QUARTERLY ENVIRONMENTAL MONITORING REPORT (QEMR) MARCH 2023

DUNMORE RECYCLING & WASTE DEPOT
44 BUCKLEYS ROAD,
DUNMORE, NSW, 2529

ENVIRONMENT PROTECTION LICENCE (EPL) 5984

Prepared For: **Shellharbour City Council**
Project Number: **ENRS0033**
Date: **May 2023**

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The project was conducted through close liaison with Shellharbour City Council (SCC) and ALS Environmental.

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EXECUTIVE SUMMARY

Environment & Natural Resource Solutions (ENRS Pty Ltd) were commissioned as independent environmental consultants by *ALS Environmental* (Wollongong) on behalf of *Shellharbour City Council* (SCC) to prepare the Quarterly Environmental Monitoring Report (QEMR) for the Dunmore Recycling and Waste Depot (*herein referred to as the Site*).

This (QEMR) summarises the results of field testing and laboratory analysis conducted by ALS for the March 2023 monitoring period, and provides the necessary data assessment and analysis to meet requirements of the Site's Environment Protection Licence/s (EPL's); No.5984 and No.12903.

The Site was established in 1945 and has been managed by Shellharbour City Council (SSC) since 1983. The Site accepts putrescible and non-putrescible waste within its managed landfill cell. Recycling activities conducted at the site include Resource Recovery Centre, Revolve Centre and Food Organics and garden Organics (FOGO) processing.

In late 2020 to July 2021 Shellharbour City Council moved away from sole reliance on traditional onsite leachate management techniques through initiating a secondary leachate treatment option in which leachate was transported from site for processing at a contractor facility.

In early 2021 Shellharbour City Council constructed a new Leachate Treatment Plant (LTP) on site, which was commissioned in July/August 2021. The LTP is comprised of three primary biological treatment units, including an anoxic reactor, nitrifying reactor, and sequencing batch reactor. The treated stream meets Sydney Water requirements for discharge into Sydney Water sewer, under a trade waste agreement. On average the LTP discharges 60kL/day of treated water, equating to approximately 22ML of leachate removal from site per annum.

Waste regulation in NSW is administered by the EPA under the Protection of the Environment Operations (POEO) Act (1997); the *Waste Avoidance and Resource Recovery Act* (2001).

The Site operates under the conditions of two (2) EPLs:

- **EPL No. 5984**. Landfill activities. Consisting of; extractive activities, waste disposal and composting.
- **EPL No. 12903**. Resource recovery activities. Consisting of; composting and waste storage within the FOGO Facilities and Resource Recovery Centre.

A copy of the relevant EPL sections outlining the sampling requirements is provided in **Appendix A** (EPL No. 5984). ENRS note that EPL No. 12903 does not specify sample points.

The objectives of this AEMR are to:

- Meet the environmental monitoring requirements of Sites EPLs; No. 5984 and 12903;
- Assess and analyse the environmental monitoring data for the Site against NSW EPA endorsed criteria;
- Identify trends of the environmental monitoring data over the reporting period;
- Identify any on-site or off-site impacts associated with operation of the Site;

- Advise SCC if the current environmental monitoring program is providing adequate information to identify potential environmental impacts from existing operations (if any) and provide recommendations on improvement to the monitoring program if required; and
- Document monitoring results in an Annual Environmental Monitoring Report.

The scope of work for this QEMR comprised the collation, assessment and reporting of Site data made available to ENRS from the March 2023 monitoring period in regard to the following tasks:

- Review previous reports and document the hydrogeological setting;
- Tabulate results of all monitoring data for both water and dust samples, collected and provided by *ALS* as required by the EPLs for the respective reporting period.
- Analysis and interpretation of all monitoring data (water, dust and landfill surface gas);
- Review all quarterly environmental monitoring reports from the 2021-2023 reporting period and available data from the last three (3) years;
- Identification of any deficiencies in environmental performance identified by the monitoring data, trends or environmental incidents, and identification of remedial actions taken or proposed to be taken to address these deficiencies; and
- Recommendations on improving the environmental performance of the facility including improvement to the monitoring program.

Based on the findings obtained during the March 2023 monitoring program the following conclusions and recommendations are provided:

- Shallow groundwater flow is expected to mimic topography with low hydraulic gradients flowing towards the south and southeast towards Rocklow creek. The nearest sensitive receptors are likely to include; recreational users of the Minnamurra River estuary environs; down gradient stakeholders; and downgradient alluvial aquifers, swamps, Rocklow Creek, Minnamurra River and Groundwater Dependent Ecosystems near discharge zones;
- Groundwater throughout the monitoring period reported exceedances of the assessment criteria for; ammonia, heavy metals, nitrate, sulphate and salinity (EC) within all groundwater bores. This was considered to be consistent with historical values;
- A single exceedance in the surface water of Rocklow Creek was reported for ammonia above the ecological stressor values of 0.2mg/L;
- On five (5) out of eight (8) occasions, flare operating temperatures were below operating threshold target of 760 degrees during the monitoring period. Operations taken by the operator to address the root causes of the low Flare Stack temperatures are outlined in the monthly LGI reports attached as **Appendix G**;
- Surface gas methane monitoring reported satisfactory results all within the adopted assessment criteria;
- Gas accumulation monitoring reported satisfactory results for all enclosures tested within 250m of emplaced waste or leachate storage facility;

- Dust deposition gauges recorded satisfactory results below the guidelines provided in AS3580.10.1. Monitoring should continue in accordance with EPL 5984 requirements;
- Based on this review of the March 2023 monitoring period, contaminants associated with the landfill cell, leachate dam/s and general site uses are considered to be relatively consistent with the range of historical results;
- Should any change in Site conditions or incident occur which causes a potential environmental impact, a suitable environmental professional should be engaged to further assess the Site and consider requirements for any additional monitoring; and

This report must be read in conjunction with the attached Statement of Limitations.

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1.0 INTRODUCTION

Environment & Natural Resource Solutions (ENRS Pty Ltd) were commissioned as independent environmental consultants by *ALS Environmental* (Wollongong) on behalf of *Shellharbour City Council* (SCC) to prepare the Quarterly Environmental Monitoring Report (QEMR) for the Dunmore Recycling and Waste Depot (*herein referred to as the Site*).

This (QEMR) summarises the results of field testing and laboratory analysis conducted by ALS for the March 2023 monitoring period, and provides the necessary data assessment and analysis to meet requirements of the Site's Environment Protection Licence/s (EPL's); No.5984 and No.12903.

1.1 PROJECT BACKGROUND

1.1.1 Site History

The Site was established in 1945 and has been managed by Shellharbour City Council (SSC) since 1983. The Site accepts putrescible and non-putrescible waste within its managed landfill cell. Recycling activities conducted at the site include Resource Recovery Centre, Revolve Centre and Food Organics and garden Organics (FOGO) processing.

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1.1.2 EPL Requirements

Waste regulation in NSW is administered by the EPA under the Protection of the Environment Operations (POEO) Act (1997); the *Waste Avoidance and Resource Recovery Act* (2001).

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1.2 OBJECTIVES

The objectives of this AEMR are to:

- Meet the environmental monitoring requirements of Sites EPLs; No. 5984 and 12903;
- Assess and analyse the environmental monitoring data for the Site against NSW EPA endorsed criteria;
- Identify trends of the environmental monitoring data over the reporting period;
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- Advise SCC if the current environmental monitoring program is providing adequate information to identify potential environmental impacts from existing operations (if any) and provide recommendations on improvement to the monitoring program if required; and
- Document monitoring results in an Annual Environmental Monitoring Report.

1.3 SCOPE OF WORK

The scope of work for this QEMR comprised the collation, assessment and reporting of Site data made available to ENRS from the March 2023 monitoring period in regard to the following tasks:

- Review previous reports and document the hydrogeological setting;
- Tabulate results of all monitoring data for both water and dust samples, collected and provided by *ALS* as required by the EPLs for the respective reporting period.
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- Recommendations on improving the environmental performance of the facility including improvement to the monitoring program.

2.0 SITE DESCRIPTION

2.1 LOCATION

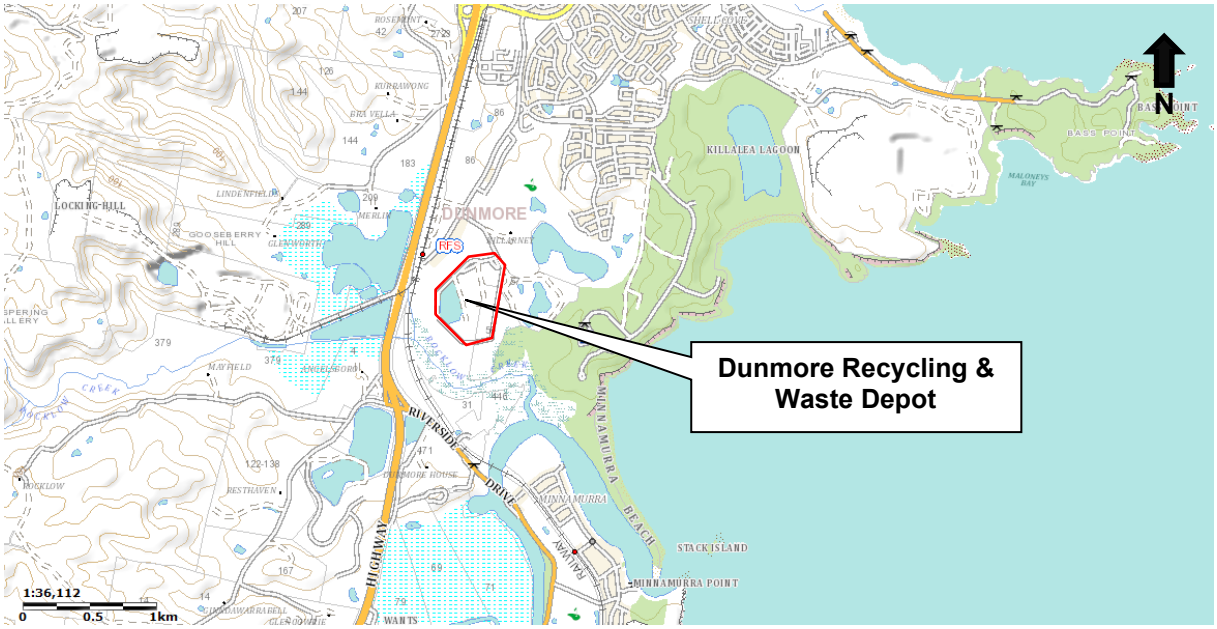
The Site is located at 44 Buckleys Road, Dunmore, NSW, 2529, legally defined as Lot 21 in Deposited Plan 653009 and Lot 1 Deposited Plan 419907. The Site is situated approximately three and a half (3.5) kilometres southwest of the Shellharbour town centre. The area's regional location is defined in **Figure 1** below. Details of the Site boundary and sampling points

are provided in the Site Plan (see **Figure 2**). The key features required to identify the Site are summarised in **Table 1**.

Table 1: Site Identification

Aspect	Description
Site	Dunmore Recycling and Waste Depot
Street Address	44 Buckleys Road, Dunmore, NSW 2529
Site Area	72.36 hectares
Title Identifier	Lot 21 DP 653009, Lot 1 DP 419907
Zoning	RU1 Primary Production
Local Government Area	Shellharbour City Council

Figure 1: Site Location Map



Source: SIX Maps (https://maps.six.nsw.gov.au/) (cited 16/01/2020)

2.2 SURROUNDING LAND USE

The current activities and operations on adjacent properties and the surrounding area include:

Table 2: Surrounding Land use

Direction	Land Use
North:	Buckleys Road, commercial infrastructure and open grassland. Residential dwellings along the northwest border of the Site. Golf course further to the northeast.

Direction	Land Use
East:	Dunmore Resources and Recycling facility immediately to the east, bushland to the southeast.
South:	Bushland, Rocklow Creek (300m from landfill activities). Further to Kiama Community Recycling Centre and Riverside Drive.
West:	Bushland to the southwest, scattered trees immediately to the west and further to the Princes Highway. Boral Quarries complex beyond the Highway. Residential dwellings to the Northwest.

2.2.1 Sensitive Receptors

The nearest sensitive receptors are likely to include:

- Recreational users of the Minnamurra River estuary environs;
- Down gradient stakeholders; and
- Down gradient alluvial aquifers, swamps, Rocklow Creek, Minnamurra River and Groundwater Dependent Ecosystems (GDE) near discharge zones.

2.3 TOPOGRAPHY & DRAINAGE

A review of the current series Albion Park (90281N) 1:25,000 topographic map sheet was conducted to assess the regional topography and to identify potential runoff and groundwater controls in the region. Topography provides a useful indicator for groundwater controls including gradient and flow path.

The Site presents low topographic relief, remaining between approximately 3-5 mAHD across the entirety of the Site. The regional topographic gradient trends south-southeast towards Rocklow Creek and Minnamurra River.

2.4 SOIL LANDSCAPE

The previous annual monitoring report (Environmental Earth Sciences 2018) reported the soil profile at the Site as organic, black, massive sandy loam topsoil overlying loose bleached light grey sand with iron staining in the subsoil.

Review of the online *Shellharbour City Council* Acid Sulphate Soil Risk Map indicates that the Site lies within a **Class 3** area, suggesting that works beyond 1 metre below the ground level (mbGL) have the potential to encounter Acid Sulphate Soils (ASS).

2.5 GEOLOGY

A review of the Site geology was undertaken with reference to the Wollongong 1:250,000 geological series sheet (Si56.9) and the Shellharbour-Kiama area coastal quaternary 1:50,000 geology sheet (See **Figure 4**). The Site is predominately underlain by the Quaternary alluvial deposits (Qal) characterised as Holocene backbarrier flat; marine sand, silt, clay, gravel and shell (Qhbf). The northern most corner of the site is intersected by the Gerringong Volcanics (Pbb) characterised by Latite. Based on the mapped geology, previous investigations and

borehole logs, the Site infrastructure including the landfill cell is located within the alluvial deposits.

2.6 HYDROGEOLOGY

Groundwater resources in the area are expected to be associated with *Shallow unconfined* alluvial and unconsolidated systems, generally less than 20 m in depth with moderate to high transmissivity, variable water quality, and strongly controlled by rainfall recharge.

2.6.1 Existing Bores

A network of groundwater monitoring bores is installed at the Site to provide specific data on the quality and nature of groundwater. Given the spatial distribution of the bores and disturbed ground condition expected within the land fill cell, groundwater contours could not be accurately mapped.

A review of the *NSW Office of Water* (*NOW*) existing bore records was conducted to develop the conceptual understanding of regional groundwater conditions, including aquifer depths, yields, water quality, and distribution. A search of the Bureau of Meteorology Australian Groundwater Explorer groundwater database identified a total of eighty-eight (88) registered bores within one and a half (1.5) kilometres of the Site (see **Figure 5**). Registered bores in the area are predominantly associated with the Landfill Site and with the quarry complex (*Boral Site*) to the west of the EPL Site. The majority of bores are registered for monitoring purposes, excluding a single well (GW044447), which is registered for stock and domestic purposes. The stock bore is located approximately one (1) kilometre to the north of the Site, on the western side of the Princes Highway, which is considered to be up gradient of the Site and not in direct hydraulic connectivity. Registered bore depths are between 1.25 m and 22 m. Bore records indicate shallow unconsolidated aquifer systems.

2.6.2 Flow Regime

Previous reports (*Environmental Earth Sciences,* 2018) have identified that groundwater flows vary across the Site, but the general trend is south, towards Rocklow Creek.

Based on the unconfined nature of the aquifers, the shallow groundwater flow is inferred to mimic topography with low to moderate hydraulic gradients flowing towards the south.

The Site and adjoining land, was largely unsealed with potential for local recharge from rainfall infiltration. Likely discharge areas are predominantly to the south and east of the Site including swamps and Rocklow Creek. The waterbodies surrounding the Site are recognised as State Environmental Planning Policy No.14 (SEPP14) registered wetlands and Proximity Areas for Coastal Wetlands border the eastern, southern and western boundaries of the Site.

2.7 SURFACE WATER

The Site topography indicates that surface water flow will generally trend to the east towards off Site wetlands and southeast towards Rocklow Creek. These present the primary regional drainage structures for natural surface water and runoff. A series of stormwater infrastructure is present at the Site which is expected to capture run off. Infrastructure includes but not limited

to; stormwater drains; sedimentation ponds; levee banks; collection and diversion drains; and leachate dams.

3.0 ASSESSMENT CRITERIA

3.1 CONTAMINANTS OF POTENTIAL CONCERN

This section of the report provides a summary of the Contaminants of Potential Concern (CoPC) associated with the Site. CoPC's are identified in the Sites EPL/s which document the CoPC and water quality indicators required to be monitored. Analytical requirements for all water sampling are provided in **Appendix A**.

3.2 WATER QUALITY GUIDELINES

Nationally developed guidelines are provided in the National Water Quality Management Strategy (NWQMS): Guidelines for Groundwater Protection in Australia (ARMCANZ & ANZECC 1995). For the purpose of this assessment, the relevant criteria selected to protect environmental values are summarised in **Table 3** below:

Table 3: Groundwater Assessment Criteria

Environmental Value	Relevant Guideline
Ecosystems / Health Screening Levels	ANZG (2018) (Australian and New Zealand Guidelines for Fresh and Marine Water Quality).
	National Environment Protection Measure (NEPM) (2013).
Drinking Water	Australian Drinking Water Guidelines (ADWG) (2018)

3.2.1 ANZG Guidelines

The relevant criteria for this water quality assessment are the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG;2018). The ANZG (2018) provide Default Guideline Values (DGVs) for four (4) levels of protection categorised by the percentage of species possibly affected, being 80%, 90%, 95% or 99% of species. Values for a level of protection for 95% of species in a marine environment have been adopted and are displayed in **Table 4**. Where DVGs are not available reference is made against the ANZECC (2000) Trigger Values (TVs). The *NSW Office of Water* (DECCW;2007) endorsed groundwater management guidelines recommend assessment for aquatic ecosystems based on the ***95 per cent of species level of protection***.

Table 4: Adopted Guideline Criteria

Parameter	Groundwater Guideline	Surface water Guideline
Ammonia	0.9 mg/L (pH 8)	0.9 mg/L (pH 8)
Nitrate	10.6 mg/L	10.6 mg/L
pH	6.5-8.5 pH units	6.5-8.5 pH units

Parameter	Groundwater Guideline	Surface water Guideline
Soluble Iron	0.3 mg/L	0.3 mg/L
Manganese	1.9 mg/L	1.9 mg/L
Electrical Conductivity	125-2200 µS/cm	125-2200 µS/cm

Table 3.3.2 of the ANZECC (2000) also provides stressor values for physical and chemical stressors for south-east Australia for slightly disturbed ecosystems. The table provides a stressor guideline for ammonia of 0.2mg/L at pH 8 for lowland rivers. For the purposes of this assessment, the value has been applied.

Additional pH dependant trigger values for total ammonia were also adopted when water was outside of 8 pH units in accordance with Table 8.3.7 of the ANZECC (2000). Criteria and results are presented in **Table 10** attached.

3.2.2 National Environmental Protection Measure (NEPM)

The NSW EPA has endorsed the use of the Groundwater Investigation Levels (GILs) given in the 2013 ASC NEPM 'Schedule B(1) Guideline on the Investigation Levels for Soil and Groundwater'. The latest NEPM provide a framework for risk-based assessment of groundwater contamination.

Groundwater Health Screening Levels (HSLs) are provided for four (4) land use categories for vapour intrusion (Table 1A[4]) associated with Total Recoverable Hydrocarbons TRH (F1 & F2) and BTEX compounds.

NEPM	Description of Land use Categories
HIL A	Residential A with garden/accessible soil also includes children's day care centres, preschools and primary schools.
HIL B	Residential B with minimal opportunities for soil access; includes buildings with fully and permanently paved yard space such as high-rise buildings and apartments.
HIL C	Recreational C includes public open space such as parks, playgrounds, playing fields (e.g. ovals), secondary schools and unpaved footpaths.
HIL D	Commercial/industrial D includes premises such as shops, offices, factories and industrial sites.
GILs	Groundwater Investigation Levels (GILs) should be applied based on the receiving environment and groundwater resources. GILs are provided in NEPM Table 1C for; Fresh Waters; Marine Waters; and Drinking Water;
EILs	Ecological Investigation Levels (EILs) for common contaminants in the top two (2) metres of soil based on three (3) generic land use settings: • Areas of ecological significance; • Urban residential areas and public open space; and • Commercial and industrial land uses.

3.3 DUST DEPOSITION ASSESSMENT CRITERIA

Criteria for collection and assessment of dust deposition concentrations are provided within the Australian standard AS3580.10.1 - Methods for sampling and analysis of ambient air;

method 10.1- Determination of particulate matter - Deposited matter - Gravimetric method. AS3580.10.1 provides an acceptable level of 4 g/m^2/month.

3.4 SURFACE METHANE GAS ASSESSMENT CRITERIA

The NSW EPA Solid Waste Landfill Guidelines 2nd Edition (2016) provides sampling methodologies and threshold for surface methane gas concentrations at landfill sites. The acceptable threshold for capped landfills is 500 parts per million (ppm) at 5 cm above the capping surface.

3.5 GAS ACCUMULATION MONITORING IN ENCLOSED STRUCTURES

The NSW EPA Solid Waste Landfill Guidelines 2nd Edition (2016) provides sampling methodologies and threshold gas levels to ensure that gas is not accumulating within enclosed structures on or withing 250m of deposited waste or leachate storage. The acceptable threshold for 1% (volume/volume).

4.0 SAMPLING METHODOLOGY

Field sampling was conducted by *ALS Environmental* (Wollongong) as commissioned by *SCC* on quarterly basis. ENRS understands that sampling was conducted in accordance with ALS sampling protocols with reference to current industry standards and Code of Practices. The following sub-sections provide a summary of the sampling methodologies.

Monitoring frequency is defined by the EPL's and is designed to capture necessary site data to support assessment of Site conditions (quarterly and annual), any long-term trends or overflow events. Monitoring is conducted quarterly and annually for selected analytes with additional overflow and event-based sampling triggered by Site conditions.

4.1 WATER SAMPLING

4.1.1 Location of Water Monitoring Points

Groundwater and surface water monitoring requirements are defined by the EPL No. 5984, as provided in Appendix A. The water sampling regime includes; five (5) surface waters, one (1) located onsite and four (4) located off-site; twelve (12) groundwater monitoring wells surrounding the landfill operations; and one (1) leachate point. Sampling locations are illustrated in **Figure 2** attached.

4.1.2 Depth to Water

Prior to sampling, the depth to the groundwater table was measured from the top of casing (TOC) using a water dipper and clear disposable bailer. The bores were inspected for the presence of hydrocarbon and the thickness of any LNAPL was measured visually in clear disposable bailers. ***No LNAPL was identified in monitoring Wells***.

4.1.3 Sample Collection

Sampling is conducted independently by *ALS Environmental* under contract with *SCC*. Chain of Custody records and field sheets are provided in Appendix D**.** ENRS understand sampling was conducted in accordance with *ALS* sampling protocols.

4.1.4 Groundwater Sampling

Groundwater wells were sampled in order of distance from any areas of known contamination to ensure that lower contaminated wells are sampled before likely higher contaminated wells. Groundwater bores were purged prior to sampling by removing at least three (3) well volumes with samples being collected using clear disposal bailers or low flow parameter stabilisation methods applied with field sheets provided to document pumping volumes and field parameters. Post sampling all samples were sealed in laboratory-prepared sampling containers appropriate for the analysis.

Surface water samples were collected as 'grab samples' from the midpoint of the source at mid-depth.

Post flushing, leachate samples were sampled from a tap on the discharge line directly into purpose specific, pre preserved sample containers.

All samples were stored on ice immediately after their collection and transported to the laboratory under Chain of Custody (CoC) documentation.

Any loss of volatile compounds was kept to a minimum by employing the following sampling techniques:

- Minimal practical disturbance during sampling;
- Samples placed in sample containers as soon as possible;
- Sample containers contain zero headspace;
- Samples placed directly on ice and transported to the laboratory as soon as possible; and
- Employing the most appropriate analytical method to minimise volatile losses at the laboratory.

4.1.5 Field Testing

Field testing was conducted during bore purging and sampling to record physical water parameters. A multi-probe water quality meter was used to measure the following parameters:

- Oxygen Reduction Potential (ORP, representing redox).
- Electrical Conductivity (Salinity - EC);
- Temperature; and
- pH (Acidity).

4.2 DUST DEPOSITION SAMPLING

Measurement of dust deposition was carried out in accordance with the Australian Standard AS3580.10.1 (2016). This Australian Standard provides a mean of determining the mean surface concentration of deposited matter from the atmosphere.

Dust collection gauges were set up for a one (1) month period between the dates; ***1st February*** and ***1st March 2023***. A total of four (4) dust monitoring locations were considered adequate to assess site conditions.

4.3 SURFACE METHANE GAS MONITORING

The concentration of methane gas (in units of ppm) at the Site was carried out in accordance with EPA Guidelines Solid Waste Landfill 2nd Edition 2016. On the day of sampling the wind speed was below 10 km/hr. Testing was conducted using a calibrated *LaserOne* portable gas monitor specifically designed for landfill gas monitoring. A calibration Certificate is provided in **Appendix F.**

One field technician commenced data collection along transect lines in a grid pattern across the landfill surface at 25-metre spacings. A site plan depicting the sampled transect line is provide in **Figure 3**. Transects were recorded using a Magellan *SporTrak* GPS. The concentration of methane gas was measured at a height of 5 cm above the ground in areas with intermediate or final cover over the emplaced waste.

4.4 GAS ACCUMULATION MONITORING IN ENCLOSED STRUCTURES

The concentration of methane gas (in units of percent volume/volume) inside all enclosed structures within 250m of emplaced waste or leachate storage facility at the Site was carried out in accordance with EPA Guidelines Solid Waste Landfill 2nd Edition 2016. On the day of sampling testing was conducted using a calibrated *LaserOne* portable gas monitor specifically designed for landfill gas monitoring. A calibration Certificate is provided in **Appendix F.**

The internal methane concentrations for each enclosed structure were recorded by a field technician. A site plan depicting the location onsite of each structure provided in **Figure 3**. Any depressions or surface fissures away from the sampling grid were also investigated.

4.5 LABORATORY ANALYSIS

ALS, a NATA accredited laboratory, was contracted by *SCC* to undertake the sample analysis in accordance with current standards. Laboratory QA/QC results are detailed in the Laboratory reports contained in the appendices section of this report.

4.6 FLARE MONITORING

Landfill gases (LFG) are formed through bacterial action on emplaced waste and are a normal by-product of Landfilling operations. Landfill gas is a mixture of many different gases, typically its major components include methane and carbon dioxide. Smaller concentrations of

nitrogen, oxygen, ammonia, sulphides, hydrogen, carbon monoxide, and nonmethane organic compounds (NMOCs) and Volatile Organic Compounds (VOC's) may also be present.

When operated efficiently the use of a gas flare to burn landfill gas can significantly reduce emissions of methane, NMOCs and VOC's.

The flare was monitored, maintained and operated by *LGI LTD.* Copies of LFG reports for the relevant reporting period are included as **Appendix G**.

5.0 QUALITY ASSURANCE AND QUALITY CONTROL (QA/QC)

5.1 DATA QUALITY OBJECTIVES

Data Quality Objectives (DQO) are required to define the quality and quantity of data needed to support management decisions. The process for establishing DQO's is documented by Australian Standard: AS 4482.1-2005 and referenced by the National Environment Protection (Assessment of Site Contamination) Measure (NEPC;2013). The DQO's for the investigation were to obtain representative data to allow assessment of:

- groundwater quality;
- The risks posed to human health and the environment, including potential future users of the Site; and
- The requirements for any further investigative works.

The assessment was conducted to a standard consistent with generally accepted and current professional consulting practice for such an investigation. The evaluation criteria adopted for the investigation are summarised in **Table 5**.

Table 5: Data Quality Objectives

DQO	Evaluation Criteria
Documentation completeness	Completion of field records, chain of custody documentation, laboratory test certificates from NATA-accredited laboratories.
Data comparability	Use of appropriate techniques for the sampling, storage and transportation of samples. Use of NATA accredited laboratory using NEPM endorsed procedures.
Data representativeness	Adequate sampling coverage of all areas of environmental concern at the Site, and selection of representative samples.
Precision and accuracy for sampling and analysis	Use properly trained and qualified field personnel and achieve field and laboratory QA/ QC criteria.

5.2 QA/QC PROCEDURES

It should be noted that whilst the EPL does not require field duplicates, ENRS recommend sampling include rinseate samples and field duplicates at the standard rate of 1 in 10, or field QA/QC is conducted in accordance with *ALS* procedures.

The majority of the QA/QC data provided for this report by SC was prepared by *ALS* and is included in the attached ALS QC and QCI reports. *ALS* is NATA accredited for field sampling and laboratory testing.

Relative Percent Difference (RPD) analysis of all duplicate and triplicate samples(s) results was performed by ENRS and is included in the report as **Table 10**, **Table 11** and **Table 12**. Results were generally reported within the acceptance criteria documented in Table 4 of AS4482.1-2005, the RPD for inorganics was set at <30% and for organics set at <50%.

Since all QA/QC results complied with the required standards, or showed variations that would have no significant effect on the quality of the data or the conclusions of this environmental assessment. Therefore, the data was considered acceptable for use in this assessment.

5.3 EPL NON-COMPLIANCE

Based on the information provided to ENRS, no non-compliances were noted during the March 2023 quarterly monitoring period.

6.0 WATER QUALITY RESULTS

Laboratory results for groundwater and surface water were provided to ENRS for tabulation and comparison with relevant EPL assessment criteria. A summary of results is provided in **Table 9** with comparison against the relevant Site Assessment Criteria (SAC). The laboratory certificates of analysis are provided in Appendix B.

6.1 OVERFLOW RESULTS

Overflow samples were taken from SWP-1 on one (1) occasion during Q2 monitoring period. Summary results are included in **Table 6** and are consistent with EPA guidelines.

Where available, a full summary of results is provided in **Table 9** with comparison against the relevant Site Assessment Criteria (SAC). Laboratory certificates of analysis are provided in Appendix B and are discussed in detail within the relevant sections of this report.

Table 6: Summary Table of Overflow Events

Sample Date	pH	TSS	Ambient Temperature	Rainfall (mm) Previous 24Hrs
13/03/2023	7.9	17	24.7	38.2

6.2 FIELD TESTING

Field testing was conducted by ALS during sampling to record physical water parameters. A water quality meter is used to measure the following parameters in the field:

- Electrical Conductivity (Salinity);
- pH (Acidity) and

- Dissolved Oxygen (surface waters only).

6.3 PHYSICAL INDICATORS

6.3.1 Depth

Groundwater

Depth of ground water to top of casing (TOC) ranged between **0.53 mbgl** (BH-15, 02/03/2023) to **4.62 mbgl** (BH-14, 02/03/2023). Across the Site groundwater levels were generally consistently with historical data sets.

6.3.2 Temperature

Groundwater

Temperature of groundwater in the March 2023 monitoring period ranged between **18.3 degrees Celsius** (BH-4, 02/03/2023) and **24.8 degrees Celsius** (BH-1C, 02/03/2023).

Results are consistent with historical data.

Surface Waters

Surface water temperature at SWP-1 was **21.9 degrees Celsius** (01/03/2023).Results are consistent with historical data.

Leachate

Leachate Temperature at the leachate Tank (LP-1) was **24.8 degrees Celsius** (01/03/2023).

Results are consistent with historical data.

6.3.3 Salinity (EC & TDS)

Salinity is reported by the laboratory as either Electrical Conductivity (EC) or Total Dissolved Solids (TDS). The ANZECC guidelines document a conversion ratio of 0.68 mg/L = 0.68 EC (µS/cm). Table 3.3.3 of the ANZECC (2000) guidelines document default TV for EC in lowland freshwater rivers between **125 µS/cm** and **2,200 µS/cm** (~1,500 mg/L).

Groundwater

During the March 2023 monitoring period, salinity ranged between; **601 µS/cm** (BH-18, 02/03/2023) and **7,960 µS/cm** (BH-1C, 02/03/2023). Four (4) monitoring points reported salinity values in excess of freshwater SAC of **2,200 µS/cm**, **7,960 µS/cm** (BH-1c), **3,960 µS/cm** (BH-9), **2,570 µS/cm** (BH-15), **2,500 µS/cm** (BH-21).

EC readings generally consistent with historical data.

Surface Waters

Electrical Conductivity results for onsite surface water (SWP-1, 01/03/2023) was **1,210 µS/cm** which corresponds to a calculated Total Dissolved Solids result of **810 mg/L (Calculated Value)**. These results were below the TV.

Electrical conductivity for offsite surface waters ranged between **23,300 µS/cm** (SWC-DOWN_2, 01/03/2023) to **27,500 µS/cm** (SWC-2, 01/03/2023).

Total Dissolved Solids (calculated) results for offsite surface waters located along Rocklow Creek ranged between **15,611 mg/L** (SWC-DOWN_2, 01/03/2023) to **18,425 mg/L** (SWC- 2, 01/03/2023).

Results are consistent with historical data and typical of a tidal creek.

Leachate

Salinity in leachate is expected to vary significantly with leachate concentration and stormwater dilution. Leachate salinity for March 2023 monitoring was **9,620 µS/cm** (LP1, 01/03/2023) which was above the TV. Results are consistent with previous data.

6.3.4 Dissolved Oxygen

Levels of Dissolved Oxygen (DO) were measured in the field during sampling. DO reflects the equilibrium between oxygen-consuming processes and oxygen-releasing processes. DO can initiate redox reactions resulting in the uptake or release of nutrients. Low DO concentrations can result in adverse effects on many aquatic organisms which depend on oxygen for their efficient metabolism. At reduced DO concentrations many compounds become increasingly toxic, for example Zinc, Lead, Copper, phenols, cyanide, hydrogen sulphide and Ammonia.

The ANZECC (2000) guidelines Table 3.3.2 outlines a range between 85% to 110% saturation for low land rivers. Assuming a water temperature of 18°C this is equivalent to approximately 7-11 mg/L or ppm.

Surface Waters

Dissolved Oxygen at SWP-1 was **8.63 mg/L** (01/03/2023). SWP-1 was not discharging at the time of sampling and are consistent with previous data.

Dissolved Oxygen for the offsite surface waters at Rocklow Creek ranged from **4.16 mg/L** (SWC- 2, 01/03/2023) to **5.26 mg/L** (SWC-DOWN_2, 01/03/2023). Results are generally consistent with a tidal creek passing through a mangrove swamp.

Leachate

Dissolved oxygen at LP1 (Leachate Tank) was **5.66 mg/L** (01/03/2023). Results were consistent with previous data.

6.3.5 pH

pH is a measure of hydrogen activity. pH determines the balance between positive hydrogen ions (H+) and negative hydroxyl ions (OH-) and provides a test of water acidity (low pH) or alkalinity (high pH). Most natural freshwaters have a pH in the range 6.5 to 8.0. Changes in pH may affect the physiological functioning of biota and affect the toxicity of contaminants. Both increases and decreases in pH can result in adverse effects, although decreases are likely to cause more significant problems. Low pH indicates acidic conditions which may increase the mobility of heavy metals, whilst high pH indicates alkaline conditions which may also generate Ammonia. Previous investigations of other regional Landfill Sites in the Illawarra-Shoalhaven (Forbes Rigby;1996) report regionally acidic groundwater with low readings in the range of 4.3 pH associated with silica saturation and oxidation of accessory marcasites grains (iron sulphide).

Groundwater

Groundwater pH was reported between **pH 6.8** (BH-12r, BH-15 and BH-18, 02/03/2023) and **pH 7.5** (BH-19r 02/03/2023). All groundwater results were reported within the ANZECC recommended range of pH 6.5-8.0 and are generally consistent with historical data.

Surface Water

The pH of the onsite surface water for the March 2023 monitoring period was reported at **pH 7.5** (SWP-1, 01/03/2023).

The pH of the offsite surface waters for the March 2023 monitoring period ranged between **pH 7.1**, (SWC_UP, 01/03/2023) and **pH 7.3**, (SWC_2 and SWC_Down_2, 01/02023) for sample locations associated with Rocklow Creek.

All surface water were reported within the ANZECC recommended range of pH 6.5-8.5 and are consistent with historical data.

Leachate

Leachate pH was as reported as **pH 9.4** (LP-1, 01/03/2023). Results were reported above the ANZECC recommended range of pH 6.5-8.5. Leachate pH has generally been trending upward since September 2021.

6.3.6 Total Suspended Solids (TSS)

TSS provides a measure of turbidity reported as the mass of fine inorganic particles suspended in the water. Measurement of TSS provides a valuable indication of the sediment and potential nutrient load. Elevated TSS decreases light penetration whilst phosphorus is absorbed onto sediment surfaces.

TSS was reported for surface water only.

Concentrations for onsite surface waters during the March 2023 monitoring period were reported as **99 mg/L** (SWP_1, 01/03/2023). Although the result is in breach of the EPA guideline of 50mg/L it should be noted that the sample point was not discharging at the time of sampling.

Concentrations for offsite surface waters during the March 2023 monitoring period were reported between **<5 mg/L** (for all sites, 01/03/2023).

With the exception of SWP-1, which was not discharging at the time of sampling, all TSS results were below the **50mg/L** TV and are generally consistent with historical results.

6.4 INORGANIC ANALYTES

Nutrients

Water samples were analysed for select nutrients including Ammonia, Ammonium, Nitrate and Nitrite. The most bio-available forms of Nitrogen are Ammonium (NH4+) and Nitrate (NO3-). Ammonia is an oxygen-consuming compound and is toxic to aquatic biota at elevated concentrations. Ammonia toxicity increases under low oxygen levels and higher pH.

6.4.1 Ammonia

A separate summary table for ammonia with a comparison against pH modified 95% trigger value is provided within **Table 10** attached.

Groundwater

Ammonia was measured within groundwater monitoring bores between **1.02 mg/L** (BH18, and **285 mg/L** (BH-1c). All groundwater wells exceeded the site assessment criteria for the March 2023 monitoring period. Results are generally consistent with historical values.

Surface Water

Ammonia in onsite surface water samples was reported as **0.03 mg/L** (SWP-1, 01/03/2023). The result for SWP-1 was below the adopted site assessment criteria.

Ammonia in offsite surface water samples associated with Rocklow Creek ranged from **0.07 mg/L** (SWC_UP, 01/03/2023) to **0.25 mg/L** (SWC_DOWN, 01/03/2023). All results were below the blanket ammonia TV of 0.91mg/L and pH modified TV's. However, the ammonia result for SWC_DOWN was above the ecological stressor value of 0.2 mg/L.

Leachate

Ammonia in leachate was reported between **432mg/L** (LP1, 01/03/2023). Although high ammonia concentrations are expected in untreated leachate ammonia concentrations continue to trend down since the implementation of the new Leachate Treatment Plant and the subsequent disposal of treated leachate to sewer which commenced in July/August 2021.

6.4.2 Nitrate

Groundwater

Results for Nitrate in groundwater were reported between **<0.01 mg/L** in multiple bores and **9.68 mg/L** (BH-21, 02/03/2023). Although results generally continue to trend downward a total of two (2) groundwater wells reported exceedances above the TV of 0.7mg/L in the March 2023 monitoring period, including **3.2mg/L** (BH-3, 02/03/2023) and **9.68mg/L** (BH-14, 02/03/2023). It should be noted that the result for BH-14 is an unexpected outlier since the previous four (4) results were al **<0.001mg/L.**

Surface Water

The nitrate concentration of the onsite surface water SWP-1 in the March 2023 monitoring period was **<0.01 mg/L** (SWP-1; 01/03/2023).

Nitrate concentration for Rocklow Creek surface water samples in the March 2023 monitoring period ranged between **<0.01 mg/L** (SWC-2, SWC-DOWN, SWC-DOWN_2, 01/03/2023) and **0.02 mg/L** (SWC_UP; 01/03/2023).

All sites returned results below the 95% TV of **0.7mg/L** during the March 2023 monitoring period.

Leachate

The March 2023 Nitrate result of **<0.1mg/L** are typical of historical data and indicate that the higher results noted in both the September and March 2023 monitoring periods were likely due to matrix effects only as advised by the relevant ALS Laboratory report.

6.4.3 Nitrite

Groundwater

Results for Nitrate in groundwater were reported between **<0.01 mg/L** in multiple bores and **0.32 mg/L** (BH-21, 02/03/2023). Results generally continue to trend downward. No exceedances to the TV of 0.7mg/L in the March 2023 monitoring period.

Surface Water

During the March 2023 monitoring period surface water SWP-1 was reported as **<0.01 mg/L**. Results are generally consistent with previous data and below the accepted TV.

Leachate

The March 2023 result of **2.16 mg/L** appears to confirm that Leachate nitrite levels have been increasing since September 2022.

Anions

6.4.4 Chloride

Groundwater

Results for Chloride in groundwater were reported between **29 mg/L** in (BH-19r, 02/03/2023) and **1,060 mg/L** (BH-1c, 02/03/2023). The results are consistent with historical data.

Surface Water

During the March 2023 monitoring period chloride results for surface water SWP-1 was **147 mg/L** (01/03/2023). The results are below the accepted TV and are generally consistent with historical data.

Leachate

Chloride at the Leachate Tank (LP-1) was **1,460 mg/L** (01/03/2023). Results are generally consistent with previous data.

6.4.5 Fluoride

Groundwater

Results for Fluoride in groundwater were reported between **<0.1 mg/L** (BH-4, 02/03/2023) and **0.6 mg/L** (BH-14, 02/03/2023). Results are consistent with historical data.

Surface Water

During the March 2023 monitoring period the fluoride result for Onsite surface water was **0.3 mg/L** (SWP-1, 2/12/2022). Results are generally consistent with historical data.

Offsite surface water results ranged from of **0.7 mg/L** (SWC_UP and SWC_DOWN_2, 01/03/2023) and **0.8 mg/L** (SWC_DOWN, SWC_DOWN_2, 2/12/2022). Results are generally consistent with historical data.

Leachate

The fluoride result at the Leachate tank (LP-1) was **0.2 mg/L** (01/03/2023). Results have been trending down since August 2018 and have stabilised at **0.2 mg/L.**

6.4.6 Sulphate

Groundwater

Results for Sulphate in groundwater were reported between **10 mg/L** (BH-1C and BH-9, 02/03/2023) and **366 mg/L** (BH-15, 02/03/2023). Results are generally consistent with previous data.

Surface Water

Sulphate in onsite surface water was **53 mg/L** (SWP-1, 01/03/2023). Levels are consistent with previous data.

Sulphate in offsite surface water associated with Rocklow Creek ranged from **835 mg/L** (SWC_DOWN_2, 01/03/2023) and **1390 mg/L** (SWP_2, 01/03/2023). Sulphate levels are generally consistent with previous data.

Leachate

Sulphate level at the leachate tank (LP-1) in the March 2023 monitoring period was **20 mg/L** (01/03/20231). Results are generally consistent with historical data.

6.4.7 Total Alkalinity

Surface Water

Total Alkalinity at SWP-1 was **397 mg/L** (01/03/2023). Historical data indicates Alkalinity has been stable around a mean of **384.2 mg/L** with a variance of **167 mg/L** for the last five (5) quarters.

Leachate

Total Alkalinity in Leachate (LP-1) was **3,150 mg/L** (01/03/2023). Results are consistent with historical data.

6.4.8 Bicarbonate Alkalinity

Groundwater

Bicarbonate in groundwaters ranged from **261 mg/L** (BH-4, 02/03/2023) to **2,650 mg/L** (BH-1C, 02/03/2023). Results are generally consistent with historical data.

Metals & Metalloids

6.4.9 Manganese

Groundwater

Manganese was analysed as dissolved manganese in groundwater, total manganese in surface water and total manganese in leachate sampling points. Concentrations of dissolved manganese in groundwater for the March 2023 monitoring period were reported between **0.043 mg/L** (BH-22, 02/03/2023) and **0.663 mg/L** (BH-9, 02/03/2023). Results are generally consistent with historical data.

Surface Water

The total manganese concentration at SWP-1 was from **0.570 mg/L** (01/03/2023). Results are consistent with historical data.

Leachate

Total Manganese concentrations in leachate was reported as **0.092 mg/L** (Leachate Tank LP-1, 01/03/2023).

Manganese concentrations for all samples are below the adopted TV (1.9 mg/L 95% of Species - freshwater) and are considered acceptable.

6.4.10 Iron (Total Fe)

Iron was measured as total Iron in selected surface water samples including SWP-1 and Leachate Tank.

Surface Water

Concentrations of total iron for onsite surface water was reported as **1.45 mg/L** (SWP-1, 01/03/2023). Results are generally consistent with historical data.

Leachate

Concentration of iron at the leachate Tank (LP-1) was reported between **1.24 mg/L** (01/03/2023). Results are generally consistent with historical data.

6.4.11 Iron (Dissolved Fe)

Groundwater

Dissolved iron was measured within selected groundwater and surface water sampling points. Groundwater results were reported between **0.06 mg/L** (BH22, 02/03/2023) and **12.4 mg/L** (BH1C, 02/03/2023). Results are generally consistent with historical data.

6.4.12 Calcium

Calcium was measured within selected groundwater and surface water sampling points.

Groundwater

Groundwater results were reported between **73 mg/L** (BH-19r, 02/03/2023) and **207 mg/L** (BH12r, 02/03/2023). Calcium levels are generally consistent with historical data.

Surface Water

Calcium in onsite surface was measured at **67 mg/L** (SWP-1, 01/03/2023). The result is generally consistent with previous data.

Calcium in offsite surface waters ranged from **180 mg/L** (SWC_UP, 01/03/2023) to **201 mg/L** (SWC_2, 01/03/2023). Although the Calcium levels in Rocklow Creek have been generally trending down since December 2019, all offsite surface water samples exhibited 3-5-fold increases in calcium levels during the December 2022 and March 2023 monitoring rounds.

Leachate

Calcium concentration in Leachate (LP-1) for the March 2023 monitoring period was **37 mg/L** (01/03/2023).

Historical observations indicate that calcium levels have been generally trending down since 2017.

6.4.13 Potassium

Potassium was measured within selected groundwater and surface water sampling points.

Groundwater

Groundwater results were reported between **11 mg/L** (BH-18, 02/03/2023) and **240 mg/L** (BH1c, 02/03/2023). The potassium levels for groundwaters are generally consistent with historical data.

Surface Water

During the March 2023 monitoring period potassium levels for the offsite groundwaters ex Rocklow Creek ranged from **159 mg/L** (SWC_DOWN_2, 01/03/2023) to **194 mg/L** (SWC_2, 01/03/2023).

Potassium levels in the offsite surface waters remain consistent with the increased levels of December 2022.

6.5 ORGANIC ANALYTES

6.5.1 Total Organic Carbon

Total Organic Carbon (TOC) provides a measure of the total concentration of organic material in a water sample. TOC is typically higher in surface water than groundwater, however high TOC is also characteristic of leachate from landfill. TOC provides a marker for biological activity associated with contaminant degradation and can be used to delineate contaminant plumes. TOC influences geochemical processes by:

- acting as proton donors/acceptors;
- providing pH buffering;
- participating in mineral dissolution/precipitation reactions; and
- providing carbon substrate for microbe-based biodegradation.

TOC was reported during the March 2023 monitoring period at the following concentrations:

Groundwater

TOC levels ranged between **6 mg/L** (BH-19r; 02/03/2023) and **180 mg/L** (BH-1c; 02/03/2023). Results are consistent with historical data.

Surface Water

In the March 2023 monitoring period, the TOC levels in the onsite surface waters were determined as **24 mg/L** (SWP-1; 01/03/2023).

In the March 2023 monitoring period, the TOC levels in the offsite surface waters ranged between **<1 mg/L** (SWC-DOWN_2; 01/03/2023) and **7 mg/L** (All other offsite surface water sites). The results are generally consistent with historical data.

Leachate

For the March 2023 monitoring period TOC concentration in leachate was **373 mg/L** (LP-1 Leachate Storage Tank 01/03/2023). The results are generally consistent with previous data

7.0 DUST GAUGE RESULTS

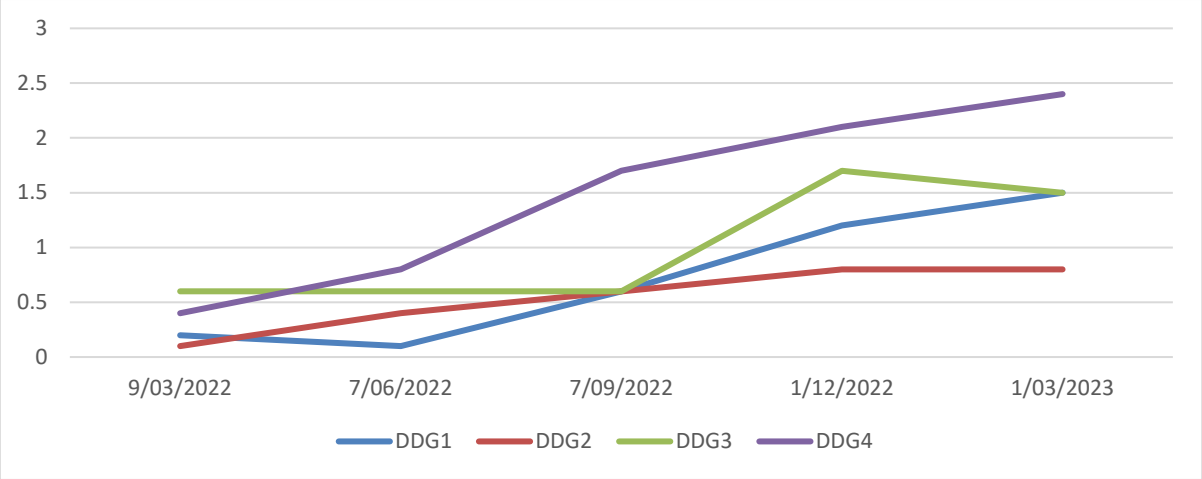
The below table provides the results of the dust depositions results. A total of four (4) dust collectors were onsite for one (1) month between **1st February 2023** and **1st March 2023**, in general accordance with AS3580.10.1. A summary of results is provided in **Table 7** below.

Table 7: Summary of Dust Gauge Results

Sample ID	Guideline Criteria (g/m²/month)	Total Insolvable Matter (g/m²/month)	Comments
DDG1	4	**1.5**	**Satisfactory**
DDG2		**0.8**	**Satisfactory**
DDG3		**1.5**	**Satisfactory**
DDG4		**2.4**	**Satisfactory**

Results for depositional dust during the March 2023 quarterly monitoring period reported levels of dust below the adopted assessment criteria of **4 g/m²/month**.

Chart 1: Monthly plot of Dust Deposition Gauge Results (g.m².month)



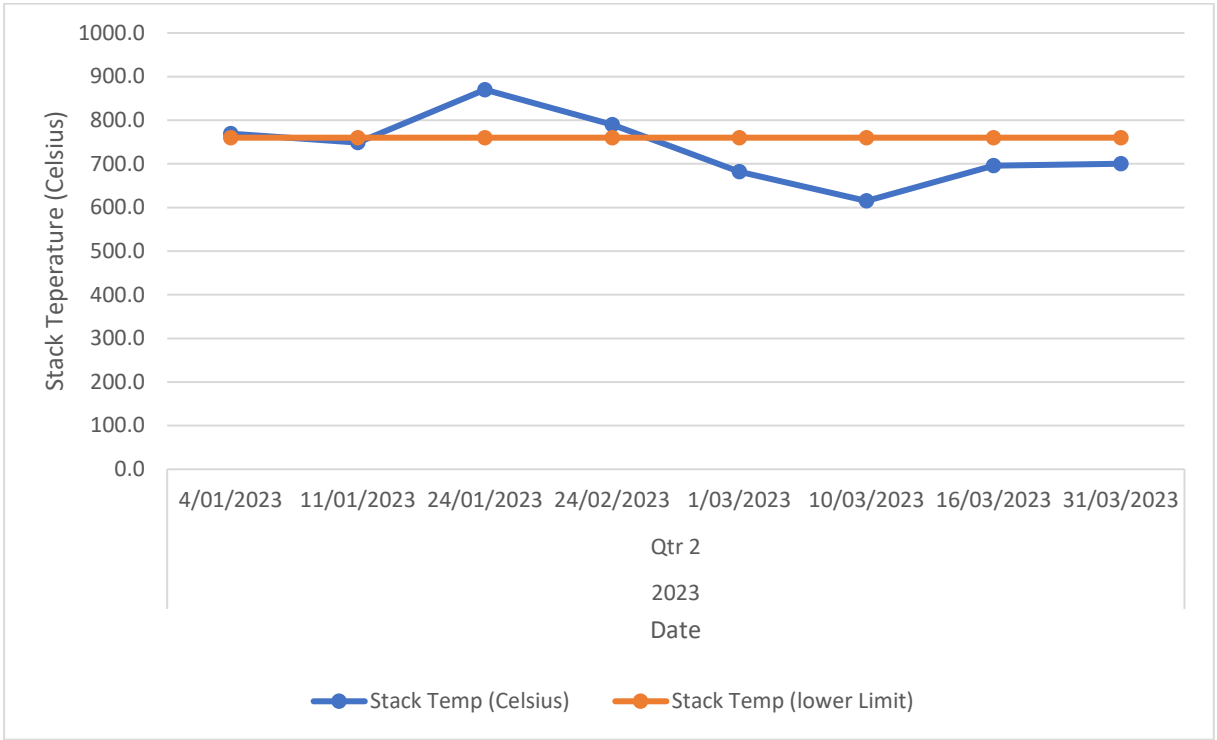
The results were considered satisfactory. Dust gauge locations are provided in **Figure 2** attached. It is recommended that monitoring is continued in accordance with EPL 5984.

Table 8: Summary of Flare Operating Temperatures

Years	Quarter	Date	Stack Temp (Celsius)	Stack Temp (lower Limit)
2023	Qtr 2	4/01/2023	769.0	760
		11/01/2023	749.0	760
		24/01/2023	870.0	760
		24/02/2023	790.0	760
		1/03/2023	682.0	760
		10/03/2023	615.0	760
		16/03/2023	696.0	760
		31/03/2023	700.0	760
2023 Q2 Total			**5871.0**	**-**

Data source: LGI (Jan-March 2023). Biogas Monthly Reports – Dunmore.

Chart 2: Weekly Flare Operating Temperatures June Quarter 2022



Data source: LGI (Jan-March 2023). Biogas Monthly Reports – Dunmore.

Weekly average operating temperatures supplied by LGI displayed typical variation associated with a continuous process. Weekly operating temperatures at the Flare fell below the Operational temperature Limit of 760 degrees on five (5) out of eight (8) occasions during the January-March 2023 monitoring period based on weekly summarise data.

The actions taken to address the root causes are outlined in the LGI Gas Flare reports included as **Appendix G**.

8.0 METHANE MONITORING

8.1 SURFACE GAS METHANE

The surface gas monitoring for the March 2023 monitoring period *DID NOT* detect any levels of methane above the EPA license limits of 500 ppm. The results were considered satisfactory. A table of results is provided in Appendix D.

8.2 GAS ACCUMULATION MONITORING IN ENCLOSED STRUCTURES

The internal methane testing for enclosed structures within 250m of the landfill during the March 2023 monitoring period *DID NOT* detect any levels of methane above the EPA license limits of 1% V/V. The results were considered satisfactory. A table of results is provided in Appendix D.

9.0 ENVIRONMENTAL ASSESSMENT

9.1 MONITORING POINT SUMMARY

Field measurements and NATA laboratory results for dust and methane results for the March 2023 monitoring period reported satisfactory results. Water results including leachate, groundwater, onsite and offsite surface water reported concentrations of analytes within the range historical values.

Data from the last four (4) years have been tabulated and presented **Charts 3-61** attached.

Groundwater and surface water within the Site boundary generally reported multiple high levels of analytes considered to be characteristic of landfill and leachate. Offsite sample locations within Rocklow Creek generally reported results consistent with previous monitoring events with a single exceedance of the stressor values for ammonia.

All dust gauges reported satisfactory results over the March 2023 monitoring period.

Results of surface methane gas monitoring recorded satisfactory results. The landfill surface cap was therefore considered intact and effective during the monitoring period.

Gas accumulation monitoring reported satisfactory results for all enclosed structures within 250m of emplaced waste or leachate storage facility.

Results for flare monitoring reported consistent temperature exceedances throughout the March 2023 monitoring period.

9.2 ENVIRONMENTAL MANAGEMENT

9.2.1 Landfill Operations

ENRS understand 'solid' waste (general solid waste putrescible and non-putrescible) landfill operations are ongoing at the Site. Landfill practices should be conducted in accordance with the Site's Landfill Environmental Management Plan (LEMP) and the EPA Solid Waste Landfill Guidelines (EPA; 2016).

9.3 ENVIRONMENTAL SAFEGUARDS

Appropriate management actions are required to continue to prevent and detect potential groundwater and surface water pollution. The nearest sensitive receptors for any uncontrolled Site water and leachate include; areas of adjoining bushland; recreational users of the Minnamurra River estuary environs, down gradient stakeholders; and down gradient alluvial aquifers, swamps, Rocklow Creek, Minnamurra River and Groundwater Dependent Ecosystems (GDE).

It is recommended that any drainage and detention structures are inspected annually by a suitably qualified environmental professional to assess their structural integrity and identify the need for any maintenance (such as removal of deep rooted vegetation, sediment, and re-lining).

Access tracks to sampling points should be inspected prior to each quaterly sampling events.

Continue to review annual surface and groundwater monitoring results from up and down gradient of the land fill cells and offsite sampling locations within Rocklow Creek. Continue to monitor surface methane gas in order to assess the cappping integrity of the landfill cells.

9.4 MONITORING PROGRAM

The water, dust and surface methane monitoring program are required to demonstrate that Site activities are not generating any off-site pollution. The Site's EPL's and monitoring regime should be reviewed annually.

Review of the March 2023 monitoring results indicate no significant change in environmental conditions at the Site during the past 3 months. Future sampling events should continue to monitor the key indicators of leachate within surface and ground waters, especially concentration of ammonia and nitrate.

Should monitoring continue to report any significant changes in analyte concentrations the need for additional monitoring locations should be reviewed, including additional groundwater monitoring bores both up and down gradient locations of areas with analytical exceedances.

It is recommended that water quality results from future monitoring rounds continue be forwarded to a suitably qualified environmental professional for review within the laboratory holding time to compare against relevant guidelines and identify any irregularities so that additional testing may be conducted within the holding time.

10.0 CONCLUSIONS

Based on the findings obtained during the March 2023 monitoring program the following conclusions and recommendations are provided:

- Shallow groundwater flow is expected to mimic topography with low hydraulic gradients flowing towards the south and southeast towards Rocklow creek. The nearest sensitive receptors are likely to include; recreational users of the Minnamurra River estuary environs; down gradient stakeholders; and downgradient alluvial aquifers, swamps, Rocklow Creek, Minnamurra River and Groundwater Dependent Ecosystems near discharge zones;
- Groundwater throughout the monitoring period reported exceedances of the assessment criteria for; ammonia, heavy metals, nitrate, sulphate and salinity (EC) within all groundwater bores. This was considered to be consistent with historical values;
- A single exceedance in the surface water of Rocklow Creek was reported for ammonia above the ecological stressor values of 0.2mg/L;
- On five (5) out of eight (8) occasions, flare operating temperatures were below operating threshold target of 760 degrees during the monitoring period. Operations taken by the operator to address the root causes of the low Flare Stack temperatures are outlined in the monthly LGI reports attached as **Appendix G**;
- Surface gas methane monitoring reported satisfactory results all within the adopted assessment criteria;
- Gas accumulation monitoring reported satisfactory results for all enclosures tested within 250m of emplaced waste or leachate storage facility;
- Dust deposition gauges recorded satisfactory results below the guidelines provided in AS3580.10.1. Monitoring should continue in accordance with EPL 5984 requirements;
- Based on this review of the March 2023 monitoring period, contaminants associated with the landfill cell, leachate dam/s and general site uses are considered to be relatively consistent with the range of historical results;
- Should any change in Site conditions or incident occur which causes a potential environmental impact, a suitable environmental professional should be engaged to further assess the Site and consider requirements for any additional monitoring; and
- This report must be read in conjunction with the attached Statement of Limitations.

11.0 LIMITATIONS

This report and the associated services performed by ENRS are in accordance with the scope of services set out in the contract between ENRS and the Client. The scope of services was defined by the requests of the Client, by the time and budgetary constraints imposed by the Client, and by the availability of access to the site.

ENRS derived the data in this report primarily from visual inspections, examination of available records, interviews with individuals with information about the site, and if requested, limited sample collection and analysis made on the dates indicated. In preparing this report, ENRS has relied upon, and presumed accurate, certain information provided by government authorities, the Client and others identified herein. The report has been prepared on the basis that while ENRS believes all the information in it is deemed reliable and accurate at the time of preparing the report, it does not warrant its accuracy or completeness and to the full extent allowed by law excludes liability in contract, tort or otherwise, for any loss or damage sustained by the Client arising from or in connection with the supply or use of the whole or any part of the information in the report through any cause whatsoever.

Limitations also apply to analytical methods used in the identification of substances (or parameters). These limitations may be due to non-homogenous material being sampled (i.e., the sample to be analysed may not be representative), low concentrations, the presence of 'masking' agents and the restrictions of the approved analytical technique. As such, non-statistically significant sampling results can only be interpreted as 'indicative' and not used for quantitative assessments.

The data, findings, observations, conclusions and recommendations in the report are based solely upon the state of the site at the time of the investigation. The passage of time, manifestation of latent conditions or impacts of future events (e.g., changes in legislation, scientific knowledge, land uses, etc) may render the report inaccurate. In those circumstances, ENRS shall not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance on, the contents of the report.

This report has been prepared on behalf of and for the exclusive use of the Client, and is subject to and issued in connection with the provisions of the agreement between ENRS and the Client. ENRS accepts no liability or responsibility whatsoever and expressly disclaims any responsibility for or in respect of any use of or reliance upon this report by any third party or parties.

It is the responsibility of the Client to accept if the Client so chooses any recommendations contained within and implement them in an appropriate, suitable and timely manner.

12.0 REFERENCES

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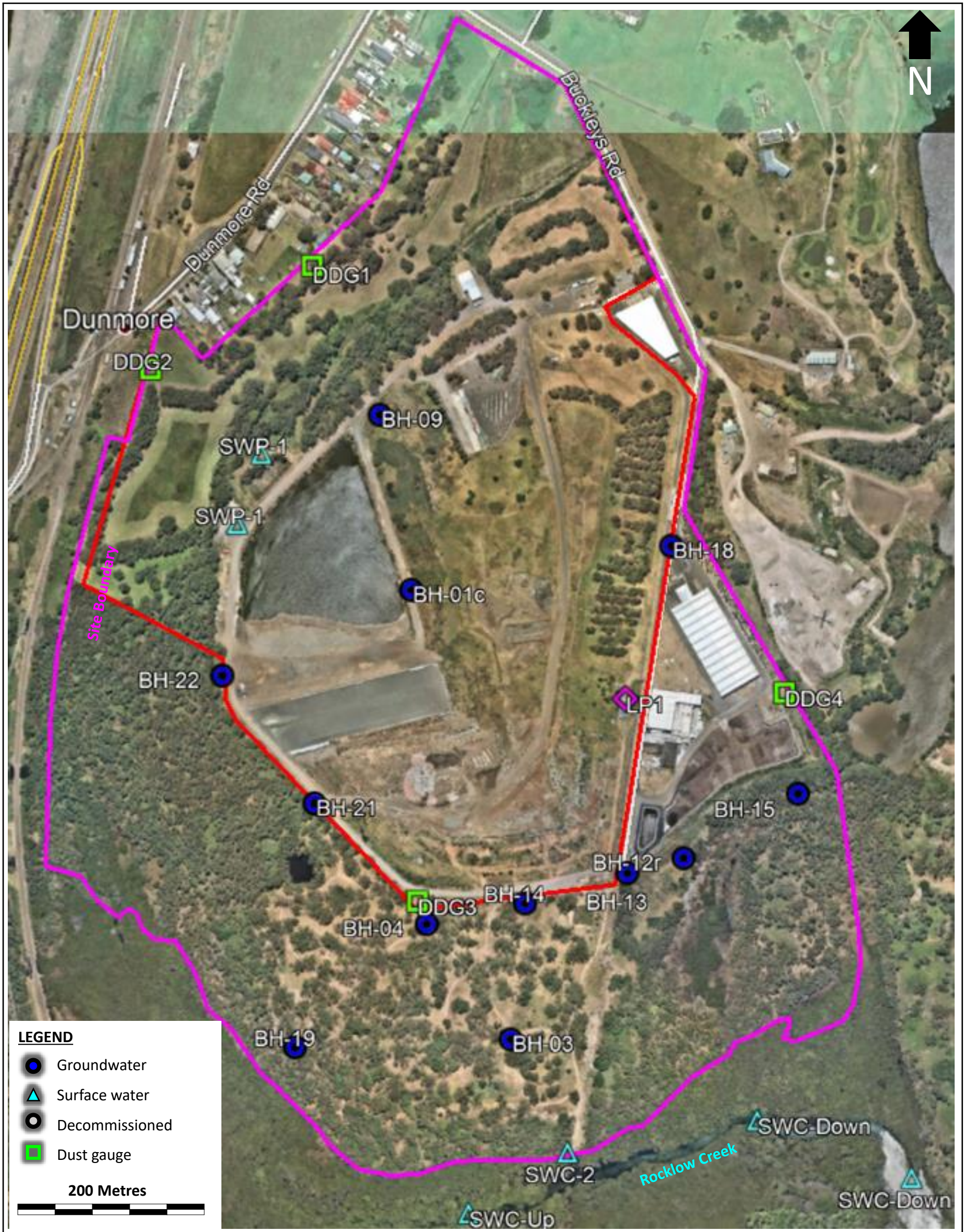
FIGURES



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Client:	**Shellharbour City Council**	Drawn:	**PL**	Figure:	**2**
Project:	**ENRS0033**	Source:	**NearMaps**	Date:	**21/05/2021**
Location:	Dunmore Recycling & Waste Depot 44 Buckleys Rd, Dunmore, NSW	Scale:	**NA**	Title:	**Site Plan**
		Status:	**Rev 2**		

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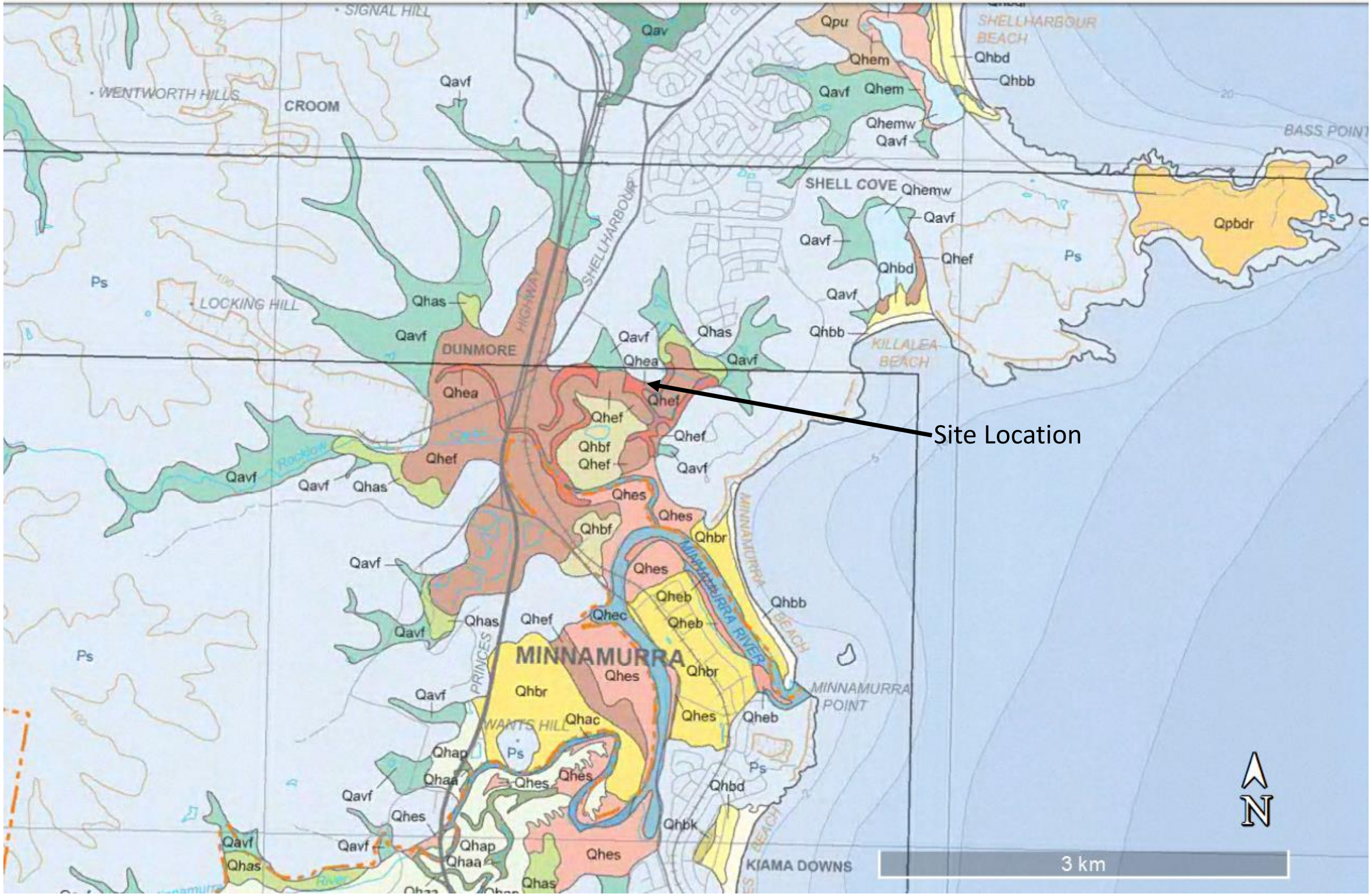
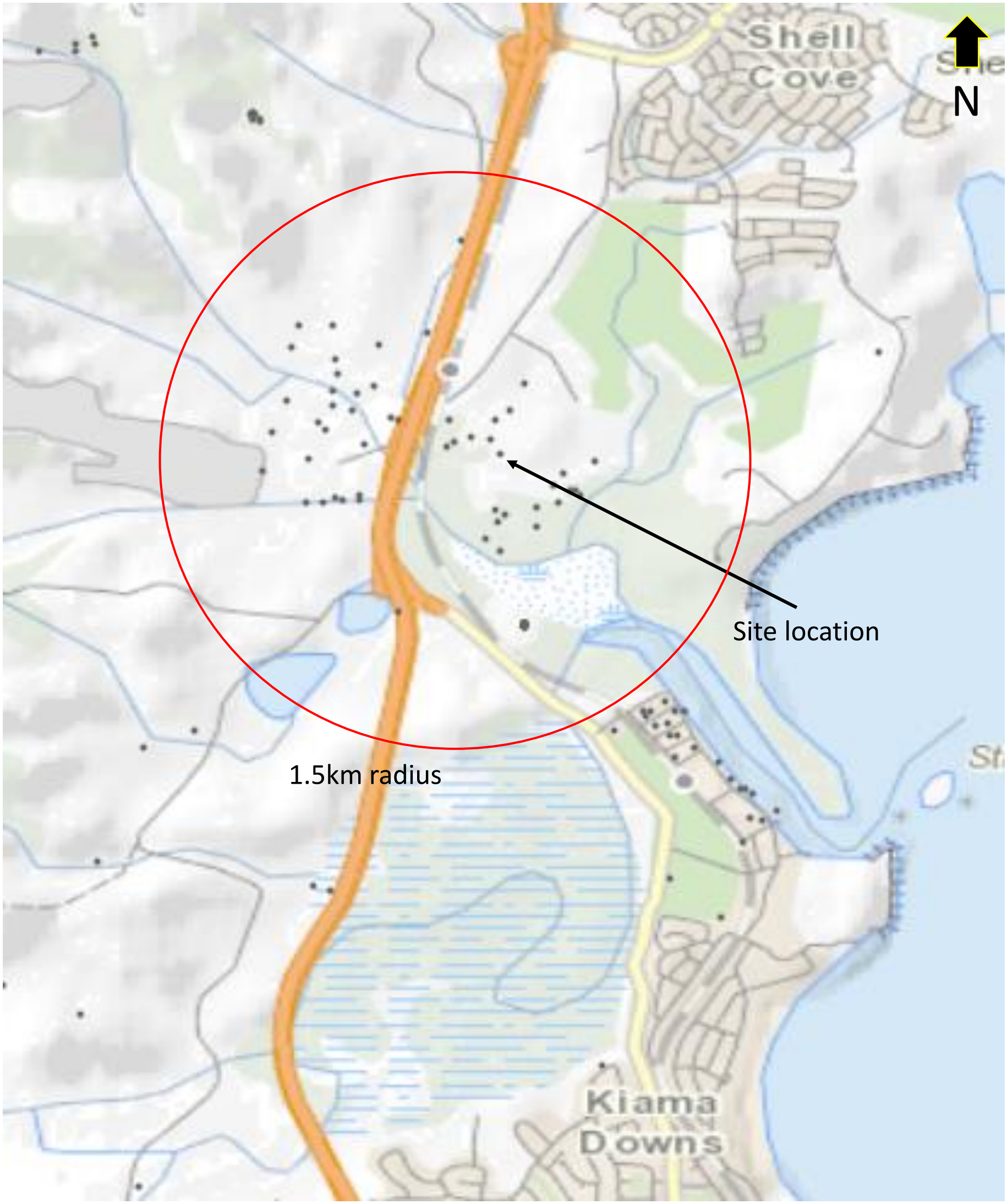
Client:	**Shellharbour City Council**	Drawn:	**PL**	Figure:	**3**
Project:	**ENRS0033**	Source:	**SixMaps**	Date:	**16/01/2020**
Location:	Dunmore Recycling & Waste Depot 44 Buckleys Rd, Dunmore, NSW, 2529	Scale:	**NA**	Title:	**Surface Gas Sample transects**
		Status:	**Rev 1**		



ENRS *Environment & Natural Resource Solutions* 108 Jerry Bailey Road, Shoalhaven Heads, NSW, 2535 Tel: 02 4448 5490 Fax: 02 90374708 projects@enrs.com.au www.enrs.com.au	Client:	**Shellharbour City Council**	Drawn:	**PL**	Figure:	**4**
	Project:	**ENRS0033**	Source:	**Geological Survey of NSW**	Date:	**16/01/2020**
	Location:	**Dunmore Recycling & Waste Depot 44 Buckleys Rd, Dunmore, NSW, 2529**	Scale:	**See figure**	Title:	**Site Geology**
			Status:	**Rev 1**		



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Client:	**Shellharbour City Council**	Drawn:	**PL**	Figure:	**5**
Project:	**ENRS0033**	Source:	**NSW Office of Water**	Date:	**16/01/2020**
Location:	Dunmore Recycling & Waste Depot 44 Buckleys Rd, Dunmore, NSW, 2529	Scale:	**NA**	Title:	**Registered Bores**
		Status:	**Rev 1**		

TABLES

TABLE 9: Total Concentration Results

Quarterly Water Monitoring Results - March 2023: Dunmore Recycling and Waste Depot

GILs -Trigger Values for Freshwater (Protection of 95% of Species) [A]					-	-	-	-	-	1.9	-	-	-	0.9 (pH 8)	-	0.7	-	-	-	-	-	-	-	-	6.5 - 8.5	2200	-	-	
GILs -Trigger Values for Marine Water (Protection of 95% of Species) [A]					-	-	-	-	-	-	-	-	-	0.91 (pH 8)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Australian Drinking Water Guidelines (2018)[C]				Health	-	-	-	-	-	0.5	-	-	1.5	-	3	50	-	-	-	-	-	-	-	-	6.5 - 8.5	-	-	-	
				Aesthetic	250	-	-	180	-	0.1	0.3	0.3	-	0.5	-	-	-	-	-	-	250	-	-	-	5	6.5 - 8.5	-	-	-	
ANZG (2018) 95% Stressor Value					-	-	-	-	-	-	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Lab Report No.	Sample No.	Sample type	EPA No.	Date Sampled	Chloride	Calcium	Magnesium	Sodium	Potassium	Manganese	Total Iron	Dissolved Iron	Fluoride	Ammonia as N	Nitrite as N	Nitrate as N	Total Organic Carbon	Bicarbonate Alkalinity as CaCO3	Total Alkalinity as CaCO3	Sulfate as SO4 - Turbidimetric	Dissolved Oxygen	Dissolved Oxygen - % Saturation	Suspended Solids (SS)	Turbidity	pH	Electrical Conductivity (Non Compensated)	Temperature	Standing Water Level	Comments
				Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	%	mg/L	NTU	pH	µS/cm	°C	mbgl	
				Laboratory PQL	1	1	1	1	1	0.001	0.05	0.05	0.1	0.01	0.01	0.01	1	1	1	1	0.01	0.1	5	0.1	0.01	1	0.1	0.01	-
EW2300850001	BH1c	Groundwater	3	2/03/2023	1,060	148			240	0.11		12.40	0.4	285	< 0.01	< 0.01	180	2,650	2,650	< 10					7.10	7,960	24.8	3.02	
EW2300850002	BH3	Groundwater	5	2/03/2023	140	134			36	0.07		0.18	0.2	11	0.14	3.20	17	318	318	143					7.30	1,230	18.5	3.10	
EW2300850003	BH4	Groundwater	6	2/03/2023	51	92			16	0.10		2.19	0.1	2	0.01	< 0.01	11	261	261	51					7.40	688	18.3	4.32	
EW2300850004	BH9	Groundwater	18	2/03/2023	382	183			88	0.66		0.81	0.4	122	< 0.01	0.02	64	1,760	1,760	< 10					7.20	3,690	18.8	3.09	
EW2300850005	BH12r	Groundwater	17	2/03/2023	174	207			28	0.55		9.67	0.2	4	< 0.01	< 0.01	20	619	619	208					6.80	1,670	19.7	4.23	
EW2300850006	BH13	Groundwater	10	2/03/2023	245	206			21	0.42		3.45	0.2	5	< 0.01	< 0.01	28	744	744	58					6.90	1,930	20.7	4.19	
EW2300850007	BH14	Groundwater	11	2/03/2023	30	96			14	0.11		0.55	0.6	1	< 0.01	< 0.01	13	359	359	73					7.00	762	20.0	4.62	
EW2300850008	BH15	Groundwater	7	2/03/2023	476	137			174	0.27		9.33	0.2	8	0.03	0.17	34	471	471	366					6.80	2,570	18.5	0.53	
EW2300850010	BH18	Groundwater	25	2/03/2023	31	80			11	0.14		2.02	0.2	1	< 0.01	< 0.01	14	272	272	< 10					6.80	601	20.8	2.10	
EW2300850009	BH19r	Groundwater	16	2/03/2023	29	73			41	0.06		0.89	0.2	2	0.02	< 0.01	6	339	339	26					7.50	638	18.3	4.52	
EW2300850011	BH21	Groundwater	23	2/03/2023	339	169			23	0.51		0.26	0.4	3	0.32	9.68	33	851	851	145					7.20	2,480	21.7	2.97	
EW2300850012	BH22	Groundwater	24	2/03/2023	240	113			39	0.04		0.06	0.4	35	< 0.01	< 0.01	29	651	651	223					7.50	2,250	18.5	2.60	
EW2300849001	SWP1	Surfacewater	1	2/03/2023	147	67	33	161	13	0.57	1.45	0.20	0.3	0.03	< 0.01	< 0.01	24	397	397	53	8.53		99	40.00	7.50	1,210	21.9		
EW2300849003	SWC_up	Surfacewater	20	2/03/2023	8,150	180	552	4,750	173	0.20	0.61	0.10	0.7	0.07	< 0.01	0.02	7	138	138	913	4.79		< 5	3.20	7.10	24,200	22.3		
EW2300849002	SWC_2	Surfacewater	19	2/03/2023	9,180	201	633	5,460	194	0.18	0.46	0.08	0.8	0.19	0.01	< 0.01	7	114	114	1,390	4.16		< 5	2.20	7.30	27,500	22.9		
EW2300849004	SWC_down	Surfacewater	21	2/03/2023	7,720	170	522	4,510	163	0.22	0.59	0.05	0.8	0.25	0.01	0.01	7	131	131	886	4.92		< 5	2.90	7.20	23,800	23.8		
EW2300849005	SWC_down_2	Surfacewater	22	2/03/2023	7,640	170	513	4,340	159	0.22	0.58	< 0.05	0.7	0.12	0.01	0.01	< 1	127	127	835	5.26		< 5	2.90	7.30	23,300	23.7		
EW2300847001	Leachate Storage Tank LP1	Leachate	2	2/03/2023	1,460	37			393	0.09	1.24		0.2	432	2.16	< 0.10	373	2,060	3,150	< 20	5.66	70.5			9.40	9,260	24.8		
EW2300849001	SWP1	Surfacewater	1	13/03/2023																			17		7.90				

TABLE 10: Ammonia Results
March 2023 Quarter: Dunmore Recycling and Waste Depot

Ammonia Results comapred against the pH Modified Trigger Values - ANZACC (2000) Table 8.3.7			pH	Assessment Criteria		Result	Comment
			pH (lab)	pH Modifed Trigger Values - 95% Freshwater	pH Modifed Trigger Values - 95% Marine Water	Ammonai As N	
		Total Concentrations - PQL	0.1	-	-	0.01	
Lab Report No.	Sample ID.	Date	pH	mg/L	mg/L	mg/L	
EW2300850001	BH1c	2/03/2023	7.1	2.26	3.56	285	> TV
EW2300850002	BH3	2/03/2023	7.3	1.88	2.84	10.6	> TV
EW2300850003	BH4	2/03/2023	7.4	1.75	2.49	2	> TV
EW2300850004	BH9	2/03/2023	7.2	1.99	3.2	122	> TV
EW2300850005	BH12r	2/03/2023	6.8	2.33	4.55	4.24	> TV
EW2300850006	BH13	2/03/2023	6.9	2.26	4.24	5.31	> TV
EW2300850007	BH14	2/03/2023	7	2.18	3.91	1.18	< TV
EW2300850008	BH15	2/03/2023	6.8	2.33	4.55	8.12	> TV
EW2300850010	BH18	2/03/2023	6.8	2.33	4.55	1.02	< TV
EW2300850009	BH19r	2/03/2023	7.5	1.61	2.15	2.28	> TV
EW2300850011	BH21	2/03/2023	7.2	1.99	3.2	2.64	> TV
EW2300850012	BH22	2/03/2023	7.5	1.61	2.15	35	> TV
EW2300849001	SWP1	2/03/2023	7.5	1.61	2.15	0.03	< TV
EW2300849003	SWC_up	2/03/2023	7.1	2.09	3.56	0.07	< TV
EW2300849002	SWC_2	2/03/2023	7.3	1.88	2.84	0.19	< TV
EW2300849004	SWC_down	2/03/2023	7.2	1.99	3.2	0.25	< TV
EW2300849005	SWC_down_2	2/03/2023	7.3	1.88	2.84	0.12	< TV
EW2300847001	Leachate Storage Tank LP1	2/03/2023	9.4	0.21*	1.7	432	> TV

* No guideline is provided for a pH of above 8.9. Therefore the TV for pH 8.9 was abdopted.

TABLE 11: Duplicate Groundwater Sample Results and QC Data

Lab Report No.				EW2300850010	EW2300850013	RPD
Sample No.				BH18	GWDuplicate	
Sample type				Groundwater	GWQC	
EPA No,				25	QC1	
Date Sampled				2/03/2023	2/03/2023	
Analyte	Units	PQL	5 x PQL	Result	Result	
Chloride	mg/L	1	5	31	32	3.17
Calcium	mg/L	1	5	80	81	1.24
Potassium	mg/L	1	5	11	11	0.00
Manganese	mg/L	0.001	0.005	0.139	0.142	2.14
Dissolved Iron	mg/L	0.05	0.25	2.02	2.02	0.00
Fluoride	mg/L	0.1	0.5	0.20	0.20	0.00
Ammonia as N	mg/L	0.01	0.05	1.02	1.10	7.55
Nitrite as N	mg/L	0.01	0.05	< 0.01	< 0.01	0.00
Nitrate as N	mg/L	0.01	0.05	< 0.01	< 0.01	0.00
Nitrite + Nitrate as N	mg/L	0.01	0.05	< 0.01	< 0.01	0.00
Total Organic Carbon	mg/L	1	5	14	14	0.00
Bicarbonate Alkalinity as CaCO3	mg/L	1	5	272	281	3.25
Total Alkalinity as CaCO3	mg/L	1	5	272	281	3.25
Sulfate as SO4 - Turbidimetric	mg/L	1	5	< 10	< 10	0.00
pH	pH	0.01	0.05	6.80	6.80	0.00
Electrical Conductivity (Non Compensated)	µS/cm	1	5	601	601	0.00
Temperature	°C	0.1	0.5	20.8	20.8	0.00
Standing Water Level	mbgl	-		2.10	2.10	0.00

TABLE 12: Duplicate Surface Water Results and QC Data

Lab Report No.				EW2300849001	EW2300849006	RPD
Sample No.				SWP1	SWDuplicate	
Sample type				Surfacewater	OffSiteSWQC	
EPA No,				1	QC2	
Date Sampled				1/03/2023	1/03/2023	
Analyte	Units	PQL	5 x PQL	Result	Result	
Chloride	mg/L	1	5	147	154	✓ 4.65
Calcium	mg/L	1	5	67	66	✓ 1.50
Potassium	mg/L	1	5	13	13	✓ 0.00
Manganese	mg/L	0.001	0.005	0.570	0.426	✓ 28.92
Total Iron	mg/L	0.05	0.25	1.45	1.33	✓ 8.63
Dissolved Iron	mg/L	0.05	0.25	0.20	0.19	✓ 5.13
Fluoride	mg/L	0.1	0.5	0.3	0.3	✓ 0.00
Ammonia as N	mg/L	0.01	0.05	0.03	0.01	✗ 100.00
Nitrite as N	mg/L	0.01	0.05	< 0.01	< 0.01	✓ 0.00
Nitrate as N	mg/L	0.01	0.05	< 0.01	0.01	✓ 0.00
Nitrite + Nitrate as N	mg/L	0.01	0.05	< 0.01	0.01	✓ 0.00
Total Organic Carbon	mg/L	1	5	24	16	✗ 40.00
Bicarbonate Alkalinity as CaCO3	mg/L	1	5	397	435	✓ 9.13
Total Alkalinity as CaCO3	mg/L	1	5	397	435	✓ 9.13
Sulfate as SO4 - Turbidimetric	mg/L	1	5	53	54	✓ 1.87
Dissolved Oxygen	mg/L	0.01	0.05	8.53	8.51	✓ 0.23
pH	pH	0.01	0.05	7.50	7.70	✓ 2.63
Electrical Conductivity (Non Compensated)	µS/cm	1	5	1,210	1,210	✓ 0.00
Temperature	°C	0.1	0.5	21.9	21.9	✓ 0.00

CHARTS

APPENDICES

Appendix A

EPL 5984 Sampling Point Summary (NSW EPA, 10/02/2022)

2	Leachate monitoring	Leachate tank labelled LP1 on the drawing titled "Shellharbour City Council - Dunmore, NSW - Site Layout - Figure no. 1" dated July 2019 (EPA Ref. no. DOC19/1027702).
3	Groundwater monitoring	BH1c - as shown on the drawing titled "Shellharbour City Council - Dunmore, NSW - Site Layout - Figure no. 1" dated July 2019 (EPA Ref. no. DOC19/1027702).
5	Groundwater monitoring	BH3 - as shown on the drawing titled "Shellharbour City Council - Dunmore, NSW - Site Layout - Figure no. 1" dated July 2019 (EPA Ref. no. DOC19/1027702).
6	Groundwater monitoring	BH4 - as shown on the drawing titled "Shellharbour City Council - Dunmore, NSW - Site Layout - Figure no. 1" dated July 2019 (EPA Ref. no. DOC19/1027702).
7	Groundwater monitoring	BH15 - as shown on the drawing titled "Shellharbour City Council - Dunmore, NSW - Site Layout - Figure no. 1" dated July 2019 (EPA Ref. no. DOC19/1027702).
10	Groundwater monitoring	BH13 - as shown on the drawing titled "Shellharbour City Council - Dunmore, NSW - Site Layout - Figure no. 1" dated July 2019 (EPA Ref. no. DOC19/1027702).
11	Groundwater monitoring	BH14 - as shown on the drawing titled "Shellharbour City Council - Dunmore, NSW - Site Layout - Figure no. 1" dated July 2019 (EPA Ref. no. DOC19/1027702).
16	Groundwater monitoring	BH19 - as shown on the drawing titled "Shellharbour City Council - Dunmore, NSW - Site Layout - Figure no. 1" dated July 2019 (EPA Ref. no. DOC19/1027702).
17	Groundwater monitoring	BH12R - as shown on the drawing titled "Shellharbour City Council - Dunmore, NSW - Site Layout - Figure no. 1" dated July 2019 (EPA Ref. no. DOC19/1027702).

18	Groundwater monitoring	BH9 - as shown on the drawing titled "Shellharbour City Council - Dunmore, NSW - Site Layout - Figure no. 1" dated July 2019 (EPA Ref. no. DOC19/1027702).
19	Surface Water Monitoring	SWC_2 - as shown on the drawing titled "Shellharbour City Council - Dunmore, NSW - Site Layout - Figure no. 1" dated July 2019 (EPA Ref. no. DOC19/1027702).
20	Surface Water Monitoring	SWC_UP - as shown on the drawing titled "Shellharbour City Council - Dunmore, NSW - Site Layout - Figure no. 1" dated July 2019 (EPA Ref. no. DOC19/1027702).
21	Surface Water Monitoring	SWC_DOWN - as shown on the drawing titled "Shellharbour City Council - Dunmore, NSW - Site Layout - Figure no. 1" dated July 2019 (EPA Ref. no. DOC19/1027702).
22	Surface Water Monitoring	SWC_DOWN2 - as shown on the drawing titled "Shellharbour City Council - Dunmore, NSW - Site Layout - Figure no. 1" dated July 2019 (EPA Ref. no. DOC19/1027702).
23	Groundwater Monitoring	BH21 - as shown on drawing titled "Monitoring Point Location Plan - Dunmore Recycling and Waste Depot - EPL No. 5984" prepared by Cardno and attached to correspondence dated 7 April 2020 (EPA ref. no. DOC20/317779).
24	Groundwater monitoring	BH22 - as shown on drawing titled "Monitoring Point Location Plan - Dunmore Recycling and Waste Depot - EPL No. 5984" prepared by Cardno and attached to correspondence dated 7 April 2020 (EPA ref. no. DOC20/317779).
25	Groundwater monitoring	BH18 - as shown on drawing titled "Monitoring Point Location Plan - Dunmore Recycling and Waste Depot - EPL No. 5984" prepared by Cardno and attached to correspondence dated 7 April 2020 (EPA ref. no. DOC20/317779).

Appendix B

Laboratory Chain of Custody (COC) & Certificates of Analysis (COA) – Water Samples

Appendix C

Laboratory Chain of Custody (COC) & Certificates of Analysis (COA) – Dust Samples

Appendix D

Surface Gas (Methane) Field Sheets

Appendix E

Laboratory Chain of Custody (COC) & Certificates of Analysis (COA) – Overflow Event

Appendix F

Calibration Certificates

Appendix G

Gas Flare Reports