

SHIRE OF DUMBLEYUNG

DUMBLEYUNG AND KUKERIN WASTE MANAGEMENT FACILITIES

SITE ASSESSMENT AND FUTURE OPERATIONAL STRATEGY



Dumbleyung and Kukerin Site Entrances

Prepared for

SHIRE OF DUMBLEYUNG

IW Projects Pty Ltd

6 Anembo Close, DUNCRAIG, WA 6023

Mobile: 0402 909 291 email: iwatkins@iwprojects.com.au

Revision:

Date of Issue:

Draft

11 Apr 2016

Table of Contents

Executive Summary	v
1. Introduction	1
2. Landfill Registration Requirements.....	2
3. Waste Management Regulators	4
3.1. Waste Authority.....	4
3.2. Environmental Protection Authority	4
3.3. Department of Environment Regulation.....	4
3.4. Impact on the Shire.....	5
4. Waste Management Future Strategy	6
4.1. WA Waste Strategy	6
4.1.1. Overall Direction.....	6
4.1.2. Impact on the Shire	7
4.2. Waste Authority Business Plan 2015/16	10
4.2.1. Overall Direction.....	10
4.2.2. Impact on the Shire	11
4.3. DER Future Direction	12
4.3.1. Overall Direction.....	12
4.3.2. Impact on the Shire	13
5. Contaminated Sites Legislation	15
6. Current Situation	16
6.1. Current Waste Management Activities.....	16
6.2. Waste Quantities and Characteristics.....	16
6.3. Site Visits	18
6.3.1. Dumbleyung Landfill.....	18
6.3.2. Kukerin Landfill.....	23
7. Landfill Future Development and Management.....	29
7.1. Landfill Operational Constraints	29
7.2. Future Landfill Areas.....	29
7.3. Tipping Areas and Waste Placement.....	29
7.4. Waste Compaction	30
7.5. Waste Cover.....	31
7.6. Leachate Management.....	31
7.7. Stormwater Management.....	32
7.8. Groundwater and Surface Water Monitoring.....	32
7.9. Dust Control.....	33
7.10. Litter Control	33
7.11. Weed Management.....	34
7.12. Vermin Control	34
7.13. Fire Control	35
8. Recycling Activities	35
8.1. Recycling Data	35
8.2. Recycling Area.....	35
8.3. Hazardous and Problematic Waste	36
9. Future Site Usage.....	37

10. Landfill Capping and Closure	38
10.1. Closure Capping	38
10.2. Continuous Capping	38
10.3. Landfill Gas	38
10.4. Infrastructure Requirements.....	38
10.5. Surface Preparation.....	39
10.6. Cap Profile	39
10.7. Capping Material.....	39
10.7.1. Purpose.....	39
10.7.2. Natural Soil	40
10.7.3. Imported Capping Material.....	40
10.8. Landfill Cap Thickness.....	41
10.9. Vegetation.....	43
10.10. Construction	43
10.11. Surface Water Management.....	44
10.12. Groundwater Management.....	44
10.13. Environmental Protection.....	44
10.14. Site Monitoring and Maintenance.....	45
10.15. Post Closure Period	45
11. Financial Planning	46
Appendices	48
Appendix No. 1 – Dumbleyung WMF Concept Layout Plan	49
Appendix No. 2 – Kukerin WMF Concept Layout Plan	50

Copyright and Disclaimer

This document has been prepared by IW Projects Pty Ltd solely for the benefit and use of the Shire of Dumbleyung.

IW Projects Pty Ltd shall assume no liability or responsibility to any third party arising out of the use of or reliance upon this document by any third party.

IW Projects Pty Ltd owns the copyright to this document and the commercial use of the document without the written permission of IW Projects Pty Ltd is strictly prohibited.

Executive Summary

The Shire has two local waste management facilities providing waste disposal services and limited recycling opportunities to the two town sites and the surrounding farming community. These facilities have been in operation for many years and are at different stages of development.

On 17 December 2015 Ian Watkins of **IW Projects** undertook a site visit to the Shire waste management facilities. Subsequent to these site inspections, the Shire of Dumbleyung commissioned Ian Watkins to provide a summary report on the Shire's two waste management facilities (based on the 17 December 2015 site visits) and to provide advice on the possible future waste management operational strategy for the Shire.

Both of the landfill sites in the Shire are Registered Sites as opposed to being Licensed sites (the method for regulating larger landfill sites). This means that the sites are governed by the *Environmental Protection (Rural Landfill) Regulations 2002* as opposed to site specific landfill Licence conditions. These Regulations set out the parameters around which landfill sites are to be operated. Non-compliance with the Regulations can lead to prosecution, with specific penalties that apply to each operational non-compliance.

There is currently limited data available on the quantity and characteristics of the waste that is managed within the Shire. Consequently, general statewide trends have to be used to determine the typical quantity and characteristics of the waste stream. This has resulted in an estimated 575 tonnes of waste and recyclable material being generated in the Shire, of which approximately 95 tonnes is recycled and 480 tonnes is landfilled.

General observations at the landfill sites were that they required some attention to landfill operations and closure in order to bring them up to a standard required by the Landfill Regulations. The primary issue being the lack of waste cover material application.

Concept layout plans have been developed for each of the sites and numerous recommendations made for the future direction of each site including landfill layout and staging, landfill airspace availability, optimisation and closure. The assessment of available landfill airspace identified that each of the sites had well beyond 100 years of future airspace (based on conservative estimates).

In addition to the specific future direction for each of the facilities, additional detail on the general concepts for future landfill development, management and closure applicable to both of the sites has been provided.

It is also recommended that the Shire consider dedicated, small scale recycling areas near the entrance to the sites be developed.

It is essential that the landfills be progressively capped as the waste reaches the final waste profile and the capping not be left to the end of the landfill life. The closed landfill portions are not anticipated to have any adverse environmental or social impacts. For this reason the ongoing site monitoring will simply determine the sustainability of the measures proposed in the capping plan. It is anticipated that an active post closure monitoring period of approximately 5 years will be sufficient to determine the effectiveness of the post closure measures implemented, primarily the vegetation survival. This will provide sufficient time for the landfill cap to stabilise and vegetation to establish on the cap surface.

The Shire is to ensure that in future, there are sufficient funds allocated during the active life of the landfill to cover the closure and post closure liabilities that are being accumulated. As environmental awareness increases, closure and post closure requirements are only going to increase with time and hence the associated cost. An assessment of the financial implications of the closure, monitoring and maintenance requirements will be necessary in order to ensure that sufficient funds are budgeted to adequately finance the necessary activities.

1. Introduction

The Shire of Dumbleyung covers an area of approximately 2,540 square kilometres with a population of approximately 610, of which 50% live in townsites and 50% on farms. Dumbleyung is the main townsite within the Shire and is approximately 285 km to the south east of Perth. Kukerin is the other smaller town within the Shire, approximately 50 km to the east of Dumbleyung.

The Shire has two local waste management facilities providing waste disposal services and limited recycling opportunities to the two town sites and the surrounding farming community. These facilities have been in operation for many years and are at different stages of development.

On 17 December 2015 Ian Watkins of **IW Projects** undertook a site visit to the Shire waste management facilities. Subsequent to these site inspections, the Shire of Dumbleyung commissioned Ian Watkins to provide a summary report on the Shire's two waste management facilities (based on the 17 December 2015 site visits) and to provide advice on the possible future waste management operational strategy for the Shire.

The Scope of Work for the landfill summary report was as follows:

- Landfill Registration requirements – Rules of operating the sites;
- Waste Authority – WA Waste Strategy – How this will impact the Shire;
- Contaminated Sites Legislation – How this will impact the Shire;
- Current situation;
- Future site development;
- Recycling activities;
- Landfill airspace availability;
- Site closure;
- Financial planning; and
- Site layout diagram for each site.

2. Landfill Registration Requirements

Both of the landfill sites in the Shire are Registered Sites as opposed to being Licensed sites (the method for regulating larger landfill sites). This means that the sites are governed by the *Environmental Protection (Rural Landfill) Regulations 2002* as opposed to site specific landfill Licence conditions. These Regulations set out the parameters around which landfill sites are to be operated.

Non-compliance with the Regulations can lead to prosecution. The Regulations set out the penalties that apply to each operational non-compliance.

The following is a summary of the operational requirements within the landfill Regulations:

- Tipping Area - The tipping area is not to be greater than 30 m in length and 2 m above ground level in height.

There is some confusion within the DER as to the interpretation of the 2 m landfill height. In some instances it has been interpreted as individual lifts within the landfill are to be a maximum of 2 m high, where in other situations, the maximum height of the landfill is not to be greater than 2 m aboveground. The DER is yet to make a formal determination of the interpretation of this condition. Based on there being documented precedents of Registered landfills being approved at greater than 2 m aboveground, it is unlikely that the DER would be able to prosecute any facility on these grounds.

Non-compliance penalty: \$5,000.

- Covering of Waste - Waste is to be covered with a dense, inert and incombustible material at least monthly (monthly for a landfill of less than 500 tonnes per annum, fortnightly for a landfill between 500 and 2,000 tonnes) so that no waste is left exposed. There is to be a readily available stockpile of suitable cover material to cover the tipping area at least twice.

Non-compliance penalty: \$5,000.

- Fencing - The boundary of the site is to be fenced as an effective barrier to cattle, horses and other stock.

Non-compliance penalty: \$5,000.

- Waste Contained on Site - The landfill site must ensure that waste does not get washed, or blown, outside the site and that waste that has been washed, or blown, away from the tipping area of the site is returned to the tipping area at least once every month.

Non-compliance penalty: \$5,000.

- Separation of Waste from Water and Site Boundary - Unless otherwise approved in writing, the landfill site must ensure that there is no waste within 35 m from the fence surrounding the site, within 100 m of any surface water body or 3 m from the highest level of the water table aquifer below the site.

Non-compliance penalty: \$5,000.

- Stormwater Management - The occupier of the landfill site must ensure that stormwater on site is adequately managed so that it is diverted from areas of the site where there is waste and water that has come into contact with waste, is to be diverted into a sump on the site or otherwise retained on site.

Non-compliance penalty: \$5,000.

- Dust Suppression - The occupier of the landfill site must ensure that no visible dust escapes from the landfill site.

Non-compliance penalty: \$5,000.

- Firebreaks - The occupier of the landfill site must ensure that there is a firebreak of at least 3 m around the boundary of the site.

Non-compliance penalty: \$5,000.

- Burning of Green Waste - Only green waste is permitted to be burnt on site. When green waste is burnt on site it is to be in accordance with the method statement as described in the Regulations.

Non-compliance penalty: \$5,000.

- Outbreak of Fire - The occupier of the landfill site must ensure that:
 - There are appropriate procedures in place at the site so that any unauthorized fire on the site is promptly extinguished;
 - Appropriate alarm and evacuation procedures are in place;
 - Unauthorized fires on the site are extinguished as soon as possible;
 - Within 14 days of the unauthorized fire at the landfill site a report is to be sent to the CEO of the DER providing necessary details of the fire.

Non-compliance penalty: \$5,000.

- Disposal of Clinical Waste and Asbestos - The occupier of a landfill site must ensure that clinical waste and material containing asbestos is disposed of in accordance with the relevant approvals.

Non-compliance penalty: \$5,000.

All waste disposal is to be supervised by authorized personnel and to be covered to a depth of at least 1 m with a dense, inert and incombustible material as soon as practical after disposal. A register of clinical waste and material containing asbestos and a plan of the landfill site showing the position of the disposed waste is to be maintained on site. Up-to-date records are to be maintained within two hours of disposal.

- Non-compliance penalty: \$5,000.
- Post Closure Management Plan - The occupier of a landfill site must prepare and submit a Post Closure Management Plan within 18 months of the site being registered. The regulations set out the basic content of the Post Closure Management Plan.

Non-compliance penalty: \$5,000.

For further details on the landfill Regulations, refer to *Environmental Protection (Rural Landfill) Regulations 2002*.

3. Waste Management Regulators

3.1. Waste Authority

The statutory Waste Authority was established on 6 May 2008 with five members appointed by the Minister for the Environment. The Authority, which replaced the non-statutory Waste Management Board, commenced full operation on 1 July 2008 and is fully funded through the Waste Avoidance and Resource Recovery Account (metropolitan landfill levies). Some of the main areas of responsibility for the Authority include developing, promoting and reviewing a waste strategy for Western Australia and coordinating its implementation; promoting community awareness and understanding of resource efficiency, waste avoidance and resource recovery; working with Local Governments to coordinate local efforts to prevent waste; administering the Waste Avoidance and Resource Recovery Account (revenue from the metropolitan landfill levy) and advising and making recommendations to the Minister for the Environment on matters relating to the *Waste Avoidance and Resource Recovery Act 2007*.

3.2. Environmental Protection Authority

The Environmental Protection Authority (EPA) is made up of a five-member board appointed by the Governor. Neither the Authority nor its Chairman are subject to the direction of the Minister for the Environment.

The EPA has statutory obligations under the *Environmental Protection Act 1986* to conduct environmental impact assessments, initiate measures to protect the environment from environmental harm and pollution and to provide advice to the Minister on environmental matters generally.

The Minister for the Environment provides the EPA with services and facilities to help it perform its functions, these services are provided by the independent Office of the EPA (OEPA).

3.3. Department of Environment Regulation

Department of Environment Regulation (DER) has broad responsibility for biodiversity conservation under the *Conservation and Land Management Act 1984* and for environmental regulation under Part V of the *Environmental Protection Act 1986*. This includes management of the State's national parks and marine parks, clearing of native vegetation, natural resource management, climate change actions, contaminated sites, preventing and responding to pollution, industry licensing and works approvals (which includes regulating the waste industry).

The DER provides executive, administrative and contract management support to the Waste Authority. The DER also coordinates project specific activities on behalf of the Authority. The DER has a broad role in facilitating and implementing, where necessary, a new approach that recognises the complexity of managing wastes in our society. In undertaking that role, the DER is responsible for developing policy in collaboration with the Waste Authority, and for undertaking, on behalf of the Authority, specific projects aimed at key points in the waste stream where the greatest strategic impacts will be made.

The DER is also responsible for the administration of Waste Avoidance and Resource Recovery Account - A financial account established for holding revenue from the landfill levy. The funds held in the account are used for implementing initiatives related to the management, reduction, reuse, recycling, monitoring or measurement of waste; and Executive support to the Waste Authority. This is the mechanism by which the DER is able to provide funding to Local Governments for waste management and minimisation initiatives.

3.4. Impact on the Shire

Of the above Regulators, the DER is the primary agency that has a direct impact on the Shire. This impact relates to the following:

- Regulator of the current landfill site activities. Using the Rural Landfill Regulations, the DER ensures that the sites are managed according to the Regulations and is able to fine offending facilities for non-compliance.
- The development of future sites and/or the expansion of existing sites will need to be approved by the DER (Works Approvals and then Licences or Registrations). The conditions and method of site development will be reviewed and approved by the DER.
- The DER administers the Local Government funding that is provided by the Waste Authority. The Waste Authority determines the amount of funds available for particular initiatives; however, the DER determines how the funds will be allocated amongst the Local Governments or Regional Groupings, as well as what projects are deemed as acceptable for a particular round of funding.

The EPA would only get involved in large-scale projects that have the potential to cause environmental harm. Due to the size of current and future anticipated waste management activities within the Shire, it is not anticipated that any projects would be referred to the EPA for assessment.

The Waste Authority is more of a decision/directions making body and does not get involved in the “on ground” activities. These activities are delegated to the DER. Consequently; there will be no direct involvement of the Waste Authority in the Shire’s activities. However, the directions and directives of the Waste Authority may impact on the future waste management activities within the Shire.

4. Waste Management Future Strategy

4.1. WA Waste Strategy

4.1.1. Overall Direction

In March 2012, the Minister for the Environment launched the WA Waste Strategy: *Creating the Right Environment*.

The Strategy employs best practice and continuous improvement, along with target setting, as primary approaches to drive this change. The Strategy builds on existing programs and initiatives such as the Regional Funding Program, Household Hazardous Waste Program, Data Program, Waste Awards, and grants programs as well as strategic partnerships, to achieve the desired outcomes.

The amount of waste being recovered in Western Australia has been increasing steadily for a number of years, and there is evidence that increases in the landfill levy have accelerated this trend. However, the State's performance when benchmarked against other mainland states is still poor and requires a significant boost if comparable outcomes are to be achieved by 2020. In order to achieve this, the key drivers that have shaped the strategies and targets in *Creating the Right Environment* include:

- Key Driver 1 - The need to lift the effectiveness of planning for long-term waste management at a State level.
- Key Driver 2 - Access to data and information to underpin the measurement of strategies and services.
- Key Driver 3 - Significant opportunities to improve performance on construction and demolition, and commercial and industrial waste recovery.
- Key Driver 4 - Consolidation and improvement in municipal waste collection and processing performance.
- Key Driver 5 - A desire to do better on packaging waste management, litter recovery and other problematic wastes.
- Key Driver 6 - Improved landfill practices and incentives to reduce waste to landfill.

Creating the Right Environment has five strategic objectives within which strategies relating to knowledge, infrastructure and incentives have been developed to support a coordinated approach to changing the behaviour of individuals, groups and organisations:

- Strategy Objective 1 – Initiate and maintain long-term planning for waste and recycling processing, and enable access to suitably located land with buffers sufficient to cater for the State's waste management needs.

- Strategy Objective 2 - Enhance regulatory services to ensure consistent performance is achieved at landfills, transfer stations and processing facilities.
- Strategy Objective 3 - Develop best practice guidelines, measures and reporting frameworks and promote their adoption.
- Strategy Objective 4 - Use existing economic instruments to support the financial viability of actions that divert waste from landfill and recover it as a resource.
- Strategy Objective 5 - Communicate messages for behaviour change and promote its adoption, and acknowledge the success of individuals and organisations that act in accordance with the aims and principles in the Strategy and assist in its implementation.

Targets in the Strategy are based on ambitious but achievable improvements in current recovery rates. The targets are expressed as the proportion of waste recovered compared to that generated. Recovery targets for municipal solid waste in the Perth Metropolitan Region are 50% by 2015 (up from 36% in 2009/10) and 65% by 2020 and in major regional centres 30% by 2015 (up from 15% in 2009/10) and 50% by 2020. Statewide targets for the commercial and industrial sector are 55% by 2015 (up from 46% in 2009/10) and 70% by 2020. Construction and demolition waste State wide targets are 60% by 2015 (up from 29%) and 75% by 2020.

The implementation of the Strategy is supported by funding from the Waste Avoidance and Resource Recovery Account, and initiatives and actions funded under the Strategy are contained in the Waste Authority's annual Business Plans.

4.1.2. Impact on the Shire

The Waste Strategy is a State wide strategy for improved waste management; hence, covers all regions within the State. As can be expected, the main concentration of focus is in those areas where the most waste is generated and consequently the implementation of the Strategy's initiatives will have the most impact. The focus areas are:

- The Perth Metropolitan Area.
- Major regional centres – Avon, Greater Bunbury, Albany, Geraldton, Kalgoorlie, Karratha, Peel and Busselton.
- All other areas within the State.

The Shire falls into the third focus area. The consequence of this is that there are no *Municipal Solid Waste Sector Targets* that directly apply to the Shire. Hence, the Strategy targets do not pressurise the Shire into making any change to its current level of recycling. Any changes made by the Shire are voluntary and based on a willingness to “do the right thing”.

Although the recycling targets are an important aspect of the overall Strategy, they are not the only aspect of the Strategy. As documented above, there are numerous Key Drivers and Strategic Objectives that set out a range of aspects of current waste management practice that the Waste Authority seeks to influence. Some of these Drivers and Objectives are relevant to the Shire and need to be considered in the Shire's future planning:

- *Key Driver 1 - The need to lift the effectiveness of planning for long-term waste management at a State level.* The Shire should review its current waste management sites to determine more accurately the future available capacity of each site and hence develop an understanding of the medium and long-term requirements within the Shire. The outcome of this investigation will determine when there will be a need to identify alternative waste disposal sites and/or how proactively the Shire embraces improved waste recovery activities.
- *Key Driver 2 - Access to data and information to underpin the measurement of strategies and services.* In order to plan for the future, it is essential that the Shire have an understanding of the quantity of waste and recycling material that is handled. There is a need to develop a simple data collection system that enables the Shire to gain a better understanding of its current activities. This data collection will provide valuable information for future decision making.
- *Key Driver 3 - Significant opportunities to improve performance on construction and demolition, and commercial and industrial waste recovery.* This Key Driver has no particular relevance to the Shire at this stage. Possibly at some time well into the future, when the Shire is looking for continuous improvement projects, the Shire may consider strategies to improve the management of construction and demolition (C&D) waste. It is however important to note that a single demolition project could generate a relatively significant quantity of C&D waste. The landfill operators should have contingency plans in place on what to do with a large quantity of C&D waste from a single source.
- *Key Driver 4 - Consolidation and improvement in municipal waste collection and processing performance.* There is an opportunity to improve on the existing waste and recycling collection systems currently in operation. This is achieved by a combination of community education to increase at source waste sorting while reducing recyclable contamination and expanding the collection service to additional properties.
- *Key Driver 5 - A desire to do better on packaging waste management, litter recovery and other problematic wastes.* For the Shire, this Driver is linked to *Key Driver 4* above as well as providing recycling opportunities at the town sites and waste management facilities improving landfill operations to reduce litter generation around the site.

- *Key Driver 6 - Improved landfill practices and incentives to reduce waste to landfill.* Due to the lack of recycling targets for the smaller regional areas, this Driver of “*reducing waste to landfill*” is more of an indication of where the Strategy would like the Shire to head rather than a serious motivation. This certainly opens up the opportunity to request funding to improve landfill practices, but these need to have the ultimate intention of “*reducing waste to landfill*” and not simply funding the Shire current landfill related liabilities.
- *Strategy Objective 1 – Initiate and maintain long-term planning for waste and recycling processing, and enable access to suitably located land with buffers sufficient to cater for the State’s waste management needs.* This Objective is somewhat linked to *Key Driver 1* whereby the Shire needs to assess where it is heading in the future with regards to waste management facility requirements. The specific reference to buffer zones is more of a Metropolitan issue where development encroachment reduces the opportunity for waste facility siting.
- *Strategy Objective 2 - Enhance regulatory services to ensure consistent performance is achieved at landfills, transfer stations and processing facilities.* This is one of the most relevant Objectives to the Shire. This Objective identifies that there is likely to be increased DER monitoring and inspections of waste management facilities in the future to ensure that facilities are managed to best practice standards. Sites not being operated appropriately will likely be encouraged to comply with best practice and in extreme circumstances penalised accordingly. The enhanced regulatory services are also likely to result in more stringent design and compliance requirements when developing new landfill sites. This has the potential to significantly increase the cost of developing future waste management facilities.
- *Strategy Objective 3 - Develop best practice guidelines, measures and reporting frameworks and promote their adoption.* This is of limited impact to the Shire and is likely to be an output from the DER at some time in the future.
- *Strategy Objective 4 - Use existing economic instruments to support the financial viability of actions that divert waste from landfill and recover it as a resource.* This is seen as a direct reference to increasing the metropolitan landfill levy to narrow the cost gap between recycling operations and landfill disposal costs. With the landfill levy only applying to the Metropolitan area, this is of no consequence to the Shire.

- *Strategy Objective 5 - Communicate messages for behaviour change and promote its adoption, and acknowledge the success of individuals and organisations that act in accordance with the aims and principles in the Strategy and assist in its implementation.* This Objective is structured around community education and the influencing of behavioural change to achieve community buy-in to improved recycling activities. This is seen as an important aspect of any proposed changes within the Shire and there is an opportunity to obtain DER funding to subsidise the implementation of a community education campaigns. It is pointed out that community education is not a one-off activity; it is an ongoing requirement to ensure continued success of the recycling activities.

Overall, the WA Waste Strategy is likely to have the following impact on the Shire:

- Require improvement in current landfill operations to comply with best practice landfill management (as a minimum, the Rural Landfill Regulations).
- Make future site development more costly due to increased regulatory requirements.
- Opportunity to obtain funding to achieve the objectives of the Strategy.

It is not considered that the Strategy will require the Shire to achieve any particular recycling target; however, this is an indication of where the Waste Authority is heading and hence it is advisable to at least commence the journey towards increased recycling.

4.2. Waste Authority Business Plan 2015/16

4.2.1. Overall Direction

In August 2015 the Waste Authority Business Plan 2015/16 was released. The Business Plan sets out the key program activity areas where actions will be taken to implement the Waste Strategy.

Business Plan activity areas for 2015/2016 include:

- Planning - Develop and maintain the necessary resources to deliver Waste Plans and waste planning advice.
- Regulation - Enhance regulatory services to ensure consistent performance is achieved at landfills, transfer stations and processing facilities and that compliance and enforcement resources are matched to the emerging challenges associated with increased landfill levies and waste diversion targets.
- Best Practise - Develop best practice benchmarks, guidelines, measures and reporting frameworks and establish support programs that lead to their implementation.

- Economic Instruments - Use existing economic instruments to support the financial viability of actions that divert waste from landfill and recover it as a resource, promote the adoption of programs that support the recovery of resources or the management of problematic products, and support individuals and groups that contribute to meeting the objectives of the Waste Strategy.
- Engagement - Communicate messages for behaviour change and promote its adoption, and acknowledge and support individuals and organisations that align their actions with the Waste Strategy.
- Data and Measurement - Collect and analyse data on waste and recycling services and performance across Western Australia to measure progress against Waste Strategy targets, assist program evaluation and meet national reporting requirements.
- Strategy and Policy Development and Review - Regular review and updating of the Waste Strategy in response to emerging issues, legislative and policy movements, changing market circumstances, national waste policy development and implementation of initiatives, such as producer responsibility schemes.
- Program Administration Support - Administrative and direct report program delivery staff salaries, office and management overheads, Waste Authority sitting fees, committee and sub-committee support and on-costs.

4.2.2. Impact on the Shire

The Waste Authority Business Plan 2015/16 activity areas are likely to have the following impact on the Shire:

- Planning – There is the possibility for the Shire to obtain funding for the development and execution of strategic waste plans; however, these are likely to require more waste minimisation focus as opposed to landfill operation activities.
- Regulation - There is no direct impact to the Shire.
- Best Practise – There is the possibility for the Shire to obtain funding for the development and rollout of waste industry best practice standards for waste diversion from landfill. This may be a future aspiration, but at present, the Shire should concentrate on improving current waste management activities.
- Economic Instruments – There is no direct impact to the Shire.
- Engagement - There is the possibility for the Shire to obtain funding to improved communication with the community with regards to improving waste management habits and actions to further divert waste from landfill or improve waste recycling activities.
- Data and Measurement - There is the possibility for the Shire to obtain funding to develop and implement an improved waste management data collection system.

- Strategy and Policy Development and Review - There is the possibility for the Shire to obtain funding to review Shire waste management activities and update strategic waste minimisation direction.
- Program Administration Support - There is no direct impact to the Shire.

The vast majority of the impact of the annual Business Plan relates to the availability of funding to implement strategies in line with the Waste Authority activity areas; however, historically, the Waste Authority (through the DER) has been reluctant to provide funding for small shires, where the impact of the spend is seen as inconsequential to the overall impact of the state-wide waste industry. Consequently, any funding that is obtained is unlikely to be substantial and will only be seed funding, with the Shire being liable to the ongoing funding of the particular project or activity.

4.3. DER Future Direction

4.3.1. Overall Direction

In line with the Waste Authority's direction of striving for best practice, the DER is insisting that all new landfill developments comply with the appropriate level of environmental protection. There are however, no landfill development guidelines that are applicable to a small rural landfill. The only available guideline that is used in the Western Australian (WA) landfill industry is the Victorian Best Practice Environmental Management (BPEM) guidelines, which the DER has adopted for use. A proponent may propose alternative technical solutions to those set out in the Victorian guidelines; however, these alternative solutions need to demonstrate equivalency to the Victorian guidelines. Unfortunately, this Victorian guideline was never intended for use in small rural landfills and hence, sets extremely onerous and unnecessary conditions for landfill development.

In an attempt to develop a local set of landfill development guidelines, the DER has commenced the process of developing an Environmental Standard for rural landfills. This document is currently being drafted by the DER in conjunction with assistance from a WALGA working group representing Local Government and an industry representative (Ian Watkins is the industry representative). Initial indications are that the Environmental Standard will not be as onerous as the Victorian guideline; however, will contain substantial conditions for the development and operation of small rural landfill sites. This Environmental Standard will also guide the DER regulation of existing rural landfill sites and hence, may impact on the progressive expansion of existing sites.

The above is an indication that the DER is striving for best practice standards to be adopted across all landfill sites (and all waste management facilities). Best practice will not be a set of rules "set in stone", but a process of continuous improvement that will always remain at the forefront of facility development and operational excellence. Hence, it is likely that there will always be a need to improve on-site activities to continually remain abreast of best practice.

As per the *Environmental Protection Act 1986*, any Prescribed site (Licensed or Registered site) needs to have a Works Approval issued by the DER prior to undertaking any activities on sites that have the potential to impact on environmental discharges (to ground, to water or to air). Theoretically, even the smallest Registered rural landfill site should obtain a Works Approval prior to excavating a new waste trench, relocating its green waste area, capping an old waste trench or establishing a recycling facility on site. In reality, the DER does not have the manpower capacity to process Works Approvals for all of WA landfill sites; hence, very few small landfill sites operate under approved Works Approvals and the DER tends to ignore the smaller sites and concentrate more on the larger ones.

With the DER increased focus on best practice, it can be anticipated that smaller sites may eventually get caught up in the “net” and be required to obtain Works Approvals before undertaking works on site. It is likely that the worst performing facilities will be caught first.

In conjunction with the DER implementing best practice through the Works Approval system (relating to facility development and closure), the DER will also be increasing monitoring of existing facility operations to ensure compliance with the facility operating Licence or Registration requirements. Enforcement has been flagged as an area of focus. This would indicate increased pressure on waste management facilities to achieve and maintain the necessary best practice standards. Failure to do so could result in penalties.

4.3.2. Impact on the Shire

The potential impact on the Shire of the DER current direction towards best practice requirements and enforcement could include the following:

- Increased monitoring of existing facilities (landfill sites). If sites are not managed in accordance with the Rural Landfill Regulations, they will be encouraged to improve the standard of operation. If the facility operator does not improve performance, it is possible that the DER will resort to enforcement to obtain the required conformance. Once the Environmental Standard for rural landfill has been formalised by the DER, this will become the benchmark of achievement for managing applicable landfills.
- Progressive development within an existing landfill site is likely to get caught up in the requirements for the new Environmental Standard and potentially Works Approvals prior to construction commencing. This will increase facility operating costs in compiling with the Environmental Standard and Works Approval documents, paying the Works Approval application fees and then implementing the proposed solution.
- Groundwater contamination is the main environmental concern with landfill sites. In some instances, the DER may insist on the installation of groundwater monitoring bores and ongoing monitoring thereof. All of this at increased effort and cost to the landfill site.

- New landfill sites will have to be approved by the DER. This will require the necessary Works Approval documentation and compliance with the approved development requirements. No longer is it a matter of selecting a site and building a landfill. The Shire will be required to demonstrate that the new site conforms to the best practice guidelines and can be operated accordingly.
- Landfill closure requirements are likely to be increased. At present, there are very few requirements for landfill closure. The operator of a Registered landfill site is to have submitted a post closure rehabilitation plan to the DER for approval within 18 months of being Registered. In future, these post closure rehabilitation plans are likely to be required to be more involved and technically robust than would have been accepted in the past. There will be the corresponding increased cost of implementing the approved post closure solution.

With the changing horizon in the landfill industry, the Shire is well advised to maximise its existing facility capacity, as future sites will be more difficult to find, permit and operate. Also the current liability associated with the old landfill areas that have not been adequately closed is likely to increase as closure standards are improved.

5. Contaminated Sites Legislation

The *Contaminated Sites Act 2003* requires all identified contaminated sites to be registered with the DER and an appropriate caveat placed on the property Certificate of Title.

The onus is upon the landowner to assess whether a property is 'contaminated' and hence register the site with the DER. The DER expectation is that all landfill sites will ultimately be classified as 'contaminated' due to past or present waste disposal activities.

The remedial action to be taken if a site is deemed as 'contaminated' and causing unacceptable off-site contamination, is highly dependent on the degree of contamination and the potential impact on surrounding receptors. Remedial action could involve simply monitoring the contamination through to the total clean-up of the site and groundwater.

The Shire is yet to register its two landfill sites with the DER as potentially contaminated sites.

Future waste management activities carried out on the sites are to be managed in a way so as to minimise the potential contamination of the sites. This will limit the potential liability that the Shire may incur in having to clean up the sites should the level of contamination negatively impact on surrounding receptors.

Continuing to operate the landfill facilities as Class II (putrescible landfill) sites will not significantly increase the Shire's liabilities with regards to the *Contaminated Sites Act 2003*. With adequate waste acceptance control (Class II), appropriate site operations and comprehensive landfill closure, the potential of site impact of the landfill facility should be negligible.

It is also important that in the Shire future planning, potential receptors (residential development) be restricted to beyond the EPA recommended 500 m buffer zones surrounding the landfill.

to consider the impact of the Carbon Trading Mechanism.

6. Current Situation

6.1. Current Waste Management Activities

The Shire currently owns and operates the following facilities:

- Dumbleyung waste management facility; and
- Kukerin waste management facility;

The Shire undertakes the following waste management activities:

- Landfill management;
- Wastewater pond management;
- General waste (green wheelie bin) kerbside collection:
 - Dumbleyung; and
 - Kukerin;
- Recycling kerbside collection:
 - Dumbleyung; and
 - Kukerin;
- Small range of recycling and waste diversion at the waste management facilities.

6.2. Waste Quantities and Characteristics

There is currently limited data available on the quantity and characteristics of the waste that is managed within the Shire. Consequently, general statewide trends have to be used to determine the typical quantity and characteristics of the waste stream.

The waste material quantity can be estimated based on a population of 610 people and the following assumptions:

- It is presumed that there are 2.5 people per residence that is approximately 245 residential properties, including farms.
- Each property will generate typically 15 kg of waste per week, which equates to approximately 190 tpa, which ends up in landfill (either via kerbside collection or self-haul).
- Each property will generate typically 13 kg of recyclable material per fortnight, which equates to approximately 85 tpa of which 50% (the percentage of town site population vs total Shire population) is removed from the Shire by the kerbside collection contractor, the remainder ending up in landfill.

- There will also be a component of bulk waste generated by the Shire, householders, agriculture and industry. Combined, this is estimated to be in the order of 300 tonnes per year, which is delivered to either of the two Shire waste management facilities; however, not all of this material would end up in the landfill. Greenwaste and other recyclables such as scrap metal are separated from the incoming waste stream prior to being landfilled. It is estimated that up to 50 tpa of the incoming 300 tpa is diverted from landfill.
- There is an estimated total quantity of 575 tpa of waste and recyclables generated within the Shire:
 - Approximately 45 tpa recycled through kerbside collection;
 - Approximately 50 tpa diverted from landfill at the waste management facilities; and,
 - Approximately 480 tonnes ends up in either of the Shire's two landfills. Based on population split of 85% and 15% between the two facilities:
 - 410 tpa at Dumbleyung; and
 - 70 tpa at Kukerin;
- This equates to approximately 785 kg/person/year of waste ending up in landfill.

Although all residential properties within the Shire are not serviced by kerbside waste and recycling collections, the number of residential properties have been used as a guide to determine the quantity of waste and recyclable material generated within each household, irrespective of whether the household is serviced by a kerbside collection or not. This also gives an idea of the typical waste characteristics of the material that is received at the landfill or removed via the kerbside recycling collection service.

The above waste quantities are "rough estimates" based on broad assumptions. The Shire should only use these values as a general guide and not rely specifically on this information.

6.3. Site Visits

On 17 December 2015 Ian Watkins of **IW Projects** undertook a site visit to both of the waste management facilities within the Shire. The following are the observations made of the sites and commentary on the future direction for each site.

6.3.1. Dumbleyung Landfill

General Information

Table 6.3.1 – General Information

Town Site Population	250
*Shire Population Served	520
Distance to Perth Metro Area	285 km
Distance to Kukerin	50 km
Property Description	Reserve XYX
DER Prescribed Category	Category 89 Putrescible Landfill Site
Waste Tonnage Landfilled Annually	410 tonnes

* Ratio of Town Site populations, 85% of total Shire population.

General Observations

The following are observations from the site visit and information gathered from discussions with Shire officers and other available information:

- Unmanned site.
- Unrestricted, 24-hour access.
- Adequate site signage.
- Free disposal.
- Partially fenced site (litter collection, not stock access prevention).
- Numerous waste disposal areas:
 - General domestic waste – two disposal areas;
 - General bulk waste;
 - Inert waste;
 - Asbestos pit; and
 - Liquid waste pit.
- Recycling/waste diversion activities:
 - Scrap metal;
 - Used motor oil; and
 - Green waste stockpile.

- General domestic waste is disposed of in aboveground bunded waste areas, which are progressively developed as required. There appears to be minimal, if any compaction of the waste prior to covering. There were two general waste tipping areas observed onsite.
- General bulky waste is disposed of in a long tipping face at ground level, which is occasionally pushed up into the landfill waste mass. The tipping face is near vertical (2 m to 3 m high). This is marginally in excess of the maximum allowance within the Landfill Regulations (<2 m), irrespective of the interpretation of this condition, an uncovered tipping face of greater than 2 m is not allowed.
- General bulky waste tipping face was approximately 30 m in length, which is the maximum allowed within the Landfill Regulations (< 30 m).
- There was no evidence of past fires on site; hence, arson does not appear to be a problem, which is a demonstration of a compliant community.
- All waste disposal areas were aboveground and to some degree surrounded on three sides with earth bunds, some of which have litter fencing on top (eastern edge). There was litter collecting along the litter fences; however, due to the large size of the site, none was observed beyond the site boundary.
- There was no evidence of any surface water having ponding on site or in the vicinity of the waste disposal areas. The site has been developed on the edge of a low ridge running from the north east to the south west. Based on the local topography, there is no noticeable upstream catchment and the site has gentle slopes in the order of 1% to 1.5% fall; hence, only in heavy rain events would there be any surface water runoff.
- The near surface geology on site appears to be a shallow layer of sand (300 mm to 500 mm) under laid by gravelly clay and ironstone to depth. This is substantiated by drilling logs from the Department of Water, Water Information Reporting website.
- It was not possible to assess the depth to groundwater on site. However, there are a number of groundwater bores in the vicinity, to the north and west of the site, but nothing within 2 km. There is minimal information on the bores other than some are shallow at 2.5 m deep and others drilled to 15 m to 25 m deep. However, all bores have been installed in the low lying ground at least 20 m lower than the elevation of the landfill site. The Landfill Regulations require a minimum of 3 m between the waste and the highest groundwater level. It is presumed that the groundwater level is significantly lower than the minimum allowed.
- There was only minimal evidence of cover material being applied progressively. The Landfill Regulations require a landfill receiving less than 500 tpa of waste to be covered monthly and to ensure that “no waste is left exposed”. There were significant areas of exposed waste, which had clearly been exposed for well in excess of one month.

- There was an amount of recyclable material, predominantly metal in the general bulky waste, which is a lost opportunity for recycling, but more importantly, a waste of landfill airspace.

General observation was that the overall property is relatively large; however, waste management activities have been well contained within a small portion of the site and hence, there is extensive area available for future landfill expansion. The vast majority of the community adhere to the site operational requirements (as depicted by the site signage).

Appendix No. 1 – Dumbleyung Waste Management Site provides detail of the current and proposed future site layout.

Future Direction

From the general observations, the following site operational modifications should be considered:

- The Shire should combine all the landfilled general waste (domestic, bulk waste and inert waste) into a single tipping location. This will decrease the amount of effort and cover material required in managing numerous active tipping areas and improve the space utilisation within the landfill.
- Maximise the excavation belowground to optimise available airspace availability and generate the maximum amount of soil cover and capping material. A target of 5 m of excavation should be set. As a minimum, at least 3 m should be easily achieved, with landfilling progressing to at least 2 m above ground. The waste trenches should be excavated as close together as possible, preferably as a single long trench, progressively excavated as the trench fills with waste. The ideal is to achieve a waste depth of at least 5m to 7 m over all areas of waste placement.
- Recommended landfill staging plan:
 - Finish landfilling in the current waste disposal areas:
 - Temporarily close the two domestic waste areas;
 - First finish off the bulk waste area, disposing of all landfill waste in this area, ideally placing inert waste on top of the other general waste;
 - Then finish off the inert waste area, this will complete the northern portion of the existing landfill;
 - Thereafter move back to the previous domestic waste areas and complete these landfill portions;
 - Filling of all of the existing disposal areas is estimated to take approximately 5 years to complete.

- Then progress in accordance with the landfill concept layout plan, landfilling in the existing access road between the domestic waste disposal area and the completed landfill area, landfilling from the south to the north, excavating within the existing road and then filling to the height of the adjacent existing areas. This future landfill area is anticipated to take approximately 10 years to complete;
 - There is approximately a further 50 years of landfilling in and around the area of existing landfill, predominantly to the south and south west of the completed landfill area;
 - Looking well into the future (+65 years), landfilling can continue in all remaining areas within the property, except within the 35 m buffer zone around the property boundary. There is sufficient available landfill area for many hundreds of years, provided landfill airspace is optimised by excavation and some aboveground filling;
- The greenwaste, scrap metal and used oil areas can remain in the current locations as they are appropriately located close to the site entrance.
 - The liquid waste pit, although identified, did not look like it has been used much. The Shire should assess the liquid waste requirements and if this facility is required, then the Shire should consider developing a formal, lined liquid waste evaporation pond.
 - The Shire should consider the future manning of the waste management facility as this will provide significantly more control of the site and improve recycling; however, at significant additional cost. At this time, it is not seen as an essential activity; however, this will become more important as neighbouring landfill sites become manned, consequently disposal costs are increased and access is restricted. Then there is the possibility of out-of-shire waste being delivered to the site.
 - If the site is to be manned and operated with restricted operating hours, then there will be a need to securely fence and lock the facility to restrict out of hours tipping.
 - Irrespective of whether the site is manned or not, the Shire should cordon off the vast majority of the property and only allow the public into specific areas for either recycling or waste disposal. This will improve the control of the site and ensure that the public only dispose of material in the appropriate locations.
 - When excavating and landfilling belowground, ensure that all stormwater flows away from the waste placement areas and not into the waste trenches.
 - Available landfill airspace has been calculated on the following assumptions:
 - Waste trenches will be progressively excavated to form long, wide trenches of approximately 20 m wide by 3 m to 5 m deep, with the length being determined by space availability, but made as long as possible.

- 80% of the future landfill area will contain waste trenches (remainder allowed for intermediate walls between trenches);
 - Minimum waste depth of 5 m, consisting of 3 m belowground and 2 m aboveground (ideally the waste depth would be nearer 7 m, based on an excavation depth of 5 m);
 - Annual waste to landfill of 410 tonnes;
 - Typical waste density of 0.5 t/m³ (excludes cover material);
 - Annual airspace consumption is 820 m³ (410 t/0.5 t/m³);
- Due to the property size and quantity of waste being landfilled, the landfill site has a potential lifespan of way beyond any planning horizon (+100 years). This asset will only be fully realised if the facility is operated to optimise the available landfill airspace typically as described above.
 - The completed and capped landfill area in the centre of the site is extremely flat, there is evidence of waste settlement and it is anticipated that there would continue to be future settlement due to the depth of waste and lack of compaction. The cap thickness is unknown, but should be at least 1 m deep (in accordance with the Landfill Regulations), ideally 1.5 m deep. Settlement causes depressions in the surface in which stormwater can collect and hence increase water infiltration into the waste mass. It may be necessary to occasionally resurface portions of the capped landfill area to fill depressions. Due to minimal rainfall, it is anticipated that if the cap is at least 1 m thick, the capping layer will absorb the majority of stormwater and hence reduce infiltration into the waste. Planting native grasses and/or shrubs on the capped surface will improve the stability and moisture uptake and further decrease the quantity of moisture infiltration. A further option is to place an additional layer of waste in the area and form a gradual dome shape to counter the impact of settlement, and once capped, allows an ability to shed excess surface water runoff. This is not seen as an essential activity as the annual rainfall is relatively low as is the likelihood of significant surface water runoff from a vegetated capped surface.
 - In future, when completing portions of the landfill, the final waste profile should be finished off to form a low ridge sloping to the outside of the landfill. This counters the impact of settlement within the waste and reduces the likelihood of depressions forming in the final capped surface, which will collect stormwater in the event that there is surface water runoff.

- In order to reduce the quantity of waste going to landfill, the Shire should consider developing a small-scale recyclable material drop-off facility at the entrance to the waste management site where residents can drop off recyclable products before progressing to the waste disposal area. This can be as simple as a few yellow wheelie bins for recyclable material drop-off or a yellow bin exchange system for properties that are not on the kerbside collection routes. These bins can then be emptied by the kerbside collection contractor on its regular collection schedule. The degree of waste diversion from landfill will be dependent to the recycling facilities available to the community and the extent of participation (buy-in) by the community.
- As the landfill area progresses, the areas that are finished, should be capped with at least 1 m of soil, ideally 1.5 m (from future waste trench excavations) and revegetated with native shallow rooted shrubs and grasses to return the area back to natural bush.

6.3.2. Kukerin Landfill

General Information

Table 6.3.2 – General Information

Town Site Population	40
*Shire Population Served	90
Property Description	Reserve XYZ
DER Prescribed Category	Category 89 Putrescible Landfill Site
Distance to Perth Metro Area	335 km
Distance to Dumbleyung	50 km
Waste Tonnage Landfilled Annually	70 tonnes

* Ratio of Town Site populations, 15% of total Shire population.

General Observations

The following are observations from the site visit and information gathered from discussions with Shire officers and other available information:

- Unmanned site.
- Unrestricted, 24-hour access.
- Some site signage, with evidence of vandalism.
- Free disposal.
- Fenced site.
- Numerous waste disposal areas:
 - General domestic waste – One new disposal areas and one older disposal area;
 - General bulk waste, including some inert waste;
 - Inert waste; and

- Liquid waste pit.
- Recycling/waste diversion activities:
 - Scrap metal, including some inert waste;
 - DrumMuster compound; and
 - Green waste stockpile.
- General domestic waste is disposed of in belowground waste trenches, which are progressively developed as required. There appears to be minimal, if any compaction of the waste prior to covering. There were two general waste tipping areas observed onsite, one recent area and one old trench that was partially filled and not covered.
- General bulky waste is disposed of in a tipping face at ground level, which is occasionally pushed up into a pile, but not compacted or covered. The waste pile is approximately 3 m high. This is marginally in excess of the maximum allowance within the Landfill Regulations (<2 m). Even marginal compaction will break up some of the waste and substantially reduce the tipping face height.
- General bulky waste tipping face was approximately 20 m in length, which is well within the maximum allowed within the Landfill Regulations (< 30 m).
- There is minimal inert waste disposed of on site. Between the scrap metal area and bulk waste area there is a small area where some inert waste has historically been disposed of; however, there is no signage to direct site users to this area, which results in the inert waste being disposed of in the metal stockpile and the bulk waste area.
- There was no evidence of past fires on site; hence, arson does not appear to be a problem, which is a demonstration of a compliant community.
- All waste disposal areas are to some degree surrounded on three sides with low earth bunds, which are more for demarcating the individual tipping areas or preventing people inadvertently walking into a waste trench than controlling litter. There is some fencing, trees and shrubs relatively close to the disposal areas, which reduce litter generation and trap some litter that is generated. There was not a significant quantity of litter observed on site.
- The site has been developed on the south-eastern edge of a low hill. Based on the local topography, there is no noticeable upstream catchment and the site has gentle slopes in the order of 1.5% to 2.0% fall from east to west and 0.25% fall from north to south; hence, only in heavy rain events would there be any surface water runoff.
- Consistent with the above, there was no evidence of any surface water having flowed through the site; however, there was evidence of minor ponding of rainwater that falls directly on site. This would be expected, as the site is extremely flat with a clayey soil type. This minor ponding is not a cause for concern.

- As observed from excavated waste trenches, the geology on site consists of gravelly clay to approximately 1 m and then a light coloured clay at depth. There was a small pool of stormwater in the bottom of one waste trench, which would attest to the relatively low permeability of the clay material.
- It was not possible to assess the depth to groundwater on site, except to say that it is lower than 3 m below ground level as observed in the waste trench excavation. There are three groundwater bores within 6 km of the landfill, which indicate that the groundwater is well below the surface (>15 m) and is saline. The Landfill Regulations require a minimum of 3 m between the waste and the highest groundwater level. It is presumed that the groundwater level on site is significantly lower than the minimum allowed and in the order of 15 m to 20 m below ground (the landfill has been developed on the side of a low hill; hence, should be a greater depth to groundwater in comparison to the low-lying areas where the groundwater bores have been installed).
- There was only minimal evidence of cover material being applied progressively. The Landfill Regulations require a landfill receiving less than 500 tpa of waste to be covered monthly and to ensure that “no waste is left exposed”. There were significant areas of exposed waste, which had clearly been exposed for well in excess of one month.

General observation was that the overall property is relatively large for the size of landfill, especially to the north east of the landfill area; however, waste management activities have been well contained within a small portion of the site and hence, there is extensive area available for future landfill expansion.

Appendix No. 2 – Kukerin Waste Management Site provides detail of the current and proposed future site layout.

Future Direction

From the general observations, the following site operational modifications should be considered:

- The Shire should combine all the landfilled general waste (domestic, bulk waste and inert waste) into a single tipping location. This will decrease the amount of effort and cover material required in managing numerous active tipping areas and improve the space utilisation within the landfill.
- Maximise the excavation belowground to optimise available airspace availability and generate the maximum amount of soil cover and capping material. A target of 5 m of excavation should be set. As a minimum, at least 3 m should be easily achieved, with landfilling progressing to 2 m above ground. The waste trenches should be excavated as close together as possible, preferably as a single long, trench, progressively excavated as the trench fills with waste. The ideal is to achieve a waste depth of 5 m to 7 m over all areas of waste placement.

- Recommended landfill staging plan:
 - Finish landfilling in the current waste disposal areas:
 - The inert and bulk waste areas have the option of simply being pushed up, compacted as best as possible and then being capped and covered over permanently. The other option being to push the bulk waste stockpile towards the inert stockpile, excavate a large hole in the bulk waste area and then push the bulk waste into the void, compacting as best possible, and then placing the inert waste on top of the bulk waste to further increase the compaction effort. Once all the waste is in the hole, use the excavated material to completely cap the buried waste. The emptied inert area can then also be used for additional scrap metal stockpiles.
 - Finish off the existing domestic waste trench to 2 m above ground and cover with an intermediate cover layer of 300 mm of soil (temporary capping);
 - Complete filling the small existing waste trench to the north of the central access road, up to ground level (consistent with all previous waste trench finished profiles;
 - Thereafter move back to the southern side of the central access road and continue trench excavations adjacent to the completed and temporarily capped domestic waste. Use some of the excavated material to permanently cap the two recently completed waste trenches, including covering any other exposed waste;
 - Future waste trench excavation should progress clockwise towards the liquid waste pond, the rear of the site and then progress towards the site entrance. Landfilling should also progress aboveground over the previous belowground waste trenches to the north of the access road. With there being a minimum of 50 years of landfill airspace in the undisturbed areas on site and the additional airspace gained above the previous belowground waste trenches, it is anticipated that landfilling could continue within the existing operational area of the site for potentially 100 years (provide airspace in conserved and optimised);

- There will come a time, within approximately 10 years when the access to the liquid waste pond will be cut off and the pond will need to be relocated or a separate access gained in the western corner of the operational area. The ideal is to relocate the pond to a new location to the south (left) of the site entrance, which will be easily accessible to liquid waste trucks. From an environmental point of view, the new liquid waste pond should be plastic lined to significantly reduce infiltration of liquid waste into the ground. The pond will also need to be fenced. The plastic pond liner will be highly flammable and hence, should not be located near the greenwaste area, which is occasionally burnt;
- The greenwaste and scrap metal areas can remain in their current locations as they are appropriately located close to the site entrance; however, again there will be a time when the access to these areas will be cut off by the progressive landfill development and they will need to be relocated.
- The Shire should consider the future manning of the waste management facility as this will provide significantly more control of the site and improve recycling; however, at significant additional cost. At this time, it is not seen as an essential activity; however, this will become more important as neighbouring landfill sites become manned, consequently disposal costs are increased and access is restricted. Then there is the possibility of out-of-shire waste being delivered to the site.
- If the site is to be manned and operated with restricted operating hours, then there will be a need to securely fence and lock the facility to restrict out of hours tipping.
- Irrespective of whether the site is manned or not, the Shire should cordon off the vast majority of the property and only allow the public into specific areas for either recycling or waste disposal. This will improve the control of the site and ensure that the public only dispose of material in the appropriate locations.
- When excavating and landfilling belowground, ensure that all stormwater flows away from the waste placement areas and not into the waste trenches.
- Available landfill airspace has been calculated on the following assumptions:
 - Waste trenches will be progressively excavated to form long, wide trenches of approximately 20 m wide by 3 m to 5 m deep, with the length being determined by space availability, but made as long as possible.
 - 80% of the future landfill area will contain waste trenches (remainder allowed for intermediate walls between trenches);
 - Minimum waste depth of 5 m, consisting of 3 m belowground and 2 m aboveground (ideally the waste depth would be nearer 7 m, based on an excavation depth of 5 m);
 - Annual waste to landfill of 70 tonnes;

- Typical waste density of 0.5 t/m³ (excludes cover material);
- Annual airspace consumption is 140 m³ (70 t/0.5 t/m³);
- Due to the property size and quantity of waste being landfilled, the active site area has a potential lifespan of potentially 100 years, which covers the foreseeable future. This asset will only be fully realised if the facility is operated to optimise the available landfill airspace typically as described above. Further into the future, there is the option to move into the southern portion of the site and landfill around the previously landfilled areas to fully consume all readily available landfill airspace. Once this area has been consumed, then landfilling should progress to the north of the existing landfill area.
- When completing portions of the landfill, the final waste profile should be finished off to form a low ridge sloping to the outside of the landfill. This counters the impact of settlement within the waste and reduces the likelihood of depressions forming in the final capped surface, which will collect stormwater in the event that there is surface water runoff.
- In order to reduce the quantity of waste going to landfill, the Shire should consider developing a small-scale recyclable material drop-off facility at the entrance to the waste management site where residents can drop off recyclable products before progressing to the waste disposal area. This can be as simple as a few yellow wheelie bins for recyclable material drop-off or a yellow bin exchange system for properties that are not on the kerbside collection routes. These bins can then be emptied by the kerbside collection contractor on its regular collection schedule. The degree of waste diversion from landfill will be dependent to the recycling facilities available to the community and the extent of participation (buy-in) by the community.
- As the landfill area progresses, the areas that are finished, should be capped with at least 1 m to 1.5 m of soil (from future waste trench excavations) and revegetated with native shallow rooted shrubs and grasses to return the area back to natural bush.
- There is an area to the south of the active landfill portion where historically waste has been landfilled. This area has never been adequately capped and closed off. This represents a future liability for the Shire. Ideally, this area is also eventually finished off and adequately capped. It is not proposed to landfill any more waste in this area, but over time, as excess cover material becomes available from future excavations, this material can be used to cover any exposed waste and to facilitate the rehabilitation of the area.

7. Landfill Future Development and Management

The specific future direction for each of the landfill sites has been covered above. Additional detail on the general concepts for landfill future development and management applicable to all of the landfills is set out below.

7.1. Landfill Operational Constraints

In accordance with environmental protection requirements the landfill operations are to be managed in accordance with the Landfill Regulations as set out in Section 2 above.

7.2. Future Landfill Areas

Both sites have ample available future landfill areas. Due to the relatively small quantity of waste being landfilled, the sites are anticipated to have operating lives of well in excess of 100 years.

The material excavated for waste trenches is suitable for use as either daily cover or final landfill capping material. Consideration of future waste trench development locations and dimensions needs to be taken into account when sourcing cover material. Sourcing of cover material in the appropriate area can be used as a cost effective method of developing future landfill waste trenches. As the trenches are excavated, the majority of the excavated material should be used to cover previous landfill areas. Typically, it would be anticipated that the waste trench excavations would be 3 m to 5 m deep.

7.3. Tipping Areas and Waste Placement

Both landfills should be operated with a single tipping face for all waste streams (with the exception of asbestos). This has the following advantages over multiple tipping faces:

- Reduced operator effort.
- Reduced consumption of cover material.
- Reduced surface area of exposed waste; hence, less litter, vermin activity, leachate generation.
- Neater looking landfill site.

Ideally, the waste trenches should commence in the furthest portion of the site and progressive fill towards the entrance gate (to prevent having to drive over or around landfill areas).

All waste management activities are to be in accordance with the Landfill Regulations.

7.4. Waste Compaction

Compaction of waste is carried out for the following reasons:

- Increasing the density of the waste and hence increasing the quantity of waste that can be disposed of within a fixed volume (optimising landfill airspace consumption).
- Providing a relatively smooth surface for the cover material to be placed on; hence, reducing the quantity of cover material required.
- Reduce waste settlement.
- Reducing the opportunity for vermin to scavenge in the waste.
- Reduce windblown litter.
- Reduce odour generation.
- Reduce water ingress into the waste.
- Reduce the potential for fires within the waste.

There is currently minimal or no waste compaction occurring. The Shire should concentrate on trying to achieve some compaction of the waste within the landfill. Due to the size of the landfills it is not economically viable for the Shire to obtain a dedicated waste compactor. The occasional use of a front-end loader or road compactor (if available) is adequate for achieving a reasonable waste density.

Waste density is impacted by the following:

- Compactive effort applied by the waste compactor (front-end loader).
- Waste type (smaller waste size compacts easier).
- Landfilling methodology (placing inert material on top of light/fluffy waste applies natural compaction of the waste mass).
- Depth of uncompacted waste (thin layers compact more efficiently).
- Amount of cover material utilised (less cover material results in greater waste density).

Typically it would be anticipated that a waste density of approximately 400 kg/m³ to 600 kg/m³ could be achieved provided the waste was adequately placed, pushed up and occasionally compacted and also allowing for some waste settlement over time. For future airspace consumption calculations a waste density of 500 kg/m³ is to be used; hence an anticipated average position.

7.5. Waste Cover

Waste cover is a critical activity on site. In accordance with the Landfill Regulations there is a requirement to apply cover material over the waste on a monthly basis so that no waste is left exposed.

The use of cover material is to be optimised so that excessive cover material is not used unnecessarily. The amount of cover material used is highly dependent on the condition of the waste surface onto which it is being applied. The Shire is to ensure that the compacted waste surface is relatively smooth and firm before applying cover material. An irregular waste surface with excessive voids will result in significant quantities of cover material being consumed in order to achieve an adequate coverage. Utilising a wheeled loader for compaction, it is likely that there will be wheel tracks in the waste if it is not compacted sufficiently, the tracks will also consume excess cover material; hence, if available, a tracked machine is preferred.

The use of excessive cover material results in the following:

- Wasted effort in sourcing, covering and removing cover material.
- Waste of cover material.

For areas that have reached the final design levels, the final cover of a minimum of 1 m (ideally 1.5 m) is to be applied over all waste surfaces. This final cover layer should be placed as soon as possible after the final waste profile has been reached.

The benefits of immediately covering the final waste profile include:

- Earlier completion of portions of the landfill.
- Improved visual amenity.
- Reduced litter generation.
- Improved odour and vermin control.
- Improved surface water management.
- Reduced leachate generation.

An adequate supply of cover material is essential for the continuous operation of the landfills. The Shire should always maintain adequate stockpiles of available cover material on site (from waste trench excavation).

Landfill capping will consume significant quantities of cover material and should be accounted for when assessing the available sources of cover material on site.

Cover material should be used sparingly as there may come a time when there will be insufficient on-site cover material to suit the operational and closure needs.

7.6. Leachate Management

Leachate management revolves primarily around minimising the amount of leachate being generated. This is achieved by ensuring that the appropriate final waste profile is attained and the waste is suitably capped in order to absorb and retain the majority of the seasonal rainfall and potentially shed excess surface water flow away from the waste mass.

In time, as the vegetation develops on the capped areas this will consume the majority of water absorbed into the cap and further reduce the generation of leachate.

Due to the landfills both being unlined and there being low annual rainfall, there will be only minimal leachate forming in the bottom of the waste trenches. All leachate that is generated gradually seeps out through the base of the landfill. The naturally occurring soil on site has a high clay content (based on the site observations, no soil analysis was undertaken) and hence it would not be anticipated that there would be rapid leachate migration through the soil and into the groundwater. Leachate migration into the soil would be slow and localised to the immediate area around the landfill sites.

7.7. Stormwater Management

It is a requirement of the Landfill Regulations that adequate stormwater management is put in place to ensure that stormwater is diverted away from areas of waste placement and that all contaminated water is retained and managed on site.

The landfill sites are both relatively flat with no established watercourses flowing across the sites. In a rain event, it is likely that there will be some standing water and some relatively minor surface water flow across the sites. The site operator is to ensure that there are sufficient surface water drains and bunds constructed to direct the uncontaminated water away from the areas of waste placement and where the surface water has come into contact with the waste, that it is retained on site and treated as contaminated.

Fortunately, due to the flat topography, the degree of effort to construct and maintain the surface water drainage system will be minimal. There is no formal watercourse into which to divert the surface water, it should simply be diverted away from the landfill areas.

7.8. Groundwater and Surface Water Monitoring

Groundwater Monitoring

There is no requirement within the Landfill Regulations for the Shire to monitor groundwater.

The sites have no groundwater monitoring bores; hence, there is no ability to monitor the groundwater.

Surface Water Monitoring

There is no requirement within the Landfill Regulations for the Shire to monitor surface water.

There is no surface water flowing through the sites or any retention dams; hence, there is no opportunity to sample any surface water.

7.9. Dust Control

It is a requirement of the Landfill Regulations that no visible dust escapes from the site.

It is not anticipated that dust would be a problem at the landfills. This assumption is based on the following:

- Relatively small sites.
- Small number of traffic movements on site.
- Slow-moving traffic.
- Earthworks only carried out on an occasional basis.
- No adjacent receptors within 500 m.

During times of occasional earthworks there is the potential for excess dust to be generated. These activities shall be conducted with due consideration for appropriate dust suppression as and when required

7.10. Litter Control

The Landfill Regulations cover the requirements for the adequate containment of waste on site. There is a requirement to collect any litter that has blown beyond the site boundaries on a monthly basis.

Litter collection fencing is only one means for the control of litter on site. Litter control on site is achieved via the following mechanisms:

- Regular pushing up and compaction of the waste.
- Regular collection of uncontrolled tipping and placing the material into the active tipping face.
- Application of adequate cover material.
- Site fencing acting as a litter collection device.
- Regular clearing of litter from fences and other areas of site.
- Progressive closure of completed landfill areas.
- Planting vegetative screens (tall trees) around the landfill to reduce wind impact.

The higher the landfill, the greater the potential to generate litter and hence the greater the effort required managing litter on site. In these circumstances it is more important to correctly position fences to optimise litter collection. In addition to this, landfilling should be planned around seasonal wind variations and direction.

As part of the ongoing management of the landfill sites the operators are to conduct monthly litter collection operations around sites and beyond the site boundaries.

7.11. Weed Management

Active weed management on site is essential to ensure the control of noxious weed species.

With green waste being delivered to sites, there is always the presence of noxious weeds. It is the Shire's responsibility to ensure that noxious weed species are not allowed to infest the landfill sites and neighbouring properties.

The Shire should develop an active weed management system on site including, regular on-site weed inspections and when noxious weeds are identified, a weed eradication programme instigated either by the Shire or by an appropriate weed control contractor.

7.12. Vermin Control

Vermin are attracted to landfill sites by the presence of an abundant food source within the waste. Vermin have the potential to spread disease within the local area and also negatively impact the local ecology around the facility. For example if cats are allowed to propagate on and around the landfill site they will have a significant negative impact on the local fauna in the area.

Vermin control on site is achieved via the following mechanisms:

- Regular pushing up and compaction of the waste.
- Regular collection of uncontrolled tipping and placing the material into the active tipping face.
- Application of adequate cover material.
- Progressive closure of completed landfill areas.
- Adequate perimeter fencing and gates.
- Vermin control such as baiting and trapping.

The landfill operators are to be mindful of the presence of vermin on site and should evidence of vermin activity be noticed, appropriate action should be taken to control the particular vermin type.

Mechanisms for control of specific types of vermin include:

- Cats - baiting and trapping.
- Rats and Mice - baiting and trapping.
- Dogs - adequate fencing.
- Birds - covering of waste and removal of surface water.

7.13. Fire Control

The Landfill Regulations allow burning of green waste. This should be the only material that is burnt on site.

The Shire should have a fire management procedure in place and the appropriate equipment available so that the Shire can extinguish an unauthorised fire as soon as possible.

8. Recycling Activities

In order to strive to comply with the Waste Authority's *Waste Strategy* (major consideration) and to reduce the quantity of waste sent to landfill (minor consideration), materials recycling activities could be improved and increased.

Currently limited recycling/waste diversion occurs on site and primarily involves the following:

- Metal;
- Plastic containers (DrumMuster) and,
- Green waste (burning).

The costs associated with the vast majority of recycling activities are not covered by the revenue received from the sale of the recycled products (separation and handling costs, high transport costs, low revenue). Consequently, to proceed down the direction of increased recycling and reduced waste to landfill the Shire needs to be committed to the cause and cover the costs associated with increased recycling activities.

8.1. Recycling Data

There is no historical data available on the quantity of material being recycled within the Shire.

8.2. Recycling Area

In order to improve recycling opportunities at the landfill sites, it is recommended that the Shire consider dedicated recycling areas near the entrance of the sites to be developed. This should be the area within which residential and small commercial customers are able to drop off recyclables and any residual general waste is then taken to the active landfill tipping face.

The recycling area should be developed based on the type and quantity of recyclable materials that are being targeted. Due to the size of the landfill sites and the small communities that they support, it is not seen as practical to develop an elaborate recycling solution at the sites, a few yellow wheelie bins for recyclable packaging material would suffice. These would then be incorporated into the normal kerbside collection activity.

The recycling areas (and the rest of the landfill site) should be maintained in a neat and orderly fashion, including active litter collection. This will encourage users to do the right thing and place the correct material in the appropriate location; hence, reducing the amount of site clean-up required by the landfill operator.

It is not the intention to simply collect as much recyclable material as possible. Recyclable materials should only be collected if there is a reliable and viable system in place for the removal, transport and delivery of the material to the appropriate processing facility or application.

8.3. Hazardous and Problematic Waste

Hazardous and problematic waste, even in small quantities, has the potential to cause environmental harm or safety concerns. Consequently, an effort should be put in to reduce the amount of hazardous and problematic waste that is disposed of via landfill.

In a broad context, typically hazardous and problematic waste includes:

- Household chemicals;
- Industrial chemicals;
- Asbestos products (dedicated burial in the landfill is the preferred solution);
- Used oil (limited quantities currently collected);
- Paints;
- Medicines;
- Fluorescent light globes and tubes;
- Electronic and electrical equipment;
- Dry cell batteries including mobile phone and other electronic devices;
- Gas bottles and fire extinguishers;
- Fire detectors; and
- Flares.

The methodology for the handling of hazardous and problematic waste types is primarily a function of the specific hazard or problem that the individual waste type presents to the environment. As these waste types are diverted from landfill and collected at a recycling facility, specific handling methodologies need to be developed to ensure the appropriate handling and storage of the material. Typically, the different waste sources are stored separately depending on the waste type and downstream handling methodology. Secure weatherproof cabinets are the most common method of storing hazardous waste, while asbestos products are buried in the landfill. The Shire is to be aware that the disposal of hazardous waste can be an expensive activity.

Significant information is available from the DER with regards to the appropriate handling methodologies for most hazardous and problematic wastes.

Once collected, the material needs to be securely stored either on site or in a Shire works depot. to prevent inappropriate access to the material by members of the general public. Only if the sites become manned should the Shire consider the collection of hazardous material at the landfill site. If the sites remain unmanned, then the preferred solution is to collect the materials at the Shire works depot.

The Waste Authority, through the DER currently has a household hazardous waste disposal program running where the Shire can deliver the hazardous waste to a number of Perth Metropolitan or regional drop-off facilities no charge, the nearest being Albany, Toodyay or the Metropolitan area (depending on the direction being travelled).

9. Future Site Usage

Due to the anticipated long life of the landfills, for the foreseeable future, the sites will be used for waste management purposes.

There has been no consideration given to the post landfill usage of the site. Because the sites are relatively remote, it is unlikely that there will be a future need to develop anything substantial on sites that would need to be considered in designing the final waste footprint or profile.

10. Landfill Capping and Closure

10.1. Closure Capping

The final result of the closure capping is to provide an environment that is long-term sustainable and that will not need resurfacing in the future. Any maintenance and resurfacing work carried out on the cap will result in machines having to drive over the vegetated surface, thus usually resulting in significant damage to the surface and hence a long time for the vegetation to recover. If this work is done during the wet season and the cap surface is soft, the vehicle damage is usually greater than if the work was carried out in summer.

10.2. Continuous Capping

It is essential that the landfills be progressively capped as the waste reaches the final waste profile and the capping not be left to the end of the landfill life. The benefit of continuous capping include:

- Progressively closing off portions of the site.
- Increased ability to shed surface water off the landfill and hence reducing the quantity of leachate being generated.
- Reducing the ongoing closure liability costs for the landfill as these costs are incurred progressively through the life of the landfill.
- Using the capping costs as a guide to assist the Shire to determining what closure reserves will be required towards the end of the life of the landfill and during the post closure period.
- Reduced litter generation.
- Improved aesthetics.

10.3. Landfill Gas

There is no evidence of any discernable volume of landfill gas being generated within the landfill waste trenches. The landfill capping system does not need to be specifically designed to accommodate landfill gas capture.

The landfill capping layer has an ability to oxidise some methane as the landfill gas passes through the cap and hence reduce the emissions from the landfill. The degree of emissions will depend on the quantity of landfill gas being emitted and the thickness of the landfill cap.

10.4. Infrastructure Requirements

With landfilling anticipated to continue on the sites well into the future and there being no future site afteruse determined, there is no need to incorporate any future infrastructure requirements into the proposed capping program.

10.5. Surface Preparation

Once waste placement has ceased in an area and the final profile obtained, any weeds need to be sprayed 14 days before the application of any capping material. The waste surface then needs to be compacted and flattened by the loader, roller or excavator. This will ideally fill in as many voids as possible in the waste mass. Providing a relatively smooth, rolled surface will reduce the quantity of cover material needed to develop a suitable capping layer. If the waste mass is left with large voids, the cover material will simply infiltrate into the waste and require additional cover material to be applied.

10.6. Cap Profile

The proposed cap profile consists of a single soil layer placed on top of the finished waste profile.

It is not proposed that a layer of topsoil be utilised as this is not the naturally occurring situation in the local environment and will primarily promote weed growth. Native vegetation is adequately surviving in the surrounding environment and hence replicating these environmental conditions should be sufficient to sustain native vegetation on the landfill capped areas. By the addition of a topsoil layer, weed species will thrive to the detriment of the native vegetation.

The exception being, if there is a seed bank of cleared material from the undisturbed portions of the sites or other sites in the region, this should be spread on the cap surface. However, weed infestation is still a major concern and should be closely monitored.

10.7. Capping Material

10.7.1. Purpose

The intention of the waste cap is to provide a long-term sustainable barrier between the waste and the environment. The capping material is not necessarily required to “entomb” the waste as moisture assists in the waste decomposition process and hence allowing controlled amounts of water through the cap is beneficial to the long-term overall stability of the closed landfill.

The intended purpose of the landfill cap includes:

- Provision of a barrier between the waste and the environment.
- Control of moisture ingress.
- Provides a habitat for the establishment of native vegetation.
- Control of erosion of the cap material.
- Prevent vermin access to the decomposing waste.
- Control odour emissions.
- Encourage excess stormwater runoff.
- Divert water from the area of waste placement.

- Ability to accommodate waste settlement.
- Oxidise limited amounts of landfill gas (if present).
- Improved aesthetic appeal of the site.

The Landfill Regulations state that the waste shall be covered by a layer of soil cover of at least 1 m thick.

10.7.2. Natural Soil

From on-site observations, the natural soil in the immediate area of the sites (and the majority of the region) is fine-grained clayey soil and hence has a relatively low permeability. This soil is well suited as landfill capping material. This is based on the following:

- The natural soil allows surface water to slowly permeate into the cap and be absorbed and retained in the cap (to sustain the vegetation cover). Excess moisture will either pass through the capping layer into the waste mass or be shed off the surface of the landfill.
- Is suitable for vegetation to establish on the surface (moisture retention).
- Wind and water erosion can be managed.

Over time, there will be large surface areas of landfill to cover and a limited amount of soil available. This soil supply needs to be carefully managed during landfill operations to ensure that there is sufficient material available for the capping layer. Continuously capping the completed areas of the landfill will ensure that the natural soil is apportioned appropriately and not simply wasted.

It is preferable that, if there is to be a shortfall in naturally occurring soils on site, that the on-site soil be utilised as landfill capping material in preference to regular waste cover material. The native vegetation is thriving in this soil; hence, it is better to use this material in the final cap and imported material as regular cover material (which may be less suitable for sustaining the native vegetation).

10.7.3. Imported Capping Material

If the onsite-excavated material is managed appropriately, it is likely that there will be sufficient cover and capping material available. However, if there is insufficient, then there will be a need to import additional material. As mentioned above, it is preferable to use the imported material for regular waste cover material and the naturally occurring material for final capping material.

If imported material is required, ideally, this material should be sourced from the local environment, as this is the soil that the native vegetation is growing in. If soil is imported from afar, it may be that the native vegetation will not survive in that soil type or struggle to survive and hence leave a cap that will always look like a “capped landfill” and not blend into the natural surrounds.

If the imported soil is sourced from different locations, where possible it should be mixed to achieve a homogeneous blend. This will provide a more consistent soil type across the landfill and hence there is more likely to be uniform vegetation growth on the capped surface and hence a more natural appearance.

10.8. Landfill Cap Thickness

Based on the intended purpose of the landfill cap, there are various minimum thicknesses of cap that would be required to achieve the various outcomes.

- Provision of a barrier between the waste and the environment – a cap thickness of approximately 1 m would be sufficient to prevent any waste from being exposed to the surface environment. An important aspect is to prevent wind and surface water erosion from gradually reducing the depth of the cap and ultimately exposing the waste. Establishing a comprehensive vegetation cover is the best way to control wind and surface water erosion.
- Control of moisture ingress – the degree of moisture passing through the capping layer into the waste is a function of the rainfall intensity, landfill slope, cap thickness, the capping material type and the degree of vegetated cover. The rainfall intensity and the landfill profile are a given, there is flexibility to control the moisture ingress by designing the appropriate capping material, cap thickness and achieving a suitable cover of vegetation. The material type will influence the moisture retention within the cap and hence the cap thickness. If fine cohesionless sand is used for the cap, the cap would be highly permeable and a significant quantity of moisture would pass through the cap; however, if clayey capping material was used the permeability of the soil would be reduced and hence, the water retention in the cap would be increased. With the retention of moisture in the cap the vegetation would have a far better chance of survival. The thriving vegetation cover would consume the moisture and further prevent it from entering the waste mass. To accurately determine the moisture retention capacity of the soil, laboratory analysis would need to be undertaken.
- Provides a habitat for the establishment of native vegetation – the ability of the vegetation to survive on the cap will be a function of the water retention capacity of the cap. With more water retention, there would be a greater range of plant species that would survive on the landfill cap. Typically, the landfill cap would ideally need to be approximately 2 m thick to sustain a broad range of plant species.
- Control of erosion of the cap material – this is a matter of retaining the cap thickness. Ultimately the soil cap needs to be marginally thicker than the minimum requirements to allow for some erosion to occur until the cap stabilises and the vegetation cover is established.
- Prevent vermin access to the decomposing waste – Typically a sandy cap of 1 m would be sufficient to act as a barrier to prevent vermin from scavenging into the waste.

- Control odour emissions – odour in a closed landfill is a primarily function of fugitive landfill gas emissions. The Shire landfills do not contain significant levels of landfill gas and hence is most unlikely to have an odour problem. Consequently, a 500 mm cap would be sufficient to provide a thin oxidation zone through which to oxidise any fugitive gas emissions.
- Encourage stormwater runoff – the closed landfill profile is a given (relatively flat grades). The landfill cap thickness will have no impact on the stormwater runoff capacity; it will simply follow the shape of the waste profile below.
- Divert water from the area of waste placement – again, the closed landfill shape is a given, with the surface water flowing in a particular direction. The landfill cap shape (thickness) could be used to slightly influence where the surface water flows.
- Ability to accommodate waste settlement – it is likely that over time (10 to 15 years), there areas of landfill that will subside/settle as the waste breaks down, this settlement could be in the order of 15% to 20% of the waste depth. With the waste proposed to be a minimum of 5 m deep and ideally +7 m deep, localised settlement is likely to be in the order of 1 m; however, this will occur gradually with the whole surface slowly settling at a similar rate. There will be some differential settlement as a result of the different types of waste in the landfill and the variable degrees of compaction achieved. A landfill cap of approximately 1 m thick would be able to accommodate this differential settlement. The repair of the cap is relatively easy, as the settlement void would simply be filled with additional clayey soil.
- Oxidise limited amounts of landfill gas (if present) – as mentioned above, a cap of typically 500 mm thick should be able to oxidise the minimal concentration of landfill gas emitting through the cap. Over time this landfill gas will decrease in quantity and hence the need for oxidation reduced.

The maximum thickness of the cap will be a function of vegetation survival and not an aspect of waste management need. Consequently, the cap should ideally be approximately 1.5 m to 2 m thick; however, this is not always achievable due to a shortage of capping material and the cost of installation.

If a thinner cap (<1.5 m) is utilised it will suffice but is likely that this depth of cap will be less sustainable. A broad range of vegetation will not adequately survive and hence, in time the cap vegetation is likely to only consist of a few shallow rooted species and grasses. The capping material may be subjected to excessive erosion (wind and water) and ultimately the landfill cap may need to be reinstated at sometime in the future (at significant additional cost).

10.9. Vegetation

Native vegetation should be used on the landfill cap. The primary reason is that the native vegetation is currently thriving around the sites, once established; the capped landfill surface would blend into the natural environment.

When selecting plant species it is preferable to select a range of shallow rooted plants and shrubs, ideally similar to the surrounding vegetation on site.

Ultimately it is a matter of trial and error as to see which plant species survive on the landfill capping surface. Initially it is advisable to try a wide range of species and then over time (a number of years) the stronger species will outperform those that are not suited to the landfill capping environment.

If deeper-rooted species are tried on the cap, it is likely that they will survive adequately for a few years until their demand for moisture is greater than the moisture retention capacity of the capping layer and then the plants will start showing signs of stress and ultimately die off. It may be that if sufficient moisture is retained within the stabilised waste mass that a few of the deeper-rooted species may survive.

It is preferable to broadcast seeds across the landfill cap as opposed to planting tube stock. The primary advantage is that a significantly larger number of seeds can be applied to the landfill cap for the same cost as would be applicable to a far smaller number of tube stock. Experience on other landfill caps has indicated that within two years it is difficult to identify which plants originated as tube stock or seeds. Ideally the seeds utilised will be collected from the local environment, either from the site or local native bushlands.

Once the landfill capping works and rehabilitation have been completed, the area is to be barricaded off to prevent vehicle access and disturbance by human activity.

During the early stages of the rehabilitation phase, it is essential that the perimeter fence surrounding the landfill site be maintained to prevent fauna from entering the site and feeding on the young seedlings.

10.10. Construction

Site preparation prior to capping material placement should include:

- Spraying of weed 14 days before the works commence.
- Rolling/flattening exposed waste.

When constructing the cap, there is no need to attempt to compact the cap material other than what is achieved via the placement machinery tracking over the surface during the material placement and spreading operation. From a rehabilitation point of view greater vegetation survival and growth will be achieved if the soil is only lightly compacted.

The capping material is simply to be spread out over the landfill surface, to the required thickness. The cap has been designed as a single layer and hence there is no need for placing the material in a number of layers. It is more efficient to place the full cap thickness in a single operation. This also limits the amount of compaction applied to the soil by the construction equipment and hence provides a better growing environment for the cap vegetation.

If a seed bank of scrapings is available from adjacent landfill expansion, it should be spread out on top of the cap.

10.11. Surface Water Management

The cap profile and thickness has been designed to allow surface water infiltration into the capping layer. This is a desirable situation as there is a need for moisture to be retained within the capping material in order to sustain the vegetation planted on top of the landfill cap. In periods of heavy rainfall it is likely that there will be some runoff from the capped areas and also a limited amount of moisture seeping through into the waste mass. Initially, when the plants are relatively small and only require a small amount of moisture some excess moisture will percolate through the landfill cap and enter the waste mass. However, in time as the plants grow and they consume more and more moisture, less water will end up in the waste. The ideal situation is that the vegetation consumes all moisture within the landfill cap and no water ends up going into the waste.

Due to the relatively gentle slopes on the landfill cap, it is unlikely that there would be any significant surface water run-off from the capped landfill surface except in heavy rainfall events. In this circumstance, the runoff is to be directed away from the landfill perimeter.

10.12. Groundwater Management

Capping and revegetating the landfill surface will decrease the quantity of rainfall percolating through the waste mass and hence decrease the quantity of leachate generation. This will ultimately have less impact on the groundwater than is currently occurring.

10.13. Environmental Protection

The potential environmental impacts associated with the closed landfill are anticipated to be extremely minimal if any. This is due to:

- The relatively small quantity of waste disposed of at the landfills.
- The type of waste disposed of to landfill.
- The age of the waste in the landfill.
- The distance to the nearest receptors.
- Depth of capping material.

With the landfill areas being closed in accordance with the design and intention of this capping plan, it is not anticipated that there will be any adverse environmental impacts emanating from the closed landfill.

10.14. Site Monitoring and Maintenance

Site monitoring and maintenance is to be undertaken beyond the closure of portions of the landfill (continuous capping) to ensure that the closure measures adopted as part of the landfill capping plan are providing an ongoing, sustainable environmental solution.

Site monitoring and maintenance is to include:

- Monitoring and repair of erosion and settlement of the cap.
- Monitoring of vegetation rehabilitation success and infill planting as needed.
- Monitoring of weed infestation and eradication as appropriate.

Initially, general site monitoring should occur as a minimum every three months for the first year after closure. During the first wet season and particularly after heavy downpours, the capped area should be monitored monthly or more regularly if needed. Beyond the first year, the monitoring frequency can be reduced. Typically six monthly monitoring should be adequate.

Should the monitoring identify a deficiency in the proposed closure methodology, then the methodology needs to be modified to suit the on-site conditions and implemented in the next tranche of closure works. With many years of closure work still to occur on the sites, the landfill closure techniques can be perfected so that the resultant capping is long-term sustainable.

10.15. Post Closure Period

The closed landfill portions are not anticipated to have any adverse environmental or social impacts. For this reason the ongoing site monitoring is simply to determine the sustainability of the measures proposed in the capping plan.

It is anticipated that an active post closure monitoring period of approximately five years will be sufficient to determine the effectiveness of the post closure measures implemented, primarily the vegetation survival. This will provide sufficient time for the landfill cap to stabilise and vegetation to establish on the cap surface.

11. Financial Planning

As can be seen from the above, the closure of a landfill is an essential activity and to do it properly is an expensive operation. The cost is significantly more if there is a need to import landfill capping material (hence the conservation of existing resources is essential). Financial planning for closure and post closure landfill expenses is an important aspect of landfill management.

The Shire is to ensure that in future, there are sufficient funds allocated during the active life of the landfill to cover the closure and post closure liabilities that are being accumulated. As environmental awareness increases, closure and post closure requirements are only going to increase with time and hence the associated costs. With progressive closure, these costs are incurred over many years and it is difficult to distinguish between facility operating costs and landfill closure costs.

An assessment of the financial implications of the closure, monitoring and maintenance requirements will be necessary in order to ensure that sufficient funds are budgeted to adequately finance the necessary activities.

Typical costs incurred during post-closure activities include:

- Labour costs for undertaking regular site inspections.
- Cap repair and vegetation infill planting (usually in the first two years of the cap construction).
- Weed control.

With the Shire's landfills anticipated to last for in excess of 100 years, the Shire has sufficient time to ensure that the appropriate reserves are in place to adequately cover the anticipated expenses. However, if the Shire does not regularly reassess its future liabilities and adjust its reserves accordingly, there is a risk that future generations will have to source significant additional funds to cover the past shortfalls in reserves to cover future liabilities.

The typical costs associated with operating, closing and monitoring a small landfill are detailed below.

Table 11.1 – Dumbleyung Landfill Operating Assumptions

Item	Assumption
1	Unmanned site
2	Unlined landfill
3	Annual tonnage = 410 tonnes (average landfill size)
4	Waste density 500 kg/m ³
5	Airspace consumption at 820 m ³ /yr
6	Waste placement average 3 m aboveground
7	Annual waste trench excavation 490 m ³ , 60% of airspace requirements
8	Some previous landfill areas needing rehabilitation

Table 11.2 – Dumbleyung Landfill Operating Costs

Activity	Estimated Annual Cost
Trench Excavation (incl. mob/demob)	\$8,000
Compaction & Cover	\$8,000
Site Operations	\$12,000
Site Maintenance	\$10,000
Progressive Closure	\$12,000
Contingency	\$5,000
Total	\$55,000
Rate per Tonne	Approximately \$135/tonne

Manning a site for 2 days per week, one week day and one weekend day plus ute, is likely to cost in the order of \$350/day or \$36,400/yr, which equates to \$90/tonne; hence a total anticipated cost of facility operating cost of \$225/tonne.

Table 11.3 – Kukerin Landfill Operating Assumptions

Item	Assumption
1	Unmanned site
2	Unlined landfill
3	Annual tonnage = 70 tonnes (average landfill size)
4	Waste density 500 kg/m ³
5	Airspace consumption at 140 m ³ /yr
6	Waste placement average 3 m aboveground
7	Annual waste trench excavation 85 m ³ , 60% of airspace requirements
8	Some previous landfill areas needing rehabilitation

Table 11.4 – Kukerin Landfill Operating Costs

Activity	Estimated Annual Cost
Trench Excavation (incl. mob/demob)	\$1,500
Compaction & Cover	\$3,000
Site Operations	\$3,000
Site Maintenance	\$2,000
Progressive Closure	\$3,000
Contingency	\$1,500
Total	\$14,000
Rate per Tonne	Approximately \$200/tonne

Manning a site for 2 half-days per week, one week day and one weekend day plus ute, is likely to cost in the order of \$175/half-day or \$18,200/yr, which equates to \$260/tonne; hence a total anticipated cost of facility operating cost of \$460/tonne.

In addition to the above typical costs, there will be a requirement to monitor the closed landfill site for up to five years. Provided the progressive closure occurs annually, the site will be substantially capped and rehabilitated at the time of closure and all that will be needed is to cap and rehabilitate the last waste trench.

During the life of the landfill operations, the lessons would have been learnt as to the most appropriate landfill cap thickness and which plant species adequately survive. Consequently, there will be minimal effort required to monitor the site. The primary activity being monitoring weed infestation in the recently capped areas.

Over the five year post closure monitoring period, it is anticipated that it would cost approximately \$5,000 per year to have a Shire officer undertake six-monthly visits to the site and carry out minimal weed control activities. Only if there were an extreme storm event within a few years of the final cap construction (before the vegetation established) would there be a need to possibly undertake some cap maintenance activities. These costs cannot be anticipated or accrued for, as the event is highly unlikely.

If progressive closure is not undertaken and all capping material is consumed by regular waste covering activities, the Shire will be left with a massive landfill closure cost. If this is not accounted for by maintaining adequate reserves the landfill closure costs have to be covered by future generations.

Appendices

Appendix No. 1 – Dumbleyung WMF Concept Layout Plan

This page is intentionally left blank

Appendix No. 2 – Kukerin WMF Concept Layout Plan

This page is intentionally left blank

DUMBLEYUNG WASTE MANAGEMENT SITE



2.8 km to
Centre of
Town



CONCEPT LAYOUT PLAN

Rifle Range Road
Rifle Range Rd

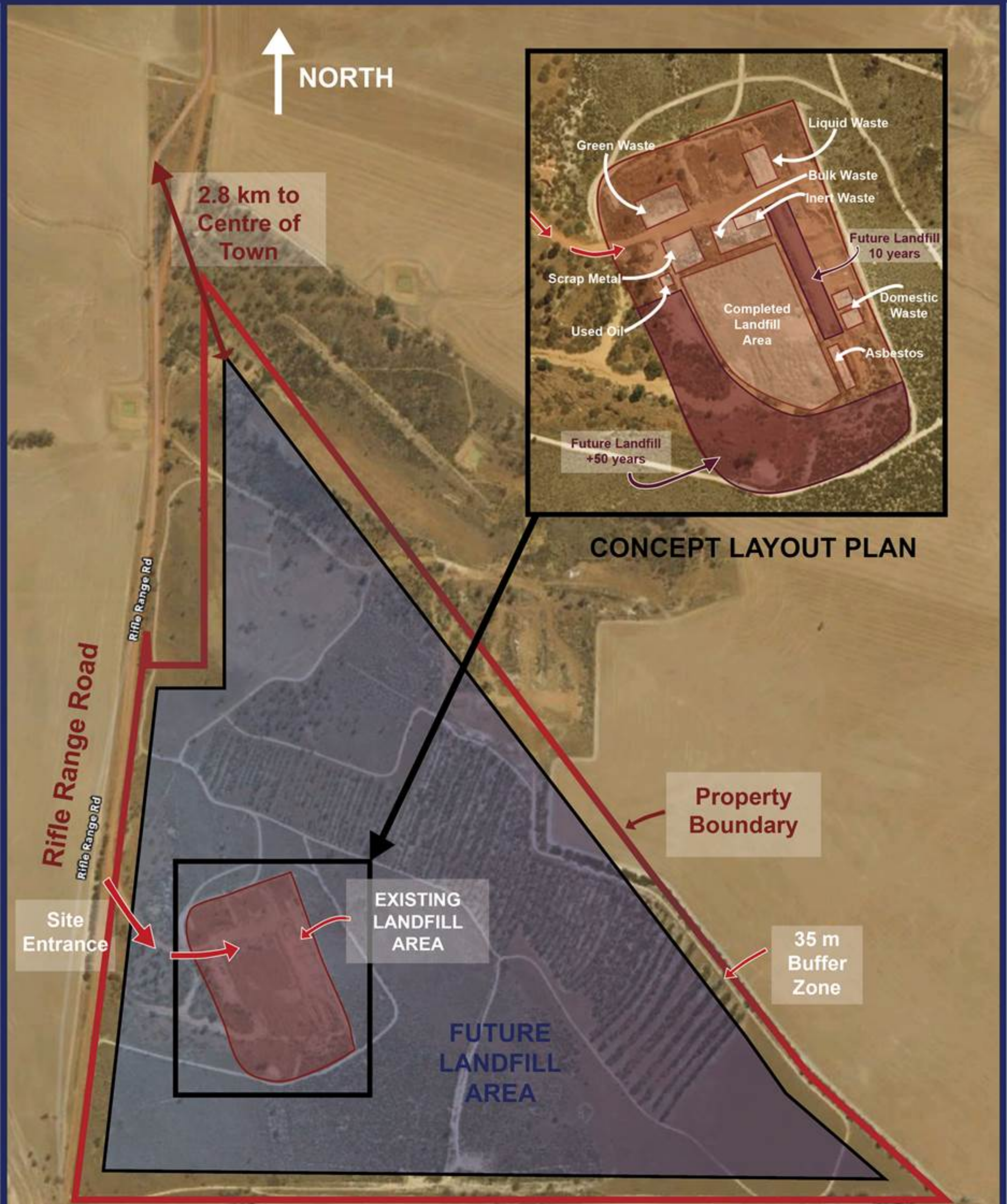
Site Entrance

EXISTING
LANDFILL
AREA

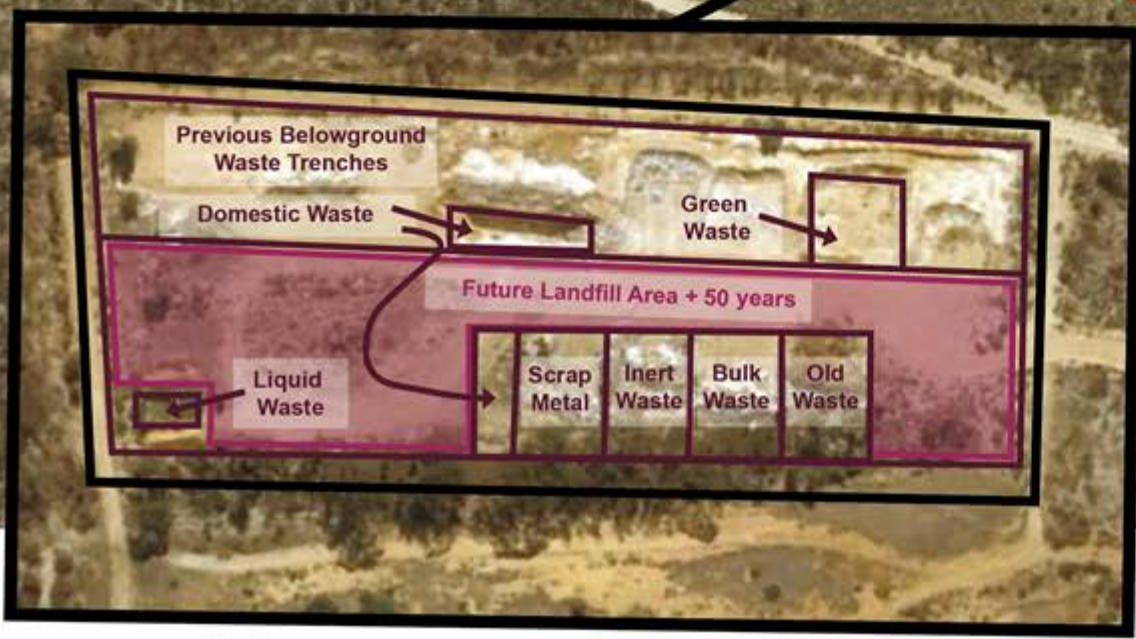
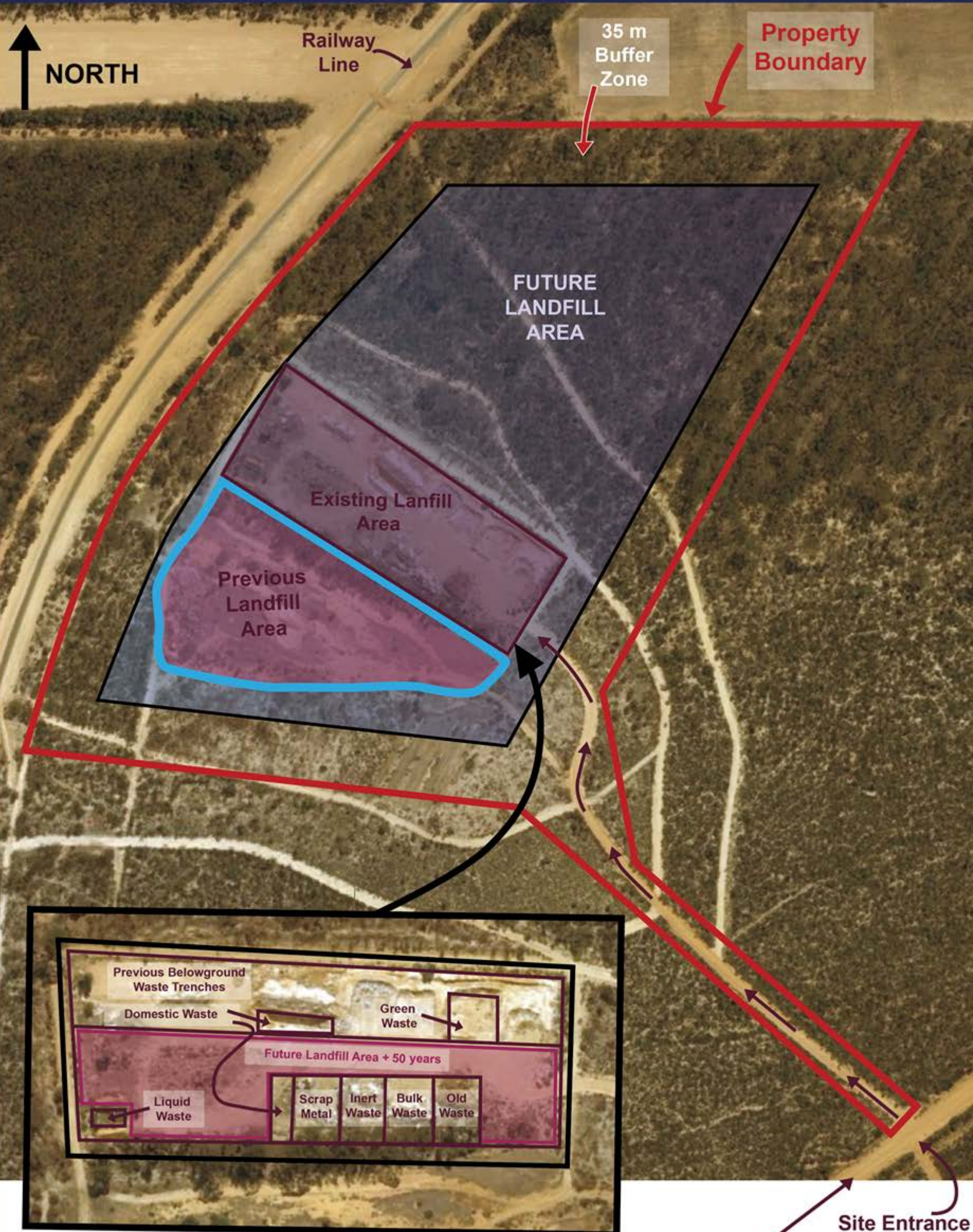
FUTURE
LANDFILL
AREA

Property
Boundary

35 m
Buffer
Zone



KUKERIN WASTE MANAGEMENT SITE



CONCEPT LAYOUT PLAN

Site Entrance
Kukerin Road NE