

To: Shay McDonald (ORC)

From: James Elliott (SLR)

cc: Samantha Iles (SLR)

Date: 24 October 2024

RE: RM23.185 - Green Island Landfill Design and Management Technical Review Memorandum 02

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1.0 Introduction

SLR Consulting New Zealand (SLR) has been engaged by Otago Regional Council (ORC) to conduct a technical review of the resource consent application (including subsequent attachments and request for information (RFI) responses submitted by Dunedin City Council (the applicant, or DCC) for the operation, expansion and closure of the Green Island Landfill (referred to herein as the site).

The applicant is proposing to extend the life of the site to allow acceptance of waste until sometime between December 2029 and March 2031, following which closure operations and landfill aftercare will commence.

SLR prepared technical memorandums in late 2023 in response to the application. This included a technical memorandum in relation to Landfill Design and Management (LDM) issued on 5th December 2023 (2023 LDM Memo). The 2023 LDM Memo raised a number of items requiring further clarification. In October 2024, further information was provided by the applicant in response to the SLR issued technical memorandums, including the 2023 LDM Memo. The information supplied included new memorandums, new reports, updated reports, responses to specific queries and proposed consent conditions.

The further information provided has been reviewed. The technical memorandum herein (2024 LDM Memo) details the reviewers (James Elliott) opinion as to whether the recently provided information addresses the items raised in the 2023 LDM Memo. Additionally, this 2024 LDM Memo also details any other items from the recently provided information that require further clarification.

2.0 Scope of Review

2.1 Scope

The scope of this review included;

- Re-familiarisation with the findings of the review that informed the 2023 LDM Memo.
- Review of sections of the documents listed in Section 2.3 considered relevant to the questions posed by ORC with respect to LDM.
- Consideration of the relevant LDM aspects against the requirements of WasteMINZ 2018¹. Referred to herein as the WasteMinz Guidelines.

¹ As of September 2023, the guideline document has been updated and reissued. However, given that the updates relate to waste acceptance criteria for landfills, and not landfill design matters, reference to the 2018 document is acceptable.

- Preparation of this technical memorandum (2024 LDM Memo).

2.2 Items Considered

The review considers landfill design and management only, as detailed in the documents listed later in this section, and as relevant to the questions posed by ORC. The design and management aspects considered as part of this review are summarised as;

- Proposed landfill cap.
- Leachate management.
- Landfill gas (LFG) management.
- Stormwater management.
- Landfill fires.

2.3 Key Documents Reviewed

2.3.1 Original Resource Consent Application

The following key documents, which were submitted as part of the application in 2023, were reviewed in the development of the 2023 LDM Memo:

- Boffa Miskell Limited, *Green Island Landfill Closure, Assessment of Environmental Effects*, Dated March 2023.
- GHD Limited, *Waste Futures – Green Island Landfill Closure Design Report*, Dated 29 September 2023. Referred to herein as the Design Report.
- GHD Limited, *Waste Futures – Green Island Landfill Closure Surface Water Report*, Dated 7 March 2023.
- GHD Limited, *Fire Management Plan, Green Island Landfill*, Dated 13 March 2023. Referred to herein as the FMP.
- Stantec New Zealand, *Green Island Landfill, Development and Management Plan*, Dated September 2023.
- Tonkin and Taylor Limited, *Landfill Gas Masterplan, Green Island Landfill*, Dated September 2023. Referred to herein as the LFG Masterplan.
- Tonkin and Taylor Limited, *Green Island Landfill, LFG Management Letter Report*, Dated 21 September 2023. Referred to herein as the LFG Letter.

2.3.2 Section 92 Responses

The following key documents, have been reviewed to assess if the items requiring clarification in the 2023 LDM Memo have been addressed;

- Boffa Miskell Limited, *Green Island Landfill Closure, Assessment of Environmental Effects*, March 2023 (Updated October 2024). Referred to herein as the AEE.
- Dateless and unnamed PDF document without letter head with the filename “*Question 11 Response*” provided to SLR by Shay McDonald of ORC on 10 October 2024. Referred to herein as Question 11 Response.
- Dateless and unnamed PDF document without letter head with the filename “*Question 12A response*” provided to SLR by Shay McDonald of ORC on 10 October 2024. Referred to herein as Question 12A Response.



- Dateless excel file without letter head with eleven worksheets with filename “MASTER_RM23.185 GILF RFI Jan 2024-Tranche5-6.xlsx” provided to SLR by Shay McDonald of ORC on 10 October 2024. Referred to herein as DCC Comments Response Spreadsheet.
- Dateless PDF document without letter head titled “Green Island Landfill Closure – Draft ORC Conditions of Consent” provided to SLR by Shay McDonald of ORC on 10 October 2024. Referred to herein as Existing Consent Conditions.
- Dateless and unnamed PDF document without letter head with the filename “LDMP Recommended Changes” provided to SLR by Shay McDonald of ORC on 10 October 2024.
- GHD Limited, *Waste Futures – Green Island Landfill Closure Surface Water Report – October 2024 Update*, Dated 18 July 2024. Referred to herein as the SW Report
- Tonkin and Taylor Limited, *Green Island Landfill - Landfill Gas Risk Assessment*, Tonkin & Taylor Ltd, dated July 2024 (Ref: 1008787.5010 v2.0). Referred to herein as the LFGRA.

2.4 Exclusions and Assumptions

The following assumptions and exclusions apply to the information provided herein.

- Discussion with respect to potential adverse human health and environmental effects associated with water and air discharges from the landfill are covered by other technical memorandums. Other technical memorandums should be read in conjunction with this technical memorandum.
- The entire contents of the documents listed in Section 2.3 were not necessarily reviewed. The review focussed on the documents described in Section 2.3.2.
- A detailed analysis of LFG modelling, LFG pipe sizing, HELP modelling etc. was not undertaken, and models were not rerun as part of this review.
- No site inspection was undertaken as part of this review. However, photos of the site were provided, and a SLR colleague inspected the site and provided verbal details of key site information.
- The design elements considered in this review are considered to be conceptual designs at this stage and are subject to detailed design at a later date.

3.0 Assessment

3.1 Original Questions

3.1.1 Question 1 - Is the technical information provided in support of the application robust, including being clear about uncertainties and any assumptions?

In relation to the robustness of the technical information, the 2023 LDM Memo stated that:

“The technical information provided in support of the application is generally robust, and clear about uncertainties and assumptions. However, there are some items that require further clarification.”

A summary of the key technical items which required further clarification by the applicant is provided in Table 1, with a reference to relevant section(s) of this technical memorandum where the applicants response has been assessed as part of the current scope of works.



Table 1 Summary of 2023 LDM Memo Technical Information Questions/Clarifications

Technical Information Bullet Point	2023 LDM Memo Questions/Clarification Sought	2024 LDM Memo Reference Section
1	Further information was required with respect to the classification and fate of runoff from the intermediate cap (referred to herein as intermediate cover).	Section 3.2.1 Bullet Points 1 through 5
2	Further information was required with respect to the frequency and associated impacts to the environment of leachate overflowing from the northern leachate pond in prolonged rainfall events.	Section 3.2.1 Bullet Points 6 and 7
3	Further information was also required with respect to the lining of the northern leachate pond.	Section 3.2.2 Bullet Points 3 through 5
4	That further information was required with respect to the exact timing of LFG well installation for the LFG capture system.	Section 3.2.3 Bullet Points 1 and 2
5	Further information was required with respect to the potential use of a piggyback liner.	Section 3.2.4 Piggyback Liner
6	Further information was required with respect to the potential impact of subsurface LFG migration.	Section 3.2.3 Landfill Gas Risk Assessment Report

3.1.2 Question 2 - Are there any other matters that appear relevant to you that have not been included? Or is additional information needed?

The 2023 LDM Memo identified two other items requiring further information. These related to landfill gas and leachate impacts on the environment.

A summary of these items which required further clarification by the applicant is provided in Table 2, with a reference to relevant section(s) of this technical memorandum where the applicants response has been assessed as part of the current scope of works.

Table 2 Summary of 2023 LDM Memo Other Questions/Clarifications

Other Item Reference	2023 LDM Memo Questions/Clarification Sought	2024 LDM Memo Reference Section
Landfill Gas	It was recommended that a LFGRA is undertaken for the site, or if a LFGRA has already been completed, this is provided for review.	Section 3.2.3 LFGRA Report
Leachate Impacts	A key input to the design elements of the application is that leachate is not impacting the surrounding environment. Whilst review of leachate impacts is outside the scope of this review, further assessment has been recommended in other technical memorandums (prepared by SLR) related to groundwater quality and surface water quality. The outcomes of further assessment could influence the comments provided herein.	Section 3.2.2



3.1.3 Question 3 - If granted, are there any specific conditions that you recommend should be included in the consent?

The 2023 LDM Memo provided the following commentary regarding consent conditions;

“Based on the information provided to date, and considering the comments provided herein, it is recommended that specific conditions are included. A summary of the key items that should be addressed by specific conditions are provided in the following. Note that the below are not intended to be the actual conditions. Further consideration, including review of any additional information that is provided after issue of this technical memorandum, would be required before the exact conditions are confirmed.”

A summary of the consent requirements requested to be considered by the applicant is provided in Table 3. This table includes a reference to relevant section(s) of this technical memorandum where the applicants response has been assessed as part of the current scope of works.

Table 3 Summary of 2023 LDM Memo Consent Condition Recommendations

Consent Condition Bullet Point	2023 LDM Memo Questions/Clarification Sought	2024 LDM Memo Reference Section	Recommended Resource Consent Condition
1	The need for further assessment of potential impacts, particularly from leachate, to the surrounding environment from the landfill, to help inform the need for, if any, additional management measures such as active leachate extraction and enhancements to the landfill cap profile and grades.	Section 3.2.2	It is noted that the impact of leachate on the surrounding environment may require further assessment. Full details of this are provided in Memos prepared by others. Additional assessment related to leachate impacts recommended by other reviewers of the application should be included as consent conditions. Refer to other Technical Memorandums for recommendations.
2	Improvements to be made to leachate management, such as active leachate extraction from the existing LFG wells, in an effort to reduce leachate head within the waste mass.	Section 3.2.2	There is a significant leachate head within the landfill. No additional information has been provided by the applicant to suggest that efforts will be made to reduce the leachate head in the waste mass. Therefore; The comment from the 2023 LDM Memo is still considered to apply, Efforts should be made to reduce the leachate head at the within the landfill, A consent condition requiring the lowering of leachate head should be applied, and A target leachate head should be derived by the applicant for consideration by ORC.
4	Implementation and timing, and where required additional details/detailed design, of	Section 3.2.3	The applicant has committed to the completion of Eastern Culvert Remedial works by March 2025.



Consent Condition Bullet Point	2023 LDM Memo Questions/Clarification Sought	2024 LDM Memo Reference Section	Recommended Resource Consent Condition
	proposed remedial activities, which include construction of the final cap in specific areas, installation of additional LFG wells and potentially LFG flares/engines, extension of the LIT, and eastern culvert works where leachate seepage has previously occurred.		However, other remedial works are considered worthy of consent conditions in relation to timing. These include; Timebound milestones for progressive capping of the landfill, Timebound milestones for the commissioning of the new LFG Flare, and other LFG management infrastructure including vertical LFG wells, and Timebound milestones for the construction/installation of the Leachate Interception Trench extension.
5	Surface water management, including the need to reduce the mixing of different water types; and to be clear about the fate of all water types, including intermediate cover runoff.	Section 3.2.1	The following consent conditions regarding the fate of surface water runoff are recommended; Runoff from intermediate cover areas should be treated as “leachate” and directed to the leachate collection system, and landfill documents, including the LDMP, should be updated as required to reflect this. To the extent practical, the different types of runoff as defined in the AEE (i.e. clean stormwater, sediment laden stormwater, and leachate) should be kept separate, to reduce the potential for contamination of runoff, and to reduce the volume of leachate and sediment laden runoff.
6	Details regarding assessment of fire risk, and associated additional mitigation, monitoring and management requirements.	Section 3.2.5	It is recommended that a consent condition related to this be included which requires the preparation, and periodic update, of a fire risk assessment, and update of the fire management plan to incorporate the comments detailed in Section 3.2.5.

3.1.4 Question 4 - Is the landfill design and management fit for purpose with regards to the Technical Guidelines for Disposal to Land (WasteMINZ, 2018)?

It is acknowledged that the landfill has been operating for almost 30 years, and pre-dates current landfill guidance including the WasteMINZ Guidelines. Some of the existing engineering controls do not conform to current guidance e.g. there is no engineered liner or



leachate collection system on the landfill floor. This is a significant constraint for older landfills, including the site. However, the 2023 LDM Memo did request further clarification regarding a number of LDM items, as summarised in Table 4. A reference to relevant section(s) of this technical memorandum where the applicants response has been assessed is also included.

Table 4 Summary of 2023 LDM Memo Design Questions

LDM Bullet Point	2023 LDM Memo Questions/Clarification Sought	2024 LDM Memo Reference Section
1	Section 5.6 of the WasteMINZ Guidelines includes objectives of surface water and stormwater management. One of these objectives is to “maintain separation of stormwater from waste/leachate”. Based on the application documents, leachate is combined with runoff from areas that aren’t considered leachate, and also leachate will overflow from the northern leachate pond during prolonged rainfall events. Both of these scenarios result in leachate combining with stormwater, which does not align with the aforementioned objective.	Section 3.2.1
2	The landfill does not include a base liner and leachate collection system. Due to the age of the landfill, and the guidance at the time, this is not considered to contravene the WasteMINZ Guidelines relevant to this review. However, the leachate head in the landfill is over 10 m in some parts. This is a considerable head of leachate and is not in line with the WasteMINZ Guidelines objective to minimise leachate head.	Section 3.2.2
3	Further to the above, the WasteMINZ Guidelines states that leachate needs to be controlled to influence the biodegradation of the waste and consequently the generation of landfill gas. The elevated leachate head is expected to be inhibiting the performance of the LFG collection system and is therefore not considered to meet the requirements of the WasteMINZ Guidelines.	Section 3.2.3
4	The proposed grades and material thickness of the landfill cap profile are not considered to meet the recommendations of the WasteMINZ Guidelines.	Section 3.2.4

3.1.5 Question 5 – Is the leachate and stormwater management appropriate for the site, including the changes proposed by the Applicant as part of this application.?

The 2023 LDM Memo raised a number of queries with respect to the water management of the site. These are summarised in Table 5. This table includes a reference to relevant section(s) of this technical memorandum where the applicants response has been assessed as part of the current scope of works.

Table 5 Summary of 2023 LDM Memo Stormwater and Leachate Management Questions/Clarifications

Water Management Bullet Point	2023 LDM Memo Questions/Clarification Sought	2024 LDM Memo Reference Section
Stormwater Management System		
1	Runoff from intermediate cover areas is not clearly defined in the documentation. The SW Report indicates that areas of	Section 3.2.1



Water Management Bullet Point	2023 LDM Memo Questions/Clarification Sought	2024 LDM Memo Reference Section
	intermediate cover are treated as leachate. However, the LDMP indicates that intermediate cover runoff can be considered as sediment laden water (which is interpreted to mean “stormwater”) that can be discharged to the environment via a sedimentation pond. The Design Report indicates that runoff from some areas of intermediate cover will be treated as leachate, and from other areas will be treated as stormwater. The classification, and fate, of runoff from intermediate cover areas should be confirmed and be made consistent across all application documents.	Bullet Points 1 through 5
2 and 3	It is acknowledged that where water categories are combined, the water is considered to be the lower quality water of the two categories being combined (i.e. if clean and leachate are combined, the water will be treated as leachate), which is also considered appropriate if combining waters is unavoidable. Further to this it is noted that the SW Report (Section 4.1) states that “it is acceptable for clean and sediment laden waters to be directed to the leachate system. The high proportion of catchments currently being directed to the leachate system without causing issues is proof of this”. It is unclear what “without causing issues” is referring to. This statement should be supported with definition of what an “issue” is and provide the relevant evidence that an “issue” hasn’t occurred.	Section 3.2.1 Bullet Points 1 through 5
4	Some of the catchment areas include a combination of water categories. However, effort should be made to avoid mixing higher quality water with lower quality (as described in Section 5.6 of the WasteMINZ Guidelines). Mixing various water types increases the volume of water needing management via the sedimentation ponds and/or GIWWTP. This is particularly evident in the Catchments 2, 2a and 5a which are from areas of final capping but are directed to the northern leachate pond and treated as leachate. Similarly for catchment 4a, 6a, 7a, 7b and 10, where potentially sediment laden waters (i.e. stormwater) are treated as leachate. It is noted that there are constraints to keeping water types separated (e.g. where “Clean” water flows downwards onto a “Stormwater” area), which may limit the possibility of separating all water types.	Section 3.2.1 Bullet Points 1 through 5
5	There is reference to runoff being allowed to soak into waste mass. Whilst this is acceptable for rainfall in the active tipping area, it should not apply to runoff from areas up stream of the active tipping face. Care needs to be taken to ensure that water does not pool on the landfill, where it could generate odours or become a hindrance to landfill operations. Given the significant head in the landfill, where possible, water considered to be leachate should be directed to the GIWWTP via the quickest route, rather than be allowed to seep into the waste mass.	Section 3.2.1 Bullet Points 1 through 5
6	It is noted in Section 4.1.3 of the SW Report, “in prolonged high rainfall events water from this pond (northern leachate pond) will overflow to perimeter swales and discharge to Kaikorai Stream”. It is not clear what a prolonged high rainfall event is, however, leachate should not be allowed to discharge to the environment without treatment. This needs further assessment in relation to	Section 3.2.1 Bullet Points 6 and 7



Water Management Bullet Point	2023 LDM Memo Questions/Clarification Sought	2024 LDM Memo Reference Section
	the potential frequency of leachate overflow and associated potential impacts to the surrounding environment.	
7	The discharge of water from the final vegetated cap direct to the environment is considered acceptable, provided the cap is sufficiently vegetated to prevent both erosion of the cap, and sediment laden water from discharging directly to the environment.	Section 3.2.1 Bullet Points 6 and 7
Leachate Management System		
1	Some parts of the landfill have leachate head of 10 m or more. It is acknowledged that due to the age of the landfill, and the guidance at the time, a base liner and leachate collection system were not incorporated into the landfill design. Therefore it is difficult to manage leachate levels in the waste mass, and to address the WasteMINZ Guidelines objective to “minimise head of leachate above the liner”. However, a 10 m leachate head is considered to be significant, and is not in line with WasteMINZ Guidelines. There is no active extraction of leachate at the site. The Design Report states that active extraction from the existing LFG wells is an option for leachate removal. It is recommended that leachate is actively pumped from the waste mass, on a trial basis as a minimum, to assess if extraction can reduce the leachate head in the cells, and in turn reduce the potential for leachate migration offsite to occur. A reduction in leachate head at the site would also be expected to improve the LFG collection rates (refer response to Question 6). Active extraction, even a trial, should be based on a thorough understanding of the landfill, and take into account any effects the extraction may have at the site, such as fate of removed leachate, potential for increased LFG generation, possible rebound of leachate after extraction etc.	Section 3.2.2 Bullet Points 1 and 2
2	Further to the above, the Design Report refers to extracted leachate being transferred to the perimeter leachate collection system and ultimately the GIWWTP. It is recommended that any leachate actively extracted from the landfill is transported to the GIWWTP via enclosed drains that do not allow for potential loss of leachate to the environment such as in the LIT or surface drains.	Section 3.2.2 Bullet Points 1 and 2
3	The lining of the northern leachate pond is not entirely clear. An unlined, or poorly lined pond has the potential to allow migration of leachate into the underlying geology. It is noted that the landfill itself is not lined, and that the northern leachate pond is within the LIT catchment area. Therefore, if leachate did leak through the northern pond base it may not necessarily have any noticeable, or significant impact on the environment. However, the suitability of the liner should be considered in relation to potential for leachate to impact the environment.	Section 3.2.2 Bullet Points 3 through 5
4	The proposed horizontal leachate collection drains in the waste mass, where waste will be placed atop the existing waste mass, are considered appropriate and should be used wherever possible to help improve leachate removal and therefore reduce leachate head within the waste mass.	Section 3.2.2 Bullet Points 3 through 5



Water Management Bullet Point	2023 LDM Memo Questions/Clarification Sought	2024 LDM Memo Reference Section
5	Remedial measures to address the leachate seepage from the eastern culvert should be implemented at the earliest opportunity to reduce potential for more leachate seepage from the waste mass.	Section 3.2.2 Bullet Points 3 through 5
6	<p>The LIT allows for mixing of leachate and groundwater within the trench. This increases the volume of leachate. Similar to the comments made about the stormwater management system, the mixing of leachate with other water types, including groundwater, should be avoided.</p> <p>However, the LIT appears to provide a preferred flow path for leachate where it can be extracted and sent to the GIWWTP. This is expected to reduce the volume of leachate entering the water table, which would be expected to reduce the impact of leachate on the surrounding environment. Therefore, whilst the mixing of leachate and groundwater should be avoided, the use of the LIT to reduce potential impact of leachate on the surrounding environment is considered to be acceptable. This is of particular importance given the absence of a liner and leachate collection system at the base of the landfill.</p> <p>Furthermore, the extension of the LIT as proposed in the application is considered appropriate to further reduce the potential for leachate migration offsite. The extension of the LIT should be subject to detailed design, in particular noting that the drawings provided in the application show;</p> <ol style="list-style-type: none"> a. A direct connection between leachate and groundwater. b. The materials to be placed on either side of the trench following excavation are not defined. c. The horizontal component of the trench extends into existing waste. d. The trench is founded in the natural underlying geology. e. The existing trench is understood to include a High-density Polyethylene (HDPE) layer, and its unclear if this will be incorporated into the LIT extension. 	Section 3.2.2 Bullet Point 6
7	Regardless of the above, further assessment of the potential for leachate to impact groundwater and surface water should be undertaken to assess the effectiveness of the LIT in preventing impacts to the environment, and to inform if additional measures to manage leachate are required.	Section 3.2.2 Bullet Point 7

3.1.6 Question 6 – Is the landfill gas management appropriate for the site, including the changes proposed by the applicant as part of this application?

The 2023 LDM Memo raised a number of queries with respect to landfill gas management of the site. These queries are summarised in Table 6. This table includes a reference to relevant section(s) of this technical memorandum where the applicants response has been assessed as part of the current scope of works.



Table 6 Summary of 2023 LDM Memo Landfill Gas Management Questions/Clarifications

LFG Management Bullet Point	2023 LDM Memo Questions/Clarification Sought	2024 LDM Memo Reference Section
1	<p>The leachate level in the waste mass is more than 10 m above the base of the landfill in some areas. Leachate build up within the waste mass would be inhibiting the generation of LFG, and would also be expected to be reducing the effectiveness of LFG wells where leachate is present at a level above the base of the LFG well. A reduction of leachate levels would be expected to increase LFG generation rates, and may improve LFG collection efficiency also.</p>	<p>Section 3.2.3 Bullet Point 1 and 2 Section 3.1.3</p>
2	<p>The modelled LFG generation rates and associated modelled LFG capture rates presented in the LFG Masterplan are much higher than recent LFG capture rates. For example, in 2022, a total of 2M m3 LFG was captured, which equates to about 228 m3/hr. This is compared to modelled 80% and 50% capture rates of 646 m3/hr and 404 m3/hr respectively. This indicates the system is performing poorly. It is noted that the modelled rates are based on a lower leachate level, than what is present at the site. This may result in LFG generation estimates being overestimated. Improvements to leachate level management (refer response to Question 5) may improve LFG collection rates. The LFG Masterplan offers some reasoning for the discrepancy between captured and modelled LFG rates, however leachate level is not mentioned, which is curious.</p>	<p>Section 3.2.3 Bullet Point 1 and 2 Section 3.1.3</p>
3	<p>It is also noted that the LFG utilisation and treatment systems (engine and flare) have significant downtime. This results in the landfill having extended periods of lower capacity for LFG utilisation/treatment. The maximum recorded LFG flow was 493 m3/hr in January 2021, which exceeds the capacity of the flare and the engine if one was operating without the other. Furthermore, the maximum future predicted LFG collection rate is over 800 m3/hr, which exceeds the capacity of the flare and engine operating together. It is therefore surmised that;</p> <p>Even with the relatively low LFG collection rates, the system could potentially have extensive periods where treatment capacity is less than the LFG capture rate due to regular downtime of the flare/engine.</p> <p>If the capture rates improve (as predicted in the LFG Masterplan), the above issue will be exacerbated further.</p> <p>If LFG collection rates improve to predicted rates (i.e. 80% capture), the treatment capacity, even if both the engine and flare are operating at full capacity, will still not be sufficient.</p>	<p>Section 3.2.3 Bullet Points 3 and 4</p>
4	<p>The above is expected to become more critical if the LFG generation rates increase over time, which the LFG Masterplan predicts will occur. It is noted that the installation of a replacement flare has been “discussed”. It is recommended that treatment capacity is improved to ensure that all captured LFG can be treated, even during periods of downtime of the flare/engine, and that treatment capacity is sufficient for the expected increased capture rates in the future.</p>	<p>Section 3.2.3 Bullet Points 3 and 4</p>



LFG Management Bullet Point	2023 LDM Memo Questions/Clarification Sought	2024 LDM Memo Reference Section
5	It is understood that existing wells in areas where waste is to be placed will be extended over time to the top of final waste height. This is supported, although noting that wells that are located in operating areas are at risk of damage from landfill operations (e.g. waste placement and compaction), as well as from settlement. The detailed design of such wells will need to account for this hazard.	Section 3.2.3 Bullet Points 5 through 7
6	The exact timing of installation of new LFG extraction wells is not clear. Typically this would be done at the time that waste reaches final height. The period in which areas of waste are without LFG extraction capability should be minimised. It is recommended that more detailed timing of LFG well installation compared to waste placement in each area is provided, to provide an understanding of waste volumes that may be left untreated. new LFG extraction wells is not clear	Section 3.2.3 Bullet Points 5 through 7
7	The LFG Masterplan considers the use of horizontal LFG wells for LFG collection. However, the LFG Masterplan recommends that horizontal LFG wells are not installed due to the “sporadic nature of filling and the varied waste depth”. Whilst it is agreed that horizontal wells may not be as effective in this type of landfill, they may still provide some collection capacity in areas where LFG may remain uncollected for a significant period of time whilst the waste mass reaches full height.	Section 3.2.3 Bullet Points 5 through 7

3.1.7 Question 7 - Is the landfill closure concept design appropriate as described in section 4 of the Design Report (Appendix 3)?

The 2023 LDM Memo found the landfill closure concept design is generally considered appropriate. However, some specific comments/questions were posed to the applicant. These related to the adoption of a piggyback liner, the final capping profile, and grade of the final landfill cap. Refer to Section 3.2.4 for a summary of the technical assessment completed in support of the applicants responses to the 2023 LDM Memo.

3.1.8 Question 8 - Has the risk of landfill fire been adequately assessed? Please explain.

The 2023 LDM Memo noted that the mitigation, monitoring, and management detailed in the Fire Management Plan was generally acceptable. However, the assessment highlighted a number of questions with respect to the assessment of fire risk at the site. Refer to Section 3.2.5 for a summary of the technical assessment completed in support of the applicants responses to the 2023 LDM Memo.

3.2 Applicant Responses and SLR Assessment

3.2.1 Stormwater Management System

Stormwater Bullet Points 1 through 5 from 2023 LDM Memo

Since the issue of the 2023 LDM Memo, new information regarding stormwater management has been included in the DCC Comments Response Spreadsheet, and an updated SW Report.



In relation to Stormwater Bullet Points 1 to 3 from the 2023 LDM Memo, it was generally unclear at the time exactly what runoff from the Intermediate Cover was considered to be (i.e. leachate or sediment laden runoff suitable for discharge to the environment via the sedimentation pond). The DCC Comments Response Spreadsheet included a statement that;

“surface water runoff from intermediate cover is currently treated as leachate and directed to the leachate collection system”.

The DCC Comments Response Spreadsheet aligns with the SW Report but is contrary to section 3.5.2.3 of LDMP and parts of the Design Report. It is recommended that the practice of directing runoff from intermediate cover areas to the leachate collection system continue, and future revisions of the LDMP and Design Report are updated to reflect this.

In relation to Bullet Point 4 from the 2023 LDM Memo, Section 4.1 of the SW report has been updated since the 2023 LDM Memo, which clarifies that the report is referring to the fact that the leachate collection system pump capacity is not reached, even during rainfall events. Therefore, directing various water types to the leachate system is evidence that the system can handle the increased water volume. The applicants response has clarified the reviewers query, and this item is considered closed.

In relation to Bullet Point 5 from the 2023 LDM Memo, it is recommended that efforts are made to avoid allowing runoff to enter the tip face where practicable to do so. Future revisions of the LDMP should be updated to highlight that runoff from non tipping face areas should be diverted away from the tipping face, even if the runoff is considered leachate.

Stormwater Bullet Points 6 and 7 from 2023 LDM Memo

Since the issue of the 2023 LDM Memo, new information regarding stormwater management is included the DCC Comments Response Spreadsheet, and an updated SW Report.

Based on updated information provided in the SW Report, the offsite discharge of leachate from the northern leachate pond is expected to only occur less than once every five years, and the water overflowing from northern leachate pond will be at or approaching “Clean Stormwater Criteria” (noting that “Clean Stormwater” is currently directed to Kaikorai Stream), and discharge would be diluted due to the higher than average stream flow due to increased rainfall.

Discharge of leachate to the environment should be avoided, and dilution should not be a justification for contributing chemicals to the environment. However, if water in the northern leachate pond is demonstrated to be “Clean Stormwater” i.e. the water meets clean stormwater criteria, including for leachate indicators, and offsite discharge occurs less than every five years i.e. only once or twice before the landfill is fully capped, then offsite discharge may be acceptable. Regular monitoring of the northern leachate pond should be undertaken to assess if water in the pond meets “Clean Water Criteria” before any offsite discharge is allowed to occur. Additionally, the water level in the northern leachate pond should be managed to prevent the likelihood of overflow, particularly when heavy and/or prolonged rainfall periods are forecast.

3.2.2 Leachate Management System

Leachate Bullet Points 1 and 2 from 2023 LDM Memo

No additional information relevant to Bullet Points 1 and 2 for leachate management appears to have been provided since the 2023 LDM Memo. Therefore, the comments provided in Bullet Points 1 and 2 for leachate management from the 2023 LDM Memo are considered to still apply.



Leachate Bullet Points 3 through 5 from 2023 LDM Memo

Since the issue of the 2023 LDM Memo, new information regarding leachate management is included in the DCC Comments Response Spreadsheet (for Bullet Points 3 and 5), the AEE (Bullet Point 5) and an updated SW Report (for Bullet Point 3).

In relation to Bullet Point 3, the DCC Comments Response Spreadsheet states that the northern leachate pond is lined, and that the SW report provides greater detail about the pond. However, the SW Report does not appear to clearly state that the pond is lined or provide details of the lining system. Further details on the pond lining system should be provided.

No additional information relevant to Bullet Point 4 for leachate management appears to have been provided since the 2023 LDM Memo. Therefore, the comments provided in Bullet Point 4 for leachate management from the 2023 LDM Memo are considered to still apply.

In relation to Bullet Point 5, and the remedial works to repair the leaking eastern culvert which has allowed leachate discharge to the environment, the DCC Comments Response Spreadsheet states that “work is now underway and is expected to be completed by the end of March 2025”. This information is included in the AEE also. This is considered acceptable subject to successful completion of the works.

Leachate Bullet Point 6 from 2023 LDM Memo

No additional information relevant to Bullet Point 6 for leachate management appears to have been provided since the 2023 LDM Memo. Therefore, the comments provided in Bullet 6 are still considered to be applicable.

Leachate Bullet Point 7 from 2023 LDM Memo

Additional information in relation to this item has been provided by the applicant, in particular the updated GW Report, updated SW Report and HHERA. Whilst detailed review of those documents is outside the scope of this 2024 LDM Memo, it is understood that these assessments indicate that;

There may be leachate indicators in the deeper groundwater aquifer and further monitoring/assessment of the deeper aquifer is required.

Whilst the HHERA concluded that a low risk to humans and the environment existed in relation to potential contamination of the Kaikorai Stream and underlying aquifer from landfill leachate, there were limitations to the dataset used as the basis for the HHERA.

Given these findings, Bullet Point 7 is still considered to be applicable.

3.2.3 Landfill Gas Management System

LFG Bullet Point 1 and 2 from 2023 LDM Memo

No additional information relevant to Bullet Points 1 and 2 for landfill gas management appear to have been provided since the 2023 LDM Memo. Therefore, the comments provided in Bullet Points 1 and 2 for landfill gas management from the 2023 LDM Memo are considered to still apply.

LFG Bullet Point 3 and 4 from 2023 LDM Memo

Since the issue of the 2023 LDM Memo, new information regarding landfill gas management is included in the DCC Comments Response Spreadsheet and the updated AEE. Section 4.7 of the updated AEE states that a new enclosed flare with 1000 m³/hr capacity is proposed to replace the existing candlestick flare. This is considered acceptable, on the



assumption that the enclosed flare is a new fully functional unit that is not expected to have significant downtime as is understood to have occurred with the candlestick flare; and on the assumption that the LFG engine continues to operate, and with two units at the landfill there is some contingency during periods of downtime due to maintenance or unexpected malfunction of one of the units.

LFG Bullet Point 5 through 7 from 2023 LDM Memo

No additional information relevant to Bullet Points 5 to 7 for landfill gas management appear to have been provided since the 2023 LDM Memo. It is noted that in the DCC Comments Response Spreadsheet there is a comment stating that timing of LFG well installation is in the LFG Masterplan. However, the LFG Masterplan has not been updated since the 2023 LDM Memo was issued. Therefore, the comments provided in Bullet Points 5 through 7 for LFG management from the 2023 LDM Memo are considered to still apply.

Landfill Gas Risk Assessment (LFGRA) Report

Since the issue of the 2023 LDM Memo, a LFGRA has been undertaken and is documented in the LFGRA. The LFGRA conclude that;

“This assessment has identified that the risk of lateral migration impacting current adjacent site users is considered to be negligible to low risk. The main factors influencing this assessment are the low permeability of the natural materials underlying and surrounding the landfill, and the shallow groundwater level. These features will limit the ability for the LFG to migrate beyond the site boundary.”

The reviewer agrees that shallow groundwater and low permeability natural soil will limit the lateral migration of LFG through the subsurface. However, further information, in the form of an updated LFGRA would be needed to support the conclusion of a low to negligible risk, including, but not limited to, consideration of the following;

- It is acknowledged that the LFGRA is not intended to be a monitoring report, however it still needs to be informed by a robust data set. Additional data and assessment of data quality is warranted, including;
 - I. Additional LFG monitoring parameters should be recorded to help inform the assessment of risk, including LFG bore flowrate, relative pressure, depth of water in the bore (this is particularly important given presence of shallow groundwater, and should be measured after LFG bore parameters have been monitored), atmospheric pressure trend and fugitive emissions. It is noted that the report states that “*flow data was not typically captured*”, however it is unclear where and when flow data was recorded as the data set indicates no flow data was ever recorded.
 - II. Details of LFG gas bore monitoring methodology and equipment.
 - III. An assessment of the validity of the LFG monitoring data should be included, including consideration of equipment calibration, equipment operation in the field (e.g. zeroing transducers), peak and stabilised readings, details and suitability of bore construction and integrity etc.
- Provision of figures showing location of relevant items to this LFGRA. In particular;
 - I. LFG bores and offsite receptors.
 - II. A conceptual site model figure articulating the LFG migration pathways and receptors.



- The report states that the risk assessment is based on CIRIA 665, however the risk matrix appears to differ from CIRIA 665. The LFGRA methodology should explain the reasoning for variation from the adopted guidance.
- The risk evaluation (Table 5.4 in the LFGRA) provides details of receptor groups, pathways, and assessment of risk. However, the actual hazard and potential consequence if the hazard occurred are not detailed.
- Notwithstanding the above, the highest consequence applied to any hazard is medium. CIRIA 665 refers to “chronic” impacts to humans equating to a medium consequence. However, impacts from the main constituents of LFG i.e. methane and carbon dioxide, is typically acute (i.e. explosion or asphyxiation). CIRIA 665 defines acute impacts as a severe consequence.
- The LFGRA appears to be limited to humans in buildings offsite. The report does comment that onsite receptors are not considered as “*these risks are managed through the operation of the landfill*”. It is recommended that onsite receptors are still considered in any assessment of risk, particularly given the proximity to the source of LFG. Furthermore, it is unclear why other receptors were not considered, such as flora and fauna, infrastructure, the atmosphere etc.

It is recommended that a consent condition be included to require an update of the LFGRA with a more robust data set, conceptual site model and assessment of risk. Regardless, the LFGRA does not indicate the need for any change to the onsite management of LFG beyond the existing controls and associated improvements detailed in the resource consent application, and other information provided in this 2024 LDM Memo.

3.2.4 Closure Concept Design

In relation to Question 7 and the closure concept design, the 2023 LDM Memo made comments about three particular items, namely; piggyback liner, landfill cap grade, and the landfill cap profile. These are discussed in the following subsections.

Piggyback Liner

The 2023 LDM Memo made the following comments regarding a piggyback liner.

“Section 4.4.3 of the Design Report is titled “Proposed Approach to Landfill Liner Absence”. This section identifies that a piggyback synthetic liner (piggyback liner) is an option for the landfill development. This section seems to indicate that a piggyback liner will not be adopted, although it is not explicitly stated. Three key risks in relation to a piggyback liner are identified. Whilst a piggyback liner may not necessarily be warranted for this site, the following comments are made;

- *A piggyback liner could include a number of layers and materials and shouldn't necessarily be limited to synthetic materials only.*
- *Two key risks highlighted by the Design Report in the application of a piggyback liner include differential settlement and performance during seismic events. These two factors apply to a number of engineering controls at the landfill (base liner, cap, leachate and LFG management systems), and the design of the piggyback liner needs to take account of such factors. The fact that these risks exist doesn't necessarily mean that the option shouldn't be considered further.*
- *A third risk highlighted by the Design Report in the application of a piggyback liner relates to complications in the installation and operation of the LFG system. It is agreed that it may complicate things, but similar to the above, the design would need to account for this, and the fact that things may become complicated shouldn't necessarily be the reason not to proceed.*



- *The Design Report states that the existing leachate collection trench (this is assumed to mean the LIT) meets the required environmental outcomes, and the addition of a piggyback liner was assessed as not providing any additional benefits. The assessment referred to above should be provided. Additionally, confirmation that the current LIT is meeting environment outcomes should also be provided, noting recommendations relating to further assessment in Section 3.2.2.3 and in other SLR Tech Memos.”*

Since the issue of the 2023 LDM Memo, the only new information provided regarding the piggyback liner was a statement in the DCC Comments Response Spreadsheet.

The design report stated that *“the addition of a piggyback was assessed as not providing any additional benefits and has reliability risk”*. DCC have clarified in the DCC Comments Response Spreadsheet that an assessment has not been undertaken but based on the “three key risks” originally identified for the piggyback liner, (which the reviewer firstly considers to be hazards not risks, and secondly these hazards are expected to be applicable to most piggyback liners), was enough for this option to be discounted. Excluding a piggyback liner due to three common hazards associated with piggyback, liners is not considered suitable justification. Regardless, based on the outcomes of the HHERA (which is based on limited data but at this time indicate a low risk of impact to the surrounding environment from landfill leachate), and with adoption of other measures at the site including those detailed in this 2024 LDM Memo (in particular to reduce leachate head and increase cap grades), the absence of a piggyback liner is not considered to be problematic. The reviewer therefore agrees that a piggyback liner is not warranted at this site.

Landfill Cap Profile

The 2023 LDM Memo made the following comments regarding the landfill cap profile.

“The existing landfill cap profile is not described in Section 4, however it is described in Section 3.3 of the Design Report, which from top to bottom consists of;

- *350 mm topsoil.*
- *600 mm compacted low permeability ($<1 \times 10^{-7}$) clay.*
- *300 mm compacted intermediate cover soils.*

Section 4.3 of AEE states that final capping profile across the remainder of the site will meet these same requirements as the existing cap. Assessment of the cap profile layers against the requirements of WasteMINZ Guidelines (Table 5-8) is summarised below;

- *The cap profile includes a topsoil layer of 350 mm, which is greater than the 150 mm thickness recommended in the WasteMINZ Guidelines. The increased thickness is considered acceptable.*
- *The cap profile includes a 300 mm intermediate cover layer above the waste. This is less than the 500 mm combination of soil cover and gas dispersion layers recommended in the WasteMINZ Guidelines.*
- *It is also noted that WasteMINZ Guidelines includes a 500 mm “subsoil layer”. There is no subsoil layer included in the cap profile.*
- *The WasteMINZ Guidelines state that “where the final cover is designed to minimise infiltration of water into waste, a combination of flexible membrane liner....or geosynthetic clay liner with compacted soil...is typically used”. The proposed cap profile does not include a membrane or geosynthetic clay liner (GCL).*

It appears that the cap profile does not strictly meet the minimum recommended final cover requirements detailed in the WasteMINZ Guidelines. However, the reduced



thickness of the intermediate cover layer, and the absence of a subsoil layer and a membrane/GCL, may still be appropriate, subject to further assessment of potential for leachate to impact the surrounding environment. If leachate is found to be impacting the surrounding environment such that additional mitigation/remedial measures are required, then the cap profile may need enhancement to further reduce the potential leachate generation rates, and reduce potential impacts of leachate on the surrounding environment.”

Since the issue of the 2023 LDM Memo, the applicant provided the Question 12A Response which forms the basis of the following comments on cap profile.

The Question 12A Response states that applicant propose to include an additional 200 mm of soil cover below the intermediate cap. Based on the undated memo, and information from the Design Report, it is understood that the cap profile will now be as follows (from top to bottom);

- 350 mm topsoil.
- 600 mm low permeability clay.
- 300 mm compacted intermediate cover soils
- 200 mm soil cover.

The Waste MINZ guidance provides “Examples of final cover designs” in Figure 5-8, which includes cross sections titled “Minimum” and “Enhanced Minimum” cover profiles; and Table 5-8 of WasteMINZ provides “Minimum Recommended Final Cover Requirements”, which provides cap profiles for various landfill types. It is noted that Table 5-8 and Figure 5-8 of Waste MINZ do not appear to clearly align e.g. The “Minimum” example includes an intermediate cover layer, whilst the “Enhanced Minimum” does not (it would be expected that “Enhanced Minimum” would have more and thicker cover layers, not less); Table 5-8 includes a “500 mm subsoil layer” for Class 1 to 3 landfills types, but Figure 5-8 does not have a layer titled “subsoil layer”.



Regardless, the cap profile as described above includes a topsoil layer exceeding the requirements of Table 5-8, and a compacted cohesive layer (low permeability layer) meeting the requirements of Table 5-8, and a combined 500 mm layer (of soil cover and intermediate cap) which meets the “subsoil layer” thickness in Table 5-8. The soil layers in the cap profile are therefore considered to be acceptable.

A flexible membrane liner or geosynthetic clay liner is not included in the cap profile. Based on the results of the based on the outcomes of the HHERA (which is based on limited data but at this time indicates a low risk of impact to the surrounding environment from landfill leachate), and with adoption of other measures at the site, additional protection of the environment via a geomembrane or GCL is not considered necessary, and the absence of these items is considered acceptable at this time, pending implementation of other measures discussed in this 2024 LDM Memo, particularly in relation to cap grade and long term management of leachate at the site.

Landfill Cap Grade

The 2023 LDM Memo made the following comments regarding the landfill cap grade;

“The proposed landfill cap includes grades as low as 2%. This is well below the minimum grade recommended by the WasteMINZ Guidelines of 5%. It is understood this grade is proposed due to existing landscape and physical site constraints

The intent of the minimum grade of 5% specified in the WasteMINZ Guidelines is to promote rainfall runoff, and to allow for some changes in the final grade due to differential settlement. The flatter grade increases the potential for flat spots to occur due to differential settlement, which creates the potential for increased seepage through the final landfill cap.

The grade is therefore not considered appropriate at this time, but may be reconsidered based on further information, such as details of the physical and landscape constraints, further assessment related to potential impacts of leachate on the surrounding environment (which the landfill cap is primarily intended to reduce/prevent), and any other measures taken to manage leachate (e.g. active extraction from the waste mass).

It is noted that Section 1.3.1 of the Design Report states that the consent conditions do not impose any specific limit on height of the landfill, and therefore it may be possible to increase the cap grade without reducing the volume of airspace available for waste placement.”

Since the issue of the 2023 LDM Memo, the applicant has provided the Question 11 Response which forms the basis of the following comments on the cap profile.

The memo states that the landscape constraints that were referred to related to minimum grades required to enable a “viewing plan across the top of the Green Island landfill from the Clariton Ave area to Saddle Hill to the south”. No further information is provided. Based on the undated memo, it appears that there was no requirement that prevented the grade being greater than 2%. It is therefore unclear why this was a “landscape constraint” that prevented minimum grade of 5% as detailed in WasteMINZ from being achieved. To that end, a minimum cap grade of 5% would be expected to be adopted to promote runoff and reduce the potential for increased leachate infiltration.

The memo also states that the area of 2% grade is only 2.5 ha of the total 8 ha of landfill. Whilst it is acknowledged that the flatter area is only a portion of the entire landfill, 2.5 ha is still a large area, and equates to more than a quarter of the landfill.

The memo also states that the applicant proposes to undertake regular maintenance to prevent flatter spots and ponding water occurring on the cap where the grade is 2%. However, this maintenance is expected regardless of the cap profile.



In the absence of a base liner and a final cap without a flexible membrane liner and noting the elevated leachate levels already present at the Site, a minimum grade of 5% is considered appropriate, and is recommended to be adopted.

3.2.5 Risk of Landfill Fire

In relation to Question 8 and the assessment of fire risk at the site, the 2023 LDM Memo made the following comments;

“To provide an answer to this question, the Fire Management Plan (FMP) was reviewed. It is noted that in section 1.2 of the FMP, it is referred to as a “fire management assessment report”, with one report objective being to “assess the potential and associated risks of a fire occurring on site.” Whilst there is discussion about potential sources of fires, there does not appear to be an assessment of risk in relation to the identified hazards. Rather, the report details the expected fire hazards, and then provides details of mitigation, monitoring and management requirements for the potential fire hazards. It is recommended that a fire risk assessment is prepared, or if it has been completed already, it is provided for review, and is detailed in the FMP to assist in assessment of the suitability of the mitigation, monitoring and management requirements.

Regardless of the above, the mitigation, monitoring and management requirements detailed in the FMP generally appear acceptable, noting the following;

- *Battery fires are becoming an ever increasing issue for waste collection and disposal. Vigilance at the tipping face and weighbridge are needed to detect these in incoming loads in particular. A plan for managing these is critical, including provision for such a fire to be extinguished typically by dumping in a dedicated fire safe area away from the waste mass and other infrastructure.*
- *Further to the above, as the occurrence of such fires increases, so too does the need to enhance mitigation, monitoring and management requirements. Therefore, regular reviews, and potentially updates, to the FMP are warranted.*
- *Table 4 states that “monitoring of oxygen...and carbon monoxide...in the collected gas” will be undertaken. The details of the monitoring (i.e. frequency, location, method etc..) should be documented in a LFG monitoring program, and results reviewed after each event and reported periodically to help assess the potential for a landfill fire to occur or have occurred.*
- *Table 5 states that a “thermal imagery camera will be purchased” and a “review will be undertaken by 1st January 2024 with the aim to setup a fixed mount thermal imaging camera which is capable of scanning the active landfill area and vegetated surface of the landfill”. I agree with this measure, and support its implementation. Full details should be provided, including the results of the proposed review by Council.*
- *Section 5.6 of the report details fire risk mitigation and readiness. There is reference to water sources, in section 5.6.3, including fire extinguishers. Other types of fire fighting methods apart from water may be needed, dependant on the type of fire. For example a chemical fire maybe inadvertently provoked by the addition of water.*
- *A key environmental impact from a subsurface landfill fire is odour. Odour should be a key part of monitoring for a landfill fire, along with other items that are proposed for monitoring including presence of smoke, increased carbon monoxide in the LFG system etc.”*



No additional information in relation to the FMP appears to have been provided since the 2023 LDM Memo.

The DCC Comments Response Spreadsheet references that a fire risk assessment has been completed for the site. However, a copy has not been provided to SLR for review as part of the 2024 LDM Memo.

It is noted that although a LFGRA has now been supplied by the applicant, there is limited information in the LFGRA with respect landfill fires and the associated assessment of risk.

In the absence of new information, the comments in the 2023 LDM Memo related to the assessment of landfill fire risk are still considered to apply.

4.0 Closure

SLR trusts that this technical memorandum is adequate for its purpose. We are happy to discuss any aspects of our assessment and work collaboratively with you to undertake additional revisions if required.

Regards,

SLR Consulting Limited

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