BARKLY REGIONAL COUNCIL

TENNANT CREEK WASTE MANAGEMENT FACILITY

LANDFILL CLOSURE MANAGEMENT PLAN

NOVEMBER 2021

Practical, sustainable and innovative
waste management, landfill engineering and
environmental solutions

Document Control

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF PLATES

LIST OF FIGURES

1 INTRODUCTION

1.1 BACKGROUND

Barkly Regional Council (BRC or Council) is located in the Northern Territory (NT) in central Australia, 1,000km south of Darwin and approximately 500km north of Alice Springs. The BRC region has a population of approximately 6,650 people and Tennant Creek is the principal town in the area with a population of approximately 3,000 people. The primary industries in Tennant Creek are mining and tourism.

Council operate several small-scale landfill facilities, with their largest landfill located in Tennant Creek. A Landfill Closure Management Plan (LCMP) for Tennant Creek Waste Management Facility has been prepared with the following considerations:

- The specific site operational requirements outlined in Environmental Protection License (EPL) 281 dated 1st of July 2019;
- Conformity with the Waste Management and Pollution Control Act 1998;
- Recommendations from a 2021 Master Plan prepared by GreenTec; and
- Local community objectives to improve the environmental aspects of the community.

BRC have engaged GreenTec Consulting Pty Ltd (GreenTec) to prepare an LCMP for Tennant Creek Waste Management Facility.

1.2 PURPOSE

The purpose of the LCMP is to provide details for implementing a range of environmental aspects relating to landfilling and site operations at Tennant Creek WMF. This LCMP provides documentation of the proposed closure objectives and implementation strategies for the benefit of environment and community once the landfill has been capped.

1.3 LCMP OBJECTIVES

- Present 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 profile that will provide a physical barrier between waste and the environment and restrict the infiltration of rainwater into the waste mass and minimise the production of leachate;
- Develop a stormwater management design that minimises leachate generation and controls the release of stormwater from Tennant Creek WMF;
- Assess the feasibility of an appropriate landfill gas management system to control the generation of landfill gases and reduce risk of adversely impacting the surrounding environment; and
- 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.

1.4 LANDFILL CLOSURE MANAGEMENT PLAN STRUCTURE

A summary of the LCMP structure is presented in **Table 1** below.

TABLE 1 - LANDFILL CLOSURE MANAGEMENT PLAN STRUCTURE

Section	Description
Section 1	Introduction, scope, objectives and purpose.
Section 2	Provides a summary of the site, including climate, rainfall environmental conditions and waste generation quantities and proposed landfill development.
Section 3	Defines the legislative context.
Section 4	Risk assessment for landfill closure and management aspects.
Section 5	Outlines the post closure design and the key aspects for rehabilitation including final landform, capping profile extent of filling and final profile.
Section 6	Defines the stormwater management aspects of the post closure landfill design.
Section 7	Defines the landfill gas management aspects of the post closure landfill design.
Section 8	Defines the groundwater management aspects of the post closure landfill design.
Section 9	Defines the requirements for post closure maintenance and monitoring of Tennant Creek WMF.
Section 10	Estimates post closure cost estimates and financing strategies.

2 SITE SUMMARY

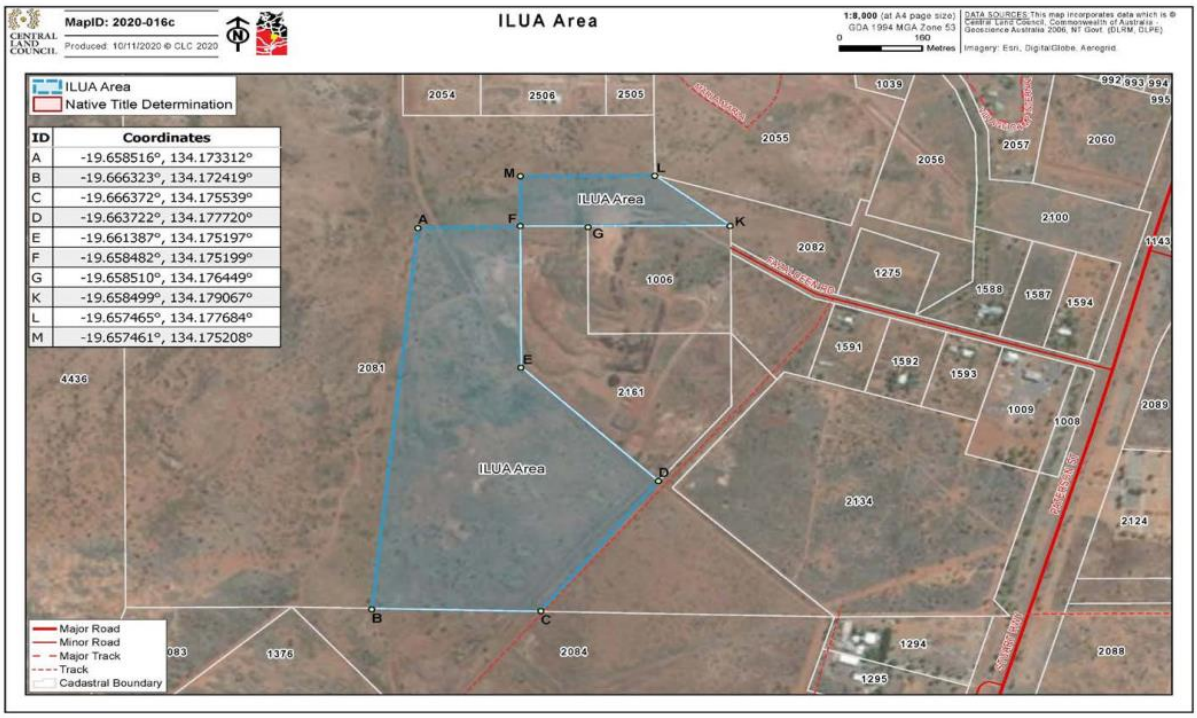
2.1 SITE OVERVIEW

The Tennant Creek Waste Management Facility (WMF) provides a waste disposal site for the township and immediate community of Tennant Creek. 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 separation of material and reduce traffic at the tip face.

Waste from the Tennant Creek area is collected via collection trucks and deposited at the landfill with approximately 1,000 bins collected each week. Tennant Creek currently does not have a kerbside comingled recycling collection service or green waste collection service but does separate and recover green waste and steel at the landfill facility.

An Indigenous Land Use Agreement (ILUA) between Barkly Regional Council, Central Land Council and Patta Aboriginal Corporation RNTBC was formalised and signed on the 27th of May 2021. This ILUA allowed Council to expand particular site operations onto defined areas of Lot 2081, with the ILUA area shown in **Plate 1** below.

PLATE 1 - ILUA AREA



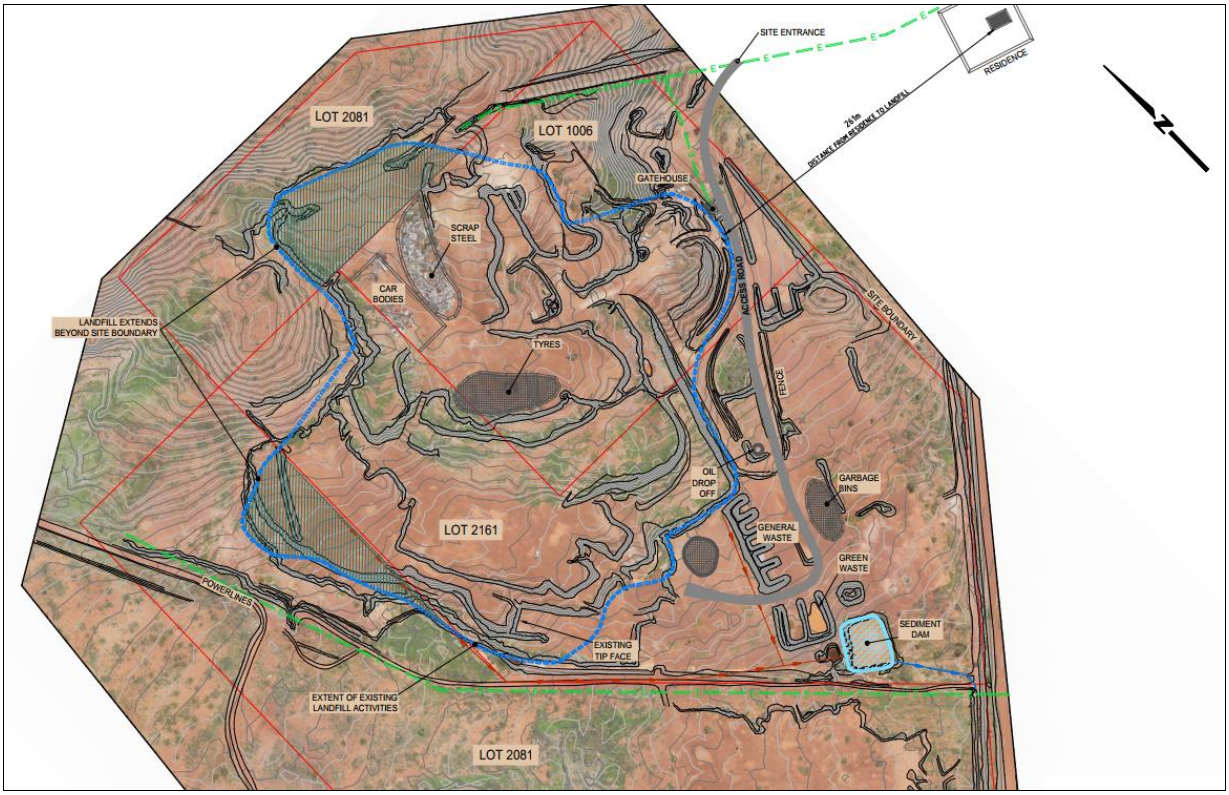
It is understood that Council will excavate soft shallow soils within Lot 2081 to use as cover soil in landfilling operations. These areas are also intended to be used for resource recovery operations and long-term storage. No landfilling is permitted to occur in the ILUA area, with historical waste placement in the ILUA area to be remediated. At this stage, Council intends to remediate the area north of Lots 2161 and 1006 ('Area 3') and to relocate the historical waste in the area west of Lot 2161 ('Area 4') to within the permissible landfilling footprint. Areas that require waste removal or remediation are shown on **Plate 2** below.

PLATE 2 - AREAS 3 AND 4 WITHIN THE ILUA AREA

2.2 SITE LOCATION

Tennant Creek WMF is located predominately within Lot 1006 and Lot 2161, at 79 Fazaldeen Road. The landfill extends into Lot 2081 and partially into Lot 2082 (entry road). Lot 1006 is held under a Crown Lease in Perpetuity to Tennant Creek Town Council. Lot 2161 is a new freehold lot. Part of Lot 2081 is currently being leased by Council as per the ILUA dated the 27th of May 2021 and Lot 2082 is Vacant Crown Land. An aerial image and layout of Tennant Creek WMF is provided in **Plate 3** and lot extents are attached in **Figure 002**.

PLATE 3 - SITE LAYOUT



2.3 RAINFALL AND CLIMATE

Tennant Creek is located 376m above sea levels with climate considered to be arid in nature with evaporation exceeding rainfall. Temperatures in the summer range from average lows of ~24°C and average highs of 37°C with winter temperature averages ranging from 12°C to 28°C.

The average annual rainfall statistics for Tennant Creek (BoM - Station 015135) have been provided below in **Table 2**.

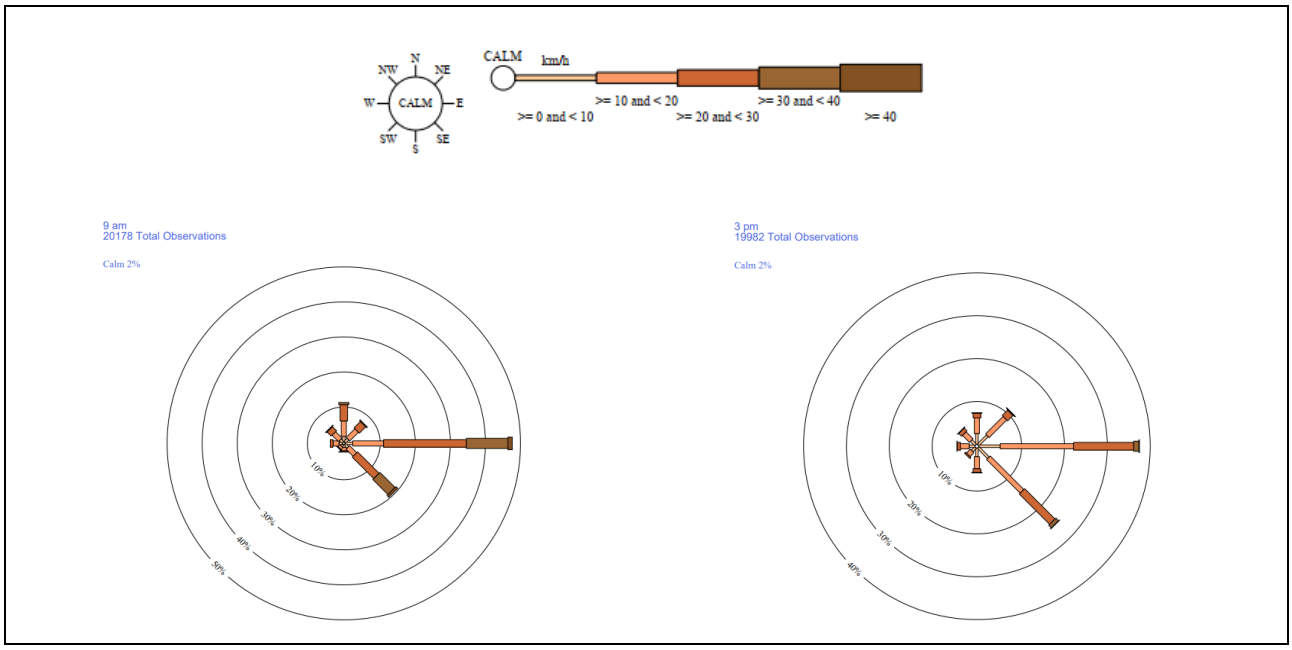
TABLE 2 - MEAN RAINFALL AND EVAPORATION

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Rainfall (mm)	116	117	54	16	8	5	5	2	7	19	40	74	465
Evaporation (mm pan)	381	314	347	324	267	216	233	288	348	406	405	400	3,942
Difference (mm)	365	196	293	308	258	211	227	286	341	388	365	326	3,477
Ratio of Evaporation to Rainfall	3.3	2.7	6.4	20.5	32.5	40.8	45.6	125.3	47.0	21.8	10.1	5.4	8.5

The average pan evaporation statistics were calculated using the mean daily evaporation data for Tennant Creek (BoM – Station 015135) and multiplied by the corresponding number of days for that month (Non-Leap year). The average annual pan evaporation is over 8 times the average rainfall, with evaporation in winter months between 40 to 125 times higher than the respective monthly rainfall and approximately 3 to 5 times higher in summer months.

The Wind Rose data for Tennant Creek Airport shown in **Plate 4** indicate predominantly easterly winds in the both the morning and in the afternoon.

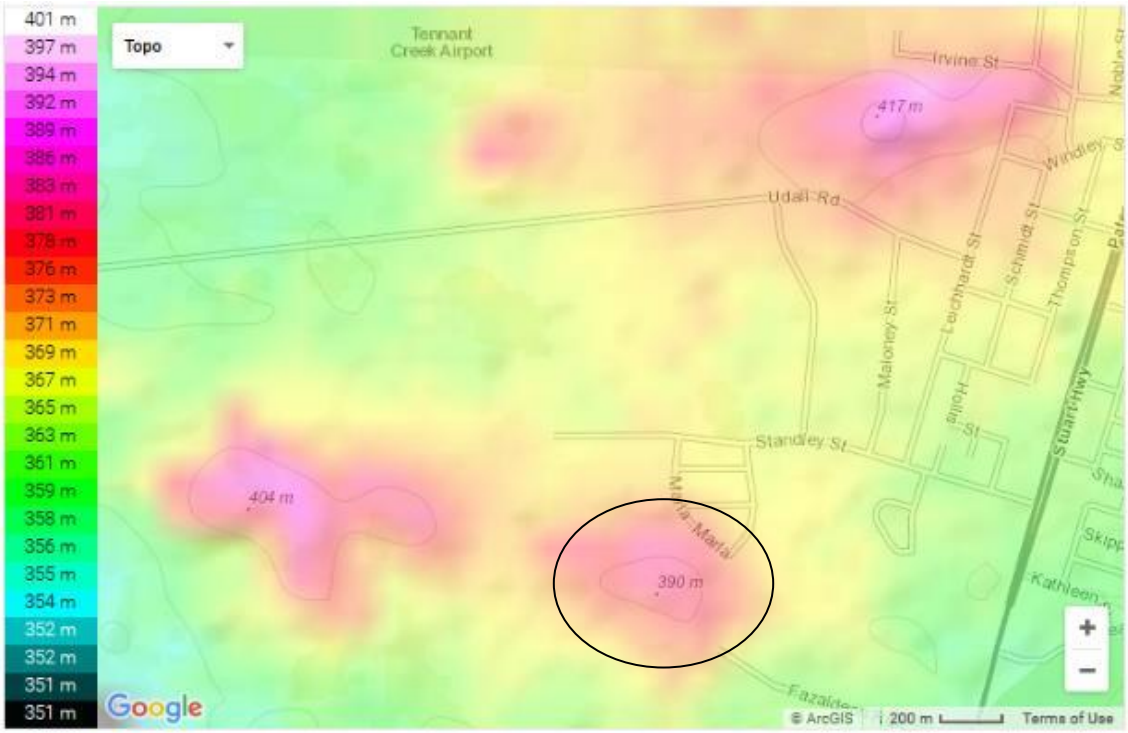
PLATE 4 - WIND ROSE DATA FROM TENNANT CREEK AIRPORT



2.4 SITE TOPOGRAPHY

The landfill site is saddled against a natural rise in the topography with this rise seen at peak height of RL390m. The landfill site slopes from north to south east with the lowest point of the site at RL 365m. A topographic map is shown in **Plate 5**.

PLATE 5 - TOPOGRAPHIC MAP



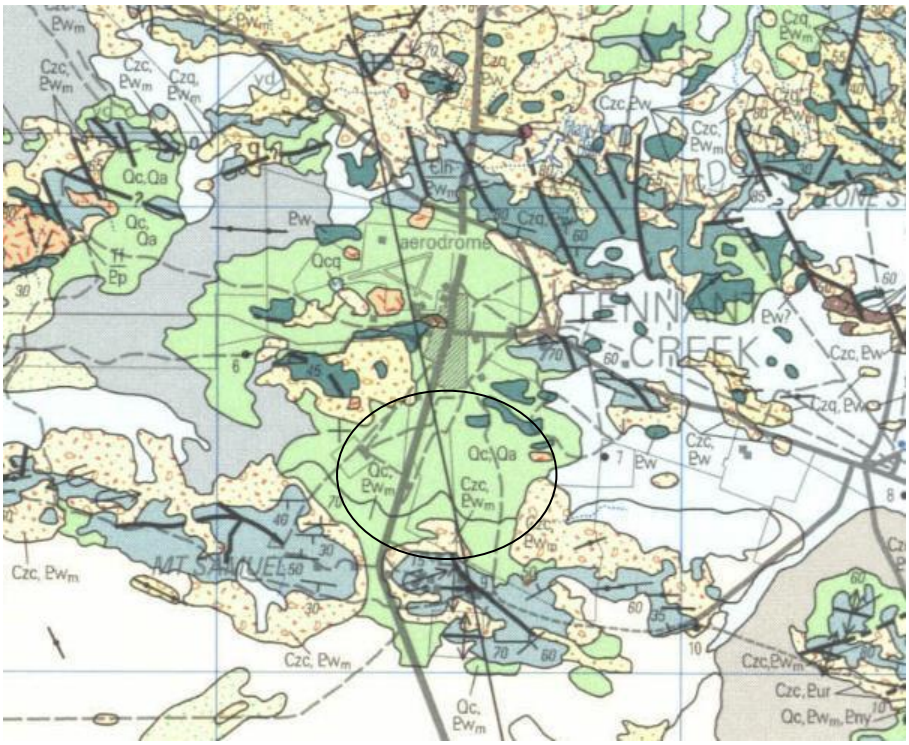
Source: http://en-au.topographic-map.com/places/Tennant-Creek-9489749/

2.5 GEOLOGY

A 1:100,000 geological map was sourced from Geoscience Australia as shown below in **Plate 6** which indicates geology of Carraman Formation of the Early Proterozoic Warramunga Group. Site soils consist of a gravelly clay material near the surface tending to be more clay extending beneath the surface with this evident in the sediment dam and new landfill trench excavations.

On site excavations conducted by Council show uniform brown clayey soils overlaying the Carraman Formation which appears to have the capacity to effectively isolate the landfill area from deeper aquifers. The existing natural soil formation (clayey soils) is estimated to have an approximated permeability of 10^{-6} to 10^{-8} m/sec. If confirmed, soils excavated to create future waste cells and leachate containment ponds, are suitable for the construction of low permeability earthen waste cell liners and final capping.

PLATE 6 - SITE GEOLOGY



2.6 SITE HYDROLOGY

Groundwater hydrological conditions cannot be confirmed due the absence of groundwater monitoring boreholes and associated data on site and in the local area. The following historical monitoring boreholes were checked in-field by Council staff in April 2021, with the aim to obtain groundwater level data (all bores were reported to be abandoned, decommissioned and/or unusable):

- RN013251;
- RN002099;
- RN016253; and
- RN001048.

Anecdotal evidence from a variety of sources and historical reporting in the Tennant Creek area indicates that the water table is at least 60 metres below ground level and that it is low yielding and of a quality unsuitable for domestic or agricultural use. Due to the groundwater conditions in the township area, the main water supply is sourced some distance south at the Kelly Well Borefields. It is also noted that the Tennant Creek WMF site is not located within the constraints imposed by a coastal estuarine or groundwater recharge area *(Hydrology of Australia, 1987).*

Groundwater in the wider regional area is deep and located beneath indurated Warramunga sediments, which are anticipated to be highly impervious, meaning groundwater contamination from landfilling is unlikely. Additionally, the aquifer which the town's main water supply is approximately 20km south, meaning landfilling activities are very unlikely to impact this specific aquifer. Furthermore, the installation of groundwater monitoring bores to depths between 60m – 100m on site is economically unfeasible based on discussions with Council.

It has been previously established in the 2006 EMP that the deep groundwater table, coupled with the low permeability soils encountered at the site, makes groundwater contamination "not likely to be a significant concern" (Tennant Creek Town Council).

2.7 SITE BOUNDARIES

GreenTec undertook a test pit investigation in March 2021 which determined the approximate depths and extents of landfilling which has occurred outside the boundary of Lot 2161 and into Lot 2081. Council have recently been granted approval to extend site operations onto Lot 2081, as per the ILUA dated the 27th of May 2021. Historical waste that is placed to the north of Lot 2161 is intended to be remediated, with waste to the west of Lot 2161 to be removed and relocated to within the permissible landfilling footprint. No remediation works have been undertaken on the waste located outside the boundaries at the time of this report. As per the ILUA, no landfilling operations shall occur in the ILUA areas (Lot 2081). These areas are intended for sourcing of cover soil for landfilling operations, as well as resource recovery and long-term storage.

2.8 FLORA AND FAUNA

As described previously, both Lots 1006 and 2161 have been used historically for disposal of domestic, commercial and industry waste for many decades.

Despite historic use, native flora had re-established across most of the area, including the capped and stabilised parts of the landfill form. From anecdotal information and observations on the site native fauna consists of various bird species, including Hawks, and reptiles indigenous to the area, including snakes and lizards. Kangaroos and wallabies have also been observed from time to time.

No negative environmental impact from landfill activities have been observed on the wider flora and fauna so far, and future management endeavours to keep the impact negligible in the future.

2.9 LANDFILL ACCEPTANCE CRITERIA

The Tennant Creek Landfill is currently operating under NT EPA Environmental Protection Licence EPL 281 for the following activities:

a) *"Operating premises for the disposal of waste by burial that service, or are designed to service, the waste disposal requirements of more than 1,000 persons."*

b) *"Collecting, transporting, storing, re-cycling, treating or disposing of a listed waste (as per Table 1) on a commercial or fee for service basis, other than in or for the purpose of a sewerage treatment plant."*

c) *"Operating premises, other than a sewerage treatment plant, associated with collecting, transporting, storing, recycling, treating or disposing of a listed waste (as per Table 1) on a commercial or fee for services basis."*

The landfill is defined as Muncipal Soilid Waste Landfil and acepts a range of waste materials from the local domestic and commercial sectors.

2.10 EXISTING WASTE MANAGEMENT

Tennant Creek WMF is owned and operated by Barkly Regional Council and currently services 3,000 local and surrounding residents. Waste from the Tenant Creek area is collected via collection trucks and deposited at the landfill with approximately 1,000 bins collected each week. Tennant Creek currently does not have a kerbside co-mingled recycling collection service or green waste collection service.

2.10.1 Current Landfill Operations

The current site layout is shown on **Plate 1** and consists of a customer interception point at the entrance to the facility where tokens are collected, customers are then directed to one of the following areas being for disposal or resource recovery:

- Public tip face;
- Commercial tip face;

- Tyre stockpile;
- Car bodies area;
- Oil drop off;
- Batteries;
- Gas bottles; and
- Green waste.

The waste types accepted at the site are managed as shown in **Table 3** below.

TABLE 3 - MANAGEMENT OF WASTE

Site Area	Managed
Public Tip Face	Waste material directed to the active tip face(s) is end dumped into the unlined disposal area. At the end of each day, the waste will be compacted and covered with site soils.
Commercial Tip Face	Waste material directed to the active tip face(s) is end dumped into the unlined disposal area where it is typically left open until it has reached capacity, where it will be compacted and covered with site soils.
Tyre stockpile	Tyres are stockpiled onsite, currently they are not collected or recycled.
Car bodies area	Car bodies are directed to the upper plateau of the landfill where they are stored until sufficient quantity for collection by metal recycler.
Oil drop off	Oil is deposited at the bunded area located off the main access road.
Batteries	Batteries are collected and stored at the entrance to the facility and are sent to a battery recycler.
Gas bottles	Gas bottles are collected and stored at the entrance to the facility where and are sent to a gas bottle recycler.
Green waste	Green waste is collected in bunded area where it is stored and burnt once area is full.

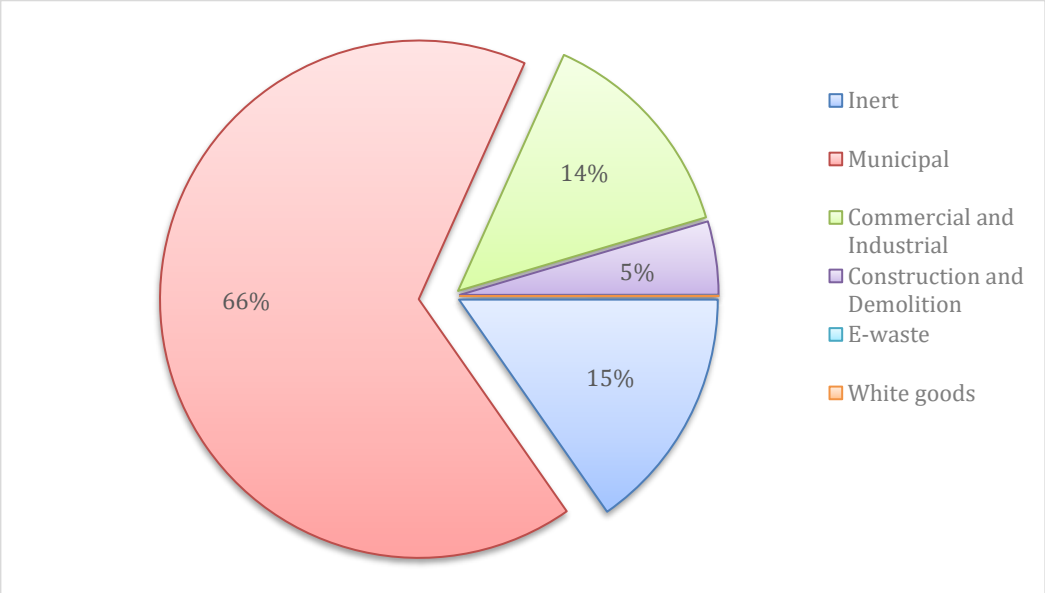
Landfilling at the tip faces generally occurs via filling in lifts across the whole site, once a lift is completed another lift will be undertaken on top of the previous lift.

2.10.2 Waste Generation

The site currently does not have a weighbridge, however, an airspace assessment conducted by GreenTec in 2021 established that the average raw landfilling rate is approximately 14,250m^3 per year. This rate was estimated by comparing the current survey (Central Drone Surveys, 2021) to a survey conducted in 2016 by Terramap and by subtracting out the assumed cover soil volume over the period (~4000m^3 per year).

Waste composition was estimated through visual observations of operations staff. Tonnages were obtained by assuming an average compaction rate of 0.8t/m^3. The breakdown of waste to landfill is shown in **Plate 7**. Most of the deposited waste is municipal waste, meaning it is important to maintain daily and intermediate cover and progressively cap the site in a timely manner.

PLATE 7 - WASTE TO LANDFILL BREAKDOWN



Based on the breakdown provided above, in **Plate 7**, the municipal waste stream is the largest contributor to landfill, followed by inert material and then commercial and industrial. However, it is noted that waste type varies significantly from year to year. Based on visual observations at the active tip face, it is believed that a large proportion of the landfilled waste is recyclable or recoverable. Using the waste stream breakdown presented in **Plate 7** and the annual waste quantities, the breakdown of waste has been estimated in tonnes, as shown in **Table 4**.

TABLE 4 - AVERAGE ANNUAL WASTE TO LANDFILL

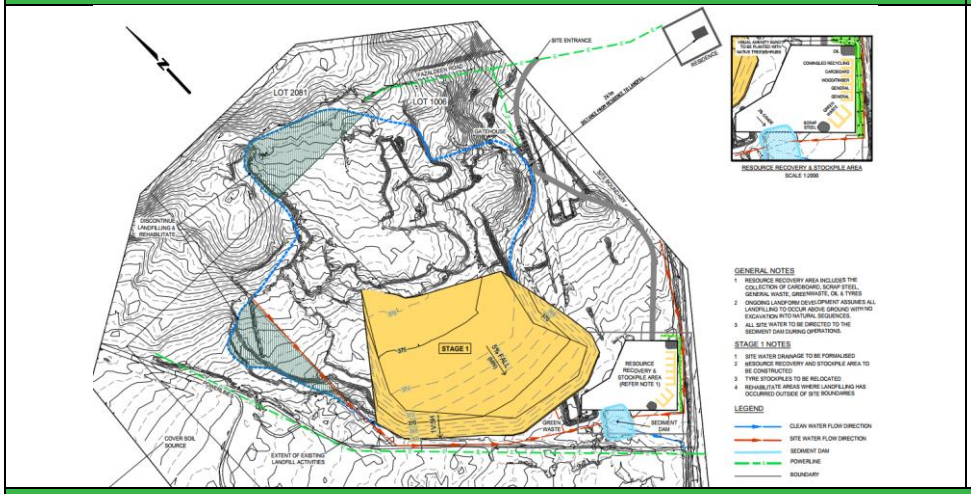
WASTE TYPE	WEIGHT (t)
Inert	1,745
Municipal	7,570
Commercial and Industrial	1,562
Construction and Demolition	522
E-waste	0.19
White goods	1
TOTAL	**11,400**

2.11 FUTURE LANDFILL DEVELOPMENT

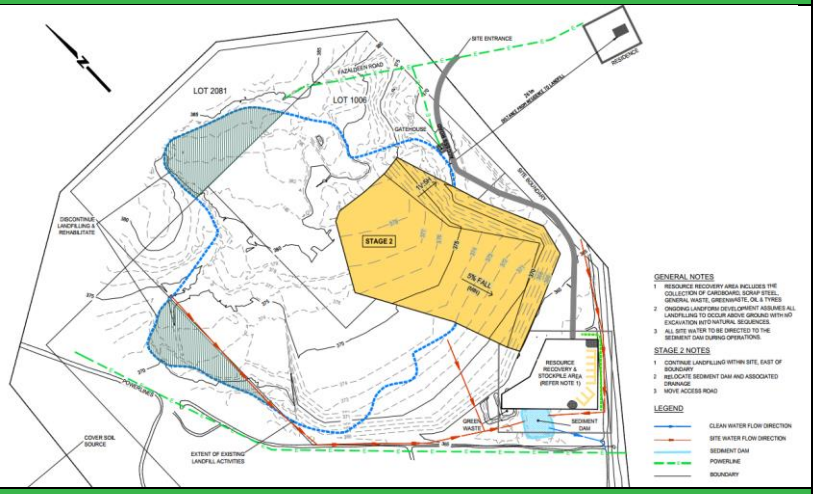
The following is a summary of the proposed future landfill development staging as outlined in the Master Plan proposed by GreenTec (2021). The landfill will progress in the following stages shown below in **Plate 8**.

PLATE 8 - LANDFILL DEVELOPMENT STAGING (GREENTEC, 2021)

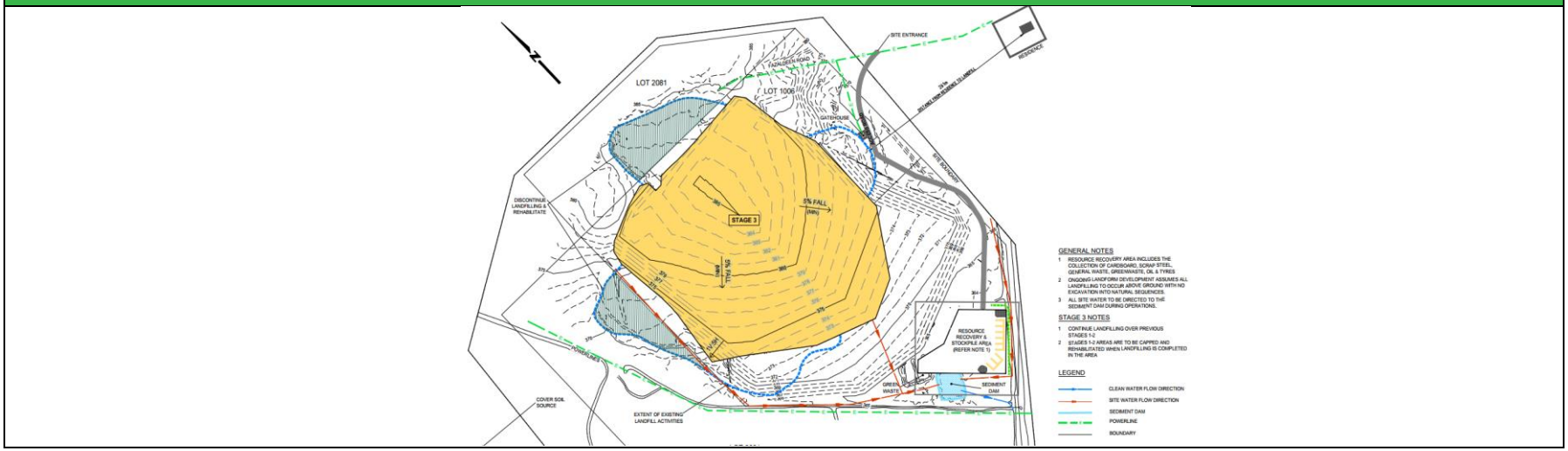
STAGE 1



STAGE 2



STAGE 3 (FINAL LANDFORM)



The estimated airspace for each stage listed in the Master Plan (GreenTec, 2021) is shown in **Table 5**.

TABLE 5 - ESTIMATED AIRSPACE FOR EACH STAGE OF LANDFILL DEVELOPMENT

STAGE	VOLUME	LIFESPAN*
Stage 1	98,778 m^3	6.9
Stage 2	102,112 m^3	7.2
Stage 3 (Final)	177,515 m^3	12.4
Total	**471,550 m^3**	**26.5**

*Calculated based on current landfilling rate of 14,250m3 per annum. This rate doesn't include cover soil or capping volume.

2.11.1 Stormwater Management

Water is generally directed around the site with any water that falls within the site directed towards the sediment dam in the south of the site. There are no formal drains in place to drain water from the top of batters to the sediment dam and no sediment and erosion controls in place, with evidence of minor erosion on batters.

2.11.2 Leachate Management

The landfill is unlined and there are currently no leachate management systems in place. It is noted that others have determined that liners are not required for this site due to the depth to groundwater and the low permeability soils present onsite. Leachate generation is minimal with evaporation far exceeding rainfall.

3 LEGISLATIVE CONTEXT

3.1 ENVIRONMENTAL PROTECTION LICENCE

Tennant Creek Waste Management Facility is a prescribed site under the Environmental Protection Act 1986 and as such is managed in accordance with an operating licence issued by the Northern Territory Environmental Protection Authority (NT EPA) Environment Regulation. As of July 2019, Tennant Creek WMF is governed by Licence Number (EPL 281).

Current conditions from the EPL and subsequent amendments that are relevant to this LCMP are as follows:

Condition 33	Where a landfill cell is no longer in use, the licensee must ensure that the landfill cell is closed and capped so as to achieve the landfill cap design objectives in the NT EPA Guidelines for the Siting, Design and Management of Solid Waste Disposal Sites in the Northern Territory.
Condition 38	The licensee must ensure there is no migration or overflow of a contaminant or waste, which causes or may cause environmental harm, beyond the boundary of the land on which the premises are located. (For the avoidance of doubt, this condition is not intended to authorise the discharge of a contaminant or waste to any land or water which discharge has not been specifically authorised by another condition of this licence.)
Condition 39	The licensee must not allow a contaminant or waste, which causes or may cause environmental harm, to enter water.
Condition 40	The licensee must ensure that stormwater does not come into contact with a contaminant or waste, which causes or may cause environmental harm.
Condition 57.1	Prepare a Landfill Closure and Post Closure Plan in accordance with the NT EPA Guidelines for the Siting, Design and Management of Solid Waste Disposal Sites in the Northern Territory.
Condition 57.2	Ensure the Plan includes a strategy to implement progressive rehabilitation of the landfill.
Condition 57.3	Ensure the Plan is consistent with recommendations provided in the 2016 Iolar Tennant Creek Landfill Concept Master Plan (Master Plan) and provides for the transition of operating activities at the premises to the proposed Lots specified in Attachment 1 to the Master Plan.
Condition 57.4	Ensure the Plan is reviewed by a qualified person and they prepare a written report of their review, prior to submission of the Plan to the NT EPA.

3.2 BEST PRACTICE GUIDELINES

This LCMP is prepared in line with a risk-based approach and draws on information and principles outlined in the NT EPA '*Guidelines for Siting, Design and Management of Solid Waste Disposal Sites in Northern Territory'* (2013).

According to the NT EPA Guidelines, best practice rehabilitation of landfills should include consideration of all appropriate controls including the management of leachate, landfill gas and surface drainage, as well as ensuring that the approved final land use is achieved.

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 minimised with 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; and
- Progressively rehabilitate the landfill.

It is to be noted that the existing Tennant Creek WMF landfill is unlined, meaning that Condition 57.1 which states the LCMP must be in accordance with the NT EPA guidelines cannot ever be fully achieved. This means additional focus will be placed on effective covering of the waste to limit leachate ingress into the waste mass, as well as progressively capping the site in a timely manner.

Additionally, site specific constraints such as the age of the landfill, Council budgeting and lack of existing infrastructure limits the ability to adhere to some requirements in the best practice guidelines.

4 LANDFILL CLOSURE PLAN RISK ASSESSMENT

An environmental risk assessment using the source, receptor and pathway model has been developed to address specific environmental risks relevant to the Tennant Creek Waste Management Facility.

4.1 SOURCE

A source is the origin of environmental risk which can lead to contamination or environmental harm. Sources of environmental impact at Tennant Creek WMF include:

- Leachate;
- Landfill gas (LFG) and odour;
- Landfill fire or site fire;
- Dust;
- Litter;
- Vermin;
- Invasive flora species; and
- Noise.

4.2 PATHWAY

A pathway is the route by which potential environmental harm or contamination can travel. Key pathways for potential environmental harm at Tennant Creek WMF include:

- Surface flow (runoff);
- Subsurface flow (underlying soils, aquifers or subsurface infrastructure that allow for contaminants to enter receptors); and
- Airborne (dust, odour and landfill gas).

4.3 RECEPTOR

The receptor is the location where the environmental harm or impact is registered, this can be onsite and offsite. Possible receptors of environmental harm from Tennant Creek WMF include:

- Groundwater;
- Surface water;
- Surrounding infrastructure;
- Surrounding land users;
- Vegetation and flora; and
- Fauna.

4.4 RISK MATRIX

Environmental risks are assessed using a risk matrix, which evaluates the likelihood and consequence of a specific risk to attain an associated level of risk.

4.4.1 Likelihood

The likelihood of a risk is probabilistic, based on the following classifications (from 1 – 5):

1. Rare – Only occurs in exceptional circumstances.
2. Unlikely – Will probably not occur in most circumstances;
3. Possible – Could occur in some circumstances;
4. Likely – Will probably occur in most circumstances; and
5. Almost certain – Expected to occur in most circumstances.

4.4.2 Consequences

Consequences from an identified environmental risk are classified as follows (from A – E):

A: Negligible	Minimal onsite impact.
B: Minor	Low onsite impact, minimal localised offsite impact and no larger scale offsite impact.
C: Moderate	Mid level onsite impact, low level localised offsite impact and minimal larger scale offsite impact.
D: Major	High level onsite impact, mid level localised offsite impact or low level larger scale offsite impact or short term impact to an area of high conservation value or special significance.
E: Severe	Catastrophic onsite impact, high level (or above) localised impact, mid level (or above) larger scale offsite impact or mid to long term or permanent impact to an area of high conservation value or special significance.

4.4.3 Risk Rating

The level of risk is qualitatively assessed based on the combination of likelihood and consequence, as shown in **Table 6** below.

TABLE 6 - RISK CALCULATOR

Likelihood	Consequence				
	Negligible (A)	Minor (B)	Medium (C)	Major (D)	Severe (E)
Almost Certain (5)	M (5A)	H (5B)	H (5C)	V (5D)	V (5E)
Likely (4)	M (4A)	M (4B)	H (4C)	H (4D)	V (4E)
Possible (3)	L (3A)	M (3B)	M (3C)	H (3D)	V (3E)
Unlikely (2)	L (2A)	M (2B)	M (2C)	M (2D)	H (2E)
Rare (1)	L (1A)	L (1B)	M (1C)	M (1D)	H (1E)

V = Very high risk - Immediate action required with a full analysis;

H = High Risk - Management required from senior staff, implement high level controls;

M = Medium risk - Plan and schedule appropriate controls;

L = Low risk - Manage with standard operating procedures or as deemed appropriate by relevant authorities.

4.4.4 Risk Assessment

An environmental risk assessment that incorporates site specific control measures to reduce the level of risk is provided in **Table 7** below. This assessment will enable supervisors to assess the environmental risks associated with Tennant Creek WMF and establish timeframes for the implementation of specific controls.

TABLE 7 - RISK ASSESSMENT

SOURCE	RECEPTOR	PATHWAY	PATHWAY DESCRIPTION	RISK DESCRIPTION	RISK LEVEL	CONTROL MEASURES AND JUSTIFICATION	REVISED RISK LEVEL
Leachate	Site personnel and users	Air	Volatised leachate becoming airborne.	Odour, nuisance.	Medium (4A)	Cover waste with daily cover or intermediate cover and undertake progressive final capping, as specified in the LCMP.	Low (2A)
	Local residents	Subsurface	Migration of leachate through groundwater and bore extraction.	Contamination of fresh water aquifers that is used by the community.	High (3D)	Groundwater is estimated to be very deep (>60m) and the landfill is underlain by a low permeability soil. Groundwater in the area is not suitable for agriculture or domestic use. Evaporation on site far exceeds rainfall.	Medium (1D)
	Surface water bodies (creeks, ponds, dams)	Surface	Leachate impacted surface water runoff.	Contaminated stormwater runoff impacting surrounding ecology.	Low (2A)	Maintain a small operational tip face (maximum 20m x 5m). Cover waste with daily or intermediate cover as appropriate. Ensure no leachate is discharged offsite and maintain clean water diversion drains and boundary around active tipface.	Low (1A)
		Subsurface	Migration of leachate within groundwater.	Direct or indirect consumption of leachate. Adverse impacts to ecosystems.	Low (2A)	Due to the large attenuation zone between the landfill and groundwater it is unlikely that leachate will impact the groundwater.	Low (2A)
	Flora and Fauna	Surface	Leachate impacted surface water runoff.	Contaminated stormwater runoff impacting surrounding ecology.	Low (2A)	Maintain a small operational tip face (maximum 20m x 5m). Cover waste with daily or intermediate cover as appropriate. Ensure no leachate is discharged offsite and maintain clean water diversion drains.	Low (1A)
		Subsurface	Migration of leachate within groundwater.	Potential impacts to deep rooted flora.	Low (1B)	Minimal deep rooted flora surrounding site. High evaporation rates make it unlikely for surrounding flora to take in leachate impacted water.	Low (1B)

SOURCE	RECEPTOR	PATHWAY	PATHWAY DESCRIPTION	RISK DESCRIPTION	RISK LEVEL	CONTROL MEASURES AND JUSTIFICATION	REVISED RISK LEVEL
LFG (explosive and asphyxiant gases)	Site personnel and users	Air	Direct LFG venting to atmosphere	Asphyxiation or explosion caused by LFG.	Low (1B)	Landfill gas causing explosions or asphyxiation is considered rare. Conditions on site are very dry, meaning decomposition of waste occurs at a very slow rate.	Low (1B)
LFG (odour)	Site personnel and users	Air	Direct LFG venting to atmosphere	Nuisance, odour.	Medium (4A)	Odour is likely present. Covering and capping of the waste whilst limiting the active tip face can reduce the odour detected at the landfills surface.	Low (3A)
Dust	Local residents and site personnel / users	Air	Airborne dust from earthworks or trafficking	Nuisance, potential health impacts	Low (3A)	Wet down access roads when large traffic is expected. Dust produced onsite is considered insignificant when compared to normal vehicle movements on unsealed roads surrounding the community.	Low (2A)
Litter	Local residents	Air	Litter blown in the wind	Mainly visual impacts and potential for fauna to ingest	Low (1A)	Windborne litter is unlikely to reach the township. Maintain daily and intermediate cover to prevent waste becoming airborne. Regularly tend to litter scattered across site. Fencing can be used if necessary.	Low (1A)
	Flora and Fauna				Medium (4A)	Maintain daily and intermediate cover to prevent litter impacting flora and fauna. Regularly tend to litter scattered across site. Fencing can be used if necessary.	Low (3A)
	Surface water bodies				Low (1A)	No nearby surface water bodies. Maintain daily and intermediate cover to prevent waste becoming airborne. Regularly tend to litter scattered across site. Fencing can be used if necessary.	Low (1A)

SOURCE	RECEPTOR	PATHWAY	PATHWAY DESCRIPTION	RISK DESCRIPTION	RISK LEVEL	CONTROL MEASURES AND JUSTIFICATION	REVISED RISK LEVEL
Invasive flora species	Flora and fauna	Air, surface water runoff, animals	Seeds present in the waste received can spread to the surrounding environment via wind, surface water or animals.	Spread of invasive flora species can impact ecosystems.	Medium (3C)	Maintain adequate cover. Undertake progressive capping and use dominant native grasses.	Medium (2C)
Landfill fire	Site users and workers	Air, direct contact	Smoke containing toxic compounds, possible ingestion or inhalation of ash.	Dangerous emissions from the burning of waste (including sulphur dioxide, lead, mercury) can cause serious immediate and/or long-term health problems.	High (3D)	Fire management plan to be implemented, restrict ignition sources on site and screen incompatible wastes.	Medium (2D)
	Local residents				Medium (2D)	Closest residential property is 300m from the landfill. Fire management plan to be implemented, restrict ignition sources on site and screen incompatible wastes.	Medium (2C)
	Fauna				High (3D)	Fire management plan to be implemented, restrict ignition sources on site and screen incompatible wastes.	Medium (2D)
Exposed waste and ponded water	Local residents	Airborne disease – flies and mosquitoes	Exposed waste and ponded water can become a breeding ground for diseases	Flies and mosquitoes in contact with exposed waste or ponded water can	Medium (2D)	Limit active tip face. Maintain adequate cover. Undertake progressive capping. Ensure adequate drainage around site and active tipface is bunded.	Low (1B)

SOURCE	RECEPTOR	PATHWAY	PATHWAY DESCRIPTION	RISK DESCRIPTION	RISK LEVEL	CONTROL MEASURES AND JUSTIFICATION	REVISED RISK LEVEL
			which can impact the community.	spread disease to the community .			
	Flora and fauna	Vermin and invasive fauna	Exposed waste becoming a food source for vermin or fauna.	Waste becoming a food source or invasive fauna and vermin leading to elevated population levels.	Medium (2D)	Limit active tip face. Maintain adequate cover. Undertake progressive capping.	Medium (2D)

5 FINAL LANDFORM REHABILITATION DESIGN

5.1 POST CLOSURE USE

Since the closure of the landfill is predicted to be more than 26 years away (GreenTec, 2021), Council have not decided on a post closure use for site. The NT EPA *Guidelines for Siting, Design and Management of Solid Waste Disposal Sites in Northern Territory* states:

"Common future uses of landfills include sports grounds, public open space and golf courses. Depending on the age of the landfill and the type of waste deposited, some landfills have been developed for commercial or industrial building development, though this requires particular consideration of the impacts of settlement on buildings and services such as water mains, gas and roads. Water features, such as ornamental lakes or ponds, should be avoided on landfills as they may leak due to cracking of their liner from differential settlement of the landfill over time. This leakage will release significant volumes of water to the landfill, thus generating significant volumes of leachate."

Deciding on a post closure use relates to the management of the landfill during the lifespan (i.e. compaction standards, quality control, filling plans, etc.). GreenTec suggests capping, restoring, and revegetating the surface of the landfill once the final landform is achieved. It is recommended to restrict public access to the final landform until most settlement has occurred. After 5-10 years of closure an assessment should be undertaken if alternative land uses have been proposed.

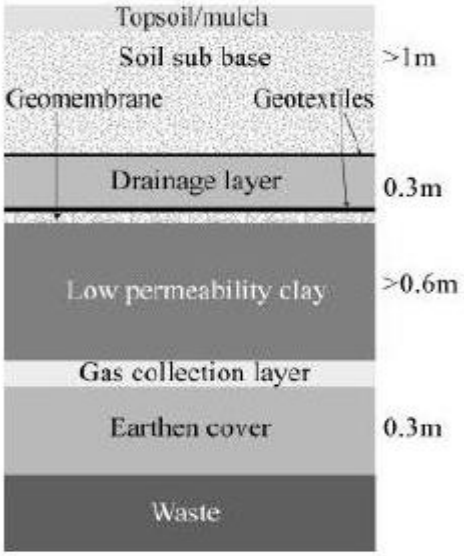
5.2 BENCHMARK CAPPING PROFILE

Once landfilling operations have ceased it is important to develop a final cap that:

- Minimises infiltration of water into the waste mass (leachate generation);
- Provides a long-term barrier to prevent wildlife or human contact with the waste;
- Prevents uncontrolled release of landfill gas; and
- Restores the land to a state that is suitable for the intended use.

An indicative landfill cap from the NT EPA guidelines (2013) is outlined in **Plate 9** below. This capping profile will be assessed and modified to suit the specific site conditions at Tennant Creek WMF.

PLATE 9 - BENCHMARK LANDFILL CAP DESIGN



The key factors to consider for final capping design are discussed herein.

5.3 TENNANT CREEK LANDFILL CAPPING PROFILE

5.3.1 Settlement Assessment

Settlement of the final landfilling profile is primarily dependent on the following:

- The amount of putrescible waste in the landfill;
- The degree of compaction;
- The duration of operations prior to capping;
- Thickness of the waste; and
- Moisture content.

At this stage the expected settlement of the waste when capped cannot be estimated due to the lack of information on the degree of compaction and the waste composition. The recommended compaction for a landfill receiving more than 50,000t of waste per annum is at least 800kg/m^3. Whereas, for a landfill receiving less than 50,000t per annum the recommended compaction is at least 600kg/m^3, as outlined in the NT EPA guidelines (2013). Higher amounts of putrescible waste and low compaction standards will lead to larger settlements, this settlement can be expected to occur over a prolonged period after closure due to the dry nature of the site (i.e. low moisture content leading to a slow decomposition rate of the putrescible waste). Due to low amount of waste placed per annuum being approximately 11,400tpa and that compaction is occurring at the site with a Caterpillar 816 landfill compactor, it is expected that settlement for Tennant Creek WMF would be minimal.

5.3.1.1 Waste Composition

The composition of the waste was estimated based on observations by operations staff. The breakdown of waste to landfill is shown in **Section 2.10.2** and indicates that approximately 66% of the waste in the landfill is municipal waste from residents. Most of the deposited waste is municipal waste, meaning it is important to maintain daily and intermediate cover and progressively cap the site in a timely manner. The site is very dry so the moisture content in the waste is expected to remain low, however, this has not been confirmed via laboratory testing.

5.3.1.2 Compaction

The waste is compacted using a Caterpillar 816 landfill compactor and it has been specified that four passes of the compactor should achieve an acceptable waste compaction between 0.6 – 0.8t/m^3.

5.3.1.3 Operational Timeframe

Landfilling began at the site in 1997 and is expected to continue for at least another 26 years, in a total of 3 stages. This long operational timeframe is beneficial, as some putrescible will be fully decomposed before the final landform is complete, reducing post-closure gas generation and settlement.

5.3.1.4 Thickness of Waste

The final waste profile is estimated to be up to 25 m thick at the deepest point in the cell, with the highest point to be RL385m as per the Master Plan (GreenTec, 2021). The total thickness impacts the amount of settlement that will occur.

Due to low amount of waste placed per annuum, the composition, low moisture content and that compaction is occurring at the site with a Caterpillar 816 landfill compactor it is expected that settlement for Tennant Creek WMF would be minimal and is not considered a large design consideration for the proposed capping profile.

5.4 LANDFILL DEVELOPMENT

5.4.1 Overfilling

Landfilling has historically occurred outside of site boundaries into Lot 2081, which Council has recently acquired as part of the ILUA dated the 27th of May 2021. No further landfilling is permitted in the ILUA area and Council have indicated that historical waste placement in this area will be removed as follows:

- Excavate all waste to the west of Lot 2161 (known as 'Area 4') and place within the confines of the landfill boundary and all future landfilling to be conducted within the landfill site boundary; or
- Waste placed outside the boundary to the north of Lot 1006 and Lot 2161 (known as 'Area 3') is to be capped and rehabilitated and all future landfilling to be conducted within the landfill site boundary.

Site boundaries have been marked out on site to prevent further overfilling.

5.4.2 Landfill Liner

The NT Guidelines for the siting, design and management of solid wastes disposal sites (2013) state that:

"New and lateral extensions of existing landfills need to provide an appropriate level of retention to protect the environment from adverse effects of leachate entering the groundwater and surface waters".

Groundwater at the site is expected to be deep (>60mbgl), overlain with low permeability clay soils and the site evaporation far exceeds rainfall. Therefore, the use of an engineered liner has not been adopted, with the likelihood of any contamination reaching groundwater very low. Additionally, groundwater in the area is not suitable for agriculture or domestic use.

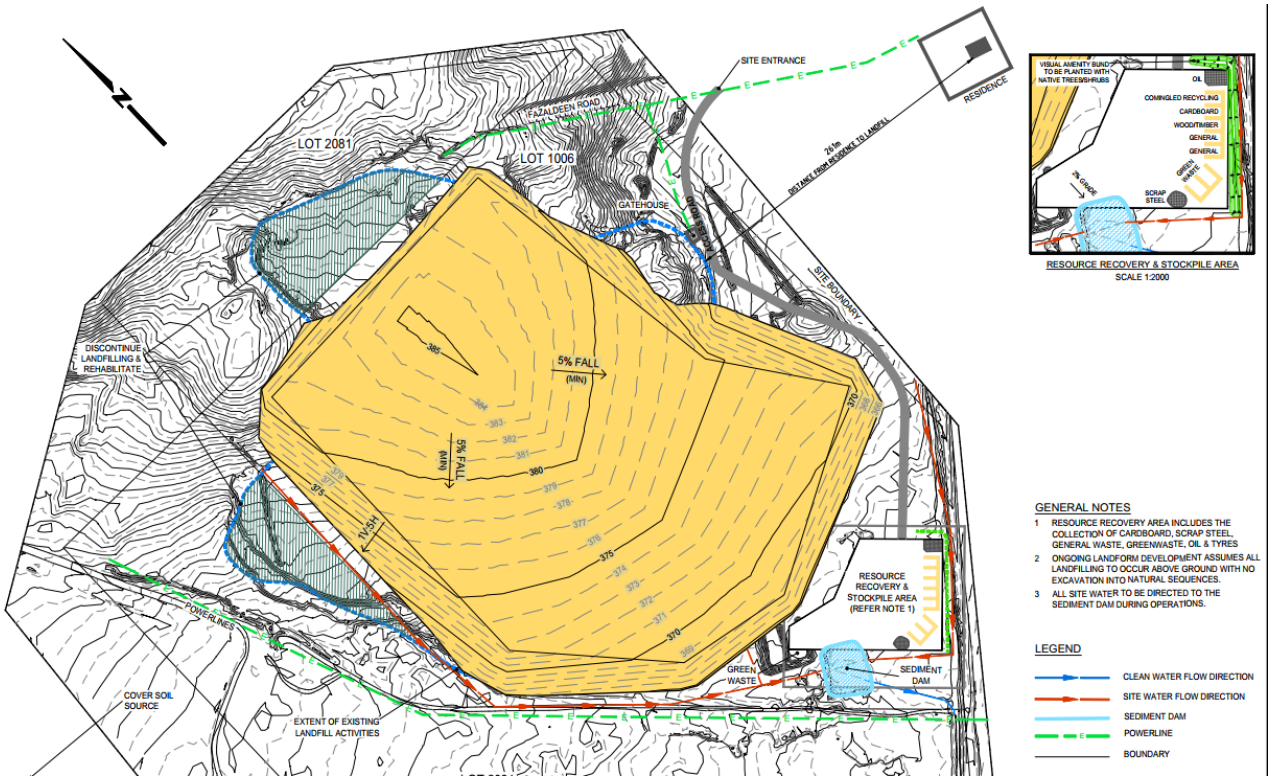
It is noted however that leachate and stormwater controls can be improved to reduce potential for contamination of stormwater discharged offsite.

Using landfilling techniques such as bunding or trenching in the active tip face will retain leachate and reduce stormwater contamination. Regarding stormwater management, the formalisation of vegetation or rock lining of site water drains connected to the sediment dam will also result in cleaner water being discharged in high rainfall events.

5.4.3 Final Landform

GreenTec prepared a Master Plan for Tennant Creek WMF which included a concept final landform. The Final landform allows for current and future site infrastructure, access roads and stormwater infrastructure. The landform consists of lower batters at 5 (H) to 1(V) for 2-5m and then a plateau of 5% minimum rising to a height of RL385m. The concept landform is Presented below in **Plate 8.**

PLATE 10 - CONCEPT FINAL LANDFORM (GREENTEC, 2021)



Council has confirmed adoption of concept landform to date to be constructed in the stages outlined in **Section 2.11**.

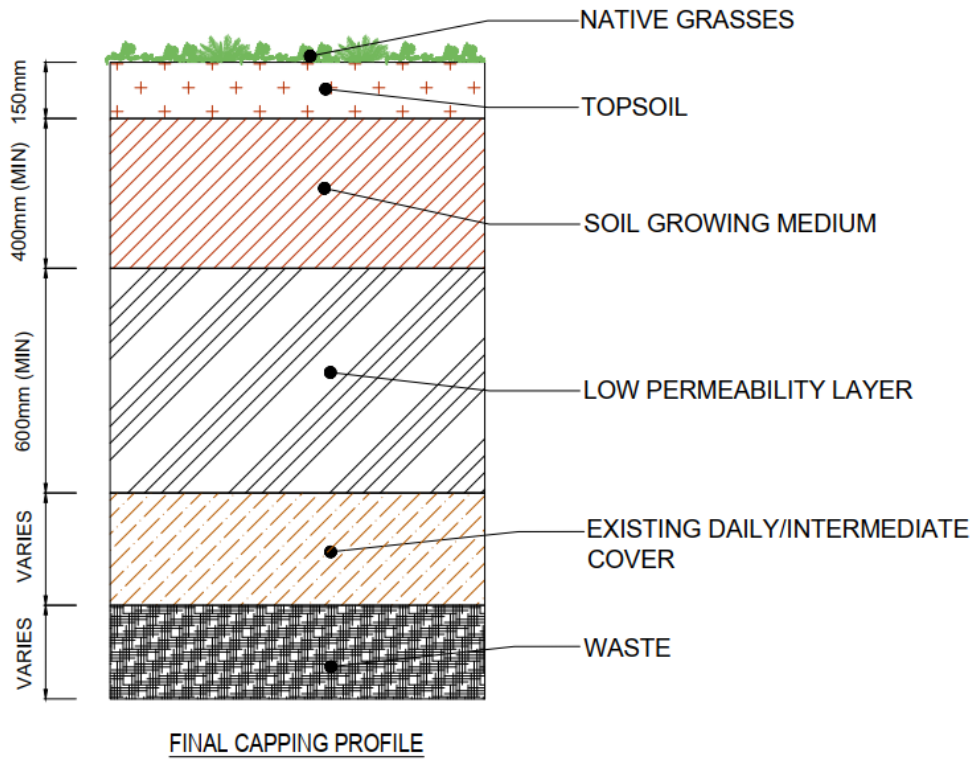
5.5 FINAL CAPPING PROFILE

The landfill cap forms a key component of the closure of Tennant Creek WMF. 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 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 facility; and
- Manage surface water flows to minimise the potential for leachate generation and surface ponding.

The risk assessment completed in **Section 4** has been used to determine an appropriate capping design profile, as shown in **PLATE 11**. The design profile reflects the site-specific risk presented by the Facility and NT EPA guidelines and local factors.

PLATE 11 - PROPOSED CAPPING PROFILE



5.5.1 Topsoil

Due to the erodibility of soils in the region and the final slopes of the sites, a 150mm layer of a topsoil or a coarse mulch will be required to minimise the risk of cap erosion until vegetation has become established. The mulch can be produced from green waste 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.

5.5.2 Soil Growing Medium

This 400mm layer of soil will provide the rooting zone for the cap's vegetation. It can be produced with uncompacted local soils and composted green waste can be applied and incorporated within this layer to improve the soils ability to support the vegetation planted on the cap.

5.5.3 Low Permeability Layer

This layer will be a fine grained cohesive material typically including a clay component to be sourced from the ILUA area in Lot 2081 (or imported) placed, compacted and moisture conditioned in a minimum of three layers to a minimum total thickness of 600mm. Approval has been granted in the ILUA (May 2021) to acquire soft shallow soils from Lot 2081 for use in capping or as cover material.

The permeability of the existing natural soil formation (clayey soils) is estimated to have an approximated permeability of 10^{-6} to 10^{-8} m/sec. Permeability is to be confirmed through laboratory tests, including on-site falling head tests conducted prior to excavation. If confirmed, soils excavated are suitable for the construction of low permeability final capping. A progressive capping design

specification should be produced that meets these minimum requirements but provide flexibility in construction quality assurance to allow for council staff or a local earthworks contractor to construct the cell.

The combination of minimum rainfall, high evaporation, surface run-off from the contoured capping layer and evapotranspiration from the vegetation, together with the compacted layer of clay are expected to exceed the 'less than 75% seepage rate' required for best practice.

5.5.4 Daily Cover / Intermediate Cover

A daily cover layer of 150mm or intermediate cover of 300mm 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 that is received at the site during its remaining operational life should be stockpiled in preparation for rehabilitation works.

5.6 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 that are indigenous to the area and local provenance. To avoid inappropriate planting, ensure the species are adoptable to the local climate and enhance the local habitat.

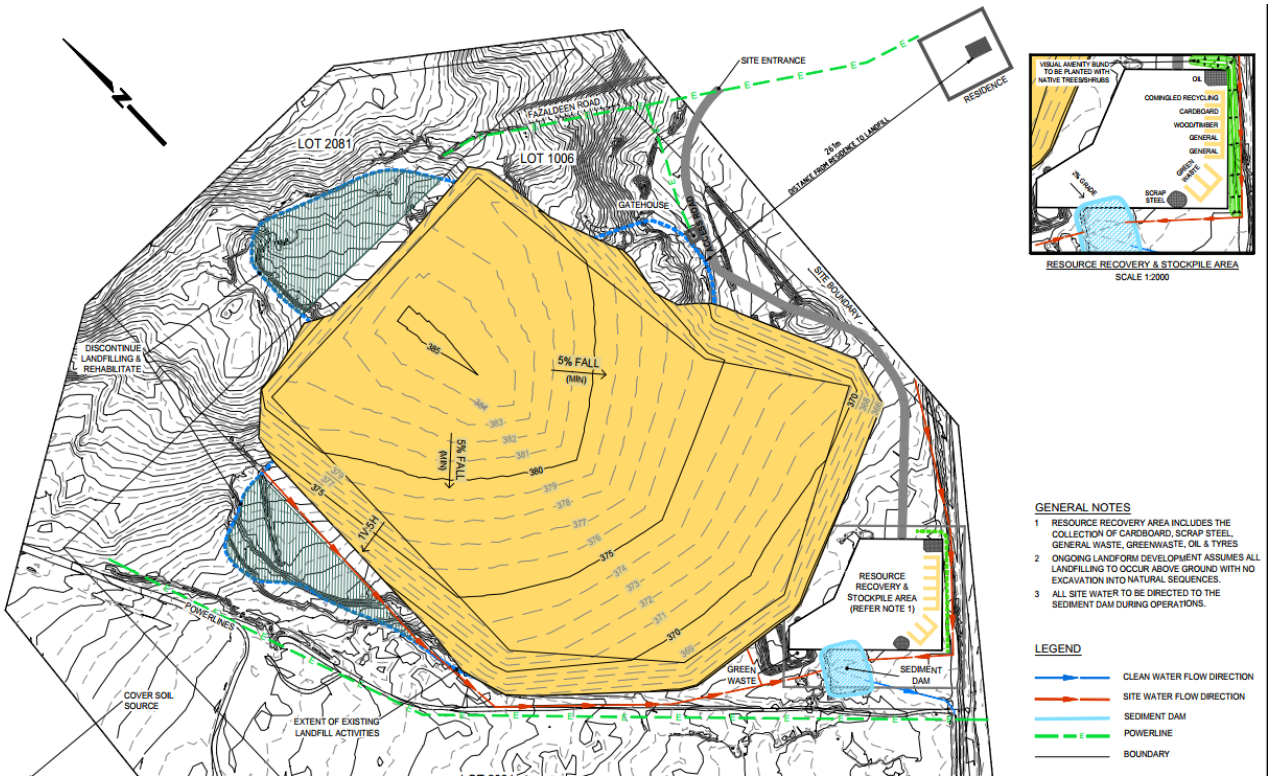
Shallower rooting species should be used, as any roots penetrating the low permeability layer into the waste body may provide a conduit for water to flow through the cap. In addition, as the waste is likely to be producing small quantities of methane (which is a toxic gas to flora) for a number of years after capping, any roots penetrating the cap would be exposed to methane and possibly result in the death of the plant. Based on the presence of the native grasses on the existing landfill they appear to be tolerant and suitable for this application. This will also integrate into the visual amenity of the region.

6 STORMWATER MANAGEMENT DESIGN

A surface water management design for Tennant Creek Waste Management Facility has been developed to manage the environmental risks associated with the infiltration of surface water into the waste mass and to minimise the production of leachate. The key stormwater design objectives include:

- During construction, all water that comes in contact with exposed soil surfaces must be considered as sediment laden water and treated appropriately in accordance with IECA 2008 best Practice guidelines for Erosion and Sediment Control;
- After construction of the landfill cap and associated infrastructure, all surfaces will be covered in vegetation and, therefore, all water can be considered clean and does not require treatment;
- All capped plateau surfaces will maintain a minimum of 5% fall to promote surface water drainage. Contour drains and batter chutes will be utilised to direct water from upper plateau surfaces, down batters, to drainage structures at the base of the landfill batters and towards the discharge location(s); and
- All clean water will eventually discharge from the site via the southern eastern point of the site adjacent via the existing sediment dam. Water on site generally sheds from north west to south east.

PLATE 12 - CONCEPT STORMWATER MANAGEMENT PLAN



6.1 SURFACE WATER MONITORING

Water is currently managed on site by directing sediment-laden water to a sediment dam, where the water ultimately evaporates. This dam contains sediment laden water and the water treatment mechanism is evaporation, with no discharges to surrounding land noted due to the high evaporation in the area. Therefore, surface water quality monitoring is currently not undertaken on site. It is recommended to excavate out the excess soil in the pond during the dry season when the pond is

dry to maintain capacity. Based on the low risk of overflow and contaminant migration to surrounding environments and site specific constraints, surface water quality monitoring is not recommended.

6.2 SEDIMENT DAM CAPACITY

A basic check on the existing capacity of the sediment dam was undertaken based on a 1 in 10 year 24 hour rainfall event on site. The current capacity of the sediment dam was estimated at 2,400m^3 assuming a depth of 1.5m. A required volume of the sediment dam was estimated assuming the following:

- A quarter of the site is intermediately covered, reporting to the sediment dam. Whilst the rest of the site has a final cap (and water is diverted); and
- An infiltration rate of 50%.

The corresponding rainfall depth for a 1 in 10 year 24 hour event on site is 110mm. Applying this depth over the assumed intermediately covered areas with an infiltration rate of 50% puts the required pond capacity at 2,255m^3, just below the estimated current capacity. This does not consider settlement zone depths or if additional areas need to report to the sediment dam.

It is recommended that Council should engage a suitably qualified person to undertake design of the sediment dam onsite if they intend to divert additional catchment to this sediment dam.

7 LANDFILL GAS

7.1 GENERAL

Landfill Gas (LFG) is a by-product of organic waste decomposition inside putrescible landfills. LFG is predominately methane and carbon dioxide but can consist of many other constituents depending on the waste composition. Migration of LFG occurs when the gas moves through surrounding soils and emissions are when the gas enters the atmosphere, both of which can have significant environmental and health and safety impacts.

The site currently has no gas migration monitoring points or gas management infrastructure. The formation of gas is likely to continue for some years, however, due to the low waste disposal rate and the low moisture content, it is expected that the risk of LFG migration is below infrastructure implementation thresholds. It is therefore proposed that monitoring is conducted on a six-monthly basis to determine ongoing risk, assess capping integrity and rectify as required. The following describes the proposed LFG monitoring criteria for surface monitoring to be conducted over the entire landfill surface on a 25m grid.

Landfill gas is predominantly characterised by the presence of methane and as such landfill gas monitoring consists largely of monitoring for methane (CH_4) gas emissions. Typically, the release of methane should not exceed the following limits:

a) 500ppm (0.05%) at 50mm above the cover surface of the landfill including batter slopes;

b) 500ppm (0.05%) of the lower explosive limit (LEL) when measured in facility structures (but excluding facility structures used for landfill gas control and landfill gas recovery system components); and

c) the LEL for methane at the facility boundary (50,000ppm or 5.0 %v/v).

Methane is explosive at concentrations between 5% and 15% (v/v), with the lower bound concentration of 5% conservatively adopted as the LEL. This is equivalent to 50,000ppm methane concentration. Equivalent landfill gas lower bound emission limits are therefore as follows:

a) 50mm above the cover surface of the landfill including batter slopes	500ppm
b) Facility structures (but excluding facility structures used for landfill gas control and landfill gas recovery (system components)	10,000ppm (1%v/v)
c) Facility Boundary	50,000ppm (5%v/v)

7.1.1 Other Parameters

Carbon dioxide (CO_2) is considered unsafe at levels exceeding 1.5 v/v%. There are no specific guidelines for monitoring other elements levels (CO, H_2S, O_2) and therefore no emission limits can be applied.

7.1.2 Frequency and Reporting

Monitoring and reporting of LFG should be undertaken on a six monthly basis minimum for a minimum period of two years after closure and until such time that the landfill poses no significant environment and public risk.

8 GROUNDWATER MONITORING

Groundwater monitoring onsite has not been undertaken to date due to the anticipated deep groundwater levels, highly impervious ground conditions, economic feasibility of installing monitoring wells and low risk of impacting any groundwater, particularly groundwater that is suitable for domestic or agricultural purposes.

It has been previously established in the 2006 site EMP (Tennant Creek Town Council) that the deep groundwater table, coupled with the low permeability soils encountered at the site, makes groundwater contamination “not likely to be a significant concern”. Based on information provided and controls put in place as outlined in the Risk Assessment, the impact on groundwater is considered a low risk. The establishment of a groundwater monitoring network is considered unfeasible for a Council of this size, however, Council may want to consider installation of a groundwater monitoring network in the future to confirm any assumptions and to ensure environmental compliance if funding from state government can be sourced.

9 POST CLOSURE MAINTENANCE AND 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.

9.1 LANDFILL MAINTENANCE PROGRAM

The maintenance program for the closed and capped landfill is comprised of the two components described below.

9.1.1 Routine Surveillance

This activity would comprise a walkover inspection and photographic recording of the decommissioned site. The focus of these inspections would be on the following aspects:

- Occurrence of rill erosion and gullying of capping layer and possible exposure of waste;
- Integrity of drainage structures;
- Evidence of leachate expression or seeps; and
- Sustainability of vegetation and areas of possible die back.

The purpose of these inspections would be to visually assess the current state of the site. A particular note would be made on the results of the inspection compared with observations made during previous inspection(s). The stability/integrity of any particular portion of the site (e.g. where some erosion had developed) would thereby be assessed. In the event that any area of the site was deemed to be unstable (i.e. worsening with time, or presenting either an immediate or longer term environmental impact), appropriate remedial action would be implemented to repair or reinstate the area of concern.

Site inspections would be carried out quarterly or following a period of intense or prolonged rainfall.

9.1.2 Maintenance

A program of maintenance works in relation to the landfill capping and landfill infrastructure would be maintained. Routine maintenance works would comprise the following:

- Repair/reinstatement of areas of scouring and drainage redirection, as required, to maintain drainage areas;
- Repair/reinstatement of drainage structures;
- Reseeding or replanting of vegetation, as required; and
- Mowing and pruning, as required.

In addition, a program of weed eradication within the site would be implemented and maintained. Routine maintenance would be carried out annually, as a minimum. This is to continue as per the requirements outlined in the Environmental Management Plan (GreenTec, 2021).

9.2 ENVIRONMENTAL MONITORING

Environmental monitoring is to be carried out following closure in relation to the following aspects:

- Surface Water quality (visual);
- Landfill gas emissions; and
- Surface settlement (visual).

The purpose of the monitoring program would be to review the performance of the closed landfill. Environmental monitoring requirements for the Tennant Creek Waste Management Facility during the operations phase are to be maintained in accordance with Development Permit and Environmental Management Plan (GreenTec, 2021). Post closure management and monitoring procedures for Tennant Creek WMF shall include the following.

9.2.1 Erosion and Sediment Control

Post closure erosion and sediment controls are important to ensure the final landform remains suitable for the intended use, even if the intended use is to be restored to the natural landform.

Sediment and erosion controls include:

- Removal of sediment from drainage flow paths including diversion banks and drains to ensure free flow along drainage paths where flow velocities and erosion can be minimised; and
- Repair and/or replace sediment control infrastructure (drains, silt fences, etc.) where necessary.

Therefore, ongoing maintenance of erosion after large rainfall events may be required. The site should be inspected and any incidents should be reported. After large rainfall events where sediment laden water has been released from site, it shall be tested as per the requirements in the Environmental Management Plan (2021). Incidents, observations and maintenance will be contained in a written plan for the site with an official document number that has been discussed and agreed with operations staff.

9.2.2 Vegetation Control

Once the landfill is closed the surface needs to be revegetated to match surrounding land as much as practicable. Therefore, it is recommended to use native plants species that can grow effectively in the local region, given the harsh climate conditions.

Initially after capping, the vegetation will be monitored to check that it can stabilise the topsoil and assists in reducing erosion. Periodic inspections will occur and any areas where the vegetation has died will be re-established.

9.2.3 Pest Control

If pests are identified during periodic inspections of the site appropriate advice will be sought to development a specific pest management plan at the site. Pests can cause vegetation issues and also damage the liner integrity in the case of burrowing animals.

9.2.4 Weed Control

Weed control will be undertaken to limit weed species on site as required. Weeds will be identified in the periodic inspections and appropriate advice to develop a site specific weed management plan will be sought if deemed necessary.

9.3 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. To ensure consistency and good record keeping, the Council 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); and
- Signed and dated by a responsible officer.

All the forms should be recorded in Council's record management system and made available to NT EPA on request.

9.3.1 Review of Landfill Closure Management Plan

This LCMP shall be reviewed every three years and updated accordingly. The review shall include:

- Results of internal audits and evaluation of compliance with legal and environmental requirements applicable to the landfill closure;
- Complaints or relevant external party correspondence;
- Environmental performance;
- Tracking of objectives and targets;
- Status of corrective and preventative actions;
- Follow up actions from previous management reviews;
- Changing circumstances, including developments in legal and other requirements pertaining to environmental aspects; and
- Recommendations.

The LCMP shall also be reviewed once detailed design of capping has been undertaken.

10 CLOSURE COST ESTIMATES

At this early stage and with some 26+ years of proposed landfilling airspace, it would not be feasible to provide realistic cost estimates due to a number of variables that could occur over this time period. However, it is vital that Council start saving for such rehabilitation and capping works as these costs can be significant. To this end, a basic estimate has been provided for the capping works for the purpose of preliminary budgeting, as shown in **Table 8**.

TABLE 8 - REHABILITATION COST ESTIMATES

DESCRIPTION	COST ESTIMATE
Capping	$6,000,000
Surface water management	$50,000
Professional fees and services	$300,000
Post Closure maintenance and monitoring	$500,000
Estimated Total (rounded)	$6,850,000
Rehabilitation Cost ($/m^3 of airspace)	$15.90

*Does not include allowance for inflation. Detailed design including the production of bill of quantities should be undertaken prior to construction which will assist in adjusting the cost estimate above.

10.1 FINANCING STRATEGY

The majority of post closure rehabilitation work 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.

Gate fees charged for the disposal of waste at Tennant Creek Waste Management Facility are the Councils primary source of revenue, with net revenue used to contribute to the Reserve Account. However, it is noted that a Council of this size with limited rate payers may have to apply for funding to facilitate the rehabilitation of the landfill.

11 REFERENCES

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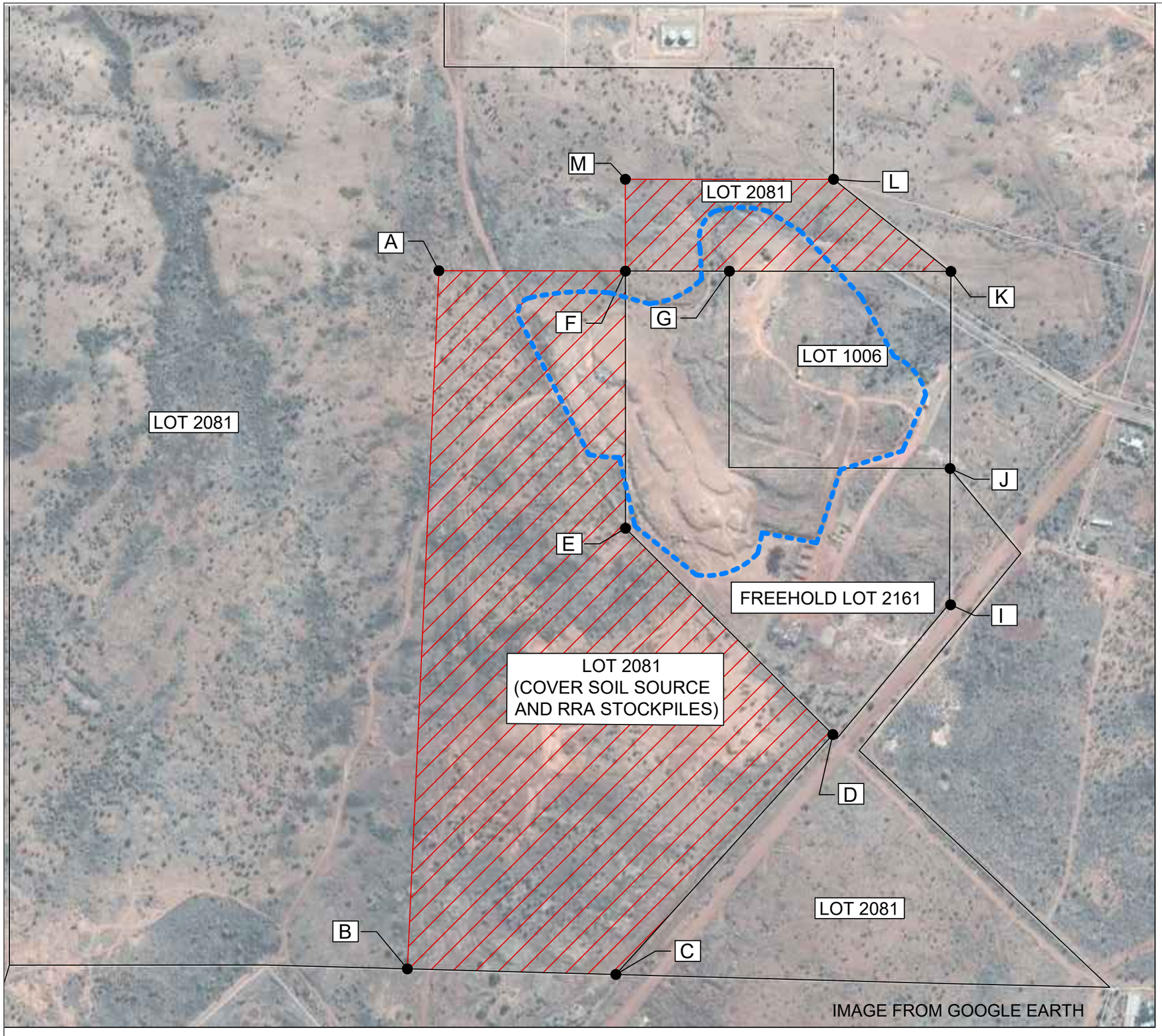
FIGURES



LEGEND

PROPOSED LOT ACQUISITION (25 HECTARES)

APPROXIMATE LANDFILL EXTENT

Points	Coordinates
A	-19.658516°, 134.173312°
B	-19.666323°, 134.172419°
C	-19.666372°, 134.175539°
D	-19.663722°, 134.177720°
E	-19.661387°, 134.175197°
F	-19.658482°, 134.175199°
G	-19.658510°, 134.176449°
H	-19.660703°, 134.176453°
I	-19.662216°, 134.179075°
J	-19.660705°, 134.179072°
K	-19.658499°, 134.179067°
L	-19.657453°, 134.177693°
M	-19.657481°, 134.175191°

REV	DATE	DRAWN	CHECKED	APPR'D	REVISION DETAILS
A	14/05/20	JJ	CL	CL	ISSUED FOR INFORMATION

DRAWING STATUS	
JOB No.	1912-02-BRC
DATE	14/05/20
DESIGN BY	-
DRAWN BY	JJ
CHECKED BY	CL
FINAL APPROVAL	CL
SCALE: (on A3 Original)	NTS

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PROJECT TITLE: LANDFILL CLOSURE MANAGEMENT PLAN

DRAWING TITLE: TENNANT CREEK LANDFILL LOT EXTENTS

CLIENT: BARKLY REGIONAL COUNCIL

PROJECT NO.: 1912-02

DRAWING NO.: 001

REV: A

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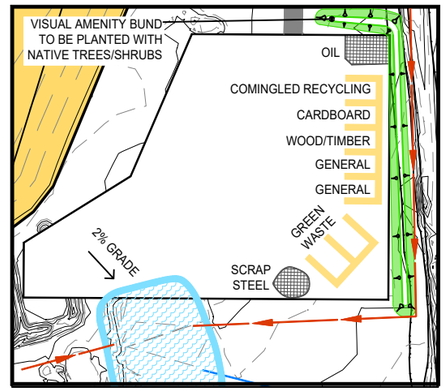

RESOURCE RECOVERY & STOCKPILE AREA
SCALE 1:2000

GENERAL NOTES

1. RESOURCE RECOVERY AREA INCLUDES THE COLLECTION OF CARDBOARD, SCRAP STEEL, GENERAL WASTE, GREENWASTE, OIL & TYRES
2. ONGOING LANDFORM DEVELOPMENT ASSUMES ALL LANDFILLING TO OCCUR ABOVE GROUND WITH NO EXCAVATION INTO NATURAL SEQUENCES.
3. ALL SITE WATER TO BE DIRECTED TO THE SEDIMENT DAM DURING OPERATIONS.

LEGEND

- CLEAN WATER FLOW DIRECTION
- SITE WATER FLOW DIRECTION
- SEDIMENT DAM
- POWERLINE
- BOUNDARY

FOR REVIEW

REV	DATE	DRAWN	CHECKED	APPR'D	REVISION DETAILS
A	19/05/21	CL	EA	CL	FOR REVIEW

DRAWING STATUS	
JOB No.	2010-01
DATE	23/04/21
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CHECKED BY	CL
FINAL APPROVAL	CL
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CAPALABA QLD 4157

PROJECT TITLE: TENNANT CREEK LANDFILL WASTE MANAGEMENT STRATEGY

CLIENT: BARKLY REGIONAL COUNCIL

DRAWING TITLE: MASTER PLAN FINAL LANDFORM

PROJECT NO.	DRAWING NO.	REV
2010-01	002	A

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