Technical Report A

Landfill Engineering

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Landfill Engineering Report

Redvale Landfill Expansion

Prepared for: WM New Zealand

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1 Introduction

1.1 Background

Tonkin & Taylor Ltd (T+T) has been engaged by WM New Zealand (WMNZ) to provide technical assessments to understand the effects from a proposal to extend the use of Redvale Landfill, north of Auckland (the Project). This report forms part of a suite of technical reports prepared for WMNZ for inclusion in a substantive application for resource consent under the Fast-Track Approvals Act 2024.

This report describes the engineering design of Redvale Landfill and is intended to support the Assessment of Environmental Effects (AEE).

1.2 Scope of work

The key objectives of this report are:

1 Review the consented lining system design and leachate collection system designs.

2 Outline the proposed changes to the consented design, including the Class 1 landfill expansion within the existing footprint and the new Class 2 footprint extension.

3 Summarise the additional airspace available under the proposed design.

4 Assess whether the Class 1 landfill extension within the existing footprint will likely change the effects from the currently authorised activity.

5 Describe the construction and operation of the Class 2 footprint extension and what effects are likely.

6 Describe the continued use of Stockpile 4.

1.3 Site description

The Redvale Landfill is located in Dairy Flat, to the north of Auckland, approximately 9 km northwest of Albany and 1 km west of State Highway 1. Redvale Landfill, including the existing landfilling area and buffer zones, occupies approximately 88 ha in area. The landfill is divided into five main sub-areas for the purpose of describing the work within this application, known as the Northern, Eastern, Western, South-Western and South-Eastern Property.

The Landfill is accessed from the south-east along Landfill Access Road off Dairy Flat Highway, with Horseshoe Bush Road running along part of the northern boundary of the Landfill area. A tributary of the Rangitopuni Stream runs eastwards along the northern and eastern site boundaries towards the Dairy Flat Highway. A full description of the site is provided in the AEE prepared for the project.

The following site features are of particular importance to this assessment:

- The existing landfill footprint.
- The proposed Class 2 footprint extension.
- Stockpile 4.

1.4 Project description

Redvale Landfill is one of only two landfill sites in the Auckland region that can receive >350,000 tonnes of waste annually to service the approximately 1.5 million tonnes of waste that the Auckland Region produces each year. Redvale Landfill is currently scheduled to cease accepting waste in December 2028 and due to a delay in obtaining the resource consents required for the establishment and operation of the replacement Auckland Regional Landfill (ARL), WMNZ considers a transition plan is required. To address this potential gap in critical landfill infrastructure for residual waste disposal in the Auckland region, WMNZ is proposing to extend the operation of Redvale to the end of 2036 and develop 4.56 Mm^3 of additional airspace at the existing facility. This includes 3.13 Mm^3 in additional Class 1 Landfill expansion on top of the existing Class 1 refuse placement area and 1.435 Mm^3 of Class 2 Landfill extension. The proposed works include the following:

- **Class 1 landfill expansion:** placement of waste within the existing landfill footprint, involving the removal of final cover, addition of a perimeter bund and steepening of the final cap slope to accommodate additional waste.
- **Class 2 footprint extension:** extension of the existing landfill to the southwest to accommodate disposal of waste meeting Class 2 landfill waste acceptance criteria (WAC).
- **Relocation of ancillary activities:** the relocation of ancillary activities to allow for the placement of waste.
- **Sediment Retention Ponds:** the removal and filling in of Sediment Retention Pond 6 and the Office Pond while enlarging Pond 1 to capture and treat the stormwater from these catchments.
- **Operation of Stockpile 4:** continued operation of Stockpile 4 as a borrow source for soil materials, along with temporary stockpiling of surplus cut materials from the landfill extension.

A full description of the proposal is included in the AEE prepared for the project.

1.5 Relevant supporting technical reports

As noted above a suite of technical reports have been prepared to support the resource consent application. Other reports that are relevant to the conclusions drawn in this report include the Geotechnical Assessment Report[1], Hydrogeological Assessment Report[2], Stormwater, ITA and Sediment Assessment report[3], the Landscape and Visual Assessment[4], the Air Quality and Odour Technical Assessment report[5] and the Waste Acceptance Criteria report[6]. Those reports have been referenced where applicable throughout this report.

1.6 Existing consents

Redvale Landfill holds a suite of existing resource consents for the management and operation of the existing landfilling activities. The relevant resource consents and conditions in relation to this assessment are:

- Landfill lining and basegrade system – Resource consent REG-61341 (NRSI 42369) conditions 83 to 86.

[1] Tonkin & Taylor Ltd (March 2026). Geotechnical Assessment Report.
[2] Tonkin & Taylor Ltd (March 2026). Hydrogeological Assessment Report.
[3] Tonkin & Taylor Ltd (March 2026). Stormwater, ITA and Sediment Assessment Report.
[4] Boffa Miskell (January 2026). Landscape and Visual Assessment.
[5] Tonkin & Taylor Ltd (March 2026). Air Quality and Odour Technical Assessment.
[6] Tonkin & Taylor (March 2026). Waste Acceptance Criteria Report.

- Leachate management – Resource consent REG-61341 (NRSI 42369) conditions 80-81, 84-98, and 108.
- Final capping – Conditions 43 of the overarching consent.
- Stockpile 4 – Resource Consents LUC60383492, DIS60400103 and WAT60400235.

1.7 Redvale Landfill design drawings

Drawings summarising the current and proposed landfill design are referred to throughout this report. The set of drawings is located in Appendix B and includes the following:

Drawing No. 1092369.3000-C01	Drawing List & locality plan
Drawing No. 1092369.3000-C10	Overall site layout
Drawing No. 1092369.3000-C11	Basegrade and phase layout
Drawing No. 1092369.3000-C12	Leachate collection layout
Drawing No. 1092369.3000-C13	Existing consented final contours
Drawing No. 1092369.3000-C14	Proposed final contours & drainage layout
Drawing No. 1092369.3000-C20	Cross sections
Drawing No. 1092369.3000-C30	Class 1 lining system details
Drawing No. 1092369.3000-C31	Class 1 perimeter bund details
Drawing No. 1092369.3000-C32	Class 1 northern perimeter details
Drawing No. 1092369.3000-C33	Class 1 and Class 2 cap details
Drawing No. 1092369.3000-C35	Class 2 lining system details
Drawing No. 1092369.3000-C40	Gas collection system layout
Drawing No. 1092369.3000-C50	Stockpile 4 overall site plan
Drawing No. 1092369.3000-C51	Stockpile 4 stage plans
Drawing No. 1092369.3000-C52	Stockpile 4 details

The Drawings are referred to throughout this report excluding the project number “1092369.3000” i.e. “Drawing No. 1092369.3000-C10” will be referred to “Drawing C10”.

2 Site development

2.1 Site history

The site history is described in the AEE prepared for the project.

2.2 Original 1992 consented landfill design

Much of the original design of the landfill was completed by Waste Management Inc. (WMI) landfill design office in Oak Brook, Illinois, USA in coordination with WMI Stafford Consultants and T+T in New Zealand.

The landfill was originally designed with a footprint of 59 ha and was projected to have a total refuse volume of approximately 20 million m³ (including final cap) or 12 million tonnes of refuse.

The footprint was divided into Eastern Property and Western Property portions. A sloping section of basegrade floor known as the Western Highwall marked the division between the Eastern and Western Properties. The floor of the Western Property portion of the landfill is approximately 15 to 20 m higher in elevation than that of the Eastern Property.

A number of changes were made to the consented design over the years. These are summarised in Section 3.2.

2.3 Landfill development to date

2.3.1 Basegrade development

The landfill development has been carried out by progressive construction of individual landfill phases. The phase construction sequence and layout have been adjusted as the overall site development has progressed. The current phase layout is shown in Drawing C11.

To date the landfill has been formed to basegrade over the entire consented area – except for a small area in the south-western corner of the Western Property, which is currently under construction in early 2026.

2.3.2 Current Class 1 and Class 2 landfill operations

Class 1 and Class 2 waste are being filled separately within the existing landfill airspace. The Class 2 landfilling operation is currently being undertaken in the western portion of the Western Property, while Class 1 waste is being landfilled in the Eastern Property and the eastern and southern portion of the Western Property. We understand from discussions with WMNZ that the western portion of the Western Property will continue to be used for Class 2 waste.

2.3.3 Cap development

The landfill has reached final grade on the eastern slope, part of the northern slope and a small area in the middle of the southern slope. These areas have been finished with a final cap system covering about 24 ha. The remaining approximately 31 ha of the landfill surface area is covered with intermediate cover, apart from active areas which have daily cover. Approximately 2 ha of the footprint does not yet have any waste in place.

2.3.4 Stormwater development

The location of stormwater ponds is shown on Drawing C13. Stormwater Ponds 1 and 4 were developed during the initial construction of Phase 1 to assist with managing stormwater. Ponds 2 and 3 were developed shortly after during subsequent phases.

Parts of the Western Property are too low to discharge by gravity to the stormwater ponds. An internal storage pond near the south-western corner is used to collect runoff from the Western Property. Water collected is then pumped to discharge into Pond 4.

2.3.5 Leachate collection system development

The construction of the leachate collection system within the consented landfill is nearly complete. The leachate collection system comprises a series of leachate collector drains positioned along the toe of the highwalls and at intervals across the base of the landfill, draining towards a number of leachate sumps as shown on Drawing C12. The leachate pipes are provided with cleanout risers so that they can be flushed when required.

The leachate is pumped from the sumps via riser pipes positioned along the southern perimeter of the Eastern Property and disposed via evaporation through the BeneVap system or trucked to a nearby appropriately authorised wastewater treatment facility.

2.3.6 Landfill gas collection system development

The installation of the landfill gas collection system has been progressed as shown on Drawing C40. The landfill gas collection system generally comprises a series of vertical extraction wells installed and extended upwards as waste is placed. Radiating collector pipes are connected to the wells at approximately 10 m vertical intervals. The wells are connected via a series of collector and header pipes which transport the landfill gas to the energy park.

2.3.7 Road development

An access road has been developed around the perimeter of the existing landfill throughout various stages of landfill development. The exception is along the southern side of Phase 22B and Phase 21 adjacent to the Southern Highwall.

A series of temporary access roads have been formed across the landfill waste mound to provide access to the landfill tip faces. These roads are removed and reconstructed as filling progresses.

2.3.8 Ancillary facilities

The existing ancillary facilities are presented in Drawing C10. The workshop, energy park and the main office are located south of the Eastern Property footprint. The BeneVap, wheel wash tanks, and the Approved Transitional Facility (ATF) Pad are located within the landfill footprint on top of existing waste.

2.3.9 Stockpile 4

During the early development phases of Redvale Landfill, it was identified that excess material that was suitable for lining and capping needed to be excavated from the landfill footprint. As this was unable to be utilised at the time, temporary stockpiling of this material was required. Stockpile 4 was developed with the intention of using this material for liner, cover and capping at a later date, once other sources for suitable materials were exhausted. Stockpile 4 was filled in during the late 1990s and planted with exotic pines for stabilisation. It was reopened in 2022 as a borrow source and continues to be utilised as required.

3 Current consented design

3.1 The site

3.1.1 Site suitability

The landfill site is underlain by low permeability materials which make the site ideal for a landfill. The Geotechnical Assessment Report provides extensive discussion and documentation about the underlying geology below the landfill. The great depth of the naturally low permeability Northland Allochthon mudstone, siltstone and limestone materials beneath the site results in the presence of a natural soil/rock liner at least 100 m thick.

Field and laboratory testing of the Northland Allochthon materials indicates the permeability of the fine-grained mudstone and siltstone to typically be (often significantly) less than 1×10^{-9} m/s. Similarly historic assessment of the limestone suggests that an inferred bulk permeability of 1×10^{-9} m/s is appropriate for those materials. No site-specific permeability testing has been carried out on the Waitemata Group materials which will underly some small parts of the site, but, based on experience with similar materials elsewhere in the Auckland region, a somewhat higher typical permeability value of about 1×10^{-6} m/s is considered appropriate.

In addition to the underlying low permeability soils, previous reports have demonstrated that the groundwater under parts of the landfill has an inward hydraulic gradient into the landfill. Further information and discussion on the groundwater characteristics of the site is provided in the Hydrogeological Assessment Report.

3.1.2 Landform

The site is located within rolling countryside. The final contours of the current design have been designed to maximise airspace while blending into the area with overall grades and elevations similar to the surrounding landscape.

3.2 Existing consented design

The 1992 consented design was progressively improved over the years, with the changes formalised in the 2015 consented design. Some improvements made to the 1992 consented design include the following:

- The slope of the Western Highwall was flattened from 1V:2H to 1V:3H to improve temporary slope stability.
- The Western Property sump was moved from the north-eastern corner to the south-eastern corner. Leachate flows are now directed toward the collection sumps along the south edge of the landfill which are closer to the leachate storage and disposal facilities.
- The overall landfill footprint was reduced slightly to 57 ha, by shifting the western corner inwards onto a natural ridgeline and making some minor outward adjustments along the southern boundary of the landfill in the vicinity of the Managed Fill.
- Basegrade slopes in the Western Property have been increased from a minimum of 1 in 100 to a minimum of 1 in 40 to improve leachate collection.
- Leachate drain spacing has been reduced in the Western Property. Maximum flow lengths on basegrade (parallel to slope direction) are now 90 m compared with lengths as long as 300 m in the 1992 consented design.
- A 300 mm thick leachate drainage blanket layer has been installed above the lining system for Phases 19, 20C, 21 and 22.
- The lining system thickness was revised from 200 to 300 mm in the 1992 consent to 900 mm to facilitate construction and improve protection. The increased lining system thickness is now a consent requirement.
- An auxiliary leachate sump (LCS-1A) was installed near LCS-1 in case there is a future problem with LCS-1. This was done because LCS-1 is the lowest point of the basegrade.
- The leachate sump in the Western Property (LCS-5) is now a “back up” sump. Leachate is transferred to LCS-4 (adjacent to LCS-3) for pump out. The pipes can be flushed through this point from the LCS-4 end. Separate cleanouts are installed at LCS-5 to allow the collection pipes within the Western Property to be flushed. The large chamber at LCS-5 is also directly connected to a pump out riser. If desired, leachate from LCS-5 could be intercepted instead of allowing it to flow down to LCS-4.

- Leachate drains and other pipes within the Western Property have been upgraded to Polyethylene pipes (PE) whereas Class E uPVC pipes were utilised in the Eastern Property.
- A leachate dosing plant and BeneVap facility is located on the landfill. This provides for disposal via a BeneVap leachate evaporator, for storage of extracted leachate, and treatment if required. Residual leachate is trucked off the site for disposal into the trade waste system.

3.3 Base containment system

3.3.1 Basegrade geometry

The landfill is constructed in a basin-shaped void excavated to depths of 20 to 40 m below the original natural ground level. Parts of this void were formed by the limestone quarrying operations at the site from the 1960s to 2004. Sub-excavation below basegrade level has been undertaken in some areas to make best use of the limestone resource on the site. In these cases, the excavations have been backfilled with compacted mudstone fill before placement of the lining system.

The existing basegrades of the landfill have been designed with slopes that direct basal leachate flows to the south end of the landfill floor where the leachate sumps are located. The Eastern Property has a basegrade floor falling southwards from about RL 46 m to about RL 40 m.

In the original 1992 consented design, the Western Property basegrade sloped north and eastwards from a high of 65 m to a low of 61 m in the north-east corner. Prior to the reconsenting in 2015, the original design was modified with the approval of the Peer Review Panel, so that the basegrade falls toward the south-eastern corner of the property.

The Western Property area has a higher design floor basegrade than the Eastern Property. The difference in basegrade elevations between the two properties has required formation of the Western Highwall about 15 to 20 m high along the Properties' common boundary. While there is a 2 m high dividing bund along the top edge of this highwall, it tapers out at the lower southern end so that basal leachate that is not collected in the leachate pipes (if any) can flow from the Western Property into the Eastern Property unhindered.

3.3.2 Lining system

The naturally low permeability in-situ materials underlying the site are supplemented by the construction of a low permeability lining system utilising the onsite mudstone and siltstone materials.

The 1992 consented design for the lining system required a minimum 200 to 300 mm thick layer of re-compacted mudstone, placed directly onto the natural ground subgrade, overlain by a 150 mm thick protection layer of limestone rubble. Both the mudstone and the limestone materials are readily available within the landfill site. The 2015 consent design now requires a minimum 900 mm thick layer of re-compacted mudstone overlain by a 150 mm thick protection layer of limestone rubble. The thicker lining system has been applied for all phases since Phase 6A.

The rationale for the use of mudstone in the lining system, instead of other materials found onsite, is documented in the Geotechnical Assessment Report. The main reasons for selection are:

- The large amount of mudstone available throughout the project.
- Ease of workability of the material to meet the saturated permeability requirement for consent (i.e. less than 1 x 10^{-9} m/s).

Historical testing shows that the placed mudstone meets or exceeds the consent requirements for saturated permeability. In most cases the constructed lining system's permeability exceeds the consented requirement by one to two orders of magnitude. The lining system's permeability therefore meets the highest known regulatory standard of less than 1 x 10^{-9} m/s.

3.3.3 Leachate collection system

The landfill has been designed to minimise leachate generation using the following methods:

- Diverting run-on surface water.
- Separating leachate from clean runoff.
- Minimising rainfall infiltration through the use of cover systems, surface slopes, and drainage. For example, a final cap covering an area of 24 ha has been constructed over slopes which have reached final grade.
- Concrete lining of drains on the intermediate covered areas helps to protect the cover from erosion and minimise maintenance requirements.

The leachate collection system has been designed to collect the leachate and direct it to the sumps for pumping out.

The sides and floor of the landfill have basegrades designed so that leachate will flow towards the leachate collector drains. The leachate collector drains are installed across the landfill floor at regular spacing to convey leachate to the leachate sumps. The flattest grades on the landfill floor are 2% and the flattest grades in the leachate collection pipes are 1% in the Eastern Property. Side wall gradients are much steeper and are between 1V:3H and 1V:3.5H.

There is a limerock protection layer formed on top of the lining system; however, it does not act as a leachate collection blanket to any significant extent. Since there is no basal leachate collection layer between the leachate collector drains, leachate travels to the collection drains via the waste mass itself.

The leachate collection drains have been installed at 120 m intervals across the floor of the Eastern Property and are designed at a maximum of 70 m intervals across the floor of the Western Property. Leachate drains are also located at the foot of the side walls and at mid slope benches to intercept leachate flows on the longer slopes.

All leachate drains lead to one of five leachate collection sumps. There are three leachate collection sumps in the Eastern Property (LCS-1, LCS-2, and LCS-3) and one in the Western Property (LCS5). The fourth sump (LCS4) is located on the southern sidewall of the Eastern Property adjacent to LCS-3. It is directly connected to LCS-5 so that all leachate from the Western Property flows down to LCS4 for pump out. LCS-5 has therefore never been used for leachate extraction.

All the main leachate collection drains are fully flushable and are connected to dedicated leachate cleanout risers spaced around the perimeter of the landfill.

Leachate transfer between the collection drains and the leachate collection sumps is via perforated sections of pipe. The leachate must flow out of the holes in the collection pipes, through gravel occupying the sumps, and into the larger diameter collection risers containing the submersible pumps. The pumps lift the leachate to ports alongside the southern perimeter road, and then on to storage tanks at the leachate dosing plant.

Leachate is disposed of in a BeneVap leachate evaporator, where the water in the leachate is evaporated using heat from the combustion of landfill gas. The capacity of the BeneVap is approximately 50 m³/day. Approximately 5 m³/day of residual solids are returned to the landfill.

Pumping frequency from the landfill to the leachate holding tanks at the dosing plant depends on leachate generation rates and levels within the landfill. Excess leachate generated is transported by trucks to an offsite wastewater treatment facility. The trucks can also remove leachate directly from the LCS1 sump via a dedicated port.

3.3.4 Leachate recirculation

Raw untreated leachate has been re-injected into Redvale Landfill at times since 2002, but is not currently being undertaken, and is not proposed for the future.

3.4 Final landform, capping and drainage

3.4.1 Final contours geometry

The current design has the landfill rising from the perimeter to near the crest at relatively uniform grade, with the crest of the landfill rounded over. Overall cap grades are designed to be no steeper than 1V:4H. The minimum design gradient at the crest of the landfill is 5% (or 1V:20H).

3.4.2 Final cap system

The final cap system design includes a minimum 1,000 mm vertical thickness of low permeability clay with target permeability of approximately 1 x 10^{-8} m/s. The 1992 consent requirement was for 900 mm thickness of low permeability clay.

The primary growth medium consists of a topsoil layer at least 150 mm thick, with an additional thickness of growth medium below this in landscaping areas as described below.

Additional growth medium, or compacted soil is used beneath the topsoil layer to form contour drains on the cap surface.

3.4.3 Landscaping

Landscaping of the final cap is set out in the Landscape and Visual Assessment report.

In areas where shrubs will be established, a thickened growth medium layer is to be used below the topsoil layer and above the low permeability clay to support root growth. This is illustrated in Detail I on Drawing C33.

3.4.4 Cap drains and downspouts

The proposed final cap design includes contour drains built into the slopes approximately every 50 m to divert sediment laden runoff from completed areas of the cap. The contour drains are spaced to break up overland flow, thereby reducing the risk of erosion and rilling on the landfill cap. Downspouts are used to convey flows from the contour drains to the outer edge of the cap.

To allow for on-going differential settlement on the final landfill surface, the contour drains are designed with a 2% minimum slope, and generous freeboard.

Refer to Drawing C13 for the existing cap drain layout.

3.5 Stockpile 4

Stockpile 4 is located in several former gullies lying to the east of the existing Managed Fill. The stockpile has maximum side slopes of 1V:3H, with the southern side at 1V:4H. Prior to borrow operations, it had a maximum elevation of approximately RL 136 m and a capacity of about 700,000 m³.

A band of pine trees on the western side of the stockpile crest, as shown in Drawing C50, is to be retained to provide visual screening to the landfill operation. This limits the amount of material that can be removed from the stockpile. Currently it is estimated that approximately 550,000 m³ of material is available for removal, with approximately 40,000 m³ already removed as of June 2025.

Stockpile 4 has its own erosion and sediment control system, separate from the landfill as detailed within the Stormwater, ITA and Sediment Assessment Report.

3.6 Daily and intermediate cover

All waste is covered at the end of each working day. This is done by placing about 150 mm of soil over the waste. This soil is stripped from the working face at the start of each day to allow waste placement.

When filling reaches a level where no further waste will be placed for several months, the daily cover is thickened to about 300 mm to form intermediate cover. When the landfill reaches final levels, final cap is placed over the intermediate cover. The intermediate cover, and to a lesser extent the daily cover, minimise rainfall infiltration into the landfill, and reduce odour and carbon emissions by helping to contain the landfill gas.

4 Proposed works

4.1 Introduction

This section outlines the proposal to increase the airspace of Redvale Landfill, including the Class 1 landfill expansion and the Class 2 footprint extension.

4.2 Class 1 landfill expansion

4.2.1 Class 1 landfill expansion overview

As described in Section 1.1, a Class 1 landfill expansion is proposed within the existing landfill footprint. The Class 1 landfill expansion comprises a steepened wedge of airspace around most of the landfill perimeter. To increase the volume of the expansion, a perimeter bund is proposed along the eastern and southern sides of the landfill.

Placement of Class 1 waste within the overlay will remain within the consented “Line A” footprint, consistent with the existing landfill.

The final cap will tie-in with a perimeter bund (described below) and has a maximum slope of 1V:3H. The maximum pre-settlement cap elevation has been set at RL 106.7 m with the top surface of the overlay having a minimum slope of 1V:20H (5%).

No changes to the base containment and leachate collection systems are proposed.

The post settlement cap contours for the Class 1 landfill expansion are presented in Drawing C14. These can be compared with the existing consented surface profile shown in Drawing C13.

4.2.2 Class 1 waste definition

Class 1 waste refers to non-hazardous municipal solid waste as described in the Waste Acceptance Criteria Report. This waste can be subdivided into putrescible wastes and non-putrescible wastes. The Air Quality and Odour Technical Assessment report describes these waste types and sets out how a 500 m separation distance will be maintained between placement of putrescible waste and the dwellings that surround the landfill.

4.2.3 Final landform, capping and drainage

The proposed final landform retains the existing landfill slopes and crest above approximately RL 106.7 m, noting that this area will need to be filled prior to expiry of the existing consents. Below this, is a wide bench sloping outwards, meeting a 1V:3H slope rising from the edge of the landfill – which in some locations has been raised above existing levels via a perimeter bund. The maximum final post settlement cap grades have been steepened from 1V:4H to 1V:3H, with a minimum grade of 5%, to maximise available airspace volume.

The maximum pre-settlement elevation of the new section of cap (the wide bench) has been limited to RL 106.7 m. Based on an assumed settlement of 5% (of landfill depth) the maximum post-settlement elevation varies, but is typically around RL 104 m. A reduced settlement percentage (5%, compared with the typically adopted 7.5%) was assumed based on the age of the waste already placed beneath the highest parts of the landfill, and the likely compression and decomposition that would have already occurred by the time the overlay is filled.

Capping details for the Class 1 landfill expansion remain unchanged from the current design. It will comprise 150 mm of topsoil overlying 1,000 mm of clay with a maximum permeability of 1×10^{-8} m/s.

Stormwater from the Class 1 landfill expansion will be conveyed to a perimeter drain via a revised layout of cap contour drains and downspouts. Contour drains will continue to be designed with a minimum post-settlement grade of 2% and freeboard of 300 mm to allow for differential settlement of the final landfill surface. Details of the stormwater management are presented in the Stormwater, ITA and Sediment Assessment report.

The final proposed landfill contour plan and cap details are presented in Drawings C14 and C33. The proposed cap drainage layout is shown in Drawing C14.

4.2.4 Perimeter bund

A perimeter bund is proposed along the eastern and southern sides of the existing landfill. It is generally 2 m high, but up to 6 m high where there is sufficient space outside of the current landfill footprint. The perimeter bund allows the edge of the waste mound to be elevated, increasing the available airspace.

The perimeter bund is intended to be utilised as an access road and includes a 5.5 m wide pavement to support a single lane of traffic. The proposed cap ties-in to the inner edge of the bund which is positioned directly above consented “Line A” footprint.

Geotechnical stability analyses confirming that the proposed perimeter bund meets the stability requirements are detailed in the Geotechnical Assessment Report. The report details the requirements for undercutting the Pleistocene sediments present beneath the perimeter bund and replacing with a shear key to achieve stability requirements.

A typical section of the perimeter bund is presented in Drawing C31.

4.2.5 Leachate collection system

The existing leachate collection system will remain largely unchanged, other than where it interacts with the new perimeter bund.

Where the perimeter bund is constructed along the southern side of the landfill, it will cover the existing leachate collection sump (LCS) and leachate cleanout riser (LCR) access ports. The LCS and LCR pipes will need to be extended through the perimeter bund, to new access ports on the outer side of the perimeter road.

Leachate interceptor strip drains are proposed to be installed at intervals over the surface of the existing waste prior to adding on additional waste. These drains will be installed at approximately 45° to the slope in a 10 m wide zone on the inside of the perimeter bund. They will collect leachate from the new waste should there be any unexpected hindrance to downward flow. Collected leachate will be directed toward the perimeter of the landfill where a perimeter collection drain will be installed on the inside of the perimeter bund. Leachate sumps will be provided at low points for extraction of collected leachate.

The proposed leachate collection system is presented in Drawing C12. Details of the perimeter drains are shown on Drawing C31.

4.2.6 Overlay tie-in to existing

Prior to placement of additional waste in the overlay area, the cover and final material will need to be removed and stockpiled appropriately for re-use as cover and final cap. This is to ensure that new waste is properly tied-in to old waste and a potential slip surface is not created.

To minimise odour and release of greenhouse gases, cap and cover will need to remain in place as long as possible, with removal immediately prior to placing overlying waste. Additional detail on this is provided in the Air Quality report.

4.2.7 Landfill gas extraction wells

Existing gas wells will need to be extended through the proposed Class 1 landfill expansion by installing additional lengths of vertical riser, and additional horizontal collectors where required.

4.3 Class 2 footprint extension

4.3.1 Class 2 footprint extension overview

An extension is proposed on the south side of the existing landfill for filling with Class 2 waste. The Class 2 footprint extension is located in the area currently occupied by the Managed Fill and Pond 6 as shown on Drawing C10.

The design of the Class 2 footprint extension comprises the following components:

Decommissioning and removal of any remaining soils in the Managed Fill Site.

1 Decommissioning and removal of Pond 6, retaining the pond dam.
2 Reconfiguration of the pond dam to act as a toe bund for the waste fill. Extension of this bund to tie in with the proposed perimeter bund south of the landfill.
3 Excavation of soils beneath the Managed Fill Site and Pond 6 to form the landfill basegrade.
4 Basegrade slopes in a south-easterly direction towards the existing Pond 6 dam.
5 Formation of a landfill lining system and leachate drainage and extraction system.
6 Final cap and final landform consistent with the existing landfill design.
7 Access road around the perimeter, along with perimeter drainage.

4.3.2 Class 2 waste definition

Class 2 waste refers to construction and demolition waste that may include a mix of clean fill, controlled fill, and managed fill materials. This waste type is typically generated from building, renovation, and demolition activities, and while it does not include putrescible waste, it may contain some biodegradable and leachable components. The potential for landfill gas generation is generally low in Class 2 waste. Further details around the composition of Class 2 waste are outlined in the Waste Acceptance Criteria report.

4.3.3 Base containment system

4.3.3.1 Basegrade geometry

The basegrade is generally bowl-shaped with a flat floor and steep side slopes. The floor of the extension forms a vee-shaped valley grading in a south-easterly direction toward a low point of approximately RL 65 m near the existing Pond 6 dam. The floor is graded at 3% towards the central valley, with the centreline of the valley itself having a minimum grade of 2%.

The sidewalls are graded at 1V:3H from the perimeter road down to the floor. Sidewall height varies from about 30 m on the north-western side to about 2 m at the eastern corner.

Refer to Drawing C11 which shows the basegrade geometry.

4.3.3.2 Lining system

The base containment system proposed for the Class 2 footprint extension comprises a minimum 900 mm thick compacted cohesive soil lining system with a maximum permeability of 1 x 10^{-8}m/s, compacted in layers no thicker than 150 mm.

Refer to Drawing C30 for details of the proposed lining system.

4.3.4 Leachate collection system

The leachate collection system will collect leachate and direct it to the leachate collection sump for extraction. A leachate drainage blanket is proposed above the lining system in the Class 2 Footprint Extension to allow leachate to flow towards the leachate pipes. The drainage blanket will consist of either 300 mm of drainage aggregate (or tyre derived aggregate), or a suitable geosynthetic drainage layer.

Leachate will be collected in a series of perforated HDPE leachate collector and header pipes. These will include:

- A centrally located leachate header pipe positioned along the central valley in the landfill floor.
- Collection pipes at the toe of all sidewalls.
- A series of lateral leachate cut-off pipes located at nominal 70 m intervals across the floor.

Non-perforated leachate cleanout risers will be provided on the sidewalls to allow flushing of the leachate header pipes.

The combination system of leachate collection pipes in the leachate drainage blanket will be designed to keep leachate head on the lining system below 300 mm. This is usually achieved by adjusting the spacing of the lateral leachate cut-off pipes and/or the grading (permeability) of the leachate drainage blanket.

A leachate collection sump will be provided at the low point to allow leachate to be extracted via pumping. The leachate collection sump will consist of an inclined HDPE pipe installed down the sidewall to a sump formed at the low point. The pipe will be suitably sized to allow a submersible pump on a trolley to be located within the sump. The leachate collection sump design will be similar to those already in use in the existing landfill.

The 300 mm leachate head requirement will not apply to the leachate sump, since the pump will need a greater depth than this to operate effectively.

The leachate level will be monitored above the lining system surface outside, but near, the leachate sump. This will be used to control pump operation and limit build-up of leachate head. While

leachate may accumulate within and outside the sump area immediately after heavy rainfall, it will be pumped back down to less than 300 mm depth as quickly as possible.

Refer to Drawing C12 for the leachate system layout and Drawing C35 for typical details.

4.3.5 Final landform, capping and drainage

The Class 2 footprint extension takes the form of a ridge extending southwards from the middle of the southern face of the landfill. It has been designed with a maximum grade of 1V:3H, and a minimum grade of 5%, consistent with the Class 1 landfill expansion. The crest of the ridge is limited to RL 106.7 m pre-settlement, which is approximately RL 105 m post-settlement.

The final cap thickness will be consistent with the existing design and will comprise 150 mm of topsoil overlying 1,000 mm of clay with a maximum permeability of 1×10^{-8} m/s.

Stormwater from the Class 2 footprint extension will be conveyed to a perimeter drain via cap contour drains and downspouts. which will eventually discharge predominantly towards the nearest pond, Pond 1. Contour drains will be designed with a minimum post-settlement grade of 2% and freeboard of 300 mm to allow for differential settlement of the final landfill surface. Details of the stormwater management are presented in the Stormwater, ITA and Sediment Assessment report.

The final proposed landfill contour plan and cap details are presented in Drawings C14 and C33. The proposed cap drainage layout is shown in Drawing C14.

4.3.6 Groundwater

4.3.6.1 Basegrade cut below water table

Recent geotechnical investigations and groundwater monitoring undertaken in the proposed Class 2 footprint extension area indicate that the groundwater level is at approximately RL 75 m. The lowest portion of the proposed basegrade is at approximately RL 65 m, and therefore, there will be groundwater drawdown effects due to seepages into the excavation that will need to be continually managed until sufficient waste has been placed to counteract uplift of the lining system.

The Hydrogeological Assessment Report concluded that maximum early time daily flows into the excavation are estimated to be 102 m^3/day reducing to a steady state flow of approximately 19 m^3/day (assuming a winter high groundwater level in the area of RL 82 m).

Temporary inflows will be managed with surface water drains and sumps where possible and pumped out and discharged to Pond 1.

Where seepage zones will be located below the lining system, these areas will need to be collected in a temporary groundwater drainage system. Flows will be collected via perforated subsoil drains and directed out into the surface water system to the east of the extension (in the vicinity of the leachate sump) via a non-perforated pipe. The groundwater drainage system will be designed to be grouted up once sufficient waste is in place to resist lining system uplift pressures.

4.3.6.2 Subsoil drains

Temporary subsoil drains may be required to drain seepages beneath the proposed clay lining system to limit buoyancy effects lifting the lining system from the subgrade. This could be managed via a temporary infilled gravel pit installed adjacent to the observed seepage, discharging flows downstream via a solid groundwater drainage pipe. The exact layout of these subsoil systems will need to be considered during detailed design.

The groundwater system will be grouted up once sufficient weight of refuse is in place to prevent uplift. This will allow groundwater levels to return to pre-development levels and help to maintain an inward hydraulic gradient.

4.3.7 Landfill gas

We understand from discussions with WMNZ that a landfill gas collection system is not proposed within the Class 2 footprint extension due the low organic content of Class 2 waste and therefore limited landfill gas generation potential of Class 2 waste. In the event landfill gas extraction is necessary in the future, horizontal collector pipes will be installed near the surface of the waste.

4.4 Airspace

The net airspace of the existing landfill, the proposed Class 1 landfill expansion and the Class 2 footprint extension are summarised in the below table. The total net airspace that would be gained from the Class 1 landfill expansion and Class 2 footprint extension are approximately 3.13 Mm^3 and 1.5 Mm^3 respectively.

Table 4.1: Airspace summary

	Current landfill	Proposed landfill
Current net airspace	19.7 Mm^3	19.7 Mm^3
Class 1 landfill expansion airspace		3.1 Mm^3
Class 2 footprint extension airspace		1.5 Mm^3
Total net airspace	**19.7 Mm^3**	**24.3 Mm^3**
Total area	57.0 ha	65.3 ha
Cap volume	0.66 Mm^3	0.75 Mm^3
Total gross airspace	**20.4 Mm^3**	**25.1 Mm^3**

4.5 Construction sequence

4.5.1 Class 1 landfill expansion

The actual construction sequence used will depend on a number of factors including the timing of commencement. Section 4.2.2 sets out a requirement to maintain 500 m separation between putrescible waste placement activities and neighbouring dwellings. Both putrescible and non-putrescible wastes will be imported concurrently over the life of the expansion and disposed of in different areas. Therefore, separate phasing sequences will be required for the putrescible and non-putrescible areas.

Phasing for the putrescible area will need to be coordinated with relocation or removal of the various facilities that occupy the southern side of the existing footprint. Phasing for the non-putrescible area, will most likely proceed anticlockwise around the landfill as portions of the perimeter bund are constructed.

For both areas, filling will need to commence adjacent to the landfill perimeter and work up towards the top of the landfill. The construction sequence will include:

1 Decommission or relocate the perimeter road and any facilities or services in the vicinity of the perimeter bund.

2 Construct the perimeter bund, leachate perimeter drainage, and new perimeter access road.

3 Strip intermediate cover and/or final cap from the area adjacent to the perimeter bund.

4 Install perimeter leachate collection strip drains where required.

5 Fill waste over stripped areas – working uphill and only stripping cover/cap immediately prior to placing waste.

4.5.2 Class 2 footprint extension

The Class 2 footprint extension will need to be filled commencing from the low point working westwards and north to tie-in with the existing landfill. The construction sequence will include:

1 Decommissioning and removal of any remaining soils in the Managed Fill Site.

2 Decommissioning and removal of Pond 6, retaining the pond dam.

3 Reconfiguration of the pond dam to act as a toe bund for the waste fill.

4 Staged excavation of soils beneath the Managed Fill Site and Pond 6 to form the landfill basegrade.

5 Formation of the lining system in stages.

6 Installation of the leachate extraction system.

7 Staged installation of the leachate drainage system.

4.6 Re-location of existing facilities

As part of the landfill overlay and extension, a number of existing facilities will need to be relocated or decommissioned. Many of these facilities lie along the southern side of the Eastern Property and may be able to remain in place until that area is required for perimeter bund construction and waste filling. Drawing C10 shows the location of the existing facilities and proposed new locations.

4.6.1 Roading/access

Currently the landfill is being operated as a one-way circuit, with vehicles entering the landfill from the southern side and exiting via the perimeter road around the north and east sides. Periodically during construction of the proposed perimeter bund, two-way access will need to be developed along the current southern access route.

As filling of the landfill nears completion, the current access route will need to be relocated around the perimeter of the Class 2 footprint extension to provide access to the upper parts of the landfill. The proposed access road over the final cap is shown on Drawing C14.

4.6.2 Dosing plant and BeneVap

The dosing plant and BeneVap are currently located on the waste near the southern side of the existing footprint. This will remain in place until the immediate area is required for waste filling. The BeneVap will then be decommissioned and removed, and the dosing plant will be moved off the footprint to a new bunded location adjacent to the energy park. Once the BeneVap has been removed, all leachate will be trucked off site for treatment and disposal.

Leachate will need to be continually removed from the Class 2 footprint extension to maintain the leachate head within the landfill to less than 300 mm depth. It is anticipated that if leachate is not trucked directly off site, the leachate will be stored in tanks outside of the landfill until it can be trucked off the site. Prior to decommissioning of the BeneVap, an additional four 26 m^3 tanks will be provided adjacent to the energy park for storage of leachate arising from the Class 2 footprint extension, unless at this time alternative appropriate management is identified.

4.6.3 Approved Transitional Facility

The ATF pad is currently located on the waste near the southern side of the existing footprint, to the west of the BeneVap. Containment and management of imported waste, cleaning and decontamination processes are undertaken on the ATF pad. The ATF pad is proposed to be relocated to a site immediately west of the current WMNZ site office. This relocation will likely not occur until the immediate area is required for waste filling. Runoff from the ATF Pad will be directed to Pond 1 which is detailed in the Stormwater, ITA and Sediment Assessment report.

4.6.4 Light engineering workshop

The light engineering workshop is located just east of the ATF pad. The workshop is proposed to be re-located to a site south of the main workshop. As with the BeneVap and the ATF pad, this will likely only occur when that area is required for waste filling.

4.6.5 Secondary wheel wash

The secondary wheel wash is located on the landfill just west of the existing BeneVap. It will be removed as it will be no longer needed once the primary wheel wash is upgraded. Refer to the Stormwater, ITA and Sediment Assessment report for details.

4.6.6 Wheel wash water supply tanks

The wheel wash water supply tanks are located near the centre of the Eastern property on the existing landfill final cap. Water is pumped up to these tanks from Ponds 1, 2 and 3, and supplies this to the secondary wheel wash. These tanks will be relocated to another site on the landfill as the Class 1 landfill expansion filling progresses.

4.6.7 Site water supply tanks

The site water supply tanks are currently positioned near the western side of the existing Managed Fill site just south of the North Haul Road. These tanks provide potable water supply to the landfill facilities including the site offices and workshops. These tanks are proposed to be relocated just south of the new Perimeter Access track for the Class 2 footprint extension.

4.7 Stockpile 4

It is proposed to continue to use Stockpile 4 throughout the landfill extension, and for closure activities. This will include:

- Use as a source of borrow material for landfill construction and for capping.
- Stockpiling of surplus soils removed during development of the Class 2 footprint extension.

Once the Class 2 footprint extension has been developed, Stockpile 4 will be the main area on site for sourcing and storing suitable soil materials. The area will remain active after the cessation of waste placement. This is to allow it to be used as a source of final capping materials – since the final cap cannot be constructed until after the last waste has been placed in the landfill.

The development of the Class 2 landfill extension will generate a significant volume of cut as this area is developed in stages. Some of this will be used to construct the perimeter bund around the southern and eastern sides of the existing footprint, and some will be used for daily cover or final capping. Surplus cut material will be stockpiled within the Stockpile 4 area during each stage of development. Stockpiled materials will be confined entirely within the existing Stockpile 4 envelope, and grades will be limited to 1V:3H, and the maximum elevation is restricted to approximately RL 136 m.

Operation of the borrow and stockpile area will be staged to restrict the catchment area flowing into the Pond 5. Erosion and sediment control measures are described in the Stormwater, ITA and Sediment Assessment report.

Upon completion of borrowing/stockpiling activities, the borrow area, will be shaped to a suitable low maintenance, long-term profile, retopsoiled and revegetated prior to removal of erosion and sediment control measures.

4.8 Daily and intermediate cover

Daily cover thickness is proposed to be increased to 300 mm and intermediate cover to 450 mm. The maximum working face will be limited to 900 m² in the case of putrescible waste, and 2,500 m² for each of non-putrescible Class 1 and Class2 wastes.

While these measures are provided to restrict the escape of landfill gas and odour, they will also reduce rainfall infiltration and the generation of leachate. Landfill gas and odour aspects are addressed in the Air Quality and Odour Technical Assessment report.

5 Performance assessment

5.1 Introduction

This section compares the current and proposed design and practices at the Redvale Landfill to international modern standards and the WasteMINZ Technical Guidelines for Disposal to Land[7] (WasteMINZ Technical Guidelines) and discusses the performance of these.

5.2 Base containment system

5.2.1 WasteMINZ Technical Guideline recommendations

The overriding aim of the WasteMINZ Technical Guidelines is to provide guidelines for acceptable levels of protection against contamination of the surrounding environment until the waste material no longer poses a risk.

The Guidelines recommend that for a Class 1 landfill such as Redvale Landfill, a composite lining system such as a synthetic flexible membrane and a 600 mm layer of compacted clay liner (CCL) be used. The CCL should achieve a coefficient of permeability not exceeding 1 x 10^{-9} m/s and be compacted in 150 mm lifts.

The WasteMINZ Technical Guidelines recommend a minimum basegrade slope of 2%.

The Guidelines recommend that for a Class 2 footprint extension, a composite lining system such as a synthetic flexible membrane and a 600 mm layer of CCL be used. The CCL should achieve a coefficient of permeability not exceeding 1 x 10^{-8} m/s and be compacted in 150 mm lifts. Alternatively, in the absence of the synthetic flexible membrane, the CCL can be thickened to 900 mm.

Sections 5.2.2 and 5.2.3 provide further discussion about the existing and proposed lining system performance.

[7] Waste Management Institute New Zealand (WasteMINZ) September 2023. Technical Guidelines for Disposal to Land Revision 3.1.

5.2.2 Existing landfill - Evaluation of lining system performance

A robust Quality Assurance and Quality Control process has been used for all lining constructed to date. Historical testing shows that the recompacted mudstone materials available on the site can easily achieve a saturated permeability of better than 1 x 10^{-9} m/s.

The Hydrogeological Assessment Report evaluates the migration of leachate in groundwater, should it occur, and its potential effects on the Rangitopuni Stream. The existing lining system used at Redvale Landfill does not include a synthetic flexible membrane. However, the groundwater regime and nature of the natural ground materials underlying the site at Redvale provide at least as good a level of protection to the surrounding environment as the lining system recommended in the WasteMINZ Technical Guidelines would achieve in a typical installation.

The basegrade in the existing landfill at Redvale Landfill already complies with the 2% recommendation in the WasteMINZ Technical Guidelines.

The quantity of leachate generated and the depth of leachate within the landfill are related to the total area of the landfill and cover practices during operations. Since the total footprint is not changing, and the practices will remain similar to or more restrictive than existing practices, this is not expected to affect the performance of the containment system.

Based on the geology of the site and the findings from the Hydrogeological Assessment Report, the lining system used at Redvale forms an appropriate containment system.

5.2.3 Proposed Class 2 footprint extension – evaluation of expected lining system performance

The proposed Class 2 footprint extension basegrade will include a 900 mm thick CCL with a maximum permeability of 1 x 10^{-8} m/s in accordance with the WasteMINZ Technical Guidelines. Based on past site experience with recompacted mudstone, it is known that a saturated permeability of better than 1 x 10^{-8} m/s can easily be achieved.

The lining system will have a minimum basegrade slope of 3%, which is steeper than the 2% set out in the WasteMINZ Technical Guidelines.

The proposed elevation of the leachate sump at the lowest point of RL 65 m is lower than the natural groundwater level and similar to the western part of the existing landfill. Therefore, there is likely to be an inwards hydraulic gradient in this area. The inwards gradient is likely to prevent any significant outwards migration of leachate from the Class 2 footprint extension.

Potential effects from the migration of leachate, should it occur, are discussed in the Hydrogeological Assessment Report.

For the reasons above, it is considered that the proposed lining system provides an appropriate level of containment for the Class 2 footprint extension.

5.3 Final landform and final cap

5.3.1 WasteMINZ Technical Guideline recommendations

The WasteMINZ Technical Guideline objectives for the final cap system are as follows:

- Control water ingress.
- Reduce leachate generation.
- Provide final contour and stormwater management.
- Control gas migration.

- Provide physical separation between waste and plant and animal life.
- Allow plant growth.
- Provide a stable, maintainable long-term landform.

The minimum recommended final cap system includes a 150 mm thick topsoil layer for plant growth over a 600 mm compacted soil layer with a maximum permeability of 1 x 10^{-7} m/s. This is the same for both Class 1 and 2 landfills, with Class 1 landfills also including a minimum of 500 mm of daily and intermediate cover below the compacted soil layer.

The Guidelines recommend minimum cap grades of 1V:20H and maximum of 1V:3H.

Stormwater channels or drains constructed on the final cap system should be designed and constructed to accommodate settlement, minimise erosion and cope with localised design storms.

Section 5.3.2 provides an evaluation of the proposed design.

5.3.2 Evaluation of design

Refer to Drawing C14 for the final landform contours and Drawing C30 for typical cap cross sections.

The existing and proposed final cap system at Redvale Landfill for both Class 1 and Class 2 areas includes a 150 mm topsoil layer and a minimum 1,000 mm thick layer (measured vertically) of compacted clay with a target average permeability of 1 x 10^{8} m/s. Therefore, the final cap design exceeds the recommendations of the WasteMINZ Technical Guidelines in both in thickness and permeability.

The permeability of the cap system has a significant effect on leachate generation after closure of the landfill. In evidence prepared for the original Redvale Landfill consents, Wayne Russell[8] predicted that capping the landfill with 150 mm of topsoil over 900 mm of clay at 1 x 10^{-9} m/s would result in leachate generation rates of approximately 12 m³/day after closure. While the permeability assumed by Russell is lower than the target average permeability, the analysis outlined in Section 5.4.4.2 below indicates that the overall performance of the landfill cap to date is similar to that predicted by Russell.

The grades at Redvale Landfill are within the range recommended in the WasteMINZ Technical Guidelines. The overall maximum proposed gradients on the side slopes of the landfill are 1V:3H and the minimum proposed gradients on the crest and the wide bench are 1V:20H which is within the WasteMINZ Technical Guideline recommendations.

Cap contour drains will have a minimum post-settled grade of 2% which allows for grades to be maintained in the case of differential settlement, as required by the WasteMINZ Technical Guidelines. They can also be adjusted and repaired as required to cater for unexpected settlement effects. Other aspects of the drainage design are assessed in the Stormwater, ITA and Sediment Control Assessment report.

5.4 Leachate collection system

5.4.1 WasteMINZ Technical Guideline recommendations

The WasteMINZ Technical Guideline objectives for the leachate collection system are to allow for removal of leachate, and to minimise head of leachate above the lining system.

[8] Russell, W J. November 1991: Statement of Evidence of Wayne John Russell, Evidence presented to the Planning Tribunal on behalf of Waste Management Ltd.

The WasteMINZ Technical Guidelines state that the leachate collection system should comprise the following:

- A drainage layer constructed of granular material.
- Perforated leachate collection pipes conveying leachate to a collection sump.
- A filter layer above the drainage layer to prevent physical clogging of the drainage layer.
- Leachate monitoring points.
- Leachate collection sumps from which leachate can be removed.

Minimum leachate collection system requirements for both Class 1 and Class 2 landfills are:

- Drainage media and/or perforated pipes.
- Maximum leachate head of 300 mm.

The WasteMINZ Technical Guidelines state that reliable leachate generation estimates are important for consideration in landfill design and landfill operation. The original consented design for Redvale Landfill included a detailed estimate of leachate generation throughout the life of the landfill. Details about this estimate are provided in Section 5.4.4 below.

5.4.2 Existing landfill – collection system

As discussed in Sections 2.3.5 and 3.3.33.3.3, the leachate collection system in the existing landfill is almost fully complete – having been constructed as the landfill has been developed. The system installed is consistent with the requirements of the WasteMINZ Technical Guidelines, with the exception of a drainage layer above the lining system. While this affects leachate levels within the landfill, the Hydrogeology Assessment Report concludes that overall performance of the containment system is sufficient to protect the surrounding environment.

Reprofiling of the top surface of the landfill will not have any material effect on the collection of leachate at the base of the landfill. Existing capping will be removed as waste is placed to allow downward migration of leachate to the existing leachate collection system.

Where the edge of the landfill is raised by the perimeter bund, the perimeter collection system will provide additional mitigation against the risk of leachate breakout on the eastern side of the landfill. The perimeter collection drain will provide preferential drainage paths and prevent elevated leachate heads from developing, should any leachate accumulate inside the perimeter bund.

5.4.3 Proposed Class 2 footprint extension – Collection system

As discussed in Section 4.3.4, the leachate collection system in the Class 2 footprint extension will comprise a network of leachate collection pipes within a leachate collection blanket and filter layer, conveying leachate to a collection sump located on the south-eastern end of the landfill. In particular, the system will be designed to maintain leachate head on the lining system (outside of the leachate sump) below 300 mm.

The leachate collection system proposed in the Class 2 footprint extension is consistent with the recommendations in the WasteMINZ Technical Guidelines.

The effects of leachate seepage, should it occur, are assessed in the Hydrogeology Assessment Report.

5.4.4 Leachate generation assessment

5.4.4.1 Assessment for the original consent

For the 1992 consents an assessment of projected leachate quantity was completed by Wayne Russell. The software package Hydrological Evaluation of Landfill Performance (HELP) Version 2 was used by Russell to estimate total leachate volumes. The HELP model is one dimensional and simulates vertical percolation through a typical landfill profile.

The following input parameters and assumptions were used in Russell's model:

- A final cap permeability of 1 x 10^{-9} m/s.
- Annual rainfall of 1,450 mm.
- 73 m³/d of waste moisture storage is available.
- Open refuse area of 0.18 ha.
- Daily cover area of 0.9 ha.
- Remainder of area is covered by low permeability intermediate cover or final cap.

Using the above assumptions, Russell modelled the different cap types with HELP to obtain the leachate infiltration rates listed in Table 5.1: . These rates were then combined with the overall footprint and different areas of various cover types to arrive at a total leachate generation rate for each phase.

Table 5.1: Leachate infiltration rates from HELP modelling

Cover type	% of rainfall
Open Refuse	50% to 70%
Daily Cover	40% to 50%
Intermediate Cover	1 to 5 %
Final Cap k=1 x 10^{-9} m/s	0.5%

The maximum rates of leachate generation were predicted to occur during operation of the original Phase 8. This is equivalent to about Phase 12 or 14 for the order the landfill has actually been developed. Leachate generation at this time was forecast to be between 30 and 55 m³/day.

Russell also forecast that the average leachate generation rate 20 years after closure and final capping would be 12 m³/day.

Russell's assessment was based on the assumption that leachate is generated from rainfall alone. However, some inward seepage may also contribute. GCNZ Consultants[9] predicted that 6 m³/day would flow into the landfill as a result of the inward groundwater gradient. This is based on an assumed lining system permeability of 1 x 10^{-9} m/s and a leachate head level that is lower than the surrounding groundwater level. Allowing for this, Russell's maximum leachate generation forecast becomes 36 to 61 m³/day.

[9] GCNZ Consultants. March 1990: Waste Management NZ Ltd, Estimate of Groundwater Inflows and Drawdown around the Proposed Sanitary Landfill Site – Redvale Quarry. Ref 2450.02.

5.4.4.2 Historic leachate generation in the existing landfill

The volume of leachate pumped out of the landfill has been recorded since the landfill opened. To evaluate the leachate generation at Redvale Landfill since 1994, pumping data from the sumps has been compared with the leachate generation forecast modelled by Russell in 1991.

The depth of leachate within the landfill is variable. While changes in level within the landfill can affect leachate extraction rates, this effect is considered minor in the context of the longer-term data presented in this section.

In order to evaluate the accuracy of Russell's predictions, measured leachate extraction (pumping data) has been plotted alongside the modified 1991 lower range model results (Figure 5.1:). Actual footprint areas have been calculated from surveys and aerial photos from 1996, 2011, 2013, 2019, 2022, 2025 and 2026.

The annual rainfall value of 1,450 mm/year used by Russell has been compared with rainfall data obtained from the onsite rain gauge which has been plotted on Figure 5.1: . The annual rainfall average of 1,450 mm/year appears to be generally representative of onsite rainfall. The exception is between 2022 and the end of 2023 when higher than normal rainfall was recorded.

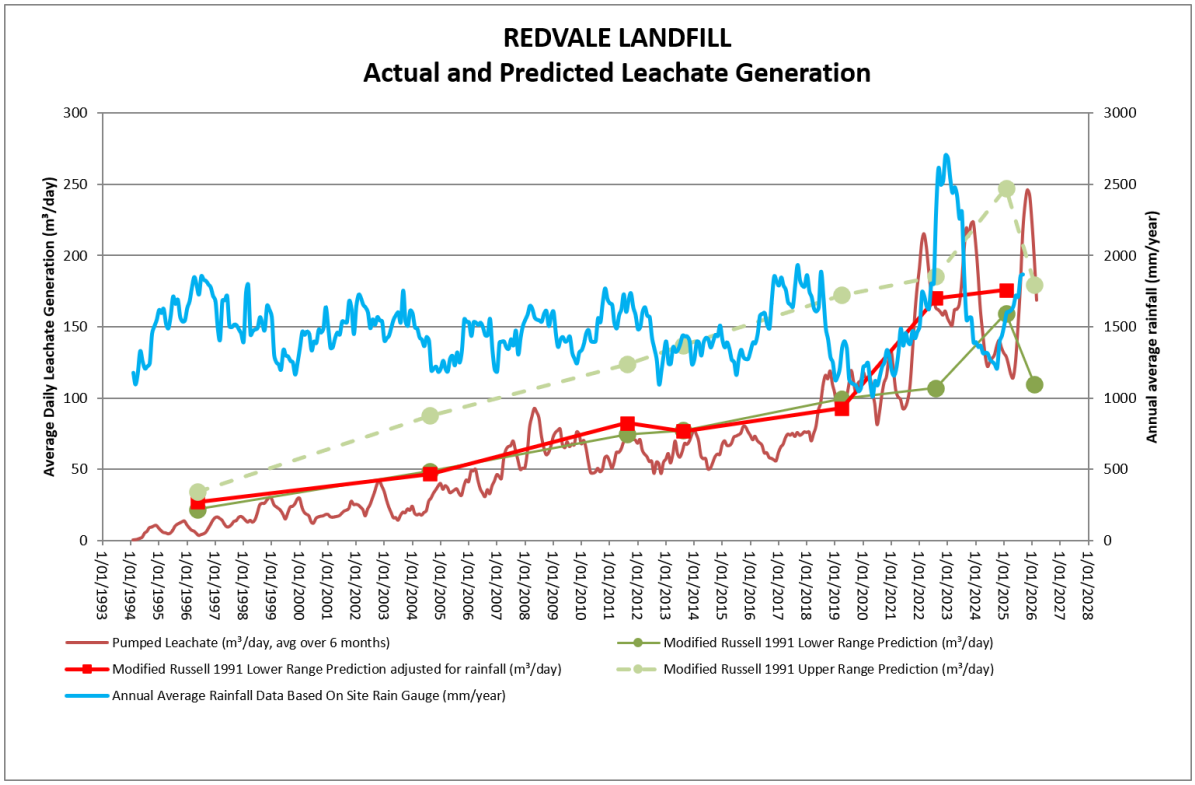

Figure 5.1: Comparison of pumped leachate data to HELP model leachate generation predictions.

In practice, the areas of each type of cover have not been as small as those assumed by Russell in 1991.

The following are the typical areas that WMNZ worked within up until 2018:

- Open refuse area for landfilling is typically maintained at 0.1 ha (or 1,000 m²).
- The daily cover area is maintained at less than about 1 ha.

- Thickened daily cover consists of an additional 150 mm of clean soil. It can extend to an area of up to approximately 3 to 4 ha before intermediate cover is applied.
- Intermediate clay cover of 0.5 m thickness is track rolled into place.
- Final cap is only placed once waste filling has reached target levels, with an allowance for settlement.

In 2018, WMNZ established a separate disposal area for asbestos contaminated material, which later transformed into a designated Class 2 landfill cell. This required an additional tip face within the western end of the existing landfill, increasing the open refuse and daily cover areas. Based on an assessment of aerial photographs and WMNZ's operational procedures, the operational areas were delineated for 2019, 2022, 2025 and 2026, presented in Table 5.2: . The main change from previous operations is that the open refuse area had generally increased substantially to approximately 1 to 3.5 ha from 0.1 ha. We understand from WMNZ that the operational practices within the Class 2 area may have contributed to the increased open refuse area. Changes to operational practices during late 2025 have substantially reduced the open area.

Table 5.2: Cover areas

Aerial survey date	Open refuse (m^2)	Daily cover (m^2)	Thickened daily cover (m^2)	Intermediate cover (m^2)	Final cap (m^2)
March 2019	10,900	10,400	40,000	276,400	142,400
July 2022	11,600	13,200	40,000	302,300	164,400
January 2025	32,800	20,600	40,000	237,300	235,800
January 2026	7,700	20,000	40,000	253,400	235,800

The following conclusions can be drawn from Figure 5.1: :

- The leachate generation of 160 m^3/day from the modified 1991 Russell lower range prediction based on current operational areas is higher than the predictions made by Russell in 1991. Russell estimated that a maximum of 30 to 55 m^3/day of leachate would be generated. The key difference is the second tip face, and significantly higher open refuse and daily cover areas that have been utilised as part the Class 2 operations.
- The modified Russell 1991 lower range model predicted well the actual volume of leachate pumped, except for years 2022 and 2023 where abnormally high rainfall was recorded.
- The predictions from Russell's further modified model (adjusted to reflect higher than average annual rainfall) fitted within the range of the pumped leachate volumes for years when higher rainfall was recorded in 2022.
- The modified Russell 1991 upper range model is typically higher than the volume of leachate pumped, but can be useful for predicting peak leachate generation.
- Based on these results, Russell's modified lower range model appears to remain suitable for predicting typical future leachate generation rates – based on the areas required for future operations. Sufficient contingency should be available to deal with periods of higher than average rainfall.
- While the specified maximum permeability for the final cap clay layer is higher than that assumed by Russell in 1991, the cover soils used at Redvale are typically very low in permeability, and the proposed infiltration rate is considered appropriate.

5.4.4.3 Leachate generation forecast

As discussed in the above section, the rate of leachate generation can be mostly attributed to the open, operational parts of the landfill, while capped portions of the landfill do not contribute significantly to the overall quantity of leachate. Therefore, if the working face and daily cover requirements set out in Section 4.8 are implemented, leachate generation rates are likely to remain similar to or lower than current operations, even with a larger overall footprint.

Leachate generation rates have been forecast for the remaining life of the proposed landfill expansion through to post closure. Generation rates have been estimated based on the following:

- The modified version of Russell's 1991 lower range model discussed in Section 5.4.4.2 above has been used
- The conceptual staging is shown on Drawing C16.
- The proposed daily and intermediate cover requirements set out in Section 4.8.
- Half of each newly developed stage is assumed to be diverted to stormwater prior to any waste being placed on that portion.
- The upper range prediction indicates peak leachate generation rates below those experienced in 2025.

The expected leachate generation after closure (13 m^3/day) is similar to the estimate of 12 m^3/day previously used for just the existing footprint.

Table 5.3: Leachate forecast

Stage	Existing Class 1 footprint (m^3/day)		Class 2 footprint extension (m^3/day)		Total (m^3/day)	
	Lower bound	Upper bound	Lower bound	Upper bound	Lower bound	Upper bound
1	90	148	15	21	105	169
2	69	124	29	41	98	165
3	68	115	30	44	98	159
4	68	115	30	44	98	159
Pre closure	67	100	30	41	97	141
Post closure	11	11	2	2	13	13

5.4.4.4 Leachate storage and disposal

The full capacity of the leachate evaporator is 50 m^3/day. Over the last few years, Figure 5.1: above shows that leachate pumping has generally exceeded this amount with 50 to 200 m^3/day trucked off-site.

Currently leachate removed from the landfill is either trucked directly, or stored in four 26 m^3 tanks at the dosing plant, prior to being evaporated or trucked off site. These tanks are currently sufficient for the volume of leachate that is evaporated and trucked off-site daily, and are expected to remain so with predicted leachate volumes similar to, or lower than, recent disposal volumes.

It is anticipated that leachate generated by the Class 2 footprint extension will be continually removed and stored outside the landfill prior to being trucked off site. Based on the upper bound forecast, the proposed four additional 26 m^3 leachate storage tanks will provide two days of emergency storage for leachate from the Class 2 footprint extension, in the event that trucking operations are interrupted.

5.5 Landfill gas management

5.5.1 WasteMINZ Technical Guideline recommendations

The WasteMINZ Technical Guidelines state that the primary objectives of landfill gas control are to:

- Reduce the short and long term hazards associated with landfill gas (which is flammable, explosive and an asphyxiant gas).
- Minimise odour nuisance.
- Minimise greenhouse gas emissions.
- Maximise energy recovery, where appropriate.

The WasteMINZ Technical Guidelines note that abstraction systems should be utilised where hazard and environmental controls are required. The abstraction systems should comprise gas wells with vacuum pressure applied, with the gas transported through a collection system to be either destroyed in flares or reused for electricity generation.

For sites where insufficient landfill gas is being produced to result in direct hazard, migration risk, or environmental impacts that warrant or enable flaring, passive venting systems through vent stacks and gravel filled trenches could be considered.

5.5.2 Existing Class 1 landfill

The clay lining system and cap at Redvale are low permeable systems which trap landfill gas within the waste mass. The landfill gas extraction system within the Class 1 waste comprises an active abstraction system consisting of a series of extraction wells connected via a network of header pipes. The extraction wells are extended vertically through the waste through perforated vertical risers as the waste operations progress. The gas is transported to the energy park to be reused to generate energy, with any excess gas managed via the existing enclosed flares. Existing infrastructure such as the ring main will be relocated as necessary during waste filling. The existing system therefore meets the requirements of the WasteMINZ Technical Guidelines. The landfill gas collection system layout is presented in Drawing C40.

5.5.3 Existing and proposed Class 2 operations

The WAC for Class 2 waste is set out in the Waste Acceptance Criteria report. Class 2 waste comprises inert materials and soils with maximum incidental biodegradable materials of no more than 5% by volume per load. Therefore, landfill gas generation potential is limited, and the release of greenhouse gases and risk of significant short/long term hazards and odour are low.

Landfill gas infrastructure is therefore not expected to be installed within the Class 2 footprint extension. In the event that landfill gas collection does become necessary in the future, horizontal collector pipes will be installed near the surface.

6 Summary and conclusions

6.1 Proposed works

The proposed modifications to the Redvale Landfill include a Class 1 landfill expansion for the existing footprint and a Class 2 footprint extension to the south. The Class 1 landfill expansion involves steepening the final cap slopes and constructing a perimeter bund to raise the landfill edge. The Class 2 footprint extension is proposed within the existing Managed Fill and Pond 6 areas, incorporating a separate containment and leachate collection system from the existing landfill. The net capacity of the landfill (i.e. waste only) increases from 19.7 to 24.3 Mm^3.

6.2 Final landform

The final landform design for the proposed Class 1 landfill expansion and Class 2 footprint extension includes steepened slopes (maximum 1V:3H) and a minimum crest gradient of 5%, consistent with the recommendations of the WasteMINZ Technical Guidelines. The final cap system will include a 1,000 mm thick compacted clay layer with a topsoil cover, exceeding the minimum requirements for both Class 1 and Class 2 landfills set out in the WasteMINZ Technical Guidelines. Cap drains have been designed with a minimum post-settlement grade of 2% which allows for grade to be maintained should differential settlement of the waste occur.

6.3 Base containment

The base containment system currently used at Redvale Landfill provides an appropriate level of environmental protection for the following reasons:

- The currently adopted lining system comprises a 900 mm thick compacted clay layer with a maximum permeability of 1 x 10^{-9} m/s.
- The selected site is well suited to leachate containment, with deep layers of low-permeability materials below the landfill.

The proposed Class 2 footprint extension will adopt a 900 mm thick compacted clay layer with a maximum permeability of 1 x 10^{-8} m/s consistent with the recommendations of the WasteMINZ Technical Guidelines.

6.4 Leachate collection and generation

The existing leachate collection system within the existing footprint is largely consistent with the requirements of the WasteMINZ Technical Guidelines, with the exception of a drainage layer above the lining system. However, the Hydrogeology Assessment Report concludes that the overall containment system, including the leachate collection system, is sufficient to protect the surrounding environment.

The Class 2 footprint extension will include a leachate collection and extraction system consistent with the requirements of the WasteMINZ Technical Guidelines. This will allow leachate head on the lining system to be maintained at less than 300 mm.

Leachate generation rates for the existing landfill align closely with predictions from the original HELP modelling presented in the original consent design, particularly when these predictions have been modified to account for areas of open refuse, daily and intermediate cover that have been present over the landfill's life. Increases in leachate generation have been observed from 2018 onwards following operation of the Class 2 landfill within the western portion of the footprint. Leachate generation rates for the larger overall footprint are expected to remain similar to existing rates due to increased cover thickness and reduced operating areas.

Leachate will be disposed of via a combination of the existing BeneVap leachate evaporator and trucking off site. Trucking will be used once the BeneVap is decommissioned to allow filling of the southern side of the Class 1 landfill extension.

7 Applicability

This report has been prepared for the exclusive use of our client WMNZ, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

We understand and agree that our client will submit this report as part of an application under the Fast-track Approvals Act 2024 and that an Expert Panel as the consenting authority will use this report for the purpose of assessing that application. We understand and agree that this report will be used by the Expert Panel in undertaking its regulatory functions.

Tonkin & Taylor Ltd
Environmental and Engineering Consultants

Lead author:

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Andrew Shallard
Senior Civil Engineer

Authorised for Tonkin & Taylor Ltd by:

.....

Simonne Eldridge
Project Director

12-Aug-26
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Appendix A Code of Conduct

A1 Compliance with the Environment Court Practice Note 2023

I confirm that, in my capacity as lead author of this report, I have read and abided by the Environment Court of New Zealand's Code of Conduct for Expert Witnesses contained in the Practice Note 2023.

I am a senior civil engineer at Tonkin & Taylor Ltd (T+T), where I specialise in landfill design. I have worked at T+T since 20 September 1999. Prior to joining T+T, I was a civil engineer at Manukau Consultants Ltd.

I have 31 years' experience in landfill design. I hold the following qualifications – BE (Civil).

Recent relevant projects and services that I have been involved with include: preparation of landfill cell designs for Phase 9 through 22 at Redvale Landfill, expert witness for the reconsenting of Redvale Landfill in 2015, preparation of landfill cell designs for Stages 1A.1 through 2B (10 stages) of the New Zealand Steel East Landfill, and landfill designer and expert witness for consenting of the Tirohia Landfill – Phase C.

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Andrew Shallard

Senior Civil Engineer

Appendix B Drawings

WM New Zealand

WM NEW ZEALAND

REDVALE LANDFILL EXPANSION

CONCEPT DESIGN

SUBSTANTIVE ISSUE

PROJECT NO : 1092369.3000

ISSUE DATE : 10.08.2026

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DRAWING REGISTER

		DRAWING NUMBER	REV	TITLE
1	ü	1092369.3000-C01	A	DRAWING LIST AND LOCALITY PLAN
2	ü	1092369.3000-C10	A	OVERALL SITE LAYOUT
3	ü	1092369.3000-C11	A	BASEGRADE AND PHASE LAYOUT
4	ü	1092369.3000-C12	A	LEACHATE COLLECTION LAYOUT
5	ü	1092369.3000-C13	A	EXISTING CONSENTED FINAL CONTOURS
6	ü	1092369.3000-C14	A	PROPOSED FINAL CONTOURS AND DRAINAGE LAYOUT
7	ü	1092369.3000-C15	A	PROPOSED PRE-SETTLEMENT ENVELOPE PLAN
8	ü	1092369.3000-C16	A	PROPOSED CONCEPTUAL PHASE LAYOUT PLAN
9	ü	1092369.3000-C20	A	CROSS SECTIONS
10	ü	1092369.3000-C30	A	CLASS 1 LINING SYSTEM DETAILS
11	ü	1092369.3000-C31	A	CLASS 1 PERIMETER BUND DETAILS
12	ü	1092369.3000-C32	A	CLASS 1 NORTHERN PERIMETER DETAILS
13	ü	1092369.3000-C33	A	CLASS 1 AND CLASS 2 CAP DETAILS
14	ü	1092369.3000-C35	A	CLASS 2 LINING SYSTEM DETAILS
15	ü	1092369.3000-C36	A	CLASS 1 AND CLASS 2 LEACHATE SUMP DETAILS
16	ü	1092369.3000-C40	A	GAS COLLECTION SYSTEM LAYOUT
17	ü	1092369.3000-C50	A	STOCKPILE 4 LAYOUT
18	ü	1092369.3000-C51	A	STOCKPILE 4 STAGING
19	ü	1092369.3000-C52	A	STOCKPILE 4 DETAILS
	ü	DENOTES DRAWINGS IN THIS ISSUE: 10.08.2026		

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LOCALITY PLAN

SCALE (A1) NTS
SCALE (A3) NTS

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CLIENT **WM NEW ZEALAND**

PROJECT **REDVALE LANDFILL EXPANSION**

TITLE DRAWING LIST AND LOCALITY PLAN

SCALE (A1) NTS DWG No. 1092369.3000-C01 REV A

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NOTES

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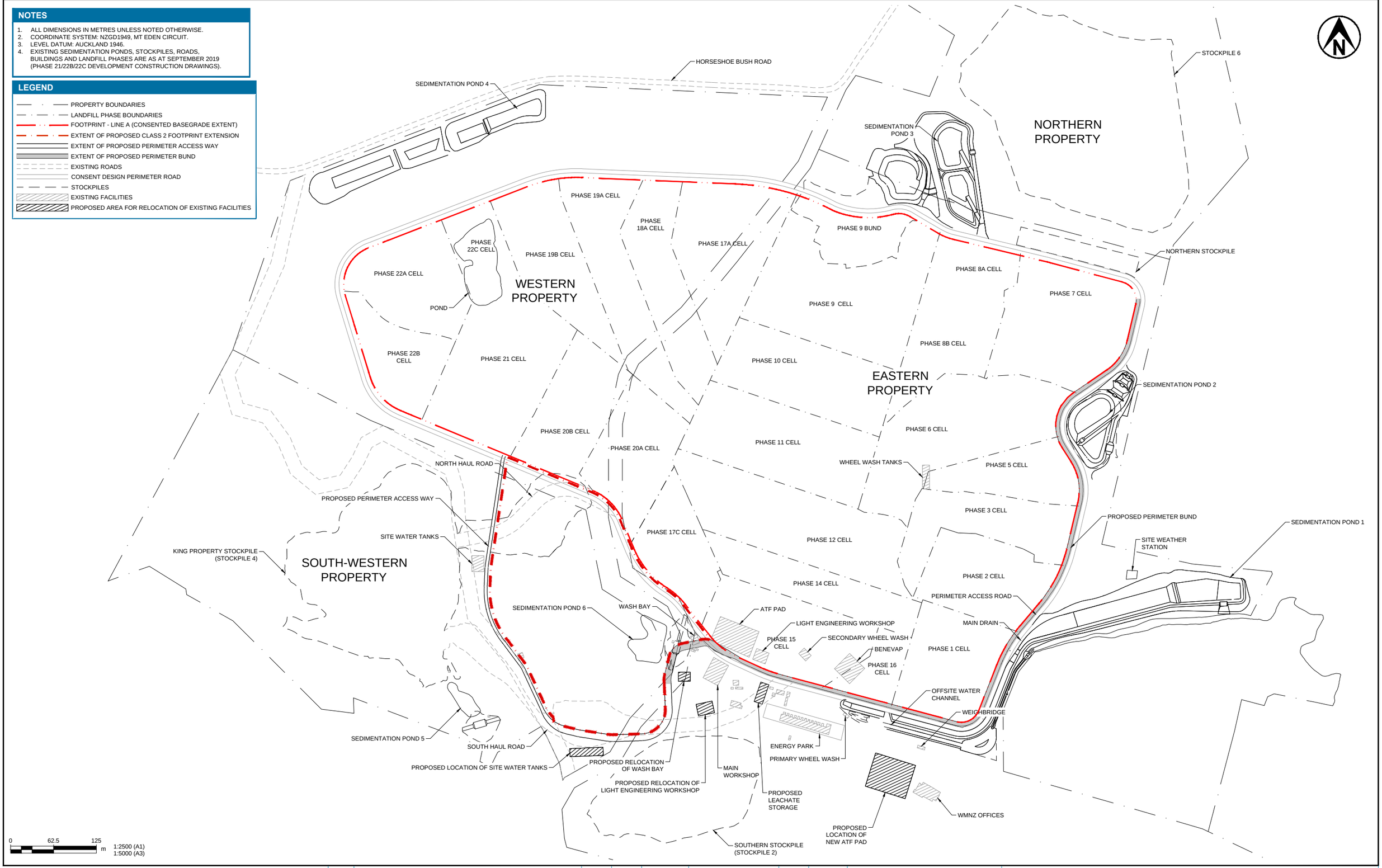
3. LEVEL DATUM: AUCKLAND 1946.
4. EXISTING SEDIMENTATION PONDS, STOCKPILES, ROADS, BUILDINGS AND LANDFILL PHASES ARE AS AT SEPTEMBER 2019 (PHASE 21/22B/22C DEVELOPMENT CONSTRUCTION DRAWINGS).

LEGEND

- PROPERTY BOUNDARIES
- LANDFILL PHASE BOUNDARIES
- FOOTPRINT - LINE A (CONSENTED BASEGRADE EXTENT)
- EXTENT OF PROPOSED CLASS 2 FOOTPRINT EXTENSION
- EXTENT OF PROPOSED PERIMETER ACCESS WAY
- EXTENT OF PROPOSED PERIMETER BUND
- EXISTING ROADS
- CONSENT DESIGN PERIMETER ROAD
- STOCKPILES
- EXISTING FACILITIES
- PROPOSED AREA FOR RELOCATION OF EXISTING FACILITIES



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TITLE OVERALL SITE LAYOUT

SCALE (A1) 1:2500 DWG No. 1092369.3000-C10 REV A

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NOTES

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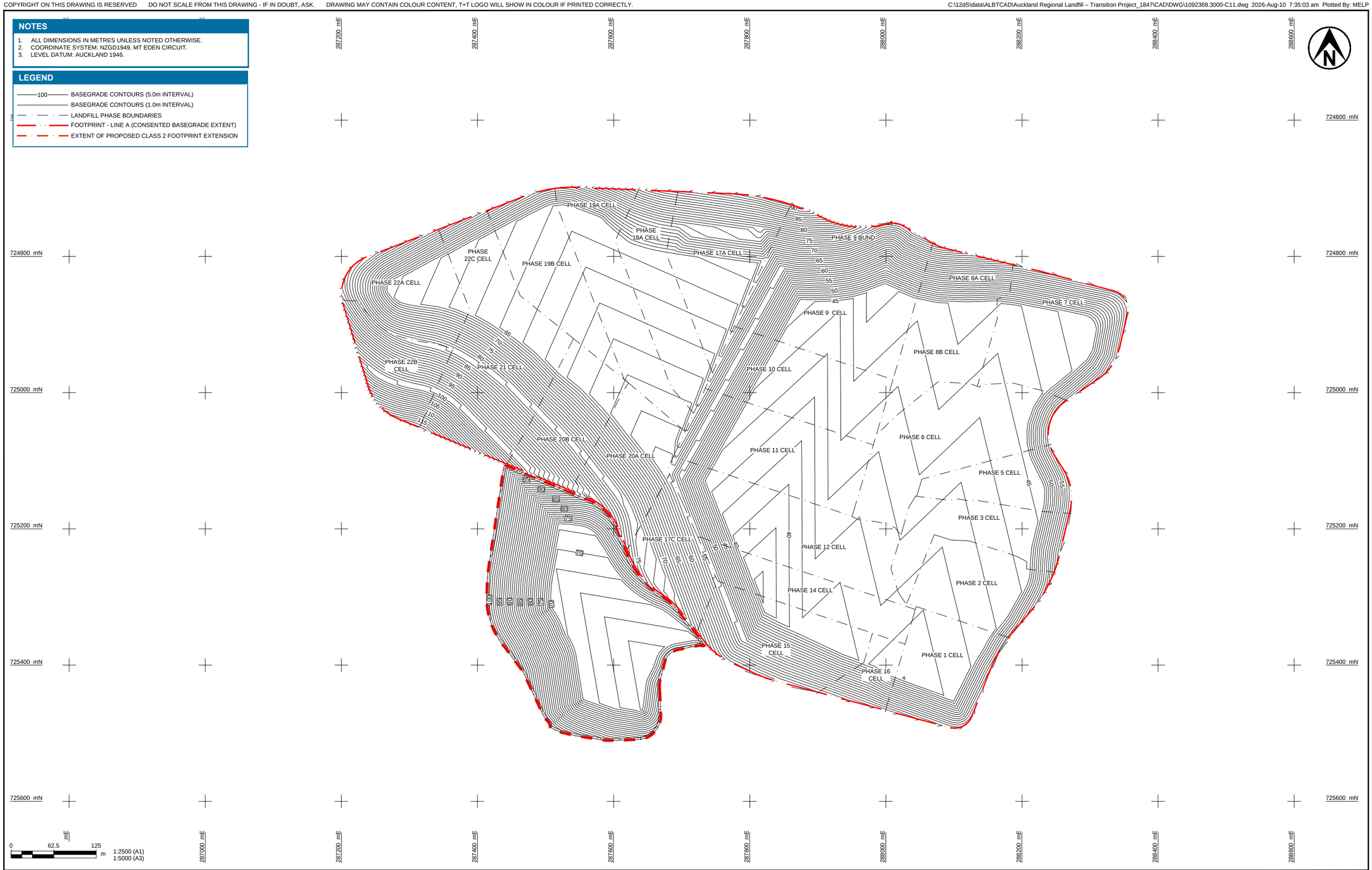
3. LEVEL DATUM: AUCKLAND 1946.

LEGEND

- 100 BASEGRADE CONTOURS (5.0m INTERVAL)
- BASEGRADE CONTOURS (1.0m INTERVAL)
- LANDFILL PHASE BOUNDARIES
- FOOTPRINT - LINE A (CONSENTED BASEGRADE EXTENT)
- EXTENT OF PROPOSED CLASS 2 FOOTPRINT EXTENSION



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TITLE BASEGRADE AND PHASE LAYOUT

SCALE (A1) 1:2500 DWG No. 1092369.3000-C11 REV A

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NOTES

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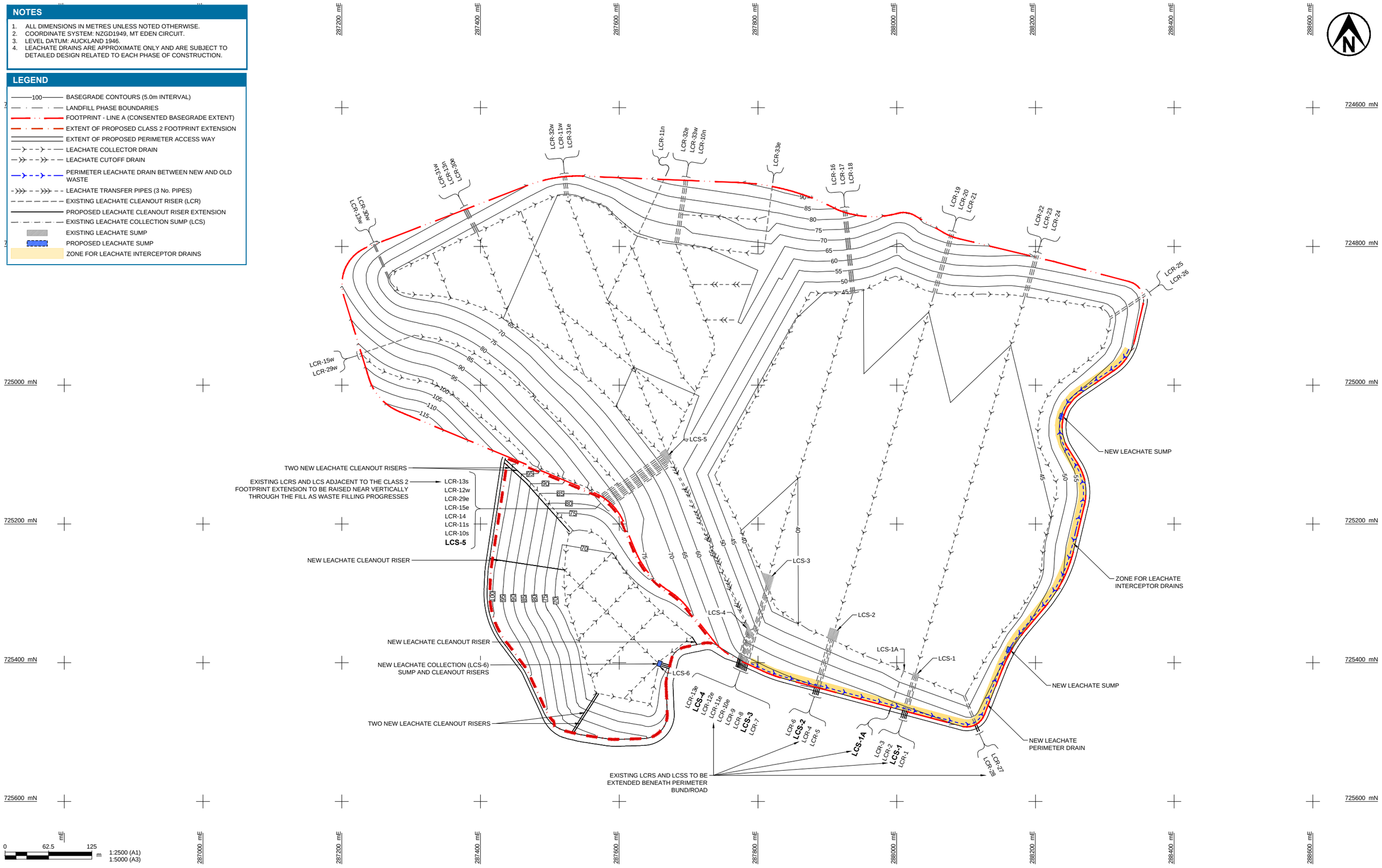
3. LEVEL DATUM: AUCKLAND 1946.
4. LEACHATE DRAINS ARE APPROXIMATE ONLY AND ARE SUBJECT TO DETAILED DESIGN RELATED TO EACH PHASE OF CONSTRUCTION.

LEGEND

- 100 — BASEGRADE CONTOURS (5.0m INTERVAL)
- LANDFILL PHASE BOUNDARIES
- FOOTPRINT - LINE A (CONSENTED BASEGRADE EXTENT)
- EXTENT OF PROPOSED CLASS 2 FOOTPRINT EXTENSION
- EXTENT OF PROPOSED PERIMETER ACCESS WAY
- LEACHATE COLLECTOR DRAIN
- LEACHATE CUTOFF DRAIN
- PERIMETER LEACHATE DRAIN BETWEEN NEW AND OLD WASTE
- LEACHATE TRANSFER PIPES (3 No. PIPES)
- EXISTING LEACHATE CLEANOUT RISER (LCR)
- PROPOSED LEACHATE CLEANOUT RISER EXTENSION
- EXISTING LEACHATE COLLECTION SUMP (LCS)
- EXISTING LEACHATE SUMP
- PROPOSED LEACHATE SUMP
- ZONE FOR LEACHATE INTERCEPTOR DRAINS



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TITLE LEACHATE COLLECTION LAYOUT

SCALE (A1) 1:2500 DWG No. 1092369.3000-C12 REV A

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NOTES

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3. LEVEL DATUM: AUCKLAND 1946.
4. CAP DRAIN LOCATIONS ARE APPROXIMATE ONLY AND ARE SUBJECT TO DETAILED DESIGN FOR SETTLEMENT.
5. GROSS AIRSPACE IS THE AIRSPACE BETWEEN THE BASEGRADE AND THE UPPER SURFACE OF THE FINAL CAP.
6. NET AIRSPACE IS THE AIRSPACE BETWEEN THE BASEGRADE AND THE UNDERSIDE OF THE FINAL CAP. THIS INCLUDES THE AIRSPACE OCCUPIED BY WASTE, DAILY COVER AND INTERMEDIATE COVER.
7. FINAL CAP IS EARTH FILL AND TOPSOIL WHICH ARE PLACED OVER THE FINISHED WASTE PILE. IT HAS A NOMINAL THICKNESS OF 1150mm.

LEGEND

- 100 — FINAL CAP CONTOURS (5.0m INTERVAL)
- FOOTPRINT - LINE A (CONSENTED BASEGRADE EXTENT)
- EXISTING ROADS
- CONSENT DESIGN PERIMETER ROAD
- CAP DRAINS
- STORMWATER DRAINS

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TITLE EXISTING CONSENTED FINAL CONTOURS

SCALE (A1) 1:2500 DWG No. 1092369.3000-C13 REV A

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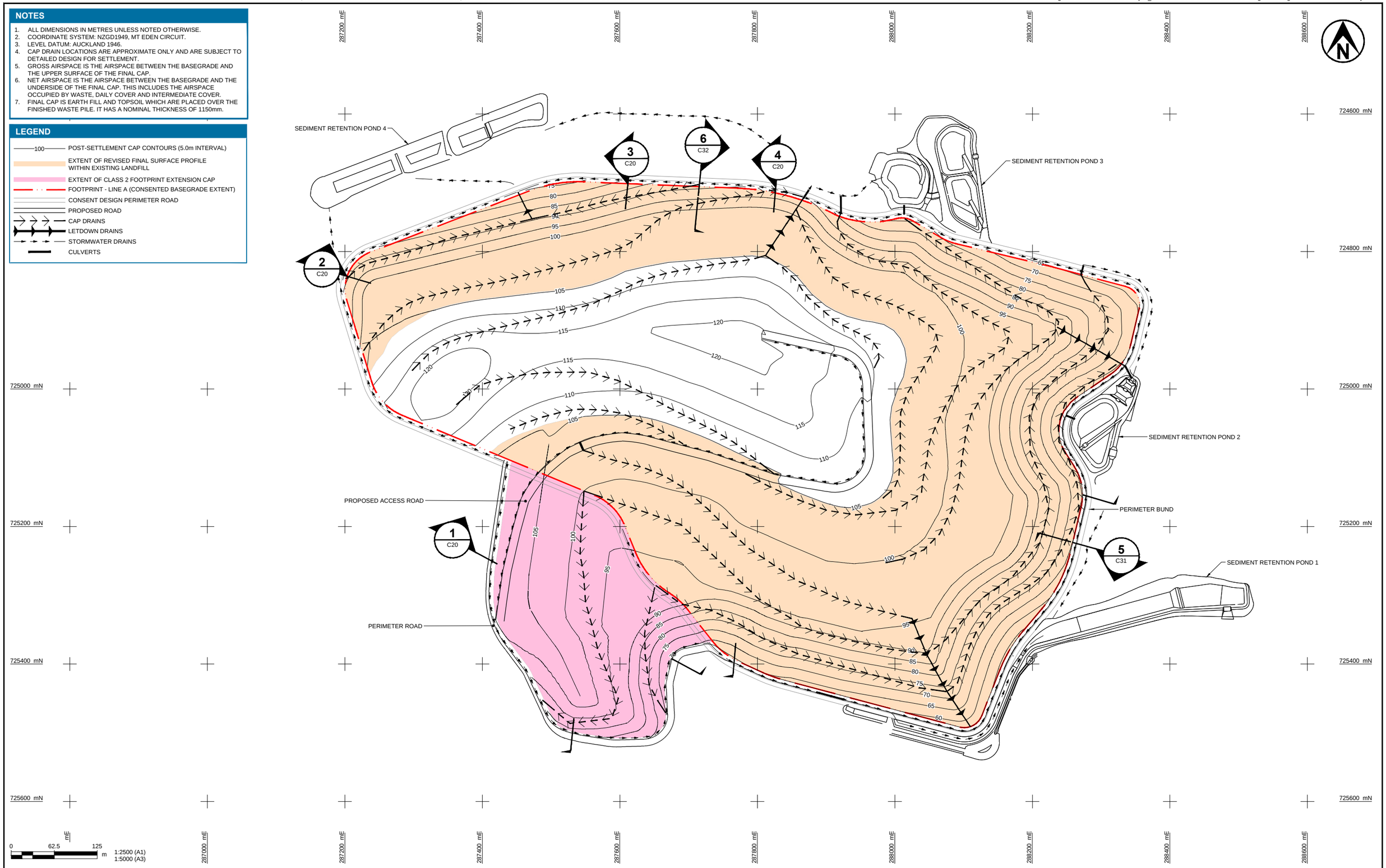
2. COORDINATE SYSTEM: NZGD1949, MT EDEN CIRCUIT.
3. LEVEL DATUM: AUCKLAND 1946.
4. CAP DRAIN LOCATIONS ARE APPROXIMATE ONLY AND ARE SUBJECT TO DETAILED DESIGN FOR SETTLEMENT.
5. GROSS AIRSPACE IS THE AIRSPACE BETWEEN THE BASEGRADE AND THE UPPER SURFACE OF THE FINAL CAP.
6. NET AIRSPACE IS THE AIRSPACE BETWEEN THE BASEGRADE AND THE UNDERSIDE OF THE FINAL CAP. THIS INCLUDES THE AIRSPACE OCCUPIED BY WASTE, DAILY COVER AND INTERMEDIATE COVER.
7. FINAL CAP IS EARTH FILL AND TOPSOIL WHICH ARE PLACED OVER THE FINISHED WASTE PILE. IT HAS A NOMINAL THICKNESS OF 1150mm.

LEGEND

- 100 — POST-SETTLEMENT CAP CONTOURS (5.0m INTERVAL)
- EXTENT OF REVISED FINAL SURFACE PROFILE WITHIN EXISTING LANDFILL
- EXTENT OF CLASS 2 FOOTPRINT EXTENSION CAP
- FOOTPRINT - LINE A (CONSENTED BASEGRADE EXTENT)
- CONSENT DESIGN PERIMETER ROAD
- PROPOSED ROAD
- CAP DRAINS
- LETDOWN DRAINS
- STORMWATER DRAINS
- CULVERTS



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TITLE PROPOSED FINAL CONTOURS AND DRAINAGE LAYOUT

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NOTES

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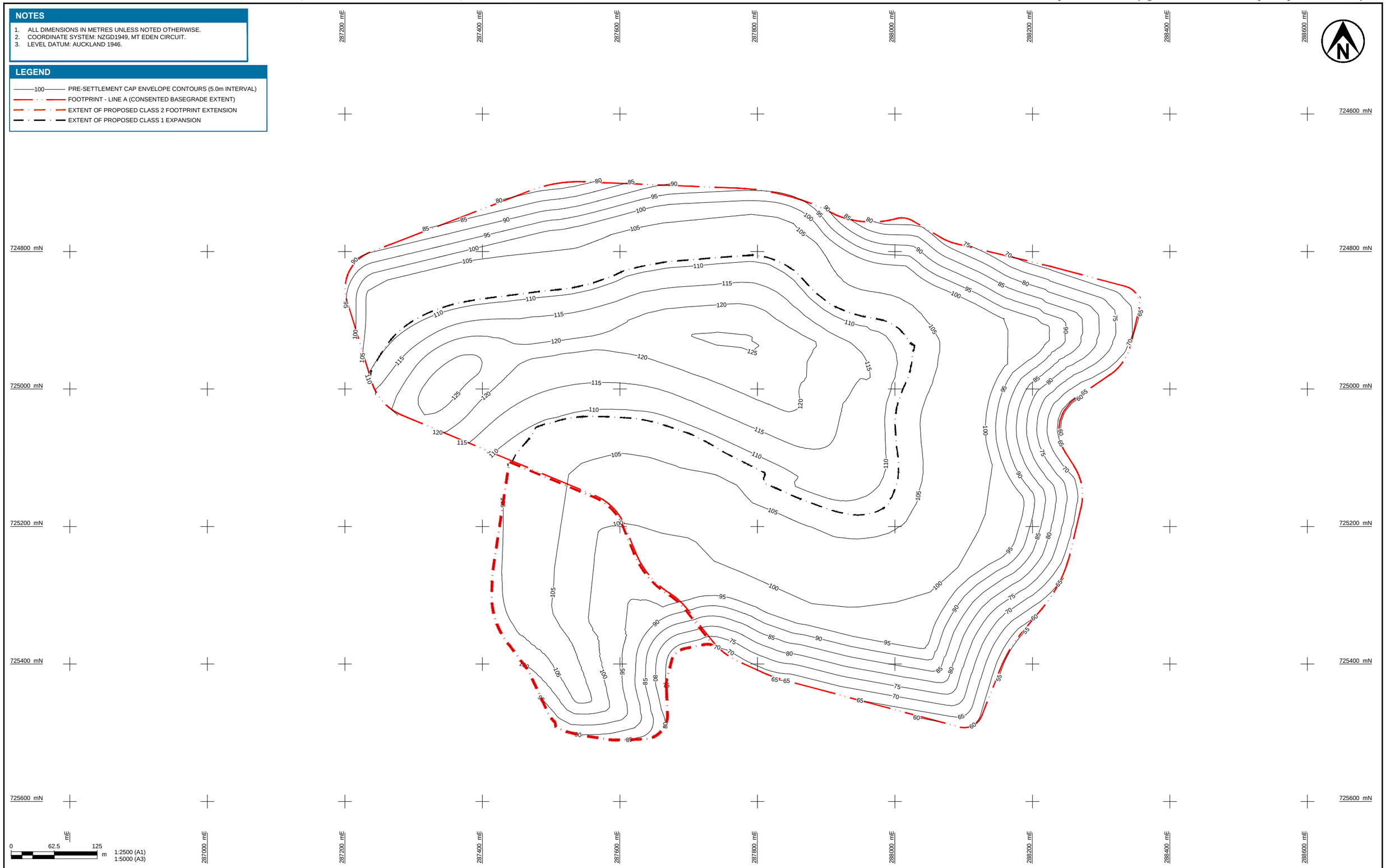
2. COORDINATE SYSTEM: NZGD1949, MT EDEN CIRCUIT.
3. LEVEL DATUM: AUCKLAND 1946.

LEGEND

- 100 — PRE-SETTLEMENT CAP ENVELOPE CONTOURS (5.0m INTERVAL)
- FOOTPRINT - LINE A (CONSENTED BASEGRADE EXTENT)
- EXTENT OF PROPOSED CLASS 2 FOOTPRINT EXTENSION
- EXTENT OF PROPOSED CLASS 1 EXPANSION



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TITLE PROPOSED PRE-SETTLEMENT ENVELOPE PLAN

SCALE (A1) 1:2500 DWG No. 1092369.3000-C15 REV A

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NOTES

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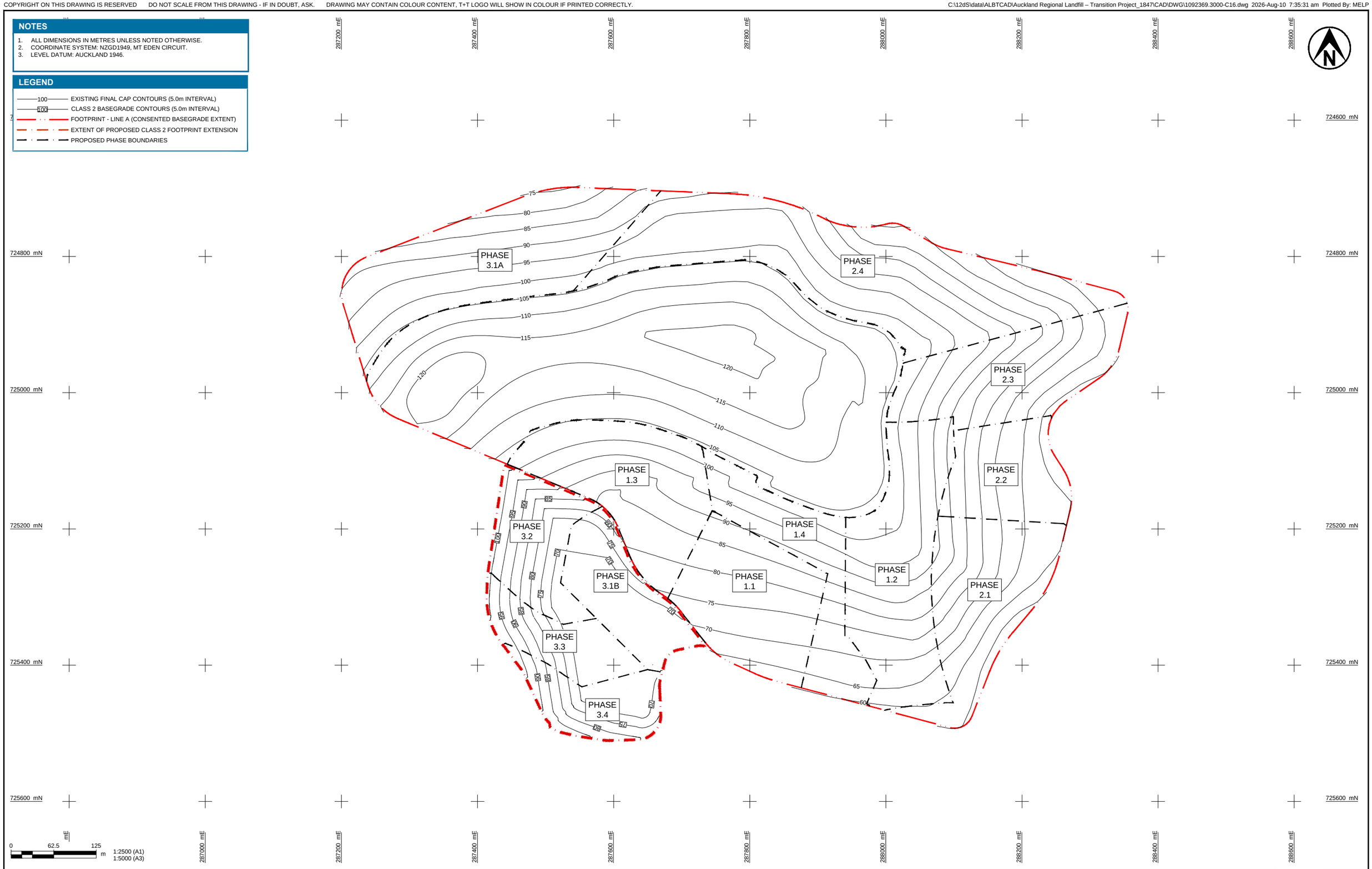
2. COORDINATE SYSTEM: NZGD1949, MT EDEN CIRCUIT.
3. LEVEL DATUM: AUCKLAND 1946.

LEGEND

- 100 — EXISTING FINAL CAP CONTOURS (5.0m INTERVAL)
- 100 — CLASS 2 BASEGRADE CONTOURS (5.0m INTERVAL)
- FOOTPRINT - LINE A (CONSENTED BASEGRADE EXTENT)
- EXTENT OF PROPOSED CLASS 2 FOOTPRINT EXTENSION
- PROPOSED PHASE BOUNDARIES



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CLIENT **WM NEW ZEALAND**

PROJECT **REDVALE LANDFILL EXPANSION**

TITLE PROPOSED CONCEPTUAL PHASE LAYOUT PLAN

SCALE (A1) 1:2500 DWG No. 1092369.3000-C16 REV A

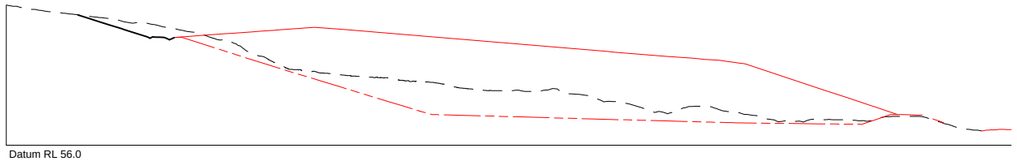
C:\12dS\data\ALBTCAD\Auckland Regional Landfill – Transition Project_1847\CAD\DWG\1092369.3000-C20.dwg 2026-Aug-10 7:35:38 am Plotted By: MELP

NOTES

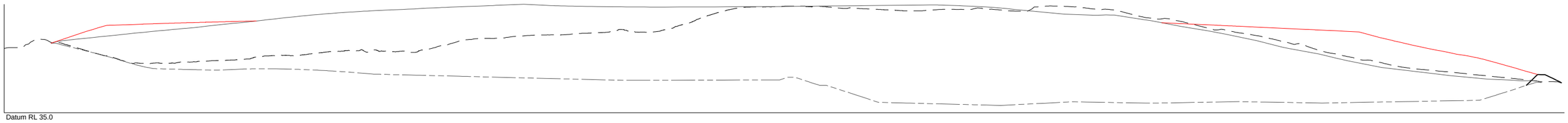
1. ALL DIMENSIONS IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATE SYSTEM: NZGD1949, MT EDEN CIRCUIT.
3. LEVEL DATUM: AUCKLAND 1946.

LEGEND

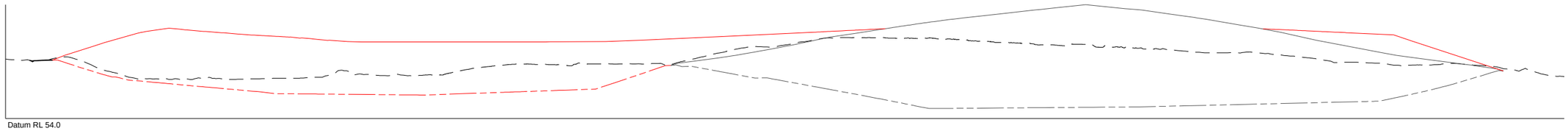
- EXISTING GROUND
- CONSENTED BASEGRADE
- PROPOSED BASEGRADE
- CONSENTED POST SETTLEMENT CAP
- PROPOSED POST SETTLEMENT CAP
- PROPOSED PERIMETER ROAD



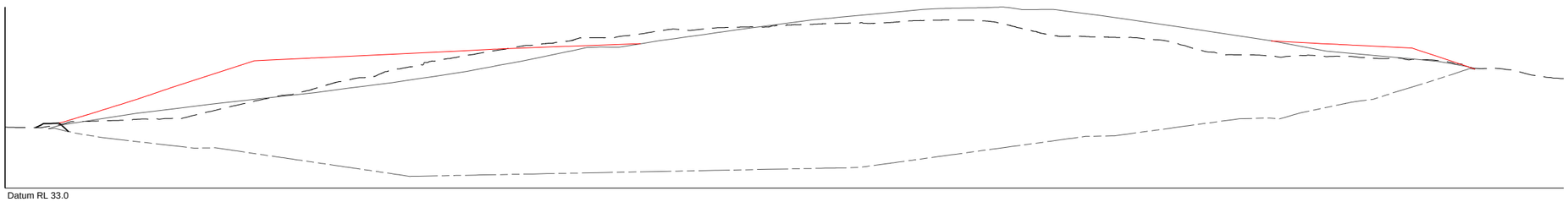
1 SECTION
C14
SCALE (A1) 1:1250
SCALE (A3) 1:2500



2 SECTION
C14
SCALE (A1) 1:1500
SCALE (A3) 1:3000



3 SECTION
C14
SCALE (A1) 1:1250
SCALE (A3) 1:2500



4 SECTION
C14
SCALE (A1) 1:1250
SCALE (A3) 1:2500

0 31.25 62.5 m
1:1250 (A1)
1:2500 (A3)

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REV	DESCRIPTION	CAD	CHK	DATE	APPROVED	DATE
A	SUBSTANTIVE ISSUE	MELP	AWS	10.08.26		

DESIGNED	AWS	Aug.26	DRAWING STATUS
DRAWN	MELP	Aug.26	SUBSTANTIVE ISSUE
DESIGN CHECKED	SFE	Aug.26	PROJECT PHASE
DRAWING CHECKED	JC	Aug.26	CONCEPT DESIGN

NOT FOR CONSTRUCTION

THIS DRAWING IS NOT TO BE USED FOR CONSTRUCTION PURPOSES UNLESS SIGNED AS APPROVED

CLIENT **WM NEW ZEALAND**

PROJECT **REDVALE LANDFILL EXPANSION**

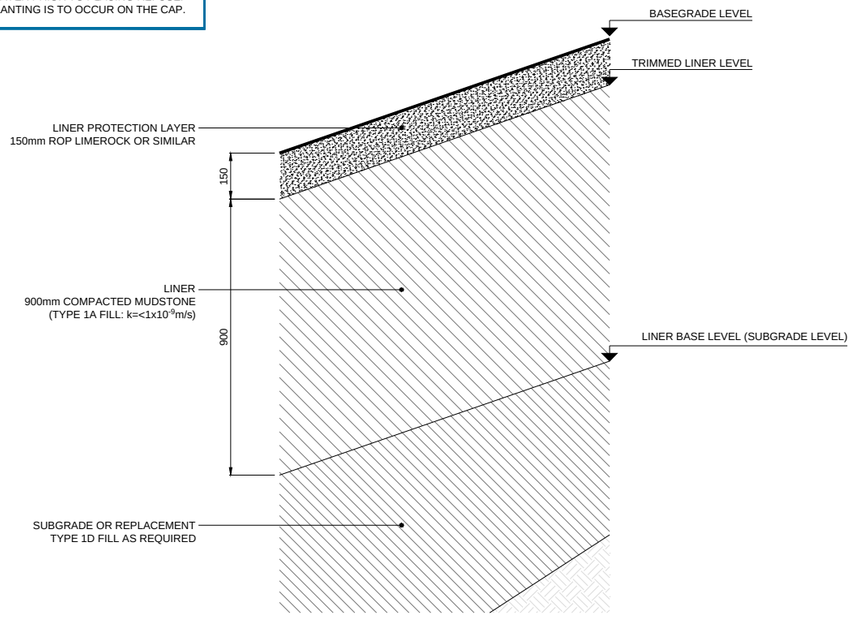
TITLE CROSS SECTIONS

SCALE (A1) AS SHOWN DWG No. 1092369.3000-C20 REV A

C:\12dS\data\ALBTCAD\Auckland Regional Landfill – Transition Project_1847\CAD\DWG\1092369.3000-C30.dwg 2026-Aug-10 7:35:46 am Plotted By: MELP

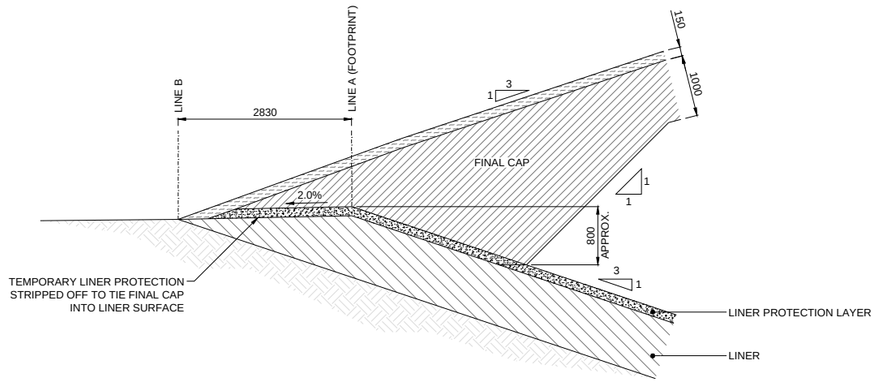
NOTES

1. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. STORMWATER DIVERSION BUND TO BE REMOVED AND REPLACED WITH 150mm THICK LINER PROTECTION LAYER PRIOR TO PLACING REFUSE.
3. CAP THICKNESS VARIES WHERE PLANTING IS TO OCCUR ON THE CAP.



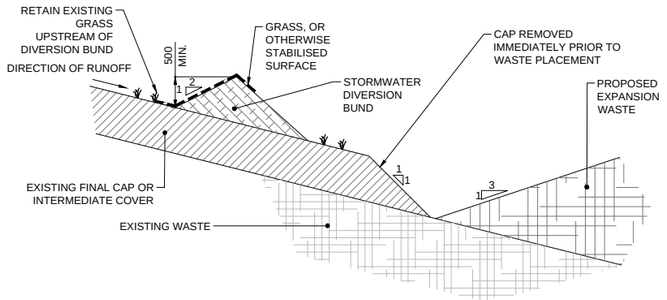
A STANDARD CLASS 1 LANDFILL LINING SYSTEM

SCALE (A1) 1:10
SCALE (A3) 1:20



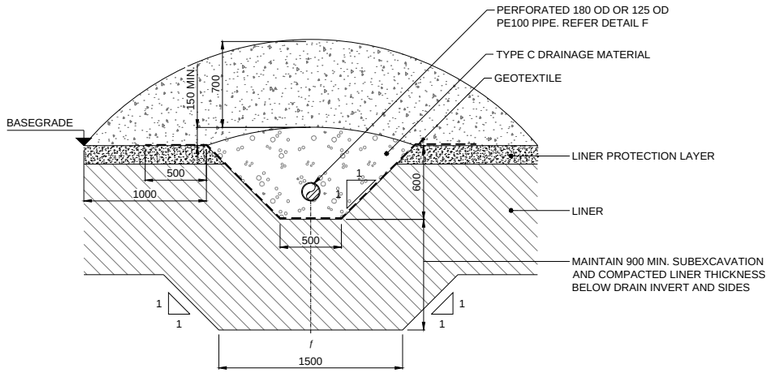
B TYPICAL DETAIL OF CLASS 1 LANDFILL FINAL CAP PERIMETER TIE-IN

SCALE (A1) 1:50
SCALE (A3) 1:100



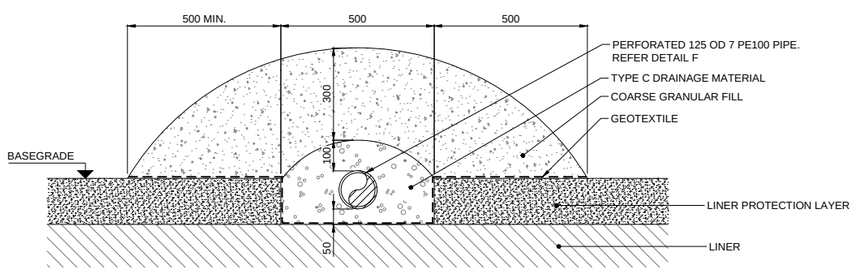
C TYPICAL TEMPORARY CLASS 1 LANDFILL STORMWATER DIVERSION BUND

SCALE (A1) 1:50
SCALE (A3) 1:100



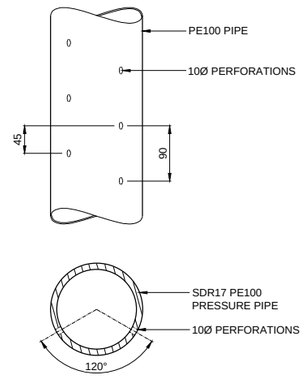
D TYPICAL CLASS 1 LANDFILL LEACHATE COLLECTOR DRAIN

SCALE (A1) 1:25
SCALE (A3) 1:50



E TYPICAL CLASS 1 LANDFILL LEACHATE CUTOFF DRAIN

SCALE (A1) 1:10
SCALE (A3) 1:20



F LEACHATE COLLECTOR PIPE PERFORATIONS

SCALE (A1) 1:5
SCALE (A3) 1:10

0 0.125 0.25 m — 1:5 (A1) 1:10 (A3)
0 0.25 0.5 m — 1:10 (A1) 1:20 (A3)
0 0.625 1.25 m — 1:25 (A1) 1:50 (A3)
0 1.25 2.5 m — 1:50 (A1) 1:100 (A3)

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REV	DESCRIPTION	CAD	CHK	DATE
A	SUBSTANTIVE ISSUE	MELP	AWS	10.08.26

DESIGNED	AWS	Aug.26	DRAWING STATUS	SUBSTANTIVE ISSUE
DRAWN	MELP	Aug.26		
DESIGN CHECKED	SFE	Aug.26	PROJECT PHASE	CONCEPT DESIGN
DRAWING CHECKED	JC	Aug.26		

NOT FOR CONSTRUCTION

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APPROVED DATE

CLIENT **WM NEW ZEALAND**

PROJECT **REDVALE LANDFILL EXPANSION**

TITLE CLASS 1 LINER DETAILS

SCALE (A1) AS SHOWN DWG No. 1092369.3000-C30 REV A

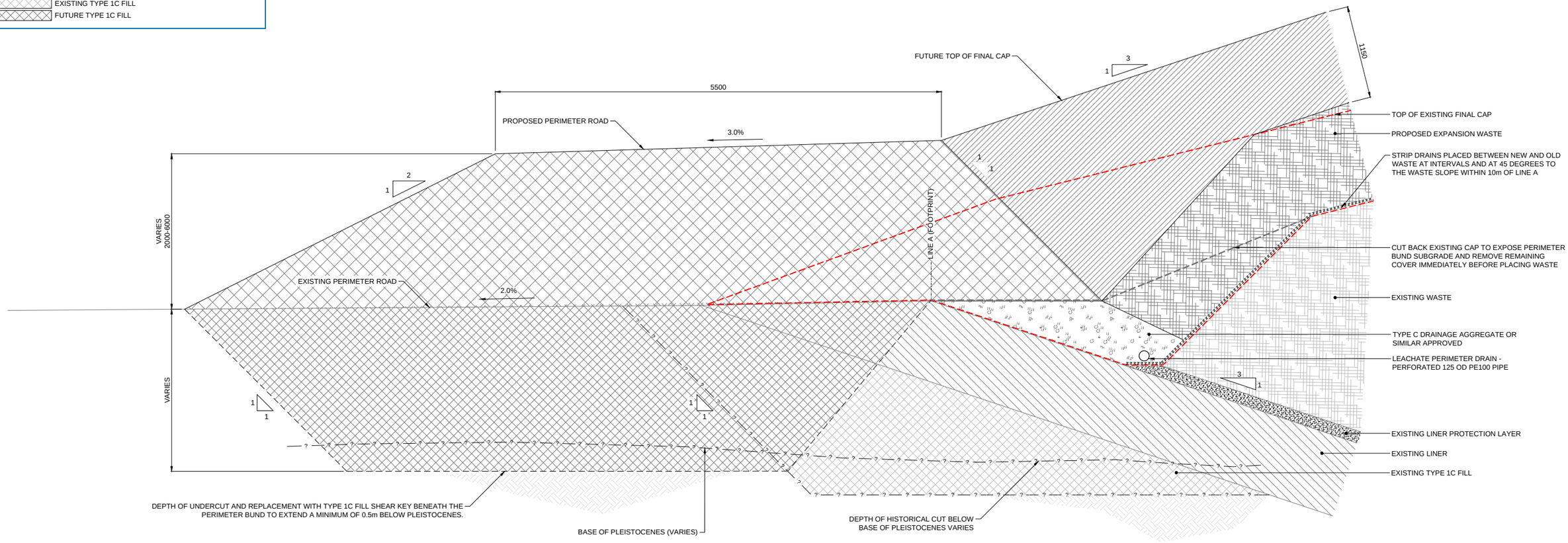
C:\12dS\data\ALBTCAD\Auckland Regional Landfill – Transition Project_1847\CAD\DWG\1092369.3000-C31.dwg 2026-Aug-10 7:35:52 am Plotted By: MELP

NOTES

1. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.

LEGEND

- EXTENT OF EXISTING CAP AND WASTE TO BE REMOVED
- EXISTING LINER
- EXISTING LINER PROTECTION LAYER
- PROPOSED FINAL CAP
- PROPOSED TYPE C DRAINAGE
- EXISTING WASTE
- FUTURE WASTE
- EXISTING TYPE 1C FILL
- FUTURE TYPE 1C FILL



5 TYPICAL DETAIL OF PERIMETER BUND AND REVISED FINAL SURFACE TIE-IN

C14

SCALE (A1) 1:25
SCALE (A3) 1:50

0 0.625 1.25 m
1:25 (A1)
1:50 (A3)

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REV	DESCRIPTION	CAD	CHK	DATE	APPROVED	DATE
A	SUBSTANTIVE ISSUE	MELP	AWS	10.08.26		

DESIGNED	AWS	Aug.26	DRAWING STATUS
DRAWN	MELP	Aug.26	SUBSTANTIVE ISSUE
DESIGN CHECKED	SFE	Aug.26	PROJECT PHASE
DRAWING CHECKED	JC	Aug.26	CONCEPT DESIGN

NOT FOR CONSTRUCTION

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CLIENT **WM NEW ZEALAND**

PROJECT **REDVALE LANDFILL EXPANSION**

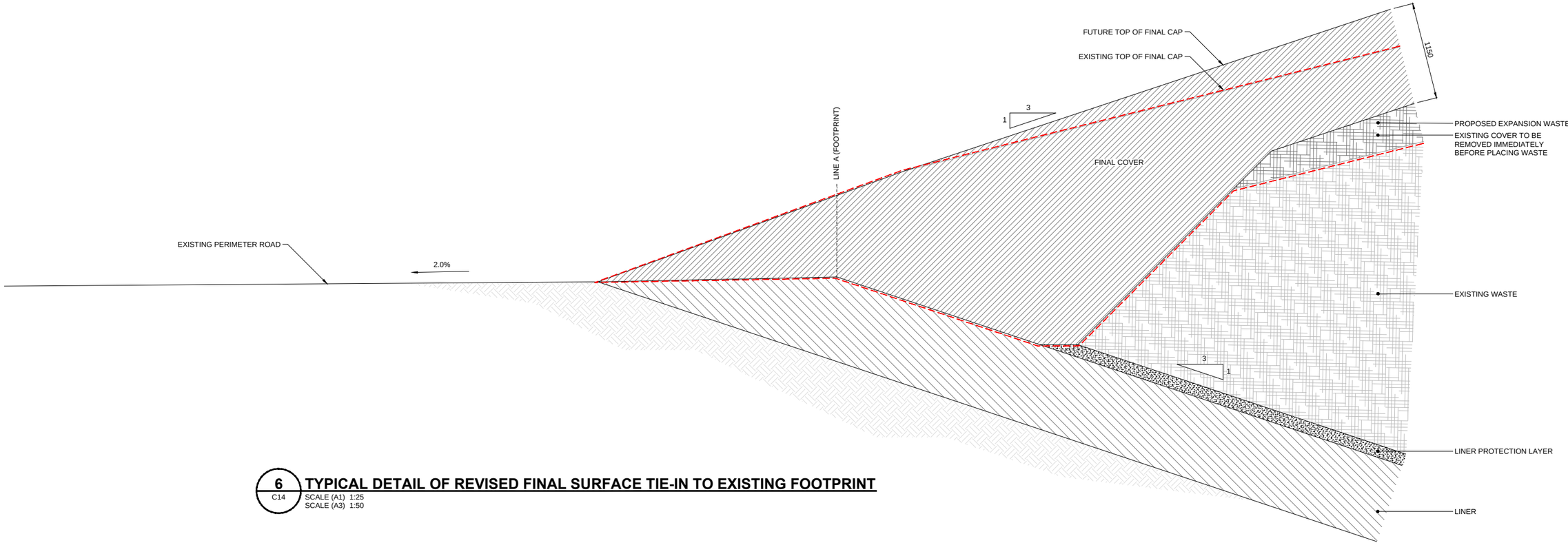
TITLE CLASS 1 PERIMETER BUND DETAILS

SCALE (A1) 1:25 DWG No. 1092369.3000-C31 REV A

C:\12dS\data\ALBTCAD\Auckland Regional Landfill – Transition Project_1847\CAD\DWG\1092369.3000-C32.dwg 2026-Aug-10 7:35:58 am Plotted By: MELP

NOTES

1. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.



6 C14 **TYPICAL DETAIL OF REVISED FINAL SURFACE TIE-IN TO EXISTING FOOTPRINT**

SCALE (A1) 1:25
SCALE (A3) 1:50

0 0.625 1.25 m
1:25 (A1)
1:50 (A3)

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REV	DESCRIPTION	CAD	CHK	DATE
A	SUBSTANTIVE ISSUE	MELP	AWS	10.08.26

DESIGNED	AWS	Aug.26	DRAWING STATUS
DRAWN	MELP	Aug.26	SUBSTANTIVE ISSUE
DESIGN CHECKED	SFE	Aug.26	PROJECT PHASE
DRAWING CHECKED	JC	Aug.26	CONCEPT DESIGN

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APPROVED DATE

CLIENT **WM NEW ZEALAND**

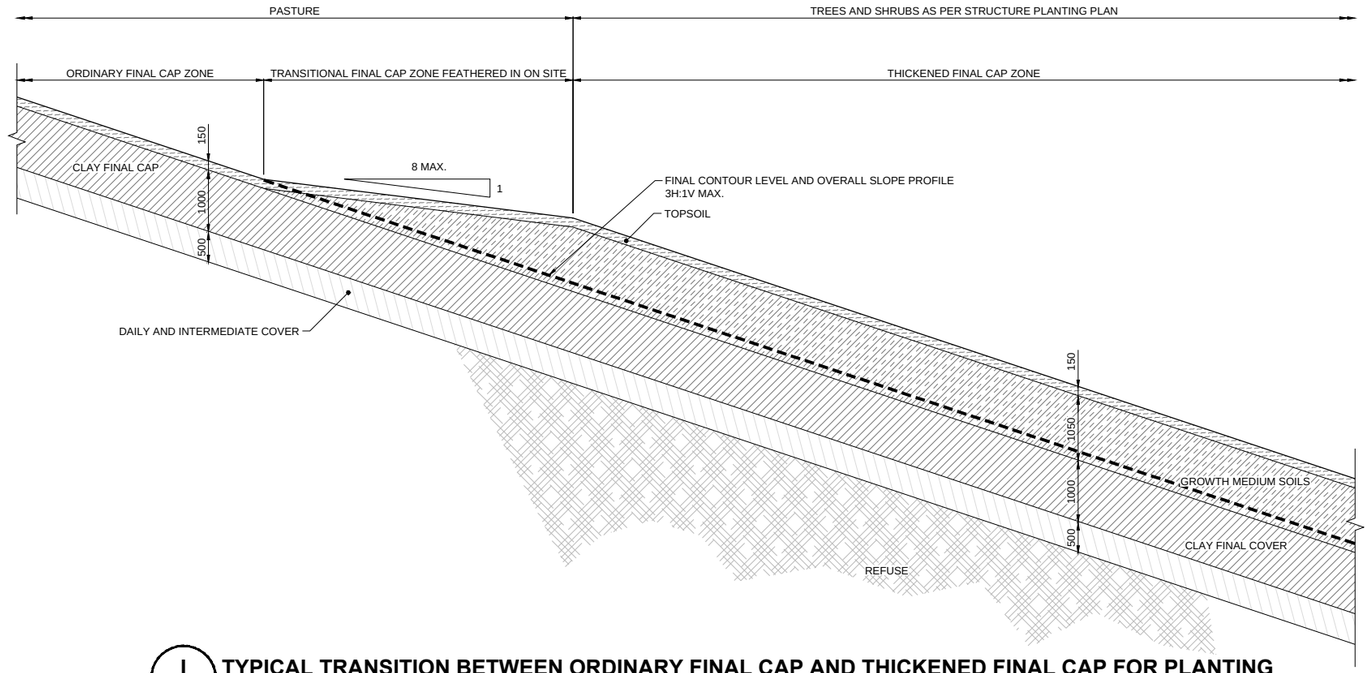
PROJECT **REDVALE LANDFILL EXPANSION**

TITLE CLASS 1 NORTHERN PERIMETER DETAILS

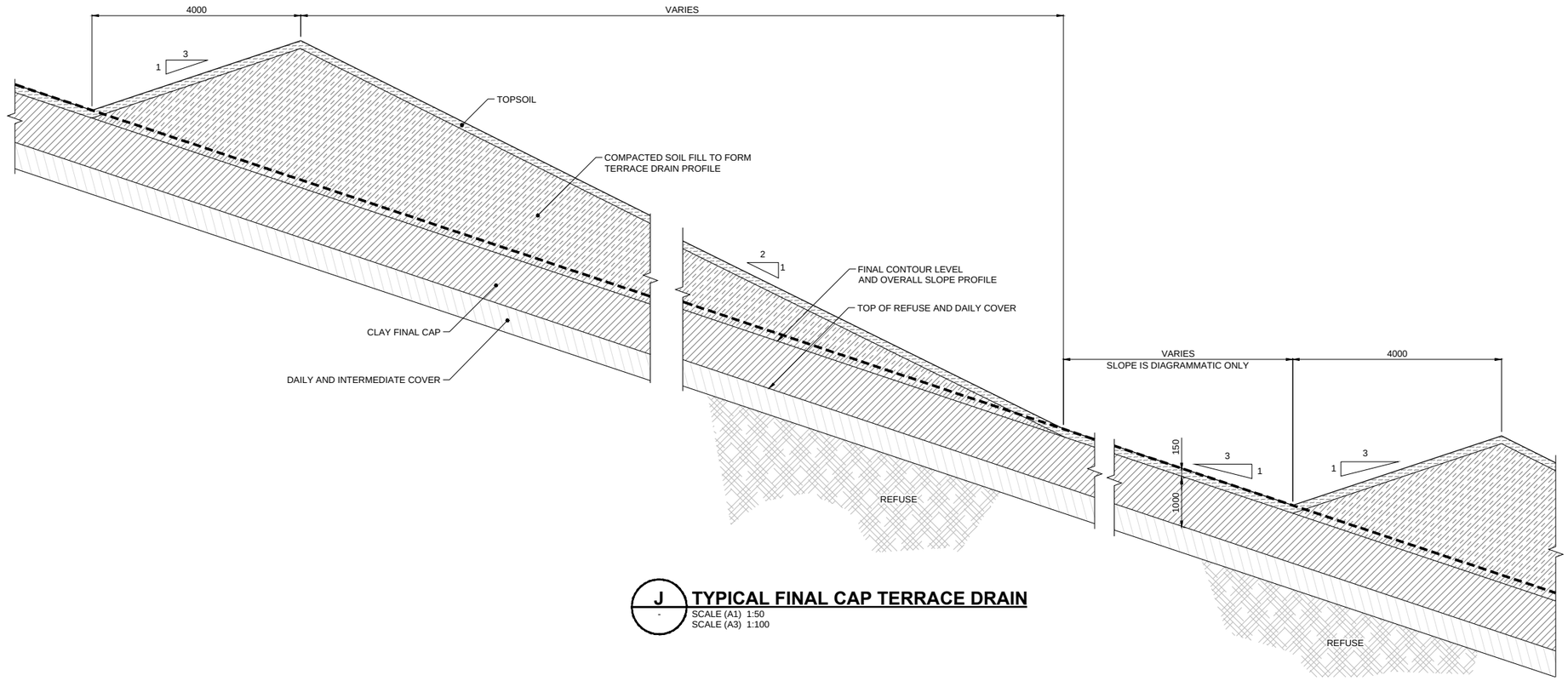
SCALE (A1) 1:25 DWG No. 1092369.3000-C32 REV A

NOTES

1. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.



I — **TYPICAL TRANSITION BETWEEN ORDINARY FINAL CAP AND THICKENED FINAL CAP FOR PLANTING**
SCALE (A1) 1:50
SCALE (A3) 1:100



J — **TYPICAL FINAL CAP TERRACE DRAIN**
SCALE (A1) 1:50
SCALE (A3) 1:100

0 0.05 0.1 m
1:2 (A1)
1:4 (A3)

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REV	DESCRIPTION	CAD	CHK	DATE	APPROVED	DATE
A	SUBSTANTIVE ISSUE	MELP	AWS	10.08.26		

DESIGNED	AWS	Aug.26	DRAWING STATUS
DRAWN	MELP	Aug.26	SUBSTANTIVE ISSUE
DESIGN CHECKED	SFE	Aug.26	PROJECT PHASE
DRAWING CHECKED	JC	Aug.26	CONCEPT DESIGN

NOT FOR CONSTRUCTION

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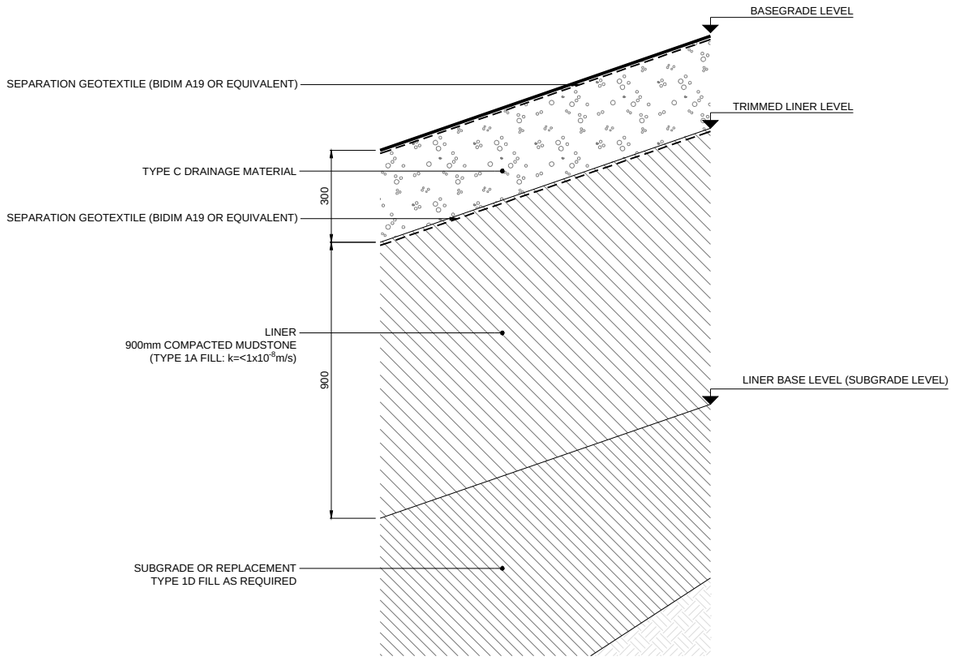
CLIENT **WM NEW ZEALAND**
PROJECT **REDVALE LANDFILL EXPANSION**
TITLE CLASS 1 AND CLASS 2 CAP DETAILS

SCALE (A1) 1:50 DWG No. 1092369.3000-C33 REV A

C:\12dS\data\ALBTCAD\Auckland Regional Landfill – Transition Project_1847\CAD\DWG\1092369.3000-C35.dwg 2026-Aug-10 7:36:11 am Plotted By: MELP

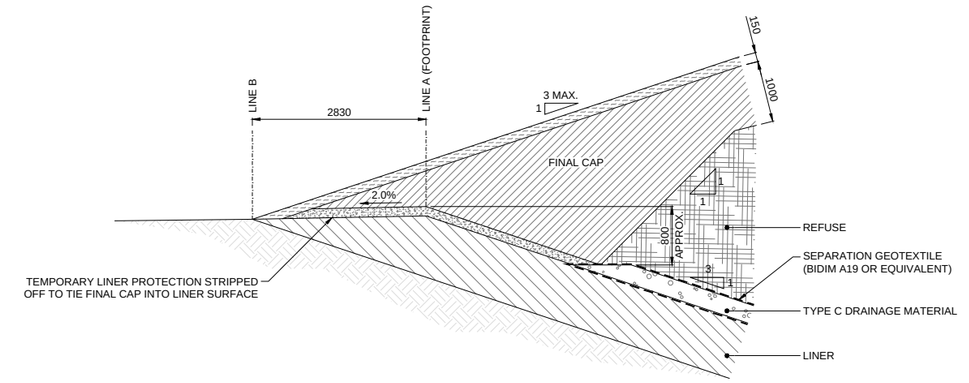
NOTES

1. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. LEACHATE DRAINAGE LAYER THICKNESS SHALL BE A MINIMUM OF 300mm FOR TYPE C AGGREGATE.
3. STORMWATER DIVERSION BUND TO BE REMOVED AND REPLACED WITH 300mm THICK TYPE C AGGREGATE PRIOR TO PLACING REFUSE.



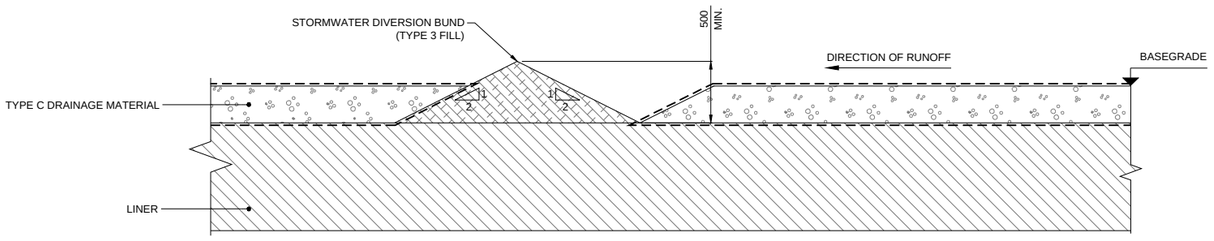
K STANDARD CLASS 2 FOOTPRINT EXTENSION LINING SYSTEM

SCALE (A1) 1:10
SCALE (A3) 1:20



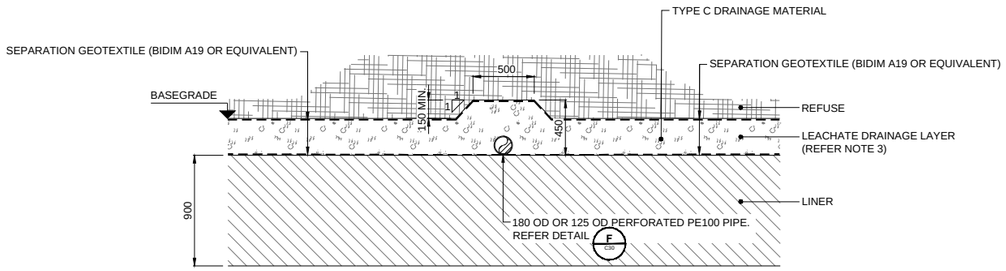
L TYPICAL DETAIL OF CLASS 2 FOOTPRINT EXTENSION FINAL CAP PERIMETER TIE-IN

SCALE (A1) 1:50
SCALE (A3) 1:100



M TYPICAL TEMPORARY CLASS 2 FOOTPRINT EXTENSION STORMWATER DIVERSION BUND

SCALE (A1) 1:25
SCALE (A3) 1:50



N TYPICAL CLASS 2 FOOTPRINT EXTENSION LEACHATE COLLECTOR DRAIN

SCALE (A1) 1:25
SCALE (A3) 1:50

0 0.25 0.5 m 1:10 (A1) 1:20 (A3)
0 0.625 1.25 m 1:25 (A1) 1:50 (A3)
0 1.25 2.5 m 1:50 (A1) 1:100 (A3)

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REV	DESCRIPTION	CAD	CHK	DATE
A	SUBSTANTIVE ISSUE	MELP	AWS	10.08.26

DESIGNED	AWS	Aug.26	DRAWING STATUS
DRAWN	MELP	Aug.26	SUBSTANTIVE ISSUE
DESIGN CHECKED	SFE	Aug.26	PROJECT PHASE
DRAWING CHECKED	JC	Aug.26	CONCEPT DESIGN

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APPROVED DATE

CLIENT **WM NEW ZEALAND**

PROJECT **REDVALE LANDFILL EXPANSION**

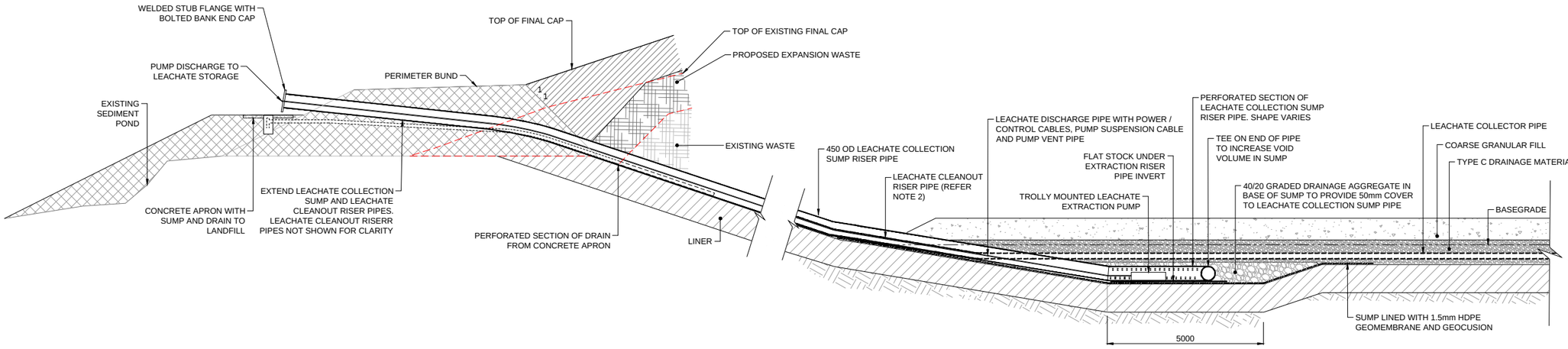
TITLE CLASS 2 LINER DETAILS

SCALE (A1) AS SHOWN DWG No. 1092369.3000-C35 REV A

C:\12dS\data\ALBTCAD\Auckland Regional Landfill – Transition Project_1847\CAD\DWG\1092369.3000-C36.dwg 2026-Aug-10 7:36:17 am Plotted By: MELP

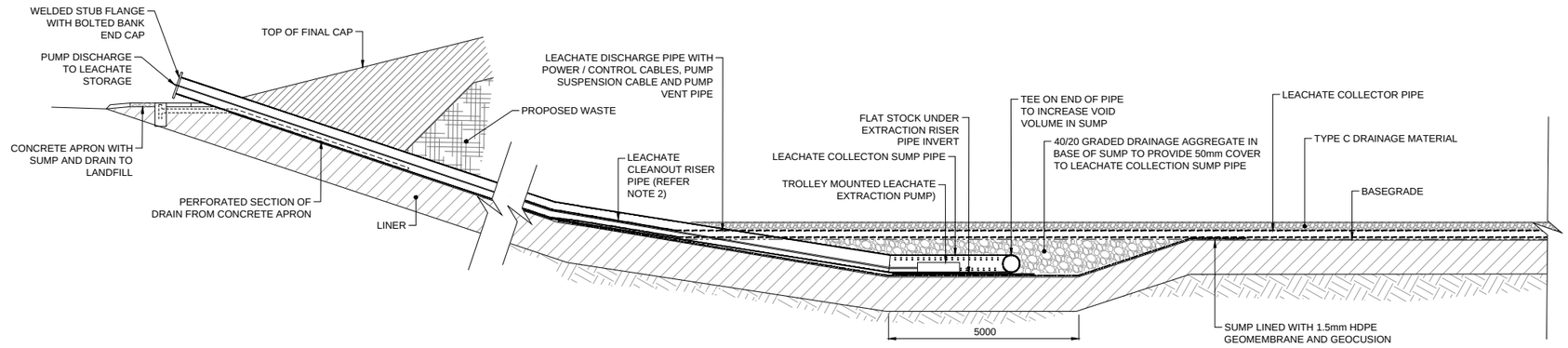
NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. LEACHATE CLEANOUT RISER PIPE NOT SHOWN IN TOP HALF OF SECTION FOR CLARITY.



CLASS 1 LEACHATE SUMP TYPICAL DETAIL

SCALE (A1) 1:75
SCALE (A3) 1:150



CLASS 2 LEACHATE SUMP TYPICAL DETAIL

SCALE (A1) 1:75
SCALE (A3) 1:150

0 1.875 3.75 m
1:75 (A1)
1:150 (A3)

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REV	DESCRIPTION	CAD	CHK	DATE	APPROVED	DATE
A	SUBSTANTIVE ISSUE	MELP	AWS	10.08.26		

DESIGNED	AWS	Aug.26	DRAWING STATUS: SUBSTANTIVE ISSUE
DRAWN	MELP	Aug.26	
DESIGN CHECKED	SFE	Aug.26	PROJECT PHASE: CONCEPT DESIGN
DRAWING CHECKED	JC	Aug.26	

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CLIENT **WM NEW ZEALAND**

PROJECT **REDVALE LANDFILL EXPANSION**

TITLE LEACHATE SUMP DETAILS

SCALE (A1) 1:75 DWG No. 1092369.3000-C36 REV A

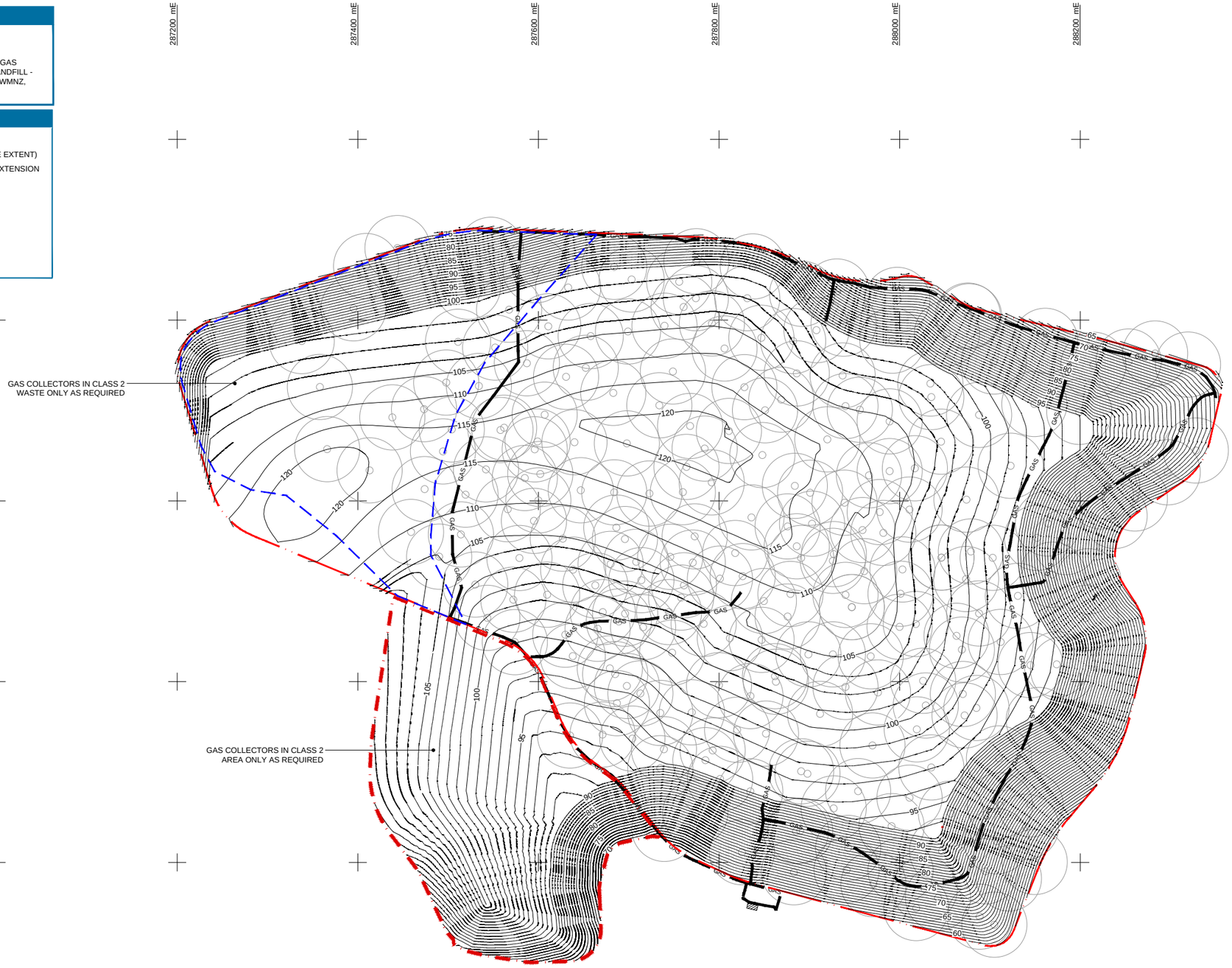
C:\12dS\data\ALBTCAD\Auckland Regional Landfill – Transition Project_1847\CAD\DWG\1092369.3000-C40.dwg 2026-Aug-10 7:36:23 am Plotted By: MELP

NOTES

1. ALL DIMENSIONS IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATE SYSTEM: NZGD1949, MT EDEN CIRCUIT.
3. LEVEL DATUM: AUCKLAND 1946.
4. THE AS-BUILT LOCATION OF THE EXISTING GAS WELLS AND GAS HEADER PIPE ALIGNMENT IS AS PER DRAWING "REDVALE LANDFILL - SITE PLAN OF THE GAS WELLS AND HEADER" PROVIDED BY WMNZ, DATED JULY 2025.

LEGEND

- 100 — FINAL CAP CONTOURS (5.0m INTERVAL)
- FOOTPRINT - LINE A (CONSENTED BASEGRADE EXTENT)
- EXTENT OF PROPOSED CLASS 2 FOOTPRINT EXTENSION
- GAS — GAS HEADER - EXISTING
- GAS WELL - EXISTING
- EXISTING CLASS 2 WASTE BOUNDARY



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REV	DESCRIPTION	CAD	CHK	DATE	APPROVED	DATE
A	SUBSTANTIVE ISSUE	MELP	AWS	10.08.26		

DESIGNED	AWS	Aug.26	DRAWING STATUS	SUBSTANTIVE ISSUE
DRAWN	MELP	Aug.26		
DESIGN CHECKED	SFE	Aug.26	PROJECT PHASE	CONCEPT DESIGN
DRAWING CHECKED	JC	Aug.26		

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CLIENT **WM NEW ZEALAND**

PROJECT **REDVALE LANDFILL EXPANSION**

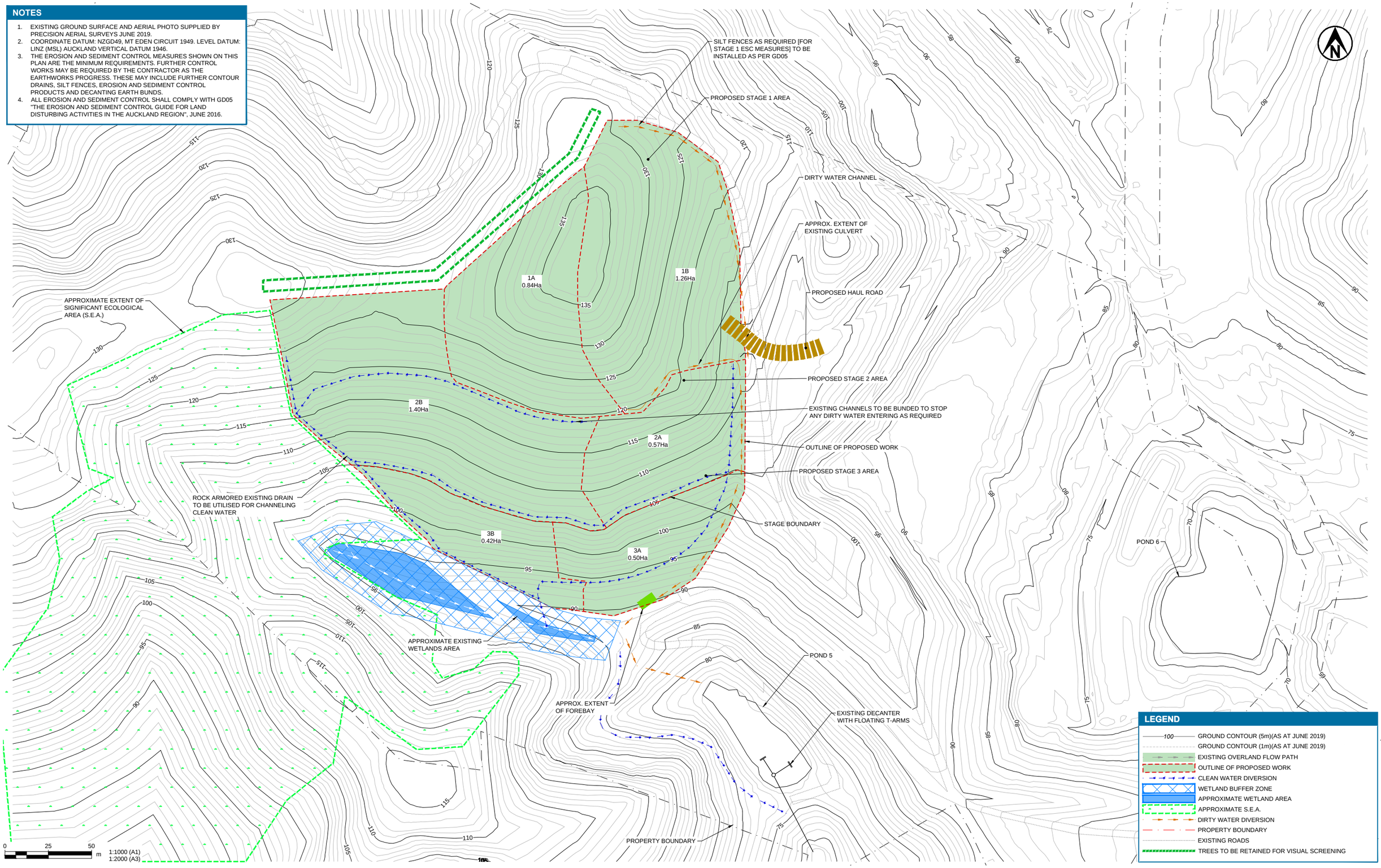
TITLE GAS COLLECTION SYSTEM LAYOUT

SCALE (A1) 1:2500 DWG No. 1092369.3000-C40 REV A

C:\12dS\data\ALBTCAD\Auckland Regional Landfill – Transition Project_1847\CAD\DWG\1092369.3000-C50.dwg 2026-Aug-10 7:36:29 am Plotted By: MELP

NOTES

1. EXISTING GROUND SURFACE AND AERIAL PHOTO SUPPLIED BY PRECISION AERIAL SURVEYS JUNE 2019.
2. COORDINATE DATUM: NZGD49, MT EDEN CIRCUIT 1949. LEVEL DATUM: LINZ (MSL) AUCKLAND VERTICAL DATUM 1946.
3. THE EROSION AND SEDIMENT CONTROL MEASURES SHOWN ON THIS PLAN ARE THE MINIMUM REQUIREMENTS. FURTHER CONTROL WORKS MAY BE REQUIRED BY THE CONTRACTOR AS THE EARTHWORKS PROGRESS. THESE MAY INCLUDE FURTHER CONTOUR DRAINS, SILT FENCES, EROSION AND SEDIMENT CONTROL PRODUCTS AND DECANTING EARTH BUNDS.
4. ALL EROSION AND SEDIMENT CONTROL SHALL COMPLY WITH GD05 "THE EROSION AND SEDIMENT CONTROL GUIDE FOR LAND DISTURBING ACTIVITIES IN THE AUCKLAND REGION", JUNE 2016.



LEGEND

- GROUND CONTOUR (5m)(AS AT JUNE 2019)
- GROUND CONTOUR (1m)(AS AT JUNE 2019)
- EXISTING OVERLAND FLOW PATH
- OUTLINE OF PROPOSED WORK
- CLEAN WATER DIVERSION
- WETLAND BUFFER ZONE
- APPROXIMATE WETLAND AREA
- APPROXIMATE S.E.A.
- DIRTY WATER DIVERSION
- PROPERTY BOUNDARY
- EXISTING ROADS
- TREES TO BE RETAINED FOR VISUAL SCREENING

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REV	DESCRIPTION	CAD	CHK	DATE
A	SUBSTANTIVE ISSUE	MELP	AWS	10.08.26

DESIGNED	AWS	Aug.26	DRAWING STATUS: SUBSTANTIVE ISSUE
DRAWN	MELP	Aug.26	
DESIGN CHECKED	SFE	Aug.26	PROJECT PHASE: CONCEPT DESIGN
DRAWING CHECKED	JC	Aug.26	

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APPROVED DATE

CLIENT **WM NEW ZEALAND**

PROJECT **REDVALE LANDFILL EXPANSION**

TITLE STOCKPILE 4 LAYOUT

SCALE (A1) 1:1000 DWG No. 1092369.3000-C50 REV A

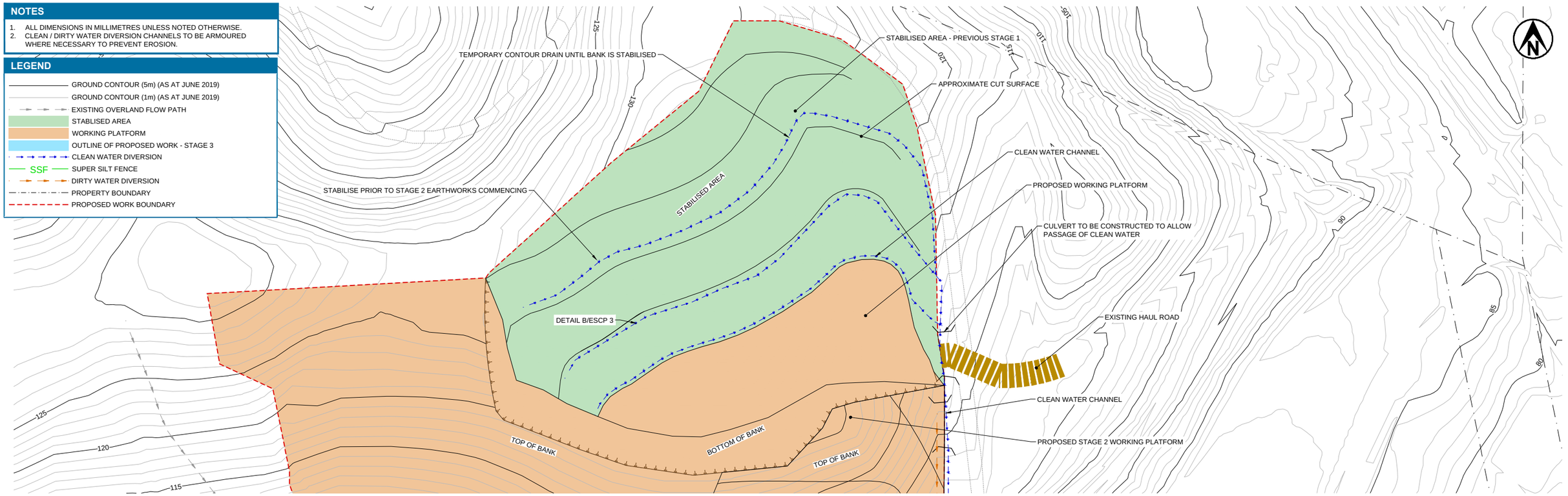
C:\12dS\data\ALBTCAD\Auckland Regional Landfill – Transition Project_1847\CAD\DWG\1092369.3000-C51.dwg 2026-Aug-10 7:36:36 am Plotted By: MELP

NOTES

1. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. CLEAN / DIRTY WATER DIVERSION CHANNELS TO BE ARMOURED WHERE NECESSARY TO PREVENT EROSION.

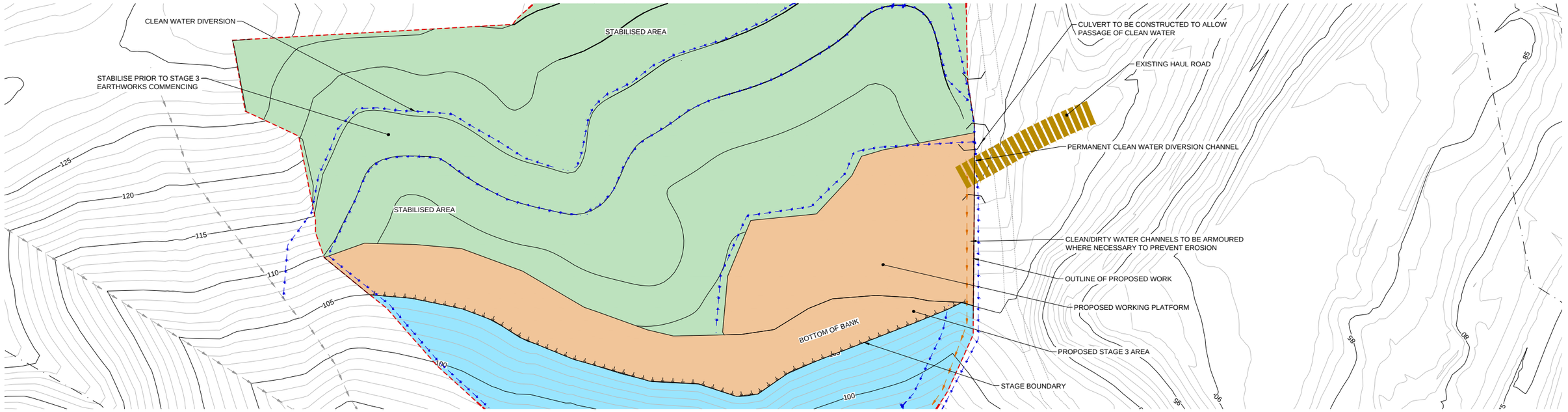
LEGEND

- GROUND CONTOUR (5m) (AS AT JUNE 2019)
- GROUND CONTOUR (1m) (AS AT JUNE 2019)
- EXISTING OVERLAND FLOW PATH
- STABLISED AREA
- WORKING PLATFORM
- OUTLINE OF PROPOSED WORK - STAGE 3
- CLEAN WATER DIVERSION
- SSF SUPER SILT FENCE
- DIRTY WATER DIVERSION
- PROPERTY BOUNDARY
- PROPOSED WORK BOUNDARY



END OF STAGE 1 / START OF STAGE 2

SCALE (A1) 1:750
SCALE (A3) 1:1500



END OF STAGE 2 / START OF STAGE 3

SCALE (A1) 1:750
SCALE (A3) 1:1500

0 18.75 37.5 m
1:750 (A1)
1:1500 (A3)

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REV	DESCRIPTION	CAD	CHK	DATE
A	SUBSTANTIVE ISSUE	MELP	AWS	10.08.26

DESIGNED	AWS	Aug.26	DRAWING STATUS	SUBSTANTIVE ISSUE
DRAWN	MELP	Aug.26		
DESIGN CHECKED	SFE	Aug.26	PROJECT PHASE	CONCEPT DESIGN
DRAWING CHECKED	JC	Aug.26		

NOT FOR CONSTRUCTION

THIS DRAWING IS NOT TO BE USED FOR CONSTRUCTION PURPOSES UNLESS SIGNED AS APPROVED

APPROVED DATE

CLIENT **WM NEW ZEALAND**

PROJECT **REDVALE LANDFILL EXPANSION**

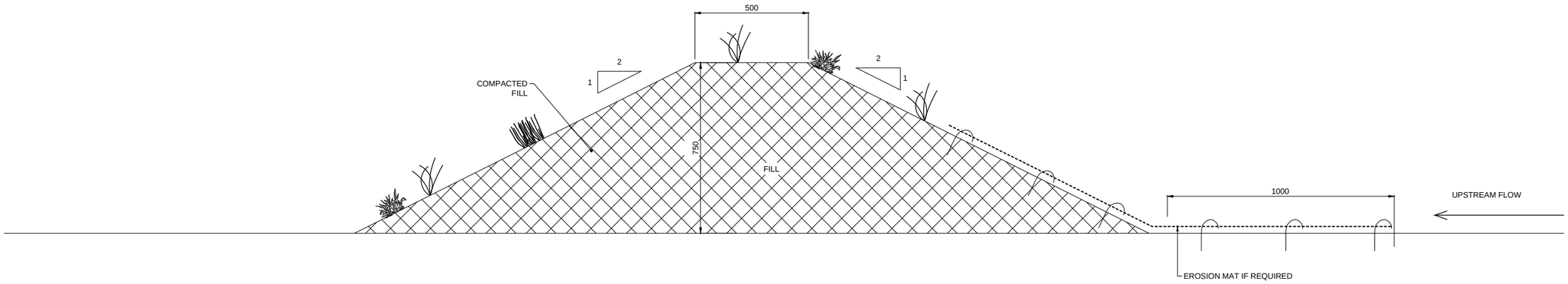
TITLE STOCKPILE 4 STAGING

SCALE (A1) 1:750 DWG No. 1092369.3000-C51 REV A

C:\12dS\data\ALBTCAD\Auckland Regional Landfill – Transition Project_1847\CAD\DWG\1092369.3000-C52.dwg 2026-Aug-10 7:42:06 am Plotted By: MELP

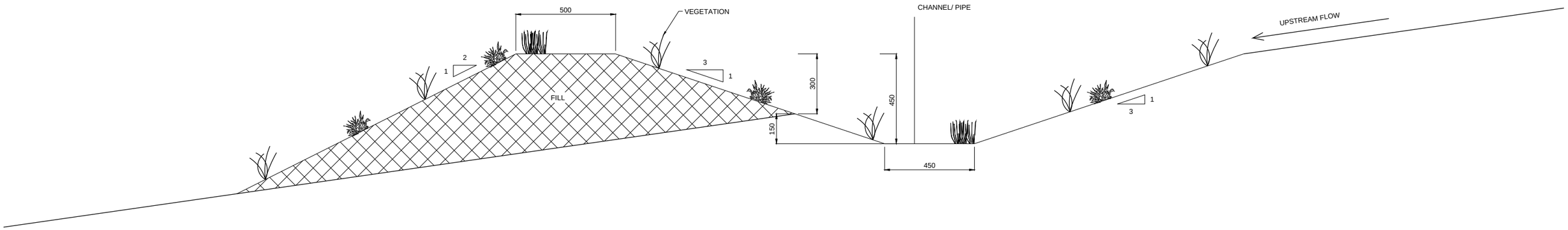
NOTES

1. ALL MEASUREMENTS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. ALL EROSION AND SEDIMENT CONTROL MEASURES TO COMPLY WITH AND BE CONSTRUCTED IN ACCORDANCE WITH GD05.
3. TYPICAL DETAILS SOURCED FROM AUCKLAND REGIONAL COUNCIL GD05.



A - EARTH BUND - TYPICAL SECTION

SCALE (A1) 1:10
SCALE (A3) 1:20



B - CLEAN WATER DIVERSION CHANNEL - TYPICAL SECTION

SCALE (A1) 1:10
SCALE (A3) 1:20

0 0.25 0.5 m
1:10 (A1)
1:20 (A3)

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REV	DESCRIPTION	CAD	CHK	DATE
A	SUBSTANTIVE ISSUE	MELP	AWS	10.08.26

DESIGNED	AWS	Aug.26	DRAWING STATUS	SUBSTANTIVE ISSUE
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CLIENT **WM NEW ZEALAND**

PROJECT **REDVALE LANDFILL EXPANSION**

TITLE STOCKPILE 4 DETAILS

SCALE (A1) 1:10 DWG No. 1092369.3000-C52 REV A

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