



QUARTERLY ENVIRONMENTAL MONITORING REPORT (QEMR) JUNE 2023

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

ENVIRONMENT PROTECTION LICENCE (EPL) 5984

Prepared For: **Shellharbour City Council**

Project Number: **ENRS0033**

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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 third quarter July 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.

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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 a quarterly 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 June 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 June 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;
- All surface water samples of Rocklow Creek reported for ammonia above the ecological stressor values of 0.2mg/L;
- Flare operating temperatures were generally 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 June 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

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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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1.2 OBJECTIVES

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1.3 SCOPE OF WORK

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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

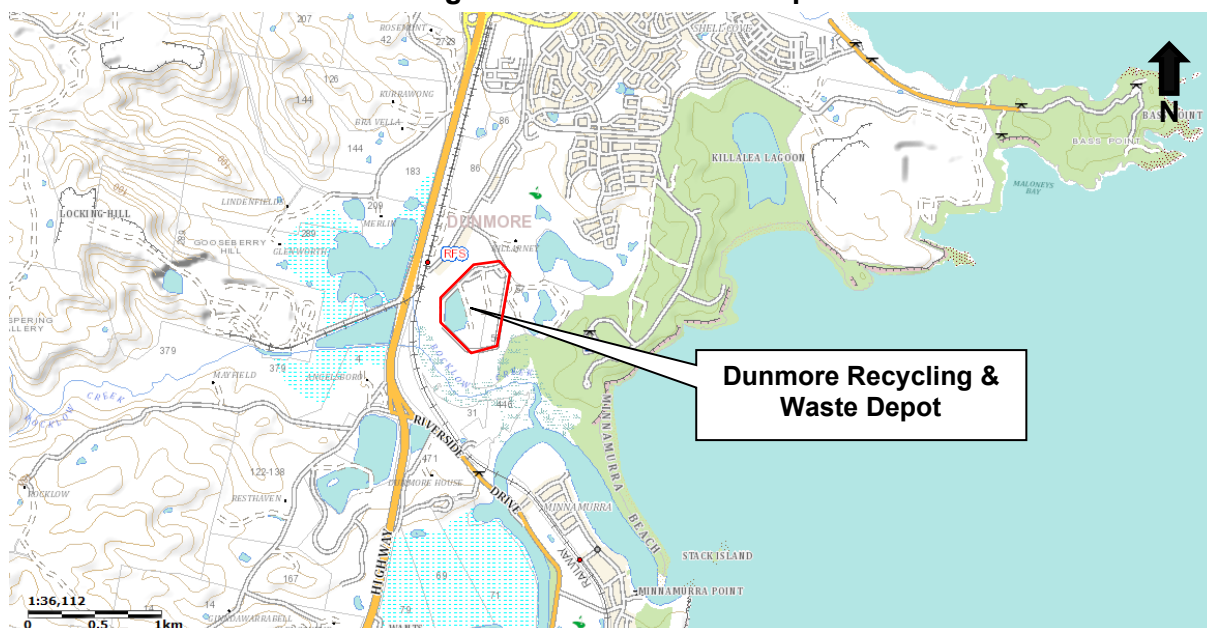
The Site is located at 44 Buckleys Road, Dunmore, NSW, 2529, legally defined as Lot 21 in Deposited Plan 653009 and Lot 1 Deposited Plan 419907. The Site is situated approximately three and a half (3.5) kilometres southwest of the Shellharbour town centre. The area's regional location is defined in **Figure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

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: <ul style="list-style-type: none"> • 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/m²/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 within 250m of deposited waste or leachate storage. The acceptable threshold for 1% (volume/volume).

4.0 DATA QUALITY OBJECTIVES (DQO)

If sampling is conducted, 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 in the National Environment Protection (Assessment of Site Contamination) Measure (NEPC;2013).

4.1 STEP 1: STATE THE PROBLEM

The Site is currently operating as an active landfill and requires regular environmental monitoring in accordance with the EPL 5984.

4.2 STEP 2: IDENTIFY THE DECISION/GOAL OF THE STUDY

The primary goals / objectives of the investigation program were 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;

4.3 STEP 3: IDENTIFY THE INFORMATION INPUTS

The sample results for the Potential Contaminants of Concern (PCoC) shall be used to inform decisions regarding the Site suitability for the proposed land use, and the requirement for any further investigation, remediation or site management works, as necessary. The following inputs are required:

- Representative environmental samples;
- Measurements of environmental parameters;
- Comparison of the parameter results against the adopted Site Assessment Criteria (SAC);
- Record of sampling methods, observations and field screening results and ground investigation logs; and
- The completion of a Quaterly Environmental Monitoring Report.

4.4 STEP 4: DEFINE THE STUDY BOUNDARIES

The assessment was limited to sampling locations listed in EPL 5984. As listed in Appendix A and depicted in Figure 2 and Figure 3.

4.5 STEP 5: DEVELOP THE ANALYTICAL APPROACH (DECISION RULE)

The site information and results obtained from this assessment scope will be compared against the NSW EPA endorsed criteria in Section 3.0 for monitoring purposes.

4.6 STEP 7: DEVELOP THE PLAN FOR OBTAINING DATA

The seventh and final step involves identifying the most effective sampling and analysis design for generating the data that is required to satisfy the data quality objectives. It was understood that the ALS sampling program was based on and accounts for the following key points:

- The monitoring requirements of the EPLs;
- The results will be compared against NSW EPA endorsed assessment criteria;
- The indicators (DQI) used to identify that data obtained during the scope of works has been done so in a way which meets project data quality objectives (DQO) summarised below.

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.

DQO	Evaluation Criteria
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 (AECs) at the Site, and selection of representative samples.
Precision and accuracy for sampling and analysis	Use properly trained and qualified field personnel and achieve laboratory QC criteria. Blind field duplicates to be collected at a minimum rate of 1 in 20 samples. RPD's to be less than 30% for inorganic and 50% for organic analyses. Rinsate samples not considered necessary as all PCoC measured by the lab were assumed to be present at the site. Disposable single use items used for the collection of samples.

5.0 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.

5.1 WATER SAMPLING

5.1.1 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.

5.1.2 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 reported on field sheets provided by ALS.**

5.1.3 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.

5.1.4 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.

5.1.5 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).

5.2 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; **4th May** and **1st June 2023**. A total of four (4) dust monitoring locations were considered adequate to assess site conditions.

5.3 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.

5.4 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.

5.5 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.

5.6 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**.

5.7 QA/QC PROCEDURES & ANALYSIS

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 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.

5.8 EPL NON-COMPLIANCE

Based on the information provided to ENRS, no non-compliances were noted during the June 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 were consistent with EPA guidelines. 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
1/05/2023	7.6	9	19.5	-

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 **0.68 mbgl** (BH-15) to **4.64 mbgl** (BH-14). Across the Site groundwater levels were generally consistently with historical data sets.

6.3.2 Temperature

Groundwater

Temperature of groundwater in the June 2023 monitoring period ranged between **17.1°C** (BH-15) and **25.9°C** (BH-3).

Results were consistent with historical data.

Surface Waters

Surface water temperature at SWP-1 was **13.4°C**. Results were consistent with historical data.

Leachate

Leachate Temperature at the leachate Tank (LP-1) was **13.8°C**.

Results were 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 ($\mu\text{S}/\text{cm}$). Table 3.3.3 of the ANZECC (2000) guidelines document default TV for EC in lowland freshwater rivers between 125 $\mu\text{S}/\text{cm}$ and 2,200 $\mu\text{S}/\text{cm}$ (~1,500 mg/L).

Groundwater

During the June 2023 monitoring period, salinity ranged between; **511 $\mu\text{S}/\text{cm}$** (BH-18) and **7,945 $\mu\text{S}/\text{cm}$** (BH-1C). Four (4) monitoring points reported salinity values in excess of

freshwater SAC of 2,200 $\mu\text{S/cm}$ being **7,945 $\mu\text{S/cm}$** (BH-1c), **4,120 $\mu\text{S/cm}$** (BH-9), **2,260 $\mu\text{S/cm}$** (BH-15), **2,550 $\mu\text{S/cm}$** (BH-21).

EC readings were generally consistent with historical data.

Surface Waters

Electrical Conductivity results for onsite surface water (SWP-1) was **1,080 $\mu\text{S/cm}$** . The result was below the TV of 2,200 $\mu\text{S/cm}$.

Electrical conductivity for offsite surface waters ranged between **17,400 $\mu\text{S/cm}$** (SWC_2) to **32,600 $\mu\text{S/cm}$** (SWC-Down).

Results were 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 June 2023 monitoring was **7,380 $\mu\text{S/cm}$** (LP1,) which was above the freshwater 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 **5.9 mg/L**. 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 **6.05 mg/L** (SWC-Down) to **6.71 mg/L** (SWC-Up). Results were generally consistent with a tidal creek passing through a mangrove swamp.

Leachate

Dissolved oxygen at LP1 (Leachate Tank) was **6.22 mg/L**. 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-13, BH-18) and **pH 7.5** (BH-3). All groundwater results were reported within the SAC range of pH 6.5-8.0 and were generally consistent with historical data.

Surface Water

The pH of the onsite surface water for the June 2023 monitoring period was reported at **pH 7.7** (SWP-1).

The pH of the offsite surface waters ranged between **pH 7.2**, (SWC_UP, SWC_2, SWC_Down) and **pH 7.3**, (SWC_Down_2) for sample locations associated with Rocklow Creek.

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

Leachate

Leachate pH was as reported as **pH 9.3** (LP-1). Results were reported above the SAC. Leachate pH has generally been elevated 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 was reported as **<5 mg/L** (SWP_1).

Concentrations for offsite surface waters in Rocklow Creek were reported between **<5 mg/L** (SWC_Down, SWC_Down 2) and **7 mg/L** (SWC_2).

The results were below the SAC of 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 **1.05 mg/L** (BH18) and **298 mg/L** (BH-1c). All groundwater wells exceeded the site assessment criteria for the June 2023 monitoring period. Results were generally consistent with historical values.

Surface Water

Ammonia in onsite surface water samples was reported as **0.96 mg/L** (SWP-1).

Ammonia in offsite surface water samples associated with Rocklow Creek ranged from **0.2 mg/L** (SWC_UP) to **0.69 mg/L** (SWC_DOWN). All results were above the ecological stressor value of 0.2 mg/L.

Leachate

Ammonia in leachate was reported between **344mg/L** (LP1). 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 **5.94 mg/L** (BH-14). BH3 and BH14 exceeded the SAC.

Surface Water

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

Nitrate concentration for Rocklow Creek surface water samples ranged between **<0.01 mg/L** (SWC-2, SWC-DOWN, SWC-DOWN_2) and **0.14 mg/L** (SWC_UP).

All sites returned results below the 95% TV of 0.7mg/L.

Leachate

The June 2023 Nitrate result of **0.1mg/L** was reported in sample LP1.

6.4.3 Nitrite

Groundwater

Results for Nitrate in groundwater were reported between **<0.01 mg/L** in multiple bores and **0.13 mg/L** (BH-3). Results generally continue to trend downward. No exceedances to the TV of 0.7mg/L were reported.

Surface Water

Onsite SWP-1 was reported **0.04 mg/L**. Rocklow Creek samples reported results **0.02 mg/L** in all samples. Results were generally consistent with previous data and below the accepted TV.

Leachate

Leachate tank sample LP1 reported a result of **6.96 mg/L** indicating an upward trend since September 2022.

Anions

6.4.4 Chloride

Groundwater

Results for Chloride in groundwater were reported between **16 mg/L** in (BH-18) and **970 mg/L** (BH-1c). The results are consistent with historical data.

Surface Water

Chloride results for surface water SWP-1 was **173 mg/L**. The results are below the accepted TV and are generally consistent with historical data. Rocklow Creek samples reported results between **6,870 mg/L** (SWC_2) and **12,100 mg/L** (SWC_Down).

Leachate

Chloride at the Leachate Tank (LP-1) was **1,810 mg/L**. Results were generally consistent with previous data.

6.4.5 Fluoride

Groundwater

Results for Fluoride in groundwater were reported between **0.1 mg/L** (BH-4) and **0.8 mg/L** (BH-22). Results were consistent with historical data.

Surface Water

Fluoride result for Onsite surface water was **0.3 mg/L** (SWP-1). The result was generally consistent with historical data.

Offsite surface water results ranged from of **0.6 mg/L** (SWC_2) and **0.9 mg/L** (SWC_Down). Results were generally consistent with historical data.

Leachate

The fluoride result at the Leachate tank (LP-1) was **0.3 mg/L**.

6.4.6 Sulphate

Groundwater

Results for Sulphate in groundwater were reported between **10 mg/L** (BH-1C and BH-18) and **366 mg/L** (BH-15). Results were generally consistent with previous data.

Surface Water

Sulphate in onsite surface water was **39 mg/L** (SWP-1). Levels were consistent with previous data.

Sulphate in offsite surface water associated with Rocklow Creek ranged from **908 mg/L** (SWC_2) and **2,000 mg/L** (SWP_Down). Sulphate levels are generally consistent with previous data.

Leachate

Sulphate level at the leachate tank (LP-1) was **50 mg/L**. Results are generally consistent with historical data.

6.4.7 Total Alkalinity

Surface Water

Total Alkalinity at SWP-1 was **431 mg/L**. Historical data indicates Alkalinity has been stable.

Leachate

Total Alkalinity in Leachate (LP-1) was **2,780 mg/L**. Results were consistent with historical data.

6.4.8 Bicarbonate Alkalinity

Groundwater

Bicarbonate in groundwaters ranged from **267 mg/L** (BH-18) to **2,600 mg/L** (BH-1C). Results were 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 leachate sampling points. Concentrations of dissolved manganese in groundwater were reported between **0.06 mg/L** (BH-19r) and **0.71 mg/L** (BH-9). Results were generally consistent with historical data.

Surface Water

The total manganese concentration at SWP-1 was from **0.12 mg/L**. Results were consistent with historical data.

Leachate

Total Manganese concentrations in leachate was reported as **0.1 mg/L** (Leachate Tank LP-1). Manganese concentrations for all samples are below the adopted TV (1.9 mg/L 95% of Species - freshwater).

6.4.10 Iron (Total Fe)

Iron was measured as total Iron in surface water samples and Leachate Tank.

Surface Water

Concentrations of total iron for onsite surface water LP1 was reported as **0.16 mg/L**. Rocklow Creek samples reported results between **0.34 mg/L** (SWC_Down) and **0.88 mg/L** (SWC_2).

Leachate

Concentration of iron at the leachate Tank (LP-1) was reported between **1.29 mg/L**.

6.4.11 Iron (Dissolved Fe)

Groundwater

Dissolved iron was measured within groundwater and surface water sampling points. Groundwater results were reported between **0.05 mg/L** (BH14) and **11.6 mg/L** (BH1C).

6.4.12 Calcium

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

Groundwater

Groundwater results were reported between **60mg/L** (BH-18) and **213 mg/L** (BH13).

Surface Water

Calcium in onsite surface was measured at **73 mg/L** (SWP-1).

Calcium in offsite surface waters ranged from **155 mg/L** (SWC_2) to **288 mg/L** (SWC_Down).

Leachate

Calcium concentration in Leachate (LP-1) was **39 mg/L**.

6.4.13 Potassium

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

Groundwater

Groundwater results were reported between **10 mg/L** (BH-18) and **207 mg/L** (BH1c). The potassium levels for groundwaters were generally consistent with historical data.

Surface Water

Potassium levels for the offsite groundwaters in Rocklow Creek ranged from **122 mg/L** (SWC_2) and **244 mg/L** (SWC_Down).

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 June 2023 monitoring period at the following concentrations:

Groundwater

TOC levels ranged between **10 mg/L** (BH-4) and **186 mg/L** (BH-1c). Results were consistent with historical data.

Surface Water

TOC levels in the onsite surface waters were determined as **25 mg/L** (SWP-1).

TOC levels in the offsite surface waters ranged between **8 mg/L** (SWC-DOWN_2) and **10 mg/L** (SWC_2).

Leachate

TOC concentration in leachate was **403 mg/L** (LP-1 Leachate Storage Tank 01/03/2023). The results are generally consistent with previous data

7.0 DUST GAUGE RESULTS

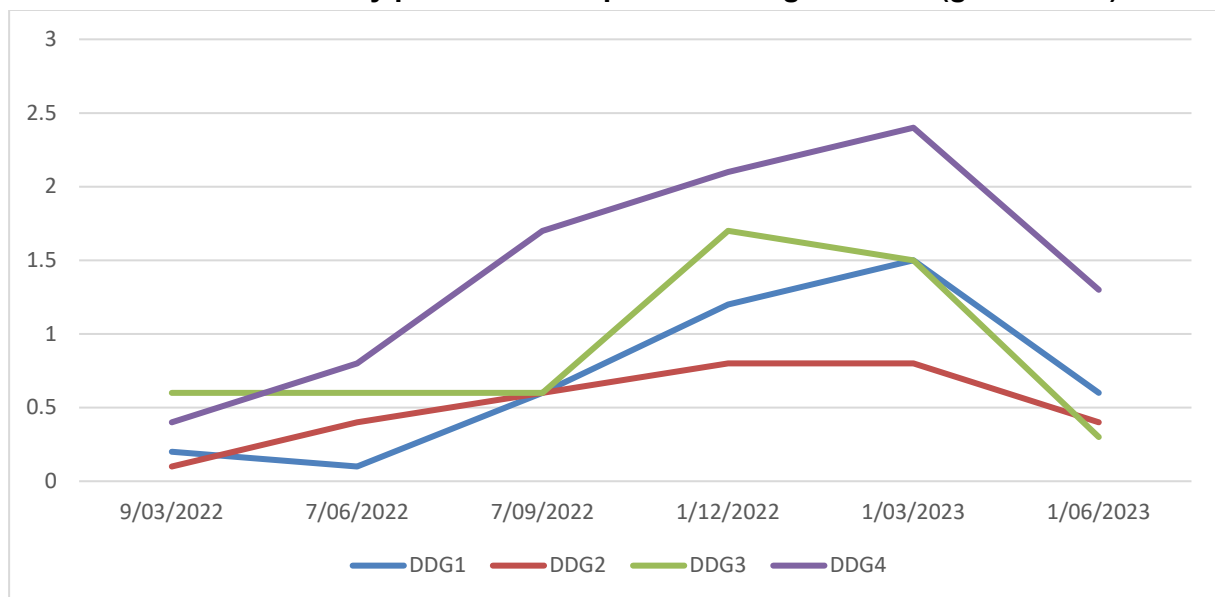
The below table provides the results of the dust depositions results. A total of four (4) dust collectors were onsite for one (1) month between **4th May 2023** and **1st June 2023**, in general accordance with AS3580.10.1. A summary of results is provided in **Table 7** below.

Table 7: Summary of Dust Gauge Results

Sample ID	Guideline Criteria (g/m ² /month)	Total Insoluble Matter (g/m ² /month)	Comments
DDG1	4	0.6	Satisfactory
DDG2		0.4	Satisfactory
DDG3		0.3	Satisfactory
DDG4		1.3	Satisfactory

Results for depositional dust during the June 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)



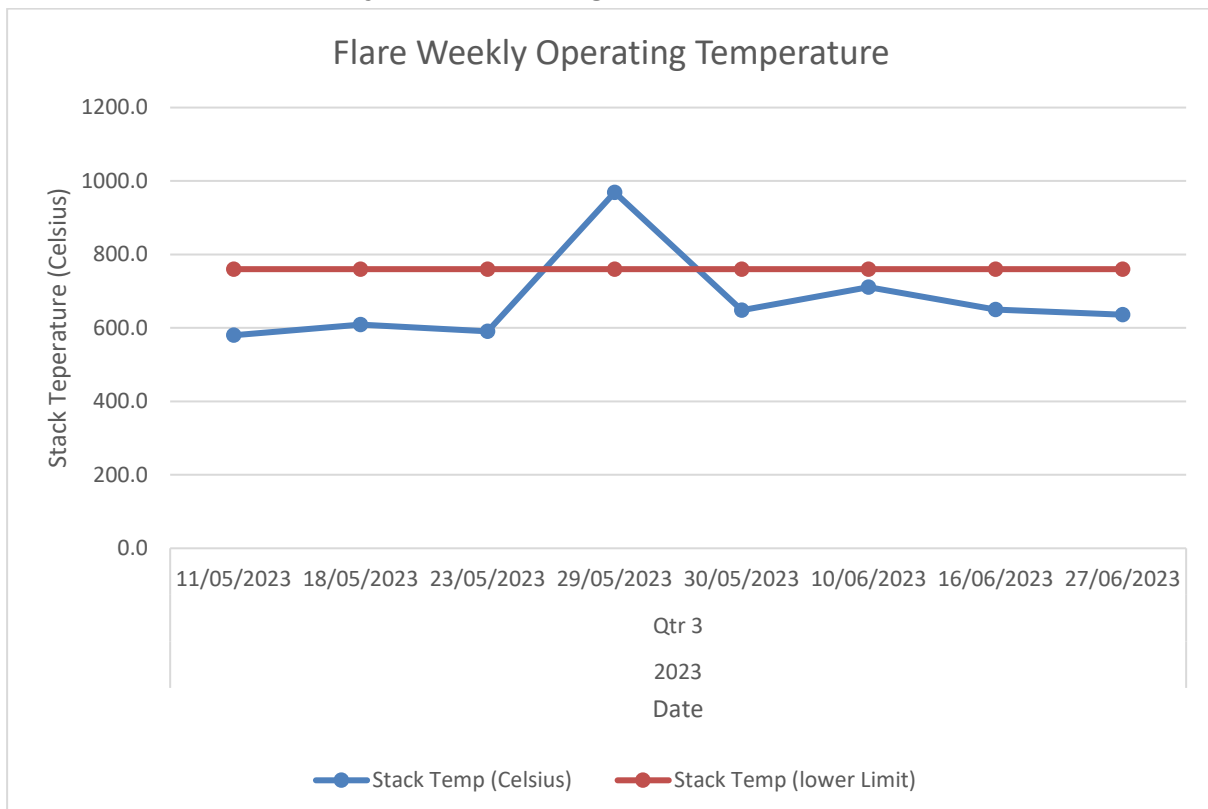
The results were considered satisfactory. Dust gauge locations are provided in **Figure 2** attached. It is recommended that monitoring is continued in accordance with EPL 5984.

Table 8: Summary of Flare Operating Temperatures

Years	Quarter	Date	Stack Temp (Celsius)	Stack Temp (lower Limit)
2023	Qtr 3	11/05/2023	580	760
		18/05/2023	609	760
		23/05/2023	591	760
		29/05/2023	969	760
		10/06/2023	711	760
		16/06/2023	650	760
		27/06/2023	636	760
		30/05/2023	648	760
2023 Q3 Average			674.25	-

Data source: LGI (May-June, 2023). Biogas Monthly Reports – Dunmore.

Chart 2: Weekly Flare Operating Temperatures June Quarter 2023



Data source: LGI (May-June 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 were generally below the Operational temperature lower limit of 760 degrees.

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 June 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 June 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 June 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 exceedances of the stressor values for ammonia.

All dust gauges reported satisfactory results over the June 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 temperatures below the minimum operating temperature throughout the June 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 quarterly 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 capping 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 June 2023 monitoring results indicated generally consistent results with no significant change in environmental conditions at the Site during the past 3 months. The monitoring period reported continued elevated results above the criteria for; ammonia, heavy metals, nitrate, sulphate and salinity (EC) within all groundwater bores. Future sampling events should continue to monitor the key indicators of leachate within surface and groundwaters, especially concentration of ammonia and nitrate in accordance with the EPL.

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 June 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;
- All surface water samples of Rocklow Creek reported for ammonia above the ecological stressor values of 0.2mg/L;
- Flare operating temperatures were generally 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 June 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.

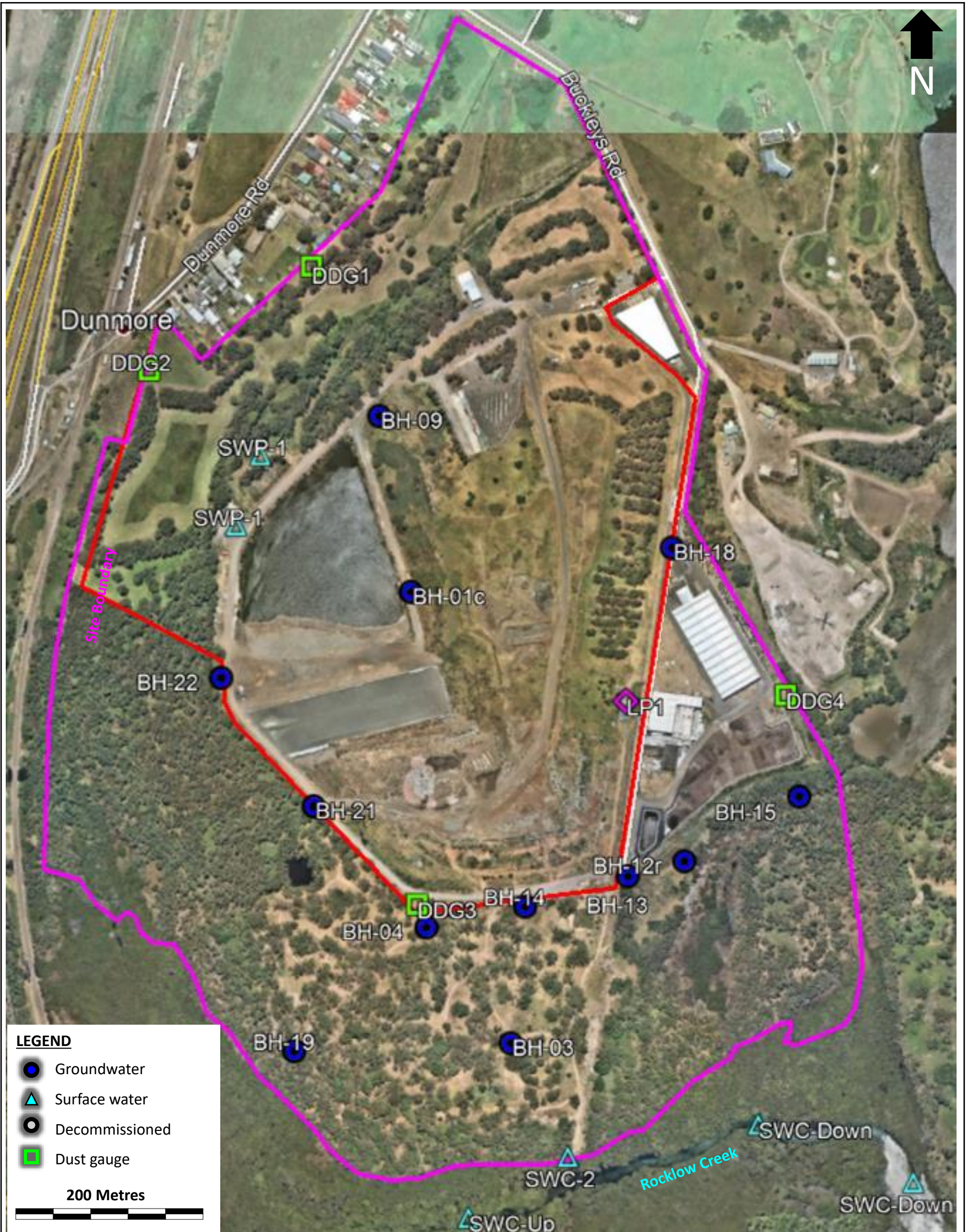
This report has been prepared on behalf of and for the exclusive use of the Client, and is subject to and issued in connection with the provisions of the agreement between ENRS and the Client. ENRS accepts no liability or responsibility whatsoever and expressly disclaims any responsibility for or in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

- ANZECC (1996). Guidelines for the Laboratory Analysis of Contaminated Materials.
- ANZECC (2000) Australian Water Quality Guidelines for Fresh and Marine Waters. Australian and New Zealand Environment & Conservation Council. ISBN 09578245 0 5 (set).
- 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.
- Australian Government (2011) National Health & Medical Research Council. National Resource Management Ministerial Council. National Water Quality Strategy. Australian Drinking Water Guidelines.
- Australian Standard AS 3580.10.1. Methods for sampling and analysis of ambient air; method 10.1- Determination of particulate matter - Deposited matter - Gravimetric method
- Environmental Earth Sciences (2018) Annual Report 2018- Environmental Monitoring at the Dunmore Recycling and Waste Depot, Dunmore, New South Wales
- NEPC (2013). National Environment Protection (Assessment of Site Contamination) Measure.
- Netherlands (1994) Environmental Quality Objectives in the Netherlands. Ministry of Housing, Spatial Planning and the Environment, Netherlands Government. ISBN 90-6092-783-4.
- NSW Department of Environment and Climate Change (2009a). Contaminated Sites: Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997
- NSW Department of Environment and Conservation (1997). Guidelines for the Assessment and Management of Groundwater Contamination
- NSW EPA (1995) Sampling Design Guidelines. ISBN 0-7310-3756-1.
- NSW EPA (2020) Guidelines for Consultants Reporting on Contaminated Sites.
- NSW Department of Environment and Conservation (1997). Guidelines for the Assessment and Management of Groundwater Contamination.
- NSW EPA (1996) Environmental Guidelines: Solid Waste Landfills. ISBN 0 7310 3774 X
- NSW EPA (2016) Environmental Guidelines: Solid Waste Landfills (2nd Edition). ISBN 978 1 76039 350 2
- NSW EPA (Mar. 2020) Environmental Protection Licence (EPL) 5984
- NSW EPA (Dec. 2017) Environmental Protection Licence (EPL) 12903
- NSW Government (1997). Protection of the Environment Operations Act.
- NSW Government (2005). Protection of the Environment (Waste) Regulation.
- NSW Landcom (2008). Managing Urban Stormwater: Soils and Construction, Volume 2B – Waste Landfills.

FIGURES



LEGEND

- Groundwater
- ▲ Surface water
- Decommissioned
- Dust gauge

200 Metres



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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		

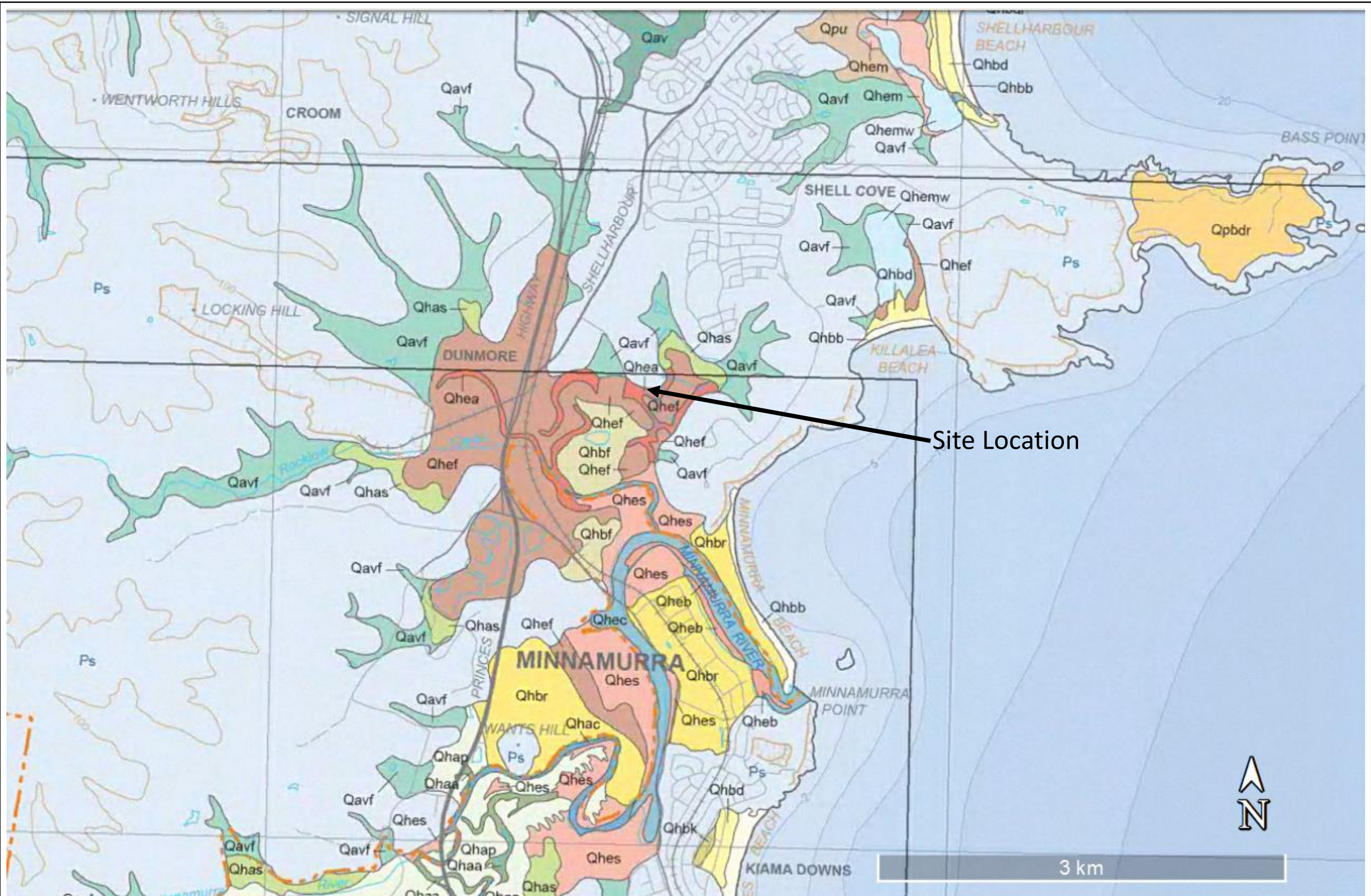


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Client:	Shellharbour City Council	Drawn:	PL	Figure:	3
Project:	ENRS0033	Source:	SixMaps	Date:	16/01/2020
Location:	Dunmore Recycling & Waste Depot 44 Buckleys Rd, Dunmore, NSW, 2529	Scale:	NA	Title:	Surface Gas Sample transects
		Status:	Rev 1		

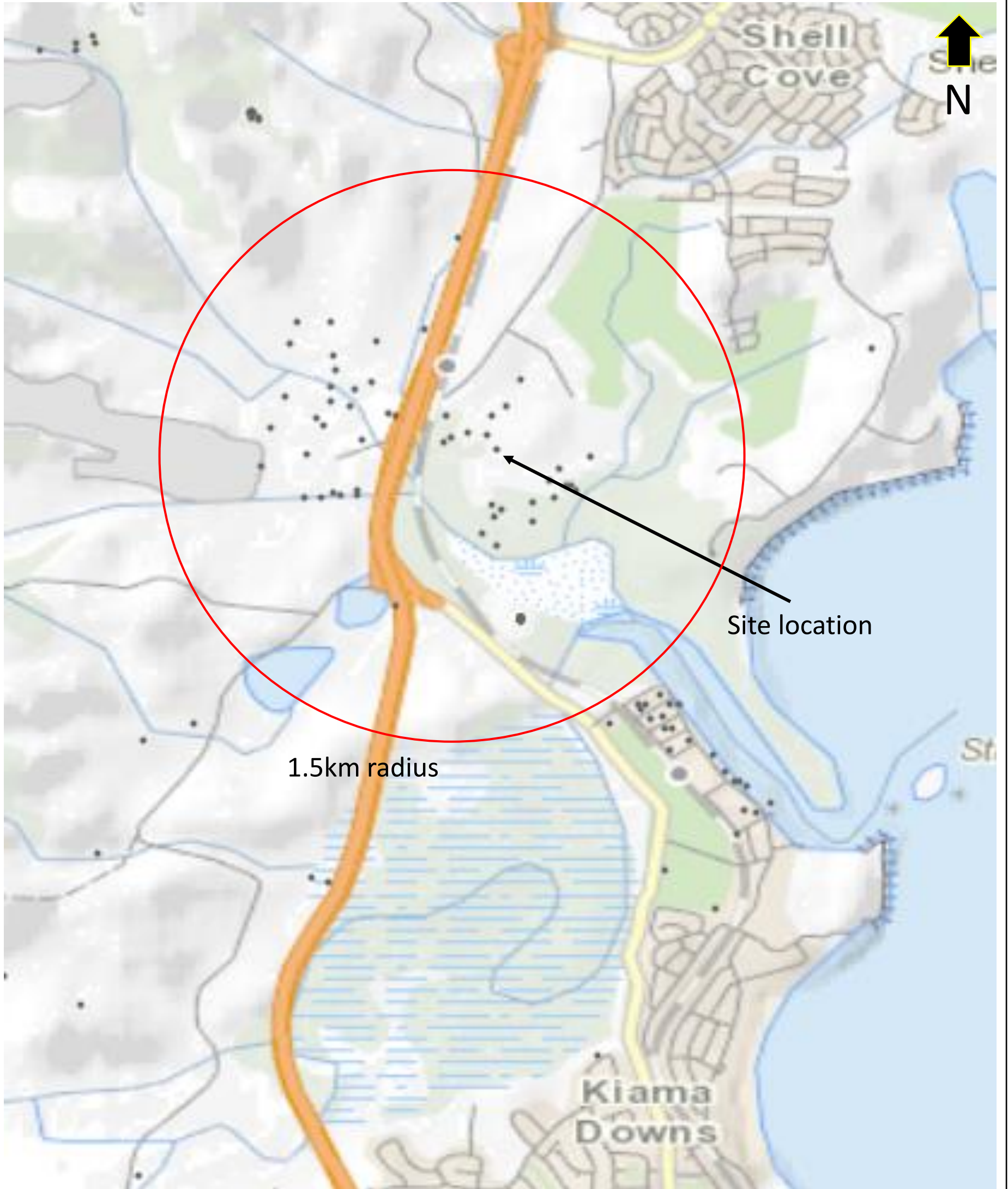


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Client:	Shellharbour City Council	Drawn:	PL	Figure:	4
Project:	ENRS0033	Source:	Geological Survey of NSW	Date:	16/01/2020
Location:	Dunmore Recycling & Waste Depot 44 Buckleys Rd, Dunmore, NSW, 2529	Scale:	See figure	Title:	Site Geology
		Status:	Rev 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

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