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146 TE MAWHAI ROAD, TE AWAMUTU

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FORMER TOKANUI PSYCHIATRIC HOSPITAL DEMOLITION AND REMEDIATION EXISTING DISPOSAL SITE REPAIR AND UPGRADE WORKS REPORT

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EXISTING DISPOSAL SITE REPAIR AND UPGRADE WORKS REPORT

EXECUTIVE SUMMARY

The Former Tokanui Psychiatric Hospital (FTPH) site (the Site) was part of a land package taken under the Public Works Act in 1910. The Tokanui Hospital opened in 1912 and closed in 1998. The Site was then transferred into the Treaty Settlements Landbank in 1999 (managed by the Ministry of Justice at the time) to potentially be used as redress to settle historical claims. The Site was transferred to Toitū Te Whenua Land Information New Zealand (LINZ) in 2016 with the remainder of Treaty Settlements Landbank property portfolio and is currently managed by LINZ.

While operational, the hospital had its own landfill comprising two separate areas (referred to as the Disposal Site in this report), located off Farm Road (private road), directly east of the Wharekōrino Stream located within the Site boundary. The landfill was closed in 2000 and is authorised by the Waikato Regional Council under the existing disposal consents numbered 102269.01.01, 102270.01.01 and 102271.01.01.

The FTPH is a deferred selection property in the Ngāti Maniapoto Deed of Settlement (the Deed). Under the Deed, the Crown has committed to undertaking demolition and remedial works on the main hospital complex, but is not required to carry out remedial works on the closed landfill (defined as existing Disposal Sites in the Deed). LINZ, on behalf of the Crown, is, however required to maintain valid land use resource consents for the monitoring of the existing Disposal Site in perpetuity and is tasked with the ongoing management and monitoring of the existing Disposal Site.

As part of this responsibility, LINZ requested Fraser Thomas Ltd (FTL) to undertake an intrusive investigation of the closed landfill to help inform a long-term management strategy and ensure the existing disposal sites are compliant with the current consent conditions. Investigation of the existing Disposal Site has found that there are a number of issues with its current condition, that have potential to result in adverse human health or environmental effects. These include:

- Some areas have non-compliant capping (i.e., inadequate thickness and/or permeability) and/or topsoil cover in relation to the approved resource consent for the landfill site. This will tend to increase leachate generation from direct rainfall onto the landfill whilst also increasing the risk of some buried material becoming exposed, representing a potential human health threat.
- The landfill does not have a leachate collection system, so the leachate will flow through the landfill to the groundwater table, while the lack of landfill base and side liners and groundwater subsoil drainage allows groundwater to come into direct contact with buried refuse in some locations. Together, these factors mean that groundwater passing through the landfill contains some elevated contaminants from direct refuse contact and leachate ingress, with the groundwater flowing into the Wharekōrino Stream. Elevated boron levels are present in the groundwater and stream, which are still occurring in 2024, albeit within ANZECC 95% freshwater protection and long-term irrigation trigger values in the stream.
- Culvert 3 (1350dia) pipes the Wharekōrino Stream through Area A2/H of the landfill. This culvert is estimated to be 44-65 years old and could be subject to differential settlement from landfill activity, leading to leaking joints and ultimately possible pipe failure. These landfill areas are both outside the landfill extent referred to under the existing resource consent. Pipe failure could result in fill/refuse

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washout down the stream, causing adverse human health and environmental damage, representing a long-term risk.

- Flood modelling of the Wharekōrino Stream has shown that the landfill areas A, B, C, G and H are currently likely to be inundated to varying extents during a 1% AEP (annual exceedance probability) storm event, particularly if the two downstream culverts on the stream are blocked or become blocked during the storm, with these effects worsening with predicted climate change. Areas D, E and F have been found unlikely to be affected by flooding. Flooding of landfill areas could cause scour/erosion of landfill side slopes and possible exposure of refuse, potentially causing downstream pollution and contamination.

Based on this assessment, a high-level assessment of options to repair and/or upgrade the existing Disposal Site was undertaken. LINZ objectives for the options assessment were to ensure that human health, social and cultural values and the environment are protected from closed landfill hazards, to ensure responsible long-term taxpayer value for money, and to reduce the Crown's long-term liability.

Effectively, the options considered, shown in Table E.1, below, represent a continuum from Option 1 (do nothing) through various options, involving one to six different work components, including transfer of contaminated soil from the hospital site demolition works into the landfill and transfer of clean soil material from the landfill to the hospital for use as backfill. The option of complete removal and off-site disposal of all landfilled material was also considered following feedback from mana whenua. These options were evaluated against a range of criteria developed specifically in relation to the identified issues. The options considered, evaluation criteria and scoring are summarized in the following table.

The preferred option is Option 4 which involves the following works:

(a) Improved capping of the entire landfill.
(b) Removal of Culvert 2 and associated road embankment.
(c) Transfer of contaminated soil from hospital demolition works into Area E/F and isolated medical waste removal, with excavated material from this area being used as backfill in the demolition works.
(d) Shifting of fill/refuse material from the south-eastern corner of Area A1 that is located on AgResearch land (Section 3 SO 534156), outside of the subject site, into the A1 area within the subject site.
(e) Shifting of fill/refuse material from Areas A2/H into Area A1 and associated removal of Culvert 3, plus stream reinstatement, with a new embankment on the eastern side of the stream to separate the reclaimed area from existing landfill area A1.
(f) Maintain existing southern farm track crossing embankment, raising it slightly to assist with flood mitigation, and line or replace first section of culvert running under this, tying into reinstated stream.

This option has the greatest benefits across the adopted evaluation criteria. Following engagement with iwi, selection of the preferred option from the above assessment process, further engineering design work was undertaken to assess the constructability and affordability of this option. This work found that the proposed Culvert 3 removal, stream reinstatement and new landfill toe bund embankment would result in an estimated volume of approximately 7,500m^3 of refuse having to be moved from Area A2/H and part of Area A1 into Area A1/B. As Area H contained considerably less refuse than Area A2, the following refinements were made to the preferred option:

(a) The alignment of the new shorter culvert through the farm track crossing embankment was shifted more to the north-west so as to avoid passing through Area A2 as much as practicable.
(b) The reinstated stream was also shifted further west of the original alignment to lie entirely outside of Area A2.
(c) The intersection of this stream with the existing stream was shifted further downstream.

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(d) These changes meant that Culvert 3 no longer needed to be removed to facilitate the works in this area, but could remain in place and instead be filled with grout and sealed at each end.

Based on the information presented in this report, including the Assessment of Environmental Effects in section 6 of this report, it is considered that the proposed landfill repairs and upgrade works represent the best practicable option for the Crown's long-term management of the closed landfill as it will improve the integrity and resilience of the existing landfill, provide a disposal site for the hospital contaminated soil, and be a source of backfill material for the hospital demolition and remediation works. It is considered that these works can be adequately managed to protect workers and avoid any adverse effects on human health and the receiving environment, while the long-term benefits and reduction in liability are significant due to the removal of Culvert 2, diversion of the Wharekōrino Stream around the landfill, and plugging of Culvert 3 in relation to potential landfill washout/failure and flood mitigation. This option also addresses feedback from iwi over the course of the project, as it will result in greater protection to nearby waterways by installing improved barriers to reduce leachate generation.

This investigation has been managed, reviewed and approved by a Suitably Qualified and Experienced Practitioner (SQEP), as defined in the Resource Management (National Environment Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 (NESCS) and by suitably qualified and experienced staff with landfill experience.

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Table E1: Options Assessment

Option ID - Name	Work Components						Benefits					
	Improved Capping	Transfer Contam. Soil from Hospital into landfill area E/F and remove medical waste from Area F	Shift Refuse Material from Areas A2/H + Ag. land to Area A1 + Stream Rein-statement	Culvert 3 Partial Removal	Culvert 2 Removal	Install Up-gradient Ground-water Cutoff Drain	Opti-mising Use of Existing Landfill	Improved Waste Contain-ment and Capping	Reduced Leachate Generation and Groundwater Contamination	Elim-inate Culvert 3 Risk of Leaks/ Failure	Flooding Miti-gation	Min-imal off-site effects during works
1 - No change	Excluded	Excluded	Excluded	Excluded	Excluded	Excluded	N	N	N	N	N	Y
2 - Minimum	Included	Excluded	Excluded	Excluded	Included	Excluded	N	YY	Y	N	Y	N
3 – Inter-mediate	Included	Included	Excluded	Excluded	Included	Excluded	Y	YY	Y	N	Y	N
4 - Advanced	Included	Included	Included	Included	Included	Included	YY	YY	YY	YY	YY	N
5 - Off-site Removal	Off-site removal of all refuse and replacement with imported clean soil.						NN	Y	YY	YY	YY	NN

Note:

1. All options 2-4 all include removal of culvert 2, as this was selected as a beneficial remediation option in the Horizontal Infrastructure investigation work.
2. Shadings: Red = significant negative benefit (NN); orange = no benefit (N); light green = some benefit (Y), dark green = significant benefit (YY)
3. Ag. = AgResearch

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1.0 INTRODUCTION

This report describes the proposed repair and upgrade works for the closed landfill (existing Disposal Sites[1]) at the former Tokanui Psychiatric Hospital (FTPH, the Site).

This investigation has been managed, reviewed and approved by a Suitably Qualified and Experienced Practitioner (SQEP), as defined in the Resource Management (National Environment Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 (NESCS) and by suitably qualified and experienced staff with landfill experience.

2.0 OBJECTIVES AND SCOPE

The key objectives and scope of this report are:

(a) To summarise the current state of knowledge relating to the existing Disposal Site and the main issues associated with its ongoing management.

(b) To provide an overview of associated regulatory requirements and best practice for closed landfill management.

(c) To provide a high-level assessment of repair and upgrade options for the existing Disposal Site. This includes possible placement of low and moderate level contaminated soils from hospital demolition and remediation works within the existing Disposal Site area (refer to section 3 for background and context).

(d) To identify the preferred repair and upgrade option and associated works methodology.

(e) To provide an assessment of environmental effects for the preferred repair and upgrade option.

3.0 BACKGROUND

3.1 CONTEXT

The Site is part of a land package taken under the Public Works Act in 1910, which included approximately 1,194 ha for health services. The Tokanui Hospital opened in 1912 and closed in 1998. The Site was then transferred into the Treaty Settlements Landbank in 1999 (managed by the Ministry of Justice at the time) to potentially be used as redress to settle historical claims. The Site was transferred to Toitū Te Whenua Land Information New Zealand (LINZ) in 2016 with the remainder of Treaty Settlements Landbank property portfolio and is currently managed by LINZ.

The FTPH is a deferred selection property in the Ngāti Maniapoto Deed of Settlement (the Deed). Under the Deed, the Crown has committed to undertaking demolition and remedial works on the main hospital complex, but is not required to carry out remedial works on the closed landfill (defined as existing Disposal Sites in the Deed). LINZ, on behalf of the Crown, is, however, required to maintain valid land use resource

[1] As defined by 9.1.13 under Schedule 9: Tokanui Hospital Deferred Selection Process of the Ngāti Maniapoto Deed of Settlement Schedule: Property Redress

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consents for the monitoring of the existing Disposal Site in perpetuity and is tasked with the ongoing management and monitoring of the existing Disposal Site. Detailed information on the Crown's commitments under the Deed is provided in section 3.7, below, and wider context to the overarching demolition and remediation project is provided in the Project Background Document (LINZ, 2024).

3.2 EXISTING CLOSED LANDFILL DISPOSAL SITE

The existing Disposal Site is located on Farm Road (private road), directly east of the Wharekōrino Stream, located within the FTPH site boundary. The area investigated by Fraser Thomas as potentially being used for landfilling encompassed an area approximately 7.7ha in size, as shown in Figure 1. This area is currently in pastoral land use (grazing).

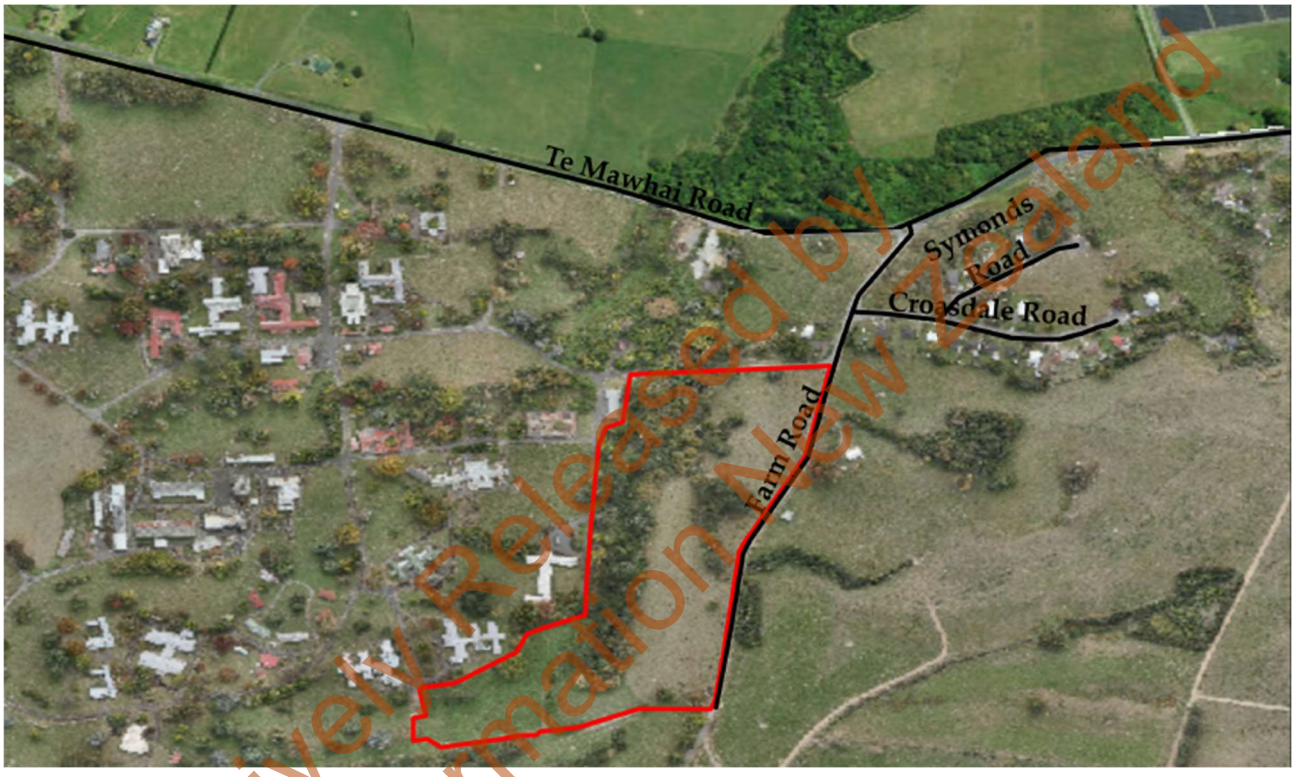

Figure 1: Closed Landfill Investigation Area (red outline)

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3.3 INTRUSIVE INVESTIGATION FINDINGS

The Tokanui Hospital Landfill Closure Assessment of Environmental Effects (AEE) (1998) describes the existing Disposal Site as comprising one fenced off area approximately 1.92ha in size, within which there were several distinct areas that have been used for different types of refuse disposal, as shown in Figure 2.

The Fraser Thomas 2022-23 investigation identified ten areas for intrusive investigation, of which all but two were found to contain landfill material, as shown in Figure 3.

Estimated Disposal Site areas and volumes, closure dates, topsoil, cover and fill characteristics and contamination status are summarised in Table 1.

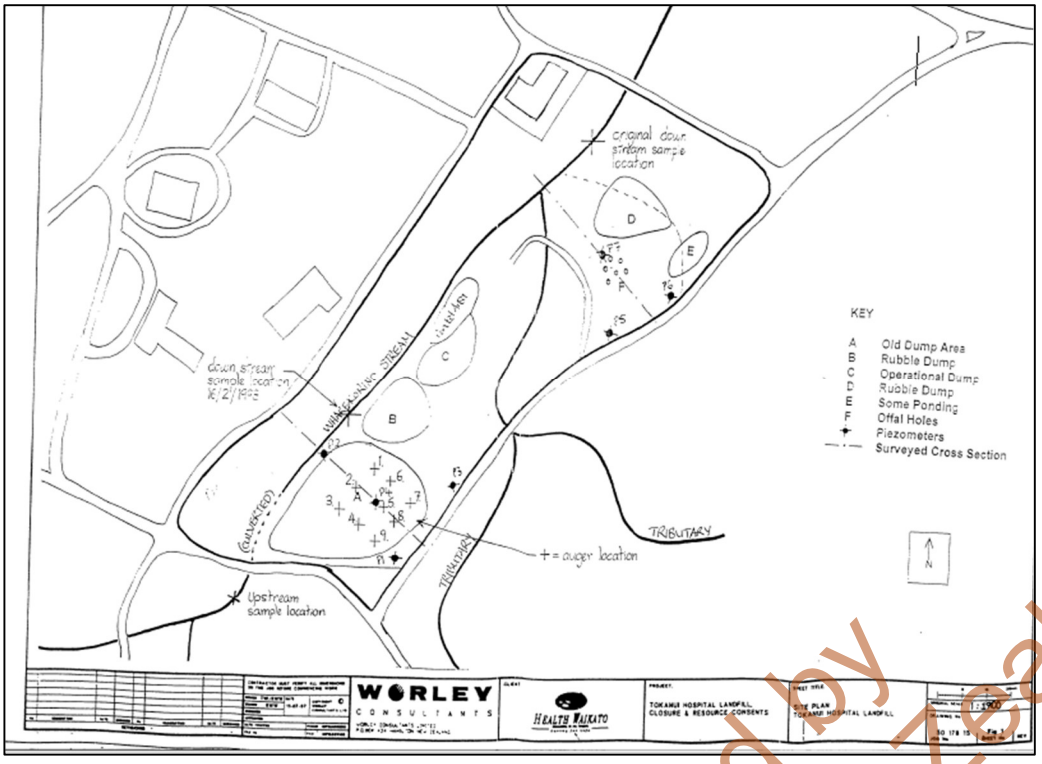

Figure 2: Closed Landfill Site Plan ex Worley

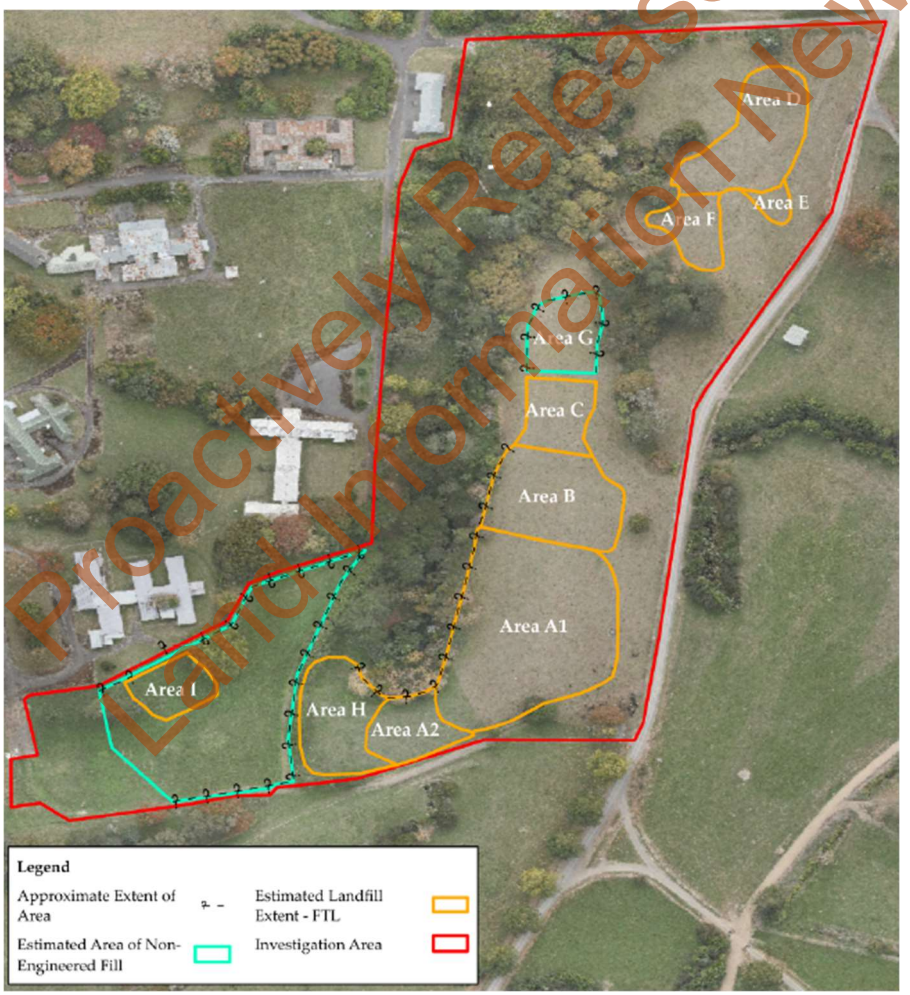

Figure 3: Areas confirmed as being used for Historic Landfilling (8 of 10 areas).

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Table 1: Existing Disposal Sites Areas/Volumes and Topsoil/Cap/Fill Characteristics

Item	Area							
	A	B	C	D	E	F	G	H
Area (m^2)	7,990	2,790	1,180	2,440	660	930	1,310	1,980
Fill Volume (m^3)	12,960-16,310*	3,420	1,350	3,870	0	3,730	0	910
Estimated Date for End of Filling	1988	1979	1997	~1979	~ 1979	~ 1979	~1979	~1979
Topsoil cover – range (average) (mm)	100-300 (145)	100-200 (157)	100-200 (162)	50-200 (139)	100	200	100-200 (151)	0
Topsoil contamination	83% > BG but < GL; 9.5% > RR/CI (Asb)	All > BG but < GL	50% > BG but < GL; 50% > RR/CI (Asb)	All > BG < GL	All < BG	All > BG < GL	All > BG < GL	All > BG but < GL; 20% > RR/CL (Asb)
Landfill Cap Thickness – range (avg (mm)	100-800 (522)	100-400 (275)	400-600 (476)	0-250 (155)	200 (1 Test pit)	300 (1 Test pit)	0	0
Cap permeability (m/s)	$<10^{-7}$ except TP2	$<10^{-7}$	$<10^{-7}$	$<10^{-7}$	$<10^{-7}$	$<10^{-7}$	Not applicable	Not applicable
Fill Description (main content)	Construction & general waste, burnt material, inferred boiler ash, asbestos	Construction/demolition waste, some burnt debris	General & construction waste	Construction waste, including wood, metal, concrete and bricks	None	Medical waste buried in multiple small offal pits	Reworked Material	Generally soil with some construction & general waste, burnt material, tree stumps/wood fragments
Fill contamination status (% samples)	Landfill (90%), Managed Fill (10%)	Landfill (40%), managed fill (20%), cleanfill (40%)	Landfill (100%)	Landfill (100%)	N/A	Landfill (100%) due to hazardous medical waste	N/A	Landfill (100%)

Notes:

1. BG = background, RR = rural residential, C/I = commercial/industrial, GL = guideline, Asb = asbestos, * - range accounts for potential fill volume based on filling method in cells rather than uncontrolled filling.
2. Estimated areas and volumes have ±10-30% accuracy, with the higher 30% range allowing for the method and nature of filling in Areas A, H and F (uncontrolled filling).

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Overall, the aerial photographs and desktop information show that the portions of the site assessed as part of this investigation were subject to landfilling from at least 1943 through to 1979 and possibly into the 1980s, while information in the Worley AEE indicates Area A was closed in 1988 and Area C in 1997. Areas outside of the primary landfilling areas (Areas H & I), east of the historic Disposal Site were also assessed, given visual identification of potential filling activities during the historical review and onsite interviews with local Kaumātua. However, Area I was found to be more an isolated opportunistic fill area and is not considered part of the historical landfill – hence it is discussed further in the hospital demolition resource consent application documents referred to as the Remediation Application, prepared by SLR Consulting Ltd (2024).

The geotechnical information available has confirmed the site underlying geology is non-volcanic, and consists largely of alluvial material belonging to the Tauranga Group. Laboratory testing of soil samples confirmed contamination is present within various areas of the Disposal Site, with exceedances of both the NESCS rural residential/lifestyle block - no produce (unpublished) land use criteria and the NESCS commercial/industrial outdoor worker (unpaved) land use criteria. In addition, there were numerous exceedances of the BRANZ asbestos in soil guidelines for both residential and commercial/industrial sites. There were also numerous exceedances of the Class 1 Landfill acceptance criteria in Areas A, C, D & H, which are predominantly located within the 'old landfill' areas where disposed material was burnt.

Toxicity Characteristic Leaching Procedure (TCLP) testing was undertaken on the samples exhibiting the highest levels of contamination across the Disposal Site. Thirteen samples were analysed, with all results indicating the various soil & fill materials in the Disposal Site would be suitable for disposal off-site, to a Class 1 Landfill.

Given the extent and nature of the fill material found and the contamination identified thus far, it is considered unlikely that the contaminated fill materials could be separated from other materials within Areas A, B, C, D & H.

3.4 CRITICAL ASSESSMENT OF LANDFILL CONSTRUCTION, LIFECYCLE STATUS & RISKS

3.4.1 Landfill Key Issues

The fill material within the landfill would generally be classified as Class 1 landfill material, along with some managed fill and cleanfill materials, as well as some special wastes (i.e. medical wastes, asbestos). A critical assessment of landfill construction identified the following key items of concern:

- Lack of landfill base and side liner and groundwater subsoil drainage allows groundwater to come into direct contact with buried refuse.
- Refuse burning was common practice over much of the period that the hospital's closed landfills have been in operation. It was a cheap method of reducing waste volumes (thus maximising landfill lifetime), minimising leachate generation and landfill gas production from the decomposition of combustible organic wastes and providing rudimentary "sterilisation" of some wastes.
- Some areas have non-compliant clay capping (i.e. inadequate thickness and/or permeability) and/or topsoil cover in relation to the approved resource consent for the landfill site.
- There is no leachate collection or landfill gas collection systems, this being consistent with landfilling practice at the time the landfilling areas were constructed.
- Elevated (but within guideline) levels of boron are present in groundwater sampled from the landfill monitoring bores and in the adjacent stream. In our opinion, the coal ash disposed of in

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Areas A and C of the landfill and used as cover material in some areas is the likely source of this boron, as explained further below.

- The proximity to the Wharekōrino Stream means the site is potentially subject to inundation by flood waters – refer section 3.4.3 below for further details.

3.4.2 Landfill Lifecycle Status

The landfill aftercare period refers to the duration of ongoing monitoring for site integrity and environmental effects until the landfill no longer has the potential for adverse environmental effects, effectively defining the landfill "end of life". All landfill areas were assessed to be in the latter stages of the aftercare period, which typically lasts 30-50 years post-closure, as Area C was closed about 26 years ago, Area A 35 years ago and the other areas likely as long as 44 years ago. This is supported by:

- Typical leachate parameters (ammoniacal-nitrogen and chloride) having relatively low concentrations in groundwater and pH being approximately neutral.
- No landfill gas being detected on-site during the 2022 or 2023 intrusive investigations.
- The majority of landfill settlement is inferred to have already occurred.

However, the complicating factor here is the presence of boron in the landfilled materials, which is inferred to derive from boiler coal ash deposition within the landfill, either directly or for use as cover material. Such practice is likely to have created a significant boron reservoir, with boron being soluble and likely to leach out slowly over a long period, resulting in elevated boron levels in the groundwater and stormwater, which are still occurring in 2023, while boron is very difficult and costly to remove. In our opinion, this "potential adverse environmental effect" endpoint has yet to be reached for boron and hence ongoing monitoring should be continued.

3.4.3 Landfill Risk Assessment

The landfill risk assessment found the main issues to be:

(a) Groundwater contamination (boron) from passage through the landfill, with groundwater flowing into the adjacent stream, as explained above, and illustrated in more detail below.

Long term monitoring data for boron levels in the landfill (P2, groundwater bore) as well as upstream (S1), midstream (S3) and downstream (S2) are given in Figures 4-5 below. Dissolved boron levels within groundwater sampled from monitoring bore P2 exceed ANZECC 95% freshwater trigger levels, leading to elevated total boron levels in the mid-stream and downstream samples in the Wharekōrino Stream, but the boron levels are well within ANZECC 95% freshwater trigger levels, after mixing with other surface waters in the stream.

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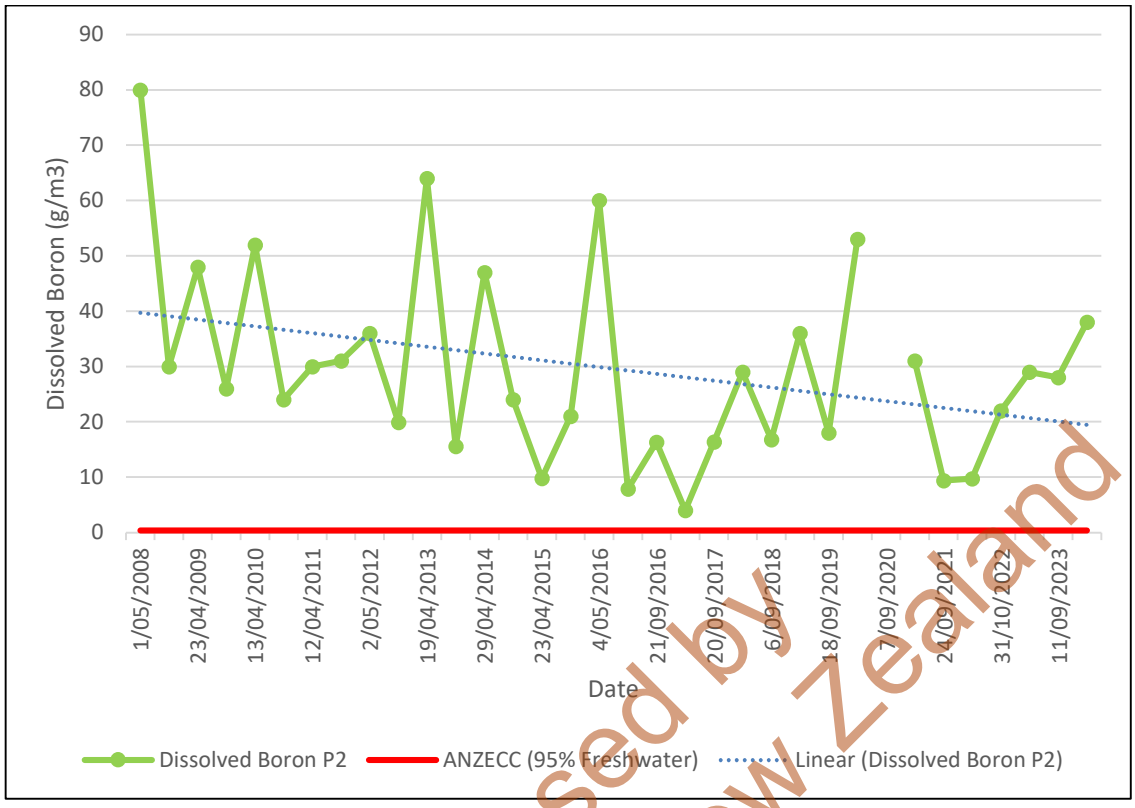

Figure 4: Long term dissolved boron levels (g/m³) within the landfill (P2)

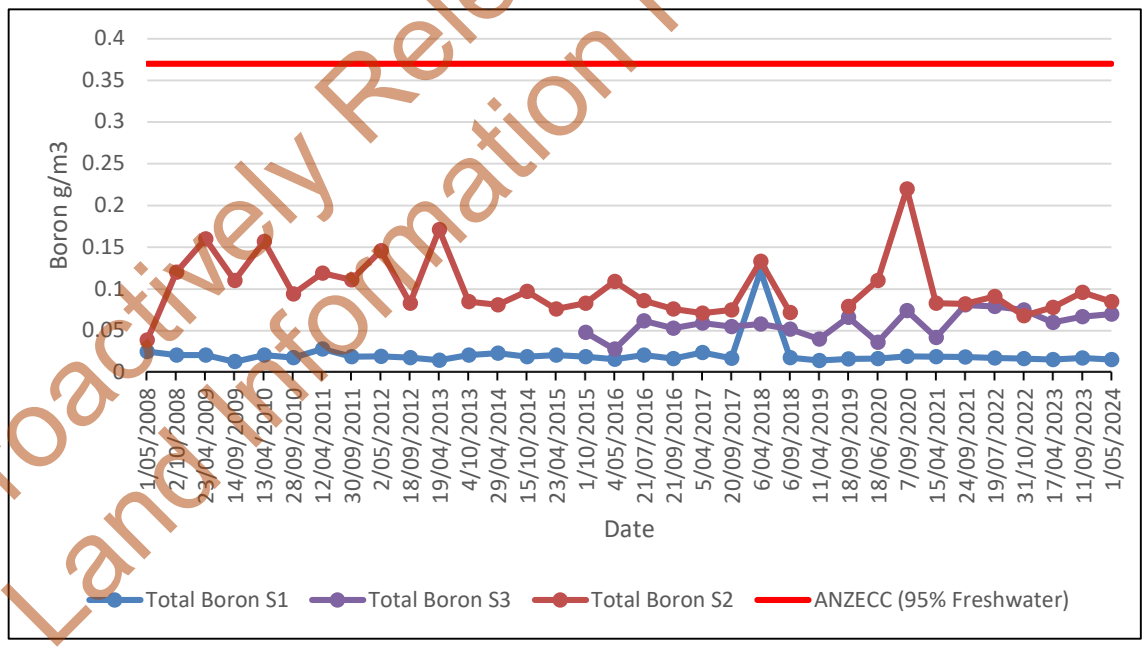

Figure 5: Long term total boron levels (g/m³) upstream (S1), midstream (S3), and downstream (S2) of the landfill in comparison to ANZECC 95% protection trigger value for aquatic species.

(b) Culvert 3 (1350dia) pipes the Wharekōrino Stream through Area A2 of the landfill. This culvert is estimated to be 44-65 years old and could be subject to differential settlement from landfill activity, leading to leaking joints and ultimately possible pipe failure. Attempts have been

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made to CCTV this culvert but have not been successful to date, as this culvert is generally full of water, due to the flat nature of the stream bed through this area and the downstream culvert invert being higher than the invert of this culvert (based on best available information).

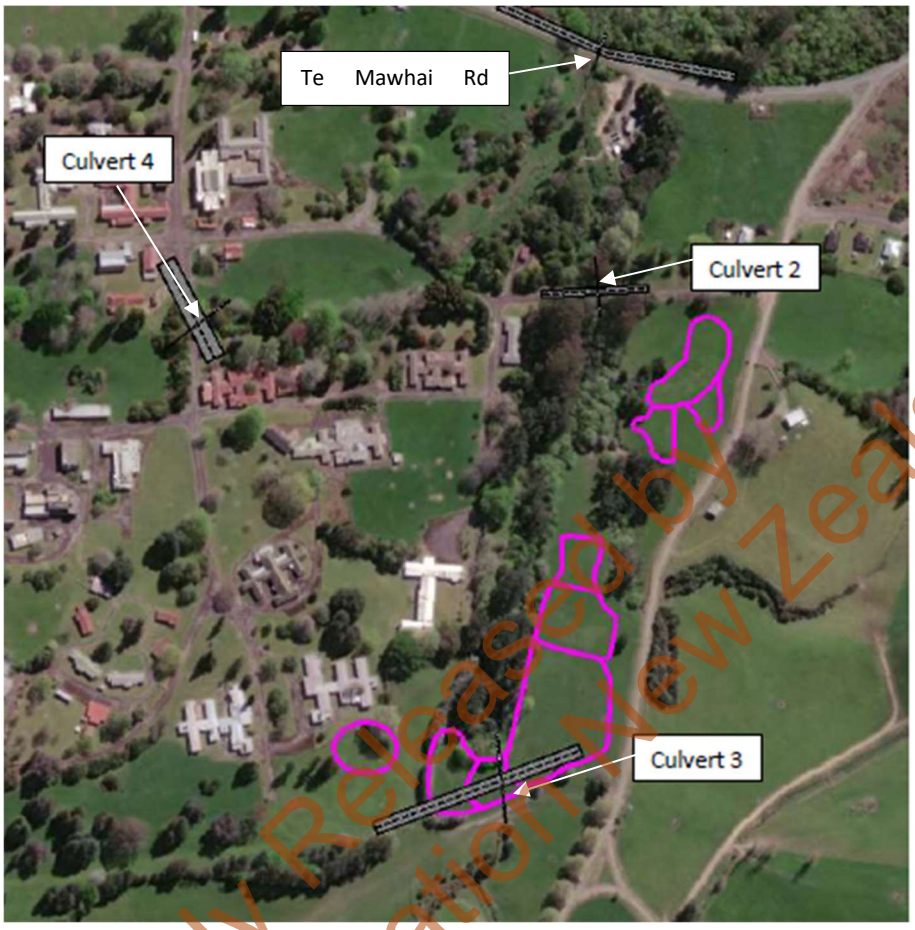

Figure 6: Location of Key Culverts, including Culvert 3 through the landfill and Culvert 2, downstream of the landfill

(c) Flood modelling of the Wharekōrino Stream has shown that the landfill areas A, B, C, G and H are currently likely to be inundated to varying extents during a 1% AEP (annual exceedance probability[2]) storm event, particularly if the two downstream culverts (culvert 2 and Te Mawhai Rd culvert) on the stream are blocked or become blocked during the storm, with these effects worsening with predicted climate change. Areas D, E and F have been found unlikely to be affected by flooding. Flooding impacts could potentially be significantly mitigated by the removal of Culvert 2 and the associated embankment, which forms a redundant road crossing over the stream, located below the landfill and above the culvert on Te Mawhai Rd.

[2] A 1% AEP event is a rainfall event that has a 1% probability of occurring in any given year.

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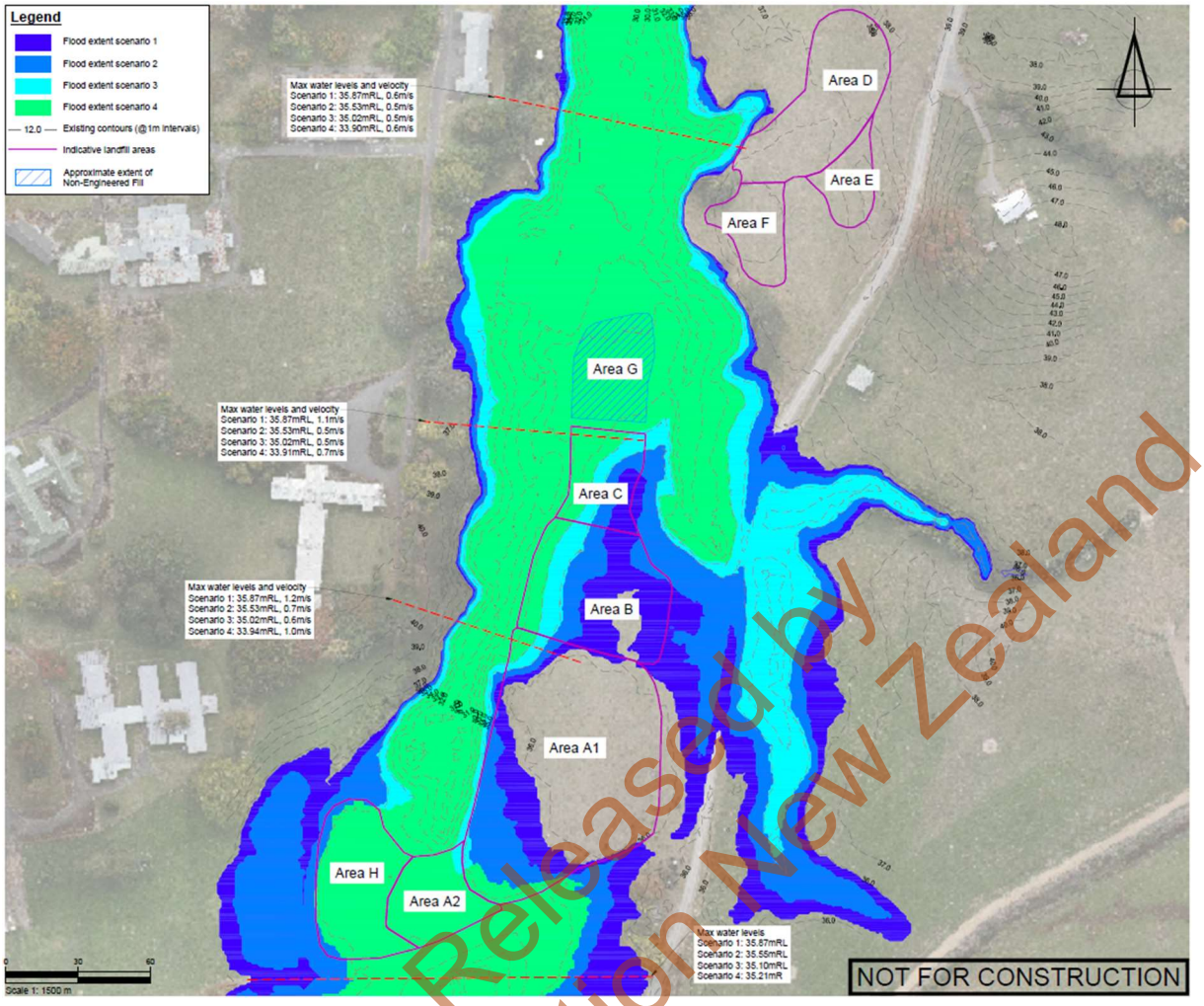

Figure 7: Flood Scenario Modelling Results

Scenario 3 = 1% AEP storm event, all culverts operational (light blue)

Scenario 2 = 1% AEP + climate change event, all culverts operational (medium blue)

Scenario 1 = 1% AEP + climate change event, all culverts blocked (dark blue)

Scenario 4 = 1% AEP + climate change event with culvert 2 and associated embankment removed (green)

3.5 EXISTING GROUNDWATER AND SURFACE WATER USERS

An Environment Waikato database search was done for all groundwater bores within 1km radius of the landfilling area, the results of which are shown on Figure 8. This search showed there are six groundwater bores within 1km of the site, of which only one is located downgradient (north) of the landfill. This bore (Bore 72, Station 10906) uses water for nursery irrigation (abstraction depth not stated) according to the Environment Waikato database. However, the nursery is part of the Pūniu River Care operation and they have advised by email from Shannon Te Huia (8 August 2024) that they no longer use this bore, but instead have a water surface take from the Wharekōrino Stream as described further below. There is one further downgradient bore just outside the 1km limit - Bore 72, Station 4997 – which takes water for household supply and stock watering purposes, according to the Environment Waikato database.

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Figure 8: Environment Waikato Groundwater Bore Database Search Results

Pūniu River Care have a resource consent AUTH144702.01.01 valid till October 2037 to take water from the Wharekōrino Stream for irrigation of a 3ha plant nursery during September-March inclusive, based on a daily maximum take of 100m^3 and total annual take of not more than 10,000m^3. The inlet structure is located on the Wharekōrino Stream at the location shown below. The ANZECC 2000 water quality guidelines refer to an agricultural irrigation water long term trigger value for boron of 0.5g/m^3, which the stream water quality monitoring data in Figure 5 readily complies with, indicating that using the stream water in the plant nursery should not adversely affect the health of the plants.

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Figure 9: Pūniu River Care Surface Water Take Inlet Location (red dot) on Wharekōrino Stream; yellow dot is location of their bore which is no longer used

3.6 EXISTING RESOURCE CONSENTS

Resource consents authorised by Waikato Regional Council for the closed landfill are summarised in Table 2. These consents allow for the discharge of leachate to land, discharge of stormwater into the Wharekōrino Stream and discharge of contaminants to air. They all expire in March 2035.

Table 2: Existing Closed Landfill Consents

Resource Consent	Status	Description	Commenced	Expiry
AUTH102269.01.01	Current	Discharge leachate into land in circumstances that may result in contaminants entering groundwater	17/04/2000	10/03/2035
AUTH102270.01.01	Current	Divert & discharge stormwater into the Wharekōrino Stream	17/04/2000	10/03/2035
AUTH102271.01.01	Current	Discharge contaminants to air	17/04/2000	10/03/2035
AUTH102272.01.01	Current	Undertake earthworks within 5 metres of the Wharekōrino Stream	17/04/2000	10/03/2035

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There is no stamped drawing attached to the three landfill consents showing the landfill extent. However, the resource consent states:

"Except as specifically provided by subsequent conditions of this consent and subject to complying with the other conditions of this consent, the activity authorised shall be undertaken in general accordance with the application for this resource consent and the documentation provided in support of the application. This includes the document entitled "Tokanui Hospital Landfill Closure, Assessment of Environmental Effects" dated April 1999 and prepared by Worley Consultants Ltd."

The resource consent conditions also specifically refer to Areas A, B, C, D, E and F. On this basis, the landfill extent covered by this consent is inferred to be the Area shown in Figure 2 of this report.

There is a separate consent AUTH971371.01.01, which authorises the Consent Holder to discharge up to 3.65m^3/s of stormwater to the Wharekōrino Stream in the vicinity of Tokanui Road, Tokanui, at or about map reference NZMS 260 S15:146-462. This consent was granted on 16/9/1997 and expires on 1/9/2032. Review of this consent shows that it applies to stormwater discharges from the hospital complex and not the landfill, so is not relevant to this report.

3.7 DEED REQUIREMENTS

As noted above, the Site is managed by LINZ on behalf of the Crown in the Treaty Settlements Landbank. Land held in the Landbank is Crown land which has been declared surplus and can be used as cultural or commercial redress in Tiriti o Waitangi Settlement claims. The Tokanui Hospital is a deferred selection property in the Ngāti Maniapoto Deed of Settlement (the Deed) and forms part of the Maniapoto Settlement Claims Act 2022, which gives effect to the Deed.

Under the Deed, Maniapoto and the Crown have agreed to a standalone process within the Property Redress Schedule, Part 9: Tokanui Hospital Deferred Selection Process (THDSP), for the transfer of the Site which details specific requirements for the demolition and remediation of the Site before it is available for transfer to Maniapoto. The Tokanui situation is unique as no other property included in a Treaty settlement has required demolition and remediation on this scale or required a commitment to undertake remediation in a deed of settlement. LINZ is the Government agency responsible for delivering this project.

Under Section 9.1.12 of the Deed, **existing disposal sites** means the two existing sites (as described in the existing disposal consents) located on one of the Tokanui Hospital deferred selection properties that the Crown historically used to dispose of waste; indicated as 'Existing disposal sites' on the plan (subject to survey) 'Tokanui Hospital deferred selection properties' in Area 1 of the attachments to the Deed, reproduced in Figure 10 below. In this report, the existing disposal sites are referred to as the Disposal Site.

Under the Deed (see Section 9.8 and 9.13), the Crown is not required to carry out remedial works on the existing Disposal Site; however, the Crown is required to maintain valid land use resource consents for the monitoring of Disposal Site in perpetuity. The Ngāti Maniapoto Post Settlement Governance Entity (PSGE), Te Nehenehenui Trust (TNN), will have the option to purchase the land which contains the Disposal Site (Area 1, See page 16 of the Tokanui Deed Extract document) in line with the deferred

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selection property terms of the Deed. LINZ is tasked with the ongoing management and monitoring of the Disposal Site on behalf of the Crown.

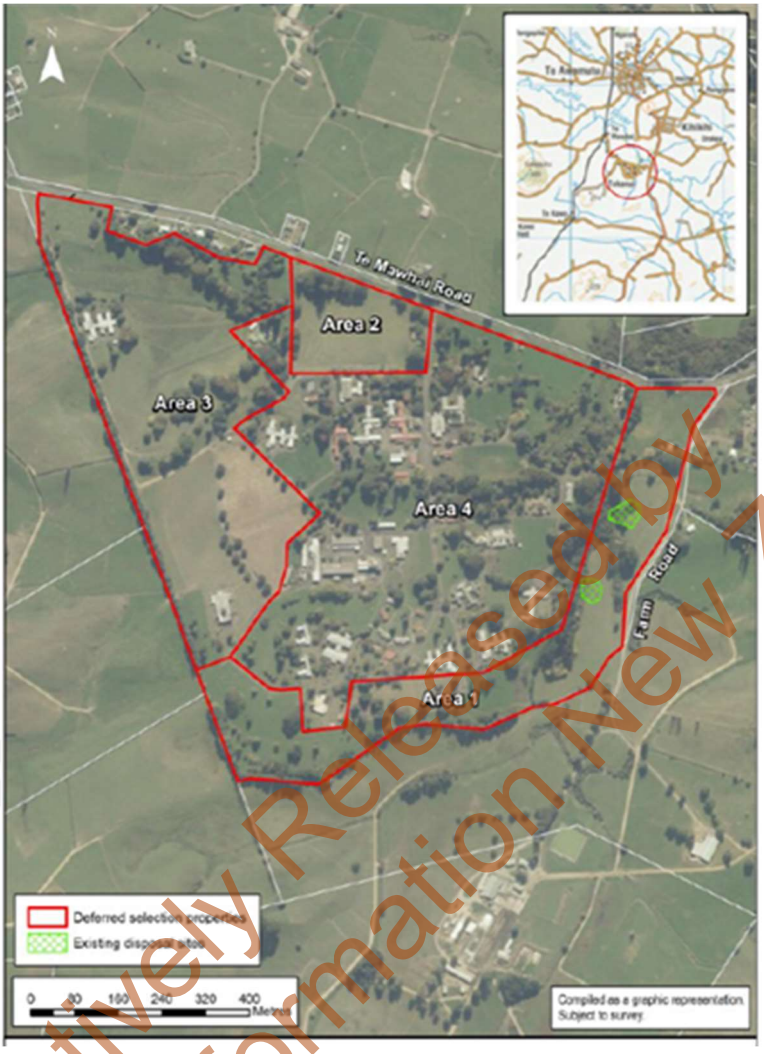

Figure 10: Site location and extent showing 4 deferred selection properties and location of existing disposal sites (green hatched areas, subject to survey as stated above)

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3.8 WASTEMINZ LAND DISPOSAL GUIDELINES

The WasteMINZ Technical Guidelines for Disposal to Land (Revision 3.1) (September 2023) provides an outline of landfill closure and aftercare requirements, the objectives of which are to ensure that the landfill/fill is completed in accordance with design principles and its proposed end use and to provide for ongoing management of final cover and leachate, stormwater and landfill gas control systems.

The closure works should provide for the continued decomposition of the disposed wastes in a safe and environmentally sound landfill/fill structure. Site capping and revegetation should ensure that the final surface provides a barrier to migration of water into the waste and controls discharges of landfill

gas and leachate. They should also promote sound land management and conservation, prevent hazards and protect amenity.

The natural processes within landfills/fills continue to produce leachate and gas that require environmental management for many years after landfilling ceases. Operations to support environmental management should be undertaken in the post-closure period in accordance with a Closure/Aftercare Plan, which takes into account the landfill/fill classification and the degree of control over the release or migration of contaminants from the landfill/fill. The plan should specify:

- the steps to be taken in stabilising the site and the time frame required;
- the requirements for all leachate, landfill gas, and stormwater control systems and monitoring and reporting practices to be maintained during the aftercare period;
- contact arrangements for adjacent property owners to maintain communications with operations personnel; and
- contingency measures in case of natural hazards.

Site operations during the aftercare period would typically include:

- leachate collection and disposal;
- landfill gas control;
- monitoring of site integrity;
- repairs to the final cover system;
- maintenance and control of vegetation;
- stormwater and sediment control; and
- monitoring of groundwater, surface water and landfill gas.

Monitoring for environmental effects and site integrity should be continued until the landfill/fill no longer has the potential for adverse environmental effects. Remedial actions should also be completed as required, based on periodic post-closure inspections.

3.9 TOKANUI CLOSED LANDFILL AFTERCARE PLAN

The Tokanui Closed Landfill Aftercare Plan is understood to have been prepared in 2000 in accordance with condition 6 of resource consent 102269.

The Aftercare Plan states:

- The landfill site will be grassed and grazed apart from the riparian margins along the stream which are to be fenced off and planted. It would also be desirable to prevent grazing of the area by large cattle (particularly bulls) to avoid damage to the integrity of the landfill cap.
- Annual visual inspections of the landfill surface and cap are to be conducted in accordance with consent condition 5.
- Ongoing monitoring of surface and ground water is required in accordance with consent requirements.

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- Riparian planting and management shall be undertaken as described in the Riparian Management Plan.

4.0 OPTIONS ASSESSMENT

4.1 INTRODUCTION

While LINZ is not required to carry out remedial works on the existing Disposal Site under the Deed, it is however required to maintain valid land use resource consents for the monitoring of the existing Disposal Site in perpetuity and is tasked with the ongoing management and monitoring of the existing Disposal Site on behalf of the Crown. As part of this responsibility, and in conjunction with the wider demolition and remediation project, LINZ has requested an assessment of options to inform a long-term management strategy This assessment therefore includes various options relating to the repair and/or upgrade of components of the existing Disposal Site to ensure that human health, social and cultural values and the environment are protected from closed disposal site hazards, to ensure responsible long-term taxpayer value for money, and to reduce the Crown's long-term liability.

4.2 OPTIONS SCREENING PROCESS

An initial options screening assessment was undertaken, involving assessing a range of different works that could be undertaken to address identified landfill issues and hazards from the landfill investigation work summarized in Section 3, as well as the opportunity of optimizing the use of the existing landfill. These works were then grouped into combination options for further assessment, described in detail, below.

Effectively, these combination options represent a continuum from doing nothing through to various long term management options; each assessment involves up to six different work components. The option of complete removal and off-site disposal of all landfilled material was also considered for completeness. Each of these options are described below in sections 4.3 to 4.7, and then evaluated in Section 4.8, leading to the selection of a preferred option.

These options were also presented to mana whenua for feedback prior to this report being finalised. Please note, this report does not include an overview of engagement with mana whenua and iwi as part of delivery of investigations and assessment of options relating to the existing Disposal Sites as this engagement is documented in detail in the Iwi Engagement Report (LINZ, 2024).

4.3 OPTION 1: DO NOTHING

Continuing landfill consent compliance monitoring and maintenance as at present essentially involves six monthly surface and groundwater sampling, an annual visual inspection of the landfill area and annual reporting. This option would not involve any physical works (e.g. cap repair works), other than minor ongoing maintenance works to address minor compliance issues under the existing resource consent.

Pros

- Lowest cost "minimalist" option

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- No temporary off-site effects as no major repair/upgrade works done.

Cons

- The landfill cap is currently not fully compliant with existing resource consents. If no repair works were undertaken, a variation to the existing landfill consent would be required to authorise a lesser standard of capping than consented, which is unlikely to be granted.
- Landfill areas H & A2 are not covered by the existing resource consents, which is also a potential compliance issue because these areas are considered an unauthorised discharge to land and hence a potential risk of enforcement action being taken by the regional council.
- Effects on groundwater and surface water from boron will continue, albeit a slow decrease is expected over time, as the boron reservoir within the landfill is depleted.
- Long term risks remain, with the most significant being potential leaking or failure of culvert 3, leading to refuse washout down the stream, and secondly flood risks in an extreme event.

4.4 OPTION 2: MINIMUM WORKS

4.4.1 Overview

This option is considered the minimum required to comply with the existing resource consents and reduce the flood risk. It involves:

(a) Improved capping of the entire landfill.
(b) Removal of Culvert 2.

Improved capping of the landfill is considered necessary in order to better comply with the existing consent conditions.

Culvert 2 removal is common to all options and already approved for implementation by LINZ and supported by Te Nehenehenui as described in the Horizontal Infrastructure report and per the Ministerial decision.

4.4.2 Improved Capping

Improved capping of the landfill will involve establishment of appropriate erosion and sediment controls, stripping and stockpiling the existing topsoil and cap over an approximately 1.9ha area; compacting, shaping and trimming the landfill surface to make it suitable for capping; recapping the landfill, with an appropriate, low permeability, engineering cap, utilising as much of the stripped material as appropriate, retopsoiling and grassing. This work would be done in a number of sub-stages.

Additional resource consents would also be required for stripping and upgrading the existing landfill cap. These may include earthworks in close proximity to a stream, disturbance of contaminated soil under the NESCS, and the discharge of contaminants to authorise ongoing discharges from the landfill.

Pros

- Landfill would comply with existing consent requirements in terms of capping and be future proofed for potential more stringent requirements for resource consent renewal in 2035.
- All topsoil cover would be within adopted NESCS guidelines, ensuring this area remaining suitable for agricultural use post-landfilling.

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- Reduced rainfall infiltration into the landfill, reducing contaminant leaching to the stream.
- Overall, a significant reduction in long term risk and liability.

Cons

- Significantly increased repair works costs.
- Resource consenting process may increase timeframes for works to be implemented.

4.4.3 Culvert 2 Removal (confirmed for implementation)

This is a redundant road embankment crossing the Wharekōrino Stream that provided an historical side road entrance to the Site. The location of this road crossing is highlighted in red below. The culvert through this embankment has not been able to be located yet, due to it being completely submerged. This culvert is estimated to have a diameter of 1350mm to be consistent with the upstream culvert 3. The road embankment is approximately 6m wide (at the top) by 50-60m long. It is relatively high, with an estimated height of 5.5m from the stream bed to the embankment crest. This culvert has a significant influence on flood levels affecting the existing Disposal Site while the road embankment acts as a dam, affecting stream flow patterns and ecology. The embankment itself was heavily overgrown and had been subject to fly tipping, but this has recently been cleared, with all debris, waste and vegetation removed.

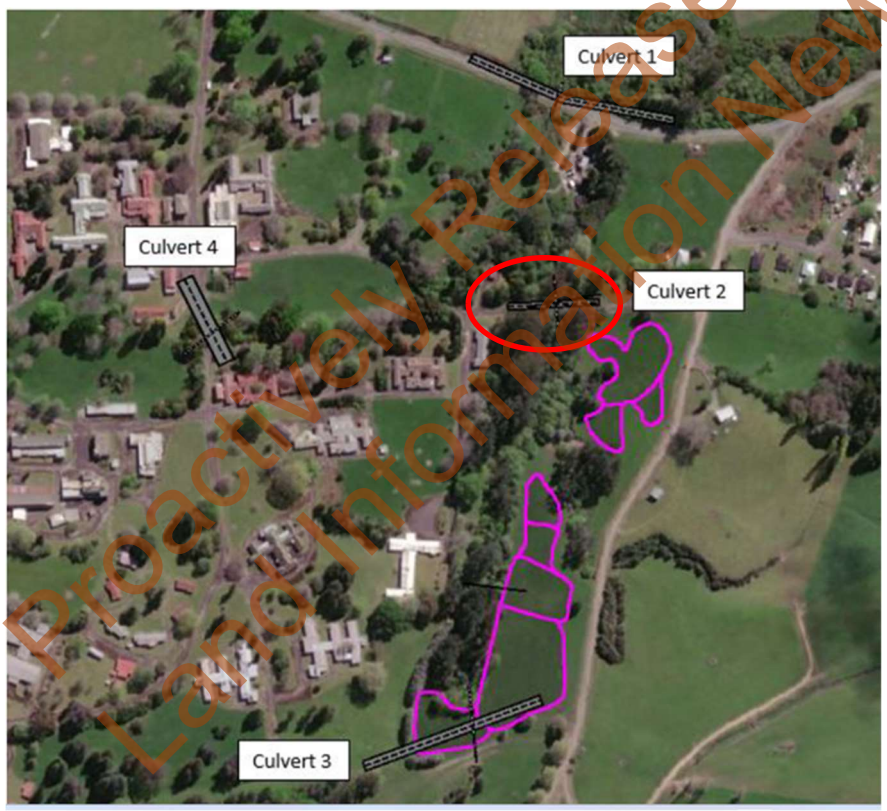

Figure 11: Redundant Road Embankment Crossing Wharekōrino Stream

The stream bed is very flat through this area, with significant water ponding both upstream and downstream of the culvert. This means it will be challenging to remove the bottom section of embankment within the stream bed itself.

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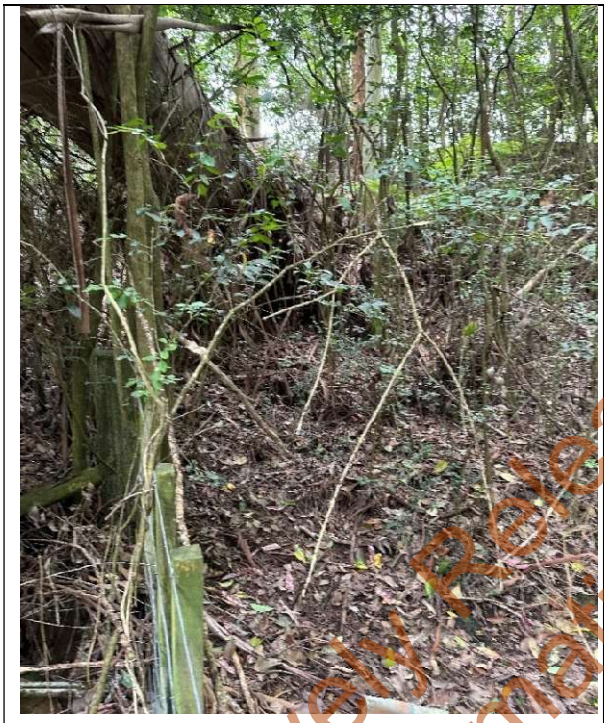
Geotechnical investigation of this embankment found that the majority of the fill material appears to be controlled fill, likely borrowed from a nearby source. The exception was fill material, containing minor (ETP05), trace (ETP06) and abundant (ETP07) construction debris including concrete, bricks, metal and wire in 0.6-1.0m layers.

Embankment fill testing for contamination found that most samples comply with site specific remedial standards. The exception is one relatively high PAH result, with BAP at 5.4mg/kg and one asbestos detect, which was from a sample adjacent to where an asbestos pipe was found.

These findings indicated that the majority of the fill embankment can be reused for backfilling within the hospital site.



Typical vegetation by road embankment

Likely location of culvert 3 under embankment

Figure 12: Redundant Road Embankment Crossing Wharekōrino Stream

Removal of this culvert would involve works over an approximately 3,000m^2 area, involving total excavation volume (soil and roading materials) of 6,800m^3. These works would include:

(a) vegetation and tree removal;
(b) establishment of erosion and sediment controls, including temporary damming of stream (likely both upstream and downstream) and diversion of stream runoff by pumping around the works area;
(c) remove road embankment materials to stockpile and reuse suitable materials on-site as backfill material and dispose of other materials off-site to appropriate processing or disposal facility.
(d) Removal the culvert and trim stream banks to tie in with existing stream profile.
(e) Place clean topsoil along stream batters, grass upper stream banks and plant lower stream banks.
(f) Remove temporary dams and erosion/sediment controls.

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4.5 OPTION 3: INTERMEDIATE WORKS

4.5.1 Overview

This option is considered an intermediate option that goes further than Option 2 to future reduce long term risks and potential human health and environmental effects and improve optimisation of the existing landfill. It involves:

(a) Improved capping of the entire landfill (as per Option 2).
(b) Removal of Culvert 2 (as per 4.4.3).
(c) Excavating clean backfill material from landfill Areas E/F where only isolated refuse material were found and transferring this material to the Hospital for use as backfill, and then placing excavated contaminated soils from the hospital in the excavated area, followed by capping, retopsoiling and grassing. Isolated pockets of medical waste in "offal pits" in Area F would be removed at the same time and disposed of off-site to a Class 1 landfill.

Items (a) has been described in section 4.4. Item (b) is described in section 4.4.3. Item (c) is described below.

4.5.2 Contaminated Soil Transfer Rationale

There is growing impetus in New Zealand towards the sustainable management of surplus soil and subsoil, as demonstrated in the following recent documents:

Manaaki Whenua produced a consultation draft report on the **Sustainable Management of Surplus Soil and Subsoil (LC4326)** in August 2023. Excerpts from the report website summary are repeated below:

'Surplus soils' are those soils that have been disturbed through land and infrastructure development or natural processes (e.g. landslips, silt/sediment) and are unable to be beneficially used on-site… The project arose from the growing awareness of the widespread extent of soil disturbance, movement, and disposal to landfill, and questions raised about the necessity and sustainability of current practices by multiple sectors in New Zealand.

The focus of the project was to develop a greater understanding of the factors leading to the generation of surplus soils, and the barriers to reusing them, in order to develop guidance to support the emerging practice of sustainable management of surplus soils. The work involved te ao Māori and mātauranga Māori from inception to completion.

Concerns expressed about surplus soil include the lack of sustainability, unnecessary disposal costs, emissions associated with transporting surplus soil, lack of data on the amount of material encompassed as 'surplus' soil, lack of agreement on what should be measured, and regulatory challenges with reuse – even for low-risk (i.e. lightly contaminated) soils. Perhaps the most tangible evidence of the challenges faced is an increase in the proportion of inert materials (which include soil) disposed to Class 1 landfills since 2012 (Figure 1). This closely coincided with the introduction of the National Environmental Standard for Managing Soil Contaminants for the Protection of Human Health (NES-SC) in 2011. Anecdotally, large volumes of soil are also disposed to other classes of landfills, although hard data are currently lacking.

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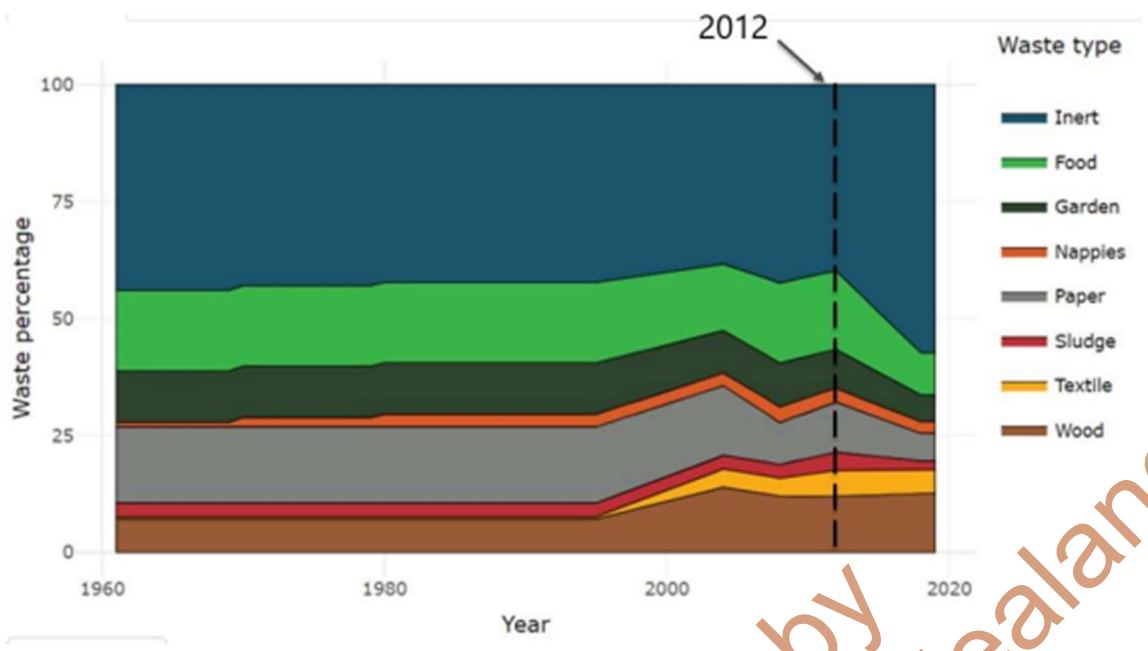

Figure 1. Proportion of different types of waste disposed to Class 1 landfills. The NES-SC was introduced in 2011. (Adapted from Dee & Lidgard 2021)

Through the project there was strong engagement with different industry sectors, including contaminated land management and waste disposal to land, as well as central and local government and government agencies, including regional and unitary councils, city and district councils, the Ministry for the Environment, Land Information New Zealand, Kainga Ora – Homes and Communities, and Māori.

A stakeholder workshop identified the primary source of surplus soils as being greenfield residential subdivisions, followed by brownfield residential developments… The workshop also identified that the bulk of soil disposed to landfills is considered to have contaminant concentrations above background concentrations but below applicable soil contaminant standards (residential, followed by commercial/industrial) for the protection of human health. In other words, the majority of soil disposed to landfill is low-risk.

A key finding of the project was that a good understanding of soil science is lacking in many land and infrastructure development activities. At present, soils in most projects are primarily assessed for geotechnical characteristics and (frequently) contamination. The project report (Cavanagh et al. 2023) includes case studies of surplus soil reuse and outlines next steps to guide councils, government, Māori, and industry to enable the sustainable management of surplus soils. A key recommendation was that a national soils strategy should be developed to effect higher-level change and generate the impetus and pathway to effectively and sustainably manage our soils.

The **Parliamentary Commissioner for the Environment** prepared a report titled "**Urban Ground Truths**" in March 2024 which found that healthy soil is the unseen engine room of our cities' green spaces, supporting a range of environmental services, absorbing and filtering stormwater and permitting the growth of trees that provide vital shade and cooling among other benefits. However, it is under pressure from residential development processes, particularly extensive earthworks that are eroding the capacity of soil to provide these services.

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It makes several recommendations for better protection of this important asset, including Councils should look at incentives to encourage developers to conserve and protect soil and reuse soils on site instead of disposing of them off-site if possible and when the soil in question poses a low level of risk to people and the environment. The same thinking can be applied to the Tokanui Hospital demolition works, relating to the management of low-level contaminated soils.

The **WasteMINZ Technical Guidelines: Characterizing Surplus Soil for Disposal (Draft for consultation)** (April 2024) refers to this being "Soil that is excess to site requirements and is being transported with the intention of depositing it at a receiving site." It deliberately refers to these soils as being 'surplus' rather than 'waste', as the Working Group who prepared this report recognise the value of this soil as a finite resource for which management can be improved.

4.5.3 Low and Moderate Level Contaminated Soil Overview

Results from intrusive soil investigations within the hospital site between 2019 - 2024 by AECOM, GHD, HAIL Environmental and Fraser Thomas Ltd have been compiled and plotted on aerial plans of the site and then categorised into low and moderate level contaminated soil with and without asbestos, giving a total estimated volume of approximately 3,255m^3, as summarised below in Table 3.

Additional estimates of likely contaminated soil have been made for soil scrapes around building perimeters post-demolition (869m^3), building subfloor surface scrapes post-demolition (1,930m^3) and inferred asbestos contaminated soil around asbestos watermains post-pipe removal (328m^3). These volumes, combined with the low/moderate level contaminated soil volume, gives an upper estimate of up to 7,800m^3 of contaminated soil from the hospital demolition works that may need disposing at the existing Disposal Site.

Table 3: Estimated Contaminated Soil Volumes from Hospital Demolition Works (solid measure)

Contamination Level Classification	Contaminated Soils Description	Source	Estimated Volumes (m^3)
Low Level (Management) (2)	Exceeds site specific rural residential soil remedial standard but not the managed remedial standard.	Near Buildings	**977**
		Other Areas[4]	**797**
Moderate Level (Remedial) (3)	Exceeds site specific managed remedial standard.	Near Buildings	**1,426**
		Other Areas[4]	**55**
		TOTAL	**3,255**
PROVISIONAL ALLOWANCES			
Estimated halo scrape post-building demolition[2] (4)		Some	**869**
Estimated building subfloor space scrape, post-building demolition[3] (5)		Some	**1,930**
Inferred asbestos contaminated soil around asbestos watermains[1] (6)		Likely	**328**
Contingency		Some Likely	**1,400**
		TOTAL INCLUDING PROVISIONAL ALLOWANCES (Rounded)	**7,782 (7,800)**
Notes:			

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1. **Assumed that on average a 100 mm wide ring of soil around the asbestos watermains that are to be removed is contaminated with asbestos. Soil testing may be undertaken at the time of watermain removal at the discretion of the assessor to confirm the volume of soil requiring remediation. This is addressed further in the separate Demolition Management Plan for the Site.**
2. **Provisional allowance made for soil scrape around all buildings, post-demolition and post-contaminated soils removal, comprising 1m wide strip x 150 mm deep, excluding areas already remediated (Halo Scrape).**
3. **Provisional allowance made for soil scrape across the subfloor space of all buildings excluding those with concrete floor slabs, post-demolition and post-contaminated soils removal comprising building footprint areas x 150 mm depth.**
4. **Other areas comprise Area I, Culvert 2 embankment, WWTP, Agricultural area and Demolished Structure area.**

4.5.4 Required Works

This option is based on existing landfill areas E and F essentially containing non-engineered fill material, rather than refuse, as summarised below:

- Area E covers an area of approximately 660m^2. No landfill material was found in this area (TP25 and TR37-40).
- Area F covers an area of 930m^2, with an estimated fill volume of 3,730m^3. Medical waste (needles, razors, blood bags and bottles; no soil matrix) was found in Area F at TP26, where 7 x 600mm diameter bored “offal pits” were encountered within the test pit and surrounding area. Inferred boiler ash was also noted in one of the offal pits. No other offal pits were found in the three trenches excavated in this area. Low density construction and demolition debris as well as non-engineered fill (likely reworked natural ground) was also identified in this area.

Groundwater in this area is also relatively deep, as no groundwater has ever been detected in piezometer P7 (5.2m deep) in the monitoring done to date over the period 2008-2024.

These areas would be excavated out, including the intermediate area between them if required, with clean soil material complying with the adopted remedial standards being transferred to the hospital site for use as backfill material. The medical waste and any pockets of construction waste would be separated from this material and disposed off-site to a Class 1 landfill.

Contaminated soils from the landfill would be transferred from the hospital site and placed in the Area E/F excavation cavity, followed by capping and retopsoiling, as per Option 2. These materials have been tested to have low leachability, so no impermeable membrane base liner is proposed.

These works should ideally be done before Culvert 2 is removed, so that vehicle movements can be via the existing Culvert 2 embankment road crossing.

The extent of these works would be limited to avoid any overland flow or floodplain risks.

Pros

- Cap is proposed to be stripped from Area F under Option 2, so no increase in capping requirements.
- Contaminated soil from hospital demolition works is disposed of on-site to a consented, compliant landfill, reducing off-site transportation costs and associated carbon emissions and avoiding shifting soil to another rohe (home area of a particular Iwi).
- Improved utilisation of existing Disposal Site and generation of suitable material for backfill use in hospital.

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- Finished ground levels should be similar to existing, ensuring this area remaining suitable for agricultural use post-landfilling.
- Small quantities of medical waste in offal pits removed off-site to appropriate disposal facility, off-site.
- The work can be undertaken in conjunction with the main hospital demolition and remediation works, providing greater efficiency and optimal use of the contractors who will already be onsite, completing all associated landfill repair and upgrade works in "one go".
- Overall, some reduction in long term risk and liability.

Cons

- Areas E/F are located within 65m of a cluster of existing residential dwellings outside the site and approximately 50m from a nearby farm house on AgResearch land, so potential short term nuisance effects on these properties during the works; however, this would be managed through resource consent conditions to ensure minimal disturbance.
- Landfill area would be temporarily unavailable for grazing use during works and until pasture re-established.
- More works included in this scope, increasing the costs.

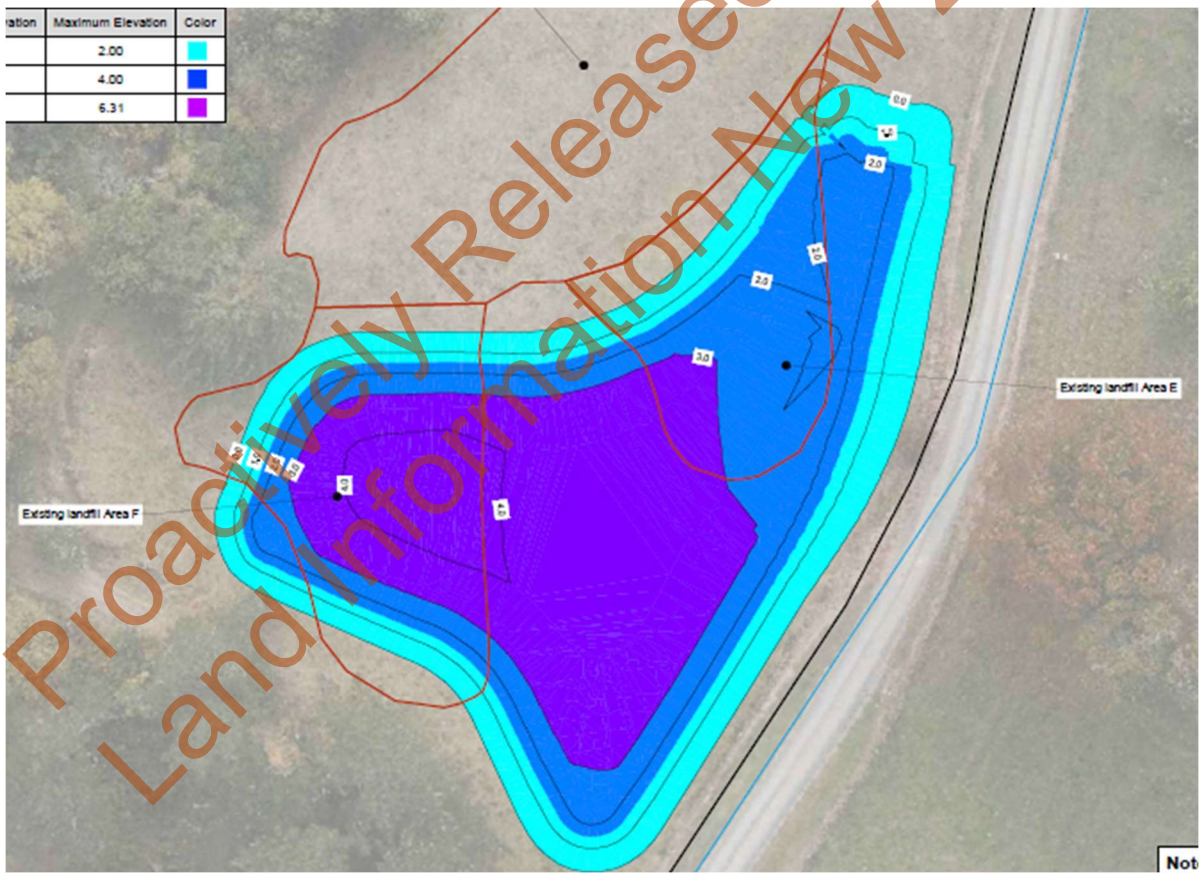

Figure 13: Area E/F Landfill – Filling Plan

Replacement consents would be required, as the extended landfill would be beyond the scope of the existing landfill consents. New consents may include earthworks in proximity to a stream; disturbance of contaminated land under the NESCS; discharge of contaminants to land, and subsequently water

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or air; possibly for discharge of stormwater to land/water; and for land use activity (landfill) under the Waipā District Plan.

4.6 OPTION 4 - ADVANCED WORKS

4.6.1 Overview

Option 4 involves the following works:

(a) Improved capping of the entire landfill (as per Option 2).
(b) Removal of Culvert 2 (as per 4.3.3).
(c) Low & Moderate level contaminated soil transfer from hospital remediation and isolated medical waste removal (as per Option 3).
(d) Partial or full lining of Culvert 3, or its partial or complete removal and reinstatement of the stream through this area, with new embankments either side to protect the landfill from scour/erosion.
(e) Possible shifting of fill/refuse material from Areas A2/H into Area A1, along with partial or full culvert 3 removal.
(f) Shifting of fill/refuse material from the south-eastern corner of Area A1 that is located on AgResearch land (Section 3 SO 534156), outside of the subject site, into the A1 area within the subject site.

Items (a) to (c) have been described already. Items (d), (e) and (f) are described below.

4.6.2 Culvert 3 Remediation/Removal Options

Culvert 3 is a 1350mm diameter culvert that pipes the stream through the landfill area. It is approximately 4m deep below the existing ground surface over most of its length (approximately 60m).

A farm access track runs across the upper end of this culvert, while its inlet is located in the neighbouring AgResearch property. Historical aerial photographs from the 1940s show that this track appears to be present pre-landfilling of this area, while another smaller track may possibly cross over the culvert at its downstream end. These aerials suggest that the upper and lower culvert crossings are likely founded on good ground, rather than landfill material.

As explained earlier in this report, this culvert is estimated to be 44-65 years old and could be subject to differential settlement from landfill activity, leading to leaking joints and ultimately possible pipe failure due to this and its age, which would likely lead to refuse washout down the stream. Attempts have been made to CCTV this culvert but have not been successful to date, due to this culvert being full of water, due to the flat gradient of the stream through this area and the downstream culvert invert level being higher than the invert level of Culvert 3.

Flood modelling has shown that the effect of removing both culverts 2 and 3 results (compared with culvert 2 removal alone) in:

- a slight increase in overtopping across Te Mawhai Rd, if culvert 2 is removed;
- increased peak flows below Te Mawhai Road (44.4m^3/s) and another 0.33m increase in water level if both culverts are removed;

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- increased reduction in floodplain extent affecting the landfill from 44% (Culvert 2 removed) to 74% (Culverts 2 and 3 removed);

This modelling shows that this culvert provides a flood detention function in storm events and hence at least some form of embankment and culvert are required at the site's southern boundary in order to mitigate potential increased downstream effects, particularly at Te Mawhai Rd.

Landfill areas A2 and H are outside the known historical landfill footprint and are not shown as landfill areas in historical drawings referred to in the existing landfill consent. Culvert 3 runs through Area A2 while Area H is located on the western side of Area A2. Hence, these landfilling areas are currently unconsented. This means that there are other benefits from not just removing Culvert 3 but also transferring fill/refuse material from Areas A2 and H into Area A1 of the existing landfill (which is consented for landfilling).

Review of relevant test pit information from the FTL intrusive investigation has found that refuse does extend to the depth zone within which the pipe is located but likely not below the lower 10-20% of the pipe or pipe base. However, no test pits were undertaken directly above or adjacent to this pipe to verify this. Hence, it is not clear if the culvert is founded in good ground and backfilled with good material over its entire depth or may be in contact or near contact with some landfilled materials, particularly between the top and bottom sections. Refer Figure 14 for offset test pit logs superimposed on the culvert long-section.

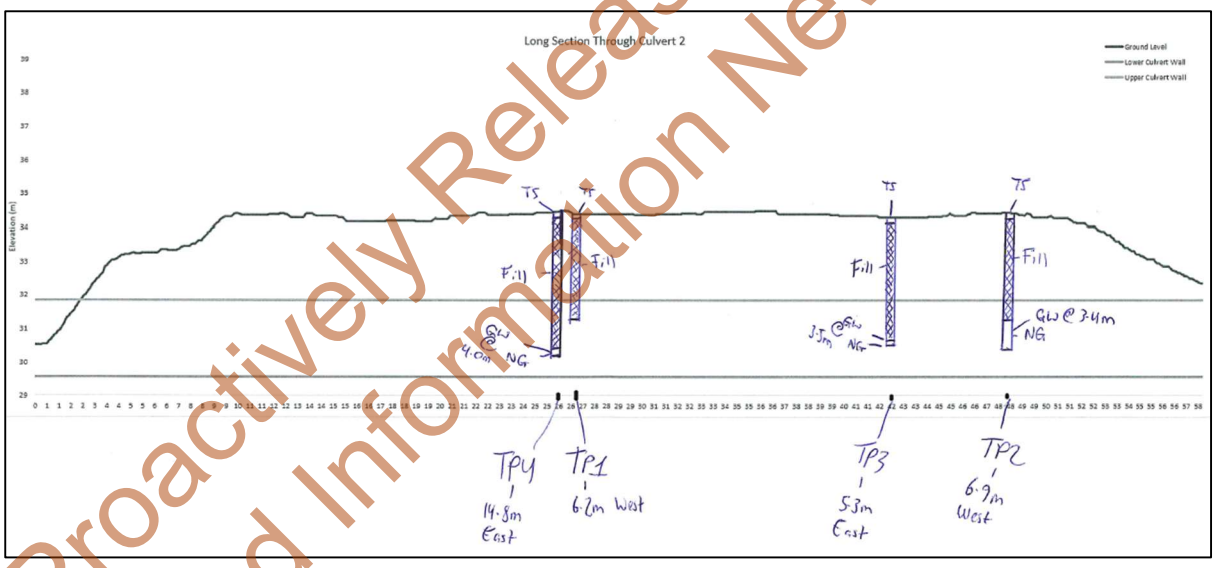

Figure 14: Long-section showing culvert depth relative to test pit logs from nearby intrusive investigation test pits

Taking all these considerations into account, the following remediation/removal options for this culvert were assessed.

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Table 4: Estimated Contaminated Soil Volumes from Hospital Demolition Works

ID	Option	Evaluation
A	Lining the interior of the culvert, with a "pipe liner", which should increase its lifetime by approximately 50 years, subject to checking the existing pipe integrity and there being no vertical displacement of the existing pipe.	Rejected, as existing pipe condition is unknown and defers culvert issue for potentially 50 years, but does not solve the problem of refuse being within the stream channel and floodplain.
B	Installing a smaller pipe within culvert 3 (likely 1050dia) by pipe jacking. This effectively makes the existing pipe redundant, turning it into a duct.	Rejected for similar reason to Option A, as again defers problem for ~50 years.
C	Removal of the culvert and fill material, reinstating the stream through the landfill, creating a narrow channel and constructing lined embankments along both sides and the base of the stream to prevent water from leaching into the landfill and to protect the landfill from stream scour/erosion, followed by retopsoiling and planting. This is known as "stream daylighting".	Rejected, as complete removal of culvert further worsens downstream flood effects at Te Mawhai Rd and below it. Part of the culvert is not on LINZ property and would require agreement of the landowner.
D	Maintain southern road crossing embankment and line or replace first section of culvert running under this and remove the rest of culvert 3 and reinstate the stream as per Option C.	Second preferred option, as maintains flood mitigation function of existing culvert and embankment, whilst removing all of the section of culvert 3 located within landfill areas.
E	Maintain southern road crossing embankment (raising height slightly) and line or replace first culvert section running under this; remove rest of Culvert 3 and shift associated refuse/fill material in Areas A2/H to Area A1, reinstating the stream in this area, with new embankment on eastern side to separate the reclaimed area from existing landfill area A1. See Figure 15.	Preferred option - maintains flood mitigation function of existing culvert and embankment, removes all of Culvert 3 located within landfill areas, and removes associated landfill material from the unconsented A2/H areas.

4.6.3 Shifting Refuse/Fill Materials from Areas A2/H to Area A1/B

The are of refuse removal in Area A2 is approximately 715m^2 in area with estimated refuse, cap and topsoil removal volumes of 1,600m^3, 340m^3 and 132m^3 respectively. Relevant test pits are TP1, TP2, TP3, TP4, TP35, TP38 and TP39. Topsoil depths range from 0.1-0.3m thick underlain by landfill cap to 0.5-1.0m bgl, underlain by fill/refuse material to 2.3-4.0m bgl. Groundwater was reached in 5 test pits at depths of 2.9-4.0m bgl in November 2022 (4) and April 2023 (1). Contamination testing results show that the topsoil and cap comply with the adopted site specific rural residential standards (but do have above background boron levels). The lab results combined with visual observations of the nature of the fill material mean that refuse transfer works from this area will need to be done as asbestos related works in Area A2.

Area H is approximately 1,700m^2 in area with estimated fill and cover/topsoil volumes of 1,800m^3 and 75m^3 respectively. Relevant test pits are TP32, TP33, TP34, TP37, TP54 and TP55. Surficial soils comprised topsoil/fill to 0.2-0.5m depth, underlain by natural ground. Refuse material was only found in TP32 at 0.3-1.5m depth. Groundwater was not encountered in all test pits to 1.1-2.0m depth.

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Contamination testing results show that the topsoil/cover complies with the adopted site specific rural residential standards except for one location (TP54, asbestos). The lab results combined with visual observations of the nature of the fill material mean that refuse transfer works from this area will need to be done as asbestos related works in Area H. Figure 15 shows the proposed refuse transfer areas.

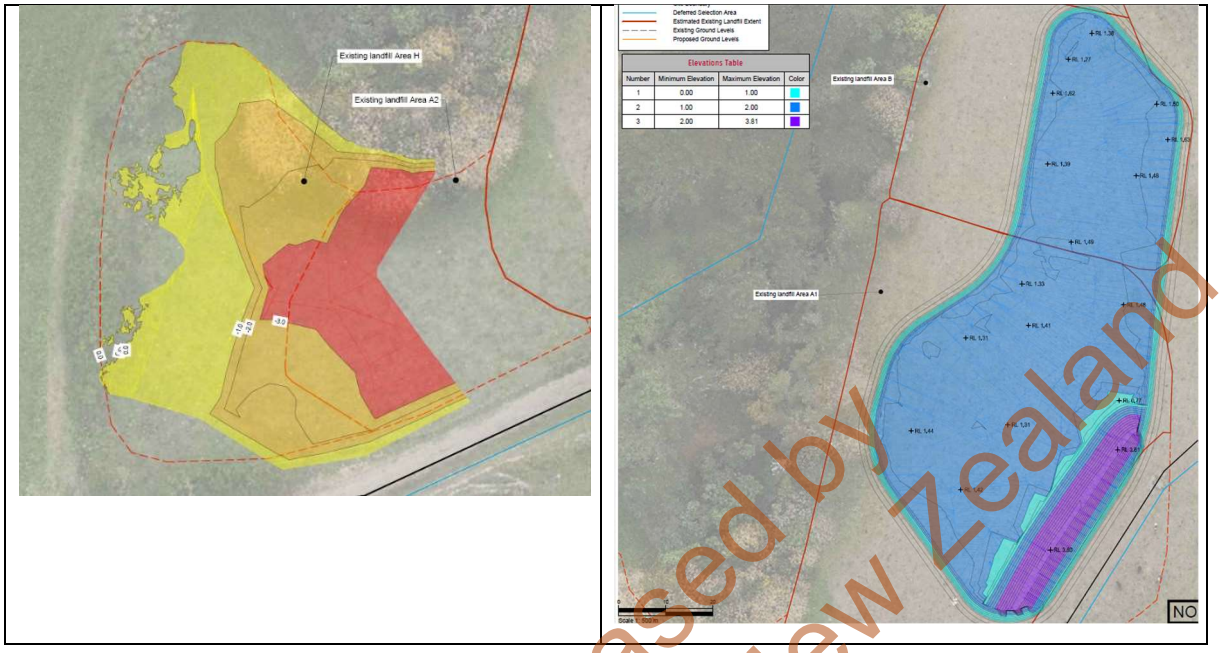

Figure 15: Landfill material to be shifted from Area A2/H (left) to Area A1/B (right) - refer 33205/LF drawings for details

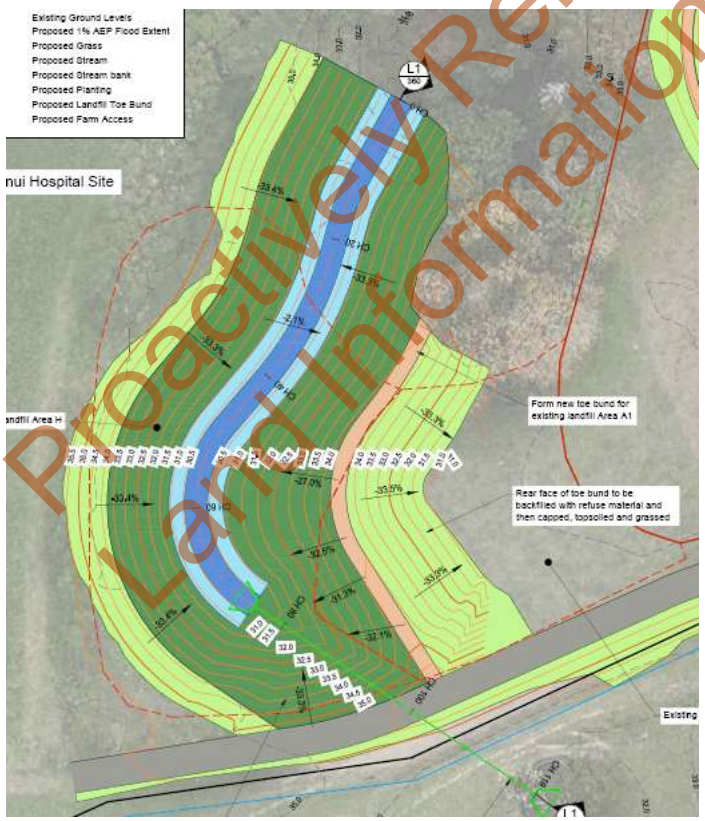

Figure 16: New Shorter Culvert 3 to reinstated stream channel

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4.6.4 Landfill Area A1 on AgResearch Land

There is a small area of existing landfill, estimated to be 370m^2, that is located outside the subject site , on the adjacent AgResearch property (Section 3 SO 534156), as shown in Figure 17. The fence in this paddock is not located on the site boundary but closer to the road.

It is proposed to transfer all refuse material from the AgResearch area back into Area A1 within the subject site. The estimated refuse volume to be shifted is 850m^3. This allows for excavating some refuse within the subject site in order to create a new toe bund for this area of the landfill, abutting the site boundary.

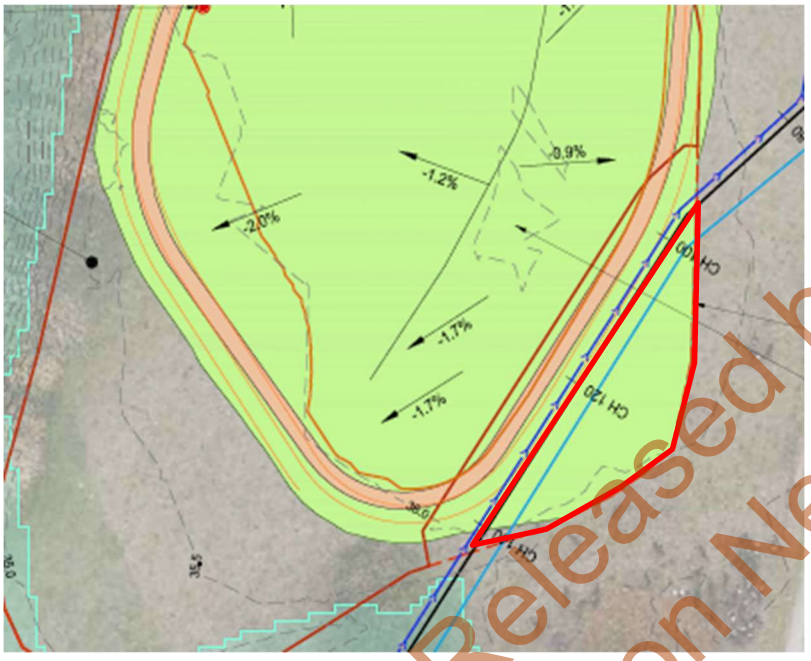

Figure 17: Portion of Area A1 located with AgResearch site (red outline)

4.6.5 Pros and Cons

Pros

- Cap is proposed to be stripped from Area A1 in any case as per Option 2, so only a small increase in capping requirements based on raised expanded fill profile.
- Improved utilisation of existing Disposal Site.
- Unconsented landfill areas outside historical landfill extents are removed.
- Landfill area within neighbouring AgResearch site is removed.
- Culvert 3 partially removed, eliminating risk of culvert failure, restoring watercourse with associated ecological benefits.
- Transferred refuse is properly contained, capped and topsoiled within Area A1 and outside of the stream floodplain.
- Raised farm crossing embankment maintains farm access through this area and helps mitigate flood risks.
- Lowered Areas A2/H will contribute to flood detention (minor benefit).
- Overall significant reduction in long term risk and liability.

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Cons

- Transferred refuse raises fill height in Area A1 by up to 1.5m, so appropriate design required to ensure area still suitable for agricultural use post-works.
- The existing and transferred refuse represents an ongoing long-term liability that has to be managed to avoid associated adverse human health and environmental effects. This can be achieved through best practice design and ongoing maintenance by LINZ.
- Works area temporarily unavailable for grazing use during works and until pasture re-established.
- Minor earthworks and culvert works will be required along the northern fringes of the neighbouring AgResearch site for the Culvert 3 replacement and raising of the existing farm crossing embankment.

New resource consents would be required for these works and may include earthworks in proximity to a stream; temporary damming/diversion during works; permanent stream diversion; disturbance of contaminated land under the NESCS; discharge of contaminants to land, and subsequently water or air; possibly for discharge of stormwater to land/water; and for land use activity (landfill) under the Waipā District Plan.

4.7 OPTION 5: OFF-SITE REMOVAL OF ALL LANDFILLED MATERIALS

As noted above, the Crown has accepted liability for the landfill in perpetuity. There is no requirement to remove the landfill in its entirety as it is a consented closed landfill under the consents described above. This option is, however, being assessed for completeness and to respond to feedback during engagement with mana whenua where the desire for complete removal of the landfill to be undertaken was voiced.

This option would involve the removal of all landfilled materials and disposal off-site to an approved Class 1 landfill. Culvert 3 would be removed and the stream reinstated through this area. The excavated areas would be reinstated at a lower level, similar to original levels prior to landfilling. This would involve an area of 2.1ha and volume of refuse material up to 32,700m^3. Backfill requirements would be minimal, primarily involving regrading and shaping the land, depending on the adopted final ground levels.

Pros

- Landfilled materials transferred to Class 1 landfill, subject to stringent operational and environmental controls eliminating landfill risk and associated long term liability to the Crown.
- Stream restored, as Culvert 3 and landfilled areas would be removed.

Cons

- Most costly option.
- Landfill area not available for grazing use during the works.
- Significant off-site effects during construction, involving traffic movements for fill/refuse disposal and backfilling requirements for reinstatement of the land and associated vehicle emissions.

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- Refuse/fill material shifted to another rohe.
- Minor earthworks and culvert works will be required along the northern fringes of the neighbouring AgResearch site for the Culvert 3 removal/replacement and raising of the existing farm crossing embankment.

New resource consents would be required for these works, including earthworks in proximity to a stream; temporary damming/diversion during works; permanent stream diversion; and disturbance of contaminated land under the NESCS.

4.8 OPTIONS ASSESSMENT

The options assessment process took a different approach from the options assessment for the hospital remediation works, as the options were assessed against specific key issues with the existing landfill. The assessment process was based on the following criteria:

- **Optimising use of the existing landfill.** This takes into account that an existing landfill is present on-site, that LINZ is responsible for and committed to looking after in perpetuity. There is potential to dispose of low and moderate-contaminated soil from the hospital into the landfill, as well as shift some waste materials from riskier areas of the landfill (i.e. within the floodplain) to less risky areas (i.e. outside the floodplain) within the landfill footprint.
- **Improved waste containment and capping.** This will effectively address a number of identified landfill compliance issues and risks, including topsoil contamination, landfill cover/cap integrity, settlement, subsidence and erosion, stability and potential surface runoff contamination.
- **Reduced leachate generation and groundwater contamination.** This will result from a combination of improved capping, reducing rainwater infiltration into the landfill and hence leachate generation, as well as other measures to divert upgradient groundwater so that it no longer passes through the landfill waste mass.
- **Elimination of the risk of Culvert 3 leaks or failure.** This culvert has been identified as a critical landfill risk, which could have significant consequences were it to fail.
- **Flood mitigation.** Parts of the landfill are located within the Wharekōrino Stream floodplain and there is potential to remove or modify one of more culverts along the stream that will reduce flood water levels, reducing the landfill area exposed to potential flooding.
- **Reduced off-site effects.** This covers temporary effects during the repair/upgrade works, primarily associated with vehicle movements for the import/export of refuse/backfill/capping/topsoil materials, including associated vehicle emissions.

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Table 5: Combination Disposal Site Repair/Upgrade Options Screening Assessment

Option ID - Name	Work Components						Benefits					
	Improved Capping	Transfer Contam. Soil from Hospital into landfill area E/F and remove medical waste from Area F	Shift Refuse Material from Areas A2/H + Ag. land to Area A1 and Stream Rein-statement	Culvert 3 Partial Removal	Culvert 2 Removal	Install Up-gradient Ground-water Cutoff Drain	Opti-mising Use of Existing Landfill	Improved Waste Contain-ment and Capping	Reduced Leachate Generation and Groundwater Contam-ination	Eliminate Culvert 3 Risk of Leaks/ Failure	Flooding Miti-gation	Min-imal off-site effects during works
1 - No change	Excluded	Excluded	Excluded	Excluded	Excluded	Excluded	N	N	N	N	N	Y
2 - Minimum	Included	Excluded	Excluded	Excluded	Included	Excluded	N	YY	Y	N	Y	N
3 - Intermediate	Included	Included	Excluded	Excluded	Included	Excluded	Y	YY	Y	N	Y	N
4 - Advanced	Included	Included	Included	Included	Included	Included	YY	YY	YY	YY	YY	N
5 - Off-site Removal	Off-site removal of all refuse and land reinstatement						NN	Y	YY	YY	YY	NN

Note:

1. All options 2-4 all include removal of Culvert 2, as this was selected as a beneficial remediation option in the Horizontal Infrastructure investigation work.
2. Shadings: Red = significant negative benefit (NN); orange = no benefit (N); light green = some benefit (Y), dark green = significant benefit (YY)
3. Ag. = AgResearch

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5.0 PREFERRED REPAIR AND UPGRADE OPTION

5.1 PREFERRED OPTION

The preferred option is Option 4 which involves the following works:

(a) Improved capping of the entire landfill.

(b) Removal of Culvert 2 and associated road embankment, followed by stream reinstatement.

(c) Transfer of low and moderate level contaminated soil from hospital remediation works into Area E/F and isolated medical waste removal, with excavated material from this area being used as backfill in the hospital remediation works.

(d) Shifting of fill/refuse material from the south-eastern corner of Area A1 that is located on AgResearch land, outside of the subject site, into the A1 area within the subject site.

(e) Shifting of fill/refuse material from Areas A2/H into Area A1 and associated partial removal of Culvert 3 from these areas, followed by stream reinstatement, with a new embankment on the eastern side of the stream to separate the reclaimed area from existing landfill area A1.

(f) Maintain existing southern farm track embankment and replace first section of culvert running under this, tying into reinstated stream. Raise track crossing slightly to assist with flood mitigation.

This option has the greatest benefits across the adopted evaluation criteria.

5.2 CONSTRUCTION STAGING

The works will be divided into two stages, covering Areas D-F and A-C + H. No remediation works are proposed for Area G, as no fill or contamination was found in this area. These stages are shown below.

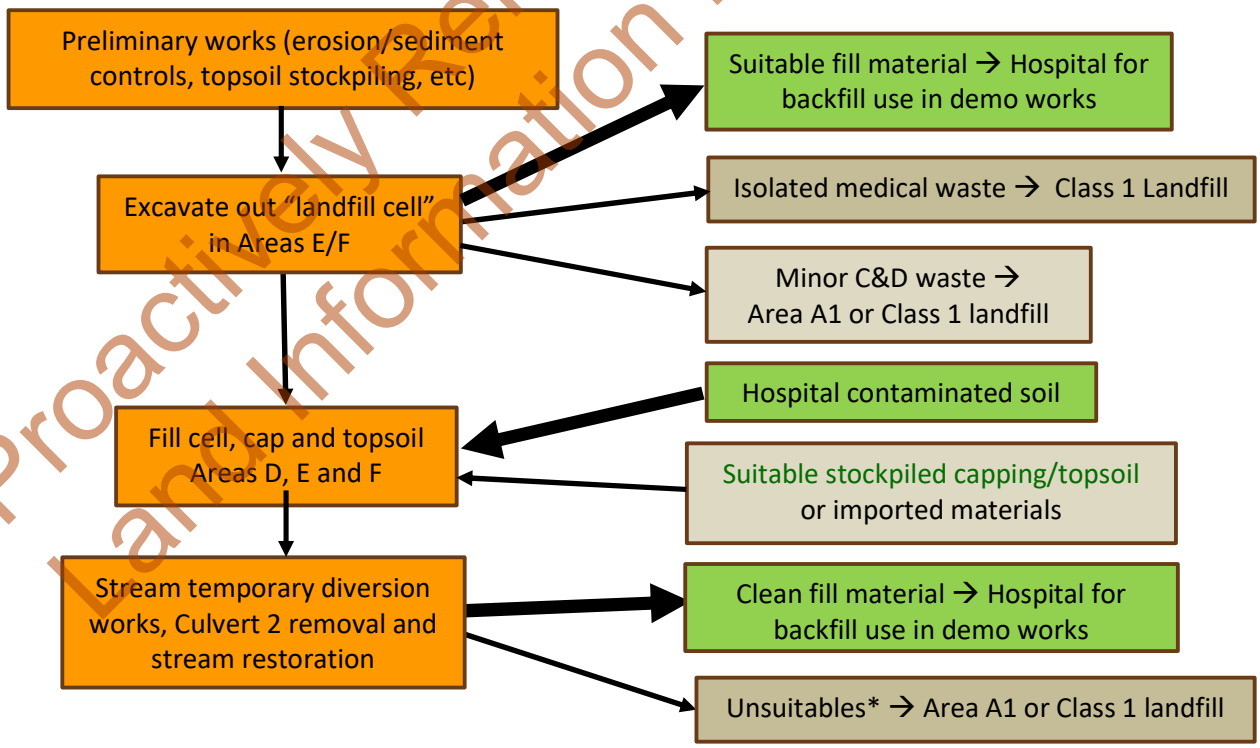

Figure 18: Stage 1: Area D-F and Culvert 2 (unsuitables = alluvial or soft materials that need to be undercut prior to filling on top of them; orange shows main works process; green represents internal movement of materials within hospital; grey represents imported materials or off-site disposal)

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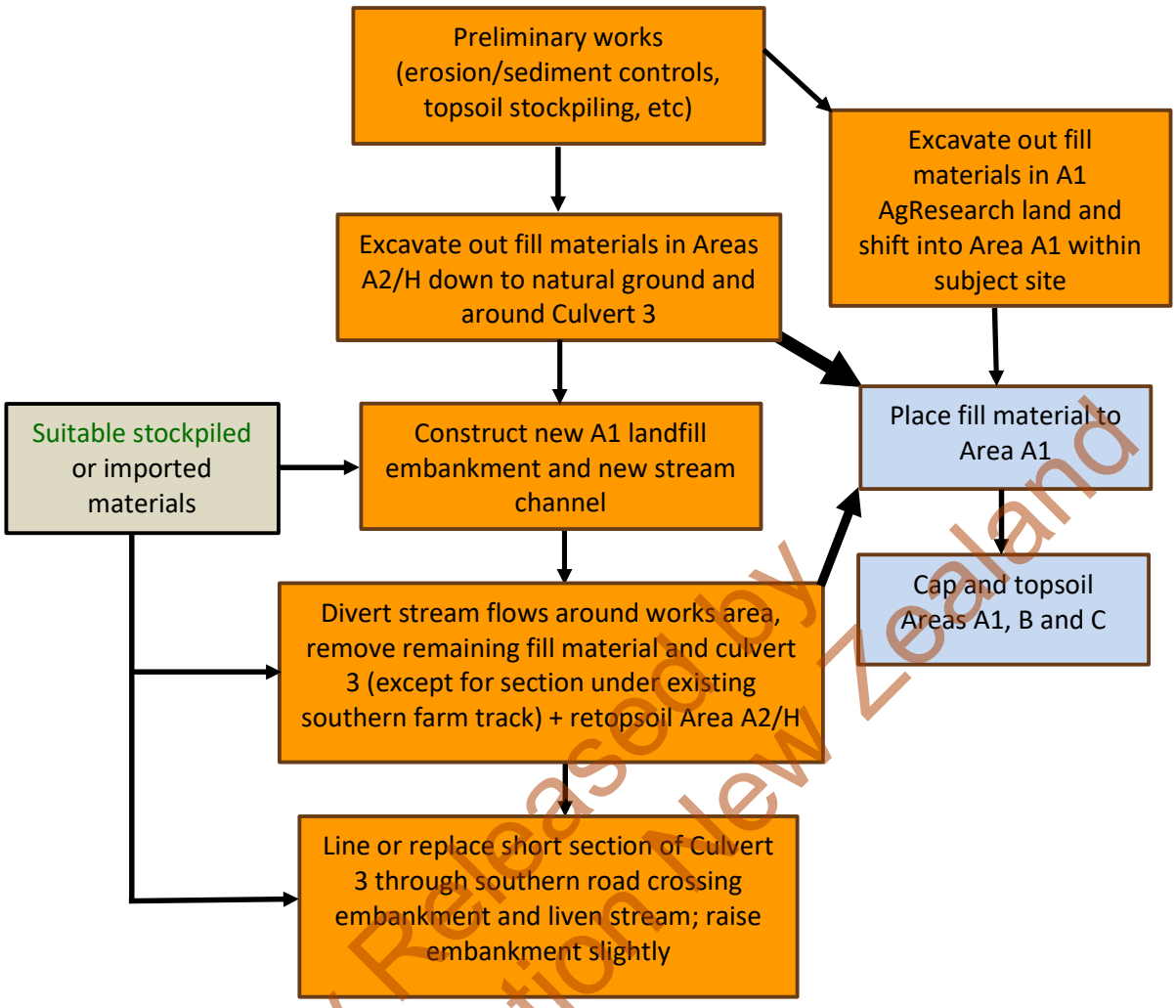

Figure 19: Stage 2: Areas A-C and H (orange = main works relating to Area A2/H and partial steam reinstatement; blue = works in Area A1/B/C; green represents internal movement of materials within hospital; grey represents imported materials or off-site disposal)

5.3 REFINEMENT OF PREFERRED OPTION

5.3.1 Overview

Following selection of the preferred option and engagement with mana whenua, further engineering design work was undertaken to assess the constructability and affordability of this option. This work found that the proposed Culvert 3 removal, stream reinstatement and new landfill toe bund embankment would result in an estimated volume of approximately 7,500m^3 of refuse having to be moved from Area A2/H and part of Area A1 into Area A1/B. As Area H contained considerably less refuse than Area A2, the following refinements were made to the preferred option:

(e) The alignment of the new shorter culvert through the farm track crossing embankment was shifted more to the north-west so as to avoid passing through Area A1 completely.

(f) The reinstated stream was also shifted further west of the original alignment to lie entirely outside of Area A2.

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(g) The intersection of this stream with the existing stream was shifted further downstream.
(h) These changes meant that Culvert 3 no longer needed to be removed to facilitate the works in this area, but could remain in place and instead be filled with grout and sealed at each end.

5.3.2 Pros and Cons

Pros (relative to Option 4 assessed above)

- Remaining refuse material in Area A2 is now located on the eastern side of the Wharekōrino Stream, are properly capped and topsoiled, and protected from flooding and scour/erosion by the new stream embankment.
- Avoids significant quantities of refuse materials having to be transferred from Area A2/H and part of A1.
- Avoids having to remove Culvert 3, but Culvert 3 long term failure risks are eliminated by grouting this entire pipe.
- Restoration of 75m of stream with associated ecological benefits incorporating feedback from mana whenua to undertake the demolition and remediation project in a manner that would enable flora growth.
- Raised farm crossing embankment maintains farm access through this area and helps mitigate flood risks.
- Overall significant reduction in long term risk and liability.

Cons

- Transferred refuse and other materials from Areas A2/H will raise fill height in Area A1 by up to 1.5m, so appropriate design required to ensure area still suitable for agricultural use post-works.
- The existing and transferred refuse represents an ongoing long-term liability that has to be managed to avoid associated adverse human health and environmental effects. This can be achieved through best practice design and ongoing maintenance by LINZ.
- Works area temporarily unavailable for grazing use during works and until pasture re-established.
- Minor earthworks and culvert works will be required along the northern fringes of the neighbouring AgResearch site for the Culvert 3 replacement and raising of the existing farm crossing embankment.
- A short section of the existing stream will only receive inflows from localized overland flow and not from the Culvert 3 discharge. This is discussed further in the Assessment of Environmental Effects.

New resource consents would be required for these works and may include earthworks in proximity to a stream; temporary damming/diversion during works; permanent stream diversion; disturbance of contaminated land under the NESCS; discharge of contaminants to land, and subsequently water or air; possibly for discharge of stormwater to land/water; and for land use activity (landfill) under the Waipā District Plan.

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5.4 METHODOLOGY

This section summarises the proposed methodology for the existing Disposal Site repair and upgrade works. These works are shown on the attached Fraser Thomas drawings, as referenced in this section and listed at the front of this report. An overview of these works is included on drawing 33097/LF010.

The final methodology and sequencing of these works may vary from that shown here, and will be determined on-site by the contractor and supervising engineer prior to commencement of works within each stage or substage. Approval for any significant changes will be sought from Waikato Regional Council, if and as required.

5.4.1 General

G.1 These works should be undertaken during the Waikato region earthworks season, with the landfill material transfer works and stream works ideally being undertaken during January-March, assuming a typical dry summer, so that rainfall, seasonal surface water flows and groundwater levels should be at their minimum.

G.2 Required erosion and sediment control measures will be installed and maintained during the works in accordance with best practice, utilising recommended measures set out in the latest version of the Waikato Regional Council publication, TR2009/02 "Erosion and Sediment Control: Guidelines for Soil Disturbing Activities" (2014 update), including updated fact sheets available on: https://www.waikatoregion.govt.nz/services/publications/tr200902/, and the separate Landfill Erosion and Sediment Control Plan (ESCP).

G.3 All imported materials (e.g. capping material, topsoil) will be verified cleanfill, as defined in the consent conditions.

G.4 The following plans will be required to be submitted to Environment Waikato prior to works commencing in each stage:
(a) Erosion and Sediment Control Plan, including stream temporary diversion methodology;
(c) Asbestos Removal Control Plan (for asbestos materials within the landfill);
(d) Construction Management Plan (which the above items may be incorporated into). This shall include a component addressing potential and actual contamination issues, that may be encountered during the works, and any associated validation sampling requirements.

G.5 An Aftercare and Monitoring Plan will be required to be submitted to Env-Waikato for approval on completion of the works.

5.4.2 Stage 1: Area D, E, F Works (DEF)

These works are shown on drawings 33097/LF100-LF191. They will be done in two phases. The first phase involves works in Area EF as described in items DEF.1-7. The second phase involves the recapping of Area D, following steps DEF.8-9. This is reflected in the two phases of erosion and sediment controls shown on drawings 33097/LF190 and LF191.

Area EF:

DEF.1 Install all erosion and sediment controls in accordance with the approved ESCP. This will involve silt fences, super silt fences and/or Decanting Earth Bunds (DEBs) on the downgradient

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side of the works area and clean water diversion channels on the upgradient side. See FTL Drawing 33097/LF190. These devices are considered more appropriate than sediment removal ponds (SRPs) for this site, as SRPs typically require a reasonable land area and their construction would involve excavation into the ground and potentially through landfilled material, while the proposed works will form excavation cavities that will contain any direct rainfall, thus reducing the risk of dirty runoff generation. Allow for pump in lowest area of excavation to pump dirty runoff to DEB. Where any runoff from within landfill works area comes into contact with refuse, testing of the runoff post-treatment, is required to check it can be discharged on-site to the natural environment. If not, then any such runoff will either need to be treated further on-site prior to discharge, or be tankered off-site for disposal as a trade waste.

DEF.2 Strip vegetation from works area prior to works. For this purpose, it would be useful to graze or mow the works areas pre-commencement.

DEF.3 Strip topsoil and cap from the works area and stockpile these materials outside of the works area for future reuse as cover material, if suitable, or placement into the landfill itself. Remove additional fill material from Area F to expose the former "offal pits" (cylindrical holes) used for the disposal of medical waste (mainly sharps). Excavate any medical waste found and dispose of off-site to a Class 1 landfill. Separate out any other pockets of refuse material from the works area and transfer to Area A1 (subject to suitable timing) or off-site to a Class 1 landfill.

DEF.4 Excavate suitable non-engineered fill material from the works area and transfer to the hospital via the Culvert 2 embankment road for use as backfill. Once sufficient material has been shifted from the works area to create space, contaminated soil can be transferred to the works area from the hospital and placed as compacted fill.

DEF.5 Compact, shape and trim the landfill surface to make it suitable for capping. Ensure that landfill batters adjacent to the stream are adequate to minimise scour/erosion which could damage the cap and expose underlying refuse in storm events.

DEF.6 Recap the landfill, with a GCL (geosynthetic clay liner) cap, underlain by a 150-300mm bedding/protection layer and overlain by a minimum 150mm thick protection layer, 300mm thick agricultural growth layer and 150mm thick topsoil, followed by regrassing. This gives a 600mm thick soil profile above the GCL liner, which is consistent with advice from Soil and LUC Consultant, Dr Scott Fraser that if a cap of no less than 60cm of good quality soil was reinstated this land could also be restored as Highly Productive Land.

DEF.7 Relocate groundwater monitoring bore, P7, to outside the landfill extent, and install at a greater depth than the existing monitoring bore.

Area D:

DEF.8 Set up all erosion and sediment controls as per drawing 33097/LF191. Remove vegetation and topsoil, and then remove existing cap, except for leaving the bottom 200mm of cap in place to avoid exposing historic refuse and to provide a suitable ground surface for running trucks and small excavators across. Stockpile these materials outside of Area D for future reuse as cover material, if suitable, or for placement within the landfill.

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DEF.9 Replace previous, lower quality, landfill cap materials on top of refuse to form a 150-300mm thick base layer, comprising compacted cohesive soils of permeability $1x10^{-7}$m/s with no sharps/abrasive material. This should connect into the cap over the perimeter bund. Construct new low permeability cap comprising a geosynthetic clay liner or similar, overlain by a 150mm thick protection layer. Replace previous landfill cap materials (if suitable) or imported materials on top of the protection layer to form a 300mm thick agricultural growth layer. Place minimum 150mm thick, verified clean topsoil on top of new landfill cap, reusing existing topsoil where appropriate, and then grassing.

Both areas:

DEF.10 Remove erosion/sediment controls once sufficient ground stabilisation (grass cover) achieved.

DEF-11 Reinstate any farm troughs and associated water supply lines, if disturbed or damaged by the works.

Notes:

1. No groundwater cutoff drain upgradient of the landfill is required for this area as groundwater has not been encountered in long term monitoring to the bottom of the piezometer (P7, 5.2m depth).
2. This work can be done in stages, keeping ahead of contaminated soil generation from the hospital demolition works.
3. Once the soil transfer process is completed, the Culvert 2 embankment can be removed.

5.4.3 Stage 2: Area A1/B/C Works (A1)

These works are shown on drawings 33097/LF200-LF291.

Area A1 (on AgResearch land; (Section 3 SO 534156)):

A1.1 Begin works on AgResearch land area outside of the perimeter bund. Set up all erosion and sediment controls.

A1.2 Strip and temporary stockpile topsoil and landfill cap materials from this area.

A1.3 Remove all refuse from this area and a sufficient distance into the subject site for the new landfill toe bund.

A1.4 Construct a new landfill toe bund abutting the site boundary, including groundwater diversion trench under the toe bund.

A1.5 Backfill the AgResearch area with cleanfill (subsoils and minimum 150mm topsoil, followed by regrassing.

A1.6 Fill in the void created within the subject site to facilitate the toe bund construction with refuse material or suitable subsoils.

These works have to be undertaken before the perimeter toe bund referred to below can be completed. However, some of the steps outlined below for Raised Area A1B need to be undertaken first, so that refuse from the AgResearch land can be placed into the A1/B area avoiding double handling of it. Hence, there will be some overlap between works in these areas.

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Raised Area A1/B:

A1.7 Install all erosion and sediment controls in accordance with Waikato Regional Council Erosion and Sediment Control Guidelines and the landfill ESCP. Further details are provided below for Area A2/H, while silt fences, super silt fences and/or DEB should be placed around Area A1/B as shown on FTL Drawings 33097/LF290-291.

A1.8 Earthworks will be staged to minimise the open area. Begin with only the southern disposal area works.

A1.9 Construct perimeter bund, removing topsoil from beneath the bund and stockpiling/using to form clean water diversion drains. Perimeter bund to comprise of compacted clay or other suitable materials around Area A1/B in preparation for the placement of refuse

A1.10 Strip topsoil and cap from Area A1/B, except for leaving the bottom 200mm of cap in place to avoid exposing historic refuse and to provide a suitable ground surface for running trucks and small excavators across. Stockpile these materials outside of Area A1/B for future reuse as cover material, if suitable, or for placement within the landfill.

A1.11 Place transferred refuse/fill from Area A2/H into Area A1/B bunded cell. Contamination testing results for Areas A2 and H show some of the fill is contaminated with asbestos, with concentrations indicating these works will need to be done as Asbestos Related Works. Class B asbestos controls would be implemented in any localised areas, if necessary, based on site observations. Create minimum 1x1m windows through residual cap at 5m^2 spacings prior to placing additional refuse/fill on top.

A1.12 Place transferred fill material from Area H into Area A1 on top of the A2 material. If necessary, drier material from Area H may be mixed with any deeper, likely moist material from step A1.5.

A1.13 Replace previous, lower quality, landfill cap materials on top of refuse to form a 150-300mm thick base layer, comprising compacted cohesive soils of permeability 1x10^{-7}m/s with no sharps/abrasive material. This should extend over the top of the perimeter bund. Construct new low permeability cap comprising a geosynthetic clay liner or similar, overlain by a 150mm thick protection layer. Replace previous landfill cap materials (if suitable) or imported materials on top of the protection layer to form a 300mm thick agricultural growth layer. Place minimum 150mm thick, verified clean topsoil on top of new landfill cap, reusing existing topsoil where appropriate.

A1.14 Stabilise the southern disposal area with hay mulch and seed.

Area A1/B/C (outside perimeter bund):

A1.15 Begin works on area outside of the perimeter bund. Set up all erosion and sediment controls.

A1.16 In stages, remove vegetation and topsoil, and then remove existing cap, except for leaving the bottom 200-300mm of cap in place to avoid exposing historic refuse and to provide a suitable ground surface for running trucks and small excavators across. Stockpile these materials outside of Area A1 for future reuse as cover material, if suitable, or for placement within the landfill.

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A1.17 Replace previous, lower quality, landfill cap materials on top of refuse to form a 150-300mm thick base layer, comprising compacted cohesive soils of permeability $1x10^{-7}$m/s with no sharps/abrasive material. This should connect into the cap over the perimeter bund. Construct new low permeability cap comprising a geosynthetic clay liner or similar, overlain by a 150mm thick protection layer. Replace previous landfill cap materials (if suitable) or imported materials on top of the protection layer to form a 300mm thick agricultural growth layer. Place minimum 150mm thick, verified clean topsoil on top of new landfill cap, reusing existing topsoil where appropriate.

A1.18 Relocate groundwater monitoring bore, P2, to outside the landfill extent.

A1.19 Reinstate any farm troughs and associated water supply lines, if disturbed or damaged by the works.

A1.20 Complete construction of a groundwater cutoff drain upgradient of the landfill adjacent to Farm Rd and extend along sides of landfill to suitable discharge point for gravity discharge to stream.

5.4.4 Area A2/H works (A2)

These works are shown on drawings 33097/LF300-LF390.

A2.1 Install silt fences, portable silt/sediment removal device or DEB(s) outside of works area and clean water diversion drains, as shown on drawing 33097/LF390. Allow for pump in lowest area of excavation to pump dirty runoff to portable silt/sediment removal device/DEB(s). Where any runoff from within landfill works area comes into contact with refuse, testing of the runoff post-treatment, is required to check it can be discharged on-site to the natural environment. If not, then any such runoff will either need to be treated further on-site prior to discharge, or be tankered off-site for disposal as a trade waste. Use the existing farm crossing as a clean water diversion bund upstream of the works, and maintain Culvert 3 live for as long as possible during the works. Allow for clean water diversion pump to be available for diversion of stream water if necessary.

A2.2 Groundwater piezometers are planned to be installed in this area to check groundwater depths within Area A2/H as part of detailed design. If necessary, based on the groundwater depth findings, install a number of dewatering wells or wellpoints or temporary pump for dewatering to lower the groundwater table within the works area.

A2.3 Mark out the approximate alignment of Culvert 3 pre-works (assumed straight line between inlet and outlet). Trafficking over this culvert should be minimised during the works, with refuse being shifted from Area A2/H to A1/B by truck via the existing farm crossing. The best available information indicates that the top of Culvert 3 is just over 2m below existing ground level (see Figure 14).

A2.4 Strip existing topsoil and landfill cap from the works area and stockpile separately outside the works area. Refuse layers will then be removed and transferred to Area A1 by truck. Fill material (that is not refuse) will either be transferred to Area A1 or used for other purposes (e.g. cap) depending on its contamination status.

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A2.5 Once the refuse has been transferred, construct a compacted toe bund embankment along the western side of the residual A2 Area. Stockpiled landfill material will be placed in the void between the toe bund and refuse as necessary. A low permeability cap will then be placed over the material followed by topsoil. Capping details will be as for Area A1.

A2.6 Cut in the new stream channel (approximately 75m long with base width of 3m with side slopes of 1V:3H, with some meanders), retopsoiling the channel and line with biodegradable coir matting to stabilise it, followed by planting with natives in accordance with the landscaping plan and placement of some rocks and logs. Place clean, stockpiled capping material or clean fill material from Area H to fill any depressions within Area A2 and then retopsoiling, using clean topsoil.

A2.7 For the new outfall to the stream, strip vegetation and trees. Install a temporary dam comprising steel shields or similar around the outfall works area and pump out water from inside the dam. Continue the stream channel to connect into the existing stream. Line with biodegradable coir matting to stabilise it, followed by planting as above.

A2.8 For installation of the new shorter Culvert 3 (1350 dia x 44 m long), install this in a downstream to upstream direction starting at the top of the new channel. A temporary dam will be installed as for A2.7 on the western side of the existing Culvert 3 inlet, to isolate the area where the new culvert inlet will be installed, from water in the existing stream which will continue to flow through the existing culvert. Water will then be pumped out from inside the dam. Once the new culvert is “live”, the temporary dams at each end of the stream diversion will be relocated to block off the inlet and outlet to the existing culvert. This culvert (1350mm dia x approximately 60m long) will then be filled with flowable concrete fill or similar (~86m^3), with both ends of this culvert being sealed. Water within this culvert will be pumped out if necessary, or alternatively expelled naturally during the filling process.

5.5 CONTAMINATED SOIL MANAGEMENT AND VALIDATION

It is important to emphasise that the majority of the works described above are considered to be landfill repair and upgrade works and will be managed accordingly, while contaminated soil matters are limited to a number of specific issues and areas, as explained in the following:

- Landfill (refuse) material will be dealt with as landfill material. This applies to refuse which will be shifted from one part of the landfill to another, and landfill material that is accidentally exposed during recapping works.
- The landfill cap and topsoil material will need verifying that it complies with the site specific rural residential standards. This can be achieved in advance using existing data for on-site materials and cleanfill verification material for imported materials, supplemented by additional verification testing as required. Validation sampling may also be undertaken of the cap and topsoil, following placement, if necessary.
- Proof will need to be provided that all medical waste in Area F has been disposed of off-site to a Class 1 landfill. The medical waste is located in well defined and contained “offal pits” (cylindrical holes). This proof would include SQEP visual observation, photographs, landfill dockets and possibly validation sampling of the adjacent soil.

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- Areas where landfill material will be completely removed (Area H, part A2 and AgResearch land) and restored to agricultural use will need to be verified by validation testing of the natural ground and placed topsoil as complying with the site specific rural residential standards.
- Measures are set out in the associated ESCP for managing any rainfall or runoff that may come into contact with exposed refuse during the works and for dewatering of any groundwater that may be in contact with refuse in the existing landfill.

6.0 ASSESSMENT OF ENVIRONMENTAL EFFECTS

This Assessment of Environmental Effects addresses the potential or actual human health and environmental issues associated with the proposed works for the existing situation, during the works and post-works completion.

6.1 EXISTING SITUATION

The potential human health and environmental effects of the contaminated soil within the Hospital area is covered in the separate Fraser Thomas Remedial Options Report and are not repeated here, as this comes under a separate consent application.

As explained in section 3.4 of this report, the existing landfill is considered to be in the latter stages of its aftercare period (typically 30-50 years post-closure), with Area C closed about 26 years ago, Area A 35 years ago and the other areas likely as long as 44 years ago. This is supported by:

- Typical leachate parameters (ammoniacal-nitrogen and chloride) having relatively low concentrations in groundwater and pH being approximately neutral.
- No landfill gas being detected on-site during the 2022 or 2023 intrusive investigations.
- The majority of landfill settlement is inferred to have already occurred.

The fill material within the landfill would generally be categorised as Class 1 landfill material, along with some managed fill and cleanfill materials, as well as some special wastes (i.e., medical wastes, asbestos). Monitoring indicates that Boron is present in the landfilled materials, which is inferred to derive from coal ash deposition within the landfill.

The existing Disposal Site may present the following human health or environmental effects:

- Some areas have non-compliant capping (i.e., inadequate thickness and/or permeability) and/or topsoil cover in relation to the approved resource consent for the landfill site. This will tend to increase leachate generation from direct rainfall onto the landfill whilst also increasing the risk of some buried material become exposed, representing a potential human health threat.
- The landfill does not have a leachate collection system, so the leachate will flow through the landfill to the groundwater table, while the lack of landfill base and side liners and groundwater subsoil drainage allows groundwater to come into direct contact with buried refuse in some locations. Together, these factors mean that groundwater passing through the landfill contains some elevated contaminants from direct contact and leachate ingress, with the groundwater flowing into the Wharekōrino Stream. Elevated boron levels are present in the groundwater and stream, which are still occurring in 2024, albeit within ANZECC 95% freshwater protection and long-term irrigation trigger values.

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- Culvert 3 (1350dia) pipes the Wharekōrino Stream through Area A2/H of the landfill. This culvert is estimated to be 44-65 years old and could be subject to differential settlement from landfill activity, leading to leaking joints and ultimately possible pipe failure. These landfill areas are both outside the landfill extent referred to under the existing resource consent. Pipe failure could result in fill/refuse washout down the stream, causing adverse human health and environmental damage and represents a long-term risk.
- Flood modelling of the Wharekōrino Stream has shown that the landfill areas A, B, C, G and H are currently likely to be inundated to varying extents during a 1% AEP (annual exceedance probability) storm event, particularly if the two downstream culverts on the stream are blocked or become blocked during the storm, with these effects worsening with predicted climate change. Areas D, E and F have been found unlikely to be affected by flooding. Flooding of landfill areas could cause scour/erosion of landfill side slopes and possible exposure of refuse, potentially causing downstream pollution and contamination.

6.2 DURING REPAIR/UPGRADE WORKS

Potential risks to contractors during landfill repair and upgrade works will be mitigated through all workers following requirements set out in the associated Construction Management Plan, including appropriate personal/respiratory protective equipment (PPE/RPE).

Again, this AEE does not cover potential risks associated with hospital demolition works overlapping with the landfill works (i.e. transfer of contaminated soil from hospital to landfill and transfer of backfill material from landfill to hospital, once in the hospital area), as these are addressed in the separate consent application for the hospital remediation (SLR, 2024).

The main potential human health and environmental risks during the landfill repair/upgrade works are considered to be:

(a) Earthworks and erosion/sediment control;
(b) Nuisance effects on neighbours - dust, noise, vibration and vehicle movements;
(c) Potential exposure of construction workers to refuse/fill materials, including asbestos and medical waste;
(d) Culvert removal results in silt/sediment and/or fill/refuse being washed down the stream.
(e) Part of the existing landfill erodes or slips into the stream during the works;
(f) A significant flood event occurs during the works, washing silt/sediment and/or fill/refuse down the stream.

6.2.1 Soil Disturbance and Earthworks

As stated above, all soil disturbing activities, including earthworks, will requires erosion and sediment control measures to be installed in advance of the works and maintained during the works in accordance with best practice, utilising recommended measures set out in the latest version of the Waikato Regional Council publication, TR2009/02 “Erosion and Sediment Control: Guidelines for Soil Disturbing Activities” (2014 update).

Estimated earthworks areas and volumes are listed below.

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Table 6: Earthworks Summary

Item	Area DEF	Area A1BC	Area A2H	Total
Area (m^2)	6,400	11,800	4,800	23,000
Cut Volumes (m^3):				
➢ Topsoil stripping to stockpile	750	2,380	130	3,360
➢ Cap stripping to stockpile	470	5,300	400	6,170
➢ Clay	5,900	-	4,800	10,700
➢ Unsuitables	50	100	50	200
➢ Refuse	800	**850**	3,400	5,150
➢ Total:	**7,970**	**8,630**	**8,780**	**25,580**
Fill Volume (m^3):				
➢ Refuse/Unsuitables	7,900	7,200		15,100
➢ Capping	4,150	7,300	450	11,900
➢ Topsoil	1,000	1,670	700	3,370
➢ Clay	-	1350	2,400	3,750
➢ Total:	**13,050**	**17,520**	**3,550**	**34,120**

Notes:

1. Volumes calculated using existing ground levels obtained from LiDAR, survey data and limited test pit investigations.
2. Stated fill volumes are solid measure, and do not include any bulking or compaction factors.
3. Total clay and cap cut = 16,870m^3 vs clay and cap fill = 15,650m^3; total topsoil cut = 3,360m^3 vs topsoil fill = 3,370m^3.

A draft ESCP has been prepared for this purpose and submitted to WRC for approval alongside the consent application and may be updated and shared with WRC prior to the works commencing. This plan has the following objectives:

- To minimize disturbance to areas where erosion may occur, including steep slopes and exposed land.
- To minimize the extent and duration of works on the site, including temporary stockpiles, and to ensure site stabilisation can occur in a staged manner, so as to reduce the risk of silt/sediment running off the site and entering the downstream receiving environment.
- To install perimeter controls such as diversion drains, silt fences, super silt fences and DEBs and construction entrances to prevent sediment leaving the site.
- To provide sediment removal devices to minimise the amount of sediment laden runoff leaving the site.
- To ensure exposed areas are stabilized as soon as practicable by sowing or mulching to prevent erosion.
- To provide guidance in case of unforeseen events including poor weather.
- To ensure all control measures are inspected and repaired after storm events.
- To ensure that the site is rehabilitated prior to the removal of sediment control measures.
- To mitigate dust emissions from the site during earthworks so as not to adversely affect any nearby properties.
- To minimize potential environmental effects.

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Implementation of the measures in this plan, including inspection, maintenance and site restoration requirements, should ensure that the potential negative environmental effects associated with earthworks and associated activities are avoided or mitigated, so that these effects are less than minor. It also addresses requests from my mana whenua during consultation to ensure water quality through the remediation and demolition activities is protected and that discharge of contaminants should be managed during the works.

6.2.2 Nuisance Effects on Neighbours

Collectively, the measures set out below in relation to dust, noise and vibration management, combined with the low volumes of traffic movements expected on public roads, means that nuisance effects on neighbours should be appropriately managed during the works to adequately mitigate any potential adverse effects.

A. Dust

Dust management during the Disposal Site repair/upgrade works will generally comply with the procedures set out in *Good Practice Guide for Assessing and Managing Dust* (Ministry for the Environment, 2016).

Dust control aims to prevent or reduce the movement of dust from disturbed soil surfaces that may create nuisance, health hazards, traffic safety problems and/or off-site damage and discharge to the environment.

Standard dust control measures will be used to control dust at the site and soil disturbance measures will be suspended if dry and windy conditions prevail, or alternatively the disturbance area shall be watered and maintained in a slightly moist state to minimise dust generation.

Dust will be controlled at the works site using appropriate measures from the following toolbox:

- Minimising the extent of the exposed area at any one time.
- Limiting traffic to specified construction access roads and minimising travel distances by optimising site layout.
- Controlling vehicle speeds.
- Maintaining road surfaces.
- Minimising tracking of dirt on vehicle wheels onto paved surfaces.
- Minimising drop heights when loading and unloading vehicles.
- Limiting stockpile heights.
- Providing shelter from the wind for stockpiles.
- Consolidating and sealing off loose surface material.
- Progressive placement of hardfill (sub-basecourse) for hardstand areas and mulching and grass establishment, as works are completed in grassed/vegetated areas.
- Use of water carts to dampen exposed areas.
- Use of soil binders to form a cohesive membrane or protective crust that reduces windblown dust generation (contingency measure).
- Use of textiles as temporary covers on stockpiles or partially completed batter slopes, or as permanent cover (e.g. vegetation promotion blanket) on completed areas (contingency measure).

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B. Noise

All works will be undertaken in accordance with the requirements of NZS 6803: 1999 'Acoustic – Construction Noise', the SLR Acoustic Assessment, and any relevant resource consent conditions. All works on the site and the use of associated heavy machinery shall be undertaken between the following hours only:

- Monday to Saturday: 7.30 am to 7.00 pm
- Sunday and Public Holidays: No work

The New Zealand Standard NZS 6803:1999 "Acoustics - Construction Noise" (NZS6803) provides comprehensive guidelines for measuring and assessing noise from both existing and proposed construction work, including activities such as maintenance and demolition. Compliance with the noise limits in NZS 6803 should ensure that noise from Disposal Site repair and upgrade works is assessed and managed in accordance with regulations and to minimise disruptions to the surrounding area.

The nearest residence to the Disposal Site works is approximately 65m from Area DEF. The largest, noisiest equipment is likely to be a 20T excavator, a medium sized bulldozer and possibly a landfill compactor. Where possible, the quietest appropriate machine to be used for works (requirement from acoustic report) will be used. It is expected that all other residences will not be affected by noise compliance issues. Similarly, the operating hours of noisy activities would be restricted to not occur after 6pm on working days.

Noise from other activities such as loading dump trucks and dump truck movements (on the basis that they would be quieter or at a similar level than those discussed above) would be expected to either comply or be controlled to achieve compliance with the relevant noise limit 70 dB LAeq, at surrounding receivers.

C. Vibration

Any effects of vibration will be temporary and limited to the duration of construction works. The effects of vibration will be limited by following relevant measures from DIN 4150-3:1999 "Structural Vibration – Part 3 Effects of Vibration on Structures".

D. Vehicle Movements

The majority of vehicle movements will involve:

- The transfer of contaminated soil from the Hospital to Area DEF, and the transfer of backfill material from Area DEF to the hospital, via the internal Culvert 2 embankment road, avoiding any traffic movements on public roads.
- The transfer of refuse material from Area A2H to Area A1BC. Again this will be done via the internal existing farm track or else directly across the landfill areas themselves.

External traffic on public roads will involve the removal of small amounts of medical waste from Area F, small amounts of unsuitables, both to a Class 1 landfill, and the import of any additional fill materials required (clay or other suitable materials for toe bund construction, imported capping soil and topsoil.

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6.2.3 Potential Exposure to Refuse/Fill Materials including Isolated Medical Waste and Asbestos

There will be a risk of direct contact or ingestion of the contaminated fill materials by repair workers, and potential inhalation of asbestos fibres in specific areas, as well as medical waste/sharps in isolated areas, based on the nature of the refuse/fill and associated contaminants present. The site is not accessible to the general public as is located on private property. The risk to workers will be avoided, eliminated or mitigated through following the controls set out in the Construction Management Plan, particularly in relation to Personal Protective Equipment (PPE) and Respiratory Protective Equipment (RPE) for works involving asbestos, while the contractor will be responsible for preparing an Asbestos Control Removal Plan. This will need to cover the following:

(a) Transfer of fill/refuse material with some asbestos contamination from Area A2/H to Area A1 - asbestos related works.
(b) Deposition of low-moderate level contaminated soil from hospital demolition into Area DEF - unlicensed asbestos works.
(c) Deposition of building halo scrape soil, building subfloor scrape soil and asbestos pipeline removal soil into Area DEF - asbestos works classification not currently known, but will be confirmed prior to transfer, with appropriate controls put in place. This will include air monitoring if required.

6.2.4 Culvert Removal "Washout"

These works will be targeted to be done during a summer low flow period and an extended period of fine weather as much as practicable, reducing this risk.

Appropriate stream diversion measures will be put in place during the works, along with associated erosion/sediment controls, in accordance with the methodology set out in Section 5.4 of this report. The relatively flat stream bed gradient through the works area means the stream is a low energy environment, making installation and maintenance of these measures easier.

The proposed methodology deliberately targets minimising the potential for silt/sediment generation during the works and for contact with fill/refuse material within the landfill.

Pūniu River Care does have an irrigation surface water take from the Wharekōrino Stream which has an intake structure with a mesh size of 1.9mm. The contractor will liaise with Pūniu River Care during the works over any increased blockage frequency of the intake screen and assist with cleaning it, if caused by the landfill works.

Collectively, these measures should ensure that potential effects from culvert removal causing increased silt/sediment loads to be discharged down the stream, and/or fil/refuse material to be washed down the stream will be minimised.

6.2.5 Landfill Erosion/Slips

The risk of landfill erosion/slips into the stream is considered low for the majority of the works area and will be mitigated through appropriate design and setting up and maintaining appropriate erosion and sediment controls.

The main risk area relates to the fill removal works in and around Culvert 3. The proposed methodology in section 5.4.4 aims to mitigate this risk. The contractor will have the opportunity to

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review this plan and suggest any amendments/improvements to it. Careful planning will be required during these works, including close monitoring of weather conditions.

It is considered that implementation of the proposed erosion and sediment controls and adherence to the final approved methodology will adequately mitigate this risk during the works.

6.2.6 Flood Mitigation

The Wharekōrino Stream comprises two branches, referred to here as the southern and western branches. The southern branch flows through Culverts 3, 2 and 1 and has an estimated catchment of 400ha at Culvert 1 under Te Mawhai Road.

The associated 100-year storm peak flow has been calculated to be 6.1m^3/s through Culvert 3 and 16.5m^3/s overtopping the existing farm crossing embankment over Culvert 3. These flows occur at different times, so the maximum combined flow is 19.6m^3/s. For Culvert 2, its embankment is much higher than Culvert 3, resulting in significant flood detention behind it and peak flows through the culvert being 7.5m^3/s with no overtopping occurring.

All culvert removal works will be done during summer low flows and during a forecast extended period of dry weather.

During the Culvert 2 removal works, the existing culvert will remain live for as long as possible, with the embankment being removed in horizontal layers down to near the top of the culvert. A portable pump capable of handling summer low stream flows will be used to convey water over the remaining embankment during the final removal works, while part of the embankment will also be lowered and temporarily lined with geotextile to create a spillway in the event of a storm. These measures will mitigate the potential for flood waters washing silt/sediment down the stream during a storm, while no fill or refuse material is present in the lower section of the embankment.

During the Culvert 3 removal works, a similar procedure will be followed, except that the new landfill embankment (toe bund) and new stream channel will be constructed in advance of Culvert 3 being removed. Flows through Culvert 3 will only be stopped, when the new shorter culvert and stream channel have been made live, with stream flows being diverted through them. These measures will mitigate the potential for flood waters washing silt/sediment down the stream during a storm, while the new landfill toe bund embankment will protect the existing landfilled material from being exposed to flooding.

This is also explained in the ESCP for these works.

6.2.7 Summary

Overall, the risks during the landfill repair and upgrade works will be temporary and short term in nature, and will be mitigated through following the final approved methodology for these works and the associated ESCP which also addresses stream diversion measures, including site observation by independently suitably qualified and certified engineers/environmental scientists to ensure compliance with these requirements.

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6.3 POST REPAIR/UPGRADE WORKS

Post the repair/upgrade works, the landfill area will be significantly improved and much more resilient to ongoing wear and tear as well as longer term risks, particularly in relation to Culvert 3 leaks/failure and flooding. This will ensure that potential human health and environmental risks are significantly reduced compared with the existing situation. Potential benefits and adverse effects are summarised in this section.

6.3.1 Improved Contaminated Fill/Refuse Containment and Capping

The HDPE capped landfill cells are expected to provide a reliable, robust contaminant containment system for well in excess of the expected maximum consent duration of 35 years. The potential for post-construction issues to occur is considered to be low, provided the containment cell is constructed to the appropriate standard and sufficient cover maintained over it to protect the upper liner from damage.

HDPE geomembranes are extremely durable products, designed with service lives up to several hundreds of years under ideal conditions. The service life of an HDPE geomembrane is typically defined as its half-life, which is the point at which 50% of the geomembrane has degraded. It will continue to function as a liner after this time, but at a reduced performance level.

The primary cause of degradation of lining systems is oxidation of the geomembrane, which eventually weakens the membrane and allow stress cracks to form. Oxidation is inhibited by limiting exposure of the geomembrane to UV radiation and open-air environments, and maintaining lower average ambient temperatures around the lining system. HDPE is chemically resistant to most substances, especially at lower temperatures (20°C or less), and chemical degradation of lining systems is generally considered a non-issue for most municipal uses.

The proposed containment cell includes several factors to minimize potential degradation of the lining system. The HDPE liner is sandwiched between 150mm thick protection layers. It will not be exposed to UV radiation and air, other than for a short time during construction, while it will be covered which will help maintain lower ambient temperatures around them. Durability testing completed in laboratory and field conditions estimates that an HDPE geomembrane can have a service life (50% degradation) of over 400 years. Under the conditions described it is reasonable to expect that the service life of the proposed lining system is several 100 years.

The proposed improved capping will also address a number of identified issues with the existing landfill:

- Some of the existing topsoil and landfill capping material has minor contamination and will be replaced with verified, clean topsoil.
- Landfill cover/cap integrity will be reinstated to equal or better than existing consent requirements and consistent with current best practice.
- Minor settlement, subsidence and erosion issues will be addressed during the repair/upgrade works including regrading any ponding areas to eliminate them, and so that surface runoff is shed from the landfill surface.

Collectively these measures will make ongoing landfill operation and maintenance easier, whilst reducing long term liability risks.

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6.3.2 Reduced Leachate Generation & Groundwater Contamination

This will result from a combination of improved capping, reducing rainwater infiltration into the landfill and hence leachate generation, as well as other measures to divert upgradient groundwater so that it no longer passes through the landfill waste mass. These measures should reduce ongoing leaching of contaminants in the refuse to the stream.

6.3.3 Elimination of the Risk of Existing Culvert 3 Leaks or Failure

Elimination of the risk of existing Culvert 3 leaks or failure will significantly reduce what is considered to be the most significant long term liability risk of the landfill. It will also partially restore the stream through this area, whilst maintaining the important flood detention function of a new, shorter Culvert 3 and associated farm track crossing embankment. Stream restoration and planting will have associated ecological benefits.

6.3.4 Effect of Partial Culvert Removal and Stream Reinstatement on Stream and Wetland

Project ecologists have identified a wetland being present in the Wharekōrino Stream just above Te Mawhai Road. This wetland is outside the extent of the proposed landfill repair and upgrade works.

The whole stretch of stream encompassing Culverts 1-3 is very flat, with an estimated gradient between Culverts 1 and 3 of 0.11%, based on the best available information, as shown in the stream long-section below. Essentially, this means this section of stream is likely to be subject to ponding, which is consistent with this area formerly being a swamp. The removal of Culverts 2 and 3 will be done without changing stream invert levels. This combined with the flat nature of the stream means that no changes to stream flows are expected that will affect aquatic life in the stream.

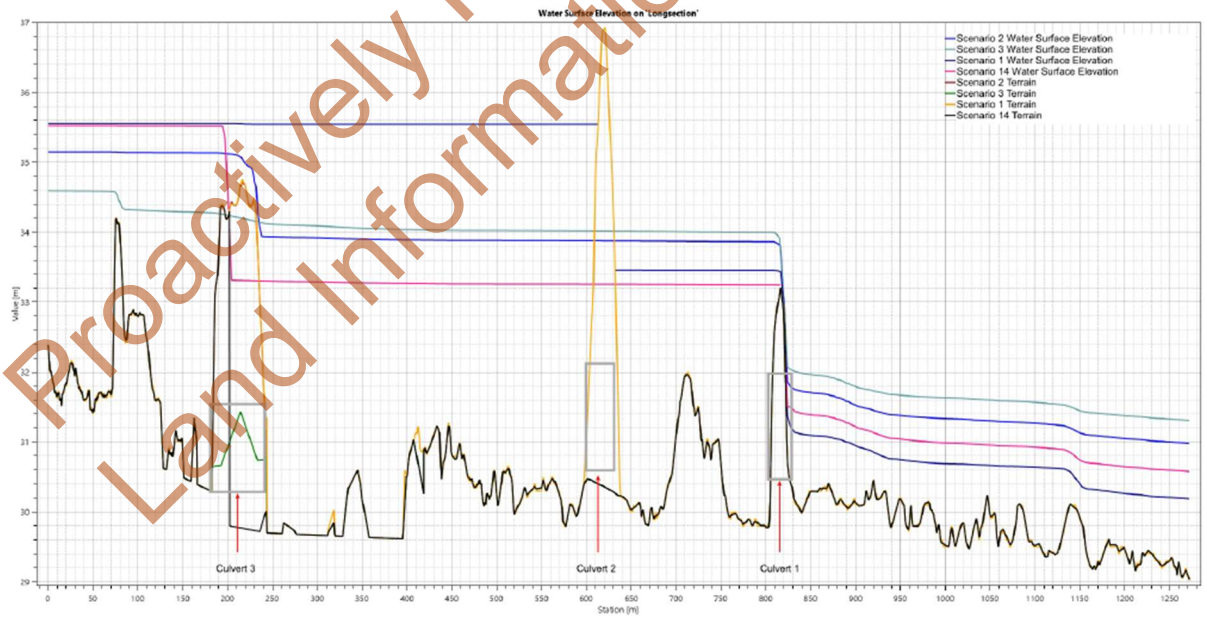

Figure 20: Stream Long-section. Note that while Culvert 2 is shown as having a higher invert level than Culverts 1 and 3 this may not be correct, but more reflective of the accuracy of the available LiDAR and survey data for this area.

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A short section of existing stream (28m) between the existing and new Culvert 3 outlets will be kept, but will no longer receive direct inflows from Culvert 3, as these will be discharged from the new stream outlet. This existing section of stream will still receive localized overland flow inputs, while it is expected that the water level in it will remain essentially the same, due to the flat nature of the stream bed. Hence, the ecology within this section of stream is expected to be maintained similar to the existing situation. Nevertheless, consideration will be given to planting of this branch of the stream with appropriate wetland plants, taking into account the expected water depth range.

The new shorter Culvert 3 will be embedded so that at least 25% of its diameter is below the level of the stream bed.

It is not feasible for the new culvert to be 1.3 times the width of the bed at its location, as required for a permitted activity under the National Environmental Standard - Freshwater. Based on an average stream width at the culvert inlet of 2.2m (see Figure 21b), this would mean a 2.9m wide culvert is required. The flood modelling is based on the existing 1.35m diameter culvert being replaced with a culvert of the same size and relies on there being some detention of flows upstream of Culvert 3. If a larger culvert was used, this would allow more flow through it and the flood effects at Te Mawhai Rd would be worse than modelled for the preferred option.

It is important to note that the existing culvert is at least 90% drowned based on multiple site visits conducted over the last two years so will normally have at least 1.2m depth of water in it (see Figures 21a & 21c). This will also apply to the new culvert. Site observations indicate that flow velocities through this pipe are generally relatively low due to it being drowned. However, during storm events, flood modelling has found that the estimated two year peak flow for existing rainfall is 6.3m^3/s, indicating that this culvert experiences relatively high flows during significant rainfall events. In order to mitigate fish potentially having a hard time getting past this culvert, consideration will be given to installing spoiler baffles within the culvert, given that it is not possible to increase the culvert size. The need for baffles, including associated spacing and sizing, will be confirmed during detailed design.

The new stream section will discharge to a wider area of the existing stream. To date, this connection has been designed based on LiDAR levels, and the exact location and design will be confirmed and submitted for approval prior to construction beginning.

The stream created will be constructed to benefit fish. This will include the watercourse having some meanders and designed to include fish habitat – i.e. planted with natives and with rocks/logs located throughout. Again, it is important to understand that the water depth within the new stream section is expected to be similar to the culvert (1.2-1.4m).

The new culvert and stream section have bed slopes of 0.5%, slightly lower than the existing culvert 3. The proposed stream bank gradient of 1V:3H is less than the existing stream bank and hence velocities in the new stream channel during high flow events will be lower than through the existing culvert.

An appropriate riparian planting for the new stream section has been prepared by others as part of this consent application. The new toe bund embankment can be planted with a preference for shallow rooting plants only.

Existing vegetation removal required to facilitate these works is shown on drawing 33097/LF311. This is indicative and will be confirmed prior to works starting. The areas shown as possibly needing

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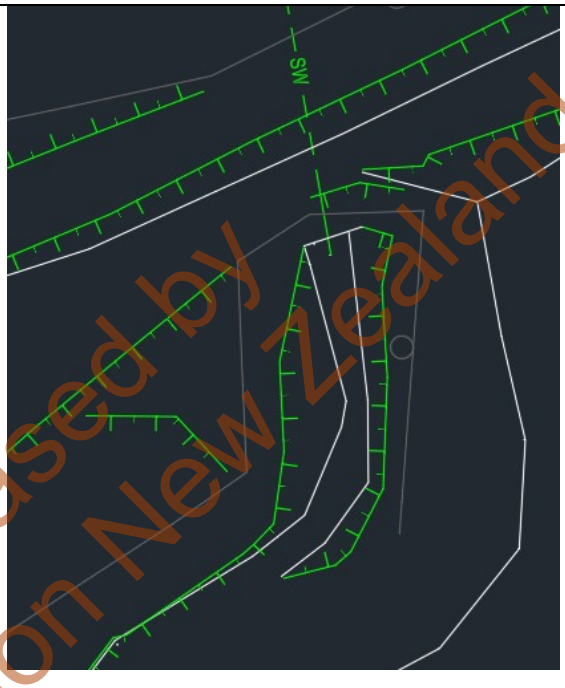
clearing around the existing culvert inlet and outlet are provisional and will depend on the contractor's methodology for getting access to these areas to seal the existing culvert, particularly how they will isolate the works area from the normal stream flows. Any riparian vegetation that has to be removed to facilitate this or is accidentally damaged during the works will be reinstated on works completion. An additional provisional vegetation removal area is shown on the same drawing. This will only be required if the stream channel is further to the east of the location indicated by Lidar data.

Overall, these proposed works are considered to enhance the existing stream environment.

A. Culvert 3 inlet - top of pipe just visible, indicating water depth of around 1200-1250mm depth. At recent Oct 24 visit, water depth measured at 1.15m but pipe was not visible, possibly due to overgrown vegetation.



B. Stream width at culvert inlet = 2.85m. Minimum width = 1.4m (slightly upstream); average = ~2.2m. Channel width at water level = 4.78m and at top of bank = 7.67m (Oct 24); channel depth (base to top of bank) = 3.20m

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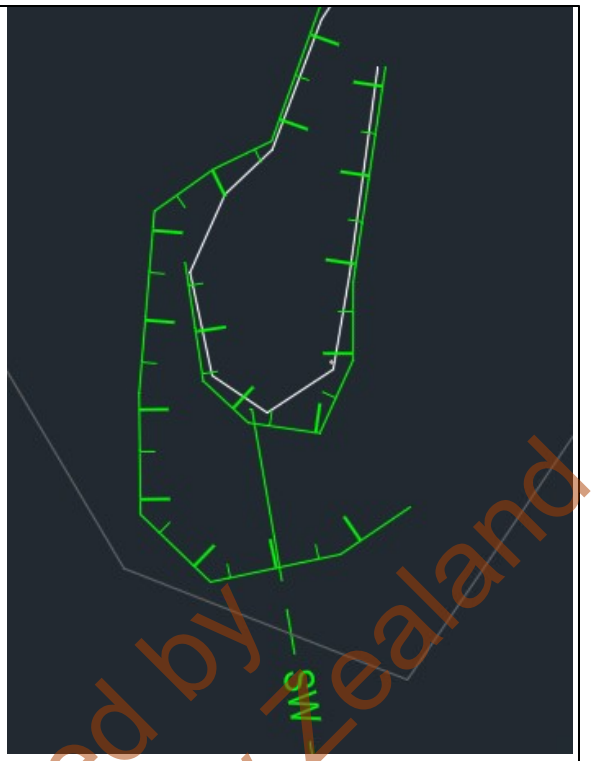
C. Existing Culvert 3 outlet into stream



D. Stream width below wider area at outlet = 2.5m and at outlet = 3.6-4.3m; water depth = 1.41m (Oct 24); channel width at water level = 6.1m and at top of bank = 15m (Oct 24); channel depth (base to top of bank) = 4.5m

Figure 21: Culvert 3 Inlet and Outlet Photos and corresponding survey data

6.3.5 Flood Mitigation

The removal of Culvert 2 and other repair/upgrade works will reduce flood water levels, reducing the landfill area exposed to potential flooding.

However, flood modelling has shown that these works and particularly the removal of Culvert 2 will increase peak flows at Te Mawhai Rd and slightly increase the flood hazard compared with the existing situation, but have no adverse effect on the Marae further downstream. Peak velocities and depths are estimated to increase from 0.73m/s and 0.54m (H3 flood hazard = unsafe for vehicles, children and the elderly) in the existing situation, to 1.59m/s and 0.84m respectively (H5 flood hazard = unsafe for vehicles, people and buildings vulnerable to structural damage) as explained further in the separate flood risk assessment report.

Modelling of another option involving installing a second large culvert under Te Mawhai Rd showed that this would reduce the flood risk at Te Mawhai Rd for local storms and for regional storms with tailwater levels of up to 33.51m RL, but make no real difference for higher tailwater levels (with the latter being likely based on regional flood information). It was also found that for more regular storm events, the preferred Option 4 would not result in any significant increase in adverse effects at Te Mawhai Rd compared with the existing situation. Significant concerns were also raised about the constructability and affordability of a second culvert. For these reasons, a second culvert was not considered necessary.

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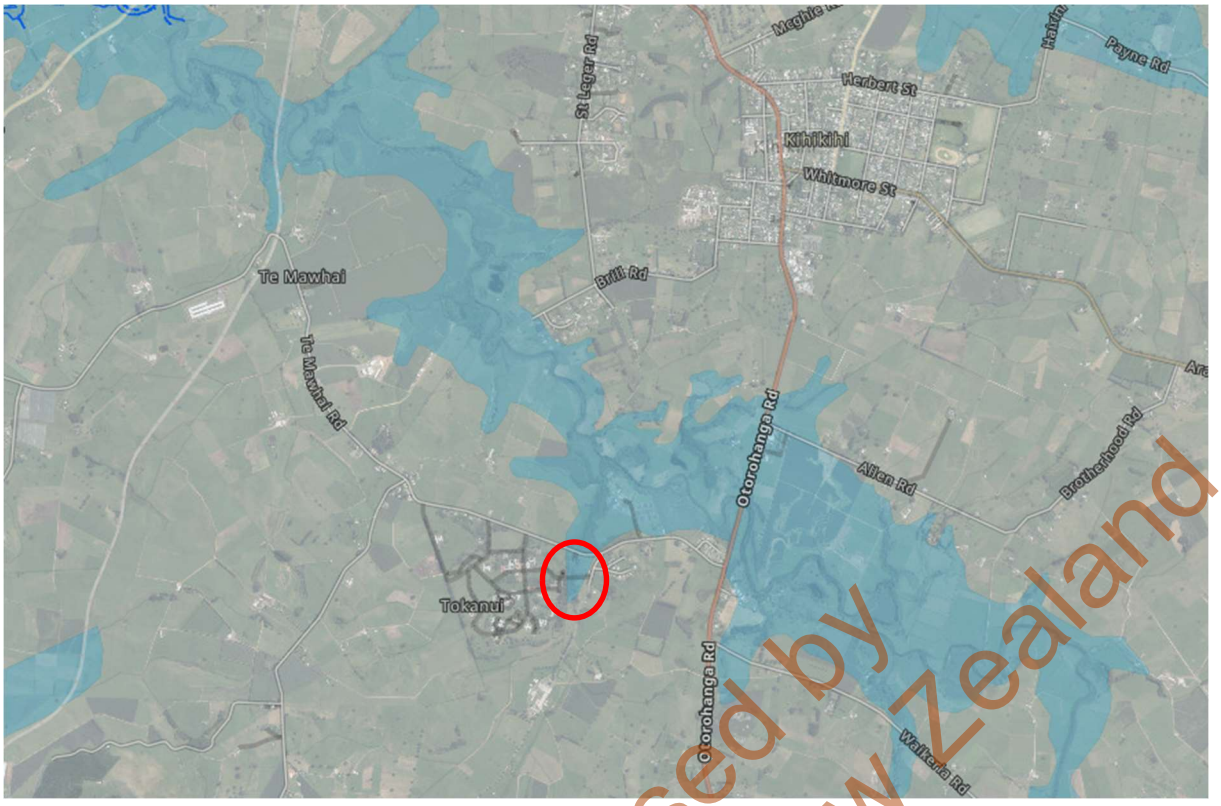

Figure 22: Waipā and Waikato River regional flood hazard maps (100-year storm) (landfill area highlighted in red)

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7.0 AFTERCARE AND MONITORING PLAN

A draft updated Aftercare and Monitoring Plan has been prepared for the closed landfill, based on the preferred repair and upgrade works set out in this report having been completed. This is provided as a separate document as part of the consent application.

This plan will supersede the existing Aftercare Plan. The main changes from the existing plan are:

(a) Removal of mercury and polycyclic aromatic hydrocarbons (PAHs) from the monitoring suite, as concentrations of these parameters have not been detected in any samples collected twice yearly over the period from 2016-2024.
(b) Deletion of sampling point S4, as only PAHs were required to be monitored here and they are being deleted as per item (a).
(c) Revised groundwater sampling locations, as a result of the repair and upgrade works.

8.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the information presented in this report, it is considered that the proposed landfill repairs and upgrade works outlined in the refined Option 4 represent the best practicable option for improving the integrity and resilience of the existing landfill, as well as providing a Disposal Site for the hospital low and moderate level contaminated soil and a source of backfill material for the hospital demolition works. It is considered that these works can be adequately managed to protect workers and avoid any adverse effects on human health and the receiving environment, while the long-term benefits and reduction in liability are significant due to the removal of Culvert 2, diversion of the

Wharekōrino Stream around the landfill and plugging of Culvert 3 in terms of potential landfill washout/failure and flood mitigation.

9.0 LIMITATIONS

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Drawings

(refer separate volume)