1.5	< 0.02
Total VOCs - as n-propane	40	< 0.8	< 0.01

Table 25: Sample information – Ammonia

Site		Shaolbay Landfill	
Sample Location		BV300_1	
Reference Method		USEPA Method 6 - CONSTANT FLOW	
Run ID		18	
Test Parameter		NH_3	
Test Date	dd/mm/yyyy	7/08/2022	
Start Time	hh:mm	8:20	
End Time	hh:mm	9:20	
Average Stack Temperature	°C	87	
Absolute Stack Pressure	mb	1009	
Moisture Content	% v/v	61.1	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.2	
Sample Volume (dry gas meter)	Nm^3	0.04	
Stack Gas Velocity	m/sec	3.2	
Actual Stack Flow Rate	m^3/min	52	
Dry Standard Stack Flow Rate	Nm^3/min	15	
Percent Isokinetic Rate	%	N/A	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
NH_3	mg/Nm^3	mg/Nm^3	g/min
Ammonia (NH_3) - in condensate	-	2,036	31.3
Ammonia (NH_3) - gaseous	-	281	4.3
Total Ammonia (as NH_3)	-	2,317	35.6

Table 26: Sample information – Fluoride

Site		Shaolbay Landfill	
Sample Location		BV300_1	
Reference Method		USEPA Method 13B - ISOKINETIC	
Run ID		15	
Test Parameter		F	
Test Date	dd/mm/yyyy	8/08/2022	
Start Time	hh:mm	8:03	
End Time	hh:mm	9:05	
Average Stack Temperature	°C	86	
Absolute Stack Pressure	mb	1011	
Moisture Content	% v/v	65.1	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.2	
Sample Volume (dry gas meter)	Nm^3	0.39	
Stack Gas Velocity	m/sec	2.9	
Actual Stack Flow Rate	m^3/min	47	
Dry Standard Stack Flow Rate	Nm^3/min	13	
Percent Isokinetic Rate	%	108	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
F	mg/Nm^3	mg/Nm^3	g/min
Fluorine - (as total HF)	50	< 2.7	< 0.03

Table 27: Sample information – Combustion gases

Site		Shaolbay Landfill	
Sample Location		BV300_1	
Reference Method		USEPA Method 3A, 7E & 10	
Run ID		Various	
Test Parameter		O_2, CO_2, NOx, CO	
Test Date	dd/mm/yyyy	6/08/2022	
Start Time	hh:mm	9:06	
End Time	hh:mm	12:43	
Average Stack Temperature	°C	86	
Absolute Stack Pressure	mb	1009	
Moisture Content	% v/v	62.5	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.2	
Stack Gas Velocity	m/sec	3.1	
Actual Stack Flow Rate	m^3/min	50	
Dry Standard Stack Flow Rate	Nm^3/min	14	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
O_2, CO_2, NOx, CO	STP	STP	g/min
Oxygen (% v/v)	-	3.8	-
Carbon dioxide (% v/v)	-	13.0	-
Carbon monoxide (mg/Nm^3)	125	61	0.9
Oxides of nitrogen (mg/Nm^3)	350	180	2.6

Table 28: Sample information – Dioxins & furans

Site		Shaolbay Landfill
Sample Location		BV300_1
Reference Method		USEPA Method 23 - ISOKINETIC
Run ID		12
Test Parameter		DF PCB
Test Date	dd/mm/yyyy	7/08/2022
Start Time	hh:mm	13:53
End Time	hh:mm	16:53
Average Stack Temperature	°C	87
Absolute Stack Pressure	mb	1009
Moisture Content	% v/v	61.1
Dry Gas Density	kg/Nm^3	1.35
Dry Gas Molecular Weight	g/g-mole	30.2
Sample Volume (dry gas meter)	Nm^3	1.30
Stack Gas Velocity	m/sec	3.2
Actual Stack Flow Rate	m^3/min	52
Dry Standard Stack Flow Rate	Nm^3/min	15
Percent Isokinetic Rate	%	99

Pollutant	Licence limit		standard conditions Concentration		Emission Rate
DF PCB	ng/Nm^3		ng/Nm^3		g/min
2378 TCDF	-		0.0068		1.0E-10
Total TCDF isomers	-		0.092		1.4E-09
2378 TCDD	-	<	0.0023	<	3.5E-11
Total TCDD isomers	-		0.036		5.6E-10
12378 PeCDF	-		0.0028		4.4E-11
23478 PeCDF	-		0.0038		5.9E-11
Total PeCDF isomers	-		0.045		6.9E-10
12378 PeCDD	-	<	0.0015	<	2.4E-11
Total PeCDD isomers	-		0.024		3.7E-10
123478 HxCDF	-		0.0032		4.8E-11
123678 HxCDF	-		0.0028		4.3E-11
234678 HxCDF	-		0.0022		3.4E-11
123789 HxCDF	-	<	0.00077	<	1.2E-11
Total HxCDF isomers	-		0.023		3.5E-10
123478 HxCDD	-	<	0.00077	<	1.2E-11
123678 HxCDD	-		0.0022		3.4E-11
123789 HxCDD	-		0.0014		2.1E-11
Total HxCDD isomers	-		0.033		5.1E-10
1234678 HpCDF	-		0.0061		9.5E-11
1234789 HpCDF	-		0.00077		1.2E-11
Total HpCDF isomers	-		0.011		1.7E-10
1234678 HpCDD	-		0.029		4.5E-10
Total HpCDD isomers	-		0.059		9.1E-10
OCDF	-		0.0018		2.7E-11
OCDD	-		0.14		2.1E-09
Sum of congeners					
Sum of positive detections	-		0.46		7.1E-09
Total I-TEQ					
Sum of positive detections	0.1		0.0044		6.8E-11

Table 29: Sample information – PCBs

PCBs (USEPA Method 23)					
PCBs	Licence limit ng/Nm^3		standard conditions Concentration ng/Nm^3		Emission Rate g/min
PCB#77	-		1.1		1.6E-08
PCB#81	-		0.039		6.0E-10
PCB#126	-		0.048		7.4E-10
PCB#169	-	<	0.00077	<	1.2E-11
PCB#105	-		4.3		6.7E-08
PCB#114	-		0.27		4.1E-09
PCB#118	-		9.9		1.5E-07
PCB#123	-		0.13		2.0E-09
PCB#156	-		1.3		2.0E-08
PCB#157	-		0.29		4.5E-09
PCB#167	-		0.45		6.9E-09
PCB#189	-		0.045		6.9E-10
Sum of PCB Congeners Sum of positive detections	-		18		2.7E-07
Total TEQ Sum of positive detections	-		0.0055		8.4E-11

6.2 Stack 2 Results

Table 30: Sample information – PFAS

Site		Shaolbay Landfill	
Sample Location		BV300_2	
Reference Method		USEPA Method 0010 - ISOKINETIC	
Run ID		30	
Test Parameter		PFAS	
Test Date	dd/mm/yyyy	7/08/2022	
Start Time	hh:mm	8:11	
End Time	hh:mm	11:11	
Average Stack Temperature	°C	88	
Absolute Stack Pressure	mb	1007	
Moisture Content	% v/v	64.5	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.3	
Sample Volume (dry gas meter)	Nm^3	1.14	
Stack Gas Velocity	m/sec	3.1	
Actual Stack Flow Rate	m^3/min	51	
Dry Standard Stack Flow Rate	Nm^3/min	14	
Percent Isokinetic Rate	%	102	
Pollutant PFAS species	Licence limit ng/Nm^3	standard conditions Concentration ng/Nm^3	Emission Rate g/min
Perfluorobutanesulfonic acid	-	1,230	1.67E-05
Perfluoropentanesulfonic acid	-	13	1.82E-07
Perfluorohexanesulfonic acid	-	132	1.80E-06
Perfluoroheptanesulfonic acid	-	5.7	7.81E-08
Perfluorooctanesulfonic acid PFOS	-	132	1.80E-06
Perfluorodecanesulfonic acid	-	< 3.5	< 4.83E-08
Perfluorobutanoic acid	-	33	4.45E-07
Perfluoropentanoic acid	-	80	1.09E-06
Perfluorohexanoic acid	-	199	2.70E-06
Perfluoroheptanoic acid	-	40	5.40E-07
Perfluorooctanoic acid PFOA	-	180	2.45E-06
Perfluorononanoic acid	-	6	7.65E-08
Perfluorodecanoic acid	-	16	2.20E-07
Perfluoroundecanoic acid	-	< 8.9	< 1.21E-07
Perfluorododecanoic acid	-	< 8.9	< 1.21E-07
Perfluorotridecanoic acid	-	< 9.0	< 1.22E-07
Perfluorotetradecanoic acid	-	< 44	< 6.03E-07
4:2 FTS	-	< 1.8	< 2.41E-08
6:2 FTS	-	72	9.84E-07
8:2 FTS	-	7.5	1.02E-07
10:2 FTS	-	< 3.5	< 4.83E-08
Perfluorooctane sulfonamide	-	< 8.9	< 1.21E-07
N-Methyl perfluorooctane sulfonamide	-	< 8.9	< 1.21E-07
N-Ethyl perfluorooctane sulfonamide	-	< 8.9	< 1.21E-07
N-Me perfluorooctanesulfonamido ethanol	-	19	2.65E-07
N-Et perfluorooctanesulfonamido ethanol	-	< 108	< 1.46E-06
MePerfluorooctanesulf-amido acetic acid	-	17	2.34E-07
EtPerfluorooctanesulf-amido acetic acid	-	14	1.86E-07
TOTAL			
Sum of positive detections	-	2,196	2.99E-05

Table 31: Sample information – Odour

Site		Shaolbay Landfill	
Sample Location		BV300_2	
Reference Method		AS4323.3 - CONSTANT FLOW	
Run ID		31	
Test Parameter		Odour	
Test Date	dd/mm/yyyy	10/08/2022	
Start Time	hh:mm	7:30	
End Time	hh:mm	7:38	
Average Stack Temperature	°C	88	
Absolute Stack Pressure	mb	1009	
Moisture Content	% v/v	62.4	
Dry Gas Density	kg/Nm^3	1.34	
Dry Gas Molecular Weight	g/g-mole	29.9	
Sample Volume (dry gas meter)	Nm^3	-	
Stack Gas Velocity	m/sec	2.9	
Actual Stack Flow Rate	m^3/min	48	
Dry Standard Stack Flow Rate	Nm^3/min	13	
Percent Isokinetic Rate	%	N/A	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
Odour	ou	ou	ou.m^3/min
Odour Sample 1	-	8,242	295,591
Odour Sample 2	-	7,277	260,973
Average Odour	-	7,759	278,282

Table 32: Sample information – Hydrogen sulfide

Site		Shaolbay Landfill	
Sample Location		BV300_2	
Reference Method		USEPA Method 15 - CONSTANT FLOW	
Run ID		32	
Test Parameter		H_2S	
Test Date	dd/mm/yyyy	10/08/2022	
Start Time	hh:mm	7:40	
End Time	hh:mm	7:45	
Average Stack Temperature	°C	87	
Absolute Stack Pressure	mb	1009	
Moisture Content	% v/v	62.4	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.2	
Sample Volume (dry gas meter)	Nm^3	-	
Stack Gas Velocity	m/sec	2.9	
Actual Stack Flow Rate	m^3/min	47	
Dry Standard Stack Flow Rate	Nm^3/min	13	
Percent Isokinetic Rate	%	N/A	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
H_2S	mg/Nm^3	mg/Nm^3	g/min
Hydrogen sulfide	5	< 1.1	< 0.01

Table 33: Sample information – Oxides of Sulfur

Site		Shaolbay Landfill		
Sample Location		BV300_2		
Reference Method		USEPA Method 8 - ISOKINETIC		
Run ID		27		
Test Parameter		SOx		
Test Date	dd/mm/yyyy	6/08/2022		
Start Time	hh:mm	9:07		
End Time	hh:mm	10:07		
Average Stack Temperature	°C	88		
Absolute Stack Pressure	mb	1009		
Moisture Content	% v/v	61.2		
Dry Gas Density	kg/Nm^3	1.35		
Dry Gas Molecular Weight	g/g-mole	30.2		
Sample Volume (dry gas meter)	Nm^3	0.32		
Stack Gas Velocity	m/sec	2.6		
Actual Stack Flow Rate	m^3/min	43		
Dry Standard Stack Flow Rate	Nm^3/min	13		
Percent Isokinetic Rate	%	94		
Pollutant SOx	Licence limit mg/Nm^3	standard conditions Concentration mg/Nm^3		Emission Rate g/min
SO_2	-	< 3.4		< 0.04
SO_3 (as H_2SO_4)	100	< 1.7		< 0.02

Table 34: Sample information – Acid gases

Site		Shaolbay Landfill		
Sample Location		BV300_2		
Reference Method		USEPA Method 26A - ISOKINETIC		
Run ID		25		
Test Parameter		HCl / Cl_2		
Test Date	dd/mm/yyyy	6/08/2022		
Start Time	hh:mm	11:45		
End Time	hh:mm	12:45		
Average Stack Temperature	°C	88		
Absolute Stack Pressure	mb	1009		
Moisture Content	% v/v	62.6		
Dry Gas Density	kg/Nm^3	1.35		
Dry Gas Molecular Weight	g/g-mole	30.2		
Sample Volume (dry gas meter)	Nm^3	0.44		
Stack Gas Velocity	m/sec	3.3		
Actual Stack Flow Rate	m^3/min	54		
Dry Standard Stack Flow Rate	Nm^3/min	15		
Percent Isokinetic Rate	%	105		
Pollutant HCl / Cl_2	Licence limit mg/Nm^3	standard conditions Concentration mg/Nm^3		Emission Rate g/min
HCl	100	< 2.3		< 0.04
Cl_2	200	< 2.3		< 0.04

Table 35: Sample information – Heavy metals

Site		Shaolbay Landfill		
Sample Location		BV300_2		
Reference Method		USEPA Method 29 - ISOKINETIC		
Run ID		24		
Test Parameter		Metals		
Test Date	dd/mm/yyyy	6/08/2022		
Start Time	hh:mm	14:22		
End Time	hh:mm	16:22		
Average Stack Temperature	°C	88		
Absolute Stack Pressure	mb	1009		
Moisture Content	% v/v	65.5		
Dry Gas Density	kg/Nm^3	1.35		
Dry Gas Molecular Weight	g/g-mole	30.3		
Sample Volume (dry gas meter)	Nm^3	0.76		
Stack Gas Velocity	m/sec	3.0		
Actual Stack Flow Rate	m^3/min	50		
Dry Standard Stack Flow Rate	Nm^3/min	13		
Percent Isokinetic Rate	%	108		
		standard conditions		
Pollutant	Licence limit	Concentration		Emission Rate
Metals	µg/Nm^3	µg/Nm^3		g/min
Antimony	-	< 7.5		< 9.6E-05
Arsenic	-	< 7.5		< 9.6E-05
Beryllium	-	< 0.6		< 7.2E-06
Cadmium	200	3.2		4.1E-05
Chromium	-	12		1.5E-04
Cobalt	-	1.1		1.4E-05
Lead	-	300		3.9E-03
Manganese	-	5.7		7.3E-05
Nickel	-	20		2.5E-04
Selenium	-	37		4.8E-04
Tin	-	< 19		< 2.4E-04
Vanadium	-	< 9.3		< 1.2E-04
Mercury	200	1.6		2.1E-05
Total Heavy Metals (lower bound)	1,000	380		4.9E-03

Table 36: Sample information – Volatile organic compounds

Site		Shaolbay Landfill	
Sample Location		BV300_2	
Reference Method		USEPA Method 18 - CONSTANT FLOW	
Run ID		28	
Test Parameter		VOC	
Test Date	dd/mm/yyyy	7/08/2022	
Start Time	hh:mm	15:00	
End Time	hh:mm	16:00	
Average Stack Temperature	°C	88	
Absolute Stack Pressure	mb	1009	
Moisture Content	% v/v	62.4	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.2	
Sample Volume (dry gas meter)	Nm^3	0.02	
Stack Gas Velocity	m/sec	2.9	
Actual Stack Flow Rate	m^3/min	47	
Dry Standard Stack Flow Rate	Nm^3/min	13	
Percent Isokinetic Rate	%	N/A	
Pollutant Total (non-methane) VOCs	Licence limit mg/Nm^3	standard conditions Concentration mg/Nm^3	Emission Rate g/min
Total VOCs - as n-hexane	-	< 2.2	< 0.03
Total VOCs - as n-propane	40	< 1.1	< 0.01

Table 37: Sample information – Ammonia

Site		Shaolbay Landfill	
Sample Location		BV300_2	
Reference Method		USEPA Method 6 - CONSTANT FLOW	
Run ID		29	
Test Parameter		NH_3	
Test Date	dd/mm/yyyy	7/08/2022	
Start Time	hh:mm	9:45	
End Time	hh:mm	10:45	
Average Stack Temperature	°C	88	
Absolute Stack Pressure	mb	1009	
Moisture Content	% v/v	62.4	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.2	
Sample Volume (dry gas meter)	Nm^3	0.04	
Stack Gas Velocity	m/sec	2.9	
Actual Stack Flow Rate	m^3/min	47	
Dry Standard Stack Flow Rate	Nm^3/min	13	
Percent Isokinetic Rate	%	N/A	
Pollutant NH_3	standard conditions mg/Nm^3	Concentration standard conditions mg/Nm^3	Emission Rate standard conditions g/min
Ammonia (NH_3) - in condensate	-	2,205	29.6
Ammonia (NH_3) - gaseous	-	144	1.9
Total Ammonia (as NH_3)	-	2,348	31.5

Table 38: Sample information – Fluoride

Site		Shaolbay Landfill	
Sample Location		BV300_2	
Reference Method		USEPA Method 13B - ISOKINETIC	
Run ID		26	
Test Parameter		F	
Test Date	dd/mm/yyyy	8/08/2022	
Start Time	hh:mm	8:04	
End Time	hh:mm	9:07	
Average Stack Temperature	°C	88	
Absolute Stack Pressure	mb	1009	
Moisture Content	% v/v	64.9	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.2	
Sample Volume (dry gas meter)	Nm^3	0.35	
Stack Gas Velocity	m/sec	2.7	
Actual Stack Flow Rate	m^3/min	45	
Dry Standard Stack Flow Rate	Nm^3/min	12	
Percent Isokinetic Rate	%	108	
Pollutant	Licence limit	standard conditions Concentration	Emission Rate
F	mg/Nm^3	mg/Nm^3	g/min
Fluorine - (as total HF)	50	< 3.0	< 0.04

Table 39: Sample information – Combustion gases

Site		Shaolbay Landfill	
Sample Location		BV300_2	
Reference Method		USEPA Method 3A, 7E & 10	
Run ID		Various	
Test Parameter		O_2, CO_2, NOx, CO	
Test Date	dd/mm/yyyy	8/08/2022	
Start Time	hh:mm	8:04	
End Time	hh:mm	16:54	
Average Stack Temperature	°C	88	
Absolute Stack Pressure	mb	1009	
Moisture Content	% v/v	63.3	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.2	
Stack Gas Velocity	m/sec	2.9	
Actual Stack Flow Rate	m^3/min	48	
Dry Standard Stack Flow Rate	Nm^3/min	13	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
O_2, CO_2, NOx, CO	STP	STP	g/min
Oxygen (% v/v)	-	3.8	-
Carbon dioxide (% v/v)	-	13.0	-
Carbon monoxide (mg/Nm^3)	125	61	0.9
Oxides of nitrogen (mg/m^3)	350	180	2.4

Table 40: Sample information – Dioxins & furans

Site		Shaolbay Landfill
Sample Location		BV300_2
Reference Method		USEPA Method 23 - ISOKINETIC
Run ID		23
Test Parameter		DF PCB
Test Date	dd/mm/yyyy	7/08/2022
Start Time	hh:mm	13:54
End Time	hh:mm	16:54

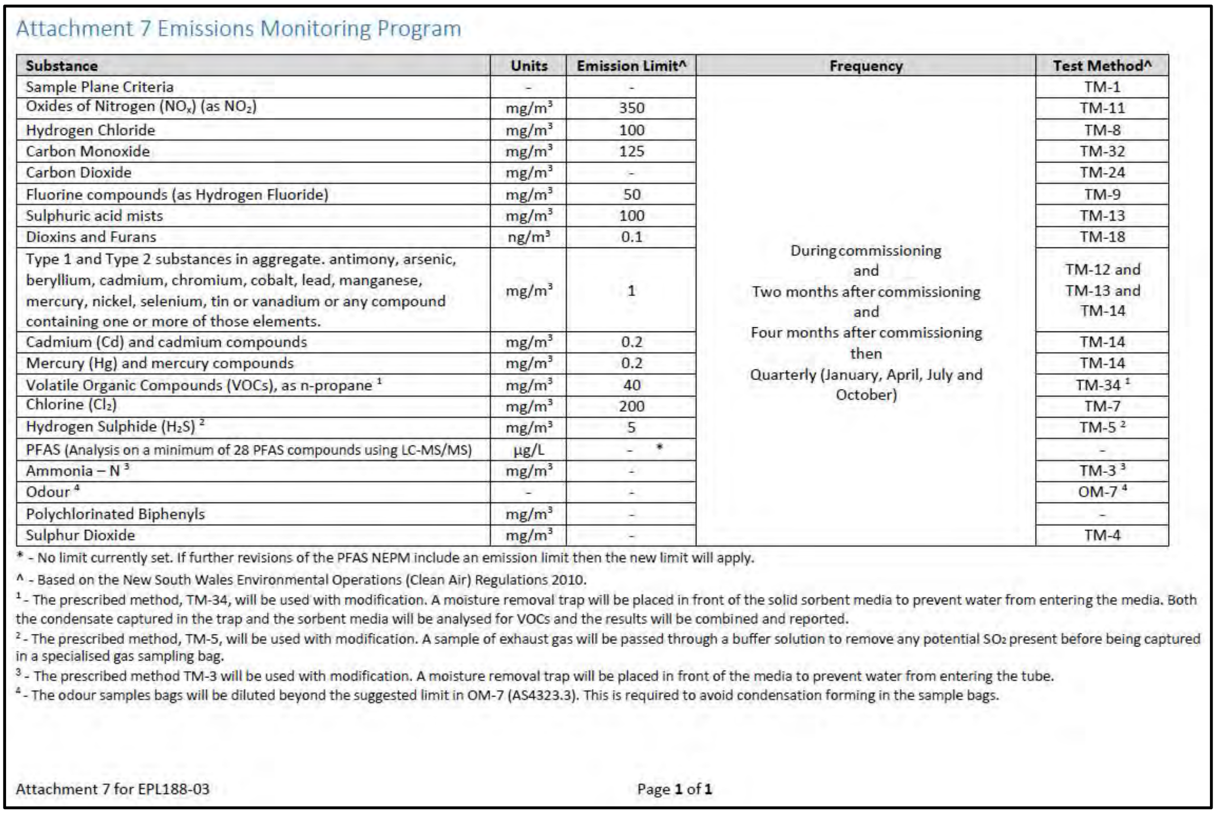
Average Stack Temperature	°C	88
Absolute Stack Pressure	mb	1009
Moisture Content	% v/v	62.4
Dry Gas Density	kg/Nm^3	1.35
Dry Gas Molecular Weight	g/g-mole	30.2
Sample Volume (dry gas meter)	Nm^3	1.11
Stack Gas Velocity	m/sec	2.9
Actual Stack Flow Rate	m^3/min	47
Dry Standard Stack Flow Rate	Nm^3/min	13
Percent Isokinetic Rate	%	101

Pollutant DF PCB	Licence limit ng/Nm^3	standard conditions Concentration ng/Nm^3	Emission Rate g/min
2378 TCDF	-	0.011	1.4E-10
Total TCDF isomers	-	0.09	1.1E-09
2378 TCDD	-	< 0.0027	< 3.6E-11
Total TCDD isomers	-	0.028	3.7E-10
12378 PeCDF	-	0.0033	4.5E-11
23478 PeCDF	-	0.0034	4.6E-11
Total PeCDF isomers	-	0.039	5.2E-10
12378 PeCDD	-	0.0014	1.9E-11
Total PeCDD isomers	-	0.019	2.5E-10
123478 HxCDF	-	0.0025	3.4E-11
123678 HxCDF	-	0.0024	3.3E-11
234678 HxCDF	-	0.0022	3.0E-11
123789 HxCDF	-	< 0.00072	< 9.7E-12
Total HxCDF isomers	-	0.017	2.3E-10
123478 HxCDD	-	< 0.00090	< 1.2E-11
123678 HxCDD	-	0.0022	3.0E-11
123789 HxCDD	-	0.0012	1.6E-11
Total HxCDD isomers	-	0.035	4.7E-10
1234678 HpCDF	-	0.0049	6.5E-11
1234789 HpCDF	-	< 0.00090	< 1.2E-11
Total HpCDF isomers	-	0.0081	1.1E-10
1234678 HpCDD	-	0.030	4.0E-10
Total HpCDD isomers	-	0.058	7.7E-10
OCDF	-	0.0014	1.9E-11
OCDD	-	0.11	1.4E-09
Sum of congeners Sum of positive detections	-	0.40	5.3E-09
Total I-TEQ Sum of positive detections	0.1	0.005	7.0E-11

Table 41: Sample information – PCBs

PCBs (USEPA Method 23)					
PCBs	Licence limit ng/Nm^3		standard conditions Concentration ng/Nm^3		Emission Rate g/min
PCB#77	-		0.81		1.1E-08
PCB#81	-		0.031		4.1E-10
PCB#126	-		0.037		4.9E-10
PCB#169	-	<	0.0018	<	2.4E-11
PCB#105	-		3.4		4.5E-08
PCB#114	-		0.21		2.8E-09
PCB#118	-		7.6		1.0E-07
PCB#123	-		0.12		1.6E-09
PCB#156	-		1.0		1.4E-08
PCB#157	-		0.22		2.9E-09
PCB#167	-		0.32		4.3E-09
PCB#189	-		0.039		5.2E-10
Sum of PCB Congeners Sum of positive detections	-		14		1.8E-07
Total TEQ Sum of positive detections	-		0.0041		5.6E-11

7 APPENDIX



Attachment 7 Emissions Monitoring Program

Substance	Units	Emission Limit^	Frequency	Test Method^
Sample Plane Criteria	-	-	During commissioning and Two months after commissioning and Four months after commissioning then Quarterly (January, April, July and October)	TM-1
Oxides of Nitrogen (NO_x) (as NO_2)	mg/m^3	350		TM-11
Hydrogen Chloride	mg/m^3	100		TM-8
Carbon Monoxide	mg/m^3	125		TM-32
Carbon Dioxide	mg/m^3	-		TM-24
Fluorine compounds (as Hydrogen Fluoride)	mg/m^3	50		TM-9
Sulphuric acid mists	mg/m^3	100		TM-13
Dioxins and Furans	ng/m^3	0.1		TM-18
Type 1 and Type 2 substances in aggregate. antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, manganese, mercury, nickel, selenium, tin or vanadium or any compound containing one or more of those elements.	mg/m^3	1		TM-12 and TM-13 and TM-14
Cadmium (Cd) and cadmium compounds	mg/m^3	0.2		TM-14
Mercury (Hg) and mercury compounds	mg/m^3	0.2		TM-14
Volatile Organic Compounds (VOCs), as n-propane [1]	mg/m^3	40		TM-34 [1]
Chlorine (Cl_2)	mg/m^3	200		TM-7
Hydrogen Sulphide (H_2S) [2]	mg/m^3	5		TM-5 [2]
PFAS (Analysis on a minimum of 28 PFAS compounds using LC-MS/MS)	µg/L	- *		-
Ammonia – N [3]	mg/m^3	-		TM-3 [3]
Odour [4]	-	-		OM-7 [4]
Polychlorinated Biphenyls	mg/m^3	-		-
Sulphur Dioxide	mg/m^3	-		TM-4

* - No limit currently set. If further revisions of the PFAS NEPM include an emission limit then the new limit will apply.

^ - Based on the New South Wales Environmental Operations (Clean Air) Regulations 2010.

[1] - The prescribed method, TM-34, will be used with modification. A moisture removal trap will be placed in front of the solid sorbent media to prevent water from entering the media. Both the condensate captured in the trap and the sorbent media will be analysed for VOCs and the results will be combined and reported.

[2] - The prescribed method, TM-5, will be used with modification. A sample of exhaust gas will be passed through a buffer solution to remove any potential SO_2 present before being captured in a specialised gas sampling bag.

[3] - The prescribed method TM-3 will be used with modification. A moisture removal trap will be placed in front of the media to prevent water from entering the tube.

[4] - The odour samples bags will be diluted beyond the suggested limit in OM-7 (AS4323.3). This is required to avoid condensation forming in the sample bags.

Attachment 7 for EPL188-03 Page **1** of **1**

Figure 4: Excerpt from EPL188-03 – Attachment 7

ASSURED ENVIRONMENTAL PTY LTD
Your environmental compliance partner

OCTOBER 2022

SOURCE EMISSIONS MONITORING – SHOAL BAY BENEVAP 150

CLIENT: BENETERRA
PROJECT ID: 14621
DATE: 29/11/2022 RELEASE: R_0

DOCUMENT CONTROL PAGE

Project Title: Source Emissions Monitoring – Shoal Bay Benevap 150

Project Reference ID: 14621

Report Prepared by:

Assured Environmental
Unit 7, 142 Tennyson Memorial Avenue
Tennyson, QLD, 4105
ABN: 87 604 851 078

Report Prepared for:

BeneTerra
Shoal Bay Access Road
Karama NT 0812

Report Author: Timon Berger

Report Reviewer: Adam Dixon

Table 1: History of Revisions

Revision	Date	Issued to	Changes
R_0	29/11/2022	N. Sharma	Formal report release.
DRAFT_0	25/11/2022	N. Sharma	Draft release for comment.

ACCREDITED FOR COMPLIANCE TO ISO/IEC 17025 (TESTING)

The results of the tests, calibrations and/or measurements included in this document is traceable to Australian/national standards.

Accreditation number: 19703

NATA
WORLD RECOGNISED
ACCREDITATION
NATA ID: 19703

DISCLAIMER

Assured Environmental acts in all professional matters as a faithful advisor to the Client and exercises all reasonable skill and care in the provision of its professional services.

Reports are commissioned by and prepared for the exclusive use of the Client. They are subject to and issued in accordance with the agreement between the Client and Assured Environmental. Assured Environmental is not responsible for any liability and accepts no responsibility whatsoever arising from the misapplication or misinterpretation by third parties of the contents of its reports.

Except where expressly stated, Assured Environmental does not attempt to verify the accuracy, validity or comprehensiveness of any information supplied to Assured Environmental for its reports.

Reports cannot be copied or reproduced in whole or part for any purpose without the prior written agreement of Assured Environmental.

Where site inspections, testing or fieldwork have taken place, the report is based on the information made available by the client or their nominees during the visit, visual observations and any subsequent discussions with regulatory authorities. The validity and comprehensiveness of supplied information has not been independently verified and, for the purposes of this report, it is assumed that the information provided to Assured Environmental is both complete and accurate. It is further assumed that normal activities were being undertaken at the site on the day of the site visit(s), unless explicitly stated otherwise.

EXECUTIVE SUMMARY

Assured Environmental (AE) conducted source emissions monitoring from the mobile BeneVap Leachate Treatment Facility (BV150) located at the Shoal Bay Waste Facility in Darwin, Northern Territory from 15th to 19th October 2022.

A summary of results and comparison against compliance levels is presented in Table 2 below from the testing conducted on the single release point on the BV150 unit.

In comparison to the emission limits outlined in EPL188-03 – Attachment 7, all measured parameters were within those limits specified. Results are reported at dry, 273.15°K and 101.325 kPa (STP).

Table 2: Summary of measured parameters

Parameter		Result BV150	Emission limit	Unit	Reference
Average source temperature		85	-	°C	-
Flue gas water vapour content		55	-	vol-%	-
Carbon dioxide concentration		9.1	-	vol-%	STP - dry
Oxygen concentration		8.8	-	vol-%	STP - dry
Flue gas molecular weight - dry		1.3	-	kg/Nm^3	STP - dry
Flue gas velocity		3.2	-	m/sec	STP - dry
Flue gas volume flow		18.8	-	Nm^3/min	STP - dry
Oxides of nitrogen (as NO_2)		83	350	mg/Nm^3	STP - dry
- emission rate		1.5	-	g/min	
Carbon monoxide		23	125	mg/Nm^3	STP - dry
- emission rate		0.43	-	g/min	
Total heavy metals		0.14	1.0	mg/Nm^3	STP - dry
- emission rate		0.0026	-	g/min	
Cadmium		0.0045	0.2	mg/Nm^3	STP - dry
- emission rate		8.2E-05	-	g/min	
Mercury		0.0021	0.2	mg/Nm^3	STP - dry
- emission rate		3.8E-05	-	g/min	
Fluorine (as HF)	<	2.0	50	mg/Nm^3	STP - dry
- emission rate	<	0.037	-	g/min	
Hydrogen chloride	<	2.2	100	mg/Nm^3	STP - dry
- emission rate	<	0.040	-	g/min	
Chlorine	<	2.2	200	mg/Nm^3	STP - dry
- emission rate	<	0.040	-	g/min	
Ammonia (NH_3) - total		1,780	-	mg/Nm^3	STP - dry
- emission rate		33	-	g/min	
Ammonia (NH_3) - in condensate		1,659	-	mg/Nm^3	STP - dry
- emission rate		31	-	g/min	
Ammonia (NH_3) - gaseous		121	-	mg/Nm^3	STP - dry
- emission rate		2.2	-	g/min	
Hydrogen sulfide	<	0.8	5	mg/Nm^3	STP - dry
- emission rate	<	0.01	-	g/min	
Sulfur dioxide	<	2.0	-	mg/Nm^3	STP - dry
- emission rate	<	0.04	-	g/min	
Sulfuric acid mist (as H_2SO_4)	<	0.8	100	mg/Nm^3	STP - dry
- emission rate	<	0.02	-	g/min	
Total VOCs (as n-propane)	<	0.9	40	mg/Nm^3	STP - dry
- emission rate	<	0.02	-	g/min	
Average odour		8,215	-	ou	STP - wet
- emission rate		354,906	-	$ou\text{-}m^3/min$	
Dioxins & Furans (i-TEQ)		0.0031	0.1	ng/Nm^3	STP - dry
- emission rate		6.2E-11	-	g/min	
PCBs (i-TEQ)		0.0031	-	ng/Nm^3	STP - dry
- emission rate		6.2E-11	-	g/min	

Table 3: Summary of PFAS results

Parameter		Result ng/Nm^3		Emission Rate g/min	Reference
Per- and polyfluoroalkyl substances					
Perfluorobutanesulfonic acid		**188**		**3.5E-06**	**STP**
Perfluoropentanesulfonic acid		**2.8**		**5.2E-08**	**STP**
Perfluorohexanesulfonic acid		**31**		**5.7E-07**	**STP**
Perfluoroheptanesulfonic acid		**1.5**		**2.7E-08**	**STP**
Perfluorooctanesulfonic acid PFOS		**38**		**7.0E-07**	**STP**
Perfluorodecanesulfonic acid	<	2.7	<	5.0E-08	STP
Perfluorobutanoic acid		**21**		**3.9E-07**	**STP**
Perfluoropentanoic acid		**75**		**1.4E-06**	**STP**
Perfluorohexanoic acid		**78**		**1.4E-06**	**STP**
Perfluoroheptanoic acid		**20**		**3.6E-07**	**STP**
Perfluorooctanoic acid PFOA		**62**		**1.1E-06**	**STP**
Perfluorononanoic acid		**3.5**		**6.5E-08**	**STP**
Perfluorodecanoic acid		**4.3**		**7.9E-08**	**STP**
Perfluoroundecanoic acid	<	6.7	<	1.2E-07	STP
Perfluorododecanoic acid	<	6.7	<	1.2E-07	STP
Perfluorotridecanoic acid	<	6.7	<	1.2E-07	STP
Perfluorotetradecanoic acid	<	34	<	6.2E-07	STP
4:2 FTS	<	1.3	<	2.5E-08	STP
6:2 FTS		**35**		**6.4E-07**	**STP**
8:2 FTS		**3.0**		**5.6E-08**	**STP**
10:2 FTS	<	2.7	<	5.0E-08	STP
Perfluorooctane sulfonamide	<	6.7	<	1.2E-07	STP
N-Methyl perfluorooctane sulfonamide	<	6.7	<	1.2E-07	STP
N-Ethyl perfluorooctanesulfonamide	<	6.7	<	1.2E-07	STP
N-Me perfluorooctanesulfonamidoethanol		**107**		**2.0E-06**	**STP**
N-Et perfluorooctanesulfonamidoethanol	<	82	<	1.5E-06	STP
MePerfluorooctanesulf-amido acetic acid		**4.4**		**8.1E-08**	**STP**
EtPerfluorooctanesulf-amido acetic acid		**5.7**		**1.1E-07**	**STP**

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

Assured Environmental (AE) was appointed by BeneTerra to sample and analyse source emissions from the BeneVap Leachate Treatment system. Sampling was conducted by AE from 15th to 19th October 2022 during typical site operations.

AE was responsible for the collection and analysis of samples, unless otherwise indicated. The samples were recovered and stored in the appropriate manner until their return to the laboratory where the samples were prepared and analysed according to the methodologies listed below in this report.

2 METHODOLGY & EQUIPMENT

2.1 Sampling methodology

All sampling and analysis was carried out in accordance with the listed requirements in Table 4. Any specific comments about the sampling and analysis have been documented where required.

Table 4: Test methods

Parameter	Reference Test Method	Test Method (NSW)	NATA accreditation	Analysis by
Sample location	AS4323.1	TM-1	Yes	1
Velocity & flow rate	USEPA Method 2	TM-2	Yes	1
Stack gas density	USEPA Method 3	TM-23	Yes	1
Oxygen	USEPA Method 3A	TM-25	Yes	1
Carbon dioxide	USEPA Method 3A	TM-24	Yes	1
Water vapour content	USEPA Method 4	TM-22	Yes	1
Sulphur dioxide	USEPA Method 6	TM-4	Yes	1
Oxides of nitrogen (as NO_2)	USEPA Method 7E	TM-11	Yes	1
Sulfuric acid mists	USEPA Method 8	TM-3[a]	Yes	1
Carbon monoxide	USEPA Method 10	TM-32	Yes	1
Hydrogen sulfide	USEPA Method 15	TM-5	Yes	1
Total VOCs	USEPA Method 18	TM-34	Yes	2
Hydrogen chloride	USEPA Method 26A	TM-8	Yes	2
Chlorine	USEPA Method 26A	TM-7	Yes	2
Fluoride (as HF)	USEPA Method 13B	TM-9	Yes	2
Heavy metals	USEPA Method 29	TM-12/13/14	Yes	2
PFAS – suite	USEPA SW846 Method 0010	Mod TM-18	No	2
Dioxins & furans	USEPA SW846 Method 0010	TM-18	Yes	3
Polychlorinated biphenyls	USEPA SW846 Method 0010	TM-18	Yes	3
Ammonia	Modified USEPA Method 26	Mod TM-4[b]	Yes	2
Odour	AS4323.3	OM-7	Yes	1

Table 5: Analysis performed by

Note	Company	Work performed	NATA ID	Report Number
1	Assured Environmental	Sampling & analysis	19703	14621
2	Envirolab Services	Sample analysis	2901	309081
3	National Measurement Inst.	PCDD/F & PCB analysis	198	DAU22_283

---

[a] EPL188-03 lists the test method for sulfuric acid mists as TM-13, this does not correspond to the *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales* listed method (TM-3).

[b] EPL188-03 lists the test method for ammonia as TM-3. A closer representation of the sampling technique is a Modified TM-4 sample train. See the description of the sampling technique in Table 6 below.

Table 6: Sampling comments

Note	Comment
Sample location	Sample location is compliant but non ideal as per AS4323.1. The sample location is greater than two, but less than six diameters downstream from a disturbance. The temperature and velocity survey showed that the sample position was in compliance to items (a) to (f) as per AS4323.1.
Calibrations	Analyser calibration performed in the laboratory prior to conducting field work and post field work in AE lab.
H_2S	A sample of exhaust gas was passed through a buffer solution to remove any potential SO_2 present before being captured in a specialised gas sampling bag. Analysis for H_2S was performed using GC-FPD within 30 hours of collection.
Heavy metals	Type 1 substances: Antimony, Arsenic, Cadmium, Lead Mercury. Type 2 substances: Beryllium, Chromium, Cobalt, Manganese, Nickel, Selenium, Tin, Vanadium.
PFAS	A modified version of the USEPA SW846 Method 0010 sample train was employed to sample for Per- and poly-fluoroalkyl substances (PFAS) material in the flue gas emission. Refer to section 2.2 for further information.
Ammonia	The ammonia sampling was performed using a modified constant flow sampling train. A condensate removal trap was placed in front of the collection trap containing the absorbing solution to separate condensing ammonia from gaseous ammonia passing through the initial dropout and into the collection solution (0.1N H_2SO_4). Both the condensate captured in the trap and the sorbent solution are analysed for ammonia individually. Ammonia results are reported in the condensate and gaseous phase separately and as total NH_3. Samples are analysed using a Discrete Analyser.
Odour	Due to the high levels of moisture in the emission the odour samples bags were diluted beyond the suggested limit in AS4323.3. This is required to avoid condensation forming in the sample bags.

2.2 Per- and poly-fluoroalkyl substances sample methodology

Suitable sampling methods for Per- and poly-fluoroalkyl substances (PFAS) in air have received considerably less attention than in other media such as water and soil matrices. As such Assured Environmental has developed a sampling method based on modifications of the promulgated USEPA SW846 Method 0010 sample train. This method includes consideration for both semi-volatile and particulate bound PFAS. It is recognised that the US EPA has recently introduced Other Test Method (OTM) – 45 and although many of the elements included in this method are consistent with the method developed by AE. It is also noted that posting of an OTM by USEPA is neither an endorsement by EPA regarding the validity of the test method nor a regulatory approval of the test method, rather to promote discussion of developing emerging methodologies prior to full endorsement. In this case the AE method was employed, which is summarised below.

The basis of the sample train is;

- Gaseous and particulate pollutants are withdrawn from an emission source at an isokinetic sampling rate and are collected in a multi-component sampling train. The sample train contains a high-efficiency glass fibre filter and a packed bed of porous adsorbent resin. The filter is used to collect organic-laden particulate materials and the porous polymeric resin to adsorb semi-volatile organic species. Semi-volatile species are defined as compounds with boiling points greater than 100°C. The impingers downstream of the resin trap are loaded with water to knock-out any water vapour prior to metering the gas. These impingers are not routinely analysed for S-VOCs.

The modifications made to this sample train in order to target PFAS materials included;

- Sorbent material is XAD-2 and XAD-4.
- The resin traps are spiked with a surrogate standard to test for retention. A known quantity of standard is injected into the trap during preparation, the trap is then shipped, sampled and returned to the laboratory for analysis. The analysis includes detecting the injected standard, which provides a measure of the recovery efficiency. Factors that may affect the recovery efficiency include, sample transport and handling procedures, sampling temperatures (the resin must be chilled during sampling and maintained below 20°C) and sample preparation at the laboratory, including the extraction of the sample from the resin.
- Condensate remove trap prior to resin traps.
- Impingers downstream of the resin trap are loaded with a sodium solution and is intended to be a breakthrough detector. Following the sampling, the impinger contents are measured and placed in a sample bottle for shipment to the laboratory. The final impinger of the sample train is then analysed separately to the filter, resin trap and front half methanol rinse so as to provide a measure of possible breakthrough. The intent of this sample train component is to provide a measure of breakthrough from the primary sampling components. Where no detections of PFAS material is made in this sample component, the limit of detection is not added to the sample result.
- Following the sampling onsite, all sample train components that have been in contact with the sample are rinsed thoroughly with methanol and stored in a sample container to be analysed as part of the sample.
- Sample train component material. According to documented water and soil PFAS sampling procedures, the use of glass, Teflon and stainless steel should be avoided and the use of polypropylene (PE) is recommended. PE is not considered to be conducive to source emissions sampling due to the temperatures of the flue gas. PE or HDPE cannot be used in the probe or filter box due to its low melting point, instead, all sampling components upstream of the resin trap was constructed of glass. Following sampling, all glassware was thoroughly rinsed with methanol at least three times to quantitatively recovery any possible PFAS material deposited on this surface.

For the analysis, the samples are extracted using a solvent desorption technique, with the filter and front half methanol rinse extract combined prior to analysis for the PFAS species. The XAD resin trap is then analysed in isolation as is the condensate downstream of the trap to gain an understanding of where the PFAS is captured within the sample train. The analysis is performed using LC/MS/MS instruments, with each analysis performed using the surrogate spikes to determine sample specific recoveries.

2.2.1 PFAS blank corrections

A full field blank sample has not been performed for this round of sampling. The stock reagents are largely unchanged from the previous round of sampling (13633), therefore the results of this previous blank are utilised for this round. A field blank is performed by the sample train being constructed as normal, however no sample is passed through it. It is then cleaned and recovered following the standard recovery procedures and the filter, resin trap and rinsate kept and analysed along with the sample.

The following details the procedures used to correct for detections of PFAS species in the blank samples.

- Where the blank result is a non-detection, no adjustment to the sample result is made.
- Where the blank result returns a positive detection, but is less than half of the sample result, the blank value is subtracted from the sample result and reported as a positive detection.
- Where the blank value returns a positive detection, and is exceeding half of the sample result, no adjustments are made to the sample result, but it is reported as a non-detection.

2.3 Sample Location

The images and figures below show the sample location and site details.

Figure 1: BeneVap treatment system stack

Table 7: Sample location summary

AS4323.1	Sample location	BV150
	Stack Shape	CIRCULAR
	Ideal Sampling Plane Assessment	
	Stack Diameter (m)	0.6
	Stack Cross Section Area (m^2)	0.28
	Distance to upstream disturbance (m) (from disturbance)	0.7
	Upstream Diameters (D)	1.1
	Distance to downstream disturbance (m) (from disturbance)	1.3
	Downstream diameters (D)	2.2
4.2.2 Table 1	Meets Requirements AS4323.1 Table 1	No
	Non-deal Sampling Plane Assessment	
	Assessment required?	No
	Total traverse point factors	1.21
	Non-conforming Sampling Plane Assessment	
4.2.2(a)	Gas flow in same direction	Yes
4.2.2(b)	Gas flow steady & evenly distributed (cyclonic or swirl <15º)	Yes
4.2.2(c)	Temperature difference between points <10%, and each point <10% of average	Yes
4.2.2(d)	Ratio of highest to lowest differential pressure & ratio highest to lowest velocity	2.7 1.6
4.2.2(e)	Minimum differential pressure	0.30
	Gas temperature above dewpoint	No
	Samling Plane Type	
4.2.2, 4.2.3, 4.2.4	Sampling plane type	Non-conforming
	Alternative sampling plane available?	No
	Number of Sample Points Adopted	
	Port size (mm)	75
	Port Thread Type	BSP
	Number of traverses	2
	Number of points per traverse	6
	Total number of traverse points	12
	Flow & temperature compliance check	No

2.4 Test equipment

The sampling equipment was transported to site and specifically setup at the test location. Sampling was performed using heated probes and filters, with a constant flow and isokinetic sample console.

Equipment used during the course of the testing is sourced from Apex Instruments and Testo, industry leaders in the supply of source testing equipment.

Figure 2: Manual sample equipment

Figure 3: Combustion gas analyser

3 MEASUREMENT UNCERTAINTY

There is an inherent uncertainty associated with any scientific measurement, including stack emissions monitoring. The measurement uncertainty can be controlled with strict adherence to the reference methodology along with utilising appropriate calibration standards with corresponding acceptable uncertainty reports.

Many source sampling methods do not outline exact procedures for establishing direct measurement uncertainty. In the absence of a defined procedure, the uncertainty budgets presented are based on estimations using ISO-GUM method.

Each individual source and test may have a unique associated uncertainty, due largely to the stack sample location in relation to the positioning requirements of AS4323.1.

Table 8: Sample specific uncertainty budgets

Parameter	Reference method	Limit of measurement	Unit of measure	Uncertainty ± %
Flue gas velocity	USEPA Method 2	3	m/sec	10
Oxygen	USEPA Method 3A	0.3	%-vol	5.0
Carbon dioxide	USEPA Method 3A	0.3	%-vol	10
Water vapour content	USEPA Method 4	0.5	%-vol	5.0
Sulphur dioxide	USEPA Method 6	2.0	mg/sample	15
Oxides of nitrogen (as NO_2)	USEPA Method 7E	2.1	mg/sample	15
Sulfuric acid mists	USEPA Method 8	2.0	mg/sample	15
Carbon monoxide	USEPA Method 10	1.5	mg/sample	15
Hydrogen sulfide	USEPA Method 15	1.0	mg/sample	20
Total VOCs	USEPA Method 18	1.0	mg/sample	20
Hydrogen chloride	USEPA Method 26A	1.0	mg/sample	15
Chlorine	USEPA Method 26A	1.0	mg/sample	15
Fluoride (as HF)	USEPA Method 13B	1.0	mg/sample	15
Heavy metals	USEPA Method 29	0.3 to 50	µg/sample	20
PFAS – suite	USEPA SW846 Method 0010	1 to 50	ng/sample	25
Dioxins & furans	USEPA SW846 Method 0010	1	pg/sample	15
Polychlorinated biphenyls	USEPA SW846 Method 0010	20	pg/sample	15
Ammonia	Modified USEPA Method 26	1	mg/sample	25
Odour	AS4323.3	100	ou	40

4 QUALITY ASSURANCE & QUALITY CONTROL (QA/QC)

AE operates within a quality system based upon the requirements of ISO17025. Our quality system defines specific procedures and methodologies to ensure any project undertaken by AE is conducted with the highest level of quality given the specific confines of each project. The overall objective of our QA/QC procedures is to representatively sample and accurately analyse components in the gas streams and therefore report valid measurements of emission concentrations.

To ensure representativeness of field work, our quality procedures target:

1. Correct sampling locations
2. Sample time
3. Frequency of samples and
4. Method selection & adherence

To ensure representativeness of lab work, our quality procedures target:

1. Sample preservation
2. Chain of custody (COC)
3. Sample preparation and
4. Analytical techniques

AE maintains strict quality assurance throughout all its sampling programs, covering on-site 'field work' and the analytical phase of our projects. Our QA program covers the calibration of all sampling and analytical apparatus where applicable and the use of spikes, replicate sample and reference standards. The test methodologies used for this project are outlined in section 2 of this document. Field test data has been recorded and calculated using direct entry into Microsoft Excel spreadsheets following the procedures of the appropriate test methods. Determination of emission concentrations has been performed using the same Microsoft Excel spreadsheets which are partially supplied as an attachment to this report. More detailed information can be supplied upon request.

QA/QC checks for this project will use validation techniques and criteria appropriate to the type of data and the purpose of the measurement to approve the test report. Records of all data will be maintained. Complete chain of custody (COC) procedures have been followed to document the entire custodial history of each sample. The COC forms also served as a laboratory sheet detailing sample ID and analysis requirements.

Table 9: Sampling data QA/QC checklist

Sampling Data QA/QC Checklist	Comment
Use of appropriate test methods	Yes
'Normal' operation of the process being tested	Yes – as instructed by client
Use of properly operating and calibrated test equipment	Yes
Use of high purity reagents	Yes
Performance of leak checks post sample (at least)	Yes

Table 10: Laboratory data QA/QC checklist

Laboratory Data QA/QC Checklist	Comment
Use of appropriate analytical methods	Yes
Use of properly operating and calibrated analytical equipment	Yes
Precision and accuracy comparable to that achieved in similar projects	Yes
Accurate reporting	Yes

Table 11: Olfactometer QA data

Item	Comment
Methodology	AS/NZ4323.3:2001 "determination of odour concentration by dynamic olfactometry".
Sample Media	Odour samples collected into Nalophan™ sample bags
Sample identification	All samples are labelled uniquely immediately following collection according to Assured Environmental identification procedure. Each sample has the following recorded: project ID, sample number, location, date, time, dilution and any deviations to AS/NZ4323.3.
Timing	All measurements were conducted within 30 hours of sampling as specified by AS/NZ4323.3
Traceability	All panel results are traceable to reference standards held by Assured Environmental
Analysis conditions	Room temperature maintained at 22 °C ± 3 °C
Odour panel location	7/142 Tennyson Memorial Avenue Tennyson, Qld. 4105
Reference odourant	40 ppm n-butanol
Odour panel threshold	100 ou

4.1 PFAS quality control

The recoveries of surrogate standards from the sampling and analysis are presented in the table below. The expected QC recovery for measurements in the ppb to ppt levels is in the range of 60 to 120%. The results are not corrected for the recovery efficiency.

Table 12: PFAS surrogate recovery (%)

Surrogate	PFAS	
	Filter	Trap
Field surrogate		
Surrogate $^{13}C_8$ PFOS	101	55
Surrogate $^{13}C_2$ PFOA	102	98

Analysis of the final bubbler containing a sodium borate solution was performed separately to the front of the sampling train in order to assess the potential for breakthrough. The results of this analysis are provided below.

Table 13: Breakthrough analysis

Perfluorinated surfactants	Abbreviation	Breakthrough analysis (ng/Nm^3)	
Perfluorobutanesulfonic acid	PFBS	<	0.1
Perfluoropentanesulfonic acid	PFPeS	<	0.1
Perfluorohexanesulfonic acid	PFHxS	<	0.1
Perfluoroheptanesulfonic acid	PFHpS	<	0.1
Perfluorooctanesulfonic acid PFOS	PFOS	<	0.1
Perfluorodecanesulfonic acid	PFDS	<	0.3
Perfluorobutanoic acid	PFBA	<	0.3
Perfluoropentanoic acid	PFPeA	<	0.3
Perfluorohexanoic acid	PFHxA	<	0.1
Perfluoroheptanoic acid	PFHpA	<	0.1
Perfluorooctanoic acid PFOA	PFOA	<	0.1
Perfluorononanoic acid	PFNA	<	0.1
Perfluorodecanoic acid	PFDA	<	0.7
Perfluoroundecanoic acid	PFUdA	<	0.7
Perfluorododecanoic acid	PFDoA	<	0.7
Perfluorotridecanoic acid	PFTrDA	<	0.7
Perfluorotetradecanoic acid	PFTeDA	<	3.3
4:2 FTS	4:2 FTS	<	0.1
6:2 FTS	6:2 FTS	<	0.1
8:2 FTS	8:2 FTS	<	0.3
10:2 FTS	10:2 FTS	<	0.3
Perfluorooctane sulfonamide	FOSA	<	0.7
N-Methyl perfluorooctanesulfonamide	N-MeFOSA	<	0.7
N-Ethyl perfluorooctanesulfonamide	n-EtFOSA	<	0.7
N-Me perfluorooctanesulfonamidoethanol	n-MeFOSE	<	0.7
N-Et perfluorooctanesulfonamidoethanol	n-EtFOSE	<	33.4
MePerfluorooctanesulf-amidoacetic acid	N-MeFOSAA	<	0.3
EtPerfluorooctanesulf-amidoacetic acid	N-EtFOSAA	<	0.3

The breakthrough analysis showed no detectable levels of PFAS.

Analysis of the field sample blank (project 13633) showed that only a small amount of PFOA was detectable in the methanol/XAD resin. The table below shows the results of the blank analysis.

Table 14: Field blank analysis

	Blank analysis		
Perfluorinated surfactants - PFAS suite	**Front half ng/sample**	**Resin Traps ng/sample**	**Breakthrough ng/sample**
Perfluorobutanesulfonic acid	< 0.2	< 0.2	< 0.2
Perfluoropentane sulfonic acid (PFPeS)	< 0.2	< 0.2	< 0.2
Perfluorohexane sulfonate (PFHxS)	< 0.2	< 0.2	< 0.2
Perfluoroheptane sulfonate (PFHpS)	< 0.2	< 0.2	< 0.2
Perfluorooctane sulfonate (PFOS)	< 0.2	< 0.2	< 0.2
Perfluorodecanesulfonic acid (PFDS)	< 0.4	< 0.4	< 0.4
Perfluorobutanoic acid	< 0.4	< 0.4	< 0.4
Perfluoropentanoic acid (PFPeA)	< 0.4	< 0.4	< 0.4
Perfluorohexanoic acid (PFHxA)	< 0.2	< 0.2	< 0.2
Perfluoroheptanoic acid (PFHpA)	< 0.2	< 0.2	< 0.2
Perfluorooctanoic acid (PFOA)	< 0.2	**2.3**	< 0.2
Perfluorononanoic acid (PFNA)	< 0.2	< 0.2	< 0.2
Perfluorodecanoic acid	< 1.0	< 1.0	< 1.0
Perfluoroundecanoic acid (PFUnA)	< 1.0	< 1.0	< 1.0
Perfluorododecanoic acid (PFDoA)	< 1.0	< 1.0	< 1.0
Perfluorotridecanoic acid (PFTrDA)	< 1.0	< 1.0	< 1.0
Perfluorotetradecanoic acid (PFTeDA)	< 5.0	< 5.0	< 5.0
4:2 Flurotelomersulphonate	< 0.2	< 0.2	< 0.2
6:2 Fluorotelomersulphonate	< 0.2	< 0.2	< 0.2
8:2 Fluorotelomersulphonate	< 0.4	< 0.4	< 0.4
10:2 Fluorotelomersulphonate	< 0.4	< 0.4	< 0.4
Perfluorooctane sulfonamide	< 1.0	< 1.0	< 1.0
N-Methyl-heptadecafluorooctane sulphonamide	< 1.0	< 1.0	< 1.0
N-Ethyl-heptadecafluorooctane sulphonamide	< 1.0	< 1.0	< 1.0
N-Me perfluorooctanesulfonamid oethanol	< 1.0	< 1.0	< 1.0
N-Et perfluorooctanesulfonamid oethanol	< 50	< 50	< 50
N-Methylperfluorooctane sulphonamidoacetic acid	< 0.4	< 0.4	< 0.4
N-Ethyl-perfluorooctane sulphonamidoacetic acid	< 0.4	< 0.4	< 0.4

4.2 Dioxins and furans QA

During sample analysis, the laboratory uses $^{13}C_{12}$ labelled dioxin, furan and PCB surrogates to test sample recovery efficiency and possible sample matrix interference.

During this analysis, the laboratory surrogate recovery for all dioxin, furan and PCB congeners was within acceptable ranges.

5 DEFINITIONS

The following terms and abbreviations may be used in this report:

Table 15: Definitions

Symbol	Definition
<	The analytes tested for was not detected; the value stated is the reportable limit of detection
Am^3	Gas volume in cubic metres at measured conditions
AS	Australian Standard
BH	Back half of sample train (filter holder and impingers) (referred to during sample recovery)
ºC	Degrees Celsius
CARB	California Air Resources Board methods
dscm	dry standard cubic meters
FH	Front half of sample train (probe and filter holder) (referred to during sample recovery)
g	Grams
Heavy metals	Sum of Antimony, Arsenic, Beryllium, Cadmium, Chromium, Cobalt, Lead, Manganese, Nickle, Selenium, Tin, Vanadium & Mercury. Also known as Type 1 and Type 2 hazardous substances. Total heavy metals refers only to those metals found in the sample and does not include limit of detection values.
kg	Kilograms
Lower range	The sum of a list of a particular group of compounds, where only those individual congeners/compounds that are detectable in the sample have been included in the total. Results below the limit of detection have not been included. Unless otherwise indicated, the lower range is reported for dioxins & furans, PCBs, heavy metals and PFAS analysis suites.
m	Metres
m^3	actual gas volume in cubic metres as measured
mbar	Millibars
mg	Milligrams (10^{-3} grams)
min	Minute
ml	Millilitres
mmH_2O	Millimetres of water
Mole	SI unit that measures the amount of substance
N/A	Not applicable
ng	Nanograms (10^{-9} grams)
Nm^3	Gas volume in dry cubic metres at standard temperature and pressure (0°C and 101.3 kPa)
NMI	National Measurement Institute
NM VOC	Non methane volatile organic compound
NR	Not required on this occasion
ou	Odour unit
PM	Particulate matter
ppb	Parts per billion
ppm	Parts per million
sec	Second
Sm^3	Gas volume in dry cubic metres at standard temperature and pressure (0°C and 101.3 kPa) and corrected to a standardised value (e.g. 15% O_2)
STP	Standard temperature and pressure (0°C and 101.3 kPa) & dry
USEPA	United States Environmental Protection Authority

6 RESULTS

Table 16: Sample information – PFAS

Site		Darwin
Sample Location		BV_150
Reference Method		USEPA Method 0010 - ISOKINETIC
Run ID		8
Test Parameter		PFAS
Test Date	dd/mm/yyyy	16/10/2022
Start Time	hh:mm	7:59
End Time	hh:mm	10:59

Average Stack Temperature	°C	84
Absolute Stack Pressure	mb	1009
Moisture Content	% v/v	55.9
Dry Gas Density	kg/Nm^3	1.33
Dry Gas Molecular Weight	g/g-mole	29.8
Sample Volume (dry gas meter)	Nm^3	1.50
Stack Gas Velocity	m/sec	3.2
Actual Stack Flow Rate	m^3/min	55
Dry Standard Stack Flow Rate	Nm^3/min	18
Percent Isokinetic Rate	%	98

		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
PFAS species	ng/Nm^3	ng/Nm^3	g/min
Perfluorobutanesulfonic acid	-	188	3.45E-06
Perfluoropentanesulfonic acid	-	2.8	5.19E-08
Perfluorohexanesulfonic acid	-	31	5.68E-07
Perfluoroheptanesulfonic acid	-	1.5	2.74E-08
Perfluorooctanesulfonic acid PFOS	-	38	7.04E-07
Perfluorodecanesulfonic acid	-	< 2.7	< 4.96E-08
Perfluorobutanoic acid	-	21	3.86E-07
Perfluoropentanoic acid	-	75	1.39E-06
Perfluorohexanoic acid	-	78	1.44E-06
Perfluoroheptanoic acid	-	20	3.64E-07
Perfluorooctanoic acid PFOA	-	62	1.14E-06
Perfluorononanoic acid	-	3.5	6.49E-08
Perfluorodecanoic acid	-	4.3	7.88E-08
Perfluoroundecanoic acid	-	< 6.7	< 1.24E-07
Perfluorododecanoic acid	-	< 6.7	< 1.24E-07
Perfluorotridecanoic acid	-	< 6.7	< 1.24E-07
Perfluorotetradecanoic acid	-	< 34	< 6.20E-07
4:2 FTS	-	< 1.3	< 2.48E-08
6:2 FTS	-	35	6.35E-07
8:2 FTS	-	3.0	5.61E-08
10:2 FTS	-	< 2.7	< 4.96E-08
Perfluorooctane sulfonamide	-	< 6.7	< 1.24E-07
N-Methyl perfluorooctane sulfonamide	-	< 6.7	< 1.24E-07
N-Ethyl perfluorooctanesulfonamide	-	< 6.7	< 1.24E-07
N-Me perfluorooctanesulfonamidoethanol	-	107	1.97E-06
N-Et perfluorooctanesulfonamidoethanol	-	< 82	< 1.50E-06
MePerfluorooctanesulf-amido acetic acid	-	4.4	8.07E-08
EtPerfluorooctanesulf-amido acetic acid	-	5.7	1.05E-07
TOTAL			
Sum of positive detections	-	680	1.25E-05

Table 17: Sample information – Odour

Site		Darwin	
Sample Location		BV_150	
Reference Method		AS4323.3 - CONSTANT FLOW	
Run ID		9	
Test Parameter		Odour	
Test Date	dd/mm/yyyy	19/10/2022	
Start Time	hh:mm	7:55	
End Time	hh:mm	8:05	
Average Stack Temperature	°C	84	
Absolute Stack Pressure	mb	1009	
Moisture Content	% v/v	57.3	
Dry Gas Density	kg/Nm^3	1.33	
Dry Gas Molecular Weight	g/g-mole	29.8	
Sample Volume (dry gas meter)	Nm^3	-	
Stack Gas Velocity	m/sec	3.3	
Actual Stack Flow Rate	m^3/min	57	
Dry Standard Stack Flow Rate	Nm^3/min	18	
Percent Isokinetic Rate	%	N/A	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
Odour	ou	ou	ou.m^3/min
Odour Sample 1	-	8,751	378,051
Odour Sample 2	-	7,679	331,762
Average Odour	-	8,215	354,906

Table 18: Sample information – Hydrogen sulfide

Site		Darwin	
Sample Location		BV_150	
Reference Method		USEPA Method 15 - CONSTANT FLOW	
Run ID		10	
Test Parameter		H_2S	
Test Date	dd/mm/yyyy	19/10/2022	
Start Time	hh:mm	7:50	
End Time	hh:mm	7:55	
Average Stack Temperature	°C	84	
Absolute Stack Pressure	mb	1009	
Moisture Content	% v/v	57.3	
Dry Gas Density	kg/Nm^3	1.33	
Dry Gas Molecular Weight	g/g-mole	29.8	
Sample Volume (dry gas meter)	Nm^3	-	
Stack Gas Velocity	m/sec	3.3	
Actual Stack Flow Rate	m^3/min	57	
Dry Standard Stack Flow Rate	Nm^3/min	18	
Percent Isokinetic Rate	%	N/A	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
H2S	mg/Nm^3	mg/Nm^3	g/min
Hydrogen sulfide	5	< 1.1	< 0.01

Table 19: Sample information – Oxides of Sulfur

Site		Darwin	
Sample Location		BV_150	
Reference Method		USEPA Method 8 - ISOKINETIC	
Run ID		5	
Test Parameter		SOx	
Test Date	dd/mm/yyyy	15/10/2022	
Start Time	hh:mm	11:45	
End Time	hh:mm	12:45	
Average Stack Temperature	°C	84	
Absolute Stack Pressure	mb	1009	
Moisture Content	% v/v	53.2	
Dry Gas Density	kg/Nm^3	1.33	
Dry Gas Molecular Weight	g/g-mole	29.8	
Sample Volume (dry gas meter)	Nm^3	0.53	
Stack Gas Velocity	m/sec	3.3	
Actual Stack Flow Rate	m^3/min	55	
Dry Standard Stack Flow Rate	Nm^3/min	20	
Percent Isokinetic Rate	%	105	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
Sox	mg/Nm^3	mg/Nm^3	g/min
SO_2	-	< 2.0	< 0.04
SO_3 (as H_2SO_4)	100	< 0.8	< 0.02

Table 20: Sample information – Acid gases

Site		Darwin	
Sample Location		BV_150	
Reference Method		USEPA Method 26A - ISOKINETIC	
Run ID		3	
Test Parameter		Acid Gases	
Test Date	dd/mm/yyyy	15/10/2022	
Start Time	hh:mm	9:10	
End Time	hh:mm	10:10	
Average Stack Temperature	°C	87	
Absolute Stack Pressure	mb	1009	
Moisture Content	% v/v	56.1	
Dry Gas Density	kg/Nm^3	1.33	
Dry Gas Molecular Weight	g/g-mole	29.8	
Sample Volume (dry gas meter)	Nm^3	0.45	
Stack Gas Velocity	m/sec	3.2	
Actual Stack Flow Rate	m^3/min	54	
Dry Standard Stack Flow Rate	Nm^3/min	18	
Percent Isokinetic Rate	%	91	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
Acid Gases	mg/Nm^3	mg/Nm^3	g/min
HCl	100	< 2.2	< 0.04
Cl_2	200	< 2.2	< 0.04

Table 21: Sample information – Heavy metals

Site		Darwin	
Sample Location		BV_150	
Reference Method		USEPA Method 29 - ISOKINETIC	
Run ID		2	
Test Parameter		Metals	
Test Date	dd/mm/yyyy	15/10/2022	
Start Time	hh:mm	11:48	
End Time	hh:mm	13:48	
Average Stack Temperature	°C	86	
Absolute Stack Pressure	mb	1009	
Moisture Content	% v/v	55.0	
Dry Gas Density	kg/Nm^3	1.33	
Dry Gas Molecular Weight	g/g-mole	29.8	
Sample Volume (dry gas meter)	Nm^3	0.83	
Stack Gas Velocity	m/sec	3.2	
Actual Stack Flow Rate	m^3/min	54	
Dry Standard Stack Flow Rate	Nm^3/min	18	
Percent Isokinetic Rate	%	81	
Pollutant Metals	Licence limit µg/Nm^3	standard conditions Concentration µg/Nm^3	Emission Rate g/min
Antimony	-	< 6.8	< 1.3E-04
Arsenic	-	< 6.8	< 1.3E-04
Beryllium	-	< 0.5	< 9.4E-06
Cadmium	200	4.5	8.2E-05
Chromium	-	10.4	1.9E-04
Cobalt	-	< 0.5	< 9.4E-06
Lead	-	106	2.0E-03
Manganese	-	3.6	6.7E-05
Nickel	-	17	3.1E-04
Selenium	-	< 6.8	< 1.3E-04
Tin	-	< 17	< 3.1E-04
Vanadium	-	< 8.5	< 1.6E-04
Mercury	200	2.1	3.8E-05
Total Heavy Metals (lower bound)	1,000	144	2.6E-03

Table 22: Sample information – Volatile organic compounds

Site		Darwin	
Sample Location		BV_150	
Reference Method		USEPA Method 18 - CONSTANT FLOW	
Run ID		6	
Test Parameter		VOC	
Test Date	dd/mm/yyyy	16/10/2022	
Start Time	hh:mm	9:15	
End Time	hh:mm	10:15	
Average Stack Temperature	°C	84	
Absolute Stack Pressure	mb	1009	
Moisture Content	% v/v	53.7	
Dry Gas Density	kg/Nm^3	1.33	
Dry Gas Molecular Weight	g/g-mole	29.8	
Sample Volume (dry gas meter)	Nm^3	0.03	
Stack Gas Velocity	m/sec	3.3	
Actual Stack Flow Rate	m^3/min	56	
Dry Standard Stack Flow Rate	Nm^3/min	20	
Percent Isokinetic Rate	%	N/A	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
Total (non-methane) VOCs	mg/Nm^3	mg/Nm^3	g/min
Total VOCs - as n-hexane	-	< 1.8	< 0.04
Total VOCs - as n-propane	40	< 0.9	< 0.02

Table 23: Sample information – Ammonia

Site		Darwin	
Sample Location		BV_150	
Reference Method		USEPA Mod Method 6 - CONSTANT FLOW	
Run ID		7	
Test Parameter		NH3	
Test Date	dd/mm/yyyy	16/10/2022	
Start Time	hh:mm	8:10	
End Time	hh:mm	9:10	
Average Stack Temperature	°C	84	
Absolute Stack Pressure	mb	1009	
Moisture Content	% v/v	57.3	
Dry Gas Density	kg/Nm^3	1.33	
Dry Gas Molecular Weight	g/g-mole	29.8	
Sample Volume (dry gas meter)	Nm^3	0.04	
Stack Gas Velocity	m/sec	3.3	
Actual Stack Flow Rate	m^3/min	57	
Dry Standard Stack Flow Rate	Nm^3/min	18	
Percent Isokinetic Rate	%	N/A	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
NH3	mg/Nm^3	mg/Nm^3	g/min
Ammonia (NH_3) - in condensate	-	1,659	31
Ammonia (NH_3) - gaseous	-	121	2.2
Total Ammonia (as NH_3)	-	1,780	33

Table 24: Sample information – Fluoride

Site		Darwin	
Sample Location		BV_150	
Reference Method		USEPA Method 13B - ISOKINETIC	
Run ID		4	
Test Parameter		Fluoride	
Test Date	dd/mm/yyyy	15/10/2022	
Start Time	hh:mm	9:11	
End Time	hh:mm	10:11	
Average Stack Temperature	°C	83	
Absolute Stack Pressure	mb	1009	
Moisture Content	% v/v	56.1	
Dry Gas Density	kg/Nm^3	1.33	
Dry Gas Molecular Weight	g/g-mole	29.8	
Sample Volume (dry gas meter)	Nm^3	0.51	
Stack Gas Velocity	m/sec	3.2	
Actual Stack Flow Rate	m^3/min	54	
Dry Standard Stack Flow Rate	Nm^3/min	18	
Percent Isokinetic Rate	%	110	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
Fluoride	mg/Nm^3	mg/Nm^3	g/min
Fluorine - (as total HF)	50	< 2.0	< 0.04

Table 25: Sample information – Combustion gases

Site		Darwin	
Sample Location		BV_150	
Reference Method		USEPA Method 3A, 7E & 10	
Run ID		Various	
Test Parameter		O_2, CO_2, NOx, CO	
Test Date	dd/mm/yyyy	15/10/2022	
Start Time	hh:mm	11:45	
End Time	hh:mm	10:10	
Average Stack Temperature	°C	85	
Absolute Stack Pressure	mb	1009	
Moisture Content	% v/v	54.8	
Dry Gas Density	kg/Nm^3	1.33	
Dry Gas Molecular Weight	g/g-mole	29.8	
Stack Gas Velocity	m/sec	3.2	
Actual Stack Flow Rate	m^3/min	55	
Dry Standard Stack Flow Rate	Nm^3/min	19	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
O2, CO2, NOx, CO	STP	STP	g/min
Oxygen (% v/v)	-	8.8	-
Carbon dioxide (% v/v)	-	9.1	-
Carbon monoxide (mg/m^3)	125	23	0.43
Oxides of nitrogen (mg/m^3)	350	83	1.5

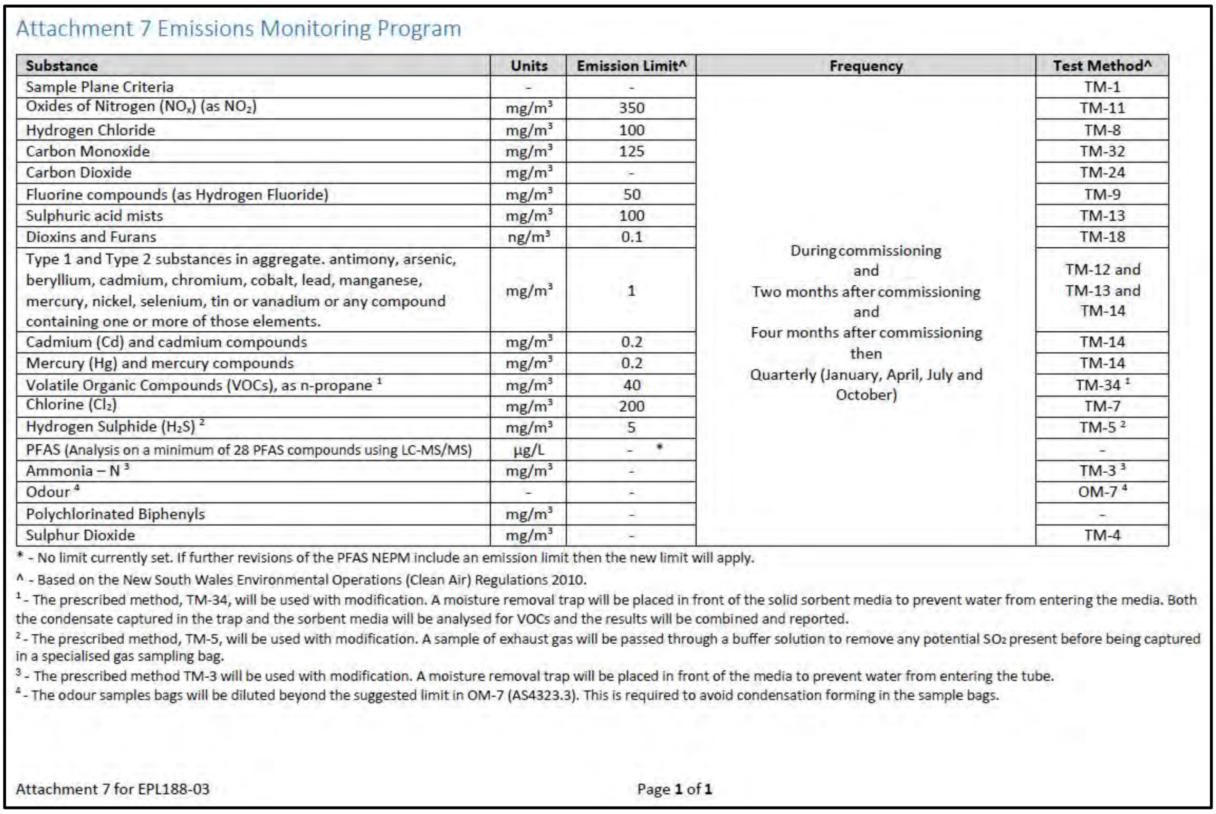
Table 26: Sample information – Dioxins & furans

Site		Darwin	
Sample Location		BV_150	
Reference Method		USEPA Method 23 - ISOKINETIC	
Run ID		1	
Test Parameter		DF & PCB	
Test Date	dd/mm/yyyy	16/10/2022	
Start Time	hh:mm	7:58	
End Time	hh:mm	10:58	
Average Stack Temperature	°C	84	
Absolute Stack Pressure	mb	1009	
Moisture Content	% v/v	53.7	
Dry Gas Density	kg/Nm^3	1.33	
Dry Gas Molecular Weight	g/g-mole	29.8	
Sample Volume (dry gas meter)	Nm^3	1.57	
Stack Gas Velocity	m/sec	3.3	
Actual Stack Flow Rate	m^3/min	56	
Dry Standard Stack Flow Rate	Nm^3/min	20	
Percent Isokinetic Rate	%	102	
Pollutant	Licence limit	standard conditions Concentration	Emission Rate
DF & PCB	ng/Nm^3	ng/Nm^3	g/min
2378 TCDF	-	0.0064	1.3E-10
Total TCDF isomers	-	0.076	1.5E-09
2378 TCDD	-	< 0.0013	< 2.5E-11
Total TCDD isomers	-	0.032	6.4E-10
12378 PeCDF	-	0.0029	5.8E-11
23478 PeCDF	-	0.0034	6.8E-11
Total PeCDF isomers	-	0.046	9.1E-10
12378 PeCDD	-	< 0.0013	< 2.5E-11
Total PeCDD isomers	-	0.026	5.2E-10
123478 HxCDF	-	< 0.0019	< 3.8E-11
123678 HxCDF	-	0.0022	4.4E-11
234678 HxCDF	-	< 0.0013	< 2.5E-11
123789 HxCDF	-	< 0.00064	< 1.3E-11
Total HxCDF isomers	-	0.017	3.4E-10
123478 HxCDD	-	< 0.0006	< 1.3E-11
123678 HxCDD	-	0.0012	2.4E-11
123789 HxCDD	-	< 0.00064	< 1.3E-11
Total HxCDD isomers	-	0.027	5.4E-10
1234678 HpCDF	-	0.0036	7.2E-11
1234789 HpCDF	-	< 0.00038	< 7.6E-12
Total HpCDF isomers	-	0.0062	1.2E-10
1234678 HpCDD	-	0.018	3.7E-10
Total HpCDD isomers	-	0.036	7.2E-10
OCDF	-	< 0.00057	< 1.1E-11
OCDD	-	0.064	1.3E-09
Sum of congeners Sum of positive detections	-	0.33	6.6E-09
Total I-TEQ Sum of positive detections	0.1	0.0031	6.2E-11

Table 27: Sample information – PCBs

PCBs (USEPA Method 23)					
PCBs	Licence limit ng/Nm³		standard conditions Concentration ng/Nm³		Emission Rate g/min
PCB#77	-		0.90		1.8E-08
PCB#81	-		0.036		7.2E-10
PCB#126	-		0.027		5.3E-10
PCB#169	-	<	0.00064	<	1.3E-11
PCB#105	-		3.1		6.1E-08
PCB#114	-		0.17		3.4E-09
PCB#118	-		6.7		1.3E-07
PCB#123	-		0.11		2.3E-09
PCB#156	-		0.74		1.5E-08
PCB#157	-		0.17		3.4E-09
PCB#167	-		0.27		5.4E-09
PCB#189	-		0.025		4.9E-10
Sum of PCB Congeners Sum of positive detections	-		12		2.4E-07
Total TEQ Sum of positive detections	-		0.0031		6.2E-11

7 APPENDIX



Attachment 7 Emissions Monitoring Program

Substance	Units	Emission Limit^	Frequency	Test Method^
Sample Plane Criteria	-	-	During commissioning and Two months after commissioning and Four months after commissioning then Quarterly (January, April, July and October)	TM-1
Oxides of Nitrogen (NO_x) (as NO_2)	mg/m^3	350		TM-11
Hydrogen Chloride	mg/m^3	100		TM-8
Carbon Monoxide	mg/m^3	125		TM-32
Carbon Dioxide	mg/m^3	-		TM-24
Fluorine compounds (as Hydrogen Fluoride)	mg/m^3	50		TM-9
Sulphuric acid mists	mg/m^3	100		TM-13
Dioxins and Furans	ng/m^3	0.1		TM-18
Type 1 and Type 2 substances in aggregate. antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, manganese, mercury, nickel, selenium, tin or vanadium or any compound containing one or more of those elements.	mg/m^3	1		TM-12 and TM-13 and TM-14
Cadmium (Cd) and cadmium compounds	mg/m^3	0.2		TM-14
Mercury (Hg) and mercury compounds	mg/m^3	0.2		TM-14
Volatile Organic Compounds (VOCs), as n-propane [1]	mg/m^3	40		TM-34 [1]
Chlorine (Cl_2)	mg/m^3	200		TM-7
Hydrogen Sulphide (H_2S) [2]	mg/m^3	5		TM-5 [2]
PFAS (Analysis on a minimum of 28 PFAS compounds using LC-MS/MS)	µg/L	- *		-
Ammonia – N [3]	mg/m^3	-		TM-3 [3]
Odour [4]	-	-		OM-7 [4]
Polychlorinated Biphenyls	mg/m^3	-		-
Sulphur Dioxide	mg/m^3	-		TM-4

* - No limit currently set. If further revisions of the PFAS NEPM include an emission limit then the new limit will apply.

^ - Based on the New South Wales Environmental Operations (Clean Air) Regulations 2010.

[1] - The prescribed method, TM-34, will be used with modification. A moisture removal trap will be placed in front of the solid sorbent media to prevent water from entering the media. Both the condensate captured in the trap and the sorbent media will be analysed for VOCs and the results will be combined and reported.

[2] - The prescribed method, TM-5, will be used with modification. A sample of exhaust gas will be passed through a buffer solution to remove any potential SO_2 present before being captured in a specialised gas sampling bag.

[3] - The prescribed method TM-3 will be used with modification. A moisture removal trap will be placed in front of the media to prevent water from entering the tube.

[4] - The odour samples bags will be diluted beyond the suggested limit in OM-7 (AS4323.3). This is required to avoid condensation forming in the sample bags.

Attachment 7 for EPL188-03 Page **1** of **1**

Figure 4: Excerpt from EPL188-03 – Attachment 7

ASSURED ENVIRONMENTAL PTY LTD

Your environmental compliance partner

OCTOBER 2022

SOURCE EMISSIONS MONITORING – SHOAL BAY BENEVAP 300

CLIENT: BENETERRA
PROJECT ID: 14621
DATE: 29/11/2022 RELEASE: R_1

1300 662 495 | www.assuredenv.com.au

DOCUMENT CONTROL PAGE

Project Title: Source Emissions Monitoring – Shoal Bay BeneVap 300

Project Reference ID: 14621

Report Prepared by:

Assured Environmental
Unit 7, 142 Tennyson Memorial Avenue
Tennyson, QLD, 4105
ABN: 87 604 851 078

Report Prepared for:

BeneTerra
Shoal Bay Access Road
Karama NT 0812

Report Author: Timon Berger

Report Reviewer: Adam Dixon

Table 1: History of Revisions

Revision	Date	Issued to	Changes
R_1	29/11/2022	N. Sharma	Updated total PFAS BV300.1 stack
R_0	29/11/2022	N. Sharma	Formal report release.
DRAFT_0	25/11/2022	N. Sharma	Draft release for comment.

ACCREDITED FOR COMPLIANCE TO ISO/IEC 17025 (TESTING)

The results of the tests, calibrations and/or measurements included in this document is traceable to Australian/national standards.

Accreditation number: 19703

NATA
WORLD RECOGNISED
ACCREDITATION
NATA ID: 19703

DISCLAIMER

Assured Environmental acts in all professional matters as a faithful advisor to the Client and exercises all reasonable skill and care in the provision of its professional services.

Reports are commissioned by and prepared for the exclusive use of the Client. They are subject to and issued in accordance with the agreement between the Client and Assured Environmental. Assured Environmental is not responsible for any liability and accepts no responsibility whatsoever arising from the misapplication or misinterpretation by third parties of the contents of its reports.

Except where expressly stated, Assured Environmental does not attempt to verify the accuracy, validity or comprehensiveness of any information supplied to Assured Environmental for its reports.

Reports cannot be copied or reproduced in whole or part for any purpose without the prior written agreement of Assured Environmental.

Where site inspections, testing or fieldwork have taken place, the report is based on the information made available by the client or their nominees during the visit, visual observations and any subsequent discussions with regulatory authorities. The validity and comprehensiveness of supplied information has not been independently verified and, for the purposes of this report, it is assumed that the information provided to Assured Environmental is both complete and accurate. It is further assumed that normal activities were being undertaken at the site on the day of the site visit(s), unless explicitly stated otherwise.

EXECUTIVE SUMMARY

Assured Environmental (AE) conducted source emissions monitoring from the mobile BeneVap Leachate Treatment Facility (BV300) located at the Shoal Bay Waste Facility in Darwin, Northern Territory from 17th to 19th October 2022.

A summary of results and comparison against compliance levels is presented in Table 2 and Table 3 below from the testing conducted on both release points of the BV300 unit.

In comparison to the emission limits outlined in EPL188-03 – Attachment 7, all measured concentrations were within those limits specified. Results are reported at dry, 273.15°K and 101.325 kPa (STP).

Table 2: Summary of measured parameters – Stack 1

Parameter		Result BV300_1	Emission limit	Unit	Reference
Average source temperature		87	-	°C	-
Flue gas water vapour content		65	-	vol-%	-
Carbon dioxide concentration		13.4	-	vol-%	STP - dry
Oxygen concentration		3.1	-	vol-%	STP - dry
Flue gas molecular weight - dry		1.4	-	kg/Nm^3	STP - dry
Flue gas velocity		3.0	-	m/sec	STP - dry
Flue gas volume flow		12.9	-	Nm^3/min	STP - dry
Oxides of nitrogen (as NO_2)		143	350	mg/Nm^3	STP - dry
- emission rate		1.9	-	g/min	
Carbon monoxide		93	125	mg/Nm^3	STP - dry
- emission rate		2.8	-	g/min	
Total heavy metals		0.098	1.0	mg/Nm^3	STP - dry
- emission rate		0.0014	-	g/min	
Cadmium		0.00088	0.2	mg/Nm^3	STP - dry
- emission rate		1.2E-05	-	g/min	
Mercury		0.0011	0.2	mg/Nm^3	STP - dry
- emission rate		1.5E-05	-	g/min	
Fluorine (as HF)	<	2.6	50	mg/Nm^3	STP - dry
- emission rate	<	0.034	-	g/min	
Hydrogen chloride	<	2.5	100	mg/Nm^3	STP - dry
- emission rate	<	0.029	-	g/min	
Chlorine	<	2.5	200	mg/Nm^3	STP - dry
- emission rate	<	0.029	-	g/min	
Ammonia (total)		1,944	-	mg/Nm^3	STP - dry
- emission rate		27	-	g/min	
Ammonia (NH_3) - in condensate		1,808	-	mg/Nm^3	STP - dry
- emission rate		25	-	g/min	
Ammonia (NH_3) - gaseous		136	-	mg/Nm^3	STP - dry
- emission rate		1.9	-	g/min	
Hydrogen sulfide	<	1.1	5	mg/Nm^3	STP - dry
- emission rate	<	0.015	-	g/min	
Sulfur dioxide	<	2.2	-	mg/Nm^3	STP - dry
- emission rate	<	0.03	-	g/min	
Sulfuric acid mist (as H_2SO_4)	<	1.4	100	mg/Nm^3	STP - dry
- emission rate	<	0.016	-	g/min	
Total VOCs (as n-propane)	<	1.0	40	mg/Nm^3	STP - dry
- emission rate	<	0.015	-	g/min	
Average odour		8,501	-	ou	STP - wet
- emission rate		324,895	-	ou-m^3/min	
Dioxins & Furans (i-TEQ)		0.0029	0.1	ng/Nm^3	STP - dry
- emission rate		4.1E-11	-	g/min	
PCBs (i-TEQ)		0.0029	-	ng/Nm^3	STP - dry
- emission rate		4.1E-11	-	g/min	

Table 3: Summary of measured parameters – Stack 2

Parameter		Result BV300_2	Emission limit	Unit	Reference
Average source temperature		87	-	°C	-
Flue gas water vapour content		66	-	vol-%	-
Carbon dioxide concentration		13.4	-	vol-%	STP - dry
Oxygen concentration		3.1	-	vol-%	STP - dry
Flue gas molecular weight - dry		1.4	-	kg/Nm^3	STP - dry
Flue gas velocity		3.0	-	m/sec	STP - dry
Flue gas volume flow		12.6	-	Nm^3/min	STP - dry
Oxides of nitrogen (as NO_2)		143	350	mg/Nm^3	STP - dry
- emission rate		1.8	-	g/min	
Carbon monoxide		89	125	mg/Nm^3	STP - dry
- emission rate		1.2	-	g/min	
Total heavy metals		0.13	1.0	mg/Nm^3	STP - dry
- emission rate		1.5E-03	-	g/min	
Cadmium		0.0039	0.2	mg/Nm^3	STP - dry
- emission rate		4.6E-05	-	g/min	
Mercury		0.0058	0.2	mg/Nm^3	STP - dry
- emission rate		7.0E-05	-	g/min	
Fluorine (as HF)	<	2.9	50	mg/Nm^3	STP - dry
- emission rate	<	0.038	-	g/min	
Hydrogen chloride	<	2.8	100	mg/Nm^3	STP - dry
- emission rate	<	0.031	-	g/min	
Chlorine	<	2.8	200	mg/Nm^3	STP - dry
- emission rate	<	0.031	-	g/min	
Ammonia (total)		1,956	-	mg/Nm^3	STP - dry
- emission rate		28	-	g/min	
Ammonia (NH_3) - in condensate		1,882	-	mg/Nm^3	STP - dry
- emission rate		27	-	g/min	
Ammonia (NH_3) - gaseous		74	-	mg/Nm^3	STP - dry
- emission rate		1.0	-	g/min	
Hydrogen sulfide	<	1.1	5	mg/Nm^3	STP - dry
- emission rate	<	0.016	-	g/min	
Sulfur dioxide	<	1.8	-	mg/Nm^3	STP - dry
- emission rate	<	0.024	-	g/min	
Sulfuric acid mist (as H_2SO_4)	<	1.3	100	mg/Nm^3	STP - dry
- emission rate	<	0.018	-	g/min	
Total VOCs (as n-propane)	<	1.0	40	mg/Nm^3	STP - dry
- emission rate	<	0.015	-	g/min	
Average odour		8,151	-	ou	STP - wet
- emission rate		312,027	-	ou-m^3/min	
Dioxins & Furans (i-TEQ)		0.0043	0.1	ng/Nm^3	STP - dry
- emission rate		6.1E-11	-	g/min	
PCBs (i-TEQ)		0.0029	-	ng/Nm^3	STP - dry
- emission rate		4.1E-11	-	g/min	

Table 4: Summary of PFAS results – Stack 1

Parameter		Result ng/Nm^3		Emission Rate g/min	Reference
Per- and polyfluoroalkyl substances				**BV300_1**	
Perfluorobutanesulfonic acid		**663**		**9.7E-06**	**STP**
Perfluoropentanesulfonic acid		**6.7**		**9.9E-08**	**STP**
Perfluorohexanesulfonic acid		**77**		**1.1E-06**	**STP**
Perfluoroheptanesulfonic acid	<	1.7	<	2.4E-08	STP
Perfluorooctanesulfonic acid PFOS		**98**		**1.4E-06**	**STP**
Perfluorodecanesulfonic acid	<	3.3	<	4.8E-08	STP
Perfluorobutanoic acid		**45**		**6.6E-07**	**STP**
Perfluoropentanoic acid		**90**		**1.3E-06**	**STP**
Perfluorohexanoic acid		**148**		**2.2E-06**	**STP**
Perfluoroheptanoic acid		**35**		**5.1E-07**	**STP**
Perfluorooctanoic acid PFOA		**100**		**1.5E-06**	**STP**
Perfluorononanoic acid		**5.9**		**8.7E-08**	**STP**
Perfluorodecanoic acid		**8.0**		**1.2E-07**	**STP**
Perfluoroundecanoic acid	<	8.3	<	1.2E-07	STP
Perfluorododecanoic acid	<	8.3	<	1.2E-07	STP
Perfluorotridecanoic acid	<	8.3	<	1.2E-07	STP
Perfluorotetradecanoic acid	<	41.3	<	6.0E-07	STP
4:2 FTS	<	1.7	<	2.4E-08	STP
6:2 FTS		**51**		**7.4E-07**	**STP**
8:2 FTS	<	3.3	<	4.8E-08	STP
10:2 FTS	<	3.3	<	4.8E-08	STP
Perfluorooctane sulfonamide	<	8.3	<	1.2E-07	STP
N-Methyl perfluorooctane sulfonamide		**9.9**		**1.4E-07**	**STP**
N-Ethyl perfluorooctane sulfonamide	<	8.3	<	1.2E-07	STP
N-Me perfluorooctanesulfonamido ethanol		**67**		**9.8E-07**	**STP**
N-Et perfluorooctanesulfonamido ethanol	<	100	<	1.5E-06	STP
MePerfluorooctanesulf-amido acetic acid		**10**		**1.5E-07**	**STP**
EtPerfluorooctanesulf-amido acetic acid		**7.0**		**1.0E-07**	**STP**

Table 5: Summary of PFAS results – Stack 2

Parameter		Result ng/Nm^3		Emission Rate g/min	Reference
Per- and polyfluoroalkyl substances				**BV300_2**	
Perfluorobutanesulfonic acid		**562**		**8.2E-06**	**STP**
Perfluoropentanesulfonic acid		**7.6**		**1.1E-07**	**STP**
Perfluorohexanesulfonic acid		**76**		**1.1E-06**	**STP**
Perfluoroheptanesulfonic acid	<	1.7	<	2.5E-08	STP
Perfluorooctanesulfonic acid PFOS		**92**		**1.4E-06**	**STP**
Perfluorodecanesulfonic acid	<	3.4	<	5.0E-08	STP
Perfluorobutanoic acid		**52**		**7.6E-07**	STP
Perfluoropentanoic acid		**120**		**1.8E-06**	**STP**
Perfluorohexanoic acid		**145**		**2.1E-06**	**STP**
Perfluoroheptanoic acid		**31**		**4.6E-07**	**STP**
Perfluorooctanoic acid PFOA		**96**		**1.4E-06**	**STP**
Perfluorononanoic acid		**3.5**		**5.2E-08**	**STP**
Perfluorodecanoic acid		**8.2**		**1.2E-07**	**STP**
Perfluoroundecanoic acid	<	8.5	<	1.2E-07	STP
Perfluorododecanoic acid	<	8.5	<	1.2E-07	STP
Perfluorotridecanoic acid	<	8.5	<	1.2E-07	STP
Perfluorotetradecanoic acid	<	42.3	<	6.2E-07	STP
4:2 FTS	<	1.7	<	2.5E-08	STP
6:2 FTS		**40**		**5.9E-07**	**STP**
8:2 FTS		**4.7**		**6.8E-08**	**STP**
10:2 FTS	<	3.4	<	5.0E-08	STP
Perfluorooctane sulfonamide	<	8.5	<	1.2E-07	STP
N-Methyl perfluorooctane sulfonamide	<	8.5	<	1.2E-07	STP
N-Ethyl perfluorooctane sulfonamide	<	8.5	<	1.2E-07	STP
N-Me perfluorooctanesulfonamido ethanol		**109**		**1.6E-06**	**STP**
N-Et perfluorooctanesulfonamido ethanol	<	103	<	1.5E-06	STP
MePerfluorooctanesulf-amido acetic acid		**8.8**		**1.3E-07**	**STP**
EtPerfluorooctanesulf-amido acetic acid		**8.8**		**1.3E-07**	**STP**

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

Assured Environmental (AE) was appointed by BeneTerra to sample and analyse source emissions from the BV300 BeneVap Leachate Treatment system. Sampling was conducted by AE from 17th to 19th October 2022 during typical site operations.

AE was responsible for the collection and analysis of samples, unless otherwise indicated. The samples were recovered and stored in the appropriate manner until their return to the laboratory where the samples were prepared and analysed according to the methodologies listed below in this report.

2 METHODOLGY & EQUIPMENT

2.1 Sampling methodology

All sampling and analysis was carried out in accordance with the listed requirements in Table 6. Any specific comments about the sampling and analysis have been documented where required.

Table 6: Test methods

Parameter	Reference Test Method	Test Method (NSW)	NATA accreditation	Analysis by
Sample location	AS4323.1	TM-1	Yes	1
Velocity & flow rate	USEPA Method 2	TM-2	Yes	1
Stack gas density	USEPA Method 3	TM-23	Yes	1
Oxygen	USEPA Method 3A	TM-25	Yes	1
Carbon dioxide	USEPA Method 3A	TM-24	Yes	1
Water vapour content	USEPA Method 4	TM-22	Yes	1
Sulphur dioxide	USEPA Method 6	TM-4	Yes	1
Oxides of nitrogen (as NO_2)	USEPA Method 7E	TM-11	Yes	1
Sulfuric acid mists	USEPA Method 8	TM-3[a]	Yes	1
Carbon monoxide	USEPA Method 10	TM-32	Yes	1
Hydrogen sulfide	USEPA Method 15	TM-5	Yes	1
Total VOCs	USEPA Method 18	TM-34	Yes	2
Hydrogen chloride	USEPA Method 26A	TM-8	Yes	2
Chlorine	USEPA Method 26A	TM-7	Yes	2
Fluoride (as HF)	USEPA Method 13B	TM-9	Yes	2
Heavy metals	USEPA Method 29	TM-12/13/14	Yes	2
PFAS – suite	USEPA SW846 Method 0010	Mod TM-18	No	2
Dioxins & furans	USEPA SW846 Method 0010	TM-18	Yes	3
Polychlorinated biphenyls	USEPA SW846 Method 0010	TM-18	Yes	3
Ammonia	Modified USEPA Method 26	Mod TM-4[b]	Yes	2
Odour	AS4323.3	OM-7	Yes	1

Table 7: Analysis performed by

Note	Company	Work performed	NATA ID	Report Number
1	Assured Environmental	Sampling & analysis	19703	14621
2	Envirolab Services	Sample analysis	2901	309081
3	National Measurement Inst.	PCDD/F & PCB analysis	198	DAU22_283

---

[a] EPL188-03 lists the test method for sulfuric acid mists as TM-13, this does not correspond to the *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales* listed method (TM-3).

[b] EPL188-03 lists the test method for ammonia as TM-3. A closer representation of the sampling technique is a Modified TM-4 sample train. See the description of the sampling technique in Table 8 below.

Table 8: Sampling comments

Note	Comment
Sample location	Sample location is compliant but non ideal as per AS4323.1. The sample location is greater than two, but less than six diameters downstream from a disturbance. The temperature and velocity survey showed that the sample position was in compliance to items (a) to (f) as per AS4323.1.
Calibrations	Analyser calibration performed in the laboratory prior to conducting field work and post field work in AE lab.
H_2S	A sample of exhaust gas was passed through a buffer solution to remove any potential SO_2 present before being captured in a specialised gas sampling bag. Analysis for H_2S was performed using GC-FPD within 30 hours of collection.
Heavy metals	Type 1 substances: Antimony, Arsenic, Cadmium, Lead Mercury. Type 2 substances: Beryllium, Chromium, Cobalt, Manganese, Nickel, Selenium, Tin, Vanadium.
PFAS	A modified version of the USEPA SW846 Method 0010 sample train was employed to sample for Per- and poly-fluoroalkyl substances (PFAS) material in the flue gas emission. Refer to section 2.2 for further information.
Ammonia	The ammonia sampling was performed using a modified constant flow sampling train. A condensate removal trap was placed in front of the collection trap containing the absorbing solution to separate condensing ammonia from gaseous ammonia passing through the initial dropout and into the collection solution (0.1N H_2SO_4). Both the condensate captured in the trap and the sorbent solution are analysed for ammonia individually. Ammonia results are reported in the condensate and gaseous phase separately and as total NH_3. Samples are analysed using a Discrete Analyser.
Odour	Due to the high levels of moisture in the emission the odour samples bags were diluted beyond the suggested limit in AS4323.3. This is required to avoid condensation forming in the sample bags.

2.2 Per- and poly-fluoroalkyl substances sample methodology

Suitable sampling methods for Per- and poly-fluoroalkyl substances (PFAS) in air have received considerably less attention than in other media such as water and soil matrices. As such Assured Environmental has developed a sampling method based on modifications of the promulgated USEPA SW846 Method 0010 sample train. This method includes consideration for both semi-volatile and particulate bound PFAS. It is recognised that the US EPA has recently introduced Other Test Method (OTM) – 45 and although many of the elements included in this method are consistent with the method developed by AE. It is also noted that posting of an OTM by USEPA is neither an endorsement by EPA regarding the validity of the test method nor a regulatory approval of the test method, rather to promote discussion of developing emerging methodologies prior to full endorsement. In this case the AE method was employed, which is summarised below.

The basis of the sample train is;

- Gaseous and particulate pollutants are withdrawn from an emission source at an isokinetic sampling rate and are collected in a multi-component sampling train. The sample train contains a high-efficiency glass fibre filter and a packed bed of porous adsorbent resin. The filter is used to collect organic-laden particulate materials and the porous polymeric resin to adsorb semi-volatile organic species. Semi-volatile species are defined as compounds with boiling points greater than 100°C. The impingers downstream of the resin trap are loaded with water to knock-out any water vapour prior to metering the gas. These impingers are not routinely analysed for S-VOCs.

The modifications made to this sample train in order to target PFAS materials included;

- Sorbent material is XAD-2 and XAD-4.
- The resin traps are spiked with a surrogate standard to test for retention. A known quantity of standard is injected into the trap during preparation, the trap is then shipped, sampled and returned to the laboratory for analysis. The analysis includes detecting the injected standard, which provides a measure of the recovery efficiency. Factors that may affect the recovery efficiency include, sample transport and handling procedures, sampling temperatures (the resin must be chilled during sampling and maintained below 20°C) and sample preparation at the laboratory, including the extraction of the sample from the resin.
- Condensate remove trap prior to resin traps.
- Impingers downstream of the resin trap are loaded with a sodium solution and is intended to be a breakthrough detector. Following the sampling, the impinger contents are measured and placed in a sample bottle for shipment to the laboratory. The final impinger of the sample train is then analysed separately to the filter, resin trap and front half methanol rinse so as to provide a measure of possible breakthrough. The intent of this sample train component is to provide a measure of breakthrough from the primary sampling components. Where no detections of PFAS material is made in this sample component, the limit of detection is not added to the sample result.
- Following the sampling onsite, all sample train components that have been in contact with the sample are rinsed thoroughly with methanol and stored in a sample container to be analysed as part of the sample.
- Sample train component material. According to documented water and soil PFAS sampling procedures, the use of glass, Teflon and stainless steel should be avoided and the use of polypropylene (PE) is recommended. PE is not considered to be conducive to source emissions sampling due to the temperatures of the flue gas. PE or HDPE cannot be used in the probe or filter box due to its low melting point, instead, all sampling components upstream of the resin trap was constructed of glass. Following sampling, all glassware was thoroughly rinsed with methanol at least three times to quantitatively recovery any possible PFAS material deposited on this surface.

For the analysis, the samples are extracted using a solvent desorption technique, with the filter and front half methanol rinse extract combined prior to analysis for the PFAS species. The XAD resin trap is then analysed in isolation as is the condensate downstream of the trap to gain an understanding of where the PFAS is captured within the sample train. The analysis is performed using LC/MS/MS instruments, with each analysis performed using the surrogate spikes to determine sample specific recoveries.

2.2.1 PFAS blank corrections

A full field blank sample has not been performed for this round of sampling. The stock reagents are largely unchanged from the previous round of sampling (13633), therefore the results of this previous blank are utilised for this round. A field blank is performed by the sample train being constructed as normal, however no sample is passed through it. It is then cleaned and recovered following the standard recovery procedures and the filter, resin trap and rinsate kept and analysed along with the sample.

The following details the procedures used to correct for detections of PFAS species in the blank samples.

- Where the blank result is a non-detection, no adjustment to the sample result is made.
- Where the blank result returns a positive detection, but is less than half of the sample result, the blank value is subtracted from the sample result and reported as a positive detection.
- Where the blank value returns a positive detection, and is exceeding half of the sample result, no adjustments are made to the sample result, but it is reported as a non-detection.

2.3 Sample Location

The images and figures below show the sample location and site details.

Figure 1: BeneVap treatment system stacks

Table 9: Sample location summary

AS4323.1	Sample location	BV300
	Stack Shape	CIRCULAR
	Ideal Sampling Plane Assessment	
	Stack Diameter (m)	0.59
	Stack Cross Section Area (m^2)	0.27
	Distance to upstream disturbance (m) (from disturbance)	0.7
	Upstream Diameters (D)	1.2
	Distance to downstream disturbance (m) (from disturbance)	1.4
	Downstream diameters (D)	2.4
4.2.2 Table 1	Meets Requirements AS4323.1 Table 1	No
	Non-deal Sampling Plane Assessment	
	Assessment required?	No
	Total traverse point factors	1.2
	Non-conforming Sampling Plane Assessment	
4.2.2(a)	Gas flow in same direction	Yes
4.2.2(b)	Gas flow steady & evenly distributed (cyclonic or swirl <15º)	Yes
4.2.2(c)	Temperature difference between points <10%, and each point <10% of average	Yes
4.2.2(d)	Ratio of highest to lowest differential pressure & ratio highest to lowest velocity	2.7 1.6
4.2.2(e)	Minimum differential pressure	0.3
	Gas temperature above dewpoint	No
	Samling Plane Type	
4.2.2, 4.2.3, 4.2.4	Sampling plane type	Non-conforming
	Alternative sampling plane available?	No
	Number of Sample Points Adopted	
	Port size (mm)	100
	Port Thread Type	BSP
	Number of traverses	2
	Number of points per traverse	6
	Total number of traverse points	12
	Flow & temperature compliance check	No

2.4 Test equipment

The sampling equipment was transported to site and specifically setup at the test location. Sampling was performed using heated probes and filters, with a constant flow and isokinetic sample console.

Equipment used during the course of the testing is sourced from Apex Instruments and Testo, industry leaders in the supply of source testing equipment.

Figure 2: Manual sampling equipment

Figure 3: Combustion gas analyser

3 MEASUREMENT UNCERTAINTY

There is an inherent uncertainty associated with any scientific measurement, including stack emissions monitoring. The measurement uncertainty can be controlled with strict adherence to the reference methodology along with utilising appropriate calibration standards with corresponding acceptable uncertainty reports.

Many source sampling methods do not outline exact procedures for establishing direct measurement uncertainty. In the absence of a defined procedure, the uncertainty budgets presented are based on estimations using ISO-GUM method.

Each individual source and test may have a unique associated uncertainty, due largely to the stack sample location in relation to the positioning requirements of AS4323.1.

Table 10: Sample specific uncertainty budgets

Parameter	Reference method	Limit of measurement	Unit of measure	Uncertainty ± %
Flue gas velocity	USEPA Method 2	3	m/sec	10
Oxygen	USEPA Method 3A	0.3	%-vol	5.0
Carbon dioxide	USEPA Method 3A	0.3	%-vol	10
Water vapour content	USEPA Method 4	0.5	%-vol	5.0
Sulphur dioxide	USEPA Method 6	2.0	mg/sample	15
Oxides of nitrogen (as NO_2)	USEPA Method 7E	2.1	mg/sample	15
Sulfuric acid mists	USEPA Method 8	2.0	mg/sample	15
Carbon monoxide	USEPA Method 10	1.5	mg/sample	15
Hydrogen sulfide	USEPA Method 15	1.0	mg/sample	20
Total VOCs	USEPA Method 18	1.0	mg/sample	20
Hydrogen chloride	USEPA Method 26A	1.0	mg/sample	15
Chlorine	USEPA Method 26A	1.0	mg/sample	15
Fluoride (as HF)	USEPA Method 13B	1.0	mg/sample	15
Heavy metals	USEPA Method 29	0.3 to 50	µg/sample	20
PFAS – suite	USEPA SW846 Method 0010	1 to 50	ng/sample	25
Dioxins & furans	USEPA SW846 Method 0010	1	pg/sample	15
Polychlorinated biphenyls	USEPA SW846 Method 0010	20	pg/sample	15
Ammonia	Modified USEPA Method 26	1	mg/sample	25
Odour	AS4323.3	100	ou	40

4 QUALITY ASSURANCE & QUALITY CONTROL (QA/QC)

AE operates within a quality system based upon the requirements of ISO17025. Our quality system defines specific procedures and methodologies to ensure any project undertaken by AE is conducted with the highest level of quality given the specific confines of each project. The overall objective of our QA/QC procedures is to representatively sample and accurately analyse components in the gas streams and therefore report valid measurements of emission concentrations.

To ensure representativeness of field work, our quality procedures target:

1. Correct sampling locations
2. Sample time
3. Frequency of samples and
4. Method selection & adherence

To ensure representativeness of lab work, our quality procedures target:

1. Sample preservation
2. Chain of custody (COC)
3. Sample preparation and
4. Analytical techniques

AE maintains strict quality assurance throughout all its sampling programs, covering on-site 'field work' and the analytical phase of our projects. Our QA program covers the calibration of all sampling and analytical apparatus where applicable and the use of spikes, replicate sample and reference standards. The test methodologies used for this project are outlined in section 2 of this document. Field test data has been recorded and calculated using direct entry into Microsoft Excel spreadsheets following the procedures of the appropriate test methods. Determination of emission concentrations has been performed using the same Microsoft Excel spreadsheets which are partially supplied as an attachment to this report. More detailed information can be supplied upon request.

QA/QC checks for this project will use validation techniques and criteria appropriate to the type of data and the purpose of the measurement to approve the test report. Records of all data will be maintained. Complete chain of custody (COC) procedures have been followed to document the entire custodial history of each sample. The COC forms also served as a laboratory sheet detailing sample ID and analysis requirements.

Table 11: Sampling data QA/QC checklist

Sampling Data QA/QC Checklist	Comment
Use of appropriate test methods	Yes
'Normal' operation of the process being tested	Yes – as instructed by client
Use of properly operating and calibrated test equipment	Yes
Use of high purity reagents	Yes
Performance of leak checks post sample (at least)	Yes

Table 12: Laboratory data QA/QC checklist

Laboratory Data QA/QC Checklist	Comment
Use of appropriate analytical methods	Yes
Use of properly operating and calibrated analytical equipment	Yes
Precision and accuracy comparable to that achieved in similar projects	Yes
Accurate reporting	Yes

Table 13: Olfactometer QA data

Item	Comment
Methodology	AS/NZ4323.3:2001 "determination of odour concentration by dynamic olfactometry".
Sample Media	Odour samples collected into Nalophan™ sample bags
Sample identification	All samples are labelled uniquely immediately following collection according to Assured Environmental identification procedure. Each sample has the following recorded: project ID, sample number, location, date, time, dilution and any deviations to AS/NZ4323.3.
Timing	All measurements were conducted within 30 hours of sampling as specified by AS/NZ4323.3
Traceability	All panel results are traceable to reference standards held by Assured Environmental
Analysis conditions	Room temperature maintained at 22 °C ± 3 °C
Odour panel location	7/142 Tennyson Memorial Avenue Tennyson, Qld. 4105
Reference odourant	40 ppm n-butanol
Odour panel threshold	100 ou

4.1 PFAS quality control

The recoveries of surrogate standards from the sampling and analysis are presented in the table below. The expected QC recovery for measurements in the ppb to ppt levels is in the range of 60 to 120%. The results are not corrected for the recovery efficiency.

Table 14: PFAS surrogate recovery (%)

Surrogate	PFAS	
	BV300_1	BV300_2
Field surrogate		
Surrogate $^{13}C_8$ PFOS	92	103
Surrogate $^{13}C_2$ PFOA	100	101

Analysis of the final bubbler containing a sodium borate solution was performed separately to the front of the sampling train in order to assess the potential for breakthrough. The results of this analysis are provided below.

Table 15: Breakthrough analysis

Perfluorinated surfactants	Abbreviation	Breakthrough analysis (ng/Nm^3)			
		BV300_1		BV300_2	
Perfluorobutanesulfonic acid	PFBS	<	0.2	<	0.2
Perfluoropentanesulfonic acid	PFPeS	<	0.2	<	0.2
Perfluorohexanesulfonic acid	PFHxS	<	0.2	<	0.2
Perfluoroheptanesulfonic acid	PFHpS	<	0.2	<	0.2
Perfluorooctanesulfonic acid PFOS	PFOS	<	0.2	<	0.2
Perfluorodecanesulfonic acid	PFDS	<	0.3	<	0.3
Perfluorobutanoic acid	PFBA	<	0.3	<	0.3
Perfluoropentanoic acid	PFPeA	<	0.3	<	0.3
Perfluorohexanoic acid	PFHxA	<	0.2	<	0.2
Perfluoroheptanoic acid	PFHpA	<	0.2	<	0.2
Perfluorooctanoic acid PFOA	PFOA	<	0.2	<	0.2
Perfluorononanoic acid	PFNA	<	0.2	<	0.2
Perfluorodecanoic acid	PFDA	<	0.8	<	0.8
Perfluoroundecanoic acid	PFUdA	<	0.8	<	0.8
Perfluorododecanoic acid	PFDoA	<	0.8	<	0.8
Perfluorotridecanoic acid	PFTrDA	<	0.8	<	0.8
Perfluorotetradecanoic acid	PFTeDA	<	4.1	<	4.2
4:2 FTS	4:2 FTS	<	0.2	<	0.2
6:2 FTS	6:2 FTS	<	0.2	<	0.2
8:2 FTS	8:2 FTS	<	0.3	<	0.3
10:2 FTS	10:2 FTS	<	0.3	<	0.3
Perfluorooctane sulfonamide	FOSA	<	0.8	<	0.8
N-Methyl perfluorooctanesulfonamide	N-MeFOSA	<	0.8	<	0.8
N-Ethyl perfluorooctanesulfonamide	n-EtFOSA	<	0.8	<	0.8
N-Me perfluorooctanesulfonamidoethanol	n-MeFOSE	<	0.8	<	0.8
N-Et perfluorooctanesulfonamidoethanol	n-EtFOSE	<	41	<	42
MePerfluorooctanesulf-amidoacetic acid	N-MeFOSAA	<	0.3	<	0.3
EtPerfluorooctanesulf-amidoacetic acid	N-EtFOSAA	<	0.3	<	0.3

The breakthrough analysis showed no detectable PFAS compounds were present in either sample.

Analysis of the field sample blank (project 13633) showed that only a small amount of PFOA was detectable in the methanol/XAD resin. The table below shows the results of the blank analysis.

Table 16: Field blank analysis

Perfluorinated surfactants - PFAS suite	Blank analysis Front half ng/sample	Resin Traps ng/sample	Breakthrough ng/sample
Perfluorobutanesulfonic acid	< 0.2	< 0.2	< 0.2
Perfluoropentane sulfonic acid (PFPeS)	< 0.2	< 0.2	< 0.2
Perfluorohexane sulfonate (PFHxS)	< 0.2	< 0.2	< 0.2
Perfluoroheptane sulfonate (PFHpS)	< 0.2	< 0.2	< 0.2
Perfluorooctane sulfonate (PFOS)	< 0.2	< 0.2	< 0.2
Perfluorodecanesulfonic acid (PFDS)	< 0.4	< 0.4	< 0.4
Perfluorobutanoic acid	< 0.4	< 0.4	< 0.4
Perfluoropentanoic acid (PFPeA)	< 0.4	< 0.4	< 0.4
Perfluorohexanoic acid (PFHxA)	< 0.2	< 0.2	< 0.2
Perfluoroheptanoic acid (PFHpA)	< 0.2	< 0.2	< 0.2
Perfluorooctanoic acid (PFOA)	< 0.2	**2.3**	< 0.2
Perfluorononanoic acid (PFNA)	< 0.2	< 0.2	< 0.2
Perfluorodecanoic acid	< 1.0	< 1.0	< 1.0
Perfluoroundecanoic acid (PFUnA)	< 1.0	< 1.0	< 1.0
Perfluorododecanoic acid (PFDoA)	< 1.0	< 1.0	< 1.0
Perfluorotridecanoic acid (PFTrDA)	< 1.0	< 1.0	< 1.0
Perfluorotetradecanoic acid (PFTeDA)	< 5.0	< 5.0	< 5.0
4:2 Flurotelomersulphonate	< 0.2	< 0.2	< 0.2
6:2 Fluorotelomersulphonate	< 0.2	< 0.2	< 0.2
8:2 Fluorotelomersulphonate	< 0.4	< 0.4	< 0.4
10:2 Fluorotelomersulphonate	< 0.4	< 0.4	< 0.4
Perfluorooctane sulfonamide	< 1.0	< 1.0	< 1.0
N-Methyl-heptadecafluorooctane sulphonamide	< 1.0	< 1.0	< 1.0
N-Ethyl-heptadecafluorooctane sulphonamide	< 1.0	< 1.0	< 1.0
N-Me perfluorooctanesulfonamid oethanol	< 1.0	< 1.0	< 1.0
N-Et perfluorooctanesulfonamid oethanol	< 50	< 50	< 50
N-Methylperfluorooctane sulphonamidoacetic acid	< 0.4	< 0.4	< 0.4
N-Ethyl-perfluorooctane sulphonamidoacetic acid	< 0.4	< 0.4	< 0.4

4.2 Dioxins and furans QA

During sample analysis, the laboratory uses $^{13}C_{12}$ labelled dioxin, furan and PCB surrogates to test sample recovery efficiency and possible sample matrix interference.

During this analysis, the laboratory surrogate recovery for dioxin, furan and PCB congeners all fell within method tolerances.

5 DEFINITIONS

The following terms and abbreviations may be used in this report:

Table 17: Definitions

Symbol	Definition
<	The analytes tested for was not detected; the value stated is the reportable limit of detection
Am^3	Gas volume in cubic metres at measured conditions
AS	Australian Standard
BH	Back half of sample train (filter holder and impingers) (referred to during sample recovery)
ºC	Degrees Celsius
CARB	California Air Resources Board methods
dscm	dry standard cubic meters
FH	Front half of sample train (probe and filter holder) (referred to during sample recovery)
g	Grams
Heavy metals	Sum of Antimony, Arsenic, Beryllium, Cadmium, Chromium, Cobalt, Lead, Manganese, Nickle, Selenium, Tin, Vanadium & Mercury. Also known as Type 1 and Type 2 hazardous substances. Total heavy metals refers only to those metals found in the sample and does not include limit of detection values.
kg	Kilograms
Lower range	The sum of a list of a particular group of compounds, where only those individual congeners/compounds that are detectable in the sample have been included in the total. Results below the limit of detection have not been included. Unless otherwise indicated, the lower range is reported for dioxins & furans, PCBs, heavy metals and PFAS analysis suites.
m	Metres
m^3	actual gas volume in cubic metres as measured
mbar	Millibars
mg	Milligrams (10^{-3} grams)
min	Minute
ml	Millilitres
mmH_2O	Millimetres of water
Mole	SI unit that measures the amount of substance
N/A	Not applicable
ng	Nanograms (10^{-9} grams)
Nm^3	Gas volume in dry cubic metres at standard temperature and pressure (0°C and 101.3 kPa)
NMI	National Measurement Institute
NM VOC	Non methane volatile organic compound
NR	Not required on this occasion
ou	Odour unit
ppb	Parts per billion
ppm	Parts per million
sec	Second
Sm^3	Gas volume in dry cubic metres at standard temperature and pressure (0°C and 101.3 kPa) and corrected to a standardised value (e.g. 15% O_2)
STP	Standard temperature and pressure (0°C and 101.3 kPa) & dry
USEPA	United States Environmental Protection Authority

6 RESULTS

6.1 Stack 1 Results

Table 18: Sample information – PFAS

Site		Darwin
Sample Location		BV_300.1
Reference Method		USEPA Method 0010 - ISOKINETIC
Run ID		19
Test Parameter		PFAS
Test Date	dd/mm/yyyy	17/10/2022
Start Time	hh:mm	12:55
End Time	hh:mm	15:55
Average Stack Temperature	°C	87
Absolute Stack Pressure	mb	1007
Moisture Content	% v/v	61.3
Dry Gas Density	kg/Nm^3	1.35
Dry Gas Molecular Weight	g/g-mole	30.2
Sample Volume (dry gas meter)	Nm^3	1.22
Stack Gas Velocity	m/sec	3.1
Actual Stack Flow Rate	m^3/min	50
Dry Standard Stack Flow Rate	Nm^3/min	15
Percent Isokinetic Rate	%	97

		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
PFAS species	ng/Nm^3	ng/Nm^3	g/min
Perfluorobutanesulfonic acid	-	663	9.71E-06
Perfluoropentanesulfonic acid	-	7	9.86E-08
Perfluorohexanesulfonic acid	-	77	1.13E-06
Perfluoroheptanesulfonic acid	-	< 1.7	< 2.42E-08
Perfluorooctanesulfonic acid PFOS	-	98	1.44E-06
Perfluorodecanesulfonic acid	-	< 3.3	< 4.84E-08
Perfluorobutanoic acid	-	45	6.64E-07
Perfluoropentanoic acid	-	90	1.32E-06
Perfluorohexanoic acid	-	148	2.17E-06
Perfluoroheptanoic acid	-	35	5.12E-07
Perfluorooctanoic acid PFOA	-	100	1.47E-06
Perfluorononanoic acid	-	5.9	8.66E-08
Perfluorodecanoic acid	-	8.0	1.18E-07
Perfluoroundecanoic acid	-	< 8.3	< 1.21E-07
Perfluorododecanoic acid	-	< 8.3	< 1.21E-07
Perfluorotridecanoic acid	-	< 8.3	< 1.21E-07
Perfluorotetradecanoic acid	-	< 41	< 6.05E-07
4:2 FTS	-	< 1.7	< 2.42E-08
6:2 FTS	-	51	7.40E-07
8:2 FTS	-	< 3.3	< 4.84E-08
10:2 FTS	-	< 3.3	< 4.84E-08
Perfluorooctane sulfonamide	-	< 8.3	< 1.21E-07
N-Methyl perfluorooctane sulfonamide	-	9.9	1.44E-07
N-Ethyl perfluorooctane sulfonamide	-	< 8.3	< 1.21E-07
N-Me perfluorooctanesulfonamido ethanol	-	67	9.83E-07
N-Et perfluorooctanesulfonamido ethanol	-	< 100	< 1.47E-06
MePerfluorooctanesulf-amido acetic acid	-	10	1.51E-07
EtPerfluorooctanesulf-amido acetic acid	-	7.0	1.03E-07
TOTAL			
Sum of positive detections	-	1,423	2.08E-05

Table 19: Sample information – Odour

Site		Darwin	
Sample Location		BV_150	
Reference Method		AS4323.3 - CONSTANT FLOW	
Run ID		20	
Test Parameter		Odour	
Test Date	dd/mm/yyyy	19/10/2022	
Start Time	hh:mm	7:05	
End Time	hh:mm	7:16	
Average Stack Temperature	°C	87	
Absolute Stack Pressure	mb	1009	
Moisture Content	% v/v	62.4	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.2	
Sample Volume (dry gas meter)	Nm^3	-	
Stack Gas Velocity	m/sec	3.0	
Actual Stack Flow Rate	m^3/min	51	
Dry Standard Stack Flow Rate	Nm^3/min	14	
Percent Isokinetic Rate	%	N/A	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
Odour	ou	ou	ou.m^3/min
Odour Sample 1	-	8,251	315,349
Odour Sample 2	-	8,751	334,440
Average Odour	-	8,501	324,895

Table 20: Sample information – Hydrogen sulfide

Site		Darwin	
Sample Location		BV_150	
Reference Method		USEPA Method 15 - CONSTANT FLOW	
Run ID		21	
Test Parameter		H_2S	
Test Date	dd/mm/yyyy	19/10/2022	
Start Time	hh:mm	7:20	
End Time	hh:mm	7:25	
Average Stack Temperature	°C	87	
Absolute Stack Pressure	mb	1009	
Moisture Content	% v/v	62.4	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.1	
Sample Volume (dry gas meter)	Nm^3	-	
Stack Gas Velocity	m/sec	3.0	
Actual Stack Flow Rate	m^3/min	51	
Dry Standard Stack Flow Rate	Nm^3/min	14	
Percent Isokinetic Rate	%	N/A	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
H_2S	mg/Nm^3	mg/Nm^3	g/min
Hydrogen sulfide	5	< 1.1	< 0.02

Table 21: Sample information – Oxides of Sulfur

Site		Darwin	
Sample Location		BV_300.1	
Reference Method		USEPA Method 8 - ISOKINETIC	
Run ID		16	
Test Parameter		SOx	
Test Date	dd/mm/yyyy	17/10/2022	
Start Time	hh:mm	17:27	
End Time	hh:mm	18:27	
Average Stack Temperature	°C	87	
Absolute Stack Pressure	mb	1007	
Moisture Content	% v/v	66.4	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.2	
Sample Volume (dry gas meter)	Nm^3	0.38	
Stack Gas Velocity	m/sec	2.9	
Actual Stack Flow Rate	m^3/min	47	
Dry Standard Stack Flow Rate	Nm^3/min	12	
Percent Isokinetic Rate	%	113	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
SOx	mg/Nm^3	mg/Nm^3	g/min
SO_2	-	< 2.2	< 0.03
SO_3 (as H_2SO_4)	100	< 1.4	< 0.02

Table 22: Sample information – Acid gases

Site		Darwin	
Sample Location		BV_300.1	
Reference Method		USEPA Method 26A - ISOKINETIC	
Run ID		14	
Test Parameter		Acid Gases	
Test Date	dd/mm/yyyy	18/10/2022	
Start Time	hh:mm	15:11	
End Time	hh:mm	16:11	
Average Stack Temperature	°C	87	
Absolute Stack Pressure	mb	1008	
Moisture Content	% v/v	69.6	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.3	
Sample Volume (dry gas meter)	Nm^3	0.39	
Stack Gas Velocity	m/sec	3.0	
Actual Stack Flow Rate	m^3/min	50	
Dry Standard Stack Flow Rate	Nm^3/min	11	
Percent Isokinetic Rate	%	120	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
Acid Gases	mg/Nm^3	mg/Nm^3	g/min
HCl	100	< 2.5	< 0.03
Cl_2	200	< 2.5	< 0.03

Table 23: Sample information – Heavy metals

Site		Darwin	
Sample Location		BV_300.1	
Reference Method		USEPA Method 29 - ISOKINETIC	
Run ID		13	
Test Parameter		Metals	
Test Date	dd/mm/yyyy	18/10/2022	
Start Time	hh:mm	11:55	
End Time	hh:mm	13:55	
Average Stack Temperature	°C	87	
Absolute Stack Pressure	mb	1008	
Moisture Content	% v/v	62.4	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.3	
Sample Volume (dry gas meter)	Nm^3	0.79	
Stack Gas Velocity	m/sec	3.0	
Actual Stack Flow Rate	m^3/min	49	
Dry Standard Stack Flow Rate	Nm^3/min	14	
Percent Isokinetic Rate	%	100	
Pollutant Metals	Licence limit µg/Nm^3	standard conditions Concentration µg/Nm^3	Emission Rate g/min
Antimony	-	< 7.1	< 9.9E-05
Arsenic	-	< 7.1	< 9.9E-05
Beryllium	-	< 0.5	< 7.4E-06
Cadmium	200	0.88	1.2E-05
Chromium	-	10	1.4E-04
Cobalt	-	2.1	3.0E-05
Lead	-	15	2.1E-04
Manganese	-	4.4	6.1E-05
Nickel	-	64	8.9E-04
Selenium	-	< 7.1	< 9.9E-05
Tin	-	< 18	< 2.5E-04
Vanadium	-	< 8.9	< 1.2E-04
Mercury	200	1.1	1.5E-05
Total Heavy Metals (lower bound)	1,000	98	1.4E-03

Table 24: Sample information – Volatile organic compounds

Site		Darwin	
Sample Location		BV_300.1	
Reference Method		USEPA Method 18 - CONSTANT FLOW	
Run ID		17	
Test Parameter		VOCs	
Test Date	dd/mm/yyyy	17/10/2022	
Start Time	hh:mm	13:20	
End Time	hh:mm	14:20	
Average Stack Temperature	°C	87	
Absolute Stack Pressure	mb	1007	
Moisture Content	% v/v	61.3	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.2	
Sample Volume (dry gas meter)	Nm^3	0.03	
Stack Gas Velocity	m/sec	3.1	
Actual Stack Flow Rate	m^3/min	50	
Dry Standard Stack Flow Rate	Nm^3/min	15	
Percent Isokinetic Rate	%	N/A	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
Total (non-methane) VOCs	mg/Nm^3	mg/Nm^3	g/min
Total VOCs - as n-hexane	-	< 2.0	< 0.03
Total VOCs - as n-propane	40	< 1.0	< 0.01

Table 25: Sample information – Ammonia

Site		Darwin	
Sample Location		BV_300.1	
Reference Method		USEPA Method Mod M6 - CONSTANT FLOW	
Run ID		18	
Test Parameter		NH$_3$	
Test Date	dd/mm/yyyy	18/10/2022	
Start Time	hh:mm	7:20	
End Time	hh:mm	8:20	
Average Stack Temperature	°C	87	
Absolute Stack Pressure	mb	1007	
Moisture Content	% v/v	62.4	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.3	
Sample Volume (dry gas meter)	Nm^3	0.04	
Stack Gas Velocity	m/sec	3.0	
Actual Stack Flow Rate	m^3/min	49	
Dry Standard Stack Flow Rate	Nm^3/min	14	
Percent Isokinetic Rate	%	N/A	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
NH$_3$	mg/Nm^3	mg/Nm^3	g/min
Ammonia (NH$_3$) - in condensate	-	1,808	25.1
Ammonia (NH$_3$) - gaseous	-	136	1.9
Total Ammonia (as NH$_3$)	-	1,944	26.9

Table 26: Sample information – Fluoride

Site		Darwin
Sample Location		BV_300.1
Reference Method		USEPA Method 13B - ISOKINETIC
Run ID		15
Test Parameter		Fluoride
Test Date	dd/mm/yyyy	18/10/2022
Start Time	hh:mm	17:03
End Time	hh:mm	18:03
Average Stack Temperature	°C	87
Absolute Stack Pressure	mb	1008
Moisture Content	% v/v	64.2
Dry Gas Density	kg/Nm^3	1.35
Dry Gas Molecular Weight	g/g-mole	30.3
Sample Volume (dry gas meter)	Nm^3	0.41
Stack Gas Velocity	m/sec	3.0
Actual Stack Flow Rate	m^3/min	49
Dry Standard Stack Flow Rate	Nm^3/min	13
Percent Isokinetic Rate	%	107

		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
Fluoride	mg/Nm^3	mg/Nm^3	g/min
Fluorine - (as total HF)	50	< 2.6	< 0.03

Table 27: Sample information – Combustion gases

Site		Darwin
Sample Location		BV_300.1
Reference Method		USEPA Method 3A, 7E & 10
Run ID		Various
Test Parameter		O_2, CO_2, NOx, CO
Test Date	dd/mm/yyyy	17/10/2022
Start Time	hh:mm	17:27
End Time	hh:mm	16:11
Average Stack Temperature	°C	87
Absolute Stack Pressure	mb	1008
Moisture Content	% v/v	64.7
Dry Gas Density	kg/Nm^3	1.35
Dry Gas Molecular Weight	g/g-mole	30.3
Stack Gas Velocity	m/sec	3.0
Actual Stack Flow Rate	m^3/min	48
Dry Standard Stack Flow Rate	Nm^3/min	13

		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
O_2, CO_2, NOx, CO	STP	STP	g/min
Oxygen (% v/v)	-	3.1	-
Carbon dioxide (% v/v)	-	13.4	-
Carbon monoxide (mg/Nm^3)	125	93	2.8
Oxides of nitrogen (mg/Nm^3)	350	143	1.9

Table 28: Sample information – Dioxins & furans

Site		Darwin	
Sample Location		BV_300.1	
Reference Method		USEPA Method 23 - ISOKINETIC	
Run ID		12	
Test Parameter		PCDD/F & PCB	
Test Date	dd/mm/yyyy	18/10/2022	
Start Time	hh:mm	7:10	
End Time	hh:mm	10:10	
Average Stack Temperature	°C	87	
Absolute Stack Pressure	mb	1009	
Moisture Content	% v/v	61.1	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.3	
Sample Volume (dry gas meter)	Nm^3	1.21	
Stack Gas Velocity	m/sec	2.9	
Actual Stack Flow Rate	m^3/min	48	
Dry Standard Stack Flow Rate	Nm^3/min	14	
Percent Isokinetic Rate	%	100	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
PCDD/F & PCB	ng/Nm^3	ng/Nm^3	g/min
2378 TCDF	-	0.0056	7.9E-11
Total TCDF isomers	-	0.065	9.2E-10
2378 TCDD	-	< 0.0017	< 2.3E-11
Total TCDD isomers	-	0.035	4.9E-10
12378 PeCDF	-	0.0023	3.3E-11
23478 PeCDF	-	0.0027	3.7E-11
Total PeCDF isomers	-	0.032	4.5E-10
12378 PeCDD	-	< 0.0017	< 2.3E-11
Total PeCDD isomers	-	0.024	3.4E-10
123478 HxCDF	-	< 0.0017	< 2.3E-11
123678 HxCDF	-	0.0017	2.3E-11
234678 HxCDF	-	< 0.0008	< 1.2E-11
123789 HxCDF	-	< 0.00066	< 9.3E-12
Total HxCDF isomers	-	0.013	1.9E-10
123478 HxCDD	-	< 0.00083	< 1.2E-11
123678 HxCDD	-	0.0016	2.2E-11
123789 HxCDD	-	0.0012	1.7E-11
Total HxCDD isomers	-	0.037	5.2E-10
1234678 HpCDF	-	0.0028	3.9E-11
1234789 HpCDF	-	< 0.00050	< 7.0E-12
Total HpCDF isomers	-	0.0051	7.1E-11
1234678 HpCDD	-	0.030	4.2E-10
Total HpCDD isomers	-	0.059	8.2E-10
OCDF	-	0.0016	2.2E-11
OCDD	-	0.13	1.9E-09
Sum of congeners			
Sum of positive detections	-	0.41	5.7E-09
Total I-TEQ			
Sum of positive detections	0.1	0.0029	4.1E-11

Table 29: Sample information – PCBs

PCBs (USEPA Method 23)					
PCBs	Licence limit ng/Nm^3		standard conditions Concentration ng/Nm^3		Emission Rate g/min
PCB#77	-		0.84		1.2E-08
PCB#81	-		0.036		5.1E-10
PCB#126	-		0.025		3.5E-10
PCB#169	-	<	0.0017	<	2.3E-11
PCB#105	-		2.9		4.1E-08
PCB#114	-		0.17		2.4E-09
PCB#118	-		6.2		8.7E-08
PCB#123	-		0.13		1.9E-09
PCB#156	-		0.8		1.1E-08
PCB#157	-		0.18		2.6E-09
PCB#167	-		0.29		4.1E-09
PCB#189	-		0.032		4.5E-10
Sum of PCB Congeners Sum of positive detections	-		12		1.6E-07
Total TEQ Sum of positive detections	-		0.0029		4.1E-11

6.2 Stack 2 Results

Table 30: Sample information – PFAS

Site		Darwin
Sample Location		BV_300.2
Reference Method		USEPA Method 0010 - ISOKINETIC
Run ID		30
Test Parameter		PFAS
Test Date	dd/mm/yyyy	17/10/2022
Start Time	hh:mm	13:06
End Time	hh:mm	16:06
Average Stack Temperature	°C	87
Absolute Stack Pressure	mb	1007
Moisture Content	% v/v	62.9
Dry Gas Density	kg/Nm^3	1.35
Dry Gas Molecular Weight	g/g-mole	30.2
Sample Volume (dry gas meter)	Nm^3	1.19
Stack Gas Velocity	m/sec	3.2
Actual Stack Flow Rate	m^3/min	52
Dry Standard Stack Flow Rate	Nm^3/min	15
Percent Isokinetic Rate	%	102

			standard conditions		
Pollutant	Licence limit		Concentration		Emission Rate
PFAS species	ng/Nm^3		ng/Nm^3		g/min
Perfluorobutanesulfonic acid	-		562		8.22E-06
Perfluoropentanesulfonic acid	-		7.6		1.11E-07
Perfluorohexanesulfonic acid	-		76		1.11E-06
Perfluoroheptanesulfonic acid	-	<	1.7	<	2.48E-08
Perfluorooctanesulfonic acid PFOS	-		92		1.35E-06
Perfluorodecanesulfonic acid	-	<	3.4	<	4.95E-08
Perfluorobutanoic acid	-		52		7.65E-07
Perfluoropentanoic acid	-		120		1.75E-06
Perfluorohexanoic acid	-		145		2.12E-06
Perfluoroheptanoic acid	-		31		4.61E-07
Perfluorooctanoic acid PFOA	-		96		1.40E-06
Perfluorononanoic acid	-		3.5		5.19E-08
Perfluorodecanoic acid	-		8.2		1.21E-07
Perfluoroundecanoic acid	-	<	8.5	<	1.24E-07
Perfluorododecanoic acid	-	<	8.5	<	1.24E-07
Perfluorotridecanoic acid	-	<	8.5	<	1.24E-07
Perfluorotetradecanoic acid	-	<	42	<	6.19E-07
4:2 FTS	-	<	1.7	<	2.48E-08
6:2 FTS	-		40		5.91E-07
8:2 FTS	-		4.7		6.82E-08
10:2 FTS	-	<	3.4	<	4.95E-08
Perfluorooctane sulfonamide	-	<	8.5	<	1.24E-07
N-Methyl perfluorooctane sulfonamide	-	<	8.5	<	1.24E-07
N-Ethyl perfluorooctane sulfonamide	-	<	8.5	<	1.24E-07
N-Me perfluorooctanesulfonamido ethanol	-		109		1.59E-06
N-Et perfluorooctanesulfonamido ethanol	-	<	103	<	1.50E-06
MePerfluorooctanesulf-amido acetic acid	-		8.8		1.29E-07
EtPerfluorooctanesulf-amido acetic acid	-		8.8		1.29E-07
TOTAL					
Sum of positive detections	-		1,364		2.00E-05

Table 31: Sample information – Odour

Site		Darwin	
Sample Location		BV_150	
Reference Method		AS4323.3 - CONSTANT FLOW	
Run ID		31	
Test Parameter		Odour	
Test Date	dd/mm/yyyy	19/10/2022	
Start Time	hh:mm	7:35	
End Time	hh:mm	7:45	
Average Stack Temperature	°C	87	
Absolute Stack Pressure	mb	1009	
Moisture Content	% v/v	61.9	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.3	
Sample Volume (dry gas meter)	Nm^3	-	
Stack Gas Velocity	m/sec	3.0	
Actual Stack Flow Rate	m^3/min	51	
Dry Standard Stack Flow Rate	Nm^3/min	15	
Percent Isokinetic Rate	%	N/A	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
Odour	ou	ou	ou.m^3/min
Odour Sample 1	-	8,658	331,436
Odour Sample 2	-	7,644	292,619
Average Odour	-	8,151	312,027

Table 32: Sample information – Hydrogen sulfide

Site		Darwin	
Sample Location		BV_150	
Reference Method		USEPA Method 15 - CONSTANT FLOW	
Run ID		32	
Test Parameter		H_2S	
Test Date	dd/mm/yyyy	19/10/2022	
Start Time	hh:mm	7:30	
End Time	hh:mm	7:35	
Average Stack Temperature	°C	87	
Absolute Stack Pressure	mb	1009	
Moisture Content	% v/v	61.9	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.3	
Sample Volume (dry gas meter)	Nm^3	-	
Stack Gas Velocity	m/sec	3.0	
Actual Stack Flow Rate	m^3/min	51	
Dry Standard Stack Flow Rate	Nm^3/min	15	
Percent Isokinetic Rate	%	N/A	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
H_2S	mg/Nm^3	mg/Nm^3	g/min
Hydrogen sulfide	5	< 1.1	< 0.02

Table 33: Sample information – Oxides of Sulfur

Site		Darwin	
Sample Location		BV_300.2	
Reference Method		USEPA Method 8 - ISOKINETIC	
Run ID		27	
Test Parameter		SOx	
Test Date	dd/mm/yyyy	17/10/2022	
Start Time	hh:mm	17:28	
End Time	hh:mm	18:28	
Average Stack Temperature	°C	86	
Absolute Stack Pressure	mb	1007	
Moisture Content	% v/v	64.1	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.2	
Sample Volume (dry gas meter)	Nm^3	0.37	
Stack Gas Velocity	m/sec	3.0	
Actual Stack Flow Rate	m^3/min	49	
Dry Standard Stack Flow Rate	Nm^3/min	13	
Percent Isokinetic Rate	%	103	
Pollutant	Licence limit	standard conditions Concentration	Emission Rate
SOx	mg/Nm^3	mg/Nm^3	g/min
SO_2	-	< 1.8	< 0.02
SO_3 (as H_2SO_4)	100	< 1.3	< 0.02

Table 34: Sample information – Acid gases

Site		Darwin	
Sample Location		BV_300.2	
Reference Method		USEPA Method 26A - ISOKINETIC	
Run ID		25	
Test Parameter		Acid Gases	
Test Date	dd/mm/yyyy	18/10/2022	
Start Time	hh:mm	15:12	
End Time	hh:mm	16:12	
Average Stack Temperature	°C	87	
Absolute Stack Pressure	mb	1008	
Moisture Content	% v/v	70.3	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.3	
Sample Volume (dry gas meter)	Nm^3	0.36	
Stack Gas Velocity	m/sec	3.0	
Actual Stack Flow Rate	m^3/min	49	
Dry Standard Stack Flow Rate	Nm^3/min	11	
Percent Isokinetic Rate	%	122	
Pollutant	Licence limit	standard conditions Concentration	Emission Rate
Acid Gases	mg/Nm^3	mg/Nm^3	g/min
HCl	100	< 2.8	< 0.03
Cl_2	200	< 2.8	< 0.03

Table 35: Sample information – Heavy metals

Site		Darwin
Sample Location		BV_300.2
Reference Method		USEPA Method 29 - ISOKINETIC
Run ID		24
Test Parameter		Metals
Test Date	dd/mm/yyyy	18/10/2022
Start Time	hh:mm	11:56
End Time	hh:mm	13:56
Average Stack Temperature	°C	87
Absolute Stack Pressure	mb	1008
Moisture Content	% v/v	67.4
Dry Gas Density	kg/Nm^3	1.35
Dry Gas Molecular Weight	g/g-mole	30.3
Sample Volume (dry gas meter)	Nm^3	0.72
Stack Gas Velocity	m/sec	3.0
Actual Stack Flow Rate	m^3/min	49
Dry Standard Stack Flow Rate	Nm^3/min	12
Percent Isokinetic Rate	%	113

Pollutant	Licence limit	standard conditions Concentration	Emission Rate
Metals	µg/Nm^3	µg/Nm^3	g/min
Antimony	-	< 7.8	< 9.4E-05
Arsenic	-	< 7.8	< 9.4E-05
Beryllium	-	< 0.59	< 7.0E-06
Cadmium	200	3.9	4.6E-05
Chromium	-	14	1.7E-04
Cobalt	-	2.2	2.6E-05
Lead	-	39	4.6E-04
Manganese	-	4.3	5.1E-05
Nickel	-	58	7.0E-04
Selenium	-	< 7.8	< 9.4E-05
Tin	-	< 20	< 2.3E-04
Vanadium	-	< 9.8	< 1.2E-04
Mercury	200	5.8	7.0E-05
Total Heavy Metals (lower bound)	1,000	127	1.5E-03

Table 36: Sample information – Volatile organic compounds

Site		Darwin	
Sample Location		BV_300.2	
Reference Method		USEPA Method M18 - CONSTANT FLOW	
Run ID		28	
Test Parameter		VOC	
Test Date	dd/mm/yyyy	17/10/2022	
Start Time	hh:mm	14:26	
End Time	hh:mm	15:26	
Average Stack Temperature	°C	87	
Absolute Stack Pressure	mb	1007	
Moisture Content	% v/v	62.9	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.2	
Sample Volume (dry gas meter)	Nm^3	0.03	
Stack Gas Velocity	m/sec	3.2	
Actual Stack Flow Rate	m^3/min	52	
Dry Standard Stack Flow Rate	Nm^3/min	15	
Percent Isokinetic Rate	%	N/A	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
Total (non-methane) VOCs	mg/Nm^3	mg/Nm^3	g/min
Total VOCs - as n-hexane	-	< 2.0	< 0.03
Total VOCs - as n-propane	40	< 1.0	< 0.01

Table 37: Sample information – Ammonia

Site		Darwin	
Sample Location		BV_300.2	
Reference Method		USEPA Method Mod M6 - CONSTANT FLOW	
Run ID		29	
Test Parameter		NH_3	
Test Date	dd/mm/yyyy	18/10/2022	
Start Time	hh:mm	8:30	
End Time	hh:mm	9:30	
Average Stack Temperature	°C	87	
Absolute Stack Pressure	mb	1009	
Moisture Content	% v/v	61.9	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.3	
Sample Volume (dry gas meter)	Nm^3	0.04	
Stack Gas Velocity	m/sec	3.0	
Actual Stack Flow Rate	m^3/min	49	
Dry Standard Stack Flow Rate	Nm^3/min	14	
Percent Isokinetic Rate	%	N/A	
	Concentration		Emission Rate
Pollutant	standard conditions	standard conditions	standard conditions
NH_3	mg/Nm^3	mg/Nm^3	g/min
Ammonia (NH_3) - in condensate	-	1,882	26.5
Ammonia (NH_3) - gaseous	-	74	1.0
Total Ammonia (as NH_3)	-	1,956	27.6

Table 38: Sample information – Fluoride

Site		Darwin	
Sample Location		BV_300.2	
Reference Method		USEPA Method 13B - ISOKINETIC	
Run ID		26	
Test Parameter		Fluoride	
Test Date	dd/mm/yyyy	18/10/2022	
Start Time	hh:mm	17:03	
End Time	hh:mm	18:03	
Average Stack Temperature	°C	87	
Absolute Stack Pressure	mb	1008	
Moisture Content	% v/v	64.4	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.3	
Sample Volume (dry gas meter)	Nm^3	0.36	
Stack Gas Velocity	m/sec	2.9	
Actual Stack Flow Rate	m^3/min	48	
Dry Standard Stack Flow Rate	Nm^3/min	13	
Percent Isokinetic Rate	%	104	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
Fluoride	mg/Nm^3	mg/Nm^3	g/min
Fluorine - (as total HF)	50	< 2.9	< 0.04

Table 39: Sample information – Combustion gases

Site		Darwin	
Sample Location		BV_300.2	
Reference Method		USEPA Method 3A, 7E & 10	
Run ID		Various	
Test Parameter		O_2, CO_2, NOx, CO	
Test Date	dd/mm/yyyy	18/10/2022	
Start Time	hh:mm	17:03	
End Time	hh:mm	10:12	
Average Stack Temperature	°C	87	
Absolute Stack Pressure	mb	1008	
Moisture Content	% v/v	65.6	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.3	
Stack Gas Velocity	m/sec	3.0	
Actual Stack Flow Rate	m^3/min	49	
Dry Standard Stack Flow Rate	Nm^3/min	13	
		standard conditions	
Pollutant O_2, CO_2, NOx, CO	Licence limit STP	Concentration STP	Emission Rate g/min
Oxygen (% v/v)	-	3.1	-
Carbon dioxide (% v/v)	-	13.4	-
Carbon monoxide (mg/Nm^3)	125	89	1.2
Oxides of nitrogen (mg/m^3)	350	143	1.8

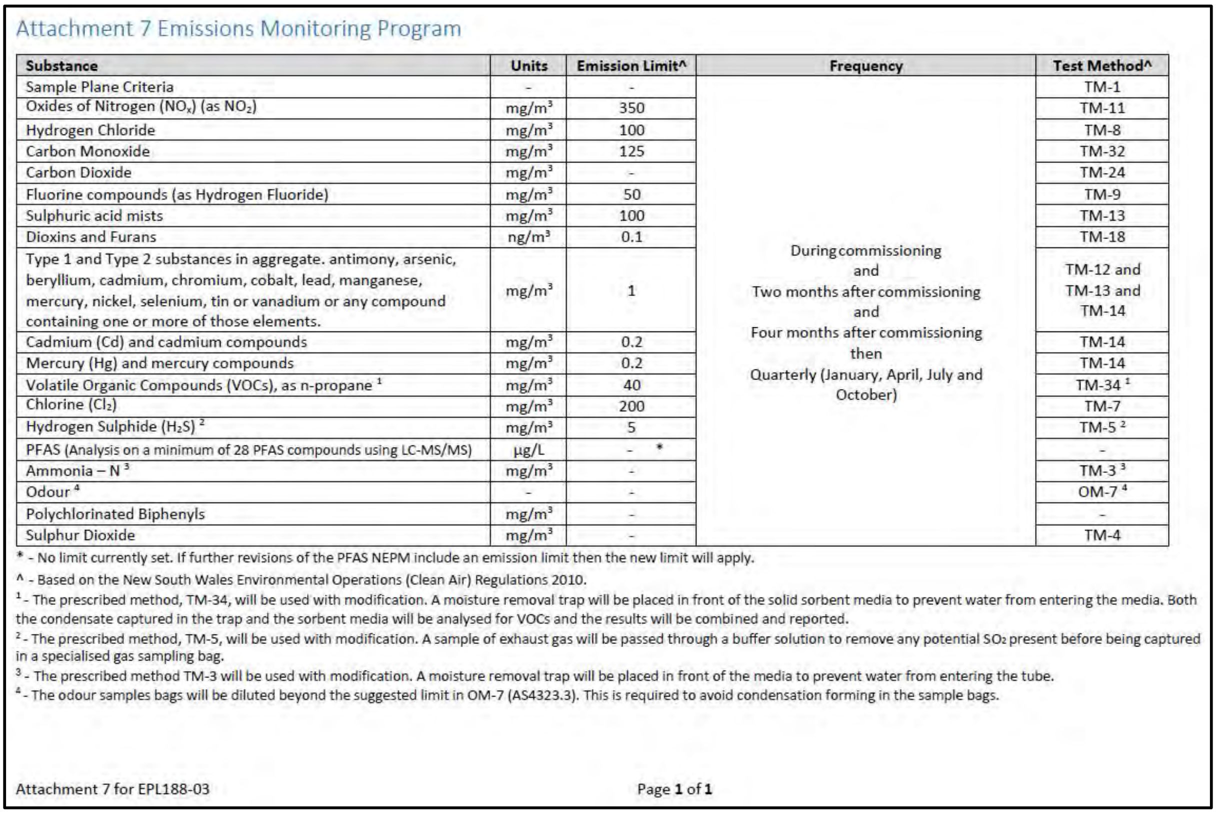
Table 40: Sample information – Dioxins & furans

Site		Darwin	
Sample Location		BV_300.2	
Reference Method		USEPA Method 23 - ISOKINETIC	
Run ID		23	
Test Parameter		PCDD/F & PCB	
Test Date	dd/mm/yyyy	18/10/2022	
Start Time	hh:mm	7:12	
End Time	hh:mm	10:12	
Average Stack Temperature	°C	87	
Absolute Stack Pressure	mb	1009	
Moisture Content	% v/v	61.9	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.3	
Sample Volume (dry gas meter)	Nm^3	1.11	
Stack Gas Velocity	m/sec	3.0	
Actual Stack Flow Rate	m^3/min	49	
Dry Standard Stack Flow Rate	Nm^3/min	14	
Percent Isokinetic Rate	%	98	
Pollutant	Licence limit	standard conditions Concentration	Emission Rate
PCDD/F & PCB	ng/Nm^3	ng/Nm^3	g/min
2378 TCDF	-	0.004	6.2E-11
Total TCDF isomers	-	0.068	9.6E-10
2378 TCDD	-	< 0.0036	< 5.1E-11
Total TCDD isomers	-	0.032	4.6E-10
12378 PeCDF	-	0.0029	4.1E-11
23478 PeCDF	-	0.0041	5.8E-11
Total PeCDF isomers	-	0.036	5.1E-10
12378 PeCDD	-	< 0.0018	< 2.5E-11
Total PeCDD isomers	-	0.022	3.0E-10
123478 HxCDF	-	0.0026	3.7E-11
123678 HxCDF	-	0.0025	3.5E-11
234678 HxCDF	-	0.0027	3.8E-11
123789 HxCDF	-	< 0.00090	< 1.3E-11
Total HxCDF isomers	-	0.022	3.0E-10
123478 HxCDD	-	< 0.00090	< 1.3E-11
123678 HxCDD	-	0.0021	2.9E-11
123789 HxCDD	-	< 0.0009	< 1.3E-11
Total HxCDD isomers	-	0.041	5.8E-10
1234678 HpCDF	-	0.011	1.5E-10
1234789 HpCDF	-	0.0022	3.2E-11
Total HpCDF isomers	-	0.020	2.8E-10
1234678 HpCDD	-	0.037	5.2E-10
Total HpCDD isomers	-	0.070	9.9E-10
OCDF	-	0.017	2.4E-10
OCDD	-	0.16	2.3E-09
Sum of congeners			
Sum of positive detections	-	0.49	6.9E-09
Total I-TEQ			
Sum of positive detections	0.1	0.004	6.1E-11

Table 41: Sample information – PCBs

PCBs (USEPA Method 23)					
PCBs	Licence limit ng/Nm³		standard conditions Concentration ng/Nm³		Emission Rate g/min
PCB#77	-		0.92		1.3E-08
PCB#81	-		0.040		5.6E-10
PCB#126	-		0.024		3.4E-10
PCB#169	-	<	0.00090	<	1.3E-11
PCB#105	-		3.0		4.3E-08
PCB#114	-		0.18		2.5E-09
PCB#118	-		6.3		8.9E-08
PCB#123	-		0.11		1.5E-09
PCB#156	-		0.81		1.1E-08
PCB#157	-		0.19		2.7E-09
PCB#167	-		0.29		4.1E-09
PCB#189	-		0.031		4.4E-10
Sum of PCB Congeners Sum of positive detections	-		12		1.7E-07
Total TEQ Sum of positive detections	-		0.0029		4.1E-11

7 APPENDIX



Attachment 7 Emissions Monitoring Program

Substance	Units	Emission Limit^	Frequency	Test Method^
Sample Plane Criteria	-	-	During commissioning and Two months after commissioning and Four months after commissioning then Quarterly (January, April, July and October)	TM-1
Oxides of Nitrogen (NO_x) (as NO_2)	mg/m³	350		TM-11
Hydrogen Chloride	mg/m³	100		TM-8
Carbon Monoxide	mg/m³	125		TM-32
Carbon Dioxide	mg/m³	-		TM-24
Fluorine compounds (as Hydrogen Fluoride)	mg/m³	50		TM-9
Sulphuric acid mists	mg/m³	100		TM-13
Dioxins and Furans	ng/m³	0.1		TM-18
Type 1 and Type 2 substances in aggregate. antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, manganese, mercury, nickel, selenium, tin or vanadium or any compound containing one or more of those elements.	mg/m³	1		TM-12 and TM-13 and TM-14
Cadmium (Cd) and cadmium compounds	mg/m³	0.2		TM-14
Mercury (Hg) and mercury compounds	mg/m³	0.2		TM-14
Volatile Organic Compounds (VOCs), as n-propane [1]	mg/m³	40		TM-34 [1]
Chlorine (Cl_2)	mg/m³	200		TM-7
Hydrogen Sulphide (H_2S) [2]	mg/m³	5		TM-5 [2]
PFAS (Analysis on a minimum of 28 PFAS compounds using LC-MS/MS)	µg/L	- *		-
Ammonia – N [3]	mg/m³	-		TM-3 [3]
Odour [4]	-	-		OM-7 [4]
Polychlorinated Biphenyls	mg/m³	-		-
Sulphur Dioxide	mg/m³	-		TM-4

* - No limit currently set. If further revisions of the PFAS NEPM include an emission limit then the new limit will apply.

^ - Based on the New South Wales Environmental Operations (Clean Air) Regulations 2010.

[1] - The prescribed method, TM-34, will be used with modification. A moisture removal trap will be placed in front of the solid sorbent media to prevent water from entering the media. Both the condensate captured in the trap and the sorbent media will be analysed for VOCs and the results will be combined and reported.

[2] - The prescribed method, TM-5, will be used with modification. A sample of exhaust gas will be passed through a buffer solution to remove any potential SO_2 present before being captured in a specialised gas sampling bag.

[3] - The prescribed method TM-3 will be used with modification. A moisture removal trap will be placed in front of the media to prevent water from entering the tube.

[4] - The odour samples bags will be diluted beyond the suggested limit in OM-7 (AS4323.3). This is required to avoid condensation forming in the sample bags.

Attachment 7 for EPL188-03 Page **1** of **1**

Figure 4: Excerpt from EPL188-03 – Attachment 7

SOURCE EMISSIONS MONITORING – SHOAL BAY BENEVAP 150

Project ID: 14714

8/03/2023

Release: R_0

Prepared For:

BeneTerra

Assured Environmental

DOCUMENT CONTROL PAGE

Project Title: Source Emissions Monitoring – Shoal Bay BeneVap 150

Project Reference ID: 14714

Report Prepared by:

Assured Environmental
Unit 7, 142 Tennyson Memorial Avenue
Tennyson, QLD, 4105 – 1300 662 495
and Unit 17, Gardeners Rd
Alexandria, NSW, 2015

Report Prepared for:

BeneTerra
Shoal Bay Access Road
Karama NT 0812

Author: Timon Berger

Reviewer: Adam Dixon

Table 1: History of Revisions

Revision	Date	Issued to	Changes
R_0	8/03/2023	N. Sharma	Initial report release – all results
INTERIM_0	1/03/2023	N. Sharma	Interim report with partial results

DISCLAIMER

Assured Environmental acts in all professional matters as a faithful advisor to the Client and exercises all reasonable skill and care in the provision of its professional services.

Reports are commissioned by and prepared for the exclusive use of the Client. They are subject to and issued in accordance with the agreement between the Client and Assured Environmental. Assured Environmental is not responsible for any liability and accepts no responsibility whatsoever arising from the misapplication or misinterpretation by third parties of the contents of its reports.

Except where expressly stated, Assured Environmental does not attempt to verify the accuracy, validity or comprehensiveness of any information supplied to Assured Environmental for its reports.

Reports cannot be copied or reproduced in whole or part for any purpose without the prior written agreement of Assured Environmental.

Where site inspections, testing or fieldwork have taken place, the report is based on the information made available by the client or their nominees during the visit, visual observations and any subsequent discussions with regulatory authorities. The validity and comprehensiveness of supplied information has not been independently verified and, for the purposes of this report, it is assumed that the information provided to Assured Environmental is both complete and accurate. It is further assumed that normal activities were being undertaken at the site on the day of the site visit(s), unless explicitly stated otherwise.

Accredited for compliance to ISO/IEC 17025

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Accreditation number: 19703

EXECUTIVE SUMMARY

Assured Environmental (AE) conducted source emissions monitoring from the mobile BeneVap Leachate Treatment Facility (BV150) located at the Shoal Bay Waste Facility in Darwin, Northern Territory from 2nd to 5th February 2023

A summary of results and comparison against compliance levels is presented in Table 2 and Table 3 below from the testing conducted on the BV 150 release point stack.

In comparison to the emission limits outlined in EPL188-03 – Attachment 7, all measured parameters were within those limits specified. Results are reported at dry, 273.15 °K and 101.325 kPa (STP).

Table 2: Summary of Emissions – BV150

Parameter	Result BV150	Emission limit	Unit	Reference
Average source temperature	88	-	°C	-
Flue gas water vapour content	60	-	vol-%	-
Carbon dioxide concentration	11.2	-	vol-%	STP - dry
Oxygen concentration	6.1	-	vol-%	STP - dry
Flue gas molecular weight - dry	1.3	-	kg/Nm^3	STP - dry
Flue gas velocity	3.4	-	m/sec	STP - dry
Flue gas volume flow	17.3	-	Nm^3/min	STP - dry
Oxides of nitrogen (as NO_2)	119	350	mg/Nm^3	STP - dry
- emission rate	2.1	-	g/min	
Carbon monoxide	24	125	mg/Nm^3	STP - dry
- emission rate	0.41	-	g/min	
Total heavy metals	0.086	1.0	mg/Nm^3	STP - dry
- emission rate	0.0014	-	g/min	
Cadmium	0.0010	0.2	mg/Nm^3	STP - dry
- emission rate	1.6E-05	-	g/min	
Mercury	0.00084	0.2	mg/Nm^3	STP - dry
- emission rate	1.4E-05	-	g/min	
Fluorine (as HF)	< 2.1	50	mg/Nm^3	STP - dry
- emission rate	< 0.038	-	g/min	
Hydrogen chloride	< 2.2	100	mg/Nm^3	STP - dry
- emission rate	< 0.037	-	g/min	
Chlorine	< 2.2	200	mg/Nm^3	STP - dry
- emission rate	< 0.037	-	g/min	
Ammonia (NH_3) - total	2,457	-	mg/Nm^3	STP - dry
- emission rate	41	-	g/min	
Ammonia (NH_3) - in condensate	2,303	-	mg/Nm^3	STP - dry
- emission rate	39	-	g/min	
Ammonia (NH_3) - gaseous	154	-	mg/Nm^3	STP - dry
- emission rate	2.6	-	g/min	
Hydrogen sulfide	< 0.8	5	mg/Nm^3	STP - dry
- emission rate	< 0.01	-	g/min	
Sulfur dioxide	8.9	-	mg/Nm^3	STP - dry
- emission rate	0.15	-	g/min	
Sulfuric acid mist (as H_2SO_4)	4.6	100	mg/Nm^3	STP - dry
- emission rate	0.08	-	g/min	
Total VOCs (as n-propane)	< 0.9	40	mg/Nm^3	STP - dry
- emission rate	< 0.02	-	g/min	
Average odour	7,172	-	ou	STP - wet
- emission rate	318,583	-	ou-m^3/min	
Dioxins & Furans (i-TEQ)	0.0022	0.1	ng/Nm^3	STP - dry
- emission rate	4.2E-11	-	g/min	
PCBs (i-TEQ)	0.0022	-	ng/Nm^3	STP - dry
- emission rate	4.0E-11	-	g/min	

Table 3: Summary of PFAS Results – BV150

Parameter		Result ng/Nm^3		Emission Rate g/min	Reference
Per- and polyfluoroalkyl substances					
Perfluorobutanesulfonic acid		**135**		**2.3E-06**	**STP**
Perfluoropentanesulfonic acid	<	3.6	<	5.9E-08	STP
Perfluorohexanesulfonic acid		**24**		**4.1E-07**	**STP**
Perfluoroheptanesulfonic acid	<	4.0	<	6.7E-08	STP
Perfluorooctanesulfonic acid PFOS		**26**		**4.4E-07**	**STP**
Perfluorodecanesulfonic acid	<	7.1	<	1.2E-07	STP
Perfluorobutanoic acid		**41**		**6.8E-07**	**STP**
Perfluoropentanoic acid		**103**		**1.7E-06**	**STP**
Perfluorohexanoic acid		**75**		**1.3E-06**	**STP**
Perfluoroheptanoic acid		**21**		**3.5E-07**	**STP**
Perfluorooctanoic acid PFOA		**53**		**8.8E-07**	**STP**
Perfluorononanoic acid	<	3.6	<	5.9E-08	STP
Perfluorodecanoic acid	<	36	<	5.9E-07	STP
Perfluoroundecanoic acid	<	36	<	5.9E-07	STP
Perfluorododecanoic acid	<	36	<	5.9E-07	STP
Perfluorotridecanoic acid	<	36	<	5.9E-07	STP
Perfluorotetradecanoic acid	<	355	<	5.9E-06	STP
4:2 FTS	<	35	<	5.9E-07	STP
6:2 FTS		**31**		**5.1E-07**	**STP**
8:2 FTS	<	7.1	<	1.2E-07	STP
10:2 FTS	<	7.1	<	1.2E-07	STP
Perfluorooctane sulfonamide		**42**		**7.1E-07**	**STP**
N-Methyl perfluorooctane sulfonamide	<	36	<	5.9E-07	STP
N-Ethyl perfluorooctanesulfonamide	<	36	<	5.9E-07	STP
N-Me perfluorooctanesulfonamidoethanol		**71**		**1.2E-06**	**STP**
N-Et perfluorooctanesulfonamidoethanol	<	1,422	<	2.4E-05	STP
MePerfluorooctanesulf-amido acetic acid	<	7.1	<	1.2E-07	STP
EtPerfluorooctanesulf-amido acetic acid	<	7.1	<	1.2E-07	STP

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

Assured Environmental Pty Ltd (AE) was appointed by BeneTerra to sample and analyse source emissions from the BeneVap Leachate Treatment system, located in Darwin, Northern Territory. Sample was conducted by AE from 2nd to 5th February 2023.

AE was responsible for the collection and analysis of samples, unless otherwise indicated. The samples were recovered and stored in the appropriate manner until their return to the laboratory where the samples were prepared and analysed according to the methodologies listed in this report.

2 MONITORING METHODOLOGY

2.1 Overview

AE personnel made contact with the nominated site representative and confirmed that the plant was operating normally. At this time, all site access permits were arranged and the previously prepared draft sampling plan for the day was agreed with the client.

The following sections provide a summary of the specific locations utilised and methodologies used for the monitoring.

2.2 Sampling Methodology

All sampling and analysis was carried out in accordance with the listed requirements in Table 4. Any specific comments about the sampling and analysis have been documented where required.

Table 4: Test Methods

Parameter	Reference Test Method	Test Method (NSW)	NATA	Analysis by
Sample location	AS4323.1	TM-1	Yes	1
Velocity & flow rate	USEPA Method 2	TM-2	Yes	1
Stack gas density	USEPA Method 3	TM-23	Yes	1
Oxygen	USEPA Method 3A	TM-25	Yes	1
Carbon dioxide	USEPA Method 3A	TM-24	Yes	1
Water vapour content	USEPA Method 4	TM-22	Yes	1
Sulphur dioxide	USEPA Method 6	TM-4	Yes	1
Oxides of nitrogen (as NO_2)	USEPA Method 7E	TM-11	Yes	1
Sulfuric acid mists	USEPA Method 8	TM-3[a]	Yes	1
Carbon monoxide	USEPA Method 10	TM-32	Yes	1
Hydrogen sulfide	USEPA Method 15	TM-5	Yes	1
Total VOCs	USEPA Method 18	TM-34	Yes	2
Hydrogen chloride	USEPA Method 26A	TM-8	Yes	2
Chlorine	USEPA Method 26A	TM-7	Yes	2
Fluoride (as HF)	USEPA Method 13B	TM-9	Yes	2
Heavy metals	USEPA Method 29	TM-12/13/14	Yes	2
PFAS – suite	USEPA OTM 45	Mod TM-18	No	2
Dioxins & furans	USEPA SW846 Method 0010	TM-18	Yes	3
Polychlorinated biphenyls	USEPA SW846 Method 0010	TM-18	Yes	3
Ammonia	Modified USEPA Method 26	Mod TM-4[b]	Yes	2

---

[a] EPL188-03 lists the test method for sulfuric acid mists as TM-13, this does not correspond to the *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales* listed method (TM-3).

[b] EPL188-03 lists the test method for ammonia as TM-3. A closer representation of the sampling technique is a modified TM-4 sample train. See the description of the sampling technique in

Table 6 below.

	Odour	AS4323.3	OM-7	Yes	1

Table 5: Analysis Performed By

Note	Company	Work Performed	NATA ID	Report Number
1	Assured Environmental	Sampling & analysis	19703	14714
2	Envirolab Services	Sample analysis	2901	316577
3	National Measurement Inst.	PCDD/F & PCB analysis	198	DAU23_052

Table 6: Sampling Comments

Note	Comment
Sample location	Sample location is compliant but non-ideal as per AS4323.1. The sample location is greater than two, but less than six diameters downstream from a distance. The temperature and velocity survey showed that the sample position was compliant with items (a) to (f) of AS4323.1.
Calibrations	Analyser calibration performed in laboratory prior to conducting field work and post field work in AE lab.
H_2S	A sample of exhaust gas was passed through a buffer solution to remove any potential SO_2 present before being captured in a specialised gas sampling bag. Analysis for H_2S was performed using GC-FPD within 30 hours of collection.
Heavy metals	Type 1 substances: Antimony, Arsenic, Cadmium, Lead, Mercury. Type 2 substances: Beryllium, Chromium, Cobalt, Manganese, Nickel, Selenium, Tin, Vanadium.
PFAS	A modified version of the USEPA SW846 Method 0010 sample train was employed to sample for Per- and polyfluoroalkyl substances (PFAS) material in the flue gas emission. Refer to section 2.2 for further information.
Ammonia	The ammonia sampling was performed using a modified constant flow sampling train. A condensate removal trap was placed in front of the collection trap containing the absorbing solution to separate condensing ammonia from gaseous ammonia passing through the initial dropout and into the collection solution (0.1N H_2SO_4). Both the condensate captured in the trap and sorbent solution are analysed for ammonia individually. Ammonia results are reported in the condensate and gaseous phase separately and as total NH_3. Samples are analysed using a Discrete Analyser.
Odour	Due to the high levels of moisture in the emission, the odour sample bags were diluted beyond the suggested limit in AS4323.3. This is required to avoid condensation forming in the sample bags.

2.3 Per- and Poly-fluoroalkyl Substances Sample Methodology

Sampling for Per- and poly-fluoroalkyl substances (PFAS) in air is undertaken using a multi-component sampling train. An internal sampling method has been developed using standard US EPA methodology as a base, such as US EPA Method SW846 0010 and later US EPA Other Test Method 45. It is noted that posting of an OTM by the US EPA is neither an endorsement by the EPA regarding the validity of the test method nor a regulatory approval of the test method, rather to promote discussion of developing emerging methodologies prior to full endorsement.

The basis of the sampling train is consideration for volatile and semi-volatile material as well as particulate bound PFAS material.

The sampling train consists of;

- Gaseous and particulate pollutants are withdrawn from an air emission source at an isokinetic sampling rate[c] and are collected in a multi-component sampling train. The sample train contains a high-efficiency glass fibre filter, a condensate (water) dropout and a packed bed of porous adsorbent resin. The filter is used to collect organic-laden particulate material and the porous polymeric resin to adsorb semi-volatile organic species. Semi-volatile species are defined as compounds with boiling points greater than 100°C. Impingers are also positioned downstream of the resin trap and loaded with sodium based solutions to capture potential PFAS breakthrough.
- Sorbent material is XAD-2 and XAD-4.
- The resin traps are spiked with a surrogate standard to test for retention. A known quantity of standard is injected into the trap during preparation, the trap is then shipped, sampled and returned to the laboratory for analysis. The analysis included detecting the injected standard, which provides a measure of the recovery efficiency. Factors that may affect the recovery efficiency include, sample transport and handling procedures, sampling temperatures (the resin must be chilled during sampling and maintained below 20°C) and sample preparation at the laboratory, including the extraction of the sample from the resin.
- Condensate removal impinger prior to XAD resin traps.
- Impingers downstream of the resin trap are loaded with a sodium solution and is intended to be a breakthrough detector. Following the sampling, the impinger contents are measured and placed in a sample bottle for shipment to the laboratory. The final impingers of the sample train are then analysed separately to the filter, resin trap and front half methanol rinse, so as to provide a measure of possible breakthrough. The intent of this sampling train component is to provide a measure of breakthrough from the primary sampling components. Where no detections of PFAS material is made in this sampling component, the limit of detection is not added to the sample result.
- Following the sampling onsite, all sample train components that have been in contact with the sample are rinsed thoroughly with methanol and stored in a sample container to be analysed as part of the sample.
- Sample train component material. According to documented water and soil PFAS sampling procedures, the use of glass, Teflon and stainless steel should be avoided and the use of polypropylene (PE) is recommended. PE is not considered to be conducive to source emissions sampling due to the temperatures of the flue gas. PE or HDPE cannot be used in

---

[c] In this case isokinetic sampling is not possible, therefore a constant flow sampling rate was used to collect a sample of the exhaust air.

the probe or filter box due to its low melting point. Instead, all sampling components upstream of the resin trap are constructed of glass. Following sampling, all glassware was thoroughly rinsed with methanol at least three times to quantitively recover any possible PFAS material deposited on this surface.

For the analysis, the samples are extracted using a solvent desorption technique, with the filter and front half methanol rinse extract combined prior to analysis for the PFAS species. The XAD resin trap is then analysed in isolation as is the condensate downstream of the trap to gain an understanding of where the PFAS is captured within the sample train. The analysis is performed using LC/MS/MS instruments, with each analysis performed using the surrogate spikes to determine sample specific recoveries.

2.3.1 PFAS Blank Corrections

A full field blank sample has not been performed for this round of sampling. The stock reagents are largely unchanged from previous rounds of sampling (13633), therefore the results of the previous blank are utilised for this round. A field blank is performed by the sample train being constructed as normal, however no sample is passed through it. It is then cleaned and recovered following the standard recovery procedures and the filter, resin trap and rinse are kept and analysed along with the sample.

The following details the procedures used to correct for detections of PFAS species in the blank samples.

- Where the blank result is a non-detection, no adjustment to the sample result is made.
- Where the blank result returns a positive detection, but is less than half of the sample result, the blank value is subtracted from the sample result and reported as a positive detection.
- Where the blank value returns a positive detection, and is exceeding half of the sample result, no adjustments are made to the sample result, but it is reported as a non-detection.

2.4 Sample Location

The figures and tables below show the sample location and site details.

Figure 1: BeneVap Treatment System Stacks

Table 7: Sample Location Summary

AS4323.1	Sample location	BV150
	Stack Shape	CIRCULAR
	Ideal Sampling Plane Assessment	
	Stack Diameter (m)	0.6
	Stack Cross Section Area (m^2)	0.28
	Distance to upstream disturbance (m) (from disturbance)	0.7
	Upstream Diameters (D)	1.1
	Distance to downstream disturbance (m) (from disturbance)	1.3
	Downstream diameters (D)	2.2
4.2.2 Table 1	Meets Requirements AS4323.1 Table 1	No
	Non- Ideal Sampling Plane Assessment	
	Assessment required?	No
	Total traverse point factors	1.2
	Non-conforming Sampling Plane Assessment	
4.2.2(a)	Gas flow in same direction	Yes
4.2.2(b)	Gas flow steady & evenly distributed (cyclonic or swirl <15º)	Yes
4.2.2(c)	Temperature difference between points <10%, and each point <10% of average	Yes
4.2.2(d)	Ratio of highest to lowest differential pressure & ratio highest to lowest velocity	5.0 2.2
4.2.2(e)	Minimum differential pressure	0.2
	Gas temperature above dewpoint	Yes
	Sampling Plane Type	
4.2.2, 4.2.3, 4.2.4	Sampling plane type	Non-conforming
	Alternative sampling plane available?	No
	Number of Sample Points Adopted	
	Port size (mm)	90
	Port Thread Type	BSP
	Number of traverses	2
	Number of points per traverse	6
	Total number of traverse points	12
	Flow & temperature compliance check	No

2.5 Test Equipment

The sampling equipment was transported to site and specifically setup at the test location. Sampling was performed using heated probes and filters, with a constant flow and isokinetic sampling console.

Equipment used during the course of the testing is sourced from Apex instruments and Testo, industry leaders in the supply of source testing equipment.

Figure 2: Manual Sample Equipment

Figure 3: Combustion Gas Analyser

3 MEASUREMENT UNCERTAINTY

There is an inherent uncertainty associated with any scientific measurement, including stack emissions monitoring. The measurement uncertainty can be controlled with strict adherence to the reference methodology along with utilising appropriate calibration standards with corresponding acceptable uncertainty reports.

Many source sampling methods do not outline exact procedures for establishing direct measurement uncertainty. In the absence of a defined procedure, the uncertainty budgets presented are based on estimations using ISO-GUM method.

Each individual source and test may have a unique associated uncertainty assigned, due to factors such as the stack sample location in relation to the positioning requirements of AS4323.1, stack temperature, water vapour content and sample analysis.

The table below outlines the estimated uncertainties associate with reports presented within this report.

Table 8: Sample uncertainty

Parameter	Reference Method	Limit of Measurement	Unit of Measure	Measurement Uncertainty ± %
Gas velocity	USEPA Method 2	3	m/sec	10
Oxygen	USEPA Method 3A	0.3	%-vol	5.0
Carbon dioxide	USEPA Method 3A	0.3	%-vol	10
Water vapour content	USEPA Method 4	0.5	%-vol	5.0
Sulphur dioxide	USEPA Method 6	2.0	mg/sample	15
Oxides of nitrogen (as NO_2)	USEPA Method 7E	2.1	mg/sample	15
Sulfuric acid mists	USEPA Method 8	2.0	mg/sample	15
Carbon monoxide	USEPA Method 10	1.5	mg/sample	15
Hydrogen sulfide	USEPA Method 15	1.0	mg/sample	20
Total VOCs	USEPA Method 18	1.0	mg/sample	20
Hydrogen chloride	USEPA Method 26A	1.0	mg/sample	15
Chlorine	USEPA Method 26A	1.0	mg/sample	15
Fluoride (as HF)	USEPA Method 13B	1.0	mg/sample	15
Heavy metals	USEPA Method 29	0.3 to 50	µg/sample	20
PFAS – suite	USEPA OTM 45	1 to 50	ng/sample	25
Dioxins & furans	USEPA SW846 Method 0010	1	pg/sample	15
Polychlorinated biphenyls	USEPA SW846 Method 0010	20	pg/sample	15
Ammonia	Modified USEPA Method 26	1	mg/sample	25
Odour	AS4323.3	100	ou	40

4 MONITORING RESULTS

4.1 Stack 1 Results

Table 9: Sampling Information – PFAS

Site		Shaol Bay Landfill	
Sample Location		BV150	
Reference Method		USEPA Method 0010 - ISOKINETIC	
Run ID		8	
Test Parameter		PFAS	
Test Date	dd/mm/yyyy	2/02/2023	
Start Time	hh:mm	12:43	
End Time	hh:mm	15:43	
Average Stack Temperature	°C	85	
Absolute Stack Pressure	mb	1005	
Moisture Content	% v/v	59.4	
Dry Gas Density	kg/Nm^3	1.34	
Dry Gas Molecular Weight	g/g-mole	30.0	
Sample Volume (dry gas meter)	Nm^3	1.42	
Stack Gas Velocity	m/sec	3.2	
Actual Stack Flow Rate	m^3/min	54	
Dry Standard Stack Flow Rate	Nm^3/min	17	
Percent Isokinetic Rate	%	105	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
PFAS species	ng/Nm^3	ng/Nm^3	g/min
Perfluorobutanesulfonic acid	-	135	2.25E-06
Perfluoropentanesulfonic acid	-	< 3.6	< 5.95E-08
Perfluorohexanesulfonic acid	-	24	4.08E-07
Perfluoroheptanesulfonic acid	-	< 4.0	< 6.68E-08
Perfluorooctanesulfonic acid PFOS	-	26	4.41E-07
Perfluorodecanesulfonic acid	-	< 7.1	< 1.19E-07
Perfluorobutanoic acid	-	41	6.83E-07
Perfluoropentanoic acid	-	103	1.73E-06
Perfluorohexanoic acid	-	75	1.25E-06
Perfluoroheptanoic acid	-	21	3.51E-07
Perfluorooctanoic acid PFOA	-	53	8.78E-07
Perfluorononanoic acid	-	< 3.6	< 5.95E-08
Perfluorodecanoic acid	-	< 36	< 5.95E-07
Perfluoroundecanoic acid	-	< 36	< 5.95E-07
Perfluorododecanoic acid	-	< 36	< 5.95E-07
Perfluorotridecanoic acid	-	< 36	< 5.95E-07
Perfluorotetradecanoic acid	-	< 355	< 5.95E-06
4:2 FTS	-	< 35	< 5.89E-07
6:2 FTS	-	31	5.12E-07
8:2 FTS	-	< 7.1	< 1.19E-07
10:2 FTS	-	< 7.1	< 1.19E-07
Perfluorooctane sulfonamide	-	42	7.09E-07
N-Methyl perfluorooctane sulfonamide	-	< 36	< 5.95E-07
N-Ethyl perfluorooctanesulfonamide	-	< 36	< 5.95E-07
N-Me perfluorooctanesulfonamidoethanol	-	71	1.18E-06
N-Et perfluorooctanesulfonamidoethanol	-	< 1,422	< 2.38E-05
MePerfluorooctanesulf-amido acetic acid	-	< 7.1	< 1.19E-07
EtPerfluorooctanesulf-amido acetic acid	-	< 7.1	< 1.19E-07
TOTAL			
Sum of positive detections	-	622	1.04E-05

Table 10: Sampling Information – Odour

Site		Shaol Bay Landfill
Sample Location		BV150
Reference Method		AS4323.3 - CONSTANT FLOW
Run ID		9
Test Parameter		Odour
Test Date	dd/mm/yyyy	5/02/2023
Start Time	hh:mm	8:30
End Time	hh:mm	8:43
Average Stack Temperature	°C	85
Absolute Stack Pressure	mb	1003
Moisture Content	% v/v	58.2
Dry Gas Density	kg/Nm^3	1.33
Dry Gas Molecular Weight	g/g-mole	29.9
Sample Volume (dry gas meter)	Nm^3	-
Stack Gas Velocity	m/sec	3.5
Actual Stack Flow Rate	m^3/min	59
Dry Standard Stack Flow Rate	Nm^3/min	19
Percent Isokinetic Rate	%	N/A

Pollutant	Licence limit	standard conditions Concentration	Emission Rate
Odour	ou	ou	ou.m^3/min
Odour Sample 1	-	6,957	309,034
Odour Sample 2	-	7,387	328,131
Average Odour	-	7,172	318,583

Table 11: Sampling Information – Hydrogen Sulfide

Site		Shaol Bay Landfill	
Sample Location		BV150	
Reference Method		USEPA Method 15 - CONSTANT FLOW	
Run ID		10	
Test Parameter		H2S	
Test Date	dd/mm/yyyy	5/02/2023	
Start Time	hh:mm	8:45	
End Time	hh:mm	8:55	
Average Stack Temperature	°C	85	
Absolute Stack Pressure	mb	1003	
Moisture Content	% v/v	58.2	
Dry Gas Density	kg/Nm^3	1.33	
Dry Gas Molecular Weight	g/g-mole	29.9	
Sample Volume (dry gas meter)	Nm^3	-	
Stack Gas Velocity	m/sec	3.5	
Actual Stack Flow Rate	m^3/min	59	
Dry Standard Stack Flow Rate	Nm^3/min	19	
Percent Isokinetic Rate	%	N/A	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
H_2S	mg/Nm^3	mg/Nm^3	g/min
Hydrogen sulfide	5	< 1.1	< 0.01

Table 12: Sampling Information – Oxides of Sulfur

Site		Shaol Bay Landfill	
Sample Location		BV150	
Reference Method		USEPA Method 8 - ISOKINETIC	
Run ID		5	
Test Parameter		Sox	
Test Date	dd/mm/yyyy	3/02/2023	
Start Time	hh:mm	7:49	
End Time	hh:mm	8:49	
Average Stack Temperature	°C	90	
Absolute Stack Pressure	mb	1003	
Moisture Content	% v/v	61.8	
Dry Gas Density	kg/Nm^3	1.34	
Dry Gas Molecular Weight	g/g-mole	30.0	
Sample Volume (dry gas meter)	Nm^3	0.49	
Stack Gas Velocity	m/sec	3.5	
Actual Stack Flow Rate	m^3/min	60	
Dry Standard Stack Flow Rate	Nm^3/min	17	
Percent Isokinetic Rate	%	106	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
SOx	mg/Nm^3	mg/Nm^3	g/min
SO_2	-	8.9	0.15
SO_3 (as H_2SO_4)	100	4.6	0.08

Table 13: Sampling Information – Acid Gases

Site		Shaol Bay Landfill	
Sample Location		BV150	
Reference Method		USEPA Method 26A - ISOKINETIC	
Run ID		3	
Test Parameter		Acid Gases	
Test Date	dd/mm/yyyy	3/02/2023	
Start Time	hh:mm	12:41	
End Time	hh:mm	13:41	
Average Stack Temperature	°C	90	
Absolute Stack Pressure	mb	1003	
Moisture Content	% v/v	60.3	
Dry Gas Density	kg/Nm^3	1.34	
Dry Gas Molecular Weight	g/g-mole	30.1	
Sample Volume (dry gas meter)	Nm^3	0.45	
Stack Gas Velocity	m/sec	3.3	
Actual Stack Flow Rate	m^3/min	56	
Dry Standard Stack Flow Rate	Nm^3/min	17	
Percent Isokinetic Rate	%	100	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
Acid Gases	mg/Nm^3	mg/Nm^3	g/min
HCl	100	< 2.2	< 0.04
Cl$_2$	200	< 2.2	< 0.04

Table 14: Sampling Information – Heavy Metals

Site		Shaol Bay Landfill
Sample Location		BV150
Reference Method		USEPA Method 29 - ISOKINETIC
Run ID		2
Test Parameter		Metals
Test Date	dd/mm/yyyy	2/02/2023
Start Time	hh:mm	12:49
End Time	hh:mm	14:49
Average Stack Temperature	°C	89
Absolute Stack Pressure	mb	1005
Moisture Content	% v/v	58.9
Dry Gas Density	kg/Nm^3	1.34
Dry Gas Molecular Weight	g/g-mole	30.0
Sample Volume (dry gas meter)	Nm^3	0.94
Stack Gas Velocity	m/sec	3.2
Actual Stack Flow Rate	m^3/min	55
Dry Standard Stack Flow Rate	Nm^3/min	17
Percent Isokinetic Rate	%	103

Pollutant Metals	Licence limit µg/Nm^3	standard conditions Concentration µg/Nm^3	Emission Rate g/min
Antimony	-	< 6.0	< 1.0E-04
Arsenic	-	< 6.0	< 1.0E-04
Beryllium	-	< 0.5	< 7.6E-06
Cadmium	200	1.0	1.6E-05
Chromium	-	5.1	8.6E-05
Cobalt	-	< 0.5	< 7.6E-06
Lead	-	18	3.1E-04
Manganese	-	2.1	3.6E-05
Nickel	-	59	9.9E-04
Selenium	-	< 7.7	< 1.3E-04
Tin	-	< 15	< 2.5E-04
Vanadium	-	< 7.6	< 1.3E-04
Mercury	200	0.8	1.4E-05
Total Heavy Metals (lower bound)	1,000	86	1.4E-03

Table 15: Sampling Information – Volatile Organic Compounds

Site		Shaol Bay Landfill	
Sample Location		BV150	
Reference Method		USEPA Method 18 - CONSTANT FLOW	
Run ID		6	
Test Parameter		VOCs	
Test Date	dd/mm/yyyy	3/02/2023	
Start Time	hh:mm	7:55	
End Time	hh:mm	8:55	
Average Stack Temperature	°C	90	
Absolute Stack Pressure	mb	1003	
Moisture Content	% v/v	61.8	
Dry Gas Density	kg/Nm^3	1.34	
Dry Gas Molecular Weight	g/g-mole	30.0	
Sample Volume (dry gas meter)	Nm^3	0.03	
Stack Gas Velocity	m/sec	3.5	
Actual Stack Flow Rate	m^3/min	60	
Dry Standard Stack Flow Rate	Nm^3/min	17	
Percent Isokinetic Rate	%	N/A	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
Total (non-methane) VOCs	mg/Nm^3	mg/Nm^3	g/min
Total VOCs - as n-hexane	-	< 1.9	< 0.03
Total VOCs - as n-propane	40	< 0.9	< 0.02

Table 16: Sampling Information – Ammonia

Site		Shaol Bay Landfill	
Sample Location		BV150	
Reference Method		USEPA Mod Method 6 - CONSTANT FLOW	
Run ID		7	
Test Parameter		NH3	
Test Date	dd/mm/yyyy	2/02/2023	
Start Time	hh:mm	12:55	
End Time	hh:mm	13:55	
Average Stack Temperature	°C	89	
Absolute Stack Pressure	mb	1005	
Moisture Content	% v/v	58.9	
Dry Gas Density	kg/Nm^3	1.34	
Dry Gas Molecular Weight	g/g-mole	30.0	
Sample Volume (dry gas meter)	Nm^3	0.03	
Stack Gas Velocity	m/sec	3.2	
Actual Stack Flow Rate	m^3/min	55	
Dry Standard Stack Flow Rate	Nm^3/min	17	
Percent Isokinetic Rate	%	N/A	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
NH3	mg/Nm^3	mg/Nm^3	g/min
Ammonia (NH$_3$) - in condensate	-	2,303	39
Ammonia (NH$_3$) - gaseous	-	154	2.6
Total Ammonia (as NH$_3$)	-	2,457	41

Table 17: Sampling Information – Fluoride

Site		Shaol Bay Landfill	
Sample Location		BV150	
Reference Method		USEPA Method 13B - ISOKINETIC	
Run ID		4	
Test Parameter		Fluoride	
Test Date	dd/mm/yyyy	3/02/2023	
Start Time	hh:mm	12:42	
End Time	hh:mm	13:42	
Average Stack Temperature	°C	85	
Absolute Stack Pressure	mb	1003	
Moisture Content	% v/v	58.7	
Dry Gas Density	kg/Nm^3	1.34	
Dry Gas Molecular Weight	g/g-mole	30.1	
Sample Volume (dry gas meter)	Nm^3	0.47	
Stack Gas Velocity	m/sec	3.4	
Actual Stack Flow Rate	m^3/min	57	
Dry Standard Stack Flow Rate	Nm^3/min	18	
Percent Isokinetic Rate	%	98	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
Fluoride	mg/Nm^3	mg/Nm^3	g/min
Fluorine - (as total HF)	50	< 2.2	< 0.04

Table 18: Sampling Information – Combustion Gases

Site		Shaol Bay Landfill	
Sample Location		BV150	
Reference Method		USEPA Method 3A, 7E & 10	
Run ID		Various	
Test Parameter		O_2, CO_2, NOx, CO	
Test Date	dd/mm/yyyy	3/02/2023	
Start Time	hh:mm	7:49	
End Time	hh:mm	13:41	
Average Stack Temperature	°C	88	
Absolute Stack Pressure	mb	1003	
Moisture Content	% v/v	59.6	
Dry Gas Density	kg/Nm^3	1.34	
Dry Gas Molecular Weight	g/g-mole	30.0	
Stack Gas Velocity	m/sec	3.4	
Actual Stack Flow Rate	m^3/min	57	
Dry Standard Stack Flow Rate	Nm^3/min	17	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
O2, CO2, NOx, CO	STP	STP	g/min
Oxygen (% v/v)	-	6.1	-
Carbon dioxide (% v/v)	-	11.2	-
Carbon monoxide (mg/m^3)	125	24	0.41
Oxides of nitrogen (mg/m^3)	350	119	2.1

Table 19: Sampling Information – Dioxins & Furans

Site		Shaol Bay Landfill
Sample Location		BV150
Reference Method		USEPA Method 23 - ISOKINETIC
Run ID		1
Test Parameter		DF PCB
Test Date	dd/mm/yyyy	3/02/2023
Start Time	hh:mm	7:49
End Time	hh:mm	10:49
Average Stack Temperature	°C	85
Absolute Stack Pressure	mb	1003
Moisture Content	% v/v	58.2
Dry Gas Density	kg/Nm^3	1.34
Dry Gas Molecular Weight	g/g-mole	30.0
Sample Volume (dry gas meter)	Nm^3	1.48
Stack Gas Velocity	m/sec	3.5
Actual Stack Flow Rate	m^3/min	59
Dry Standard Stack Flow Rate	Nm^3/min	19
Percent Isokinetic Rate	%	99

Pollutant	Licence limit	standard conditions Concentration	Emission Rate
DF PCB	ng/Nm^3	ng/Nm^3	g/min
2378 TCDF	-	< 0.0020	< 3.8E-11
Total TCDF isomers	-	0.074	1.4E-09
2378 TCDD	-	< 0.0014	< 2.5E-11
Total TCDD isomers	-	0.043	7.9E-10
12378 PeCDF	-	< 0.0020	< 3.8E-11
23478 PeCDF	-	0.0027	5.0E-11
Total PeCDF isomers	-	0.036	6.8E-10
12378 PeCDD	-	< 0.0014	< 2.5E-11
Total PeCDD isomers	-	0.038	7.0E-10
123478 HxCDF	-	< 0.0014	< 2.5E-11
123678 HxCDF	-	0.0015	2.8E-11
234678 HxCDF	-	0.0012	2.3E-11
123789 HxCDF	-	< 0.00068	< 1.3E-11
Total HxCDF isomers	-	0.013	2.4E-10
123478 HxCDD	-	< 0.0014	< 2.5E-11
123678 HxCDD	-	0.0020	3.6E-11
123789 HxCDD	-	< 0.0014	< 2.5E-11
Total HxCDD isomers	-	0.044	8.1E-10
1234678 HpCDF	-	0.0034	6.4E-11
1234789 HpCDF	-	< 0.00068	< 1.3E-11
Total HpCDF isomers	-	0.0057	1.1E-10
1234678 HpCDD	-	0.027	5.0E-10
Total HpCDD isomers	-	0.055	1.0E-09
OCDF	-	0.0012	2.3E-11
OCDD	-	0.11	2.1E-09
Sum of congeners			
Sum of positive detections	-	0.42	7.9E-09
Total I-TEQ			
Sum of positive detections	0.1	0.0022	4.2E-11

Table 20: Sampling Information – PCBs

PCBs (USEPA Method 23)			
PCBs	Licence limit ng/Nm^3	standard conditions Concentration ng/Nm^3	Emission Rate g/min
PCB#77	-	0.59	1.1E-08
PCB#81	-	0.025	4.6E-10
PCB#126	-	0.019	3.5E-10
PCB#169	-	< 0.0014	< 2.5E-11
PCB#105	-	2.0	3.7E-08
PCB#114	-	0.13	2.4E-09
PCB#118	-	4.4	8.2E-08
PCB#123	-	0.07	1.4E-09
PCB#156	-	0.57	1.1E-08
PCB#157	-	0.13	2.4E-09
PCB#167	-	0.20	3.8E-09
PCB#189	-	0.026	4.9E-10
Sum of PCB Congeners			
Sum of positive detections	-	8.2	1.5E-07
Total TEQ			
Sum of positive detections	-	0.0022	4.0E-11

5 QUALITY ASSURANCE & QUALITY CONTROL (QA/QC)

Assured Environmental operates within a quality system based upon the requirements of ISO17025.Our quality system defines specific procedures and methodologies to ensure any project undertaken by Assured Environmental is conducted with the highest level of quality given the specific confines of each project. The overall objective of our QA/QC procedures is to representatively sample and accurately analyse components in the gas streams and therefore report valid measurements of emission concentrations.

To ensure representativeness of field work, our quality procedures target:

1. Correct sampling locations
2. Sample time
3. Frequency of samples and
4. Method selection & adherence

To ensure representativeness of lab work, our quality procedures target:

1. Sample preservation
2. Chain of custody (COC)
3. Sample preparation and
4. Analytical techniques

Assured Environmental maintains strict quality assurance throughout all its sampling programs, covering on-site 'field work' and the analytical phase of our projects. Our QA program covers the calibration of all sampling and analytical apparatus where applicable and the use of spikes, replicate sample and reference standards. The test methodologies used for this project are outlined in the methods section of this document. Field test data has been recorded and calculated using direct entry into Microsoft Excel spreadsheets following the procedures of the appropriate test methods. Determination of emission concentrations has been performed using the same Microsoft Excel spreadsheets which are partially supplied as an attachment to this report. More detailed information can be supplied upon request.

QA/QC checks for this project will use validation techniques and criteria appropriate to the type of data and the purpose of the measurement to approve the test report. Records of all data will be maintained. Complete chain of custody (COC) procedures has been followed to document the entire custodial history of each sample. The COC forms also served as a laboratory sheet detailing sample ID and analysis requirements.

Table 21: Sampling data QA/QC checklist

Sampling Data QA/QC Checklist	Comment
Use of appropriate test methods	Yes
'Normal' operation of the process being tested	Yes – as instructed by client
Use of properly operating and calibrated test equipment	Yes
Use of high purity reagents	Yes
Performance of leak checks post sample (at least)	Yes

Table 22: Laboratory data QA/QC checklist

Laboratory Data QA/QC Checklist	Comment
Use of appropriate analytical methods	Yes
Use of properly operating and calibrated analytical equipment	Yes
Precision and accuracy comparable to that achieved in similar projects	Yes
Accurate reporting	Yes

Table 23: Olfactometer QA data

Item	Comment
Methodology	AS/NZ4323.4:2001 “area source sampling”
Sample Media	Odour samples collected into Nalophan^{TM} sample bags
Sample identification	All samples are labelled uniquely immediately following collection according to Assured Environmental’s identification procedure. Each sample has the following recorded: project ID, sample number, location, date, time, dilution and any deviations to AS/NZ4323.4.
Timing	All measurements were conducted within 30 hours of sampling as specified by AS/NZ4323.4
Traceability	All panel results are traceable to reference standards held by Assured Environmental
Analysis conditions	Room temperature maintained at 22°C ± 3°C
Odour panel location	7/142 Tennyson Memorial Avenue, Tennyson QLD 4105
Reference odourant	39 ppm n-butanol
Odour panel threshold	76 ou

5.1 PFAS Quality Control

The recoveries of surrogate standards from the sampling and analysis are presented in the table below. The expected QC recovery for measurements in the ppb to ppt levels is in the range of 60 to 120%. The results are not corrected for the recovery efficiency.

Table 24: PFAS Surrogate Recovery (%)

Surrogate	PFAS	
	Filter	Trap
Field Surrogate		
Surrogate $^{13}C_8$ PFOS	96	96
Surrogate $^{13}C_2$ PFOA	106	119

Analysis of the final bubbler containing a sodium borate solution was performed separately to the front of the sampling train in order to assess the potential for breakthrough. The results of this analysis are provided below.

Table 25: Breakthrough Analysis

Perfluorinated Surfactants	Abbreviation	Breakthrough Analysis (ng/Nm^3)
Perfluorobutanesulfonic acid	PFBS	< 0.4
Perfluoropentanesulfonic acid	PFPeS	< 0.4
Perfluorohexanesulfonic acid	PFHxS	< 0.4
Perfluoroheptanesulfonic acid	PFHpS	< 0.4
Perfluorooctanesulfonic acid PFOS	PFOS	< 0.4
Perfluorodecanesulfonic acid	PFDS	< 0.7
Perfluorobutanoic acid	PFBA	< 0.7
Perfluoropentanoic acid	PFPeA	< 0.7
Perfluorohexanoic acid	PFHxA	< 0.4
Perfluoroheptanoic acid	PFHpA	< 0.4
Perfluorooctanoic acid PFOA	PFOA	< 0.4
Perfluorononanoic acid	PFNA	< 0.4
Perfluorodecanoic acid	PFDA	< 3.5
Perfluoroundecanoic acid	PFUdA	< 3.5
Perfluorododecanoic acid	PFDoA	< 3.5
Perfluorotridecanoic acid	PFTrDA	< 3.5
Perfluorotetradecanoic acid	PFTeDA	< 35
4:2 FTS	4:2 FTS	< 0.4
6:2 FTS	6:2 FTS	< 0.4
8:2 FTS	8:2 FTS	< 0.7
10:2 FTS	10:2 FTS	< 0.7
Perfluorooctane sulfonamide	FOSA	< 3.5
N-Methyl perfluorooctanesulfonamide	N-MeFOSA	< 3.5
N-Ethyl perfluorooctanesulfonamide	n-EtFOSA	< 3.5
N-Me perfluorooctanesulfonamidoethanol	n-MeFOSE	< 3.5
N-Et perfluorooctanesulfonamidoethanol	n-EtFOSE	< 141
MePerfluorooctanesulf-amidoacetic acid	N-MeFOSAA	< 0.7
EtPerfluorooctanesulf-amidoacetic acid	N-EtFOSAA	< 0.7

The breakthrough analysis showed no detectable levels of PFAS compounds present, indicating good retention through the sampling train.

Analysis of the field sample blank (project 13633) showed that only a small amount of PFOA was detectable in the methanol/XAD resin. The table below shows the results of the blank analysis.

Table 26: Field Blank Analysis

				Blank Analysis		
		Front half		Resin traps		Breakthrough
Perfluorinated surfactants - PFAS suite		ng/sample		ng/sample		ng/sample
Perfluorobutanesulfonic acid	<	0.2	<	0.2	<	0.2
Perfluoropentane sulfonic acid (PFPeS)	<	0.2	<	0.2	<	0.2
Perfluorohexane sulfonate (PFHxS)	<	0.2	<	0.2	<	0.2
Perfluoroheptane sulfonate (PFHpS)	<	0.2	<	0.2	<	0.2
Perfluorooctane sulfonate (PFOS)	<	0.2	<	0.2	<	0.2
Perfluorodecanesulfonic acid (PFDS)	<	0.4	<	0.4	<	0.4
Perfluorobutanoic acid	<	0.4	<	0.4	<	0.4
Perfluoropentanoic acid (PFPeA)	<	0.4	<	0.4	<	0.4
Perfluorohexanoic acid (PFHxA)	<	0.2	<	0.2	<	0.2
Perfluoroheptanoic acid (PFHpA)	<	0.2	<	0.2	<	0.2
Perfluorooctanoic acid (PFOA)	<	0.2		**2.3**	<	0.2
Perfluorononanoic acid (PFNA)	<	0.2	<	0.2	<	0.2
Perfluorodecanoic acid	<	1.0	<	1.0	<	1.0
Perfluoroundecanoic acid (PFUnA)	<	1.0	<	1.0	<	1.0
Perfluorododecanoic acid (PFDoA)	<	1.0	<	1.0	<	1.0
Perfluorotridecanoic acid (PFTrDA)	<	1.0	<	1.0	<	1.0
Perfluorotetradecanoic acid (PFTeDA)	<	5.0	<	5.0	<	5.0
4:2 Flurotelomersulphonate	<	0.2	<	0.2	<	0.2
6:2 Fluorotelomersulphonate	<	0.2	<	0.2	<	0.2
8:2 Fluorotelomersulphonate	<	0.4	<	0.4	<	0.4
10:2 Fluorotelomersulphonate	<	0.4	<	0.4	<	0.4
Perfluorooctane sulfonamide	<	1.0	<	1.0	<	1.0
N-Methyl-heptadecafluorooctane sulphonamide	<	1.0	<	1.0	<	1.0
N-Ethyl-heptadecafluorooctane sulphonamide	<	1.0	<	1.0	<	1.0
N-Me perfluorooctanesulfonamid oethanol	<	1.0	<	1.0	<	1.0
N-Et perfluorooctanesulfonamid oethanol	<	50	<	50	<	50
N-Methylperfluorooctane sulphonamidoacetic acid	<	0.4	<	0.4	<	0.4
N-Ethyl-perfluorooctane sulphonamidoacetic acid	<	0.4	<	0.4	<	0.4

5.2 Dioxin Quality Control

During sample analysis, the laboratory uses $^{13}C_{12}$ labelled dioxin, furan and PCB surrogates to test sample recovery efficiency and possible sample matrix interference.

During this analysis, the laboratory surrogate recovery for all dioxin, furan and PCB congeners was within acceptable ranges.

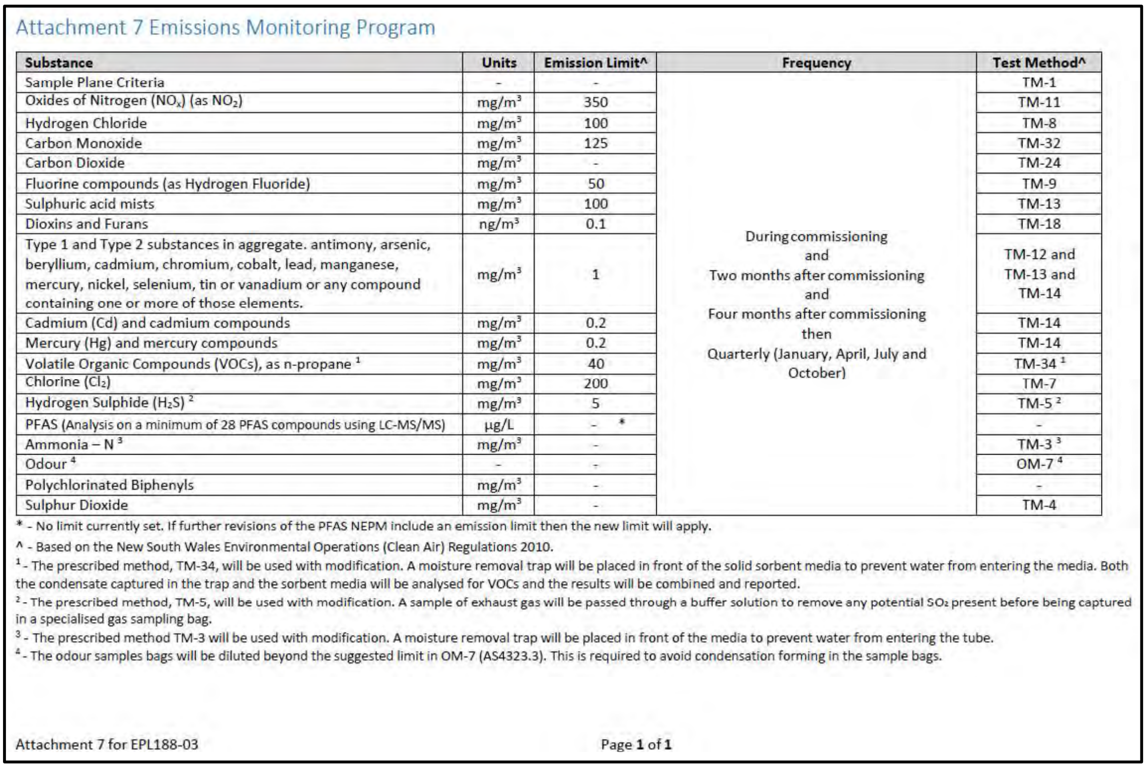
6 GLOSSARY OF TERMS

The following terms and abbreviations may be used in this report:

Table 27: Definitions

Symbol	Definition
<	The analytes tested for was not detected; the value stated is the reportable limit of detection
Am^3	Gas volume in cubic metres at measured conditions
AS	Australian Standard
BH	Back half of sample train (filter holder and impingers) (referred to during sample recovery)
^oC	Degrees Celsius
CARB	California Air Resources Board methods
dscm	dry standard cubic meters
FH	Front half of sample train (probe and filter holder) (referred to during sample recovery)
g	Grams
Heavy metals	Sum of Antimony, Arsenic, Beryllium, Cadmium, Chromium, Cobalt, Lead, Manganese, Nickle, Selenium, Tin, Vanadium & Mercury. Also known as Type 1 and Type 2 hazardous substances. Total heavy metals refers only to those metals found in the sample and does not include limit of detection values.
kg	Kilograms
Lower range	The sum of a list of a particular group of compounds, where only those individual congeners/compounds that are detectable in the sample have been included in the total. Results below the limit of detection have not been included. Unless otherwise indicated, the lower range is reported for dioxins & furans, PCBs, heavy metals and PFAS analysis suites.
m	Metres
m^3	actual gas volume in cubic metres as measured
mbar	Millibars
mg	Milligrams (10^{-3} grams)
min	Minute
ml	Millilitres
mmH_2O	Millimetres of water
Mole	SI unit that measures the amount of substance
N/A	Not applicable
ng	Nanograms (10^{-9} grams)
Nm^3	Gas volume in dry cubic metres at standard temperature and pressure (0°C and 101.3 kPa)
NMI	National Measurement Institute
NM VOC	Non methane volatile organic compound
NR	Not required on this occasion
ou	Odour unit
PM	Particulate matter
ppb	Parts per billion
ppm	Parts per million
sec	Second
Sm^3	Gas volume in dry cubic metres at standard temperature and pressure (0°C and 101.3 kPa) and corrected to a standardised value (e.g. 15% O_2)
STP	Standard temperature and pressure (0°C and 101.3 kPa) & dry
USEPA	United States Environmental Protection Authority

7 APPENDIX



Attachment 7 Emissions Monitoring Program

Substance	Units	Emission Limit^	Frequency	Test Method^
Sample Plane Criteria	-	-	During commissioning and Two months after commissioning and Four months after commissioning then Quarterly (January, April, July and October)	TM-1
Oxides of Nitrogen (NO_x) (as NO_2)	mg/m³	350		TM-11
Hydrogen Chloride	mg/m³	100		TM-8
Carbon Monoxide	mg/m³	125		TM-32
Carbon Dioxide	mg/m³	-		TM-24
Fluorine compounds (as Hydrogen Fluoride)	mg/m³	50		TM-9
Sulphuric acid mists	mg/m³	100		TM-13
Dioxins and Furans	ng/m³	0.1		TM-18
Type 1 and Type 2 substances in aggregate. antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, manganese, mercury, nickel, selenium, tin or vanadium or any compound containing one or more of those elements.	mg/m³	1		TM-12 and TM-13 and TM-14
Cadmium (Cd) and cadmium compounds	mg/m³	0.2		TM-14
Mercury (Hg) and mercury compounds	mg/m³	0.2		TM-14
Volatile Organic Compounds (VOCs), as n-propane [1]	mg/m³	40		TM-34 [1]
Chlorine (Cl_2)	mg/m³	200		TM-7
Hydrogen Sulphide (H_2S) [2]	mg/m³	5		TM-5 [2]
PFAS (Analysis on a minimum of 28 PFAS compounds using LC-MS/MS)	µg/L	- *		-
Ammonia – N [3]	mg/m³	-		TM-3 [3]
Odour [4]	-	-		OM-7 [4]
Polychlorinated Biphenyls	mg/m³	-		-
Sulphur Dioxide	mg/m³	-		TM-4

* - No limit currently set. If further revisions of the PFAS NEPM include an emission limit then the new limit will apply.

^ - Based on the New South Wales Environmental Operations (Clean Air) Regulations 2010.

[1] - The prescribed method, TM-34, will be used with modification. A moisture removal trap will be placed in front of the solid sorbent media to prevent water from entering the media. Both the condensate captured in the trap and the sorbent media will be analysed for VOCs and the results will be combined and reported.

[2] - The prescribed method, TM-5, will be used with modification. A sample of exhaust gas will be passed through a buffer solution to remove any potential SO_2 present before being captured in a specialised gas sampling bag.

[3] - The prescribed method TM-3 will be used with modification. A moisture removal trap will be placed in front of the media to prevent water from entering the tube.

[4] - The odour samples bags will be diluted beyond the suggested limit in OM-7 (AS4323.3). This is required to avoid condensation forming in the sample bags.

Attachment 7 for EPL188-03 Page **1** of **1**

Figure 4: Excerpt from EPL188-03 – Attachment 7

SOURCE EMISSIONS MONITORING – SHOAL BAY BENEVAP 300

Project ID: 14714

8/03/2023

Release: R_0

Prepared For:

BeneTerra

Assured Environmental

DOCUMENT CONTROL PAGE

Project Title: Source Emissions Monitoring – Shoal Bay BeneVap 300

Project Reference ID: 14714

Report Prepared by:

Assured Environmental
Unit 7, 142 Tennyson Memorial Avenue
Tennyson, QLD, 4105 – 1300 662 495
and Unit 17, Gardeners Rd
Alexandria, NSW, 2015

Report Prepared for:

BeneTerra
Shoal Bay Access Road
Karama NT 0812

Author: Timon Berger

Reviewer: Adam Dixon

Table 1: History of Revisions

Revision	Date	Issued to	Changes
R_0	8/03/2023	N. Sharma	Initial report release – all results
INTERIM_0	2/03/2023	N. Sharma	Partial results only. Awaiting lab analysis

DISCLAIMER

Assured Environmental acts in all professional matters as a faithful advisor to the Client and exercises all reasonable skill and care in the provision of its professional services.

Reports are commissioned by and prepared for the exclusive use of the Client. They are subject to and issued in accordance with the agreement between the Client and Assured Environmental. Assured Environmental is not responsible for any liability and accepts no responsibility whatsoever arising from the misapplication or misinterpretation by third parties of the contents of its reports.

Except where expressly stated, Assured Environmental does not attempt to verify the accuracy, validity or comprehensiveness of any information supplied to Assured Environmental for its reports.

Reports cannot be copied or reproduced in whole or part for any purpose without the prior written agreement of Assured Environmental.

Where site inspections, testing or fieldwork have taken place, the report is based on the information made available by the client or their nominees during the visit, visual observations and any subsequent discussions with regulatory authorities. The validity and comprehensiveness of supplied information has not been independently verified and, for the purposes of this report, it is assumed that the information provided to Assured Environmental is both complete and accurate. It is further assumed that normal activities were being undertaken at the site on the day of the site visit(s), unless explicitly stated otherwise.

Accredited for compliance to ISO/IEC 17025

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Accreditation number: 19703

EXECUTIVE SUMMARY

Assured Environmental (AE) conducted source emissions monitoring from the mobile BeneVap Leachate Treatment Facility (BV300) located at the Shoal Bay Waste Facility in Darwin, Northern Territory from 31st January to 5th February 2023.

A summary of results and comparison against compliance levels is presented in Table 2 to Table 5 below from the testing conducted on the two release point stacks on the BV300 unit.

In comparison to the emission limits outlined in EPL188-03 – Attachment 7, all measured parameters were within those limits specified. Results are reported at dry, 273.15 °K and 101.325 kPa (STP).

Table 2: Summary of Emissions – BV300.1

Parameter		Result BV300_1	Emission limit	Unit	Reference
Average source temperature		91	-	°C	-
Flue gas water vapour content		63	-	vol-%	-
Carbon dioxide concentration		11.8	-	vol-%	STP - dry
Oxygen concentration		5.2	-	vol-%	STP - dry
Flue gas molecular weight - dry		1.3	-	kg/Nm^3	STP - dry
Flue gas velocity		2.6	-	m/sec	STP - dry
Flue gas volume flow		11.9	-	Nm^3/min	STP - dry
Oxides of nitrogen (as NO_2)		131	350	mg/Nm^3	STP - dry
- emission rate		1.6	-	g/min	
Carbon monoxide		24	125	mg/Nm^3	STP - dry
- emission rate		0.3	-	g/min	
Total heavy metals		0.11	1.0	mg/Nm^3	STP - dry
- emission rate		0.0014	-	g/min	
Cadmium		0.0016	0.2	mg/Nm^3	STP - dry
- emission rate		1.9E-05	-	g/min	
Mercury		0.0018	0.2	mg/Nm^3	STP - dry
- emission rate		2.2E-05	-	g/min	
Fluorine (as HF)	<	3.0	50	mg/Nm^3	STP - dry
- emission rate	<	0.036	-	g/min	
Hydrogen chloride	<	2.7	100	mg/Nm^3	STP - dry
- emission rate	<	0.033	-	g/min	
Chlorine	<	2.7	200	mg/Nm^3	STP - dry
- emission rate	<	0.033	-	g/min	
Ammonia (total)		2,728	-	mg/Nm^3	STP - dry
- emission rate		33	-	g/min	
Ammonia (NH_3) - in condensate		2,441	-	mg/Nm^3	STP - dry
- emission rate		30	-	g/min	
Ammonia (NH_3) - gaseous		287	-	mg/Nm^3	STP - dry
- emission rate		3.5	-	g/min	
Hydrogen sulfide	<	0.7	5	mg/Nm^3	STP - dry
- emission rate	<	0.008	-	g/min	
Sulfur dioxide		1.4	-	mg/Nm^3	STP - dry
- emission rate		0.02	-	g/min	
Sulfuric acid mist (as H_2SO_4)		17	100	mg/Nm^3	STP - dry
- emission rate		0.190	-	g/min	
Total VOCs (as n-propane)	<	0.9	40	mg/Nm^3	STP - dry
- emission rate	<	0.011	-	g/min	
Average odour		7,293	-	ou	STP - wet
- emission rate		250,202	-	ou-m^3/min	
Dioxins & Furans (i-TEQ)		0.045	0.1	ng/Nm^3	STP - dry
- emission rate		5.5E-10	-	g/min	
PCBs (i-TEQ)		0.0046	-	ng/Nm^3	STP - dry
- emission rate		5.6E-11	-	g/min	

Table 3: Summary of Emissions – BV300.2

Parameter	Result BV300_2	Emission limit	Unit	Reference
Average source temperature	87	-	°C	-
Flue gas water vapour content	62	-	vol-%	-
Carbon dioxide concentration	11.7	-	vol-%	STP - dry
Oxygen concentration	5.3	-	vol-%	STP - dry
Flue gas molecular weight - dry	1.3	-	kg/Nm^3	STP - dry
Flue gas velocity	2.9	-	m/sec	STP - dry
Flue gas volume flow	13.5	-	Nm^3/min	STP - dry
Oxides of nitrogen (as NO_2)	134	350	mg/Nm^3	STP - dry
- emission rate	1.8	-	g/min	
Carbon monoxide	32	125	mg/Nm^3	STP - dry
- emission rate	0.4	-	g/min	
Total heavy metals	0.041	1.0	mg/Nm^3	STP - dry
- emission rate	5.6E-04	-	g/min	
Cadmium	0.00028	0.2	mg/Nm^3	STP - dry
- emission rate	3.8E-06	-	g/min	
Mercury	0.0035	0.2	mg/Nm^3	STP - dry
- emission rate	4.9E-05	-	g/min	
Fluorine (as HF)	< 2.8	50	mg/Nm^3	STP - dry
- emission rate	< 0.036	-	g/min	
Hydrogen chloride	< 2.3	100	mg/Nm^3	STP - dry
- emission rate	< 0.034	-	g/min	
Chlorine	< 2.3	200	mg/Nm^3	STP - dry
- emission rate	< 0.034	-	g/min	
Ammonia (total)	2,695	-	mg/Nm^3	STP - dry
- emission rate	36	-	g/min	
Ammonia (NH_3) - in condensate	2,597	-	mg/Nm^3	STP - dry
- emission rate	35	-	g/min	
Ammonia (NH_3) - gaseous	98	-	mg/Nm^3	STP - dry
- emission rate	1.3	-	g/min	
Hydrogen sulfide	< 0.7	5	mg/Nm^3	STP - dry
- emission rate	< 0.008	-	g/min	
Sulfur dioxide	8.1	-	mg/Nm^3	STP - dry
- emission rate	0.102	-	g/min	
Sulfuric acid mist (as H_2SO_4)	22	100	mg/Nm^3	STP - dry
- emission rate	0.280	-	g/min	
Total VOCs (as n-propane)	< 1.0	40	mg/Nm^3	STP - dry
- emission rate	< 0.011	-	g/min	
Average odour	8,472	-	ou	STP - wet
- emission rate	254,059	-	ou-m^3/min	
Dioxins & Furans (i-TEQ)	0.0034	0.1	ng/Nm^3	STP - dry
- emission rate	4.6E-11	-	g/min	
PCBs (i-TEQ)	0.0037	-	ng/Nm^3	STP - dry
- emission rate	5.0E-11	-	g/min	

Table 4: Summary of PFAS results – BV300.1

Parameter		Result ng/Nm³		Emission Rate g/min	Reference
Per- and polyfluoroalkyl substances				**BV300_1**	
Perfluorobutanesulfonic acid		**375**		**4.7E-06**	**STP**
Perfluoropentanesulfonic acid		**7.0**		**8.9E-08**	**STP**
Perfluorohexanesulfonic acid		**51**		**6.4E-07**	**STP**
Perfluoroheptanesulfonic acid	<	4.6	<	5.8E-08	STP
Perfluorooctanesulfonic acid PFOS		**52**		**6.5E-07**	**STP**
Perfluorodecanesulfonic acid	<	9.2	<	1.2E-07	STP
Perfluorobutanoic acid		**59**		**7.4E-07**	**STP**
Perfluoropentanoic acid		**171**		**2.1E-06**	**STP**
Perfluorohexanoic acid		**135**		**1.7E-06**	**STP**
Perfluoroheptanoic acid		**45**		**5.7E-07**	**STP**
Perfluorooctanoic acid PFOA		**82**		**1.0E-06**	**STP**
Perfluorononanoic acid		**9.6**		**1.2E-07**	**STP**
Perfluorodecanoic acid	<	46	<	5.8E-07	STP
Perfluoroundecanoic acid	<	46	<	5.8E-07	STP
Perfluorododecanoic acid	<	46	<	5.8E-07	STP
Perfluorotridecanoic acid	<	46	<	5.8E-07	STP
Perfluorotetradecanoic acid	<	460	<	5.8E-06	STP
4:2 FTS	<	4.6	<	5.8E-08	STP
6:2 FTS		**59**		**7.4E-07**	**STP**
8:2 FTS	<	9.2	<	1.2E-07	STP
10:2 FTS	<	9.2	<	1.2E-07	STP
Perfluorooctane sulfonamide		**55**		**6.9E-07**	**STP**
N-Methyl perfluorooctane sulfonamide	<	46	<	5.8E-07	STP
N-Ethyl perfluorooctane sulfonamide	<	46	<	5.8E-07	STP
N-Me perfluorooctanesulfonamido ethanol		**91**		**1.1E-06**	**STP**
N-Et perfluorooctanesulfonamido ethanol	<	1,840	<	2.3E-05	STP
MePerfluorooctanesulf-amido acetic acid	<	9.2	<	1.2E-07	STP
EtPerfluorooctanesulf-amido acetic acid	<	9.2	<	1.2E-07	STP

Table 5: Summary of PFAS results – BV300.2

Parameter		Result ng/Nm^3		Emission Rate g/min	Reference
Per- and polyfluoroalkyl substances				**BV300_2**	
Perfluorobutanesulfonic acid		**453**		**5.1E-06**	**STP**
Perfluoropentanesulfonic acid	<	5.2	<	5.8E-08	STP
Perfluorohexanesulfonic acid		**55**		**6.2E-07**	**STP**
Perfluoroheptanesulfonic acid	<	5.2	<	5.8E-08	STP
Perfluorooctanesulfonic acid PFOS		**63**		**7.1E-07**	**STP**
Perfluorodecanesulfonic acid	<	10.4	<	1.2E-07	STP
Perfluorobutanoic acid		**67**		**7.5E-07**	STP
Perfluoropentanoic acid		**206**		**2.3E-06**	**STP**
Perfluorohexanoic acid		**150**		**1.7E-06**	**STP**
Perfluoroheptanoic acid		**58**		**6.5E-07**	**STP**
Perfluorooctanoic acid PFOA		**97**		**1.1E-06**	**STP**
Perfluorononanoic acid		**13**		**1.5E-07**	**STP**
Perfluorodecanoic acid	<	52	<	5.8E-07	STP
Perfluoroundecanoic acid	<	52	<	5.8E-07	STP
Perfluorododecanoic acid	<	52	<	5.8E-07	STP
Perfluorotridecanoic acid	<	52	<	5.8E-07	STP
Perfluorotetradecanoic acid	<	519	<	5.8E-06	STP
4:2 FTS	<	5.2	<	5.8E-08	STP
6:2 FTS		**58**		**6.5E-07**	**STP**
8:2 FTS	<	10	<	1.2E-07	STP
10:2 FTS	<	10	<	1.2E-07	STP
Perfluorooctane sulfonamide		**62**		**6.9E-07**	**STP**
N-Methyl perfluorooctane sulfonamide	<	52	<	5.8E-07	STP
N-Ethyl perfluorooctane sulfonamide	<	52	<	5.8E-07	STP
N-Me perfluorooctanesulfonamido ethanol		**103**		**1.2E-06**	**STP**
N-Et perfluorooctanesulfonamido ethanol	<	2,074	<	2.3E-05	STP
MePerfluorooctanesulf-amido acetic acid	<	10	<	1.2E-07	STP
EtPerfluorooctanesulf-amido acetic acid	<	10	<	1.2E-07	STP

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

Assured Environmental Pty Ltd (AE) was appointed by BeneTerra to sample and analyse source emissions from the BeneVap Leachate Treatment system, located in Darwin, Northern Territory. Sample was conducted by AE from 31st January to 5th February 2023.

AE was responsible for the collection and analysis of samples, unless otherwise indicated. The samples were recovered and stored in the appropriate manner until their return to the laboratory where the samples were prepared and analysed according to the methodologies listed in this report.

2 MONITORING METHODOLOGY

2.1 Overview

AE personnel made contact with the nominated site representative and confirmed that the plant was operating normally. At this time, all site access permits were arranged and the previously prepared draft sampling plan for the day was agreed with the client.

The following sections provide a summary of the specific locations utilised and methodologies used for the monitoring.

2.2 Sampling Methodology

All sampling and analysis was carried out in accordance with the listed requirements in Table 6. Any specific comments about the sampling and analysis have been documented where required.

Table 6: Test Methods

Parameter	Reference Test Method	Test Method (NSW)	NATA	Analysis by
Sample location	AS4323.1	TM-1	Yes	1
Velocity & flow rate	USEPA Method 2	TM-2	Yes	1
Stack gas density	USEPA Method 3	TM-23	Yes	1
Oxygen	USEPA Method 3A	TM-25	Yes	1
Carbon dioxide	USEPA Method 3A	TM-24	Yes	1
Water vapour content	USEPA Method 4	TM-22	Yes	1
Sulphur dioxide	USEPA Method 6	TM-4	Yes	1
Oxides of nitrogen (as NO_2)	USEPA Method 7E	TM-11	Yes	1
Sulfuric acid mists	USEPA Method 8	TM-3[a]	Yes	1
Carbon monoxide	USEPA Method 10	TM-32	Yes	1
Hydrogen sulfide	USEPA Method 15	TM-5	Yes	1
Total VOCs	USEPA Method 18	TM-34	Yes	2
Hydrogen chloride	USEPA Method 26A	TM-8	Yes	2
Chlorine	USEPA Method 26A	TM-7	Yes	2
Fluoride (as HF)	USEPA Method 13B	TM-9	Yes	2
Heavy metals	USEPA Method 29	TM-12/13/14	Yes	2
PFAS – suite	USEPA OTM 45	Mod TM-18	No	2
Dioxins & furans	USEPA SW846 Method 0010	TM-18	Yes	3
Polychlorinated biphenyls	USEPA SW846 Method 0010	TM-18	Yes	3
Ammonia	Modified USEPA Method 26	Mod TM-4[b]	Yes	2
Odour	AS4323.3	OM-7	Yes	1

---

[a] EPL188-03 lists the test method for sulfuric acid mists as TM-13, this does not correspond to the *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales* listed method (TM-3).

[b] EPL188-03 lists the test method for ammonia as TM-3. A closer representation of the sampling technique is a modified TM-4 sample train. See the description of the sampling technique in Table 6 below.

Table 7: Analysis Performed By

Note	Company	Work Performed	NATA ID	Report Number
1	Assured Environmental	Sampling & analysis	19703	14714
2	Envirolab Services	Sample analysis	2901	316577
3	National Measurement Inst.	PCDD/F & PCB analysis	198	DAU23_052

Table 8: Sampling Comments

Note	Comment
Sample location	Sample location is compliant but non-ideal as per AS4323.1. The sample location is greater than two, but less than six diameters downstream from a distance. The temperature and velocity survey showed that the sample position was compliant with items (a) to (f) of AS4323.1.
Calibrations	Analyser calibration performed in laboratory prior to conducting field work and post field work in AE lab.
H_2S	A sample of exhaust gas was passed through a buffer solution to remove any potential SO_2 present before being captured in a specialised gas sampling bag. Analysis for H_2S was performed using GC-FPD within 30 hours of collection.
Heavy metals	Type 1 substances: Antimony, Arsenic, Cadmium, Lead, Mercury. Type 2 substances: Beryllium, Chromium, Cobalt, Manganese, Nickel, Selenium, Tin, Vanadium.
PFAS	A modified version of the USEPA SW846 Method 0010 sample train was employed to sample for Per- and polyfluoroalkyl substances (PFAS) material in the flue gas emission. Refer to section 2.2 for further information.
Ammonia	The ammonia sampling was performed using a modified constant flow sampling train. A condensate removal trap was placed in front of the collection trap containing the absorbing solution to separate condensing ammonia from gaseous ammonia passing through the initial dropout and into the collection solution (0.1N H_2SO_4). Both the condensate captured in the trap and sorbent solution are analysed for ammonia individually. Ammonia results are reported in the condensate and gaseous phase separately and as total NH_3. Samples are analysed using a Discrete Analyser.
Odour	Due to the high levels of moisture in the emission, the odour sample bags were diluted beyond the suggested limit in AS4323.3. This is required to avoid condensation forming in the sample bags.

2.3 Per- and Poly-fluoroalkyl Substances Sample Methodology

Sampling for Per- and poly-fluoroalkyl substances (PFAS) in air is undertaken using a multi-component sampling train. An internal sampling method has been developed using standard US EPA methodology as a base, such as US EPA Method SW846 0010 and later US EPA Other Test Method 45. It is noted that posting of an OTM by the US EPA is neither an endorsement by the EPA regarding the validity of the test method nor a regulatory approval of the test method, rather to promote discussion of developing emerging methodologies prior to full endorsement.

The basis of the sampling train is consideration for volatile and semi-volatile material as well as particulate bound PFAS material.

The sampling train consists of;

- Gaseous and particulate pollutants are withdrawn from an air emission source at an isokinetic sampling rate[c] and are collected in a multi-component sampling train. The sample train contains a high-efficiency glass fibre filter, a condensate (water) dropout and a packed bed of porous adsorbent resin. The filter is used to collect organic-laden particulate material and the porous polymeric resin to adsorb semi-volatile organic species. Semi-volatile species are defined as compounds with boiling points greater than 100°C. Impingers are also positioned downstream of the resin trap and loaded with sodium based solutions to capture potential PFAS breakthrough.
- Sorbent material is XAD-2 and XAD-4.
- The resin traps are spiked with a surrogate standard to test for retention. A known quantity of standard is injected into the trap during preparation, the trap is then shipped, sampled and returned to the laboratory for analysis. The analysis included detecting the injected standard, which provides a measure of the recovery efficiency. Factors that may affect the recovery efficiency include, sample transport and handling procedures, sampling temperatures (the resin must be chilled during sampling and maintained below 20°C) and sample preparation at the laboratory, including the extraction of the sample from the resin.
- Condensate removal impinger prior to XAD resin traps.
- Impingers downstream of the resin trap are loaded with a sodium solution and is intended to be a breakthrough detector. Following the sampling, the impinger contents are measured and placed in a sample bottle for shipment to the laboratory. The final impingers of the sample train are then analysed separately to the filter, resin trap and front half methanol rinse, so as to provide a measure of possible breakthrough. The intent of this sampling train component is to provide a measure of breakthrough from the primary sampling components. Where no detections of PFAS material is made in this sampling component, the limit of detection is not added to the sample result.
- Following the sampling onsite, all sample train components that have been in contact with the sample are rinsed thoroughly with methanol and stored in a sample container to be analysed as part of the sample.
- Sample train component material. According to documented water and soil PFAS sampling procedures, the use of glass, Teflon and stainless steel should be avoided and the use of polypropylene (PE) is recommended. PE is not considered to be conducive to source emissions sampling due to the temperatures of the flue gas. PE or HDPE cannot be used in the probe or filter box due to its low melting point. Instead, all sampling components upstream of the resin trap are constructed of glass. Following sampling, all glassware was thoroughly rinsed with methanol at least three times to quantitively recover any possible PFAS material deposited on this surface.

For the analysis, the samples are extracted using a solvent desorption technique, with the filter and front half methanol rinse extract combined prior to analysis for the PFAS species. The XAD resin trap is then analysed in isolation as is the condensate downstream of the trap to gain an understanding of where the PFAS is captured within the sample train. The analysis is performed using LC/MS/MS instruments, with each analysis performed using the surrogate spikes to determine sample specific recoveries.

---

[c] In this case isokinetic sampling is not possible, therefore a constant flow sampling rate was used to collect a sample of the exhaust air.

2.3.1 PFAS Blank Corrections

A full field blank sample has not been performed for this round of sampling. The stock reagents are largely unchanged from previous rounds of sampling (13633), therefore the results of the previous blank are utilised for this round. A field blank is performed by the sample train being constructed as normal, however no sample is passed through it. It is then cleaned and recovered following the standard recovery procedures and the filter, resin trap and rinse are kept and analysed along with the sample.

The following details the procedures used to correct for detections of PFAS species in the blank samples.

- Where the blank result is a non-detection, no adjustment to the sample result is made.
- Where the blank result returns a positive detection, but is less than half of the sample result, the blank value is subtracted from the sample result and reported as a positive detection.
- Where the blank value returns a positive detection, and is exceeding half of the sample result, no adjustments are made to the sample result, but it is reported as a non-detection.

2.4 Sample Location

The figures and tables below show the sample location and site details.

Figure 1: BeneVap Treatment System Stack

Table 9: Sample Location Summary

AS4323.1	Sample location	BV300
	Stack Shape	CIRCULAR
	Ideal Sampling Plane Assessment	
	Stack Diameter (m)	0.59
	Stack Cross Section Area (m^2)	0.27
	Distance to upstream disturbance (m) (from disturbance)	0.7
	Upstream Diameters (D)	1.2
	Distance to downstream disturbance (m) (from disturbance)	1.4
	Downstream diameters (D)	2.4
4.2.2 Table 1	Meets Requirements AS4323.1 Table 1	No
	Non- Ideal Sampling Plane Assessment	
	Assessment required?	No
	Total traverse point factors	1.2
	Non-conforming Sampling Plane Assessment	
4.2.2(a)	Gas flow in same direction	Yes
4.2.2(b)	Gas flow steady & evenly distributed (cyclonic or swirl <15º)	Yes
4.2.2(c)	Temperature difference between points <10%, and each point <10% of average	Yes
4.2.2(d)	Ratio of highest to lowest differential pressure & ratio highest to lowest velocity	3.5 1.9
4.2.2(e)	Minimum differential pressure	0.2
	Gas temperature above dewpoint	Yes
	Sampling Plane Type	
4.2.2, 4.2.3, 4.2.4	Sampling plane type	Non-conforming
	Alternative sampling plane available?	No
	Number of Sample Points Adopted	
	Port size (mm)	90
	Port Thread Type	BSP
	Number of traverses	2
	Number of points per traverse	6
	Total number of traverse points	12
	Flow & temperature compliance check	No

2.5 Test Equipment

The sampling equipment was transported to site and specifically setup at the test location. Sampling was performed using heated probes and filters, with a constant flow and isokinetic sampling console.

Equipment used during the course of the testing is sourced from Apex instruments and Testo, industry leaders in the supply of source testing equipment.

Figure 2: Manual Sample Equipment

Figure 3: Combustion Gas Analyser

3 MEASUREMENT UNCERTAINTY

There is an inherent uncertainty associated with any scientific measurement, including stack emissions monitoring. The measurement uncertainty can be controlled with strict adherence to the reference methodology along with utilising appropriate calibration standards with corresponding acceptable uncertainty reports.

Many source sampling methods do not outline exact procedures for establishing direct measurement uncertainty. In the absence of a defined procedure, the uncertainty budgets presented are based on estimations using ISO-GUM method.

Each individual source and test may have a unique associated uncertainty assigned, due to factors such as the stack sample location in relation to the positioning requirements of AS4323.1, stack temperature, water vapour content and sample analysis.

The table below outlines the estimated uncertainties associate with reports presented within this report.

Table 10: Sample uncertainty

Parameter	Reference Method	Limit of Measurement	Unit of Measure	Measurement Uncertainty ± %
Gas velocity	USEPA Method 2	3	m/sec	10
Oxygen	USEPA Method 3A	0.3	%-vol	5.0
Carbon dioxide	USEPA Method 3A	0.3	%-vol	10
Water vapour content	USEPA Method 4	0.5	%-vol	5.0
Sulphur dioxide	USEPA Method 6	2.0	mg/sample	15
Oxides of nitrogen (as NO_2)	USEPA Method 7E	2.1	mg/sample	15
Sulfuric acid mists	USEPA Method 8	2.0	mg/sample	15
Carbon monoxide	USEPA Method 10	1.5	mg/sample	15
Hydrogen sulfide	USEPA Method 15	1.0	mg/sample	20
Total VOCs	USEPA Method 18	1.0	mg/sample	20
Hydrogen chloride	USEPA Method 26A	1.0	mg/sample	15
Chlorine	USEPA Method 26A	1.0	mg/sample	15
Fluoride (as HF)	USEPA Method 13B	1.0	mg/sample	15
Heavy metals	USEPA Method 29	0.3 to 50	µg/sample	20
PFAS – suite	USEPA OTM 45	1 to 50	ng/sample	25
Dioxins & furans	USEPA SW846 Method 0010	1	pg/sample	15
Polychlorinated biphenyls	USEPA SW846 Method 0010	20	pg/sample	15
Ammonia	Modified USEPA Method 26	1	mg/sample	25
Odour	AS4323.3	100	ou	40

4 MONITORING RESULTS

4.1 Stack 1 Results

Table 11: Sampling Information – PFAS

Site		Shaol Bay Landfill	
Sample Location		BV300.1	
Reference Method		USEPA Method 0010 - ISOKINETIC	
Run ID		19	
Test Parameter		PFAS	
Test Date	dd/mm/yyyy	1/02/2023	
Start Time	hh:mm	8:22	
End Time	hh:mm	11:22	
Average Stack Temperature	°C	91	
Absolute Stack Pressure	mb	1005	
Moisture Content	% v/v	63.4	
Dry Gas Density	kg/Nm^3	1.34	
Dry Gas Molecular Weight	g/g-mole	30.1	
Sample Volume (dry gas meter)	Nm^3	1.10	
Stack Gas Velocity	m/sec	2.8	
Actual Stack Flow Rate	m^3/min	46	
Dry Standard Stack Flow Rate	Nm^3/min	13	
Percent Isokinetic Rate	%	104	
Pollutant PFAS species	Licence limit ng/Nm^3	standard conditions Concentration ng/Nm^3	Emission Rate g/min
Perfluorobutanesulfonic acid	-	375	4.71E-06
Perfluoropentanesulfonic acid	-	7.0	8.85E-08
Perfluorohexanesulfonic acid	-	51	6.38E-07
Perfluoroheptanesulfonic acid	-	< 4.6	< 5.78E-08
Perfluorooctanesulfonic acid PFOS	-	52	6.53E-07
Perfluorodecanesulfonic acid	-	< 9.2	< 1.16E-07
Perfluorobutanoic acid	-	59	7.45E-07
Perfluoropentanoic acid	-	171	2.15E-06
Perfluorohexanoic acid	-	135	1.70E-06
Perfluoroheptanoic acid	-	45	5.67E-07
Perfluorooctanoic acid PFOA	-	82	1.03E-06
Perfluorononanoic acid	-	9.6	1.20E-07
Perfluorodecanoic acid	-	< 46	< 5.78E-07
Perfluoroundecanoic acid	-	< 46	< 5.78E-07
Perfluorododecanoic acid	-	< 46	< 5.78E-07
Perfluorotridecanoic acid	-	< 46	< 5.78E-07
Perfluorotetradecanoic acid	-	< 460	< 5.78E-06
4:2 FTS	-	< 4.6	< 5.78E-08
6:2 FTS	-	59	7.39E-07
8:2 FTS	-	< 9.2	< 1.16E-07
10:2 FTS	-	< 9.2	< 1.16E-07
Perfluorooctane sulfonamide	-	55	6.90E-07
N-Methyl perfluorooctane sulfonamide	-	< 46	< 5.78E-07
N-Ethyl perfluorooctane sulfonamide	-	< 46	< 5.78E-07
N-Me perfluorooctanesulfonamido ethanol	-	91	1.15E-06
N-Et perfluorooctanesulfonamido ethanol	-	< 1,840	< 2.31E-05
MePerfluorooctanesulf-amido acetic acid	-	< 9.2	< 1.16E-07
EtPerfluorooctanesulf-amido acetic acid	-	< 9.2	< 1.16E-07
TOTAL			
Sum of positive detections	-	1,192	1.50E-05

Table 12: Sampling Information – Odour

Site		Shaol Bay Landfill	
Sample Location		BV300.1	
Reference Method		AS4323.3 - CONSTANT FLOW	
Run ID		20	
Test Parameter		Odour	
Test Date	dd/mm/yyyy	5/02/2023	
Start Time	hh:mm	9:15	
End Time	hh:mm	9:27	
Average Stack Temperature	°C	91	
Absolute Stack Pressure	mb	1005	
Moisture Content	% v/v	63.4	
Dry Gas Density	kg/Nm^3	1.35	
Dry Gas Molecular Weight	g/g-mole	30.1	
Sample Volume (dry gas meter)	Nm^3	-	
Stack Gas Velocity	m/sec	2.8	
Actual Stack Flow Rate	m^3/min	46	
Dry Standard Stack Flow Rate	Nm^3/min	13	
Percent Isokinetic Rate	%	N/A	
Pollutant	Licence limit	standard conditions Concentration	Emission Rate
Odour	ou	ou	ou.m^3/min
Odour Sample 1	-	6,550	224,696
Odour Sample 2	-	8,037	275,708
Average Odour	-	7,293	250,202

Table 13: Sampling Information – Hydrogen Sulfide

Site		Shaol Bay Landfill
Sample Location		BV300.1
Reference Method		USEPA Method 15 - CONSTANT FLOW
Run ID		21
Test Parameter		H_2S
Test Date	dd/mm/yyyy	5/02/2023
Start Time	hh:mm	9:00
End Time	hh:mm	9:10
Average Stack Temperature	°C	91
Absolute Stack Pressure	mb	1005
Moisture Content	% v/v	63.4
Dry Gas Density	kg/Nm^3	1.35
Dry Gas Molecular Weight	g/g-mole	30.1
Sample Volume (dry gas meter)	Nm^3	-
Stack Gas Velocity	m/sec	2.8
Actual Stack Flow Rate	m^3/min	46
Dry Standard Stack Flow Rate	Nm^3/min	13
Percent Isokinetic Rate	%	N/A

Pollutant H_2S	Licence limit mg/Nm^3	standard conditions Concentration mg/Nm^3	Emission Rate g/min
Hydrogen sulfide	5	< 0.7	< 0.01

Table 14: Sampling Information – Oxides of Sulfur

Site		Shaol Bay Landfill
Sample Location		BV300.1
Reference Method		USEPA Method 8 - ISOKINETIC
Run ID		16
Test Parameter		SOx
Test Date	dd/mm/yyyy	2/02/2023
Start Time	hh:mm	7:42
End Time	hh:mm	8:42
Average Stack Temperature	°C	90
Absolute Stack Pressure	mb	1005
Moisture Content	% v/v	63.2
Dry Gas Density	kg/Nm^3	1.34
Dry Gas Molecular Weight	g/g-mole	30.1
Sample Volume (dry gas meter)	Nm^3	0.33
Stack Gas Velocity	m/sec	2.4
Actual Stack Flow Rate	m^3/min	40
Dry Standard Stack Flow Rate	Nm^3/min	11
Percent Isokinetic Rate	%	108

Pollutant SOx	Licence limit mg/Nm^3	standard conditions Concentration mg/Nm^3	Emission Rate g/min
SO_2	-	1.4	0.02
SO_3 (as H_2SO_4)	100	17.3	0.19

Table 15: Sampling Information – Acid Gases

Site		Shaol Bay Landfill
Sample Location		BV300.1
Reference Method		USEPA Method 26A - ISOKINETIC
Run ID		14
Test Parameter		Acid Gases
Test Date	dd/mm/yyyy	31/01/2023
Start Time	hh:mm	8:45
End Time	hh:mm	9:45
Average Stack Temperature	°C	91
Absolute Stack Pressure	mb	1006
Moisture Content	% v/v	61.7
Dry Gas Density	kg/Nm^3	1.34
Dry Gas Molecular Weight	g/g-mole	30.1
Sample Volume (dry gas meter)	Nm^3	0.37
Stack Gas Velocity	m/sec	2.6
Actual Stack Flow Rate	m^3/min	43
Dry Standard Stack Flow Rate	Nm^3/min	12
Percent Isokinetic Rate	%	110

Pollutant	Licence limit	standard conditions Concentration	Emission Rate
Acid Gases	mg/Nm^3	mg/Nm^3	g/min
HCl	100	< 2.7	< 0.03
Cl_2	200	< 2.7	< 0.03

Table 16: Sampling Information – Heavy Metals

Site		Shaol Bay Landfill
Sample Location		BV300.1
Reference Method		USEPA Method 29 - ISOKINETIC
Run ID		13
Test Parameter		Metals
Test Date	dd/mm/yyyy	1/02/2023
Start Time	hh:mm	1:18
End Time	hh:mm	3:18

Average Stack Temperature	°C	92
Absolute Stack Pressure	mb	1005
Moisture Content	% v/v	63.6
Dry Gas Density	kg/Nm^3	1.35
Dry Gas Molecular Weight	g/g-mole	30.2
Sample Volume (dry gas meter)	Nm^3	0.70
Stack Gas Velocity	m/sec	2.7
Actual Stack Flow Rate	m^3/min	45
Dry Standard Stack Flow Rate	Nm^3/min	12
Percent Isokinetic Rate	%	104

Pollutant Metals	Licence limit µg/Nm^3	standard conditions Concentration µg/Nm^3	Emission Rate g/min
Antimony	-	< 8.0	< 9.7E-05
Arsenic	-	< 8.0	< 9.7E-05
Beryllium	-	< 0.6	< 7.3E-06
Cadmium	200	1.6	1.9E-05
Chromium	-	7.8	9.5E-05
Cobalt	-	< 0.6	< 7.3E-06
Lead	-	28	3.4E-04
Manganese	-	4.3	5.2E-05
Nickel	-	70	8.4E-04
Selenium	-	< 8.0	< 9.7E-05
Tin	-	< 20	< 2.4E-04
Vanadium	-	< 10	< 1.2E-04
Mercury	200	1.8	2.2E-05
Total Heavy Metals (lower bound)	1,000	113	1.4E-03

Table 17: Sampling Information – Volatile Organic Compounds

Site		Shaol Bay Landfill	
Sample Location		BV300.1	
Reference Method		USEPA Method M18 - CONSTANT FLOW	
Run ID		17	
Test Parameter		VOCs	
Test Date	dd/mm/yyyy	1/02/2023	
Start Time	hh:mm	8:30	
End Time	hh:mm	9:30	
Average Stack Temperature	°C	91	
Absolute Stack Pressure	mb	1005	
Moisture Content	% v/v	63.4	
Dry Gas Density	kg/Nm^3	1.34	
Dry Gas Molecular Weight	g/g-mole	30.1	
Sample Volume (dry gas meter)	Nm^3	0.03	
Stack Gas Velocity	m/sec	2.8	
Actual Stack Flow Rate	m^3/min	46	
Dry Standard Stack Flow Rate	Nm^3/min	13	
Percent Isokinetic Rate	%	N/A	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
Total (non-methane) VOCs	mg/Nm^3	mg/Nm^3	g/min
Total VOCs - as n-hexane	-	< 1.7	< 0.02
Total VOCs - as n-propane	40	< 0.9	< 0.01

Table 18: Sampling Information – Ammonia

Site		Shaol Bay Landfill	
Sample Location		BV300.1	
Reference Method		USEPA Method Mod M6 - CONSTANT FLOW	
Run ID		18	
Test Parameter		NH_3	
Test Date	dd/mm/yyyy	31/01/2023	
Start Time	hh:mm	11:18	
End Time	hh:mm	12:18	
Average Stack Temperature	°C	92	
Absolute Stack Pressure	mb	1007	
Moisture Content	% v/v	62.8	
Dry Gas Density	kg/Nm^3	1.34	
Dry Gas Molecular Weight	g/g-mole	30.1	
Sample Volume (dry gas meter)	Nm^3	0.03	
Stack Gas Velocity	m/sec	2.7	
Actual Stack Flow Rate	m^3/min	44	
Dry Standard Stack Flow Rate	Nm^3/min	12	
Percent Isokinetic Rate	%	N/A	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
NH_3	mg/Nm^3	mg/Nm^3	g/min
Ammonia (NH_3) - in condensate	-	2,441	30
Ammonia (NH_3) - gaseous	-	287	3.5
Total Ammonia (as NH_3)	-	2,728	33

Table 19: Sampling Information – Fluoride

Site		Shaol Bay Landfill	
Sample Location		BV300.1	
Reference Method		USEPA Method 13B - ISOKINETIC	
Run ID		15	
Test Parameter		Fluoride	
Test Date	dd/mm/yyyy	31/01/2023	
Start Time	hh:mm	15:59	
End Time	hh:mm	16:59	
Average Stack Temperature	°C	92	
Absolute Stack Pressure	mb	1006	
Moisture Content	% v/v	62.9	
Dry Gas Density	kg/Nm^3	1.34	
Dry Gas Molecular Weight	g/g-mole	30.0	
Sample Volume (dry gas meter)	Nm^3	0.36	
Stack Gas Velocity	m/sec	2.7	
Actual Stack Flow Rate	m^3/min	44	
Dry Standard Stack Flow Rate	Nm^3/min	12	
Percent Isokinetic Rate	%	104	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
Fluoride	mg/Nm^3	mg/Nm^3	g/min
Fluorine - (as total HF)	50	< 3.0	< 0.04

Table 20: Sampling Information – Combustion Gases

Site		Shaol Bay Landfill	
Sample Location		BV300.1	
Reference Method		USEPA Method 3A, 7E & 10	
Run ID		Various	
Test Parameter		O$_2$, CO$_2$, NOx, CO	
Test Date	dd/mm/yyyy	2/02/2023	
Start Time	hh:mm	7:42	
End Time	hh:mm	9:45	
Average Stack Temperature	°C	91	
Absolute Stack Pressure	mb	1006	
Moisture Content	% v/v	62.9	
Dry Gas Density	kg/Nm^3	1.34	
Dry Gas Molecular Weight	g/g-mole	30.1	
Stack Gas Velocity	m/sec	2.6	
Actual Stack Flow Rate	m^3/min	43	
Dry Standard Stack Flow Rate	Nm^3/min	12	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
O2, CO2, NOx, CO	STP	STP	g/min
Oxygen (% v/v)	-	5.2	-
Carbon dioxide (% v/v)	-	11.8	-
Carbon monoxide (mg/Nm^3)	125	24	0.3
Oxides of nitrogen (mg/Nm^3)	350	131	1.6

Table 21: Sampling Information – Dioxins & Furans

Site		Shaol Bay Landfill
Sample Location		BV300.1
Reference Method		USEPA Method 23 - ISOKINETIC
Run ID		12
Test Parameter		DF PCB
Test Date	dd/mm/yyyy	31/01/2023
Start Time	hh:mm	11:04
End Time	hh:mm	14:04

Average Stack Temperature	°C	92
Absolute Stack Pressure	mb	1007
Moisture Content	% v/v	62.8
Dry Gas Density	kg/Nm^3	1.34
Dry Gas Molecular Weight	g/g-mole	30.1
Sample Volume (dry gas meter)	Nm^3	1.09
Stack Gas Velocity	m/sec	2.7
Actual Stack Flow Rate	m^3/min	44
Dry Standard Stack Flow Rate	Nm^3/min	12
Percent Isokinetic Rate	%	106

Pollutant DF PCB	Licence limit ng/Nm^3		standard conditions Concentration ng/Nm^3		Emission Rate g/min
2378 TCDF	-		0.029		3.6E-10
Total TCDF isomers	-		0.64		7.9E-09
2378 TCDD	-	<	0.0028	<	3.4E-11
Total TCDD isomers	-		0.078		9.5E-10
12378 PeCDF	-		0.038		4.6E-10
23478 PeCDF	-		0.045		5.5E-10
Total PeCDF isomers	-		0.51		6.2E-09
12378 PeCDD	-		0.0034		4.2E-11
Total PeCDD isomers	-		0.062		7.5E-10
123478 HxCDF	-		0.051		6.2E-10
123678 HxCDF	-		0.048		5.8E-10
234678 HxCDF	-		0.029		3.6E-10
123789 HxCDF	-		0.0064		7.9E-11
Total HxCDF isomers	-		0.36		4.4E-09
123478 HxCDD	-	<	0.0018	<	2.2E-11
123678 HxCDD	-		0.0040		4.8E-11
123789 HxCDD	-		0.0027		3.3E-11
Total HxCDD isomers	-		0.070		8.5E-10
1234678 HpCDF	-		0.10		1.2E-09
1234789 HpCDF	-		0.027		3.3E-10
Total HpCDF isomers	-		0.17		2.1E-09
1234678 HpCDD	-		0.032		3.9E-10
Total HpCDD isomers	-		0.063		7.6E-10
OCDF	-		0.046		5.6E-10
OCDD	-		0.11		1.3E-09
Sum of congeners Sum of positive detections	-		2.1		2.6E-08
Total I-TEQ Sum of positive detections	0.1		0.045		5.5E-10

Table 22: Sampling Information – PCBs

PCBs (USEPA Method 23)			
PCBs	Licence limit ng/Nm^3	standard conditions Concentration ng/Nm^3	Emission Rate g/min
PCB#77	-	0.88	1.1E-08
PCB#81	-	0.040	4.8E-10
PCB#126	-	0.040	4.9E-10
PCB#169	-	0.0051	6.3E-11
PCB#105	-	2.8	3.5E-08
PCB#114	-	0.17	2.0E-09
PCB#118	-	5.9	7.2E-08
PCB#123	-	0.11	1.3E-09
PCB#156	-	0.74	9.1E-09
PCB#157	-	0.17	2.1E-09
PCB#167	-	0.28	3.4E-09
PCB#189	-	0.035	4.3E-10
Sum of PCB Congeners Sum of positive detections	-	11	1.4E-07
Total TEQ Sum of positive detections	-	0.0046	5.6E-11

4.2 Stack 2 Results

Table 23: Sampling Information – PFAS

Site			Shaol Bay Landfill		
Sample Location			BV300.2		
Reference Method			USEPA Method 0010 - ISOKINETIC		
Run ID			30		
Test Parameter			PFAS		
Test Date	dd/mm/yyyy		1/02/2023		
Start Time	hh:mm		8:22		
End Time	hh:mm		11:22		
Average Stack Temperature	°C		86		
Absolute Stack Pressure	mb		1005		
Moisture Content	% v/v		62.7		
Dry Gas Density	kg/Nm^3		1.34		
Dry Gas Molecular Weight	g/g-mole		30.1		
Sample Volume (dry gas meter)	Nm^3		0.97		
Stack Gas Velocity	m/sec		2.4		
Actual Stack Flow Rate	m^3/min		40		
Dry Standard Stack Flow Rate	Nm^3/min		11		
Percent Isokinetic Rate	%		104		
			standard conditions		
Pollutant	Licence limit		Concentration		Emission Rate
PFAS species	ng/Nm^3		ng/Nm^3		g/min
Perfluorobutanesulfonic acid	-		453		5.07E-06
Perfluoropentanesulfonic acid	-	<	5.2	<	5.80E-08
Perfluorohexanesulfonic acid	-		55		6.18E-07
Perfluoroheptanesulfonic acid	-	<	5.2	<	5.80E-08
Perfluorooctanesulfonic acid PFOS	-		63		7.09E-07
Perfluorodecanesulfonic acid	-	<	10	<	1.16E-07
Perfluorobutanoic acid	-		67		7.47E-07
Perfluoropentanoic acid	-		206		2.30E-06
Perfluorohexanoic acid	-		150		1.68E-06
Perfluoroheptanoic acid	-		58		6.49E-07
Perfluorooctanoic acid PFOA	-		97		1.09E-06
Perfluorononanoic acid	-		13		1.46E-07
Perfluorodecanoic acid	-	<	52	<	5.80E-07
Perfluoroundecanoic acid	-	<	52	<	5.80E-07
Perfluorododecanoic acid	-	<	52	<	5.80E-07
Perfluorotridecanoic acid	-	<	52	<	5.80E-07
Perfluorotetradecanoic acid	-	<	519	<	5.80E-06
4:2 FTS	-	<	5.2	<	5.80E-08
6:2 FTS	-		58		6.49E-07
8:2 FTS	-	<	10	<	1.16E-07
10:2 FTS	-	<	10	<	1.16E-07
Perfluorooctane sulfonamide	-		62		6.92E-07
N-Methyl perfluorooctane sulfonamide	-	<	52	<	5.80E-07
N-Ethyl perfluorooctane sulfonamide	-	<	52	<	5.80E-07
N-Me perfluorooctanesulfonamido ethanol	-		103		1.15E-06
N-Et perfluorooctanesulfonamido ethanol	-	<	2,074	<	2.32E-05
MePerfluorooctanesulf-amido acetic acid	-	<	10	<	1.16E-07
EtPerfluorooctanesulf-amido acetic acid	-	<	10	<	1.16E-07
TOTAL					
Sum of positive detections	-		1,386		1.55E-05

Table 24: Sampling Information – Odour

Site		Shaol Bay Landfill
Sample Location		BV300.2
Reference Method		AS 4323.3 - CONSTANT FLOW
Run ID		31
Test Parameter		Odour
Test Date	dd/mm/yyyy	5/06/2023
Start Time	hh:mm	9:30
End Time	hh:mm	9:42
Average Stack Temperature	°C	86
Absolute Stack Pressure	mb	1005
Moisture Content	% v/v	62.7
Dry Gas Density	kg/Nm^3	1.35
Dry Gas Molecular Weight	g/g-mole	30.1
Sample Volume (dry gas meter)	Nm^3	-
Stack Gas Velocity	m/sec	2.4
Actual Stack Flow Rate	m^3/min	40
Dry Standard Stack Flow Rate	Nm^3/min	11
Percent Isokinetic Rate	%	N/A

		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
Odour	ou	ou	ou.m^3/min
Odour Sample 1	-	7,536	225,998
Odour Sample 2	-	9,408	282,120
Average Odour	-	8,472	254,059

Table 25: Sampling Information – Hydrogen Sulfide

Site		Shaol Bay Landfill
Sample Location		BV300.2
Reference Method		USEPA Method 15 - CONSTANT FLOW
Run ID		32
Test Parameter		H_2S
Test Date	dd/mm/yyyy	5/02/2023
Start Time	hh:mm	9:46
End Time	hh:mm	9:57
Average Stack Temperature	°C	86
Absolute Stack Pressure	mb	1005
Moisture Content	% v/v	62.7
Dry Gas Density	kg/Nm^3	1.35
Dry Gas Molecular Weight	g/g-mole	30.1
Sample Volume (dry gas meter)	Nm^3	-
Stack Gas Velocity	m/sec	2.4
Actual Stack Flow Rate	m^3/min	40
Dry Standard Stack Flow Rate	Nm^3/min	11
Percent Isokinetic Rate	%	N/A

Pollutant H_2S	Licence limit mg/Nm^3	standard conditions Concentration mg/Nm^3	Emission Rate g/min
Hydrogen sulfide	5	< 0.7	< 0.01

Table 26: Sampling Information – Oxides of Sulfur

Site		Shaol Bay Landfill
Sample Location		BV300.2
Reference Method		USEPA Method 8 - ISOKINETIC
Run ID		27
Test Parameter		SOx
Test Date	dd/mm/yyyy	2/02/2023
Start Time	hh:mm	7:45
End Time	hh:mm	8:45
Average Stack Temperature	°C	87
Absolute Stack Pressure	mb	1005
Moisture Content	% v/v	64.2
Dry Gas Density	kg/Nm^3	1.34
Dry Gas Molecular Weight	g/g-mole	30.1
Sample Volume (dry gas meter)	Nm^3	0.36
Stack Gas Velocity	m/sec	2.9
Actual Stack Flow Rate	m^3/min	47
Dry Standard Stack Flow Rate	Nm^3/min	13
Percent Isokinetic Rate	%	103

Pollutant SOx	Licence limit mg/Nm^3	standard conditions Concentration mg/Nm^3	Emission Rate g/min
SO_2	-	8.1	0.10
SO_3 (as H_2SO_4)	100	22.2	0.28

Table 27: Sampling Information – Acid Gases

Site		Shaol Bay Landfill
Sample Location		BV300.2
Reference Method		USEPA Method 26A - ISOKINETIC
Run ID		25
Test Parameter		Acid Gases
Test Date	dd/mm/yyyy	31/01/2023
Start Time	hh:mm	8:45
End Time	hh:mm	9:45
Average Stack Temperature	°C	87
Absolute Stack Pressure	mb	1006
Moisture Content	% v/v	59.0
Dry Gas Density	kg/Nm^3	1.34
Dry Gas Molecular Weight	g/g-mole	30.1
Sample Volume (dry gas meter)	Nm^3	0.43
Stack Gas Velocity	m/sec	2.9
Actual Stack Flow Rate	m^3/min	48
Dry Standard Stack Flow Rate	Nm^3/min	15
Percent Isokinetic Rate	%	104

Pollutant	Licence limit		standard conditions Concentration		Emission Rate
Acid Gases	mg/Nm^3		mg/Nm^3		g/min
HCl	100	<	2.3	<	0.03
Cl$_2$	200	<	2.3	<	0.03

Table 28: Sampling Information – Heavy Metals

Site		Shaol Bay Landfill			
Sample Location		BV300.2			
Reference Method		USEPA Method 29 - ISOKINETIC			
Run ID		24			
Test Parameter		Metals			
Test Date	dd/mm/yyyy	1/02/2023			
Start Time	hh:mm	13:19			
End Time	hh:mm	15:19			
Average Stack Temperature	°C	87			
Absolute Stack Pressure	mb	1005			
Moisture Content	% v/v	60.0			
Dry Gas Density	kg/Nm^3	1.34			
Dry Gas Molecular Weight	g/g-mole	30.1			
Sample Volume (dry gas meter)	Nm^3	0.73			
Stack Gas Velocity	m/sec	2.8			
Actual Stack Flow Rate	m^3/min	46			
Dry Standard Stack Flow Rate	Nm^3/min	14			
Percent Isokinetic Rate	%	95			

Pollutant Metals	Licence limit µg/Nm^3		standard conditions Concentration µg/Nm^3		Emission Rate g/min
Antimony	-	<	7.8	<	1.1E-04
Arsenic	-	<	7.8	<	1.1E-04
Beryllium	-	<	0.6	<	8.0E-06
Cadmium	200		0.3		3.8E-06
Chromium	-		4.1		5.7E-05
Cobalt	-	<	0.6	<	8.0E-06
Lead	-		15		2.1E-04
Manganese	-		5.5		7.5E-05
Nickel	-		12		1.7E-04
Selenium	-	<	7.8	<	1.1E-04
Tin	-	<	19	<	2.7E-04
Vanadium	-	<	9.7	<	1.3E-04
Mercury	200		3.5		4.9E-05
Total Heavy Metals (lower bound)	1,000		41		5.6E-04

Table 29: Sampling Information – Volatile Organic Compounds

Site		Shaol Bay Landfill
Sample Location		BV300.2
Reference Method		USEPA Method M18 - CONSTANT FLOW
Run ID		28
Test Parameter		VOCs
Test Date	dd/mm/yyyy	1/02/2023
Start Time	hh:mm	9:55
End Time	hh:mm	10:55
Average Stack Temperature	°C	86
Absolute Stack Pressure	mb	1005
Moisture Content	% v/v	62.7
Dry Gas Density	kg/Nm^3	1.34
Dry Gas Molecular Weight	g/g-mole	30.1
Sample Volume (dry gas meter)	Nm^3	0.03
Stack Gas Velocity	m/sec	2.4
Actual Stack Flow Rate	m^3/min	40
Dry Standard Stack Flow Rate	Nm^3/min	11
Percent Isokinetic Rate	%	N/A

		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
Total (non-methane) VOCs	mg/Nm^3	mg/Nm^3	g/min
Total VOCs - as n-hexane	-	< 1.9	< 0.02
Total VOCs - as n-propane	40	< 1.0	< 0.01

Table 30: Sampling Information – Ammonia

Site		Shaol Bay Landfill
Sample Location		BV300.2
Reference Method		USEPA Method Mod M6 - CONSTANT FLOW
Run ID		29
Test Parameter		NH_3
Test Date	dd/mm/yyyy	31/01/2023
Start Time	hh:mm	12:30
End Time	hh:mm	13:30
Average Stack Temperature	°C	86
Absolute Stack Pressure	mb	1007
Moisture Content	% v/v	63.9
Dry Gas Density	kg/Nm^3	1.35
Dry Gas Molecular Weight	g/g-mole	30.2
Sample Volume (dry gas meter)	Nm^3	0.03
Stack Gas Velocity	m/sec	3.0
Actual Stack Flow Rate	m^3/min	49
Dry Standard Stack Flow Rate	Nm^3/min	13
Percent Isokinetic Rate	%	N/A

	Concentration		Emission Rate
Pollutant	standard conditions	standard conditions	standard conditions
NH3	mg/Nm^3	mg/Nm^3	g/min
Ammonia (NH_3) - in condensate	-	2,597	35
Ammonia (NH_3) - gaseous	-	98	1.3
Total Ammonia (as NH_3)	-	2,695	36

Table 31: Sampling Information – Fluoride

Site		Shaol Bay Landfill	
Sample Location		BV300.2	
Reference Method		USEPA Method 13B - ISOKINETIC	
Run ID		26	
Test Parameter		Fluoride	
Test Date	dd/mm/yyyy	31/01/2023	
Start Time	hh:mm	16:00	
End Time	hh:mm	17:00	
Average Stack Temperature	°C	86	
Absolute Stack Pressure	mb	1006	
Moisture Content	% v/v	63.6	
Dry Gas Density	kg/Nm^3	1.34	
Dry Gas Molecular Weight	g/g-mole	30.0	
Sample Volume (dry gas meter)	Nm^3	0.38	
Stack Gas Velocity	m/sec	2.9	
Actual Stack Flow Rate	m^3/min	47	
Dry Standard Stack Flow Rate	Nm^3/min	13	
Percent Isokinetic Rate	%	106	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
Fluoride	mg/Nm^3	mg/Nm^3	g/min
Fluorine - (as total HF)	50	< 2.8	< 0.04

Table 32: Sampling Information – Combustion Gases

Site		Shaol Bay Landfill	
Sample Location		BV300.2	
Reference Method		USEPA Method 3A, 7E & 10	
Run ID		Various	
Test Parameter		O$_2$, CO$_2$, NOx, CO	
Test Date	dd/mm/yyyy	31/01/2023	
Start Time	hh:mm	16:00	
End Time	hh:mm	14:06	
Average Stack Temperature	°C	87	
Absolute Stack Pressure	mb	1006	
Moisture Content	% v/v	62.2	
Dry Gas Density	kg/Nm^3	1.34	
Dry Gas Molecular Weight	g/g-mole	30.1	
Stack Gas Velocity	m/sec	2.9	
Actual Stack Flow Rate	m^3/min	47	
Dry Standard Stack Flow Rate	Nm^3/min	13	
		standard conditions	
Pollutant	Licence limit	Concentration	Emission Rate
O2, CO2, NOx, CO	STP	STP	g/min
Oxygen (% v/v)	-	5.3	-
Carbon dioxide (% v/v)	-	11.7	-
Carbon monoxide (mg/Nm^3)	125	32	0.4
Oxides of nitrogen (mg/m^3)	350	134	1.8

Table 33: Sampling Information – Dioxins & Furans

Site		Shaol Bay Landfill
Sample Location		BV300.2
Reference Method		USEPA Method 23 - ISOKINETIC
Run ID		23
Test Parameter		DF PCB
Test Date	dd/mm/yyyy	31/01/2023
Start Time	hh:mm	11:06
End Time	hh:mm	14:06

Average Stack Temperature	°C	86
Absolute Stack Pressure	mb	1007
Moisture Content	% v/v	63.9
Dry Gas Density	kg/Nm^3	1.35
Dry Gas Molecular Weight	g/g-mole	30.1
Sample Volume (dry gas meter)	Nm^3	1.22
Stack Gas Velocity	m/sec	3.0
Actual Stack Flow Rate	m^3/min	49
Dry Standard Stack Flow Rate	Nm^3/min	13
Percent Isokinetic Rate	%	108

Pollutant DF PCB	Licence limit ng/Nm^3		standard conditions Concentration ng/Nm^3		Emission Rate g/min
2378 TCDF	-		0.0078		1.0E-10
Total TCDF isomers	-		0.13		1.8E-09
2378 TCDD	-	<	0.0025	<	3.3E-11
Total TCDD isomers	-		0.099		1.3E-09
12378 PeCDF	-	<	0.0033	<	4.4E-11
23478 PeCDF	-		0.0030		4.1E-11
Total PeCDF isomers	-		0.053		7.2E-10
12378 PeCDD	-	<	0.0025	<	3.3E-11
Total PeCDD isomers	-		0.051		6.8E-10
123478 HxCDF	-	<	0.0025	<	3.3E-11
123678 HxCDF	-		0.0023		3.1E-11
234678 HxCDF	-		0.0018		2.4E-11
123789 HxCDF	-	<	0.00082	<	1.1E-11
Total HxCDF isomers	-		0.018		2.4E-10
123478 HxCDD	-	<	0.0016	<	2.2E-11
123678 HxCDD	-		0.0022		3.0E-11
123789 HxCDD	-	<	0.0016	<	2.2E-11
Total HxCDD isomers	-		0.052		6.9E-10
1234678 HpCDF	-		0.0040		5.4E-11
1234789 HpCDF	-	<	0.00082	<	1.1E-11
Total HpCDF isomers	-		0.0057		7.6E-11
1234678 HpCDD	-		0.031		4.2E-10
Total HpCDD isomers	-		0.060		8.0E-10
OCDF	-	<	0.0016	<	2.2E-11
OCDD	-		0.12		1.5E-09
Sum of congeners Sum of positive detections	-		0.59		7.8E-09
Total I-TEQ Sum of positive detections	0.1		0.0034		4.6E-11

Table 34: Sampling Information – PCBs

PCBs (USEPA Method 23)			
PCBs	Licence limit ng/Nm³	standard conditions Concentration ng/Nm³	Emission Rate g/min
PCB#77	-	0.95	1.3E-08
PCB#81	-	0.041	5.5E-10
PCB#126	-	0.031	4.2E-10
PCB#169	-	0.0022	3.0E-11
PCB#105	-	3.4	4.5E-08
PCB#114	-	0.18	2.4E-09
PCB#118	-	7.0	9.4E-08
PCB#123	-	0.10	1.3E-09
PCB#156	-	0.83	1.1E-08
PCB#157	-	0.20	2.6E-09
PCB#167	-	0.32	4.3E-09
PCB#189	-	0.032	4.3E-10
Sum of PCB Congeners Sum of positive detections	-	13	1.8E-07
Total TEQ Sum of positive detections	-	0.0037	5.0E-11

5 QUALITY ASSURANCE & QUALITY CONTROL (QA/QC)

Assured Environmental operates within a quality system based upon the requirements of ISO17025.Our quality system defines specific procedures and methodologies to ensure any project undertaken by Assured Environmental is conducted with the highest level of quality given the specific confines of each project. The overall objective of our QA/QC procedures is to representatively sample and accurately analyse components in the gas streams and therefore report valid measurements of emission concentrations.

To ensure representativeness of field work, our quality procedures target:

1. Correct sampling locations
2. Sample time
3. Frequency of samples and
4. Method selection & adherence

To ensure representativeness of lab work, our quality procedures target:

1. Sample preservation
2. Chain of custody (COC)
3. Sample preparation and
4. Analytical techniques

Assured Environmental maintains strict quality assurance throughout all its sampling programs, covering on-site 'field work' and the analytical phase of our projects. Our QA program covers the calibration of all sampling and analytical apparatus where applicable and the use of spikes, replicate sample and reference standards. The test methodologies used for this project are outlined in the methods section of this document. Field test data has been recorded and calculated using direct entry into Microsoft Excel spreadsheets following the procedures of the appropriate test methods. Determination of emission concentrations has been performed using the same Microsoft Excel spreadsheets which are partially supplied as an attachment to this report. More detailed information can be supplied upon request.

QA/QC checks for this project will use validation techniques and criteria appropriate to the type of data and the purpose of the measurement to approve the test report. Records of all data will be maintained. Complete chain of custody (COC) procedures has been followed to document the entire custodial history of each sample. The COC forms also served as a laboratory sheet detailing sample ID and analysis requirements.

Table 35: Sampling data QA/QC checklist

Sampling Data QA/QC Checklist	Comment
Use of appropriate test methods	Yes
'Normal' operation of the process being tested	Yes – as instructed by client
Use of properly operating and calibrated test equipment	Yes
Use of high purity reagents	Yes
Performance of leak checks post sample (at least)	Yes

Table 36: Laboratory data QA/QC checklist

Laboratory Data QA/QC Checklist	Comment
Use of appropriate analytical methods	Yes
Use of properly operating and calibrated analytical equipment	Yes
Precision and accuracy comparable to that achieved in similar projects	Yes
Accurate reporting	Yes

Table 37: Olfactometer QA data

Item	Comment
Methodology	AS/NZ4323.4:2001 "area source sampling"
Sample Media	Odour samples collected into Nalophan^{TM} sample bags
Sample identification	All samples are labelled uniquely immediately following collection according to Assured Environmental's identification procedure. Each sample has the following recorded: project ID, sample number, location, date, time, dilution and any deviations to AS/NZ4323.4.
Timing	All measurements were conducted within 30 hours of sampling as specified by AS/NZ4323.4
Traceability	All panel results are traceable to reference standards held by Assured Environmental
Analysis conditions	Room temperature maintained at 22°C ± 3°C
Odour panel location	7/142 Tennyson Memorial Avenue, Tennyson QLD 4105
Reference odourant	39 ppm n-butanol
Odour panel threshold	76 ou

5.1 PFAS Quality Control

The recoveries of surrogate standards from the sampling and analysis are presented in the table below. The expected QC recovery for measurements in the ppb to ppt levels is in the range of 60 to 120%. The results are not corrected for the recovery efficiency.

Table 38: PFAS Surrogate Recovery (%)

Surrogate	PFAS	
	BV300_1	BV300_2
Field Surrogate	**Filter**	**Trap**
Surrogate $^{13}C_8$ PFOS	98	60
Surrogate $^{13}C_2$ PFOA	104	108
Field Surrogate	**Filter**	**Trap**
Surrogate $^{13}C_8$ PFOS	100	40
Surrogate $^{13}C_2$ PFOA	107	83

Analysis of the final bubbler containing a sodium borate solution was performed separately to the front of the sampling train in order to assess the potential for breakthrough. The results of this analysis are provided below.

Table 39: Breakthrough Analysis

Perfluorinated surfactants	Abbreviation	Breakthrough analysis (ng/Nm^3)			
		BV300_1		BV300_2	
Perfluorobutanesulfonic acid	PFBS	<	0.5	<	0.5
Perfluoropentanesulfonic acid	PFPeS	<	0.5	<	0.5
Perfluorohexanesulfonic acid	PFHxS	<	0.5	<	0.5
Perfluoroheptanesulfonic acid	PFHpS	<	0.5	<	0.5
Perfluorooctanesulfonic acid PFOS	PFOS	<	0.5	<	0.5
Perfluorodecanesulfonic acid	PFDS	<	0.9	<	1.0
Perfluorobutanoic acid	PFBA	<	0.9	<	1.0
Perfluoropentanoic acid	PFPeA	<	0.9	<	1.0
Perfluorohexanoic acid	PFHxA	<	0.5	<	0.5
Perfluoroheptanoic acid	PFHpA	<	0.5	<	0.5
Perfluorooctanoic acid PFOA	PFOA	<	0.5		**0.6**
Perfluorononanoic acid	PFNA	<	0.5	<	0.5
Perfluorodecanoic acid	PFDA	<	4.6	<	5.1
Perfluoroundecanoic acid	PFUdA	<	4.6	<	5.1
Perfluorododecanoic acid	PFDoA	<	4.6	<	5.1
Perfluorotridecanoic acid	PFTrDA	<	4.6	<	5.1
Perfluorotetradecanoic acid	PFTeDA	<	46	<	51
4:2 FTS	4:2 FTS	<	0.5	<	0.5
6:2 FTS	6:2 FTS	<	0.5	<	0.5
8:2 FTS	8:2 FTS	<	0.9	<	1.0
10:2 FTS	10:2 FTS	<	0.9	<	1.0
Perfluorooctane sulfonamide	FOSA	<	4.6	<	5.1
N-Methyl perfluorooctanesulfonamide	N-MeFOSA	<	4.6	<	5.1
N-Ethyl perfluorooctanesulfonamide	n-EtFOSA	<	4.6	<	5.1
N-Me perfluorooctanesulfonamidoethanol	n-MeFOSE	<	4.6	<	5.1
N-Et perfluorooctanesulfonamidoethanol	n-EtFOSE	<	182	<	205
MePerfluorooctanesulf-amidoacetic acid	N-MeFOSAA	<	0.9	<	1.0
EtPerfluorooctanesulf-amidoacetic acid	N-EtFOSAA	<	0.9	<	1.0

The breakthrough analysis for the BV300.1 sample showed no detectable levels of PFAS compounds. The BV300.2 sample showed a PFOA level slightly above the limit of detection (0.6 ng/Nm^3). This detection is 0.6 % of the total PFOA found in the sample.

Analysis of the field sample blank (project 13633) showed that only a small amount of PFOA was detectable in the methanol/XAD resin. The table below shows the results of the blank analysis.

Table 40: Field Blank Analysis

				Blank Analysis		
Perfluorinated surfactants - PFAS suite		**Front half ng/sample**		**Resin traps ng/sample**		**Breakthrough ng/sample**
Perfluorobutanesulfonic acid	<	0.2	<	0.2	<	0.2
Perfluoropentane sulfonic acid (PFPeS)	<	0.2	<	0.2	<	0.2
Perfluorohexane sulfonate (PFHxS)	<	0.2	<	0.2	<	0.2
Perfluoroheptane sulfonate (PFHpS)	<	0.2	<	0.2	<	0.2
Perfluorooctane sulfonate (PFOS)	<	0.2	<	0.2	<	0.2
Perfluorodecanesulfonic acid (PFDS)	<	0.4	<	0.4	<	0.4
Perfluorobutanoic acid	<	0.4	<	0.4	<	0.4
Perfluoropentanoic acid (PFPeA)	<	0.4	<	0.4	<	0.4
Perfluorohexanoic acid (PFHxA)	<	0.2	<	0.2	<	0.2
Perfluoroheptanoic acid (PFHpA)	<	0.2	<	0.2	<	0.2
Perfluorooctanoic acid (PFOA)	<	0.2		**2.3**	<	0.2
Perfluorononanoic acid (PFNA)	<	0.2	<	0.2	<	0.2
Perfluorodecanoic acid	<	1.0	<	1.0	<	1.0
Perfluoroundecanoic acid (PFUnA)	<	1.0	<	1.0	<	1.0
Perfluorododecanoic acid (PFDoA)	<	1.0	<	1.0	<	1.0
Perfluorotridecanoic acid (PFTrDA)	<	1.0	<	1.0	<	1.0
Perfluorotetradecanoic acid (PFTeDA)	<	5.0	<	5.0	<	5.0
4:2 Flurotelomersulphonate	<	0.2	<	0.2	<	0.2
6:2 Fluorotelomersulphonate	<	0.2	<	0.2	<	0.2
8:2 Fluorotelomersulphonate	<	0.4	<	0.4	<	0.4
10:2 Fluorotelomersulphonate	<	0.4	<	0.4	<	0.4
Perfluorooctane sulfonamide	<	1.0	<	1.0	<	1.0
N-Methyl-heptadecafluorooctane sulphonamide	<	1.0	<	1.0	<	1.0
N-Ethyl-heptadecafluorooctane sulphonamide	<	1.0	<	1.0	<	1.0
N-Me perfluorooctanesulfonamid oethanol	<	1.0	<	1.0	<	1.0
N-Et perfluorooctanesulfonamid oethanol	<	50	<	50	<	50
N-Methylperfluorooctane sulphonamidoacetic acid	<	0.4	<	0.4	<	0.4
N-Ethyl-perfluorooctane sulphonamidoacetic acid	<	0.4	<	0.4	<	0.4

5.2 Dioxin Quality Control

During sample analysis, the laboratory uses $^{13}C_{12}$ labelled dioxin, furan and PCB surrogates to test sample recovery efficiency and possible sample matrix interference.

During this analysis, the laboratory surrogate recovery for all dioxin, furan and PCB congeners was within acceptable ranges.

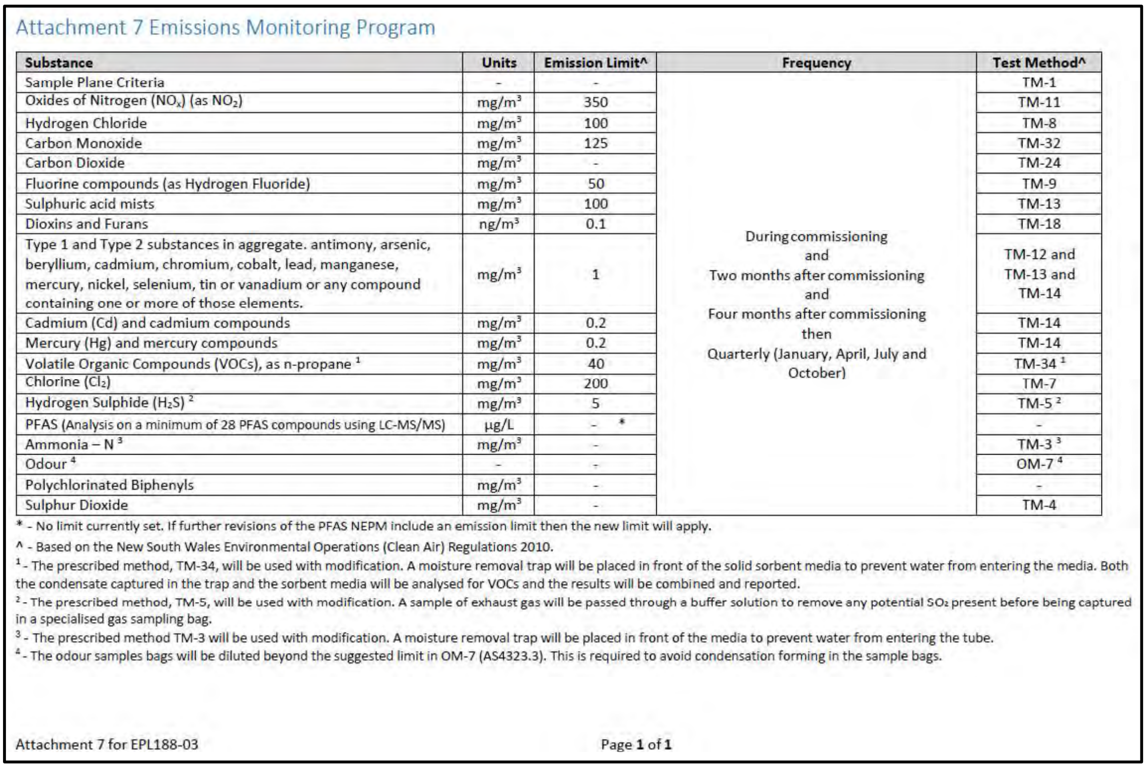
6 GLOSSARY OF TERMS

The following terms and abbreviations may be used in this report:

Table 41: Definitions

Symbol	Definition
<	The analytes tested for was not detected; the value stated is the reportable limit of detection
Am^3	Gas volume in cubic metres at measured conditions
AS	Australian Standard
BH	Back half of sample train (filter holder and impingers) (referred to during sample recovery)
^{o}C	Degrees Celsius
CARB	California Air Resources Board methods
dscm	dry standard cubic meters
FH	Front half of sample train (probe and filter holder) (referred to during sample recovery)
g	Grams
Heavy metals	Sum of Antimony, Arsenic, Beryllium, Cadmium, Chromium, Cobalt, Lead, Manganese, Nickle, Selenium, Tin, Vanadium & Mercury. Also known as Type 1 and Type 2 hazardous substances. Total heavy metals refers only to those metals found in the sample and does not include limit of detection values.
kg	Kilograms
Lower range	The sum of a list of a particular group of compounds, where only those individual congeners/compounds that are detectable in the sample have been included in the total. Results below the limit of detection have not been included. Unless otherwise indicated, the lower range is reported for dioxins & furans, PCBs, heavy metals and PFAS analysis suites.
m	Metres
m^3	actual gas volume in cubic metres as measured
mbar	Millibars
mg	Milligrams (10^{-3} grams)
min	Minute
ml	Millilitres
mmH$_2$O	Millimetres of water
Mole	SI unit that measures the amount of substance
N/A	Not applicable
ng	Nanograms (10^{-9} grams)
Nm^3	Gas volume in dry cubic metres at standard temperature and pressure (0°C and 101.3 kPa)
NMI	National Measurement Institute
NM VOC	Non methane volatile organic compound
NR	Not required on this occasion
ou	Odour unit
ppb	Parts per billion
ppm	Parts per million
sec	Second
Sm^3	Gas volume in dry cubic metres at standard temperature and pressure (0°C and 101.3 kPa) and corrected to a standardised value (e.g. 15% O$_2$)
STP	Standard temperature and pressure (0°C and 101.3 kPa) & dry
USEPA	United States Environmental Protection Authority

7 APPENDIX



Attachment 7 Emissions Monitoring Program

Substance	Units	Emission Limit^	Frequency	Test Method^
Sample Plane Criteria	-	-	During commissioning and Two months after commissioning and Four months after commissioning then Quarterly (January, April, July and October)	TM-1
Oxides of Nitrogen (NO_x) (as NO_2)	mg/m^3	350		TM-11
Hydrogen Chloride	mg/m^3	100		TM-8
Carbon Monoxide	mg/m^3	125		TM-32
Carbon Dioxide	mg/m^3	-		TM-24
Fluorine compounds (as Hydrogen Fluoride)	mg/m^3	50		TM-9
Sulphuric acid mists	mg/m^3	100		TM-13
Dioxins and Furans	ng/m^3	0.1		TM-18
Type 1 and Type 2 substances in aggregate. antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, manganese, mercury, nickel, selenium, tin or vanadium or any compound containing one or more of those elements.	mg/m^3	1		TM-12 and TM-13 and TM-14
Cadmium (Cd) and cadmium compounds	mg/m^3	0.2		TM-14
Mercury (Hg) and mercury compounds	mg/m^3	0.2		TM-14
Volatile Organic Compounds (VOCs), as n-propane [1]	mg/m^3	40		TM-34 [1]
Chlorine (Cl_2)	mg/m^3	200		TM-7
Hydrogen Sulphide (H_2S) [2]	mg/m^3	5		TM-5 [2]
PFAS (Analysis on a minimum of 28 PFAS compounds using LC-MS/MS)	µg/L	- *		-
Ammonia – N [3]	mg/m^3	-		TM-3 [3]
Odour [4]	-	-		OM-7 [4]
Polychlorinated Biphenyls	mg/m^3	-		-
Sulphur Dioxide	mg/m^3	-		TM-4

* - No limit currently set. If further revisions of the PFAS NEPM include an emission limit then the new limit will apply.

^ - Based on the New South Wales Environmental Operations (Clean Air) Regulations 2010.

[1] - The prescribed method, TM-34, will be used with modification. A moisture removal trap will be placed in front of the solid sorbent media to prevent water from entering the media. Both the condensate captured in the trap and the sorbent media will be analysed for VOCs and the results will be combined and reported.

[2] - The prescribed method, TM-5, will be used with modification. A sample of exhaust gas will be passed through a buffer solution to remove any potential SO_2 present before being captured in a specialised gas sampling bag.

[3] - The prescribed method TM-3 will be used with modification. A moisture removal trap will be placed in front of the media to prevent water from entering the tube.

[4] - The odour samples bags will be diluted beyond the suggested limit in OM-7 (AS4323.3). This is required to avoid condensation forming in the sample bags.

Attachment 7 for EPL188-03 Page **1** of **1**

Figure 4: Excerpt from EPL188-03 – Attachment 7

Appendix B Sampling Frequencies

Attachment 3 – Surface Water Monitoring Program and Trigger Values

Sample Locations			**Sample Locations**								
Site Code			SW12	SW13	SW14	GW Sump	SWStg1&2	SWStg5	GWILP	GWI5	GWI6
Easting (m E)			709035	709065	709287	709102	709724	709003	709771	708952	709811
Northing (m S)			8630495	8630504	8630536	8629880	8629982	8630206	8630733	8630107	8629975
Parameter	**Units**	**Trigger Value**	**Frequency**								
Field Measurement											
Flow	kL/day	-	-	-	-	-	M[3]	M[3]	C[4]	C[4]	C[4]
Water Level	measure	-	M	M	M	M[5]	-	-	-	-	-
pH	pH units	6 – 8.5[1]	M	M	M	M[5]	M[5]	M[5]	Q	Q	Q
Electrical Conductivity (EC)	µS/cm	-	M	M	M	M[5]	M[5]	M[5]	Q	Q	Q
Dissolved Oxygen (DO)	% saturation	80 – 100[1]	M	M	M	M[5]	M[5]	M[5]	Q	Q	Q
Temperature	ºC	-	M	M	M	M[5]	M[5]	M[5]	Q	Q	Q
Turbidity	NTU	-	M	M	M	M[5]	M[5]	M[5]	Q	Q	Q
Metals/Metalloids (filtered (0.45µm) and unfiltered)											
Boron (B)	µg/L	-	M[5]	M[5]	M[5]	M[5]	M[5]	M[5]	Q	Q	Q
Cadmium (Cd)		1.4[2]	A[5]	A[5]	A[5]	A[5]	A[5]	A[5]	A	A	A
Chromium (Cr)[7]		20[6]	M[5]	M[5]	M[5]	M[5]	M[5]	M[5]	Q	Q	Q
Cobalt (Co)		14[2]	A[5]	A[5]	A[5]	A[5]	A[5]	A[5]	A	A	A
Copper (Cu)		3[2]	M[5]	M[5]	M[5]	M[5]	M[5]	M[5]	Q	Q	Q
Lead (Pb)		6.6[2]	M[5]	M[5]	M[5]	M[5]	M[5]	M[5]	Q	Q	Q
Nickel (Ni)		200[2]	M[5]	M[5]	M[5]	M[5]	M[5]	M[5]	Q	Q	Q
Zinc (Zn)		23[2]	M[5]	M[5]	M[5]	M[5]	M[5]	M[5]	Q	Q	Q
Other											
Total Organic Carbon (TOC)	mg/L	-	M[5]	M[5]	M[5]	M[5]	M[5]	M[5]	Q	Q	Q
Chemical Oxygen Demand (COD)		-	M[5]	M[5]	M[5]	M[5]	M[5]	M[5]	Q	Q	Q
Total Suspended Solids (TSS)		10[1]	M[5]	M[5]	M[5]	M[5]	M[5]	M[5]	Q	Q	Q
Total Dissolved Solids (TDS)		-	M[5]	M[5]	M[5]	M[5]	M[5]	M[5]	Q	Q	Q
Major Ions											
Carbonate (CO_3)	mg/L	-	M[5]	M[5]	M[5]	M[5]	M[5]	M[5]	Q	Q	Q
Bicarbonate (HCO_3)		-	M[5]	M[5]	M[5]	M[5]	M[5]	M[5]	Q	Q	Q
Calcium (Ca)		-	M[5]	M[5]	M[5]	M[5]	M[5]	M[5]	Q	Q	Q
Magnesium (Mg)		-	M[5]	M[5]	M[5]	M[5]	M[5]	M[5]	Q	Q	Q
Potassium (K)		-	M[5]	M[5]	M[5]	M[5]	M[5]	M[5]	Q	Q	Q

Sodium (Na)		-	M^5	M^5	M^5	M^5	M^5	M^5	Q	Q	Q
Chloride (Cl)		-	M^5	M^5	M^5	M^5	M^5	M^5	Q	Q	Q
Sulphate (SO_4)		-	M^5	M^5	M^5	M^5	M^5	M^5	Q	Q	Q
Nutrients											
Ammonia (NH_3 as N)	µg/L	20^1	M^5	M^5	M^5	M^5	M^5	M^5	Q	Q	Q
Nitrate (NO_3)		-	M^5	M^5	M^5	M^5	M^5	M^5	Q	Q	Q
Nitrite (NO_2)		-	M^5	M^5	M^5	M^5	M^5	M^5	Q	Q	Q
Oxides of Nitrogen (NO_x)		20^1	M^5	M^5	M^5	M^5	M^5	M^5	Q	Q	Q
Total Nitrogen (TN)		300^1	M^5	M^5	M^5	M^5	M^5	M^5	Q	Q	Q
Total Phosphorous (TP)		30^1	M^5	M^5	M^5	M^5	M^5	M^5	Q	Q	Q
Filterable reactive phosphorous (FRP)		10^1	M^5	M^5	M^5	M^5	M^5	M^5	Q	Q	Q
Hydrocarbons											
Total Recoverable Hydrocarbons (TRH)	µg/L	-	A^5	A^5	A^5	A^5	A^5	A^5	A	A	A
Benzene		900^2	A^5	A^5	A^5	A^5	A^5	A^5	A	A	A
Toluene		-	A^5	A^5	A^5	A^5	A^5	A^5	A	A	A
Ethylbenzene		-	A^5	A^5	A^5	A^5	A^5	A^5	A	A	A
Xylene		-	A^5	A^5	A^5	A^5	A^5	A^5	A	A	A
Naphthalene		90^2	A^5	A^5	A^5	A^5	A^5	A^5	A	A	A
PFAS (per-and poly-fluoroalkyl substances) (Analysis on a minimum of 28 PFAS compounds using LC-MS/MS)											
PFOS	µg/L	2^8	A^5	A^5	A^5	A^5	A^5	A^5	A	A	A
PFOA		632^8	A^5	A^5	A^5	A^5	A^5	A^5	A	A	A
C – Continuous **M** – Monthly **Q** – Quarterly (January, April, July, October) **A** – Annually (January)	[1] **–** Based on Darwin Harbour Water Objectives (Shoal Bay upper area marine ambient water quality) [2] **–** Based on 90% species protection for marine waters ANZECC Water Quality Guidelines 2018 (ANZG 2018) [6] **–** Based on Hexavalent chromium 90% species protection ANZECC Water Quality Guidelines 2018 (ANZG 2018) [3] **–** Estimate the flow at the time of sampling [4] **–** Using a flow meter [5] **–** Only during months October to April [7] **–** Analyse for Trivalent and Hexavalent Chromium if total chromium exceeds trigger value [8] **–** Based on PFAS NEMP 2.0 however, trigger values for the latest NEMP must be used when available										

Attachment 4 - Groundwater Monitoring Program

Parameter	**Units**	**Frequency** **(all monitoring bores identified in Appendix 5)**
Field Measurement		
Flow	kL/day	M[1]
Standing Water Level (SWL)	m AHD	M
pH	pH units	Q
Electrical Conductivity (EC)	µS/cm	Q
Dissolved Oxygen (DO)	% saturation	Q
Temperature	ºC	Q
Reduction Oxidation Potential (REDOX)	mV	Q
Metals/Metalloids (filtered (0.45µm))		
Arsenic (As)	µg/L	A
Boron (B)		Q
Cadmium (Cd)		A
Chromium (Cr)		Q
Cobalt (Co)		A
Copper (Cu)		Q
Lead (Pb)		Q
Lithium (Li)		A
Nickel (Ni)		Q
Vanadium (V)		A
Zinc (Zn)		Q
Major Ions		
Carbonate (CO_3)	mg/L	Q
Bicarbonate (HCO_3)		Q
Calcium (Ca)		Q
Magnesium (Mg)		Q
Potassium (K)		Q
Sodium (Na)		Q
Chloride (Cl)		Q
Sulphate (SO_4)		Q
Nutrients		
Ammonia (NH_3 as N)	µg/L	Q
Ammonium (NH_4)		Q
Nitrate (NO_3)		Q
Nitrite (NO_2)		Q
Oxides of Nitrogen (NO_x)		Q
Total Nitrogen (TN)		Q
Total Phosphorous (TP)		Q
Hydrocarbons		
Total Recoverable Hydrocarbons (TRH)	µg/L	A
Benzene		A
Toluene		A
Ethylbenzene		A
Xylene		A
Naphthalene		A
PFAS (per-and poly-fluoroalkyl substances) (Analysis on a minimum of 28 PFAS compounds using LC-MS/MS)		
PFOS	µg/L	Q
PFOA		Q
Other		
Chemical Oxygen Demand (COD)	mg/L	Q
Total Organic Carbon (TOC)		Q
Total Dissolved Solids (TDS)		Q
Organophosphate Pesticides	µg/L	A

Organochlorine Pesticides		A
Polychlorinated Biphenyls		A
Tributyltin Oxide		A
Phenols		A
Escherichia Coli	CFU 100mL	A
Enterococci		A

M – Monthly
Q – Quarterly (January, April, July, October)
A – Annually (January)
[1] – If the water level is above top of casing when measuring SWLs then estimate the flow.

Attachment 6 - Leachate Monitoring Program

		Sample Locations									
	Site Code	LP01	LP02	DW2	DW3	DW5	DW6	DW7^1	DW8^1	TC Sump	LMP02
	Easting (m E)	709534	709531	709029	709038	709023	709041	709450	709459	709465	709938
	Northing (m S)	8630726	8630713	8630459	8630216	8630122	8630039	8630121	8630042	8630233	8629759
Parameter	**Units**	**Frequency**									
Flow	kL/day	-	-	C^2	C^2	C^2	C^2	C^2	C^2	C^2	C^2
Water Level	measure	M	M	M	M	M	M	M	M	M	M
pH	pH units	Q	Q	B	B	B	B	B	B	B	B
Electrical Conductivity (EC)	µS/cm	Q	Q	B	B	B	B	B	B	B	B
Dissolved Oxygen (DO)	% saturation	Q	Q	B	B	B	B	B	B	B	B
Temperature	ºC	Q	Q	B	B	B	B	B	B	B	B
Turbidity	NTU	Q	Q	B	B	B	B	B	B	B	B
Metals/Metalloids (filtered (0.45µm) and unfiltered)											
Aluminium (Al)	µg/L	Q	Q	B	B	B	B	B	B	B	B
Arsenic (As)		Q	Q	B	B	B	B	B	B	B	B
Boron (B)		Q	Q	B	B	B	B	B	B	B	B
Cadmium (Cd)		Q	Q	B	B	B	B	B	B	B	B
Chromium (Cr)		Q	Q	B	B	B	B	B	B	B	B
Cobalt (Co)		Q	Q	B	B	B	B	B	B	B	B
Copper (Cu)		Q	Q	B	B	B	B	B	B	B	B
Iron (Fe)		Q	Q	B	B	B	B	B	B	B	B
Lead (Pb)		Q	Q	B	B	B	B	B	B	B	B
Lithium (Li)		Q	Q	B	B	B	B	B	B	B	B
Manganese (Mn)		Q	Q	B	B	B	B	B	B	B	B
Mercury (Hg)		Q	Q	B	B	B	B	B	B	B	B
Nickel (Ni)		Q	Q	B	B	B	B	B	B	B	B
Selenium (Se)		Q	Q	B	B	B	B	B	B	B	B
Vanadium (V)		Q	Q	B	B	B	B	B	B	B	B
Zinc (Zn)		Q	Q	B	B	B	B	B	B	B	B
Major Ions											
Carbonate (CO_3)	mg/L	Q	Q	B	B	B	B	B	B	B	B
Bicarbonate (HCO_3)		Q	Q	B	B	B	B	B	B	B	B
Calcium (Ca)		Q	Q	B	B	B	B	B	B	B	B
Magnesium (Mg)		Q	Q	B	B	B	B	B	B	B	B
Potassium (K)		Q	Q	B	B	B	B	B	B	B	B

Sodium (Na)		Q	Q	B	B	B	B	B	B	B	B
Chloride (Cl)		Q	Q	B	B	B	B	B	B	B	B
Sulphate (SO_4)		Q	Q	B	B	B	B	B	B	B	B
Nutrients											
Ammonia (NH_3)	µg/L	Q	Q	B	B	B	B	B	B	B	B
Ammonium (NH_4)		Q	Q	B	B	B	B	B	B	B	B
Nitrate (NO_3)		Q	Q	B	B	B	B	B	B	B	B
Nitrite (NO_2)		Q	Q	B	B	B	B	B	B	B	B
Oxides of Nitrogen (NOx)		Q	Q	B	B	B	B	B	B	B	B
Total Nitrogen (TN)		Q	Q	B	B	B	B	B	B	B	B
Total Phosphorous (TP)		Q	Q	B	B	B	B	B	B	B	B
Filterable reactive phosphorous (FRP)		Q	Q	B	B	B	B	B	B	B	B
Hydrocarbons											
Total Recoverable Hydrocarbons (TRH)	µg/L	Q	Q	B	B	B	B	B	B	B	B
Polycyclic Aromatic Hydrocarbons (PAHs)		Q	Q	B	B	B	B	B	B	B	B
Benzene		Q	Q	B	B	B	B	B	B	B	B
Toluene		Q	Q	B	B	B	B	B	B	B	B
Ethylbenzene		Q	Q	B	B	B	B	B	B	B	B
Xylene		Q	Q	B	B	B	B	B	B	B	B
Naphthalene		Q	Q	B	B	B	B	B	B	B	B
PFAS (per-and poly-fluoro alkyl substances) (Analysis on a minimum of 28 PFAS compounds using LC-MS/MS)											
PFOS	µg/L	Q	Q	B	B	B	B	B	B	B	B
PFOA		Q	Q	B	B	B	B	B	B	B	B
Other											
Organophosphate Pesticides	µg/L	A	A	-	-	-	-	-	-	-	-
Organochlorine Pesticides		A	A	-	-	-	-	-	-	-	-
Polychlorinated Biphenyls		A	A	-	-	-	-	-	-	-	-
Tributyltin Oxide		A	A	-	-	-	-	-	-	-	-
Phenols		A	A	-	-	-	-	-	-	-	-
Chemical Oxygen Demand (COD)	mg/L	Q	Q	B	B	B	B	B	B	B	B
Total Suspended Solids (TSS)		Q	Q	B	B	B	B	B	B	B	B
Total Organic Carbon (TOC)		Q	Q	B	B	B	B	B	B	B	B
Total Dissolved Solids (TDS)		Q	Q	B	B	B	B	B	B	B	B
Escherichia Coli	CFU 100ml	A	A	-	-	-	-	-	-	-	-
Enterococci		A	A	-	-	-	-	-	-	-	-

C – Continuous
M – Monthly

Q – Quarterly (January, April, July, October)
B – Biannually (January, July)
A – Annually (July)

[1] - Sampling points for Stage 6 leachate collection only active once Stage 6 begins to accept waste
[2] – Using a flow meter

Attachment 7 Emissions Monitoring Program

Substance	Units	Emission Limit^	Frequency	Test Method^
Sample Plane Criteria	-	-	During commissioning and Two months after commissioning and Four months after commissioning then Quarterly (January, April, July and October)	TM-1
Oxides of Nitrogen (NO_x) (as NO_2)	mg/m^3	350		TM-11
Hydrogen Chloride	mg/m^3	100		TM-8
Carbon Monoxide	mg/m^3	125		TM-32
Carbon Dioxide	mg/m^3	-		TM-24
Fluorine compounds (as Hydrogen Fluoride)	mg/m^3	50		TM-9
Sulphuric acid mists	mg/m^3	100		TM-13
Dioxins and Furans	ng/m^3	0.1		TM-18
Type 1 and Type 2 substances in aggregate. antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, manganese, mercury, nickel, selenium, tin or vanadium or any compound containing one or more of those elements.	mg/m^3	1		TM-12 and TM-13 and TM-14
Cadmium (Cd) and cadmium compounds	mg/m^3	0.2		TM-14
Mercury (Hg) and mercury compounds	mg/m^3	0.2		TM-14
Volatile Organic Compounds (VOCs), as n-propane [1]	mg/m^3	40		TM-34 [1]
Chlorine (Cl_2)	mg/m^3	200		TM-7
Hydrogen Sulphide (H_2S) [2]	mg/m^3	5		TM-5 [2]
PFAS (Analysis on a minimum of 28 PFAS compounds using LC-MS/MS)	µg/L	- *		-
Ammonia – N [3]	mg/m^3	-		TM-3 [3]
Odour [4]	-	-		OM-7 [4]
Polychlorinated Biphenyls	mg/m^3	-		-
Sulphur Dioxide	mg/m^3	-		TM-4

* - No limit currently set. If further revisions of the PFAS NEPM include an emission limit then the new limit will apply.

^ - Based on the New South Wales Environmental Operations (Clean Air) Regulations 2010.

[1] - The prescribed method, TM-34, will be used with modification. A moisture removal trap will be placed in front of the solid sorbent media to prevent water from entering the media. Both the condensate captured in the trap and the sorbent media will be analysed for VOCs and the results will be combined and reported.

[2] - The prescribed method, TM-5, will be used with modification. A sample of exhaust gas will be passed through a buffer solution to remove any potential SO_2 present before being captured in a specialised gas sampling bag.

[3] - The prescribed method TM-3 will be used with modification. A moisture removal trap will be placed in front of the media to prevent water from entering the tube.

[4] - The odour samples bags will be diluted beyond the suggested limit in OM-7 (AS4323.3). This is required to avoid condensation forming in the sample bags.

Attachment 8 - Depositional Sampling Program

		Sample Locations			
	Site Code	DS01	DS02	DS03	DS04
	Easting (m E)	709187	709580	709788	709252
	Northing (m S)	8630904	8631014	8630614	8630601
Parameter	**Units**	**Frequency**			
Metals/Metalloids					
Aluminium (Al)	µg/L	B	B	B	B
Boron (B)		B	B	B	B
Chromium (Cr)		B	B	B	B
Cobalt (Co)		B	B	B	B
Copper (Cu)		B	B	B	B
Lead (Pb)		B	B	B	B
Lithium (Li)		B	B	B	B
Mercury (Hg)		B	B	B	B
Nickel (Ni)		B	B	B	B
Zinc (Zn)		B	B	B	B
PFAS (per-and poly-fluoro alkyl substances) (Analysis on a minimum of 28 PFAS compounds using LC-MS/MS)					
PFOS	µg/L	B	B	B	B
PFOA		B	B	B	B
B – Biannually (January, July)					

Attachment 9 – Soil Sampling Program

		Sample Locations			
Site Code		SS01	SS02	SS03	SS04
Easting (m E)		709187	709580	709788	709252
Northing (m S)		8630904	8631014	8630614	8630601
Parameter	**Units**	**Frequency**			
Metals/Metalloids					
Aluminium (Al)	µg/L	B	B	B	B
Boron (B)		B	B	B	B
Chromium (Cr)		B	B	B	B
Cobalt (Co)		B	B	B	B
Copper (Cu)		B	B	B	B
Lead (Pb)		B	B	B	B
Lithium (Li)		B	B	B	B
Mercury (Hg)		B	B	B	B
Nickel (Ni)		B	B	B	B
Zinc (Zn)		B	B	B	B
PFAS (per-and poly-fluoro alkyl substances) (Analysis on a minimum of 28 PFAS compounds using LC-MS/MS)					
PFOS	µg/L	B	B	B	B
PFOA		B	B	B	B
B – Biannually (January, July)					