Landfill Closure Management Plan

Buckleys Road Waste Management Facility

Shire of Broome

November 2022

Acknowledgements

ASK Waste Management acknowledges the Traditional Owners of the land in which we work and live, and pays respects to Elders past, present, and emerging.

ASK also gratefully acknowledge the cooperation of the Shire of Broome staff that provided information and assistance in the development of this report.

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

The Shire of Broome (the Shire) engaged ASK Waste Management (ASK) to produce a Landfill Closure Management Plan (LCMP) for the Buckleys Road Waste Management Facility (the Facility) to reflect the approved increase in the landfill footprint (DWER Licence Amendment File Number 2013/003936-1).

ASK has previously produced an LCMP for the Facility in March 2021, and this report builds on the earlier LCMP and refines it based on changes to operations and the Shire's long-term strategy.

The Facility includes an unlined Class II landfill, located approximately 7.5km north of the Broome CBD on Crown Land Reserve 40813, Lot 228, Buckleys Road, Broome. A portion of Reserve No 40813 is leased to Energy Development Ltd (EDL) for gas storage, leaving 12.45Ha available for waste receival, recovery and disposal.

The LCMP provides information relating to the progressive rehabilitation and closure of the Facility's landfill cells, together with the post-closure monitoring requirements.

The following documents were considered in the preparation of the LCMP:

- The Facility's current Environmental Protection License (EPL) (L6912/1997/11)
- Best Practice Environmental Management: Siting, design, operation and rehabilitation of landfills (EPA Victoria, 2015)
- Buckleys Road Waste Management Facility – Landfill Closure Management Plan (LCMP) (ASK, 2012)
- Buckleys Road Waste Management Facility – Review of Closure Management Plan (ASK, 2014)
- Landfill Closure Management Plan: Buckleys Road Waste Management Facility (ASK, 2021)
- DWER Licence Amendment Notice 2 (24/01/2020) – Change to above-ground waste disposal buffer distance

1.1 AMENDMENTS TO THE LCMP

In 2012, ASK produced an LCMP for the Facility considering the Victorian BPEM Best Practice Guidelines to fulfil both the Shire and the Department of Water and Environment Regulation (DWER)'s expectations. The plan included the proposed final landform, including a contingency area, rehabilitation requirements, staged filling and rehab schedule, post-closure monitoring programme and a cost estimate for the closure and post-closure costings.

The final plan that DWER approved included a landfill capping design that utilised locally available pindan soil. This capping design was lower than the specifications of BPEM but was accepted by DWER based on the risk presented by the landfill and the understanding of the likely performance of the cap in the Kimberley's weather.

In 2014, the Shire had the LCMP reviewed to ensure that the schedule of costs for capping requirements was up to date and that the capping design met best practice guidelines whilst minimising the associated capital expenditure.

A review of the LCMP in 2019 showed the remaining airspace at the Facility based on the 2012 final landform indicated a remaining operational life of less than two years. In order to increase the operational life of the Facility, a licence amendment was approved by DWER in 2020, allowing above-ground waste placement within 15 meters of the premise's boundary.

This reduction of the internal buffers at the Facility allowed a new final landform to be developed for the landfill, which also used the contingency area as an extension area extending towards the gatehouse.

In 2021 ASK produced an updated LCMP (ASK, 2021) to incorporate the proposed stormwater system and a perimeter road. The LCMP reflected the operational practices at the time, specifically the proportion of daily cover used and compaction rates achieved.

This 2022 LCMP has been revised to reflect the improvements to operations, as they align with Best Practice and the Shire's approach to progressive capping of the waste body.

1.2 OBJECTIVES AND SCOPE

This LCMP has been produced to achieve the following objectives:

- Develop final contours and landform designs for the landfill that are stable and meet best practice guidelines and can be used to guide landfilling operations and site works going forward.
- Develop a landfill cap design that will provide a physical barrier between waste and the environment, restrict rainwater's infiltration into the waste mass, and minimise leachate production.
- Develop a stormwater management design that minimises leachate generation and controls the release of stormwater from the Facility.
- Develop an appropriate landfill gas management system to control the generation of landfill gases and reduce any significant risk of adversely impacting the surrounding environment.
- Develop a post-closure management and monitoring program that can be implemented to ensure that environmental impacts are minimised after the landfill cells are closed and rehabilitated.
- Provide a bill of quantities and cost estimates for closure and rehabilitation works that the Shire can use to budget for future liabilities.

To satisfy the objectives of the LCMP, this document contains the following sections:

- Facility Overview
- Environmental Attributes
- Legislative Context
- Risk Assessment
- Rehabilitation Design
    - Current Landfill Profile
    - Proposed Final Profile
    - Detailed Capping System Design
- Surface Water Management Design
- Landfill Gas Management Design
- Revised Risk Assessment
- Post-Closure Management and Monitoring

- Closure Cost Estimates
- Financing Strategy.

1.3 REVISIONS AND UPDATES

The Shire will review and update the LCMP (as necessary) after every review of the Environmental Protection Licence (EPL) or at least every three years. The purpose of any review is to:

- Assess closure and rehabilitation operations and identify areas where performance can be improved;
- Update the LCMP to:
    - Reflect any changes to Facility operations
    - Reflect regulatory changes
    - Reflect changes to the Shire, State and Federal strategic objectives
    - Incorporate all changes arising from the review process.

2 FACILITY OVERVIEW

The following sections detail the location, history, surrounding land uses, and current and proposed waste management activities undertaken at the Facility.

2.1 SITE OVERVIEW

The facility provides a waste disposal site for the Town and immediate community of Broome. As the only licenced landfill in the vicinity, it receives a combination of Municipal Solid Waste (MSW), Commercial and Industrial waste (C&I) and Construction and Demolition waste (C&D).

The site consists of a landfill and a transfer station to allow for the separation of material and reduce traffic at the tip face. The Shire of Broome also operates a licensed Resource Recovery Area (RRA) on another site for storage and processing of greenwaste, concrete, tyres, glass, wood pallets and metal.

Table 2.1 - Summary of Buckleys Road Waste Management Facility

Facility address:	Crown Reserve No 40813, Lot 228 Buckleys Road, Broome. WA. 6725
Facility Licence number:	L6912/1997/10
Ownership:	Shire of Broome
Operator:	Shire of Broome
Landfill class:	Category 64 – Class II Putrescible Landfill Site Category 61 – Liquid Waste Facility
Waste types received:	Putrescible and inert solid waste
Tonnage per annum:	Estimated at 20,000 – 25,000 tonnes per annum
Size:	15 ha site. (12.45 ha excluding EDL lease)
Population serviced:	Approximately 16,000 residents (the significant number of tourists that visit Broome equates to a further 4,500 residents)
Method of construction:	Combination of below-ground trenches and above-ground cells
Type of liner:	No liner
Opening date:	Unknown but vested to the Shire for waste disposal in 1987 and licensed in 1997
Remaining operational life:	5 - 7 years

Historically, waste was disposed of at the Facility in below-ground trenches throughout the site. Since 2000, a combination of below-ground and above-ground waste disposal has occurred. The available below-ground airspace in the current landfill area is exhausted, and above-ground disposal is occurring.

2.2 LOCATION

The town of Broome is located in the Kimberley region of Western Australia, approximately 2,300km north of Perth by road. The Buckleys Road Waste Management Facility is situated approximately 8.6km by road, north of the Shire Chambers. The site is located at the northern end of Buckleys Road. The land title description is Crown Reserve No 40813, Lot 228 Buckleys Road, Broome.

Figure 2.1 - Facility location

2.3 SURROUNDING LAND USE

Table 2.2 lists the relevant sensitive land uses in the vicinity of the Facility, while **Table 2.3** lists the relevant environmental receptors which may be relevant to the operations of the Facility (DWER, 2020).

Table 2.2 - Surrounding land use for the Facility

Residential and sensitive premises	Distance from Prescribed Premises
Residential premises	• 660m south-east of the south-east boundary corner, residential property at Locke Street • 900m west of the landfill, dwellings on Sands Street • 1700m south of the boundary, dwellings on Fairway Drive • There are no sensitive receptors within 5km to the north of the facility, with this land zoned for cultural and natural resource use
Industry	• Adjacent to the north-west boundary, Energy Development Ltd (EDL) gas storage facility • 100m west of the boundary, a quarry and soil borrow pit

Table 2.3 - Surrounding environmental receptors

Environmental Receptors	Distance from Prescribed Premises
Public Drinking Water Areas	• 5km north-east
RIWI Act Groundwater Ares	• Premises lies within the Broome Groundwater area
Threatened and Priority Flora	• 2150m north-west of the north-western boundary
Threatened Ecological Communities	• Premises within Mangarr (relic dune system dominated by extensive stands of Minyjara)
Threatened Fauna	• 1200m west: Falco peregrines, Fregata ariel and Stern hirundo • 1000m south: Calidris acuminate, Calidris ruficollis, Charadrius veredus, Fregata ariel, Limosa, Numenius madagascariensis, Tringa nebularia, Tringa stagnatilis, Arenarai interpres, Calidris canutus, Calidris ferruginea, Calidris subminuta, Calidris tenuirostris, Charadruis mongouls, Hirundo rustica, Limosa lapponica, Numenius minutus, Stern hirundo, Calidris alba, Pluvialis squatarola, Sula leucogaster and Tringa glareola
Surface water body - wetland	• 320m north (saltwater marshes) and 600m west of the landfill

2.4 FACILITY LICENCE

The Facility is a prescribed site under the Environmental Protection Act 1986 and is managed in accordance with an operating licence issued by the Department of Water and Environment Regulation (DWER). The DWER Licence (Licence Number l6912/1997/11) governs waste management activities on-site and includes the following aspects:

- Classification of Premises: Category 64 – Class II putrescible landfill site and Category 61 - Liquid waste facility
- Commencement date (of current licence) – Monday, 11 June 2012
- Amended Expiry date (of current licence) – 10 June 2028
- Nominated Rate of Throughput – Class II putrescible landfill facility: 30,000 tonnes per annum; and Liquid waste facility: 1,932 tonnes per annum
- General Conditions
- Air Pollution Control Conditions
- Water Pollution Control Conditions Uncontaminated Stormwater Management.

The Facility is also subject to the EPL amendments detailed below:

- Instrument Issued Amendment
- 1/08/2011 Licence amendment
- 3/11/2011 Appeal amendment
- 03/11/2012 Greenwaste amendment
- 13/12/2012 Posi-shell trial
- 26/04/2016 Amendment Notice 1 – extend expiry date 10 June 2028
- 24/01/2020 Amendment Notice 2 - Change above ground waste disposal buffer distance.

The licensee shall accept and bury only the following types of wastes at the premises in compliance with criteria defined in the Landfill Waste Classification and Waste Definitions 1996 (amended December 2009):

- Clean fill
- Inert waste type 1 and 2
- Putrescible waste
- Special waste type 1 and 2
- Grease trap and mineral oil liquid waste[1]
- Quarantine waste.

2.5 WASTE MANAGEMENT ACTIVITIES

The Facility predominantly accepts waste for recycling and disposal from the town of Broome and surrounding areas. **Figure 2.2** shows the layout of key features at the Facility. A portion of the site is leased to Energy Development Ltd for gas storage.

In relation to waste disposal, the site can be broadly divided into three areas:

- The gatehouse and weighbridge provide secure access to the Facility
- Main disposal area where above-ground disposal activities are completed
- Transfer station and resource recovery area.

Since the final landform includes an extension area that will utilise parts of the existing transfer station and resource recovery area, a new site layout will need to be developed before this area is used for waste disposal.

[1] The liquid waste ponds that previously received these wastes have been decommissioned; therefore, the Facility no longer accepts any grease trap and mineral oil liquid waste.

Figure 2.2 - Facility layout

2.5.1 *Gatehouse, staff compound, weighbridge*

A gatehouse and weighbridge (**Figure 2.3**) are located at the entry to the Facility, where vehicles are stopped at an electronic boom gate to have their waste loads inspected and/or weighed and details recorded by a gatehouse operator. Staff facilities, amenities and parking are also located at the gatehouse.

Figure 2.3 - Facility gatehouse and weighbridge

2.5.2 *Domestic transfer station and resource recovery area*

A Transfer Station and resource recovery area is located adjacent to the gatehouse that is used by domestic customers to separate waste and recyclables into bins (**Figure 2.4**). These are transferred to the Shire's resource recovery site or disposed of at the landfill when required.

Figure 2.4 - Transfer Station domestic drop-off bins

A bunded and covered waste oil collection facility is located at the Transfer Station to store waste oil until it is collected for recycling. The Transfer Station also has an area to deposit household hazardous materials such as vehicle batteries, paint and gas bottles so that they can be safely disposed of or recycled.

2.5.3 *Landfill cells and reclaiming airspace*

The landfill has been filled in line with its final landform design, and some sections of the landfill have reached the final landform levels and have been capped. However, reducing the internal buffers at the Facility, in line with the 2021 licence amendment, allowed a revision to the final landform to be developed. As a result, the northern, southern and eastern batters could receive additional waste.

In some areas the capping has been removed for additional waste disposal to be completed. Once the cap had been removed, the site staff found several areas where excessive soil fill had been used to create the final landform. This is poor practice, as it is an inefficient use of both airspace and cover material. Therefore, the excess soil fill was removed for later use, creating additional airspace for waste disposal.

2.6 LANDFILL WASTE DISPOSAL QUANTITIES

Based on an assessment of gatehouse data from the previous five years, the Facility receives approximately 25,000 tonnes - 35,000 tonnes of material per year, for recycling and disposal. The waste quantities accepted, recycled, and landfilled at the Facility between 2015 and 2020 are shown in **Table 2.4**.

Table 2.4 - Waste quantities (tonnes)

Year	MSW Landfilled	C & I Landfilled	C&D Landfilled	Total Landfilled	Total Recycled	Total Accepted
2019-20	6,120	5,172	11,104	**23,430**	**11,822**	**35,253**
2018-19	8,474	14,458	29	**22,960**	**12,448**	**35,408**
2017-18	7,838	3,857	2,477	**14,171**	**11,704**	**25,875**
2016-17	13,380	3,961	2,866	**20,207**	**8,298**	**28,505**
2015-16	9,471	5,471	3,959	**18,902**	**6,070**	**24,972**

2.7 FUTURE DIRECTION FOR THE FACILITY

Since about 2015, the Shire has been actively seeking a suitable new site for a Regional Resource Recovery Park (RRRP), which will include a lined landfill. A suitable site has been identified, and the process to secure the site is underway.

In 2020, based on the previous final landform developed in 2012, the remaining operational life of the Facility was estimated to be less than two years. In order to increase the operational life of the Facility, a licence amendment was approved by DWER, allowing above-ground waste placement to within 15 meters of the boundary of the premises (previously, no waste was allowed within 35m of the boundary).

The reduction of the internal buffers at the Facility allowed a new final landform to be developed for the 2021 LCMP, which increased the remaining operational life of the landfill. Since 2021 the Facility staff have also adopted Best Practice operations for; waste compaction, minimising the active area and the efficient use of daily cover. Together with the additional airspace recovered from the historic overuse of soil fill (see **Section 2.5.3**), the projected operational life of the Facility has increased, as shown in **Section 6.1**.

3 ENVIRONMENTAL ATTRIBUTES

3.1 CLIMATE

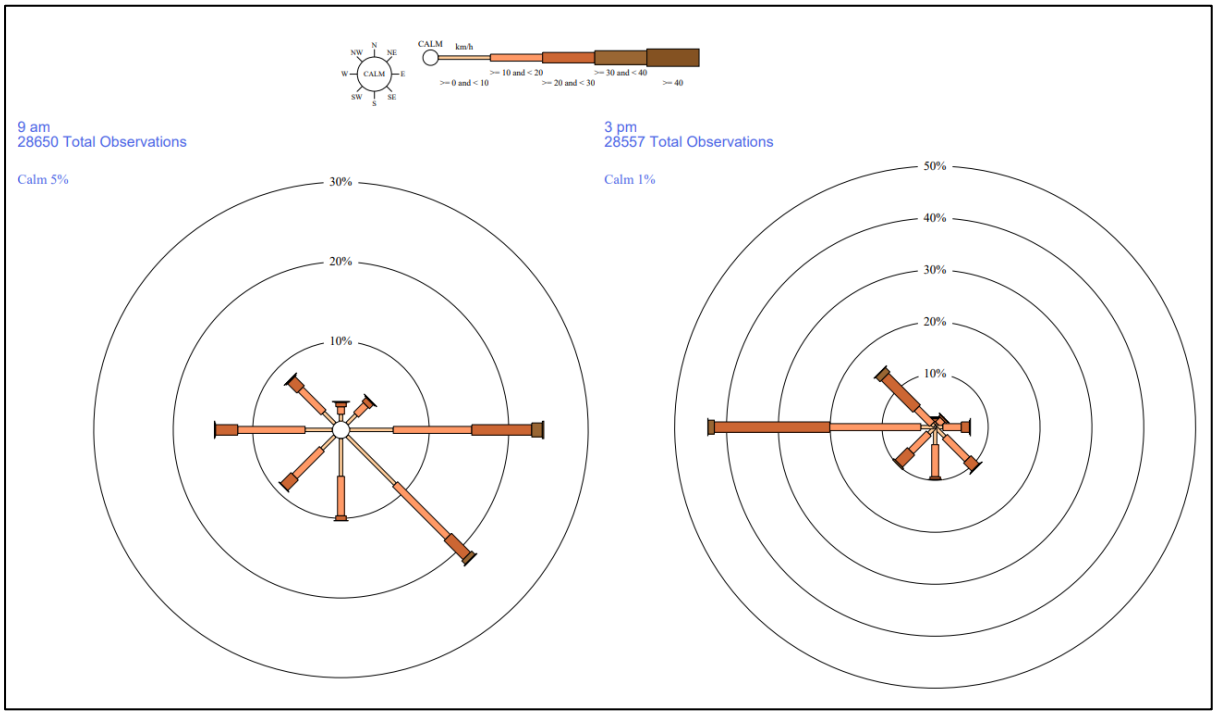
The Bureau of Meteorology has collected climate data from the Broome weather station located at the Broome Airport (Site number 003003) between 1991 and 2020. The average monthly climate data has been summarised in **Table 3.1.** The area receives an average annual rainfall of 752.6mm, with the majority of it falling throughout the summer season between December and March. The coastal location moderates temperature variations with an annual mean maximum of 32.4°C and an annual mean minimum of 21.4°C.

Table 3.1 - Monthly climate statistics for Broome weather station (1991-2020)

Climate Statistic	January	February	March	April	May	June	July	August	September	October	November	December	Annual
TEMPERATURE													
Mean maximum temperature (°C)	33.2	32.8	34.0	34.5	32.0	29.5	29.5	30.6	31.7	33.2	33.8	33.9	32.4
Mean minimum temperature (°C)	26.5	26.2	25.6	22.9	18.0	15.2	13.9	14.5	18.7	23.0	25.7	26.8	21.4
RAINFALL													
Mean rainfall (mm)	228.9	221.7	107.5	28.4	21.5	18.6	9.7	2.9	1.0	1.0	8.6	97.2	752.6
Decile 5 (median) monthly rainfall (mm)	163.5	198.6	47.0	3.4	0.4	1.4	0.2	0.6	0.8	0.0	2.8	80.4	700.4
Mean number of days of rain >= 1 mm	10.2	10.6	6.4	2.0	1.2	1.0	0.4	0.4	0.1	0.2	0.8	5.1	38.4
9 AM CONDITIONS													
Mean 9am temperature (°C)	30.2	29.6	30.1	29.5	25.8	22.7	22.1	23.9	26.9	29.5	30.6	30.6	27.6
Mean 9 am relative humidity (%)	71	74	68	55	44	45	43	42	49	53	57	65	56
Mean 9 am wind speed (km/h)	15.1	14.4	12.8	12.3	14.4	15.2	15.1	14.7	14.9	14.9	15.6	15.9	14.6
3 PM CONDITIONS													
Mean 3 pm temperature (°C)	31.6	31.2	32.6	33.1	30.8	28.3	28.1	28.8	29.4	30.6	31.6	31.7	30.7
Mean 3 pm relative humidity (%)	66	69	59	44	35	34	32	34	46	54	57	63	49
Mean 3 pm wind speed (km/h)	20.7	18.5	17.6	15.3	14.0	14.5	15.3	17.2	20.2	22.1	23.4	22.7	18.5

The Wind Rose data for Broome shown in **Figure 3.1** indicates predominantly easterly winds in the morning that switch to westerly in the afternoon.

Figure 3.1 – Wind Rose data from Broome Airport weather station (11 August 1939 to 10 August 2019)



3.1.1 *Trends and projections*

The Department of Primary Industries and Regional Development (DPIRD, 2020) reports that Kimberley temperatures have increased in winter and decreased in summer. Between 1910 and 2013, the average annual temperature increased by 0.9°C. Average summer temperature declined because increasing summer rainfall and associated cloud cover gave a cooling effect.

The intensity of hot spells generally decreased over the north-west. However, trends in the frequency and duration of hot spells are not clear and differ according to how they were estimated. In the Kimberley and Pilbara, rainfall has increased in most areas.

Over the last 60 years, annual rainfall has increased over northern and interior WA. A recent study of tree growth in the Pilbara found that five of the ten wettest years in the last 210 years occurred in the last two decades.

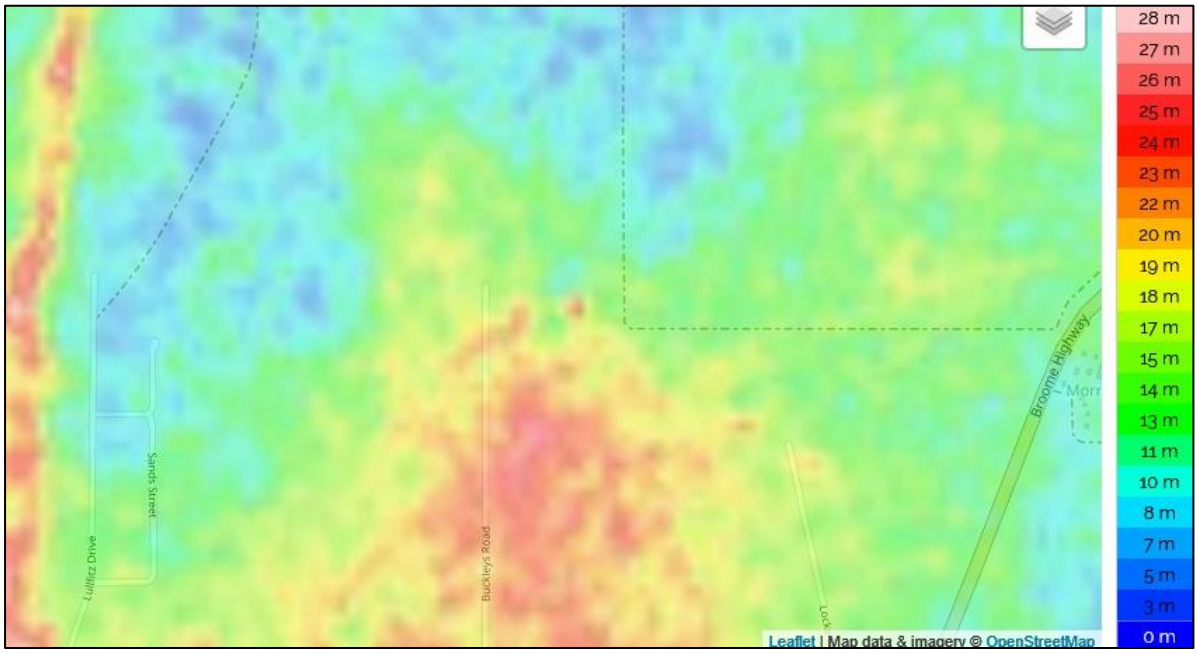
High sea surface temperatures off the north-west coast and increased summer rainfall in the Kimberley and Pilbara have coincided with major shifts in the large-scale atmospheric circulation of the southern hemisphere. These changes include a southward shift in the subtropical ridge and the polar jet stream. In addition to increased annual rainfall, the seasonality (the difference between the rainfall amount in the driest and wettest periods) has also increased in northern WA.

Although the projected rainfall increases are expected to result in increased landfill leachate generation at the Facility, risk assessments and capping designs contained in this LCMP are based on currently available data and do not consider future projections.

3.2 LOCAL TOPOGRAPHY

The Facility is situated midway down a gentle slope running in a northerly direction from a high point south along Buckleys Road.

Figure 3.2 - Local topography



3.3 GEOLOGY

Broome is located within the Canning Basin, a large sedimentary basin covering an onshore area of more than 450,000 km^2. It spans from the Pilbara Craton in the south-west to the Wunaamin Miliwundi Ranges and Halls Creek Oregon in the north-east.

The basin comprises sequences of folded sedimentary rocks up to 18 km thick (Laws, 1987). Superficial sands and pindan soils of the Quaternary age unconformably overlie the Broome Sandstone of the Cretaceous age.

The soil type within the site is described as 'pindan sand plain'; a light, clayey, fine-grained non-water-repellent sand to silt, which is characteristically deep red due to the iron oxide staining of the quartz grains.

3.4 GROUNDWATER

The depth to groundwater has been measured to be from 7.25m to 12.4m below ground level. Groundwater flow is reported from the north-east to the south-west (Department of Water, 2012a Groundwater Resource Review Dampier Peninsula). Groundwater moves under the influence of gravity down the hydraulic gradient, west towards the ocean, south-west towards the town site, and south towards Roebuck Bay.

The existing licence has conditions requiring the monitoring of groundwater below the landfill to detect any seepage and impacts on groundwater quality. There are currently five monitoring bores around the landfill.

3.5 SURFACE WATER

No permanent or ephemeral surface watercourses are located on the premises or within 5km of the premises. The nearest surface water body is a wetland approximately 320m north of the Facility and consists of saltwater marshes.

The region does experience cyclonic activity that can result in significant high-intensity rainfall events, which produce large quantities of stormwater at the Facility. During extreme rainfall events, the surface flows of stormwater exit the Facility in the north-west corner.

3.6 FLORA AND FAUNA

Table 3.2 lists the location of threatened flora and fauna in relation to the Facility (DWER, 2020)

Table 3.2 - Surrounding threatened flora and fauna

Environmental Receptors	Distance from Prescribed Premises
Threatened and Priority Flora	• 2150m north-west of the north-western boundary
Threatened Ecological Communities	• Premises within Mangarr (relic dune system dominated by extensive stands of Minyjara)
Threatened Fauna	• 1200m west: Falco peregrines, Fregata ariel and Stern hirundo • 1000m south: Calidris acuminate, Calidris ruficollis, Charadrius veredus, Fregata ariel, Limosa, Numenius madagascariensis, Tringa nebularia, Tringa stagnatilis, Arenarai interpres, Calidris canutus, Calidris ferruginea, Calidris subminuta, Calidris tenuirostris, Charadruis mongouls, Hirundo rustica, Limosa lapponica, Numenius minutus, Stern hirundo, Calidris alba, Pluvialis squatarola, Sula leucogaster and Tringa glareola

4 LEGISLATIVE CONTEXT

4.1 LICENCE

The Facility is a prescribed site under the Environmental Protection Act 1986 and is managed in accordance with an operating licence issued by the Department of Water and Environment Regulation (DWER). As of October 2022, the Facility is governed by Licence Number (L6912/1997/11) and the following EPL amendments:

- 26/04/2016 Amendment Notice 1 – extend expiry date 10 June 2028
- 24/01/2020 Amendment Notice 2 - change above-ground waste disposal buffer distance.

These amendments have been incorporated into the latest licence release (24 January 2020). Current conditions from the EPL and subsequent amendments relevant to this LCMP are detailed in **Section 4.1.1**. A copy of the EPL is provided in **Appendix C**.

4.1.1 *Current licence conditions relating to closure and capping works*

The following licence conditions (current as of October 2022) are relevant to the closure and capping works at the facility:

Condition 25. The licence holder shall divert stormwater away from all active and inactive disposal areas within the premises

Condition 26. The licensee shall ensure stormwater drains on the premise are kept clear to allow for drainage

Condition 27. The licensee shall ensure that stormwater that has come into contact with waste is diverted into a sump on the premises or otherwise retained on the premises.

4.2 BEST PRACTICE GUIDELINES

This LCMP is prepared in line with a risk-based approach and draws from the Closure Plan Risk Assessment (**Section 5**) and the *Best Practice Environmental Management (BPEM) Guidelines: Siting, design, operation and rehabilitation of landfills* (EPA Victoria, 2015). This has been used as there are no Western Australian guidelines.

According to the BPEM Guidelines, best practice rehabilitation of landfills should include consideration of the site after use, settlement and final surface profile, and landfill cap. The required outcomes of best practice landfill rehabilitation are to:

- Consider after use options for the Site
- Ensure that the seepage through the landfill cap is no more than 75% of the anticipated seepage rate through the landfill liner
- Design and construct the best cap practicable to prevent pollution of groundwater and degradation of air quality through the escape of landfill gas
- Design and construct the most robust cap to ensure that the system will continue to achieve the objective in the event of several components of the system failing
- Progressively rehabilitate the landfill.

This LCMP has been prepared to broadly align with the rehabilitation requirements as stipulated with other jurisdictional Best Practice Landfill Guidelines.

5 CLOSURE PLAN RISK ASSESSMENT

A pre-closure risk assessment for the Facility has been undertaken using a Source-Pathway-Receptor analytical model that involves an assessment of the source of potential emissions, identification of potential pathways for migration and delineation of receptors that could be impacted.

For the risk assessment, the key definitions are as follows:

- Source – The prime mover to cause significant contamination or harm to the environment
- Pathway – The route by which potential contamination or harm can migrate
- Receptor – The on-site and off-site location where the impact or harm is registered

5.1 SOURCES OF ENVIRONMENTAL IMPACT

The sources of environmental impact during the operation of the Facility include:

- Fire
- Vermin
- Landfill gas (LFG) / odour
- Leachate
- Dust
- Litter
- Invasive flora species.

5.2 RECEPTORS OF POTENTIAL ENVIRONMENTAL IMPACTS

The possible receptors of the impacts include:

- Surrounding land users – businesses and communities surrounding the Facility
- Surrounding infrastructure – buildings, road corridors, powerlines, etc., in close proximity to the Facility
- Surface water – permanent or semi-permanent surface water that provides a habitat for flora and fauna
- Groundwater – groundwater at the site or from which a water supply may be extracted for industrial or potable purposes.
- Vegetation and flora – on-site and off-site vegetation and flora species (e.g. grass or shrubs)
- Fauna – species whose habitat is within the landfill site or the surrounding area.

5.3 PATHWAYS

The key pathways include:

- Airborne – through which lightweight materials such as dust, odour, and landfill gas travel
- Surface transport – along which the sources of impact can travel (e.g. surface water run-off)
- Sub-surface flow – whereby the underlying soils, bedrock, aquifers, and infrastructure permit contaminants to pass to the soil and groundwater receptors below.

5.4 RISK MATRIX

Risk is defined as a coupled function of likelihood and consequence based on the levels shown in the following sub-sections.

5.4.1 *Likelihood*

Likelihood is measured in terms of probability, defined on a scale of 1 to 5, based on the following classification:

1. Rare - The risk event may only occur in exceptional circumstances
2. Unlikely - The risk event will probably not occur in most circumstances
3. Possible - The risk event could occur at some time
4. Likely - The risk event will probably occur in most circumstances
5. Almost Certain - The risk event is expected to occur in most circumstances

5.4.2 *Consequence*

Consequence is categorised as shown in **Table 5.1**. ASK has applied a scale of A – E for ease of reporting.

Table 5.1 - Consequence categories and impact definitions

	Environment	Public health and amenity
Slight (A)	• On-site impact: minimal • Specific Consequence Criteria (for environment) met	• Local scale: minimal impacts to amenity • Specific Consequence Criteria (for public health) criteria met
Minor (B)	• On-site impacts: low-level • Off-site impacts local scale: minimal • Off-site impacts wider scale: not detectable • Specific Consequence Criteria (for environment) likely to be met	• Specific Consequence Criteria (for public health) are likely to be met • Local scale impacts: low-level impact to amenity
Moderate (C)	• On-site impacts: mid-level • Off-site impacts local scale: low-level • Off-site impacts wider scale: minimal • Specific Consequence Criteria (for environment) are at risk of not being met	• Adverse health effects: low-level or occasional medical treatment • Specific Consequence Criteria (for public health) are at risk of not being met • Local scale impacts: mid-level impact to amenity
Major (D)	• On-site impacts: high-level • Off-site impacts local scale: mid-level • Off-site impacts wider scale: low-level • Short-term impact to an area of high conservation value or special significance • Specific Consequence Criteria (for environment) are exceeded	• Adverse health effects: mid-level or frequent medical treatment • Specific Consequence Criteria (for public health) are exceeded • Local scale impacts: high-level impact to amenity
Severe (E)	• On-site impacts: catastrophic • Off-site impacts local scale: high-level or above • Off-site impacts wider scale: mid-level or above • Mid to long-term or permanent impact to an area of high conservation value or special significance • Specific Consequence Criteria (for environment) are significantly exceeded	• Loss of life • Adverse health effects: high-level or ongoing medical treatment • Specific Consequence Criteria (for public health) are significantly exceeded • Local scale impacts: permanent loss of amenity

5.4.3 *Risk rating*

Risk is assessed on the combination of likelihood and consequence levels by a qualitative risk calculator, with the classification system shown in **Table 5.2.**

Table 5.2 - Risk calculator

Likelihood	Consequence				
	Slight	Minor	Moderate	Major	Severe
	A	B	C	D	E
Almost certainly (5)	5A	5B	5C	5D	5E
Likely (4)	4A	4B	4C	4D	4E
Possible (3)	3A	3B	3C	3D	3E
Unlikely (2)	2A	2B	2C	2D	2E
Rare (1)	1A	1B	1C	1D	1E

The risk rating is given a rating out of four possible levels, with appropriate actions associated with each as follows:

Low risk	Rectify hazard as appropriate
Medium risk	Plan and schedule appropriate controls
High risk	Implement high-level controls
Extreme risk	Conduct full analysis

5.5 RISK ASSESSMENT

Table 5.3 provides the risk profile for the operational phase of the Facility, including the identified source, pathway, receptor (S-P-R) linkage.

Table 5.3 - Pre-closure risk profile for Facility

Source	Receptor	Pathway	Pathway description	Risk description	Likelihood	Conseq.	Risk	Justification
Landfill Leachate	Community - residents	Subsurface	Leachate migration via groundwater & extraction via bores.	Leachate contaminates the aquifer and is extracted for non-potable use through groundwater bores.	Unlikely	Moderate	Medium (2C)	Groundwater flow is reported to be from the north-east to the south-west (Department of Water, 2012a Groundwater Resource Review Dampier Peninsula). The closest residential site is located approx. 900m to the west of the site (Sands Drive) and 1700m to the south (Fairway Drive). Given these distances, there would be significant contaminant attenuation, and concentrations at potential points of extraction would likely be below the limit of detection. Abstracted groundwater from private bores should not be used for potable purposes, thereby limiting potential health risks.
	Offsite Ecological Receptors – Surface water bodies (saltmarsh)	Subsurface	Vertical and lateral migration of leachate within the groundwater.	Leachate contaminates the aquifer and has adverse impacts on these receptors & associated ecosystems.	Rare	Minor	Low (1B)	Groundwater flow is reported to be from the north-east to the south-west (Department of Water, 2012a Groundwater Resource Review Dampier Peninsula). Given the direction of the groundwater flow and the location of the surface water body, approx. 320m to the north of the facility, it is rare that potentially contaminated groundwater will impact this receptor
	Offsite Ecological Receptors – Surface water bodies (saltmarsh)	Surface	Leachate migration via surface water run-off.	Contaminated surface water run-off impacting the ecological receptors.	Unlikely	Minor	Low (2B)	The distance to the nearest surface water is 320m to the north of the site. It is highly unlikely that, given this distance, surface water run-off from waste storage areas and cells may be emitted following periods of sustained and heavy rainfall. Contaminant concentrations are expected to be below the limit of detection or extremely low due to the significant dilution that would occur if rainfall was sufficient to carry leachate to these receptors.
	Onsite Ecological Receptors – Bushland flora/fauna	Surface	Leachate migration via surface water run-off.	Contaminated surface water run-off impacting the ecological receptors.	Possible	Minor	Medium (3B)	It is possible that surface water run-off from the site may cause minor impacts to these receptors and associated ecosystems located in close proximity to the site.

Source	Receptor	Pathway	Pathway description	Risk description	Likelihood	Conseq.	Risk	Justification
		Subsurface	Vertical migration of leachate within the groundwater.	Contaminated groundwater may impact deep-rooted flora.	Rare	Minor	Medium (3B)	It is possible that deep-rooted flora in close proximity to existing and historic waste cells may be impacted by leachate.
Landfill gas – explosive & asphyxiant gases	Site users and workers	Air	Landfill gas migration via direct venting into the atmosphere.	Asphyxiation & explosion caused by the landfill gas.	Rare	Major	Medium (1D)	Any landfill gas generated will be rapidly dispersed and oxidised.
Landfill gas – odour	Site users and workers	Air	Landfill gas migration via direct venting into the atmosphere.	Nuisance caused by the odour. Odour can be detected near the landfill surface.	Likely	Minor	Medium (4B)	It is likely that odour will be detected near the landfill surface and in close proximity to exposed waste.
Landfill gas – odour	Community-residents	Air	Landfill gas migration via direct venting into the atmosphere.	Nuisance caused by the odour. Odour can be detected near the landfill surface.	Unlikely	Slight	Low (2A)	The closest residential site is located approx.. 900m to the west of the site (Sands Drive) and 1700m to the south (Fairway Drive). Given these distances, there would be a significant dilution of potential odours from landfill. There are minimal exposed faces, and the use of daily cover material further negates potential impacts.
Landfill Fires	Site users and workers	Air	Burning waste emits smoke containing toxic compounds.	Bushfires causing a landfill fire. The combustion of waste materials can result in dangerous toxic emissions that includes dioxins, sulphur dioxide, lead, and mercury.	Possible	Moderate	Medium (3C)	Site workers can be potentially exposed to fires as part of the day-to-day operations or while attempting to extinguish minor fires.
	Community - residents				Unlikely	Moderate	Medium (2C)	It is unlikely that toxic smoke emissions will impact surrounding sensitive receptors given the dilution and distance factors of these receptors from the facility.

Source	Receptor	Pathway	Pathway description	Risk description	Likelihood	Conseq.	Risk	Justification
Dust	Community - residents	Air	Dust from site works, access roads and earthworks becoming airborne.	Nuisance caused by dust and health impacts from particulate matter.	Unlikely	Minor	Medium (2B)	The closest residential site is located approx. 900m to the west of the site (Sands Drive) and 1700m to the south (Fairway Drive). Given these distances, it is highly unlikely that dust emissions will reach the residential area; furthermore, there would be significant dilution of any potential dust emissions from the landfill.
Pests, Vermin and disease vectors	Offsite Ecological Receptors – Bushland flora & fauna	Surface & Air	Exposed waste may be used as a food source by vermin, and introduced fauna species, such as rodents, dogs, and cats and could result in elevated population levels.	Populations of vermin and introduced fauna species can negatively impact the surrounding natural fauna and flora.	Possible	Moderate	Medium (3C)	It is possible that exposed waste will attract vermin and fauna species causing increased populations in the vicinity of the landfill.
	Community – residents	Surface & Air	Exposed waste and ponded water can facilitate the breeding of disease vectors that are capable of impacting the community.	Flies, mosquitoes and rats can spread disease to humans and negatively impact the community amenity.	Unlikely	Moderate	Medium (2C)	Water can pond on-site during the wet season and periods of high rainfall.
Invasive flora species	Offsite Ecological Receptors – Bushland flora & fauna	Air, surface water run-off, and animal	Invasive weed species from seeds in waste received spread to the surrounding environment.	Invasive flora species impacting of the ecological value of the surrounding area.	Likely	Minor	Medium (4B)	Weed species will likely be present at the Facility due to waste being received that contains seeds. If left to become well established, weeds are likely to spread to the surrounding ecosystems where controlling them becomes more difficult and costly.

Source	Receptor	Pathway	Pathway description	Risk description	Likelihood	Conseq.	Risk	Justification
Litter	Community – residents	Air	Litter blown in the wind.	Mainly visual impact.	Rare	Slight	Low (1A)	Due to the long distance, the wind-blown litter is unlikely to reach the receptor, and the impacts are mainly visual (i.e. minor).
	Offsite Ecological Receptors – Bushland flora & fauna				Likely	Minor	Medium (4B)	It is likely that some wind-blown litter will enter the surrounding bushland, but the impacts are mainly visual (i.e. minor).

6 REHABILITATION DESIGN

The 2014 closure management plan, and the engineering design for the closure measures detailed within it, are based on the BPEM Guidelines (EPA Victoria, 2014), as this was the document the WA regulators required the industry to refer to at the time. The WA DWER no longer refers to BPEM; however, its broad objectives are appropriate, including rehabilitation to ensure that landfills are rehabilitated to minimise the seepage of water into the landfill and maximise the collection and oxidation of landfill gas from landfills.

The rehabilitation measures detailed within this section meet outcomes including:

- The seepage through the landfill cap is less than the anticipated seepage rate through a basal liner.
- Design and construction of the cap to minimise pollution of groundwater and degradation of air quality.
- Design and construction of the cap to ensure that the system will continue to protect the environment in the event of several components of the system failing.
- Development of a post-closure management plan to ensure that the site no longer poses a risk to the environment for at least 25 years after the site stops receiving waste.
- Progressive rehabilitation of the landfill.

Progressive rehabilitation of a landfill involves the closure and rehabilitation of each cell once filling is completed during the operating life of the landfill. These works are effectively a staged closure of the landfill that occurs while the operational site is being filled. Landfill cell rehabilitation works include:

- Capping and revegetation in accordance with regulatory requirements
- Where required, installation and ongoing maintenance and replacement of gas and leachate collection infrastructure
- Decommissioning of infrastructure no longer required.

Environmental and management benefits of progressive rehabilitation, specific to Buckleys Road landfill, include:

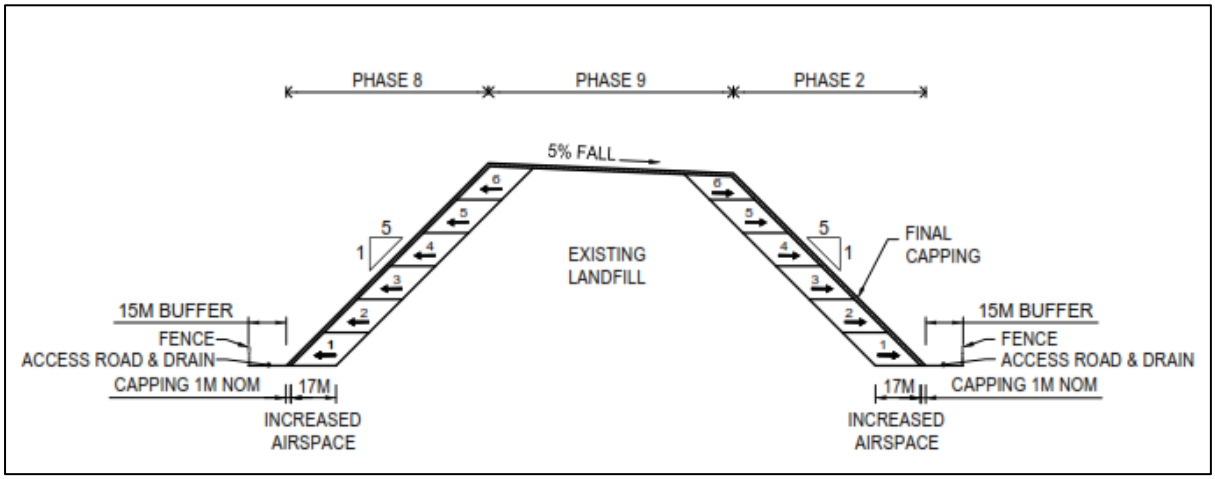
- Minimising the risk to the adjacent EDL facility
- Minimising the generation of leachate and offensive odours
- Facilitating materials budgeting through the staged use of capping materials over the life of the landfill
- Achieving cost recovery during the operational life of the landfill
- Completing rehab works while waste management personnel and plant are still based on-site
- Refining the capping design and construction methods based on experience and cap performance
- Meeting financial assurance requirements.

Implementation of progressive rehabilitation at a landfill should be consistent with the landfill closure plan.

The above-ground cells should be marked on-site to provide a defined cell for waste placement and to provide the site operators with a guide to the waste depth and final heights required. Then,

as each area at the site gradually achieves the final profile, it can be capped and rehabilitated as shown in **Figure 6.1.**

Figure 6.1 - Section from Facility Filling Plan (GreenTec, 2020)

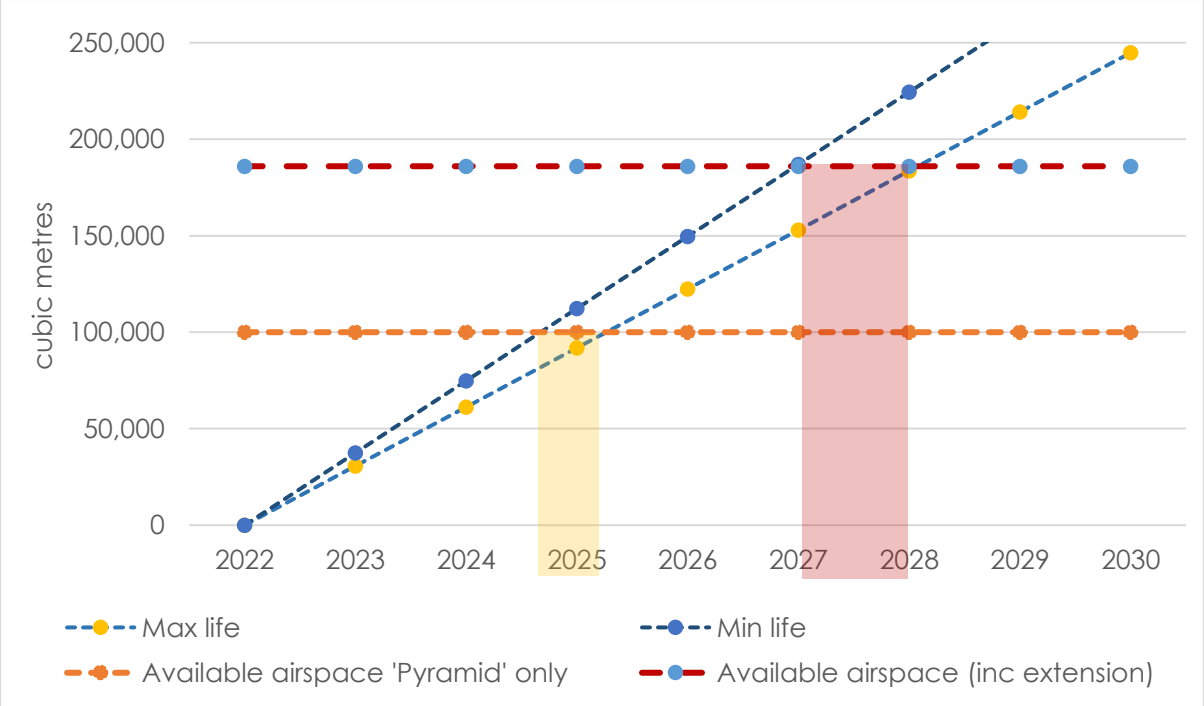


6.1 FILLING RATE

As a result of the improved operational practices, the Shire has reduced the utilisation of airspace from 40,000 cubic metres in 2019-20 to 34,000 cubic metres in 2021-22. This reduced rate of airspace use is reflected in the operational life projection.

Extending the footprint of the existing disposal area to a 15m internal buffer, including the extension area to the west and maintaining the gradients at 1(v):5(h); approximately 186,000 cubic meters of useable airspace is available (based on a survey dated June 2022). This results in a projected operational life for the 'pyramid' area until approximately June 2025 and the extension area being filled by approximately June 2027 – June 2028. The estimated cumulative airspace consumption over the remaining operational life of the landfill is shown in **Figure 6.2**.

Figure 6.2 - Estimated cumulative airspace consumption



6.2 PROPOSED FUTURE USE

The post-closure use of the site has not been decided by the Shire. Considering the proximity of the EDL facility and the risks this presents, the use of the site for any future waste management or recycling activities (such as a transfer station) should undergo a comprehensive risk assessment and include measures in the design to accommodate the risks associated with waste materials stored next to a gas facility in a cyclone area.

Considering the potential issues at the site leading from the historic uncontrolled disposal of waste and poor management practices during the initial operations at the Facility, ASK would suggest the post-closure use of the site is limited to a restored area of natural vegetation. Public access should not be encouraged until the site has completed most of its secondary settlement and the cap vegetation is mature. This could be 5 – 10 years after site closure, and a site assessment should be made prior to any change of use for the site.

6.3 PROPOSED FINAL LANDFORM

Maximising the available airspace at the Facility is essential to increase its operational life and conserve the valuable asset of established airspace. As such, the final footprint for the waste disposal area includes the reduced internal buffer and the extension area to the west (currently used for domestic waste drop-off).

Designs for the phased closure of the landfill that comply with the objectives and requirements of BPEM have been developed for the site. The key objectives for the closure designs include the following:

- Ensuring that all waste materials are covered to mitigate long-term environmental impacts
- Final profile and slopes that are greater than 1V:20H (5%) and less than 1V:5H (20%) to:
    - Ensure the long-term stability and integrity of the capping material and containment layer
    - Promote natural surface water run-off
    - Provide an aesthetically acceptable landform
    - Minimise long-term maintenance requirements.
- Facilitate phased capping of the landfill.

The proposed final landforms for each stage are discussed in the following sub-sections.

6.3.1 *Stage1: Existing above-ground 'pyramid' waste disposal area*

The final landform for the existing waste disposal area includes the following:

- An unlined expansion of the current landfill footprint to within 15m of the premise's boundary in line with DWER Amendment Notice (24/01/202)
- The final cap gradients at 1(v):5(h)
- The landfill peak has an approximate RL of 35m and is a slightly sloped area approximately 25m wide to ensure precipitation run-off
- Stormwater infrastructure, including sediment and erosion control measures on slopes and a batter (drainage) chute running adjacent to the access road to the top of the landfill to aid controlled precipitation run-off.

6.3.2 *Stage 2: Extension area*

This area expands the landfill footprint within the prescribed premise's boundary into the portion of the site currently used for community waste and recycling drop off, water tanks, standpipe and the

Rangers compound. This area is understood to be previously utilised for landfill, with several historic trenches containing asbestos and medical waste. The final landform of this area includes the following:

- Landfill to within 15m of the premise boundary. The western boundary of the landform in the contingency area is approximately 15m from the road (to EDL)
- The final cap gradients at 1(v):5(h)
- The final landform within the contingency area builds to a ridge at an approximate RL of 25m connecting the existing landform building to the landfill peak
- Stormwater infrastructure, including sediment and erosion control measures on slopes and batter (drainage) chutes running adjacent to the access road to the top of the landfill, to aid controlled precipitation run-off.

The proposed final design is shown in **Figure 6.3,** and a plan showing the two stages is shown in **Figure 6.5**. The plans of the final landform are provided in A3 format in **Appendix A**.

Figure 6.3 - Proposed final landform - top of waste (Greentec 2021)

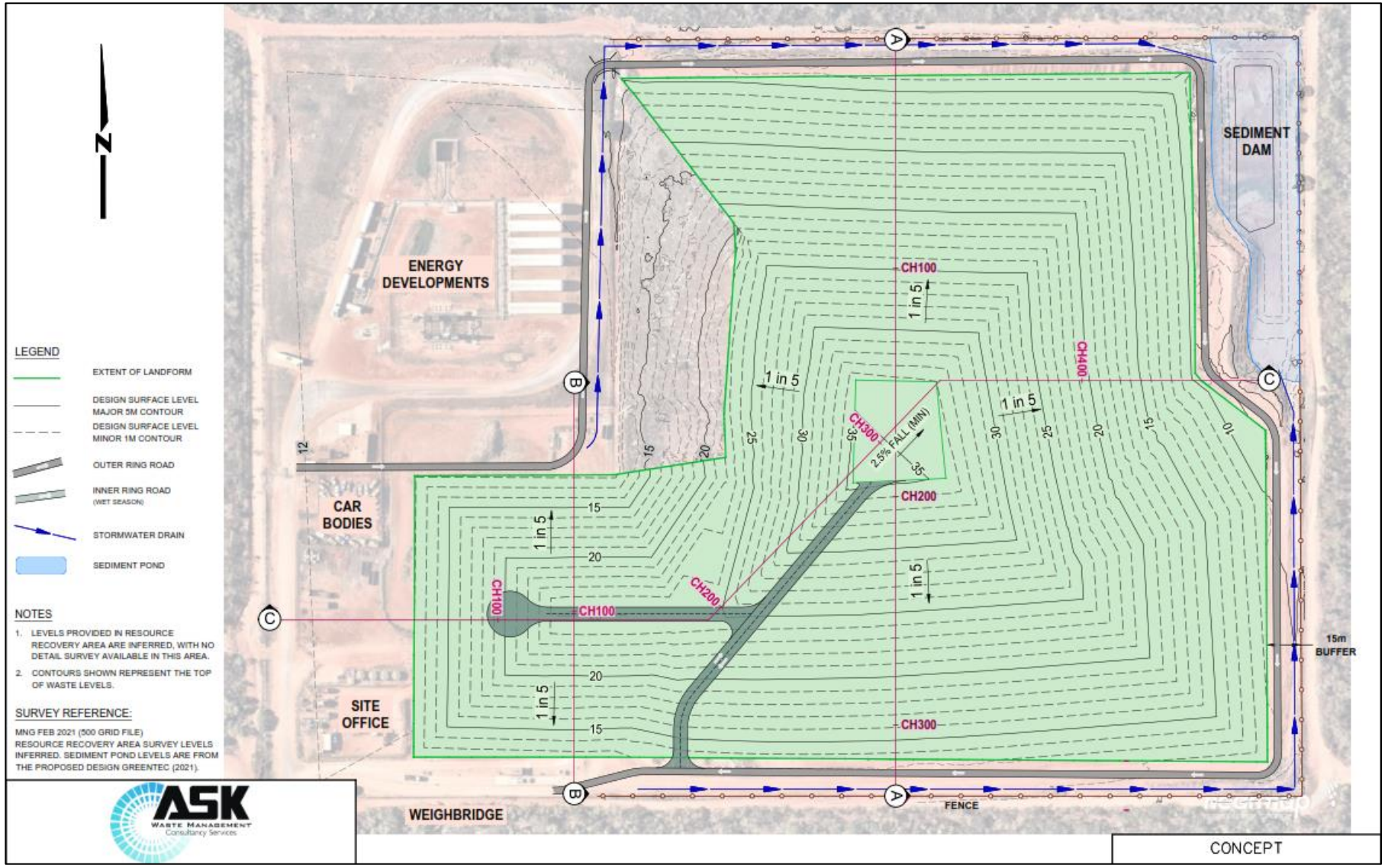


Figure 6.4 - Proposed final landform - top of the cap (Greentec 2021)

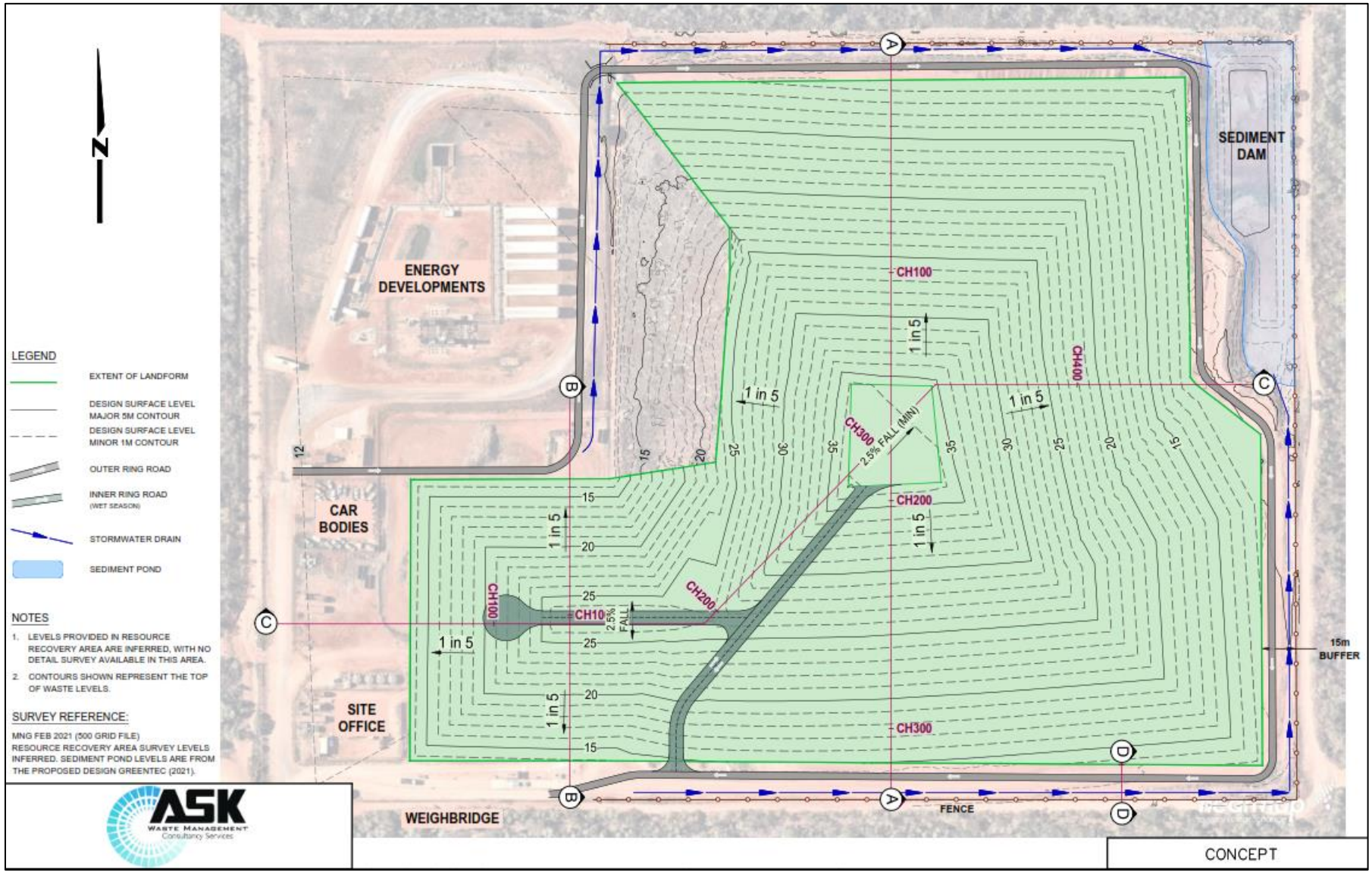
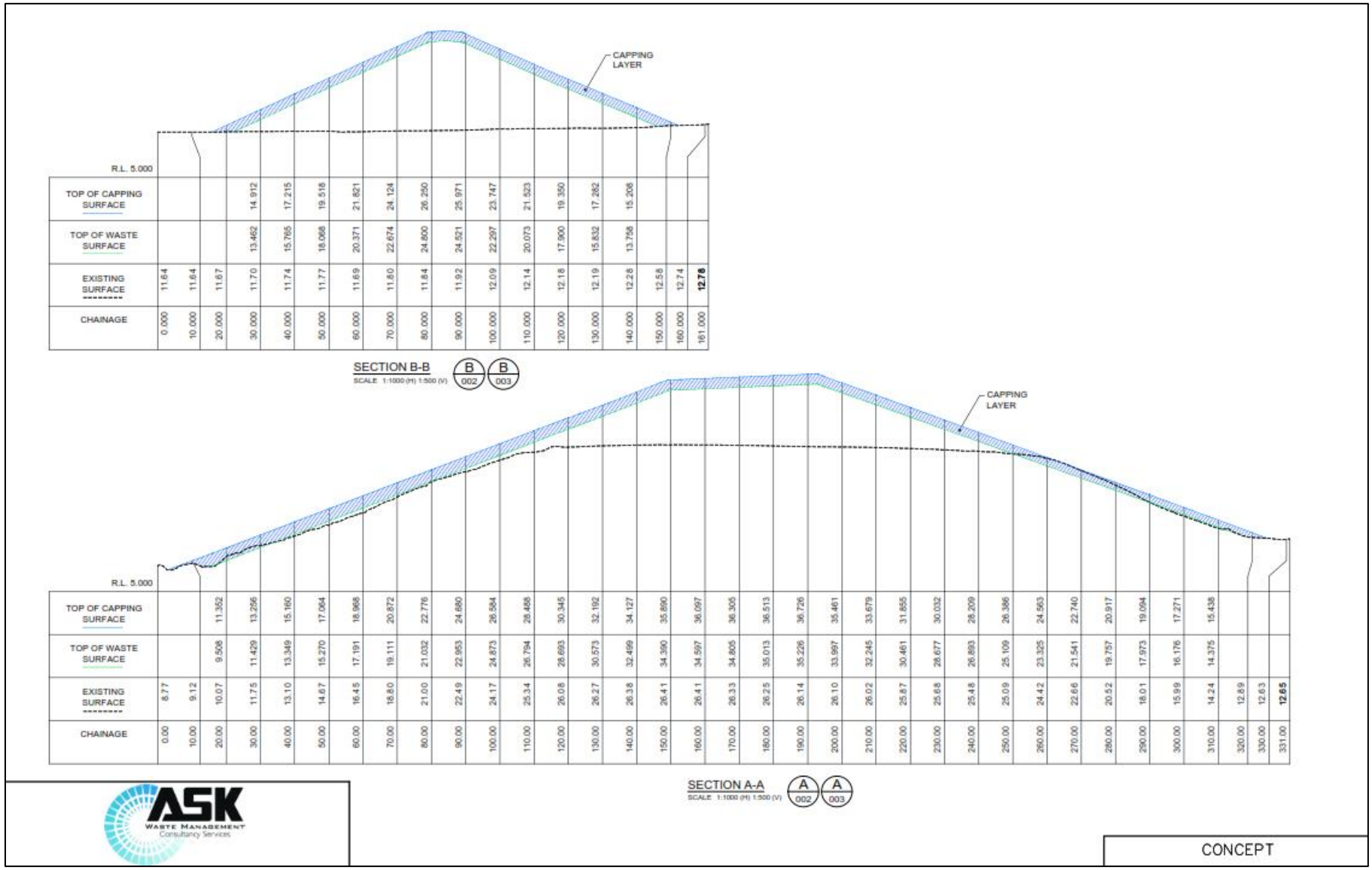
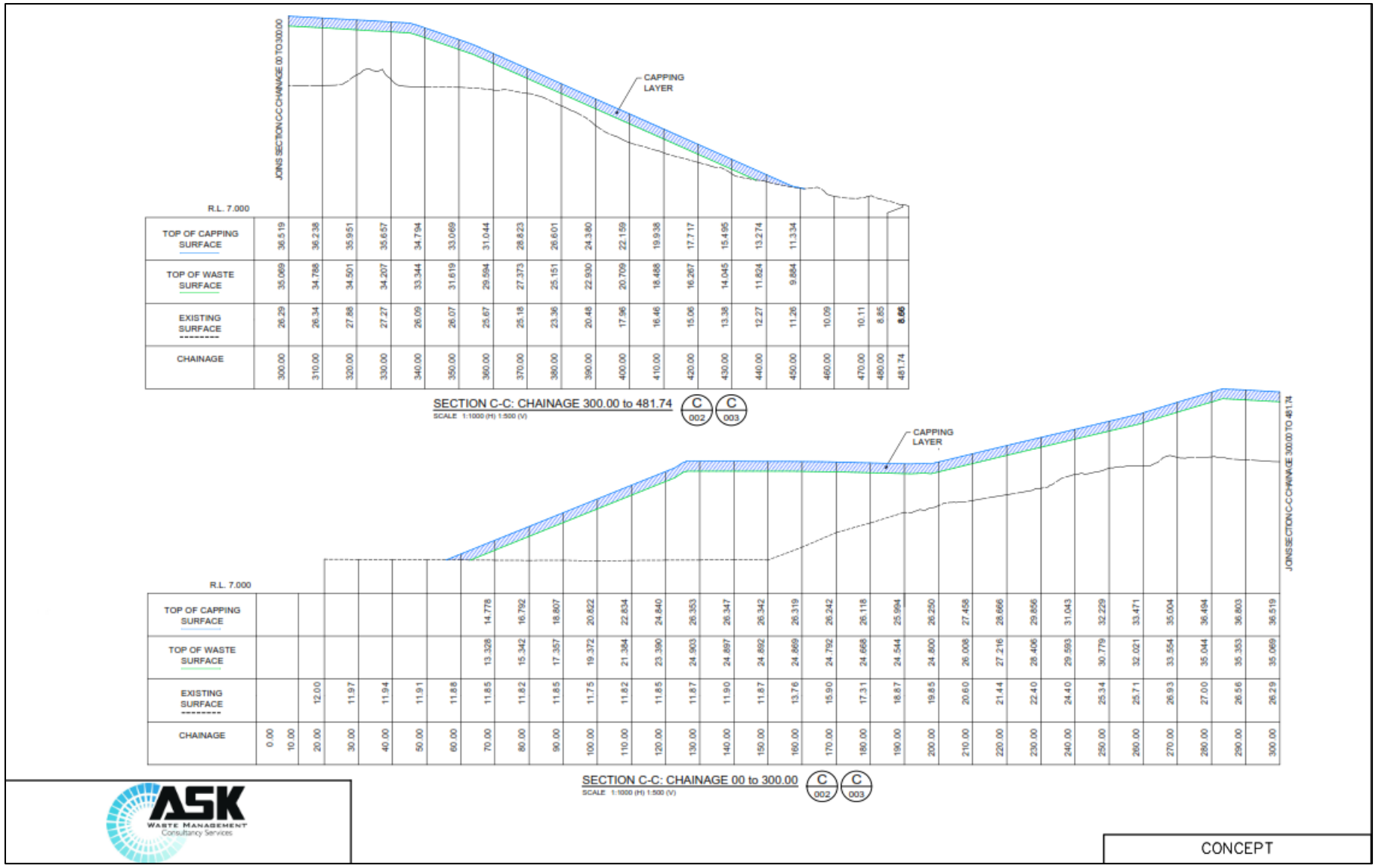


Figure 6.5 – Sections of the proposed final landform (Greentec, 2021)




JOINS SECTION C-C CHAINAGE 00 TO 300.00
CAPPING LAYER
R.L. 7.000
TOP OF CAPPING SURFACE
TOP OF WASTE SURFACE
EXISTING SURFACE
CHAINAGE
SECTION C-C: CHAINAGE 300.00 to 481.74
SCALE 1:1000 (H) 1:500 (V)
C 002
C 003
CAPPING LAYER
JOINS SECTION C-C CHAINAGE 300.00 TO 481.74
R.L. 7.000
TOP OF CAPPING SURFACE
TOP OF WASTE SURFACE
EXISTING SURFACE
CHAINAGE
SECTION C-C: CHAINAGE 00 to 300.00
SCALE 1:1000 (H) 1:500 (V)
C 002
C 003
ASK
WASTE MANAGEMENT
Consultancy Services
CONCEPT

6.4 PHASING OF SITE (FILLING PLAN)

The appropriate establishment of waste disposal cells, waste placement, compaction and covering of waste in line with best practice standards is important as it:

1. Establishes waste disposal cells in a logical order to ensure progressive capping and rehabilitation are promptly achieved, thus minimising environmental impacts from uncapped active areas of the landfill.
2. Maximises landfill airspace use and increases the lifespan of the landfill.
3. Minimises soil covering costs and allows for the use of any cover and capping materials that become available during the operational life of the landfill.

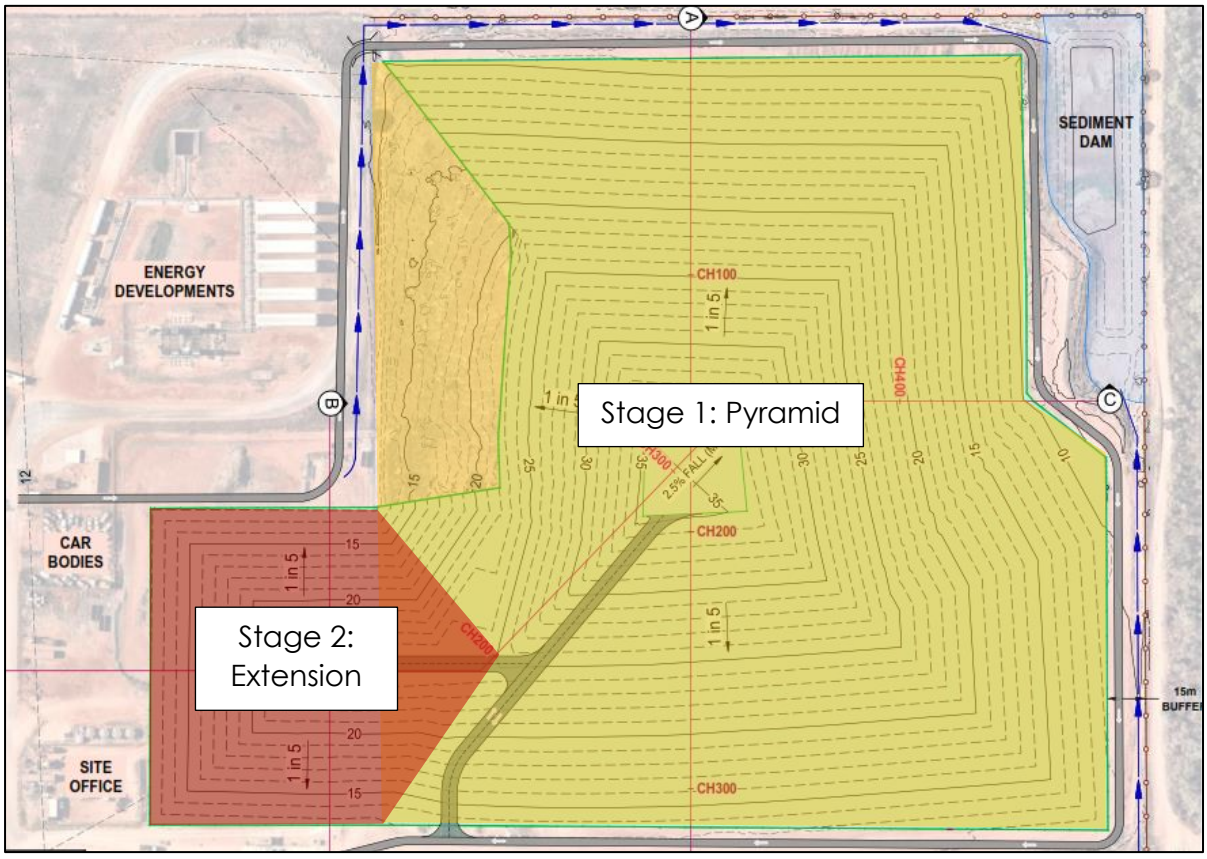
The increased landfill footprint through the reduction of the landfill buffers has involved the scraping back of the existing capping materials in some portions of the site to allow for additional waste disposal. Filling of the waste mass to achieve the final landform will be undertaken in phases.

Once the capping material has been removed from each area and stockpiled for future use, waste can be placed and compacted until the final landform contours are achieved. If waste disposal ceases in an area for more than three months before the final levels are achieved, that area should be covered with 300mm of intermediate cover. This is to minimise the risk of impacts on the environment. The intermediate cover should be removed prior to waste disposal continuing in this area.

The above-ground waste disposal areas should be marked to provide a defined cell for waste placement and the site operators with a guide to the waste depth and final heights required. As each area achieves the final landform, it can be capped and rehabilitated.

Progressive capping will reduce contaminated stormwater and leachate generation, spread rehabilitation and closure costs, and allow for initial settlement to take place before final capping is placed. It will also improve the site's aesthetics once suitably vegetated. Vegetation of the side slopes will also reduce soil erosion and sedimentation of the stormwater infrastructure.

Figure 6.6 - Stages of the Facility filling plan



6.5 CAPPING SYSTEM DESIGN

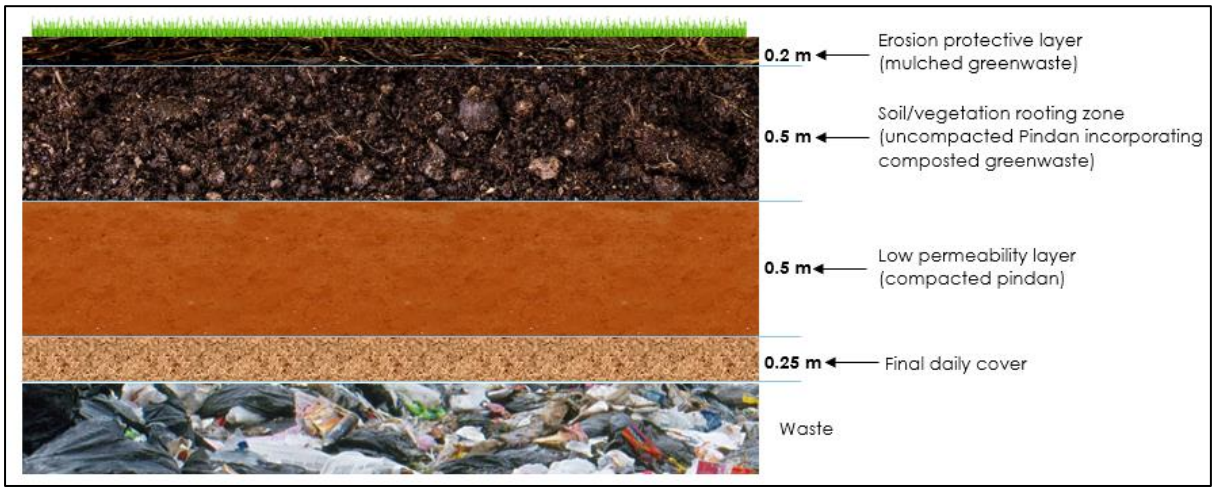
The landfill cap forms a major component of the closure of the Facility. Therefore, the design objectives for the final landform and cap are as follows:

- Minimise infiltration of water into the waste, ensuring that the infiltration rate does not exceed the seepage rate through the base of the landfill.
- Provide a long-term stable barrier between waste and the environment.
- Improve the visual amenity of the site.
- Provide a physical barrier to the waste body, minimising the risk to the EDL facility.
- Manage surface water flows to minimise the potential for leachate generation and surface ponding.

The Buckleys Road landfill is unlined; therefore, the base of the cells and historic trenches are constructed from naturally occurring subsoils (Pindan sands). The risk assessment completed in **Section 5.5** has been used to determine an appropriate capping design, as shown in **Figure 6.7.** The design reflects the risk presented by the Facility and BPEM guidelines and local factors.

This cap design was used for the 2012 LCMP and was accepted by DWER, provided the first stages of capping were assessed to ensure it would withstand the rainfall events experienced in Broome. The western batter of the landfill was capped in 2017; since then the cap has withstood several large rainfall events and cyclones with minimal erosion.

Figure 6.7 - Proposed cap design



The cap comprises of the following layers.

Erosion protection layer. Due to the intensity of rainfall events in the region and the final slopes of the sites, a 200mm layer of coarse mulch will be required to minimise the risk of cap erosion until vegetation has become established. The mulch can be produced from greenwaste received at the facility. However, to avoid the introduction of weed seeds, the mulch must be adequately pasteurised (composted), or a weed spraying program should be implemented.

Research has shown that using a layer of greenwaste over bare soil at landfill sites can reduce run-off by 50% and total suspended sediments (TSS) by 98% (Brodie, 2009).

Soil/vegetation rooting zone. This 500mm layer of soil will provide the rooting zone for the cap's vegetation. It can be produced with uncompacted local soils (Pindan), and composted greenwaste can be applied and incorporated within this layer to improve the soil's ability to support the vegetation planted on the cap.

The greenwaste received at the facility is already shredded and windrowed. Once this material has been shredded, it can be screened into mulch (larger-sized material) and composted fines (small soil-like material). The 'fines' can be mixed into the soil layer to improve the soil quality, and the coarse mulch can be used as the erosion protection layer. It has been the Shire's experience that the greenwaste contains few weed seeds; however, a weed spraying program should be implemented once the cap has been constructed.

Low permeability layer. Considering the lack of locally available clay and the DWER advice to ensure some rainfall infiltrates into the waste body to aid biological activity (Per com, Damian Thomas 2011), a 500mm layer of compacted Pindan sand will be used. Emery *et al.* (2003) state that static compaction with a natural dry back will maximise the strength of the capped layer.

The soil at the facility has undergone permeability testing at normal field density and moisture conditions. The coefficient of permeability was recorded at $6.9E^{-7}$ in these tests (SGS, 2009).Therefore, it can be expected that the compacted pindan suggested for the cap's low permeability layer would achieve a lower result, possibly in line with the testing completed for the maturation pond at Water Corporations Crab Creek WWTW, where results between $1.1x10^{-9}$ – $2.5x10^{-8}$ have been recorded for the compacted Pindan sands(DEC, 2009). Therefore, the layer of compacted pindan will provide the low permeability barrier required to limit the infiltration of water into the waste body.

The combination of surface run-off from the contoured capping layer, evapotranspiration from the vegetation, evaporation from the mulch and soil layers, together with the compacted layer of Pindan sand, are expected to provide the 'less than 75% seepage rate' required for best practice.

Final daily cover layer. A final daily cover layer of 250mm should be spread over the last layer of waste and appropriately compacted to ensure a stable, uniform layer with no exposed waste that the capping can be constructed over.

Therefore, any suitable soil material for the soil/rooting layer received at the site during its remaining operational life should be stockpiled in preparation for rehabilitation works.

6.5.1 *Vegetation*

The landfill will be rehabilitated to natural vegetation after its closure; therefore, the plantings should be of species found in the surrounding natural vegetation.

Advice should be sought regarding suitable species indigenous to the area and local provenance. To avoid inappropriate planting, ensure the species are adaptable to the local climate; and enhance the local habitat. For example, Roebuck Plains Couch is a rapidly growing local species that may provide a suitable ground cover.

Shallower rooting species should be used, as any roots penetrating the low permeability layer into the waste body may provide a conduit for water to flow through the cap. In addition, as the waste is likely to produce small quantities of methane (a toxic gas to flora) for a number of years after capping, any roots penetrating the cap would be exposed to methane and possibly result in the death of the plant.

7 SURFACE WATER MANAGEMENT DESIGN

A surface water management design for the Facility has been developed to manage the environmental risks associated with the infiltration of surface water into the waste mass and minimise leachate production.

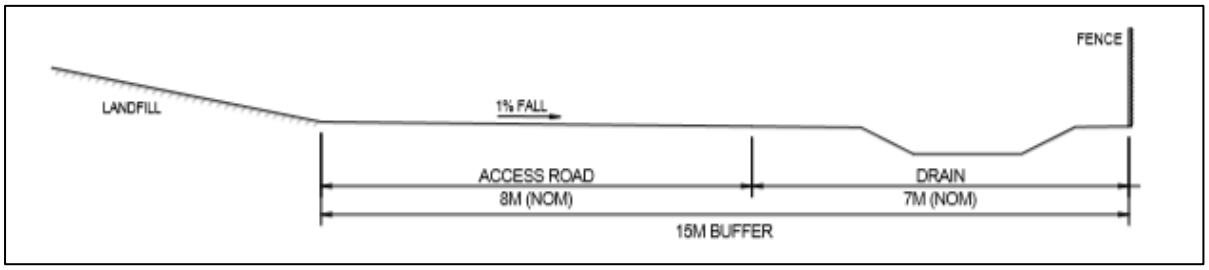
7.1 DESIGN OF SURFACE WATER MANAGEMENT INFRASTRUCTURE

The key design features utilised to achieve these objectives include:

- Implementation of a best practice capping and surface water management system over the landfill.
- Development of a perimeter drainage system along the toe of the landfill to collect stormwater.
- Diversion of stormwater away from the waste cell into the sediment dam to capture any water-borne litter and soils (eroded during high-intensity rainfall events) prior to controlled discharge off-site.
- Incorporation of measures into the capping system to direct surface water from the landfill cap to the stormwater drains, such as contour drains and drainage chutes.

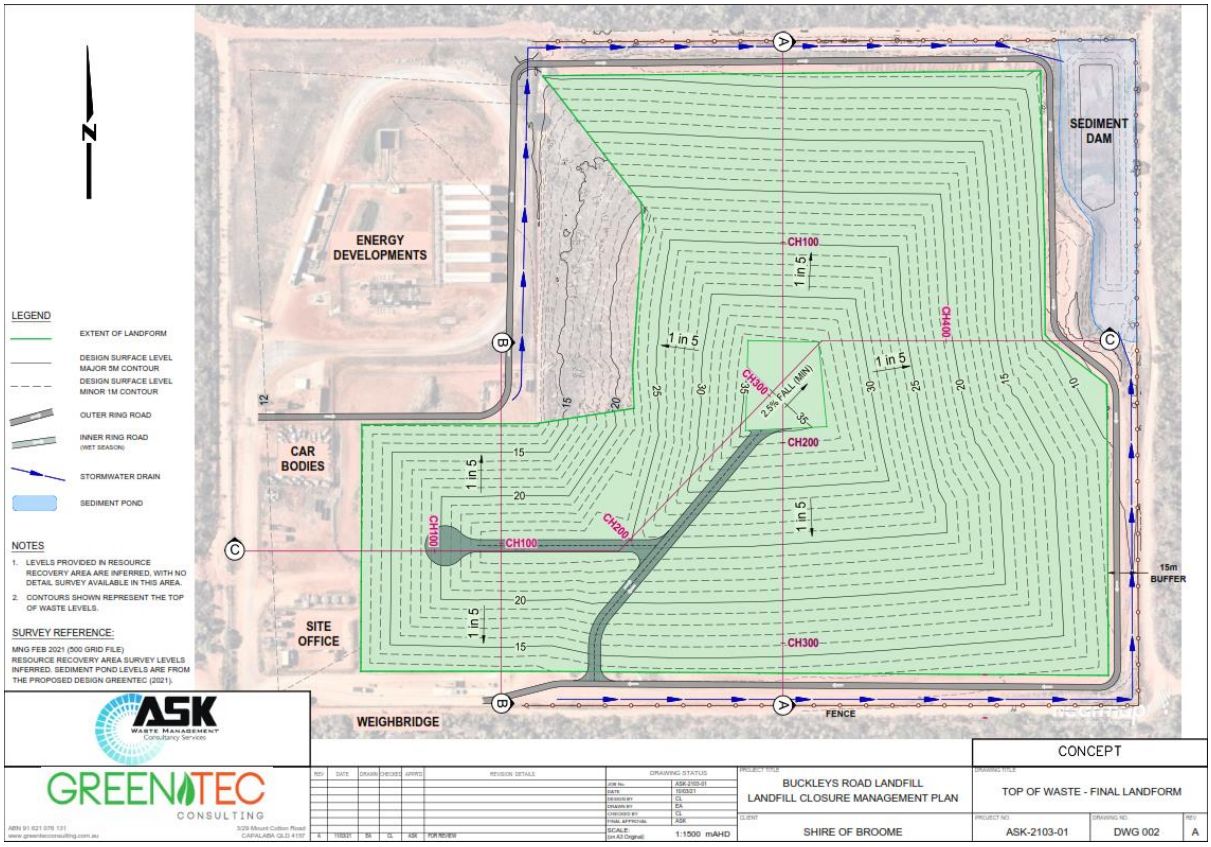
The design of the final slopes of the active area has been developed to minimise rainfall from infiltrating through the body of waste. In addition, to prevent stormwater from flowing into the filled area of the site and carry away surface water run-off from the capped area, surface drains will be constructed around the perimeter of the waste body. The schematic layout of the drains at the foot of the waste batter is shown in **Figure 7.1** for ease of understanding; it has been slightly modified to reflect the amended post-closure slopes.

Figure 7.1 - Typical final section through 15m buffer (Greentec, 2020)



A conceptual stormwater management design is shown in **Figure 7.2** and is also shown in **Appendix A**. The Shire has already produced a detailed design for an appropriate sediment pond, and the design is contained within a separate report produced by GreenTec Consulting.

Figure 7.2 - A conceptual stormwater management design



8 LANDFILL GAS MANAGEMENT DESIGN

Landfill gas (LFG) is a natural by-product of the anaerobic biological decomposition of the organic fraction of solid waste disposed of in putrescible landfills. LFG consists primarily of Methane (CH_4) and Carbon Dioxide (CO_2) but may contain many other constituents in small quantities.

Once the LFG has been generated, it often moves through and out of the landfill via the path of least resistance. If the LFG moves out of the landfill into the surrounding soils, it is called "migration". If it moves out of the landfill through the landfill cover into the atmosphere, it is called "emissions". In either case, the LFG can significantly impact the environment, human health, and safety.

The Facility currently has no gas migration monitoring points or gas management infrastructure. The formation of gas is likely to continue for some years.

8.1 LANDFILL GAS CONTROL AND MODELLING

Landfill gas (LFG) can be controlled by installing active systems where the system uses a vacuum to extract the landfill gas generated, or passive systems, similar to active but with no vacuum pump that collects and combusts the gases they no longer pose environmental and health issues.

The Victorian EPA (2015) *Siting, Design, Operation and Rehabilitation of Landfills* suggest active systems are used for moderate to large generation rates of landfill gas (> 250 m^3/hr), whereas passive systems are used for smaller rates of landfill gas (< 250 m^3/hr). Furthermore, as outlined in landfill guidelines:

- Methane concentrations associated with LFG emissions are not to exceed the following:
    - Landfill surface final cap 100 ppm
    - Within 50mm of penetrations through the final cap 100 ppm
    - Landfill surface intermediate cover areas 200 ppm
    - Within 50mm of penetrations of intermediate cap 1,000 ppm
    - Subsurface geology at the landfill boundary 1% v/v methane
    - Subsurface services on and adjacent to landfill site 10,000 ppm
    - Building structures on and adjacent to landfill site 5,000 ppm
    - Landfill Gas flares 98% destruction efficiency

As a first-order assessment of the need for an LFG management system at the Facility, LFG generation modelling has been undertaken using the USEPA landfill gas emissions estimation model (LandGEM) for the existing waste disposal area. This modelling has been based on the assumption that 19,900 tonnes per annum[2] of waste is being disposed of at the Facility and that 80% of this is putrescible and capable of producing LFG. Therefore, the quantity of putrescible waste used in the modelling is estimated to be 15,920 tonnes in 2022, with a 1% historic decline and 1% increase for each remaining year of operation.

[2] Five year average

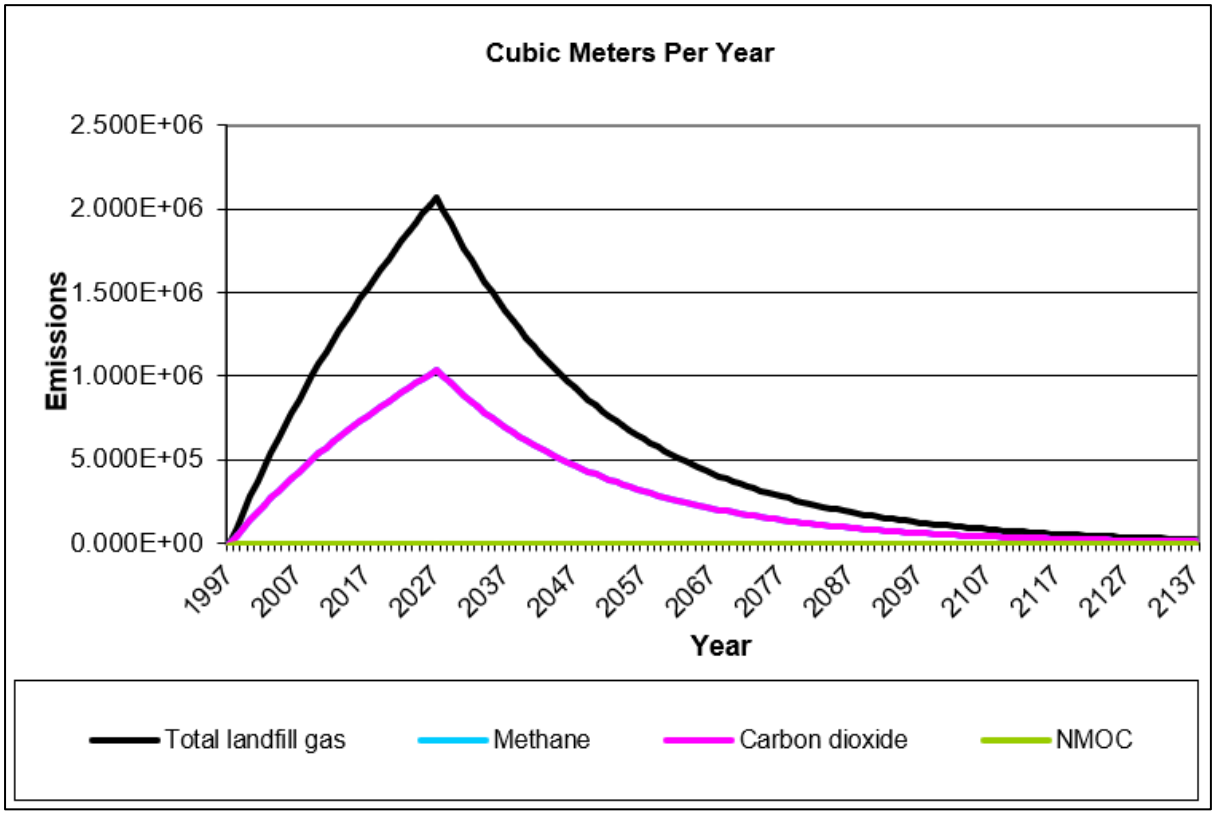
The waste acceptance criteria over this period have been restricted to putrescible waste, with the following parameters assigned:

- Methane generation decay rate (k) 0.04/year
- Potential methane generation capacity of waste (L0) 100m³/tonne
- Waste Disposal rate 15,920 tpa (2022)
- NMVOC concentration (Default Value) 4,000pmv (as hexane)
- Methane Content 50% by volume

The operational timeframe used for modelling is from 1997 to 2026, in line with the estimated range of remaining operational life for the landfill. This represents a total operating period of some 29 years and conservatively assumes that the waste materials have not stabilised.

The estimated generation of landfill gas will peak at 2,073,000 m³/yr upon closure (**Figure 8.1**); this is equivalent to a peak landfill gas generation rate of 237 m³/hr of LFG. In comparison, a one-megawatt LFG generator needs 530 – 630m³/hr to operate.

Figure 8.1 - Estimated projection of LFG generation (LandGEM)[3]



[3] The LandGEM modelling indicates projected generation of Methane (m³) to be the same as carbon dioxide. The 'blue line' for methane is hidden by the carbon dioxide line.

8.2 LANDFILL GAS MANAGEMENT SYSTEM

Based on the results observed in the modelling, a landfill gas management system to control gas emissions is justified. Therefore, a staged approach to the development of the site's gas extraction system is recommended. This approach will involve the following steps:

- Step one: A detailed preliminary design of an appropriate landfill gas management system should be completed by a landfill gas company or engineer before the first stage is completed, as some infrastructure is likely to be installed prior to capping.
- Step two: Installation of gas vents finished with 'whirly birds' for passive venting as part of capping of stage 1 (Pyramid area).
- Step three: Once the first stage of the landfill is capped and the passive vents have been installed, a gas field analysis should be completed to determine the quantity and quality of the landfill gas (LFG) emissions.
- Step four: Assess the actual quantity and quality of LFG emissions, as opposed to the modelled outcomes, to define the final design of an appropriate landfill gas management system. Actual emissions may require the installation of an active landfill gas extraction system to process landfill gas via flaring or biofilter scrubbing.

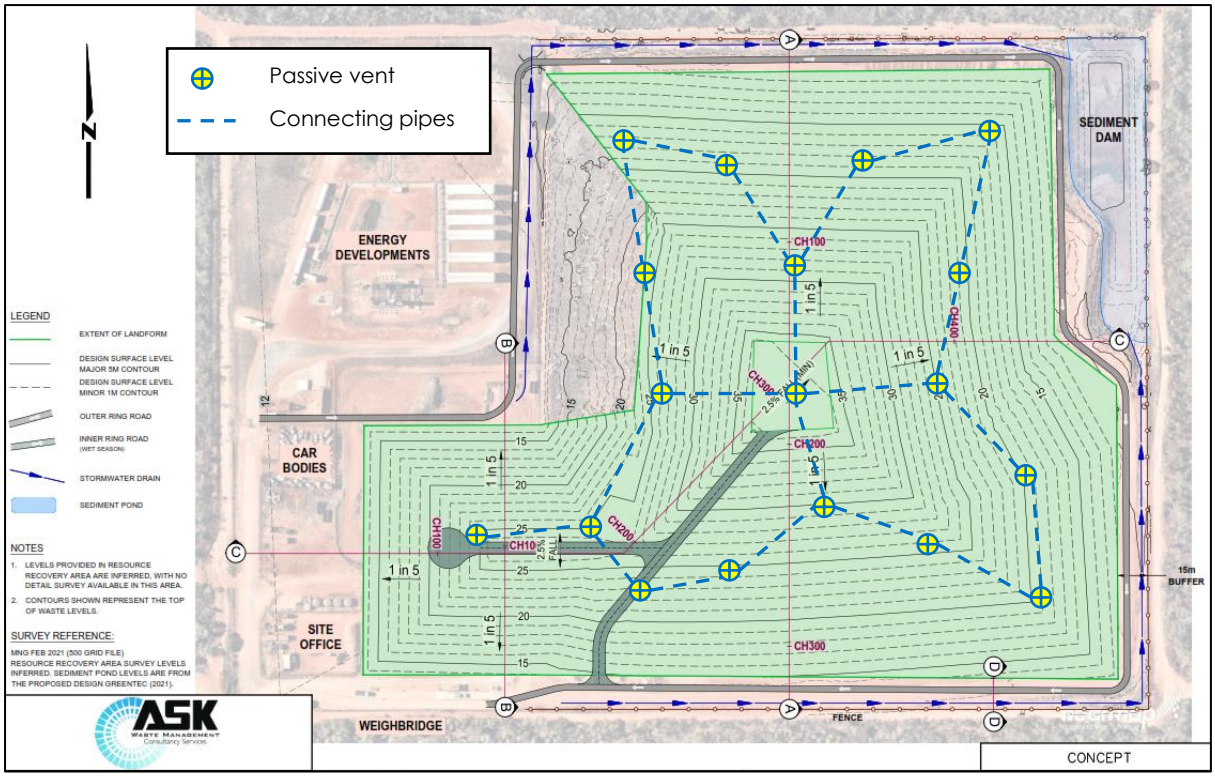
The LFG management system should be easy to use, construct and maintain and be made out of materials suitable for the local environmental conditions and be able to operate in corrosive environments.

Active and passive landfill gas extraction wells are the same design and can be used interchangeably between both systems. Horizontal gas wells are used during landfilling operations and may be superseded by vertical gas wells once an area has been completely filled, and intermediate and final cover materials have been placed (BEPM, 2015).

A typical passive venting system would include both vertical and horizontal PVC lines to maximise LFG collection. The venting system would be constructed in areas where landfilling activities have ceased and/or prior to the placement of capping layers. The vertical perforated pipes would be excavated or drilled into the waste mass to a depth within 3m from the base of the landfill, with aggregate used as backfill around the pipe. Horizontal perforated pipes will extend some 3m on the underside of the landfill cap and connect to the vertical pipes by a tee junction with the vertical pipes that penetrate through the landfill cap.

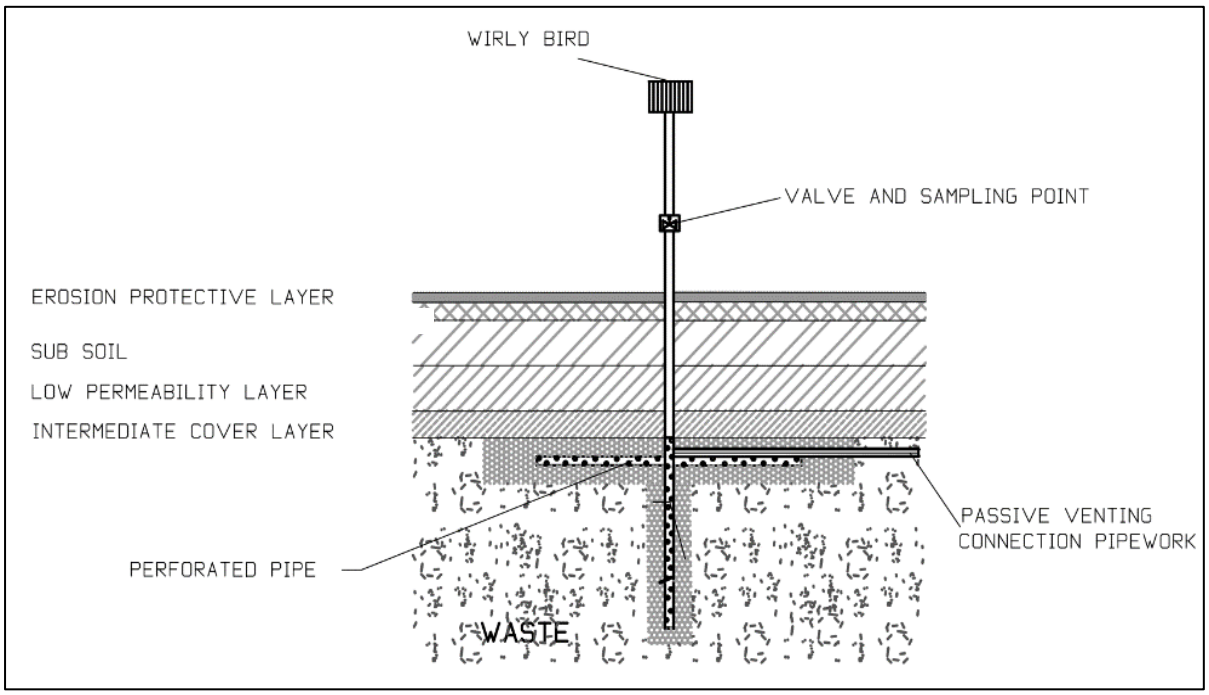
The vent pipes will extend to a minimum height of 2m above the capped surface level and include a valve for sampling and isolation with a whirly bird on the top of the pipe fixture, as shown in **Figure 8.3**. The individual vents should be connected via PE pipework to ensure redundancy in the system in the event of infrastructure failure; a conceptual layout has been provided in **Figure 8.2**.

Figure 8.2 - Conceptual layout of LFG collection system



N.B. This figure provides a conceptual layout for the LFG collection system. An LFG engineer is required to design the actual layout, prior to any capping works being completed.

Figure 8.3 - Typical design and installation of LFG passive vent (GreenTec, 2020)



9 REVISED RISK ASSESSMENT

A post-closure risk assessment for the Facility has been completed using the Source-Pathway-Receptor analytical model as detailed in **Section 5.3,** which involved an assessment of the source of potential emissions, identification of potential pathways for migration and delineation of receptors that could be impacted.

The risk assessment covers all potential emissions from the landfill, including landfill gas and groundwater contamination. The findings of the risk assessment for the Facility following closure, capping and rehabilitation are summarised in **Table 9.1**.

Table 9.1 - Post-closure risk profile for Facility

Source	Receptor	Pathway	Pathway description	Risk description	Likelihood	Conseq.	Risk	Justification
Landfill Leachate	Community – residents	Subsurface	Leachate migration via groundwater & extraction via bores.	Leachate contaminates the aquifer and is extracted for non-potable use through groundwater bores.	Rare	Minor	Low (1B)	The landfill will be capped, and this will reduce impacts on leachate generation. Groundwater monitoring will be undertaken as part of the post-closure management measures to provide data on groundwater quality and performance of the cap and water management on site.
	Offsite Ecological Receptors – Surface water bodies (saltmarsh)	Subsurface	Vertical and lateral migration of leachate within the groundwater.	Leachate contaminates adverse impacts on these receptors & associated ecosystems.	Rare	Minor	Low (1B)	
	Offsite Ecological Receptors – Surface water bodies (saltmarsh)	Surface	Leachate migration via surface water run-off.	Contaminated surface water run-off impacting the ecological receptors.	Rare	Minor	Low (1B)	Surface water management measures will mitigate any potential impacts on offsite ecological receptors.
	Onsite Ecological Receptors – Bushland flora/fauna	Surface	Leachate migration via surface water run-off.	Contaminated surface water run-off impacting the ecological receptors.	Rare	Minor	Low (1B)	
		Subsurface	Vertical migration of leachate within the groundwater.	Contaminated groundwater may impact deep-rooted flora.	Unlikely	Minor	Medium (2B)	The landfill will be capped, and this will reduce impacts on leachate generation. Groundwater monitoring will be undertaken as part of the post-closure management measures to provide data on groundwater quality and performance of the cap and water management on site.

Source	Receptor	Pathway	Pathway description	Risk description	Likelihood	Conseq.	Risk	Justification
Landfill gas – explosive & asphyxiant gases	Site users and workers	Air	Landfill gas migration via direct venting into the atmosphere.	Asphyxiation & explosion caused by landfill gas.	Rare	Minor	Low (1B)	Installation of a landfill gas management system such as that described in **Section 8** will ensure the controlled emission of landfill gas from the landfill and minimise the risk of asphyxiation and explosion.
Landfill gas – odour	Site users and workers	Air	Landfill gas migration via direct venting into the atmosphere.	Nuisance caused by the odour. Odour can be detected near the landfill surface.	Possible	Minor	Medium (3B)	Landfill will be capped. Point source odour may be detected from aspirating cowls for several years following closure.
Landfill gas – odour	Community - residents	Air	Landfill gas migration via direct venting into the atmosphere.	Nuisance caused by the odour. Odour can be detected near the landfill surface.	Rare	Slight	Low (1A)	Landfill will be capped. Point source odour may be released from aspirating cowls; however, there will be significant dilution of potential odours from landfill, thereby limiting any impacts on surrounding residents.
Landfill Fires	Site users and workers	Air	Burning waste emitting smoke containing toxic compounds.	Bushfires causing a landfill fire. The combustion of waste materials can result in dangerous toxic emissions, including dioxins, sulphur dioxide, lead, and mercury.	Rare	Minor	Low (1B)	Landfill will be capped preventing landfill fires. The only foreseeable way a landfill fire could occur would be the erosion of the landfill cap resulting in the exposure of waste. Post-closure monitoring and management (**Section 10**) is required to ensure the integrity of the cap is maintained.
	Community - residents				Rare	Minor	Low (1B)	
Dust	Community - residents	Air	Dust from site works, access roads and earthworks becoming airborne.	Nuisance caused by dust and health impacts from particulate matter.	Rare	Slight	Low (1A)	Dust generation at the Facility will be limited once the capping works are complete and vegetation becomes established.

Source	Receptor	Pathway	Pathway description	Risk description	Likelihood	Conseq.	Risk	Justification
Pests, vermin and disease vectors	Offsite Ecological Receptors –Bushland flora & fauna	Surface & Air	Exposed waste may be used as a food source by vermin, and introduced fauna species, such as rodents, dogs, and cats and could result in elevated population levels.	Populations of vermin and introduced fauna species can negatively impact the surrounding natural fauna and flora.	Rare	Minor	Low (1B)	Capping of the landfill will limit the breeding of disease vectors in the waste body, but ongoing monitoring and management will be required to ensure mosquito breeding does not occur in stormwater ponds and surface ponding associated with differential settlement. Introduced fauna species will be denied access to the putrescible waste as a food source once the landfill is capped
	Community – residents	Surface & Air	Exposed waste and ponded water can facilitate the breeding of disease vectors and be used as a food source for introduced fauna species.	Flies, mosquitoes, vermin and introduced fauna can spread disease to humans and negatively impact the community amenity.	Unlikely	Moderate	Medium (2C)	
Invasive flora species	Offsite Ecological Receptors – Bushland flora & fauna	Air, surface water run-off, and animal	Invasive weed species from seeds in waste received spread to the surrounding environment.	Invasive flora species impacting of the ecological value of the surrounding area.	Likely	Minor	Medium (4B)	It is likely that weed species will continue to be present at the Facility post-closure and will require ongoing monitoring and control in accordance with **Section 0**. If left to become well-established, weeds are likely to spread to the surrounding ecosystems where controlling them becomes more difficult and costly.
Litter	Community – residents	Air	Litter blown in the wind.	Mainly visual impact.	Rare	Slight	Low (1A)	

Source	Receptor	Pathway	Pathway description	Risk description	Likelihood	Conseq.	Risk	Justification
	Offsite Ecological Receptors – Bushland flora & fauna				Rare	Slight	Low (1A)	Wind-blown litter is unlikely to be generated once the landfill cells are closed and rehabilitated in accordance with this LCMP.

10 POST CLOSURE MONITORING

Once the landfill ceases to dispose of waste, it must still be managed to prevent any environmental impact until the waste within the landfill has sufficiently decomposed or stabilised such that it no longer presents a risk to the environment. The standard industry period for post-closure management and monitoring of a putrescible landfill is about 20 - 30 years.

Post-closure management and monitoring procedures for the Facility shall include:

- Maintenance of the landfill cap to:
    - Prevent/control erosion
    - Restore depressions, seal and monitor cracks in the cap caused by settlement
    - Restore/maintain vegetation;
- Maintenance and operation of stormwater infrastructure
- Maintenance and operation of landfill gas extraction system
- Environmental monitoring of:
    - Groundwater
    - Surface water
    - Landfill gas
    - Settlement.

The post-closure management measures and associated monitoring works that will be employed at the Facility are described in the following sections.

10.1 LANDFILL GAS

The landfill gas-extraction system needs to be maintained for the life of the landfill's gas generation. This includes maintaining the plant, such as the generation plant or flares used to combust the gas. This must continue until an assessment demonstrates that it is no longer required or that the system may be downgraded to a less intensive form of LFG management.

Initially, the monitoring and post-closure management of landfill gas shall include:

- Monitoring LFG emissions through the capped areas of the landfill
- Monitoring of landfill gas migration offsite.

This can be completed using a hand-held gas analyser to detect and measure methane and carbon dioxide content across the surface of the cap and in the existing groundwater monitoring bores. The data collected can be assessed to determine if the migration of LFG requires specific gas migration monitoring boreholes to be installed to provide a more detailed collection of data.

Once the 'pyramid' stage of the landfill has been capped, and the passive vents have been installed, a gas field analysis should be completed to determine the quantity and quality of the LFG emissions, as it may be viable to install an LFG flare at the Facility, thus reducing GHG[4] emissions from the landfill.

[4] The global warming potential (GWP) of methane is 28 times that of carbon dioxide, this means that 1 tonne of methane is equivalent to 28 tonnes of carbon dioxide https://www.cleanenergyregulator.gov.au/NGER/About-the-National-Greenhouse-and-Energy-Reporting-scheme/global-warming-potentials. By combusting the methane via a flare the greenhouse gas (GHG) emissions are significantly reduced.

10.2 TOPOGRAPHY

It is recommended that a suitably qualified person conduct walkover inspections of rehabilitated areas on a regular basis and following severe weather events to assess the following:

- Signs of erosion
- Cracking of the landfill cap
- Differential settlement
- Vegetation death
- Surface water ponding.

Any problems identified during the walkover inspections should be rectified as soon as practically possible. The frequency of monitoring can be decreased as the cap stabilises and vegetation becomes established during the aftercare period.

Landfills are expected to experience some settlement after installation of the capping system, particularly in the first two years following closure and rehabilitation as a result of waste compressing under its own weight and the weight of the cap. After this initial compression, settlement will continue for many years due to consolidation and biodegradation processes within the waste.

It is therefore recommended that topographic surveys be undertaken at least on an annual basis for the first two years following capping work completion to monitor the settlement rate. After this, it is proposed that the topographic surveys be conducted every two years for 13 years unless the settlement rate observed indicates that more frequent surveys are required. As it is anticipated that settlement will be negligible after this point, topographic surveys of the rehabilitated areas will only be required every five years or until their topography has stabilised.

10.3 SURFACE WATER

The surface water management system outlined in **Section 7.1** should be inspected and sampled regularly to ensure it is functioning effectively.

Water samples should be taken from the stormwater ponds twice annually and analysed for leachate contamination. Sampling events are recommended to occur during the wet season (October to April) to ensure that water is available for sampling purposes.

If analysis results indicate the presence of contaminants, efforts should be taken to identify the source of the contamination and actions taken to address any failures of the surface water management system. Identification of contamination sources may require the sampling of individual components of the surface water management system.

During the water sampling events, the Shire should also ensure that physical inspections of the surface water management system are undertaken to identify possible damage or evidence of failure.

Inspections and sampling of the surface water management system should be undertaken biannually and after heavy rainfall events for the first five years following rehabilitation of the landfill. If monitoring results indicate that the surface water management system is effective, further monitoring may not be required.

10.4 GROUNDWATER

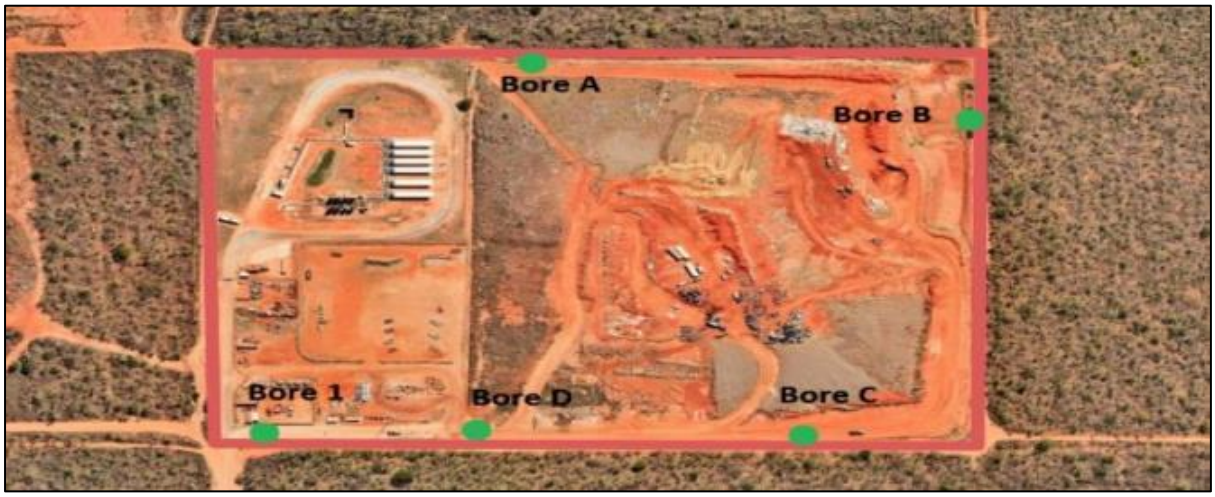
As of October 2022, the Facility has a groundwater monitoring well network that incorporates a total of five monitoring wells (**Figure 10.1**). Condition 30 of the EPL requires that these wells be sampled and analysed in accordance with Table 1 of the EPL (**Table 10.1** below).

Following closure and capping of the landfill cells, and provided the groundwater results show no significant changes, it is recommended that the frequency of sampling be reduced to biannually for the first five years and then annually for the following 20 years (refer to **Table 10.2**). A reduced sampling frequency shall only be implemented if approval to do so is granted by DWER.

Table 10.1 - Table 1 of the EPL: Monitoring of ambient groundwater quality

Monitoring Location	Sampling Frequency	Parameters to be measured	
Bore 1 (original abstraction bore), Bore A, Bore B, Bore C, Bore D (as depicted in Schedule 1)	January; April; July; and October	Aluminium; Arsenic; Cadmium; Chromium; Copper; Lead; Manganese; Mercury; Nickel; Zinc;	pH; Chloride; Sulphate; Total Cyanide; Total Dissolved Solids; Total Nitrogen; Total Phosphorus; Total Petroleum Hydrocarbons; BTEX; and PAH

Figure 10.1 Extract of Schedule 1 from Facility EPL, showing groundwater monitoring bore locations



10.5 MONITORING PROGRAM

The Shire shall ensure that post-closure monitoring of each capping phase is undertaken in accordance with the specifications detailed in **Table 10.2**. As the Facility will continue to operate as the landfill is progressively capped, the Shire must ensure that monitoring conditions required by the EPL are also met.

Table 10.2- Post-closure monitoring program

Aspect	Monitoring Method	Frequency	Duration
Landfill gas	Capped surface, passive vent and groundwater sampling. Further measures are to be confirmed following the first early phases of monitoring.	Six monthly	First 10 years
		Annually	Following 20 years
Groundwater	Groundwater sampling	Six monthly	First 10 years
		Annually	Following 20 years
Surface water	Sampling at surface water lagoon/evaporation pond	Six monthly	First 5 years
Topography	Site walkover inspections	Quarterly and after severe weather events	First 2 years
		Six monthly and after severe weather events	Following 28 years
	Topographic survey	Annually	First 2 years
		Every 2 years	Following 13 years
		Every 5 years	Following 15 years

10.6 RECORDS AND REPORTING

As the monitoring period is likely to exceed twenty years, the inspections, monitoring and corrective actions will most probably be completed by a number of different officers. Therefore, to ensure consistency and good record keeping, the Shire should use a standardised form for recording post-closure monitoring and maintenance activity. The record forms should include:

- Date and time of visit
- Results of all inspections / monitoring / actions
- Corrective actions completed (as required)
- Signed and dated by a responsible officer.

All the forms should be recorded in the Shire's record management system and made available to DWER on request.

11 CLOSURE COST ESTIMATES

An estimate of the quantities and cost for the rehabilitation, closure and post-closure monitoring has been completed and the results are provided in the following sections. As the rehabilitation works will be completed progressively, the costs will vary depending upon the timing and impacts of inflation on costs. The following sections provide a summary of the materials and costs associated with the closure of the Facility. Detailed closure cost estimates based on a six-year budget are provided in **Appendix B**.

11.1 ESTIMATED QUANTITY OF MATERIALS

Based on the proposed cap design, the total quantity of material required to complete the outstanding capping works is estimated at 55,300m^3 of additional soil. Note that this does not include the quantity of soil needed for daily cover. The breakdown of material types required for capping each stage is shown in **Table 11.1**.

Table 11.1 - Estimate of the volume of material required for capping works (cubic metres)

Cap design	Stage 1(Pyramid)	Stage 2 (Extension)	Total
Erosion layer - mulch (200mm)	6,700	2,150	8,850
Vegetation soil layer (500mm)	16,750	5,375	22,125
Low Permeability Pindan (500mm)	16,750	5,375	22,125
Final daily cover (250mm)	8,375	2,688	11,063

N.B. These quantities only allow for areas that are yet to be capped.

11.2 ESTIMATED COSTS

The estimated cost of the rehabilitation and closure works is approximately $3,500,000. The more detailed costings in **Appendix B** include some key operational costs.

These figures are based on the conceptual designs prepared for the capping design and environmental management systems for landfill gas and surface water. Further, the Shire provided costs for the capping placement, machinery hire, revegetation and project management cost estimates.

Table 11.2 - Estimated costs associated with key components

Description	Cost estimate
Removal of existing capping	70,000
Perimeter road	98,500
Landfill gas management system[5]	796,000
Importing capping material (pindan) to the site	532,000
Importing capping material (pindan) for Extension	192,000
Capping - Earthworks	806,000
Surface water management[6]	22,500
Post closure monitoring	460,000
Professional fees and services	175,000
Contingency (10%)	380,000
Total estimated cost (rounded)	**3,500,000**

[5] Estimate includes an allowance of $200,000 for a LFG flare, that's need is yet to be determined.
[6] Excludes any allowance for sediment / stormwater ponds.

12 FINANCING STRATEGY

The majority of post-closure works and monitoring occur following the closure of the site when revenues (gate fees) are no longer collected. Therefore, it is necessary to ensure that adequate resources are available to achieve effective post-closure management.

The Shire has a Reserve Account to fund the closure and rehabilitation of the Facility's landfill cells. Gate fees charged for the disposal of waste at the Facility are the Shire's primary source of revenue, with net revenue used to contribute to the Reserve Account.

As outlined in **Section 11**, the estimated costs associated with the closure and post-closure monitoring of the site are estimated to be over $3.5 million. The Shire is confident that with ongoing revenue generated from waste disposal, the Reserve Account will have sufficient funds for the closure and rehabilitation of the Facility over the next five to seven years.

REFERENCES

ASK Waste Management (2012). ***Landfill Closure Management Plan – Buckleys Road Waste Management Facility.***

ASK Waste Management (2014). ***Buckley Road Waste Management Facility – Review of Closure Management Plan***

Brodie (2009). ***Evaluation of greenwaste mulch to control runoff quality from landfill sites during frequent storms.*** Faculty of Engineering and Surveying and Australian Centre for Sustainable Catchments, University of Southern Queensland. Brodie and Misra.

Clean Energy Regulator - Australian Government (2022). National Greenhouse and Energy Reporting – Global Warming Potentials found at: https://www.cleanenergyregulator.gov.au/NGER/About-the-National-Greenhouse-and-Energy-Reporting-scheme/global-warming-potentials

Department of Primary Industries and Regional Development (DPIRD, 2020). ***Climate trends in Western Australia.*** Available at www.agric.wa.gov.au/

Emery et al. (2003) ***Sand-Clay Pindan Material In Pavements as a Structural Layer***. Emery, S J, Masterson, S and Caplehorn, M W.

Environment Protection Authority Victoria (2015). ***Best Practice Environmental Management (BPEM) Guidelines: Siting, design, operation and rehabilitation of landfills***.

Government of Western Australia (2020). ***Amendment Report L6912/1997/11***. Department of Water and Environmental Regulation. Perth WA.

Government of Western Australia (2012). ***Licence L6912/1997/11***. Department of Environment and Conservation. Perth WA.

Government of Western Australia (2012a). ***Groundwater Resource Review Dampier Peninsula***. Department of Water. Perth WA.

Government of Western Australia (2009). ***Works Approval Number W4531/2009/1.*** Department of Environment and Conservation. Perth WA

National Greenhouse and Energy Reporting

APPENDIX A – LCMP PLANS

- Current landform (2021)
- Final landform (top of waste)
- Final landform (top of cap)
- Sections A-A and B-B
- Sections C-C and D-D
- Cap and road details (inc Stormwater concept layout)

N

ENERGY DEVELOPMENTS

GREENWASTE AREA

CAR BODIES

SCRAP STEEL AREA

SITE OFFICE

RESOURCE RECOVERY AREA

WEIGHBRIDGE

EXISTING LANDFORM

SEDIMENT DAM

FENCE

12 15 20 25 25 20 15 10

LEGEND

10 EXISTING SURFACE LEVEL MAJOR 5M CONTOUR

EXISTING SURFACE LEVEL MINOR 1M CONTOUR

EXISTING FENCE

EXISTING SEDIMENT DAM

SURVEY REFERENCE:

MNG FEB 2021 (500 GRID FILE)
RESOURCE RECOVERY AREA SURVEY LEVELS INFERRED. SEDIMENT POND LEVELS ARE FROM THE PROPOSED DESIGN GREENTEC (2021).

ASK Waste Management Consultancy Services

GREENTEC CONSULTING

ABN 91 621 076 131
www.greentecconsulting.com.au

3/29 Mount Cotton Road
CAPALABA QLD 4157

REV	DATE	DRAWN	CHECKED	APPR'D	REVISION DETAILS
A	11/03/21	EA	CL	ASK	FOR REVIEW

DRAWING STATUS	
JOB No.	ASK-2103-01
DATE	10/03/21
DESIGN BY	CL
DRAWN BY	EA
CHECKED BY	CL
FINAL APPROVAL	ASK
SCALE: (on A3 Original)	1:1500 mAHD

CONCEPT

PROJECT TITLE
BUCKLEYS ROAD LANDFILL
LANDFILL CLOSURE MANAGEMENT PLAN

DRAWING TITLE
EXISTING CONDITIONS

CLIENT
SHIRE OF BROOME

PROJECT NO.	DRAWING NO.	REV
ASK-2103-01	DWG 001	A

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N

LEGEND

- EXTENT OF LANDFORM
- DESIGN SURFACE LEVEL MAJOR 5M CONTOUR
- DESIGN SURFACE LEVEL MINOR 1M CONTOUR
- OUTER RING ROAD
- INNER RING ROAD (WET SEASON)
- STORMWATER DRAIN
- SEDIMENT POND

NOTES

1. LEVELS PROVIDED IN RESOURCE RECOVERY AREA ARE INFERRED, WITH NO DETAIL SURVEY AVAILABLE IN THIS AREA.
2. CONTOURS SHOWN REPRESENT THE TOP OF WASTE LEVELS.

SURVEY REFERENCE:

MNG FEB 2021 (500 GRID FILE)
RESOURCE RECOVERY AREA SURVEY LEVELS INFERRED. SEDIMENT POND LEVELS ARE FROM THE PROPOSED DESIGN GREENTEC (2021).

ENERGY DEVELOPMENTS
SEDIMENT DAM
CAR BODIES
SITE OFFICE
WEIGHBRIDGE
FENCE
15m BUFFER
CH100
CH200
CH300
CH400
1 in 5
2.5% FALL (MIN)
A
B
C

ASK WASTE MANAGEMENT Consultancy Services

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REV	DATE	DRAWN	CHECKED	APPR'D	REVISION DETAILS
A	11/03/21	EA	CL	ASK	FOR REVIEW

DRAWING STATUS	
JOB No.	ASK-2103-01
DATE	10/03/21
DESIGN BY	CL
DRAWN BY	EA
CHECKED BY	CL
FINAL APPROVAL	ASK
SCALE: (on A3 Original)	1:1500 mAHD

CONCEPT

PROJECT TITLE: BUCKLEYS ROAD LANDFILL
LANDFILL CLOSURE MANAGEMENT PLAN

DRAWING TITLE: TOP OF WASTE - FINAL LANDFORM

CLIENT: SHIRE OF BROOME

PROJECT NO.: ASK-2103-01

DRAWING NO.: DWG 002

REV: A

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N

LEGEND

- EXTENT OF LANDFORM
- DESIGN SURFACE LEVEL MAJOR 5M CONTOUR
- DESIGN SURFACE LEVEL MINOR 1M CONTOUR
- OUTER RING ROAD
- INNER RING ROAD (WET SEASON)
- STORMWATER DRAIN
- SEDIMENT POND

NOTES

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2. CONTOURS SHOWN REPRESENT THE TOP OF WASTE LEVELS.

SURVEY REFERENCE:

MNG FEB 2021 (500 GRID FILE)
RESOURCE RECOVERY AREA SURVEY LEVELS INFERRED. SEDIMENT POND LEVELS ARE FROM THE PROPOSED DESIGN GREENTEC (2021).

ENERGY DEVELOPMENTS
CAR BODIES
SITE OFFICE
WEIGHBRIDGE
SEDIMENT DAM
15m BUFFER
FENCE
CH100
CH200
CH300
CH400
1 in 5
2.5% FALL (MIN)
2.5% FALL
12
15
20
25
30
35

ASK Waste Management Consultancy Services

GREENTEC CONSULTING
ABN 91 621 076 131
www.greentecconsulting.com.au
3/29 Mount Cotton Road
CAPALABA QLD 4157

REV	DATE	DRAWN	CHECKED	APPR'D	REVISION DETAILS
A	11/03/21	EA	CL	ASK	FOR REVIEW

DRAWING STATUS	
JOB No.	ASK-2103-01
DATE	10/03/21
DESIGN BY	CL
DRAWN BY	EA
CHECKED BY	CL
FINAL APPROVAL	ASK
SCALE: (on A3 Original)	1:1500 mAHD

CONCEPT

PROJECT TITLE: BUCKLEYS ROAD LANDFILL
LANDFILL CLOSURE MANAGEMENT PLAN

DRAWING TITLE: CAPPING - FINAL LANDFORM

CLIENT: SHIRE OF BROOME

PROJECT NO.: ASK-2103-01

DRAWING NO.: DWG 003

REV: A

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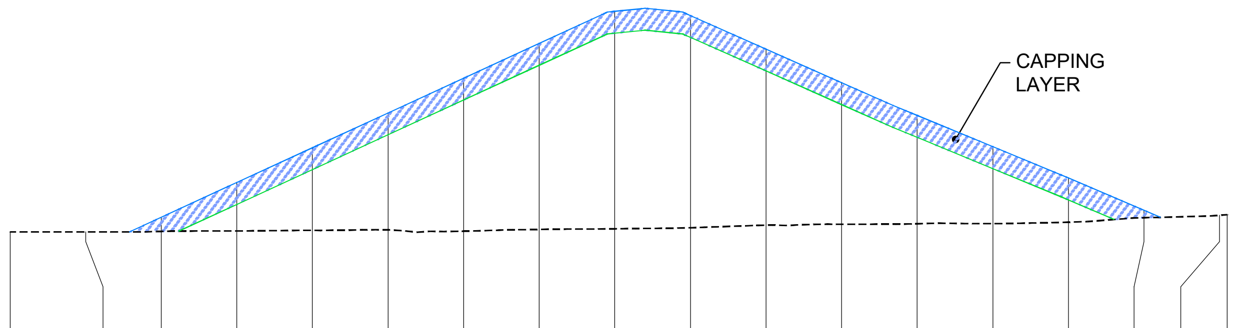
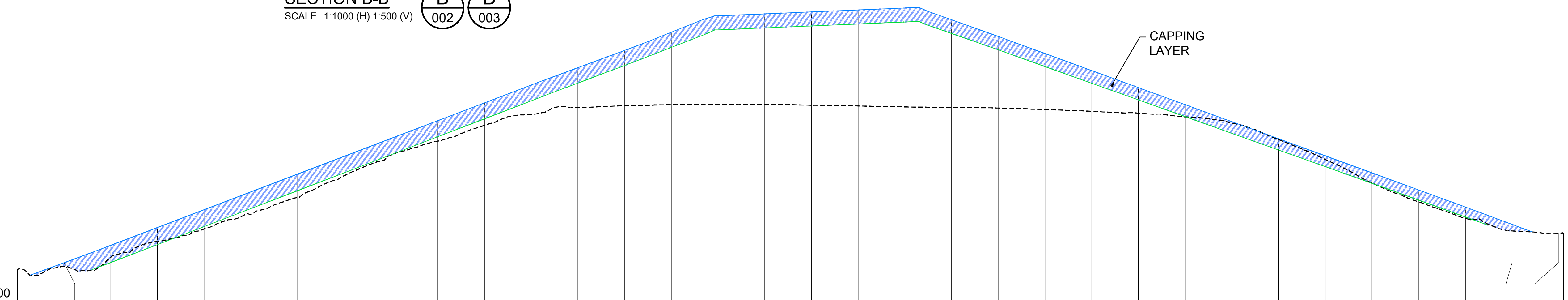


TOP OF CAPPING SURFACE				14.912	17.215	19.518	21.821	24.124	26.250	25.971	23.747	21.523	19.350	17.282	15.208			
TOP OF WASTE SURFACE				13.462	15.765	18.068	20.371	22.674	24.800	24.521	22.297	20.073	17.900	15.832	13.758			
EXISTING SURFACE	11.64	11.64	11.67	11.70	11.74	11.77	11.69	11.80	11.84	11.92	12.09	12.14	12.18	12.19	12.28	12.58	12.74	12.78
CHAINAGE	0.000	10.000	20.000	30.000	40.000	50.000	60.000	70.000	80.000	90.000	100.000	110.000	120.000	130.000	140.000	150.000	160.000	161.000

SECTION B-B
SCALE 1:1000 (H) 1:500 (V) B/002 B/003



TOP OF CAPPING SURFACE			11.352	13.256	15.160	17.064	18.968	20.872	22.776	24.680	26.584	28.488	30.345	32.192	34.127	35.890	36.097	36.305	36.513	36.726	35.461	33.679	31.855	30.032	28.209	26.386	24.563	22.740	20.917	19.094	17.271	15.438			
TOP OF WASTE SURFACE			9.508	11.429	13.349	15.270	17.191	19.111	21.032	22.953	24.873	26.794	28.693	30.573	32.499	34.390	34.597	34.805	35.013	35.226	33.997	32.245	30.461	28.677	26.893	25.109	23.325	21.541	19.757	17.973	16.176	14.375			
EXISTING SURFACE	8.77	9.12	10.07	11.75	13.10	14.67	16.45	18.80	21.00	22.49	24.17	25.34	26.08	26.27	26.38	26.41	26.41	26.33	26.25	26.14	26.10	26.02	25.87	25.68	25.48	25.09	24.42	22.66	20.52	18.01	15.99	14.24	12.89	12.63	12.65
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00	150.00	160.00	170.00	180.00	190.00	200.00	210.00	220.00	230.00	240.00	250.00	260.00	270.00	280.00	290.00	300.00	310.00	320.00	330.00	331.00

SECTION A-A
SCALE 1:1000 (H) 1:500 (V) A/002 A/003

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FINAL APPROVAL	ASK
SCALE: (on A3 Original)	AS SHOWN

PROJECT TITLE
BUCKLEYS ROAD LANDFILL
LANDFILL CLOSURE MANAGEMENT PLAN

CLIENT
SHIRE OF BROOME

CONCEPT

DRAWING TITLE
SECTIONS
SHEET 1 OF 2

PROJECT NO. ASK-2103-01
DRAWING NO. DWG 004
REV A

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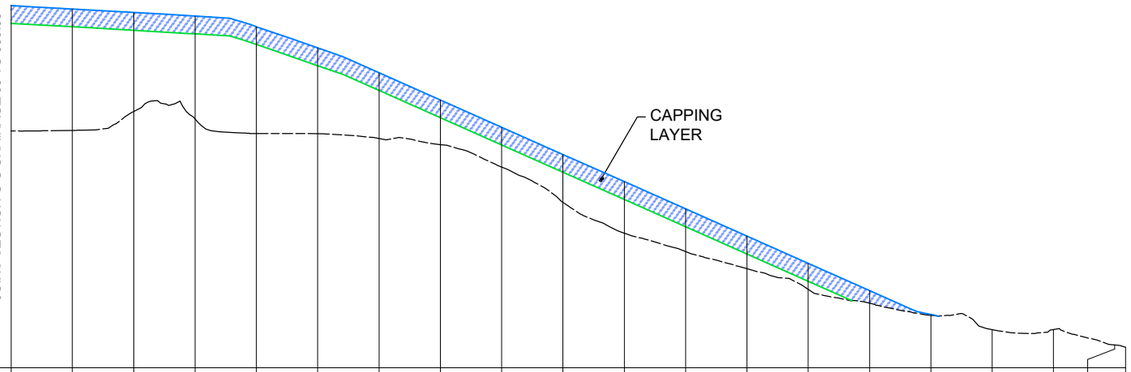
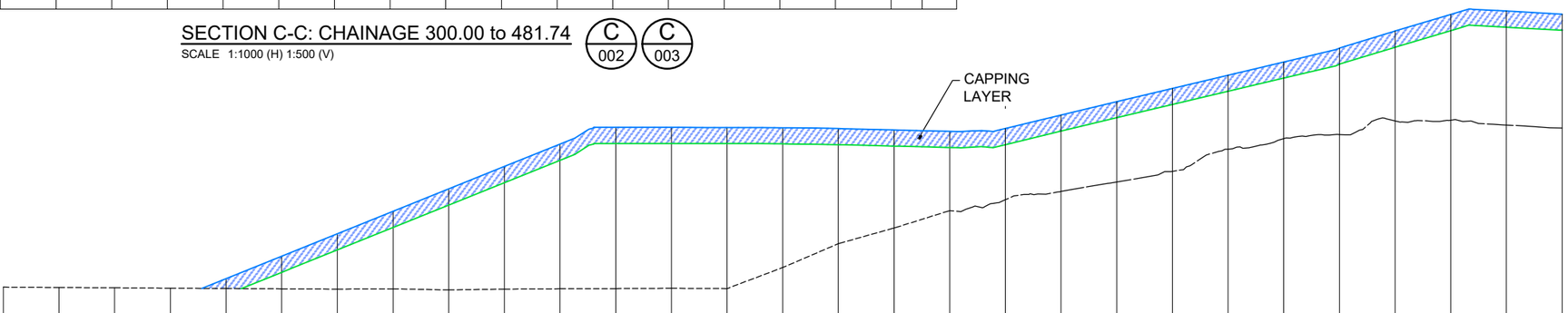


	R.L. 7.000																					
TOP OF CAPPING SURFACE	36.519	36.238	35.951	35.657	34.794	33.069	31.044	28.823	26.601	24.380	22.159	19.938	17.717	15.495	13.274	11.334						
TOP OF WASTE SURFACE	35.069	34.788	34.501	34.207	33.344	31.619	29.594	27.373	25.151	22.930	20.709	18.488	16.267	14.045	11.824	9.884						
EXISTING SURFACE	26.29	26.34	27.88	27.27	26.09	26.07	25.67	25.18	23.36	20.48	17.96	16.46	15.06	13.38	12.27	11.26	10.09	10.11	8.85	8.66		
CHAINAGE	300.00	310.00	320.00	330.00	340.00	350.00	360.00	370.00	380.00	390.00	400.00	410.00	420.00	430.00	440.00	450.00	460.00	470.00	480.00	481.74		

SECTION C-C: CHAINAGE 300.00 to 481.74

SCALE 1:1000 (H) 1:500 (V)

C 002 / C 003



	R.L. 7.000																					
TOP OF CAPPING SURFACE							14.778	16.792	18.807	20.822	22.834	24.840	26.353	26.347	26.342	26.319	26.242	26.118	25.994	26.250	27.458	28.666	29.856	31.043	32.229	33.471	35.004	36.494	36.803	36.519
TOP OF WASTE SURFACE							13.328	15.342	17.357	19.372	21.384	23.390	24.903	24.897	24.892	24.869	24.792	24.668	24.544	24.800	26.008	27.216	28.406	29.593	30.779	32.021	33.554	35.044	35.353	35.069
EXISTING SURFACE			12.00	11.97	11.94	11.91	11.88	11.85	11.82	11.85	11.75	11.82	11.85	11.87	11.90	11.87	13.76	15.90	17.31	18.87	19.85	20.60	21.44	22.40	24.40	25.34	25.71	26.93	27.00	26.56	26.29
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00	150.00	160.00	170.00	180.00	190.00	200.00	210.00	220.00	230.00	240.00	250.00	260.00	270.00	280.00	290.00	300.00

SECTION C-C: CHAINAGE 00 to 300.00

SCALE 1:1000 (H) 1:500 (V)

C 002 / C 003

CONCEPT

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SCALE: (on A3 Original)	AS SHOWN

PROJECT TITLE
BUCKLEYS ROAD LANDFILL
LANDFILL CLOSURE MANAGEMENT PLAN

CLIENT
SHIRE OF BROOME

DRAWING TITLE
SECTIONS
SHEET 2 OF 2

PROJECT NO.	DRAWING NO.	REV
ASK-2103-01	DWG 005	A

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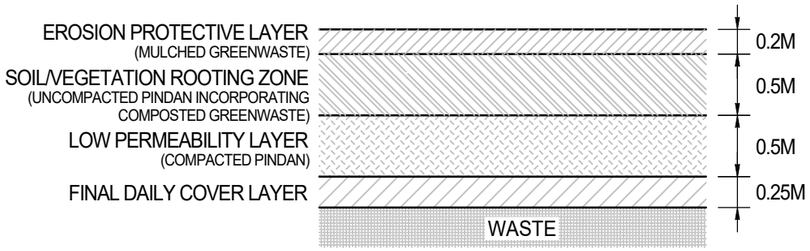
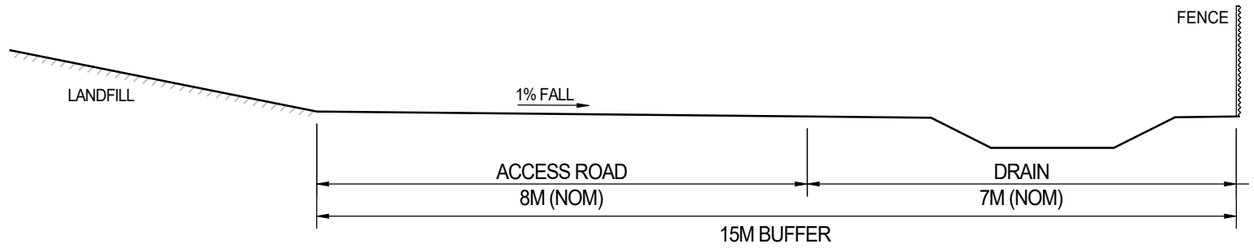


DETAIL SCALE 1:50 — 1/- 1/003 CAPPING LAYER



DETAIL SCALE 1:100 — 2/- 1/003 SECTION D-D BUFFER ZONE

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SCALE: (on A3 Original)	AS SHOWN

CONCEPT

PROJECT TITLE
BUCKLEYS ROAD LANDFILL
LANDFILL CLOSURE MANAGEMENT PLAN

DRAWING TITLE
DETAILS SHEET 1 OF 1

CLIENT
SHIRE OF BROOME

PROJECT NO.	DRAWING NO.	REV
ASK-2103-01	DWG 006	A

APPENDIX B – DETAILED COST ESTIMATES

Closure Operational, Capital and Post-Closure Monitoring Estimated Budget

Description	Parameter	Total cost	2024	2025	2026	2027	2028	2029	Post closure
Stripping back cap	Extension face (half of west)	70,000	-	-	35,000	35,000	-	-	-
Perimeter road	South and SW corner (450m length)	22,500	22,500	-	-	-	-	-	-
	Remainder of road (800m)	76,000	-	76,000	-	-	-	-	-
Surface water management	Excavate perimeter drainage channel	22,500	22,500	-	-	-	-	-	-
Post closure	Groundwater monitoring (6 monthly - 10 years)	130,000	-	-	-	-	-	-	130,000
	Groundwater monitoring (annually 11- 30 years)	120,000	-	-	-	-	-	-	120,000
	Landfill cap and rehab monitoring	15,000	-	-	-	-	-	-	15,000
	Landfill gas monitoring	15,000	-	-	-	-	-	-	15,000
	Leachate monitoring (sediment ponds)	30,000	-	-	-	-	-	-	30,000
	Landfill cap maintenance (contingency)	150,000	-	-	-	-	-	-	150,000
	TOTAL OPERATIONAL	**651,000**							
CAPITAL COST ESTIMATE									
Landfill gas management	LFG Management System (provisional)	576,000	-	-	144,000	144,000	144,000	144,000	-
	Flare (yet to be determined)	200,000	-	-	-	-	-	200,000	-
	Supply and install perimeter gas monitoring wells (yet to be determined)	20,000	-	-	-	-	-	20,000	-
Capping - Earthworks	Importing capping material (pindan) for Pyramid	532,000	106,400	106,400	106,400	212,800	-	-	-
	Importing capping material (pindan) for Extension	192,000	-	-	-	-	38,400	153,600	
	Placement cost estimate (NB Shire cost: in-house)	466,000	46,600	46,600	93,200	93,200	46,600	139,800	-
	Machine Hire - Wet and Dry (NB Shire costs: in-house)	300,000	-	37,500	75,000	37,500	75,000	75,000	

Description	Parameter	Total cost	2024	2025	2026	2027	2028	2029	Post closure
	Revegetation (NB Cost provided by Shire - works completed in-house)	40,000	-	-	10,000	10,000	10,000	10,000	-
Professional fees and services	LFG system detailed design	45,000	-	-	45,000	-	-	-	-
	Stormwater detailed design	35,000	17,500	17,500	-	-	-	-	-
	Tendering, project management, additional consultancy, etc	80,000	-	16,000	16,000	16,000	16,000	16,000	-
	Revegetation plan	15,000	-	15,000	-	-	-	-	-
Contingency	10% contingency for unforeseen events and issues	380,300	21,550	31,500	52,460	54,850	33,000	75,840	
	Total estimated cost (rounded)	**3,530,000**	**240,000**	**350,000**	**580,000**	**600,000**	**360,000**	**830,000**	**460,000**

APPENDIX C – FACILITY LICENCE

Licence

Licence number	L6912/1997/11
Licence holder	Shire of Broome
Registered business address	27 Weld Street BROOME WA 6725
DWER file number	2013/003936-1
Duration	11/06/2012 to 10/06/2028
Date of amendment	24 January 2020
Premises details	Shire of Broome Refuse Site Reserve 40813, Lot 228 Buckleys Rd BROOME WA 6725

Prescribed premises category description **(Schedule 1, *Environmental Protection Regulations 1987*)**	**Assessed design capacity**
Category 64: Class II Putrescible Landfill Site – premises on which waste (as determined by reference to the waste type set out in the document entitled "*Landfill Waste Classification and Waste Definitions 1996 (As amended 2019)"* published by the Director General, Department of Water and Environmental Regulation is accepted for burial.	30,000 tonnes per annum
Category 61: Liquid Waste Facility - premises on which liquid waste produced on other premises (other than sewerage waste) is stored, reprocessed, treated or irrigated.	1,932 tonnes per annum

This licence is granted to the licence holder, subject to the attached conditions, on 24 January 2020 by:

Steve Checker
MANAGER WASTE INDUSTRIES
REGULATORY SERVICES

an officer delegated under section 20 of the *Environmental Protection Act 1986* (WA)

Licence history

Date	Reference number	Summary of changes
L6912/1997/11	1/08/2011	Licence amendment
L6912/1997/11	3/11/2011	Appeal amendment
L6912/1997/11	03/11/2012	Greenwaste amendment
L6912/1997/11	13/12/2012	Posi-shell trail
L6912/1997/11	26/04/2016	Amendment Notice 1 – extend expiry date 10 June 2028
L6912/1997/11	24/01/2020	Change above ground waste disposal buffer distance.

Interpretation

In this licence:

(a) the words 'including', 'includes' and 'include' in conditions mean "including but not limited to", and similar, as appropriate;

(b) where any word or phrase is given a defined meaning, any other part of speech or other grammatical form of that word or phrase has a corresponding meaning;

(c) where tables are used in a condition, each row in a table constitutes a separate condition;

(d) any reference to an Australian or other standard, guideline, or code of practice means the version of the standard, guideline, or code of practice in force at the time of granting of this licence and includes any amendments to the standard, guideline or code of practice which may occur from time to time during the course of the licence;

(e) unless specified otherwise, any reference to a section of an Act refers to that section of the EP Act; and

(f) unless specified otherwise, all definitions are in accordance with the EP Act.

NOTE: This licence requires specific conditions to be met but does not provide any implied authorisation for other emissions, discharges, or activities not specified in this licence.

Licence conditions

The licence holder must ensure that the following conditions are complied with:

Waste Acceptance

1. The licence holder shall accept and bury only the following types of wastes at the premises in compliance with criteria defined in the Landfill Waste Classification and Waste Definitions 1996 (As amended 2019):

(a) Clean fill;

(b) Inert waste type 1;

(c) Inert waste type 2;

(d) Putrescible waste;

(e) Special waste type 1

(f) Special waste type 2

(g) Grease trap and mineral oil liquid waste; and

(h) Quarantine waste.

Contaminated Solid Waste

2. The licence holder shall ensure that all loads of contaminated solid wastes accepted for burial under condition 1 of this licence are inspected, and only accepted for burial if accompanied by documentary evidence to demonstrate that such waste meets the contaminated threshold values specified for Class I and II landfills as detailed in the current version of the document titled “Landfill Waste Classification and Waste Definitions 1996 (As amended 2019)”.

3. The licence holder shall ensure that the documentary evidence required under Condition 2 of this licence demonstrates that the correct leaching fluid or solution has been used for any leachability or leaching tests undertaken, in accordance with the current version of Australian Standard 4439 (*Wastes, sediments and contaminated soils: Part 3: Preparation of leachates – Bottle leaching procedure*).

4. The licence holder shall keep written or electronic records of all contaminated solid wastes accepted for burial at the premises.

5. The licence holder shall ensure that the written or electronic records required by condition 4 of this licence shall include but not be limited to:

(a) The time and date that the waste was received;

(b) The type of contaminated solid waste;

(c) The nature of the contaminated solid waste

(d) The quantity of the contaminated solid waste;

(e) The source of the contaminated solid waste;

(f) The delivery vehicle’s registration number; and

(g) The delivery vehicle driver’s name.

6. The licence holder shall ensure that the written or electronic records required by condition 4 and 5 of this licence are kept at the premises, and that these records or a complete copy of these records are made available for viewing by an Inspector on request.

Acceptance of Special Wastes Type 1 and 2

7. The licence holder shall ensure that Special Waste Type 1 (asbestos material) is deposited at the premises according to the following requirements:

(a) Before entry to the site, asbestos material shall be wrapped in heavy duty plastic;

(b) where asbestos material is presented to the premises in an unwrapped state, it shall be wet down prior to unloading or handling;

(c) the disposal area(s) for any more than 1 (one) cubic metre of asbestos material shall be defined by grid references on the site plan;

(d) a copy of the site plan marked with the location used for asbestos disposal as described in condition 7 (c) above, should be kept as a permanent record;

(e) a representative of the licensee shall be available to witness the burial of the asbestos material under 1 (one) metre of inert waste immediately after placement in the landfill and sign a bound, numbered register within 2 hours of the burial to attest that it has been buried in accordance with these procedures;

(f) ensure the disposal areas are not excavated or uncovered during subsequent landfill operations; and

(g) make the information recorded in accordance with condition 7 (d) of this licence available for viewing or copying by an Inspector during any inspection of the premises.

8. The licence holder shall take the following measures when managing the disposal of Special Waste Type 2 (biomedical waste) at the premises:

(a) The licence holder must complete and sign the original waste transport certificate, noting, in writing, any discrepancies between waste declared and waste received;

(b) keep a record of the waste transport certificate for at least three years;

(c) immediately unload and cover the waste to a minimum depth of 1 (one) metre of soil or solid waste;

(d) define the disposal area(s) by grid references on the site plan;

(e) ensure the disposal areas are not excavated or uncovered during subsequent landfill operations;

(f) restrict access to the landfill site where the Special Waste Type 2 is buried to authorised personnel only; and

(g) make the information recorded in accordance with part (b) of this condition available for viewing or copying by an Inspector during any inspection of the premises.

Acceptance of Quarantine Waste

9. The licence holder shall take the following measures when managing quarantine waste at the premises:

(a) the licence holder, or their representative, must complete and sign the original waste transport certificate, noting, in writing, any discrepancies between waste declared and waste received;

(b) ensure quarantine waste is buried in accordance with the AQIS Process Management System for the Burial of Quarantine Wastes, February 2004;

(c) keep a log of quarantine waste accepted at the premises including, but not limited to: transport details; waste generator; waste description; and volume, time and date of burial and, in the case of deep burials, location of the burial site indicated by GPS co-ordinates and burial depth;

(d) the licensee shall ensure the disposal areas are not excavated or uncovered during subsequent landfill operations;

(e) during disposal restrict access to the landfill area where Quarantine Waste is buried to authorised personnel only; and

(f) make the information recorded in accordance with part (c) of this condition available for viewing or copying by the CEO during any inspection of the premises.

Management of Landfill Activities

10. The licence holder shall:

(a) ensure that no waste is placed closer than 10 metres to the premises boundary for below ground disposal, closer than 20 metres for greenwaste and 15 metres for above ground disposal or storage;

(b) ensure that waste is placed in a defined trench or within an area enclosed by earthen bunds;

(c) ensure that the tipping area is restricted to a maximum linear length of 30 metres;

(d) manage the active landfill area such that at no time does land filling result in an exposed face exceeding two (2) metres in vertical height;

(e) cover waste with at least 150mm of cover material or 7mm of Posi-Shell cover system every day;

(f) ensure that there is enough cover material to cover waste in accordance with part (e) of this condition at least twice; and

(g) ensure that no waste is left exposed.

Fencing

11. The licence holder shall maintain a fence at least 1.8 m in height around the whole of the perimeter of the premises and ensure that any entrance to the premises is securely locked when the premises is unattended.

12. The licensee shall ensure that inspections of the premises fence and gates referred to in part (a) of this condition are undertaken daily and that any damage to the fence is repaired within two (2) working days of its discovery.

Windblown Waste

13. The licence holder shall ensure that wind-blown waste is contained within the boundaries of the premises.

14. The licensee shall ensure that any waste that has been washed or blown away from the tipping area is collected and returned to the tipping area on a weekly basis.

Signage

15. The licence holder shall maintain a sign at the entrance to the premises which clearly displays the following:

(a) contact telephone number for information and complaints or notification of fires;

(b) a list of materials that are accepted;

(c) the types of waste that must not be deposited on the premises and a contact telephone number for alternative disposal options; and

(d) a warning, indicating penalties for people lighting fires.

Monitoring and Reporting

16. The licence holder shall provide to the CEO by **1 March each year** a copy of an Annual Environmental Report containing data collected during the period from 1 January to 31 December of the previous year. The report shall contain but not be limited to:

(a) the number and severity of any fires on site;

(b) the measures taken to suppress dust;

(c) the measures taken to control windblown waste;

(d) the average compaction rates;

(e) the number and type of complaints received including complainants' name, address, nature of complaint (where appropriate cross referenced with prevailing wind directions) and action taken;

(f) any changes to site boundaries, internal buffer zones;

(g) Special wastes type 1 and 2 disposal areas;

(h) quarantine waste disposal areas;

(i) total volumes of waste buried and the volumes of quarantine waste received for disposal;

(j) location of groundwater monitoring bore(s) and surface drainage channels;

(k) an assessment of groundwater monitoring information against previous monitoring results, licence limits or other appropriate measures (e.g. standards or guidelines); and

(l) a trend comparison of groundwater monitoring results.

17. The licence holder shall by **1 March in each year**, provide to the CEO an Annual Audit Compliance Report, signed and certified in the manner required of the form, indicating the extent to which the licensee has complied with the conditions of this licence issued under Part V of the Act for the premises, during the period from 1 January to 31 December of the previous year.

Used Tyre Disposal

18. The licence holder shall bury used tyres such that:

(a) a minimum depth of not less than 500mm of cover material is maintained over the buried tyres following disposal;

(b) batches of tyres are separated from each other with at least 100mm of soil; and

(c) each batch consists of not more than 1,000 (one thousand) tyres or 40 (forty) cubic metres of tyre pieces.

Greenwaste Storage

19. The licence holder shall ensure that:

(a) no greater than 500m^3 of greenwaste, that is not mulched, is stored at the premises at any one time;

(b) no greater than 2,000m^3 of mulched greenwaste is stored at the premises at any one time;

(c) all greenwaste shall be stored in Greenwaste Stockpiles;

(d) temperatures within mulched Greenwaste Stockpiles are monitored on a weekly basis;

(e) Greenwaste Stockpiles with an internal temperature exceeding 80 degrees Celsius are turned/ mixed or otherwise treated, to reduce the temperature; and

(f) a five metre fire break shall be maintained around greenwaste storage areas.

Dust – General Requirement

20. The licence holder shall ensure that no visible dust is discharged beyond the boundary of the premises

Burning of Waste

21. The licence holder shall not burn or allow the burning of waste, including greenwaste, on the premises.

22. The licensee shall ensure that there are appropriate procedures in place at the premises so that any unauthorised fire is promptly extinguished.

23. The licensee shall notify the CEO if a fire has not been extinguished within 2 (two) hours of the licensee becoming aware of a fire.

24. The licensee shall provide the CEO with a report on an unauthorised fire within 14 days of the fire and include:

(a) details of the date, time and location of the fire;

(b) the time the fire was declared safe by the Fire Control Officer for the premises; and

(c) the cause, or suspected cause, of the fire.

Uncontaminated Stormwater Management

25. The licence holder shall divert stormwater away from all active and inactive disposal areas within the premises.

26. The licensee shall ensure stormwater drains on the premises are kept clear to allow for drainage.

27. The licensee shall ensure that stormwater that has come into contact with waste is diverted into a sump on the premises or otherwise retained on the premises.

Protection of Ground and Surface Waters

28. The licence holder shall maintain an undisturbed separation distance of at least 3 (three) metres between all active and inactive disposal areas at the premises and the highest level of the water table.

29. The licensee shall maintain a minimum distance of at least 100 metres between all

active and inactive disposal areas at the premises and any surface water body.

Groundwater Monitoring Requirements

30. The licence holder shall take representative groundwater samples from the monitoring site stated in column 1 of Table 1 and have them analysed for the parameters listed in column 3 of Table 1 at the frequency stated in column 2 of Table 1:

Table 1: Groundwater Monitoring Requirements

Column 1 Monitoring Location	Column 2 Sampling Frequency	Column 3 Parameters to be measured
Bore 1 (original abstraction bore), Bore A, Bore B, Bore C, Bore D (as depicted in Schedule 1)	January; April; July; and October.	Aluminium; Arsenic; Cadmium; Chromium; Copper; Lead; Manganese; Mercury; Nickel; Zinc; pH; Chloride; Sulphate; Total Cyanide; Total Dissolved Solids; Total Nitrogen; Total Phosphorus; Total Petroleum Hydrocarbons; BTEX; and PAH

With the exception of pH (pH units) and Standing Water Level all measurements are to be reported in mg/L.

31. The licence holder shall measure, prior to sampling in accordance with condition 30, the Standing Water Level of the monitoring bores referred to within column 1 of Table 1 at the sampling frequency within column 2 of Table 1 and provide the results in the Annual Environmental Report in accordance with condition 16.

32. The licence holder shall maintain the bores referred to within column 1 of Table 2 in a serviceable manner so that groundwater samples required by condition 30 can be taken.

33. The licence holder shall ensure that all water samples are collected, handled and preserved in accordance with Australian Standard 5667.

34. The licence holder shall ensure that all water samples are submitted to a laboratory with NATA accreditation for the analysis specified, and analysed in accordance with the current Standard Methods for Examination of Wastewater – APHA-AWWA-WEF.

35. The licence holder shall ensure that the results of the groundwater sampling program are presented in tabular form in the Annual Environmental Report required in Condition 16 of this licence.

Waste Oil Storage Area

36. The licence holder shall ensure that any waste oil is stored within a low permeability ($1x10^{-9}$ metres per second or less) compound(s) designed to contain not less than 110% of the volume of the largest storage vessel or inter-connected system, and at least 25% of the total volume of substances stored in the compound.

37. The licence holder shall ensure that the compound referred to in Condition 36 of this license shall;

(a) be graded or include a sump to allow recovery of liquid;

(b) be chemically resistant to the substances stored;

(c) include valves, pumps and meters associated with transfer operations wherever practical. Otherwise the equipment shall be adequately protected and contained in an area designed to permit recovery of hydrocarbons released following accidents or vandalism;

(d) be designed such that jetting from the storage vessel or fitting will be captured within the bunded area [see for example Australian Standard 1940-2004 Section 5.8.3 (h)]; and

(e) be controlled such that the capacity of the bund is maintained at all times (eg. regular inspections and pumping of trapped uncontaminated rain water).

38. The licence holder shall immediately remove and dispose of any liquid resulting from spills or leaks of chemicals including fuel, oil or other hydrocarbons, whether inside or outside the waste oil storage area.

39. The licence holder shall keep a record of any incident that includes the loss of chemicals including fuel, oil or other hydrocarbons and provide a summary of each incident in the annual report required in Condition16 of this licence.

Definitions

In this licence, the terms in Table 1 have the meanings defined.

Table 1: Definitions

Term	Definition
ACN	Australian Company Number
AHD	means Australian Height Datum
Annual Audit Compliance Report (AACR)	means a report submitted in a format approved by the CEO (relevant guidelines and templates may be available on the Department's website).
Approved	means approved in writing
APHA-AWWA-WEF	means American Public Health; American Water Works Association; Water Environment Federation
AQIS	means Australian Quarantine and Inspection Service
asbestos	means material containing the asbestiform variety of mineral silicates belonging to the serpentine or amphibole groups of rock-forming minerals and includes actinolite, amosite, anthophyllite, chrysotile, crocidolite, tremolite and any mixture containing 2 or more of those
Australian Standard 5667	means the most recent version and relevant part(s) of AS/NZS 5667
books	has the same meaning given to that term under the EP Act.
BTEX	means the suite of aromatic hydrocarbons that typify petroleum products and comprises Benzene, Toluene (methyl benzene), Ethyl benzene and the Xylenes (ortho-, meta-, and para-dimethyl benzene)
buffer	means the distance from the boundary of the premises to any area on the premises used for disposal, storage or transfer of waste
CEO	means Chief Executive Officer of the Department of Environment Regulation. for the purpose of correspondence means: Chief Executive Officer Department Administering the Environmental Protection Act 1986 Locked Bag 10 JOONDALUP DC WA 6027 Telephone: (08) 6367 7000 Facsimile: (08) 6367 7001 Email: info@dwer.wa.gov.au

Term	Definition
clean fill	means material that will have no harmful effects on the environment and which consists of rocks or soil arising from the excavation of undisturbed material, as defined in the document titled Landfill Waste Classification and Waste Definitions 1996 (As amended December 2009)
Cover material	means subsoil or other approved inert waste used for covering of waste
Department	means the department established under section 35 of the *Public Sector Management Act 1994* (WA) and designated as responsible for the administration of the EP Act, which includes Part V Division 3.
discharge	has the same meaning given to that term under the EP Act.
emission	has the same meaning given to that term under the EP Act.
EP Act	*Environmental Protection Act 1986* (WA)
Fire Control Officer	in relation to the premises, means a person who has such qualifications in fire fighting or fire control as are approved, appointed to that position by the occupier of the premises
grease trap	means grease trap liquid waste
greenwaste	means biodegradable waste comprising plants and their component parts such as flower cuttings, hedge trimmings, branches, grass, leaves, plants, seeds, shrub and tree loppings, tree trunks, tree stumps and similar materials and includes any mixture of those materials
Greenwaste Stockpiles	means stockpiles of greenwaste where each stockpile is less than 3 metres high and no more than 500 cubic metres in volume and separated by at least 5 metres of clear ground from any other stockpile, the boundary of the site or from other combustible material
Inert waste type 1, inert waste type 2, special waste type 1 and special waste type 2	means wastes as defined in the document titled *Landfill Waste Classification and Waste Definitions 1996 (As amended 2019*)
Inspector	means a person appointed as an Inspector under Section 88 of the *Environmental Protection Act 1986*
Landfill Waste Classification and Waste Definitions 1996 (As amended 2019)	refers to the document published by the Director General, Department of Water and Environmental Regulation

Term	Definition
licence	refers to this document, which evidences the grant of a licence by the CEO under section 57 of the EP Act, subject to the specified conditions contained within.
licence holder	refers to the occupier of the premises, being the person specified on the front of the licence as the person to whom this licence has been granted.
mineral oil	means liquid waste mineral oils unfit for their intended use
mm, mg/L and µS/cm	means millimetres, milligrams per litre and microsiemens per centimetre respectively
NATA	National Association of Testing Authorities
PAH or PAHs	means polycyclic aromatic hydrocarbons which may be one or (more usually) a mixture of a group of chemicals formed from the incomplete combustion of organic matter where the benzene rings are fused along their edge
Posi-Shell	means the synthetic daily cover system composed of an aggregate of (recycled) cementitious mineral binder, liquid (water), recycled plastic and cellulose fibres
Premises	refers to the premises to which this licence applies, as specified at the front of this licence and as shown on the premises map in Schedule 1 to this licence.
prescribed premises	has the same meaning given to that term under the EP Act.
Putrescible waste	means the component of the waste stream likely to become putrid – including wastes that contain organic materials such as food wastes or wastes of animal or vegetable origin, which readily bio-degrade within the environment of a landfill, as defined in the document titled *Landfill Waste Classification and Waste Definitions 1996 (As amended 2019)*"
Quarantine waste	means material from a foreign region or country that is capable of being host to insects, helminths or other parasites, diseases, weeds or any other organisms that are not existent or prevalent in that country and pose a potential threat to local ecosystems, people or local plant or animal industries. Quarantine waste may include: a) material used to pack and stabilise imported goods; b) galley food and any other waste from overseas vessels; c) human, animal or plant waste bought into Australia; refuse or sweepings from a hold of an overseas vessel; d) any other waste or other material, which comes into contact with quarantine waste; e) contents of AQIS airport amnesty bins; and f) articles seized by AQIS and/or not collected by clients;

Term	Definition
Surface waste body	means a water course or wetland (as those terms are defined in the *Rights in Water and Irrigation Act 1914*) and any other surface water whether artificial or natural
SWL	means Standing Water Level in metres AHD (prior to sampling)
Tipping area	means the area of the premises where waste currently being brought to the premises is being deposited
TPH or total petroleum hydrocarbons	means indicator chemicals of potential concern such as Benzene, Toluene, Ethylbenzene, Xylenes (BTEX), Naphthalene and carcinogenic Polycyclic Aromatic Hydrocarbons (PAHs) as well as the collapsed fractions group of hydrocarbons defined as C6-C10 (light non-BTEX fraction); C>10-C16 (petrol or gasoline fraction);C>16-C34 (diesel fraction); and C>34C40 (Lube or fuel oil fraction)
tyre	means a tyre made whether wholly or partly of natural or synthetic rubber or similar material
vector	means an agent capable of transmitting disease including flies, birds and rodents
Waste	has the same meaning given to that term under the EP Act.

END OF CONDITIONS

Schedule 1: Maps

Premises map

The boundary of the prescribed premises is shown in the map below.