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Memorandum

To	**Hugh Donaldson**	From	[redacted]
Copy	**Sarah Child, Tom Revell**	Reference	**520969**
Date	**2022-09-05**	Pages (including this page)	**12+ Appendices**
Subject	**Napier Ex-Prison – Retaining Wall Assessment – Stage 2 Risk Assessment**		

1 Introduction

Land Information New Zealand (LINZ) has engaged Aurecon New Zealand (Aurecon) to undertake a geotechnical assessment of all retaining walls at their site located at 55 Coote Road, Napier. The site is a Napier City Council Heritage Site containing the old Napier Prison, and is currently being used as a tourist attraction. The site also comprises two residential properties that are currently occupied, 1 and 2/57 Coote Road. Aurecon understands that LINZ was advised by the tenant that one of the retaining walls onsite was unstable and unfit for use and that there are several other retaining walls onsite that may require condition assessments.

Aurecon attended the site between 14 and 17 March 2022 to undertake a condition assessment for all retaining walls onsite. The results of the condition assessments are detailed in our memorandum *Napier Ex-Prison – Retaining Wall Assessment* dated 8 April 2022 and the structures identified are shown on the plans in Appendix A.

The purpose of this memorandum is to;

- Provide a qualitative risk assessment of the 23 walls identified in the original assessment to identify walls that are critical to servicing and operating the property.
- Review the stability of the walls identified as critical, to determine possible future scenarios and failure mechanisms to facilitate remedial solutions.
- Provide high-level remedial concept options for the differing types of walls, including the residual risk, assumptions made, and estimate costs and benefits of options.
- Provide recommendations for further geotechnical investigations (if any).

Our work has been undertaken as a variation to the existing agreement between LINZ and Aurecon dated 24 November 2021. Approval was given to proceed by Sarah Child on 30 May 2022.

Our explanatory statement is included in Section 5, and this memorandum shall be read as a whole.

2 Methodology

2.1 Overview

We have undertaken a two-stage assessment as part of this methodology to determine a critical 'risk rating' for each asset and thereby help to inform decision-making for a remediation programme. The assessment has been staged in two parts as follows:

- **The *Stage 1 Condition Assessment*** involved a site inspection of each retaining wall and rating the condition of each on a scale of 1 to 5 as detailed in Section 2.2 below.

- **The *Stage 2 Consequence Assessment*** is a desktop-based assessment to identify the relative consequence of failure for each wall asset, to identify likely effects following (for example) a future large earthquake. Details of the consequence assessment are defined against a set of criteria, including (for example) impacts on life safety, as described in Section 2.3 below.

The overall wall criticality rating is then assessed in a matrix as follows:

$$Critical\ Risk\ Rating\ (CRR) = \frac{(Wall\ Condition)\ x\ (Wall\ Consequence)}{5}$$

The scores are normalised to give answers in the range of one to five. A visualisation of the overall risk rating is shown in a matrix in Table 1 below, and typical recommended actions to inform an overall risk management strategy for each rating are provided in Table 2. The recommended actions are intended to provide a guideline only for this specific project, and do not comprise specific remediation advice for individual assets – other important aspects such as the economics of remedial action, site-specific conditions, intended end use, potential to combine repairs, sustainability of remedial action, etc. should all be considered when informing a remedial strategy, however the framework does provide a useful starting point for a risk-based approach to management of a large number of assets in the first instance which can then be refined to provide further detail.

Table 1. Matrix for assessment of critical risk ratings

Condition \ Consequence	1 – Negligible	2 – Minor	3 – Moderate	4 – High	5 – Severe
1 – Excellent	Very low	Very low	Low	Low	Medium
2 – Good	Very low	Low	Low	Medium	Medium
3 – Fair	Low	Low	Medium	Medium	High
4 – Deteriorated	Low	Medium	Medium	High	Very high
5 – Severely deteriorated	Low	Medium	High	Very high	Very high

Table 2. Typical recommended action for various critical risk ratings

Critical Risk Rating (CRR)	Risk Profile	Typical Recommended Action
< 0.5	Very low	Acceptable. Re-assess within a decade.
0.5 to1.5	Low	Acceptable. Re-assess within ~5 years.
1.5 to 2.5	Medium	Acceptable. Re-assess within ~3 years.
2.5 to 3.5	High	Assess remedial action on a case-by-case basis, considering frequent monitoring, repair, or replacement options in the near term.
> 3.5	Very high	Immediate action required.

2.2 Stage 1 – Condition Assessment

For our condition assessments, we have adopted general terminology to describe the condition of the retaining walls at the time of our site inspections. Five terms are adopted, with their respective descriptions provided below. We note that the terminology provided does not account for wall "criticality", which is assessed separately as detailed in the following sections of this letter.

Table 3. Retaining wall condition assessment terminology

Descriptive Terminology	Typical Description/Example
1 - Excellent	Wall is "like new", free of any minor defects and weathering. Wall face and surrounding ground free of vegetation. Wall is fully functional, fit for purpose and generally newly constructed. Drainage systems are fully functional and properly protected from soil infiltration/clogging and blockages.
2 - Good	Wall is free of minor defects but some minor/general weathering of wall elements visible but does not compromise the wall integrity. Some minor vegetation may be present above or below the wall but does not impact the stability of the wall or is protruding from the wall face. Wall is fully functional, fit for purpose but some minor maintenance may be required. Drainage systems are fully functional and generally free from soil infiltration/clogging and blockages.
3 - Fair	Wall has some defects, such as hairline cracking, and is weathered. Vegetation may be present at the top and bottom of the wall but is not impacting the structural stability of the wall, some minor vegetation may be visible in the wall face but is not impacting the face stability. The wall is functional and generally fit for purpose, some minor repair work or strengthening may be required. Drainage is visible and free from blockages and vegetation growth; some soil may be present/visible but not enough to compromise the drainage system functionality.
4 - Deteriorated	Wall contains defects that are or will compromise wall functionality or stability in the near future. Vegetation is present above, below and protruding from the face of the wall and is observed to be causing degradation/damage to the wall. The wall may no longer be fit for purpose and some local significant repairs may be required, such as fully replacing some wall elements and generally strengthening the wall structurally. Drainage is visible, but has been compromised with blockages, damage or vegetation growth and requires reinstatement/maintenance.
5 - Severely Deteriorated	Wall is partially or fully collapsed in places with significant defects observed over the majority of the wall. Vegetation growth may be extensive and have damaged/dislodged structural or facing elements of the wall. The wall is not fit for purpose and requires demolition and reinstated or significant repairs/reconstruction to the majority of the wall. New design or significant strengthening is likely required to ensure future stability. No drainage visible or has been completely clogged/blocked and is no longer functional.

The site inspections and wall condition assessments are summarised in our Stage 1 report letter, *Napier Ex-Prison – Retaining Wall Assessment*, Ref. 520969, dated 8 April 2022. The outputs of the assessment are reproduced in Appendix B for reference.

2.3 Stage 2 – Consequence Assessment

For our assessment of consequence of failure, we have adopted general terminology to describe the potential impacts in terms of the following criteria:

- Life safety and health consequences, e.g. potential for wall failure to cause serious injury or death;
- Operation of property and business, e.g. disruption to site access (driveways etc.);
- Disruption to utilities;
- Impacts to structures;
- Impacts outside of the property boundaries, e.g. undermining sites above / inundating sites below.

Walls have been rated to consider severity of impact in one or several of the above categories. For example a wall with '3 – Moderate' level impacts in a number of contexts may be rated as '4 – High'. We note that these criteria are site-specific for this project, and not generally applicable in other contexts.

Our assessment has been undertaken based on a review of the photographs and relevant information collected during the site inspections, and readily available information on utilities at the property from the Napier City Council online records. No as-built drawings, or other information on utilities at the property have been provided.

Table 4. Retaining wall consequence assessment terminology

Consequence Rating	Description / Example
1 – Negligible	Failure would have limited impact on heath and safety, property, utilities, and potential to cause disruption in the short term only to non-essential infrastructure, e.g. failure of a low-height wall (e.g. <1m) providing grade change in a carpark. Failure may require temporary fencing / cones and limit carpark capacity in the short term.
2 – Minor	Failure has potential to cause short term disruption to enable clean-up / repairs. No damage (or minor, localised cosmetic damage only) to adjacent buildings, services, or property expected. Though unlikely, may cause minor injury to persons nearby, e.g. failure affecting part of access driveway reduced to one lane for a short period while debris cleared.
3 – Moderate	Some short-term disruption possible or likely, failure has potential to injure persons, though serious injury or death unlikely, secondary utility (not mains) disrupted, property nearby affected, or minor impacts in a number of contexts. For example, wall protecting driveway with potential to fully block access over short length, or partially block and affect a non-critical utility.

Consequence Rating	Description / Example
4 – High	Failure has the potential to cause serious injury and death in rare circumstances; potential to undermine adjacent property or utilities; potential to disrupt business activities for months. For example, wall protecting site has the potential to collapse onto part of roof of adjacent building below, but other impacts limited.
5 – Severe	Wall failure has a range of consequences in a number of contexts, or very serious impacts in one aspect, e.g. failure has the potential to cause serious injury and death to a number of people; failure may cause temporary closure of business / site; failure would undermine structures, disrupt underground services, or damage adjacent property (e.g. residential dwellings).

Example ratings applied to real walls at the site as examples of the assessment are shown in Table 5 below.

Table 5. Example of consequence rating assessment for two walls at the site

'1 – Negligible' Consequence Rating Example	'5 – Severe' Consequence Rating Example
	
An example of a wall at the site (NAP-PRIS-RW23) assigned a '1 – Negligible' consequence of failure rating, based on potential to cause limited disruption to carpark area only.	An example of a wall at the site (NAP-PRIS-RW10) assigned a '5 - Severe' consequence of failure rating, based on potential for serious injury / death, likelihood of undermining property (and tiered retaining system) above and damaging property (buildings) below in the event of wall failure. Failure mechanism would likely be overturning / toppling in a large earthquake or from build-up of water pressure behind face.

3 Results and Recommendations

3.1 Overview

The full results of our combined risk assessment are summarised in tabular form in Appendix B. In summary, of the 23 walls considered across the site, four were assessed as having a critical risk rating of 'High' (2.5 < CRR < 3.5), and one as 'Very high' (CRR > 3.5). Additionally, the existing slip above RW6 has been assessed separately. These walls and the slip are summarised briefly in Table 6.

Table 6. Summary of assets with a CRR of 'High' (2.5 < CRR < 3.5) and 'Very high' (CRR > 3.5).

Wall ID	CRR	Comments
NAP-PRIS-RW10	4.0	Main brick/masonry wall running around prison grounds up to 5.7m height and retaining tiered walls / property above. Wall is in deteriorated condition to severely deteriorated in places with significant ground cracking developing behind the face. Top of wall is accessible and requires a handrail. Wall failure has potential to cause injury / death to people, damage structures below and undermine tiered wall system above with potentially cascading impacts.
NAP-PRIS-RW11	3.0	Brick / masonry wall in main prison grounds supporting upslope property up to 4m height and part of tiered wall system. Wall in generally fair condition, though has potential to undermine property, wall, and services above, and collapse onto people / buildings below causing serious injury / death.
NAP-PRIS-RW17	3.2	Section of unreinforced concrete and stone / gravity walls up to approx. 4.2m high. Wall in fair to deteriorated condition with some cracking between brick masonry and mortar eroded in places, loose stone blocks. Failure would undermine property (and possibly swimming pool) above and could cause serious injury / death.
NAP-PRIS-RW19	3.2	Stone / gravity wall that supports access path around eastern side of prison complex up to ~2m high. Generally in deteriorated condition with cracks developing in facing, vegetation growth and possible undermining. Failure poses low risk to life but high risk to utilities and building foundations near top of wall, particularly at northern end.
Existing slip above: NAP-PRIS-RW6	3.2	Slip has been poorly remediated, and face is exposed in places, slope in generally fair to deteriorated condition. Ongoing deterioration poses a risk to mains utilities and upslope property if runoff / erosion over bare face not controlled.

Concept-level remedial options for each wall asset are included with typical indicative costs for each in Appendix B. We note that these are not developed options, which will require geotechnical investigation and design.

Although the majority of the retaining walls are in a deteriorated state, it is anticipated that under static conditions the walls are unlikely to fail but will continue to deteriorate, which may lead to ongoing localised failures. Therefore, at the time of this report being issued there does not appear to be a significant life safety risk under static conditions. However, under adverse weather conditions and moderate seismic conditions (earthquake with MMI V [Modified Mercalli Intensity]) it is anticipated that walls will fail, and the hazard will eventuate. The exception to this is NAP-PRIS-RW10, and parts of RW12 above, and RW17 stone wall in the garden area.

NAP-PRIS-RW10, and parts of RW11 above, and RW17 stone wall in the garden area shall be addressed immediately due to imminent life safety risk. This is further discussed in more detail in the following subsection.

3.2 Retaining Wall RW10

The wall is in variable condition along its length, however across the main western section significant ground cracking was observed behind the wall, especially as this wall is located in an area that is exposed to frequent public foot traffic (i.e. the prison/tourist site is located at the toe of this wall) and may result in damage to structures, and cascading failure of the tiered wall system above. We recommend that this wall is addressed immediately due to the potential life safety risk and evidence the wall is marginally stable under static conditions. The top of the wall is also accessible, and therefore requires a fall protection handrail for safety reasons. A photograph of the ground cracking observed parallel to the wall face (indicating significant movement and failure of the wall) and tiered walls at RW10 is shown in Figure 1 below.

Additionally, we note the top of the wall is accessible, may be mown and poses a serious risk to health and safety without installation of a handrail at the top of the wall.

Figure 1. Ground cracking observed behind NAP-PRIS-RW10

The concept remediation options have considered the key constraints to any potential remediation, namely:

- The wall is significant height and length and covering a wide area. Parts of some prison buildings appear to have been built up against the wall.
- The wall is part of a tiered wall system with more than two retaining walls above.
- As the wall is part of the main prison grounds, we anticipate it is heritage listed and demolition is not a preferred / available option.
- The prison complex is currently being used as a tourist operation open to the public.
- Demolition of the existing structure would be highly complex (particularly as the wall is part of some prison buildings), time consuming, and disruptive to the tourist operation.

Based on the above we anticipate the most appropriate solution to remediate the structure would be to retrofit the existing wall with a series of ground anchors or soil nails. This system has the advantage of allowing the existing structure to remain with minimal visual impact and is relatively fast to install. A basic visualisation of a ground anchor system showing steel anchors, anchor plates and walers is shown indicatively on Figure 2 below. A similar soil nailed system might use much closer spaced nails but without the waler beams, depending on the ground conditions.

Figure 2. Indicative anchored wall system

If the existing wall is reinforced with vertical steel reinforcement (unlikely), an anchored capping beam only constructed to tie-back the top of the wall may be appropriate subject to detailed design. We note that the above are for concept-level discussions only, and subject to detailed engineering design.

4 Summary and Further Geotechnical Involvement

Aurecon has undertaken a risk assessment for the retaining walls located at the LINZ site located at 55 Coote Road, Napier, also known as the old Napier Prison. This assessment has considered the existing condition of the asset and impacts of a potential failure to inform an overall risk rating and guide an overall strategy for remediation and asset management.

We recommend that a number of the wall assets on site require immediate attention while some will need attention in the medium term as part of an asset management programme. A figure showing the approximate site location and indicative locations of all retaining walls assessed onsite is included in Appendix A, alongside a summary of remedial options and recommendations. The risk assessment for each retaining wall are tabulated in Appendix B, and photographs are included in Appendix C. For details of the structural assessment of the perimeter prison wall, we have attached the structural

assessment memo as Appendix D for reference, and the surveyed wall locations (to inform ownership discussions) are shown on the survey drawing in Appendix E.

Our full recommendations are included in Appendix A and Appendix B, however in summary:

- The condition of several assets could be improved in the short term with basic maintenance, e.g. trimming vegetation and trees / roots in key locations (e.g. causing blocks to dislodge etc. at tops of stone walls), clearing clogged drainage / improving drainage paths, and re-mortaring or grouting loose stonework.
- We recommend urgent intervention for RW10 which is showing signs of failure with significant tension cracking, has a dominant failure mechanism of overturning, and requires fall prevention as the top of the wall is accessible and of significant height. We understand that public access below the wall has been blocked based on our earlier recommendations until suitable remediation can be implemented.

In general for those walls where remediation or replacement is recommended, we consider the following next steps to be appropriate:

- A brief workshop with LINZ and their identified stakeholders to review the outputs of this assessment and identify an overall strategy for next steps.
- A geotechnical investigation to confirm the retaining wall backfill and foundation materials for design of any remedial works or replacement structures (e.g. NAP-PRIS-RW10). A typical investigation is likely to comprise a number of shallow hand auger boreholes (depending on wall height and length) with shear vane and dynamic cone (Scala) penetrometers to estimate strength and density parameters for the soils, and / or sacrificial anchor tests to inform detailed design. Depending on procurement lead times, significant savings may be achieved by progressing a conservative design in the interim that can be refined once investigations are complete.
- Confirmation of the location of any utilities to be integrated into remedial or replacement wall options, and liaison with key stakeholders (e.g. heritage aspects, wall drainage).
- Continued involvement of an Aurecon geotechnical engineer to carry out any remedial strengthening or replacement wall detailed design in accordance with the latest MBIE / NZGS (2021) *Earthquake Geotechnical Engineering Practice* guidance.
- Establish a monitoring schedule for inspection / maintenance of retaining wall assets in accordance with the outputs of this assessment.

Prepared by,

[redacted]

Geotechnical Engineer

Reviewed,

[redacted]

Lead Engineering Geologist

Verified,

[redacted]

Principal Ground Engineering

Attached:

Appendix A – Indicative Retaining Wall Locations

Appendix B – Retaining Wall Assessment Table

Appendix C – Retaining Wall Photographs

Appendix D – Perimeter Wall Structural Assessment Memo

Appendix E – Laser Scan Survey Memo

5 Explanatory Statement

The damage assessment of the retaining walls has been undertaken to assess the condition of the retaining walls. A detailed structural assessment has not been undertaken to assess the strength of the walls or to determine whether they comply with the relevant codes.

Aurecon has not made any assessment of the structural stability or safety with respect to earthquakes, which have the potential to further damage the walls and jeopardise the safety of the people and properties in the immediate vicinity of the walls.

This report is necessarily limited by the time available to carry out inspections. The report does not include defects that were not reasonably visible upon visual inspection, including defects in inaccessible places and latent defects.

While this report may assist the client in assessing whether the wall should be demolished or repaired, the decision is solely the responsibility of the client.

The review has been prepared by Aurecon at the request of the client and for the client's use. It is not possible to make a proper assessment of this review without a clear understanding of the terms of engagement, under which it has been prepared, including the scope of the instructions and the direction given to and the assumptions made by Aurecon. This report does not address issues which would need to be considered for another party should that party's particular circumstances, requirement and experience were known, and further, may make assumptions about matters of which the third party is not aware of. No responsibility of liability to any third party is accepted for any loss or damage whatsoever arising from the use of reliance on this report by any third party.

Without limiting any of the above, Aurecon liability, whether under the law of contract, tort, statute. Equity or otherwise, is limited as set in the terms of engagement with the client.

Appendix A
Figures

CLIENT	PRELIMINARY NOT FOR CONSTRUCTION	ALL DIMENSIONS APPROXIMATE ONLY	SCALE	SIZE	TITLE	SITE LOCATION PLAN					
aurecon www.aurecongroup.com / Toitū Te Whenua Land Information New Zealand	FIGURE	FIGURE 1	NTS	-							
			BY A. HILLS		REFERENCE	BACKGROUND IMAGE RETRIEVED FROM: HTTP://WWW.GIS.NAPIER.GOVT.NZ/INTRAMAPS80/DEFAULT.HTM?PROJECT=NCC&MODULE=PROPERTY					
	PROJECT	NAPIER PRISON – RETAINING WALL ASSESSMENT	REVIEWED J. MUIRSON								
			DATE 5 SEPTEMBER 2022		FIGURE No.	PROJECT 520969	WBS 000	TYPE FIG	DISC GE	NUMBER 01	REV A

CLIENT	PRELIMINARY NOT FOR CONSTRUCTION	ALL DIMENSIONS APPROXIMATE ONLY	SCALE	SIZE	TITLE	RETAINING WALL OVERALL RISK RATINGS				
aurecon www.aurecongroup.com / Toitū Te Whenua Land Information New Zealand	FIGURE	FIGURE 2	NTS	-						
			BY		REFERENCE	BACKGROUND IMAGE RETRIEVED FROM: HTTP://WWW.GIS.NAPIER.GOVT.NZ/INTRAMAPS80/DEFAULT.HTM?PROJECT=NCC&MODULE=PROPERTY				
	PROJECT	NAPIER PRISON – RETAINING WALL ASSESSMENT	A. HILLS							
			REVIEWED							
			J. MUIRSON							
			DATE		FIGURE No.	PROJECT	WBS	TYPE	DISC	NUMBER	REV
			5 SEPTEMBER 2022			520969	000	FIG	GE	02	A

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CLIENT	
PRELIMINARY NOT FOR CONSTRUCTION	ALL DIMENSIONS APPROXIMATE ONLY
FIGURE	FIGURE 2
PROJECT	NAPIER PRISON – RETAINING WALL ASSESSMENT
SCALE	NTS
SIZE	-
BY	A. HILLS
REVIEWED	J. MUIRSON
DATE	5 SEPTEMBER 2022
TITLE	RETAINING WALL OVERALL RISK RATINGS
REFERENCE	BACKGROUND IMAGE RETRIEVED FROM: HTTP://WWW.GIS.NAPIER.GOVT.NZ/INTRAMAPS80/DEFAULT.HTM?PROJECT=NCC&MODULE=PROPERTY

FIGURE No.	PROJECT	WBS	TYPE	DISC	NUMBER	REV
	520969	000	FIG	GE	02	A

Appendix B
Risk Assessment Table

Wall Name	Type	Condition Comments	Consequence Comments	Prelim. Remediation Options[4]	Remediation Comments	Cost of Remediation[5]	Condition Rating (1 to 5)	Consequence Rating (1 to 5)	Normalized[6] Risk Rating
NAP-PRIS-RW1	Stone Block/Gravity Supports soil above site access	Wall in severely deteriorated condition with loose blocks, partial collapse, and bulging. Top of wall heavily vegetated.	Limited risk to life and property. Likely to disrupt property access for days to weeks (block driveway), potential impact on utility boxes visible in photographs.	Demolish/repair Maintenance	Re-grout / shotcrete stonework; maintain vegetation (cut down any large trees / roots bulging facing) and drainage (weep holes).	$	5	2	2.0
NAP-PRIS-RW2	Stone Block/Gravity Supports upslope site access driveway	Wall in severely deteriorated condition with bottom half of wall collapsed in places. Loose/dislodged blocks present and top of wall heavily vegetated.	Limited risk to life and property. Likely to block footpath for short time (days), may undermine part of driveway (one lane).	Demolish/repair Maintenance	Re-grout / shotcrete stonework; maintain vegetation and drainage (weep holes).	$	5	1	1.0
NAP-PRIS-RW3	Stone Block/Gravity (inferred based on limited observations) Supports soil above site driveway.	Wall almost non-existent and inferred to have been a stone block wall that has almost completely collapsed over time. Heavily vegetated with some surficial soil failures.	Limited risk to life and property.	Re-instate. Maintenance	Re-grout / shotcrete stonework; maintain vegetation and drainage (weep holes). Consider replacement with timber pole / masonry wall in long term.	$	5	1	1.0
NAP-PRIS-RW4	Stone Block/Gravity (inferred based on limited observations) Supports edge of site driveway/access	Wall in severely deteriorated condition. Partially collapsed and eroded. Some areas appear to have completely been washed out and ground being supported by mesh fence down slope of wall. Some settlement of upslope driveway observed.	Wall failure does not present an immediate life safety risk. Failure may result in disruption to property access (one lane) and more significant impacts on upslope properties, if undermined.	Demolish/repair. Maintenance.	Replacement with concrete block or timber pole wall. Block wall likely to be most straightforward replacement option.	$ - $$	5	1	1.0
NAP-PRIS-RW5	Stone Block/Gravity (inferred based on limited observations) Supports soil above site driveway/access	Wall in fair condition with some displacement and bulging at one end of wall. Cracking in mortar observed and top of wall heavily vegetated.	Limited risk to life and property. May disrupt driveway access temporarily (one lane, for days to weeks).	Repair Maintenance	Maintain vegetation including any tree roots, and upslope erosion / drainage.	$	3	1	0.6
NAP-PRIS-RW6	Stone Block/Gravity (inferred based on limited observations) Supports soil above site access/driveway	Wall in fair condition and appears to have been constructed recently following the slip, which is inferred to have damaged the original wall. Some cracking of mortar already visible.	Limited risk to life and property. May disrupt driveway access temporarily (one lane, days to weeks).	Repair Maintenance	Maintain vegetation including any tree roots, and upslope erosion / drainage. Consider replacement with timber pole / masonry wall in long term.	$	3	1	0.6
Existing slip above RW5, RW6	Soil slope	Wall not of immediate concern (though drainage needs attention), however upslope slip area requires attention, including service lines.	Potential for continued erosion to place upslope properties and mains utilities lines at risk (refer Napier Council maps viewer).	Repair Maintenance	Remediation options may include shotcrete or alternative slope treatments primarily to prevent undermining of the upslope properties. Based on our understanding of the geological setting of the area, the site is underlain by highly erodible, cross-bedded sandstone and limestone. Slip appears to be <3 years old based on review of aerial photography, remedial work in poor condition (drainage clogged, matting deteriorated, etc.).	$$	4	4	3.2
NAP-PRIS-RW7	Stone Block/Gravity Supports soil above site parking area.	Parts of wall in deteriorated condition. Dislodged and loose blocks at top of wall where vegetation growth has occurred. Mortar eroded at toe. Roots observed through some drainage pipes.	Limited risk to life and property, limited disruption to parking.	Remediate/repair. Maintenance	Replace with mass concrete block wall.	$	4	1	0.8

Wall Name	Type	Condition Comments	Consequence Comments	Prelim. Remediation Options[4]	Remediation Comments	Cost of Remediation[5]	Condition Rating (1 to 5)	Consequence Rating (1 to 5)	Normalized[6] Risk Rating
NAP-PRIS-RW8	Concrete Block/Gravity. End of wall has a concrete façade, with stone blocks behind. Supports soil above site parking area, sheds and accessway to top of prison wall.	Wall in fair to deteriorated condition. Concrete façade at end of wall cracked and partially collapsed. Loose blocks observed behind façade. Blocks at top of wall loose and dislodged due to vegetation. Cracking and partial mortar loss observed in wall face.	Loose section at risk of failing onto steps below and causing injury, though walkway appears locked / disused. May damage roof of sheds if it were to fail.	Remediate/repair Maintenance.	Fully block off steps to prevent access below damaged section. Remove sections of cracked wall, replace if necessary. Maintain vegetation growth behind wall causing damage to wall elements.	$	4	3	2.4
NAP-PRIS-RW9	Stone Block/Gravity (inferred based on limited observations) Supports soil below site access and main prison wall. Onsite residential property/accommodation located downslope of toe.	Wall in severely deteriorated condition and not fully visible due to vegetation. Partially collapsed and significant bulging in wall. Some ground cracking in asphalt at top of wall possibly indicating ground movement from wall instability.	Wall presents limited risk to life but potential to completely undermine dis-used part of driveway (accessing rear of prison) and may put main prison wall at risk. Potential for loose blocks to damage carport (or cars parked) below.	Demolish/re-instate.	Replace with timber pole or soil nailed / shotcrete wall in near term.	$$	5	2	2.0
NAP-PRIS-RW10	Brick/masonry gravity wall (inferred based on limited observations) Possible concrete façade. Prison Wall.	Wall in varying condition over length, but generally fair to deteriorated. Significant ground cracking observed at top of wall over 20m length, cracks up to 300mm wide. Cracking and vegetation observed in façade. Some soil collapse behind wall observed, where alcove dug into toe of wall.	Wall presents a serious risk to life and property (both residential property above and prison buildings below).	Repair Maintenance	A soil nailed remedial option would preserve the overall appearance of the existing wall with minimal visual impact and simple construction. A more invasive repair would be to cover the existing wall with a strengthened shotcrete facing and anchors.	$$$	4	5	4.0
NAP-PRIS-RW11	Concrete Block/Gravity Supports soil below upslope neighboring properties.	Wall generally in fair condition. Limited cracking observed in wall face, but top of wall heavily vegetated and not accessible. Possible cracking and displacement of concrete drain/channel at toe of wall.	Wall is part of a tiered retaining wall system; failure of the wall would likely undermine the wall supporting residential property above. Failure might result in blocks falling into prison grounds and causing serious injury / death.	Repair. Maintenance.	Consider strengthening in tandem with RW10 option.	$ - $$$	3	5	3.0
NAP-PRIS-RW12	Mass Concrete Gravity Wall (reinforced). Supports soil below upslope neighboring properties.	Wall generally in fair condition. Localized cracking in some areas, vegetation growing over top of wall and through weeps/drains. Possible ground settlement at toe of wall.	Failure of wall presents a low / moderate risk to life in tandem with a high risk to residential property above, though no structures nearby.	Repair. Maintenance.	Maintain and monitor in short term. Wall risk rating will improve if RW11 and RW10 below are improved by means of supporting toe.	$	3	4	2.4
NAP-PRIS-RW13	Block/Gravity (inferred based on limited observations) Possibly old, benched seating above prison wall.	Wall in fair to severely deteriorated condition. Cracking and dislodgement of blocks observed, likely due to vegetation growth. Indications of ground settlement below top wall. Significant ground cracking observed at toe of bottom wall.	Wall is part of a tiered retaining wall system; failure of the wall might partially undermine the wall supporting residential property above.	Demolish and replace. Maintenance.	Maintain and monitor in short term or replace with mass block wall.	$	4	3	2.4
NAP-PRIS-RW14	Stone Block/Gravity (inferred based on limited observations) Supports soil below upslope neighboring properties.	Wall difficult to observe due to vegetation/access but appears to be in generally deteriorated condition with some cracking in mortar between blocks.	Limited impact to life, potential to undermine property.	Repair. Maintenance.	Monitor, replace with timber pole wall.	$ - $$	4	2	1.6
NAP-PRIS-RW15	Stone Block/Gravity Supports soil above path/access way to top of prison wall.	Wall in severely deteriorated condition. Partially collapsed in places with loose and dislodged blocks. Significant vegetation/root growth above and behind wall.	Failure would have limited impact.	Demolish/replace. Maintenance.	Block access to path, monitor / demolish / replace with mass concrete blocks.	$	5	1	1.0

Wall Name	Type	Condition Comments	Consequence Comments	Prelim. Remediation Options[4]	Remediation Comments	Cost of Remediation[5]	Condition Rating (1 to 5)	Consequence Rating (1 to 5)	Normalized[6] Risk Rating
NAP-PRIS-RW16	Stone Block and brick masonry gravity wall. Supports soil above steps/access to top of prison wall.	Wall in fair to deteriorated condition. Some cracking observed between brick masonry and mortar eroded in places in stone block section. Loose stone blocks at top of wall. Stone blocks possibly re-mortared.	Failure could injure someone using the path, though it appears disused.	Repair. Maintenance.	Block access to path.	$	4	2	1.6
NAP-PRIS-RW17	Stone Block/Gravity (inferred based on limited observations) Section of wall appears to be unreinforced concrete east of stone block wall Supports soil above prison site and below neighboring property.	Wall in fair to deteriorated condition. Some cracking observed between blocks and possible erosion of stone facing. Concrete wall appears to have been constructed recently/not original.	Failure of stone wall sections has the potential to cause serious injury or death to people gathered in garden area below. May undermine parts of property above though structures not close.	Repair. Maintenance.	Refer to options for RW10, repair in tandem. Recommend access is blocked in interim (inspection above not possible at time of our visit as on private property, but likely similar failure to RW10).	$$$	4	4	3.2
NAP-PRIS-RW18	Stone Block/Gravity Tiered wall supporting soils upslope of residential house onsite.	Wall in severely deteriorated condition. Stone blocks are loose without mortar and deflecting, partial collapse of top tier wall.	Limited impact to life but disruption to property.	Demolish/reinstate	Monitor, replace with shotcrete / slope treatment or timber pole wall.	$ - $$	5	2	2.0
NAP-PRIS-RW19	Stone Block/Gravity Wall supporting soil beneath access around outside of Prison complex.	Wall in deteriorated condition. Some cracking observed in the face of the wall. Top of wall heavily vegetated with some trees growing immediately behind wall.	Failure poses low risk to life but high risk to prison building foundations and services.	Repair. Maintenance.	Repair with soil nails / anchors in critical locations where undermining is likely to affect structure foundations (e.g., northern end), or demolish and replace with timber pole wall.	$$ - $$$	4	4	3.2
NAP-PRIS-RW20	Stone Block/Gravity Supports soil upslope of old walking path from Marine Parade up to the Prison site.	Wall in severely deteriorated condition, eroded stone facing, cracking and partial collapse. Section of wall appears to have "blown out", possibly due to a service rupture. Raw sewage bubbling up from sump at toe of wall and running down slope. Leaking raw sewage will need to be fixed immediately as it poses a H&S issue.	Failure of southern section protecting access track poses limited risk to safety, property, or operation. Failure of northernmost section may undermine RW20 above, with potential to affect services and property.	Demolish/reinstate	Demolish and reinstate with masonry, gabion, or timber pole wall, or consider abandoning access track from Marine Pde if not required / uneconomical. Consider soil nail / anchors for northernmost extent supporting RW20.	$ - $$	5	2	2.0
NAP-PRIS-RW21	Stone Block/Gravity Running along the down slope property boundary parallel to Coote Road.	Wall in fair to deteriorated condition. Cracking observed in places and mortar washed out over some sections of the wall. Some sections appear to have been re-mortared. Top of wall heavily vegetated with some vegetation coming through the face of the wall.	Failure poses low risk to life safety, however, will close footpath.	Repair. Maintenance.	Re-grout stonework where necessary; maintain vegetation and drainage (weep holes).	$	4	1	0.8
NAP-PRIS-RW22	Stone Block/Gravity Running along the down slope property boundary parallel to the Marine Parade.	Wall in fair to deteriorated condition. Some cracking in mortar and loose/dislodged top blocks in places. Drainpipes appear to have been asphalted over in some areas.	Failure poses low risk to life safety, however, will close footpath.	Repair. Maintenance.	Re-grout stonework where necessary; maintain vegetation and drainage (weep holes).	$	4	1	0.8
NAP-PRIS-RW23	Reinforced concrete, gravity wall. Supporting soils beneath a tiered parking area.	Walls in deteriorated condition. Cracking and spalling observed in concrete with some exposed reinforcing steel observed. Top edging around wall had broken off in places.	Limited impact, disruption to parking areas.	Demolish/reinstate	Replace with mass concrete blocks.	$	4	1	0.8

NOTES:

(1) The preliminary remedial options are based on the observed condition of the retaining wall only. The decision to undertake and extent of any remedial works will need to be considered by the client.
(2) Due to access restrictions and significant vegetation, more retaining walls may be present onsite that could not be observed/identified.
(3) No Drawings have been provided to inform this assessment.
(4) No utilities information has been provided to inform this assessment and will need to be considered as part of any detailed design solution.
(5) Estimated costs of remedial actions are provided as indicative only on scale of $ - $$$.
(6) Risk rating is calculated as *Normalized Risk Rating = (Condition Rating * Consequence Rating) / 5*
(7) Remedial options are for concept purposes only, and may require heritage assessment at the design stage.

Appendix C
Wall Photos

'Retaining Wall – NAP-PRIS-01	
	
Photo 1) NAP-PRIS-01 View	**Photo 2)** Loose, dislodged blocks.
	
Photo 3) Power box and services infront of wall.	**Photo 4)** Collapsed section of wall with visible root growth behind wall
	
Photo 5) Large displacement/gaps observed in wall. Note old tree root at toe of wall.	**Photo 6)** Site driveway/entrance showing PVC pipe outlet and erosion of soil/asphalt.

Retaining Wall – NAP-PRIS-02

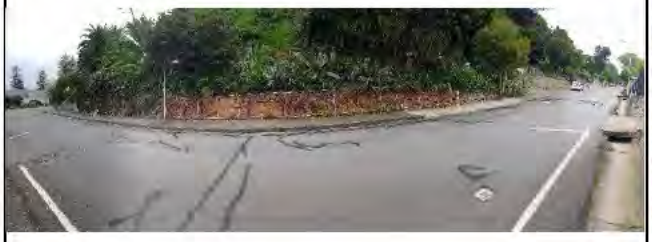

Photo 1) NAP-PRIS-02 View. Note possible ground cracking in road in front of wall.

Photo 2) Loose, dislodged blocks and partial collapse.

Photo 3) Loose blocks and partial collapse of wall.

Photo 4) Transition between NAP-PRIS-02 (right) and NAP-PRIS-21 (left).

Photo 5) Loose blocks, erosion and vegetation observed in wall face.

Photo 6) Inferred old stormwater channel observed in wall face.

Retaining Wall – NAP-PRIS-03

Photo 1) NAP-PRIS-03 view above site access/driveway.

Photo 2) Exposed soil face showing evidence of erosion.

Photo 3) Significant vegetation over face of wall/exposed soils. Note steep head slope.

Photo 4) Historical concrete stormwater channel (inferred) observed in front of wall.

Photo 5) Evidence of old block wall, which has collapsed and eroded.

Photo 6) Significant cracking and degradation of upslope concrete channel.

Retaining Wall – NAP-PRIS-04

Photo 1) NAP-PRIS-04 view.

Photo 2) Partial collapse of wall with soil and rock pushing against fence.

Photo 3) Erosion of driveway/asphalt and "channel" completely filled with soil.

Photo 4) Soil in "channel" pushing against steel mesh fence.

Photo 5) Power box observed in front of wall.

Photo 6) Vegetation and partial collapse of wall.

Retaining Wall – NAP-PRIS-05	
	
Photo 1) NAP-PRIS-05 view.	**Photo 2)** NAP-PRIS-05 view. Note heavy vegetation above wall.
	
Photo 3) Retaining wall face and weep hole/drain	**Photo 4)** End of wall, drain pipe located at toe of wall.
	
Photo 5) Cracking observed in mortar between blocks.	**Photo 6)** Weep hole, possibly recently installed, clogged with soil.

Retaining Wall – NAP-PRIS-06

Photo 1) NAP-PRIS-06 view. Note recent slope failure and "new" construction of wall, also upslope residential property.

Photo 2) Cracked and missing mortar between blocks.

Photo 3) Benched slope covered with coconut matting following slip.

Photo 4) Interface between NAP-PRIS-07 (left) and NAP-PRIS-06 (right).

Photo 5) Coconut matting placed over slope following slip. Note protruding, broken services.

Photo 6) Wall face and drainage channel at toe of wall.

Retaining Wall – NAP-PRIS-07

Photo 1) NAP-PRIS-07 view.

Photo 2) NAP-PRIS-07 view. Note heavy vegetation at top of wall.

Photo 3) Cracking observed around blocks.

Photo 4) Cracking and broken drainage pipes observed.

Photo 5) Cracking at top of wall where heavy vegetation present. Root growth through drains.

Photo 6) Wall face and drainage holes.

Retaining Wall – NAP-PRIS-08

Photo 1) NAP-PRIS-08 view. Note sheds in front of wall and heavy vegetation above wall.

Photo 2) NAP-PRIS-08 view. Note heavy vegetation at top of wall.

Photo 3) Typical view of wall face.

Photo 4) Cracking and observed in wall face.

Photo 5) Cracking and vegetation growth through wall face.

Photo 6) Cracked and partially collapsed façade. Note prison wall on left.

Retaining Wall – NAP-PRIS-09

Photo 1) NAP-PRIS-09 view, note heavy vegetation and prison wall near top of wall.

Photo 2) Heavily vegetated wall face with loosely stacked blocks.

Photo 3) Loose blocks and partial wall collapse.

Photo 4) Concrete block section of NAP-PRIS-09.

Photo 5) Interface between loose stone section and concrete block section. Note large void.

Photo 6) Cracking of access way and rotation of fence at top of wall.

Retaining Wall – NAP-PRIS-10

Photo 1) NAP-PRIS-10 view. Interior prison wall.

Photo 2) Brick masonry at cracking observed at end of wall.

Photo 3) Vegetation and observed water seepage over wall face.

Photo 4) NAP-PRIS-10 view. Note picket fence area is the prison graveyard.

Photo 5) ~300mm wide ground cracks observed at the top of the wall.

Photo 6) Cracking and possible rotation observed at top of wall.

Retaining Wall – NAP-PRIS-11	
	
Photo 1) NAP-PRIS-11 view. Located above NAP-PRIS-10.	**Photo 2)** Typical wall face observed. Note "square" holes are weep holes/wall drainage.
	
Photo 3) Heavy vegetation above top of wall.	

Retaining Wall – NAP-PRIS-12

Photo 1) NAP-PRIS-12 view. Located along upslope property boundary.

Photo 2) NAP-PRIS-12 view. Located along upslope property boundary.

Photo 3) Some cracking observed in wall face.

Photo 4) Vegetation growth over face.

Photo 5) Toe of wall. Note exposed lip of wall toe, possibly indicating some ground settlement.

Retaining Wall – NAP-PRIS-RW13

Photo 1) NAP-PRIS-RW13 view. Located below NAP-PRIS-RW12.

Photo 2) Drainage outlet at wall toe.

Photo 3) Ground cracking observed in front of wall (behind NAP-PRIS-RW10)

Photo 4) Loose/dislodged blocks observed.

Photo 5) Loose/dislodged blocks observed. Possible wall settlement resulting in "gap".

Photo 6) NAP-PRIS-RW13 view.

Retaining Wall – NAP-PRIS-RW14	
	
Photo 1) NAP-PRIS-RW14 view. Located below neighbouring residential property.	**Photo 2)** Drainage pipe observed.

Retaining Wall – NAP-PRIS-RW15	
	
Photo 1) NAP-PRIS-RW15 view. Located adjacent to NAP-PRIS-RW13.	**Photo 2)** Loose blocks, heavy vegetation and partial collapse observed.

Retaining Wall – NAP-PRIS-RW16

Photo 1) NAP-PRIS-RW16 view. Located adjacent to stairway/access to top of NAP-PRIS-RW10.

Photo 2) NAP-PRIS-RW16 view.

Photo 3) Vegetation observed at top of wall. Cracking and erosion of mortar and blocks.

Photo 4) Cracking observed in brick masonry.

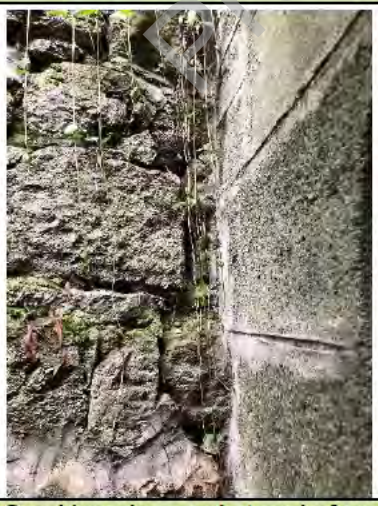

Photo 5) Cracking observed at end of wall.

Photo 6) Cracking observed at base of wall.

Retaining Wall – NAP-PRIS-RW17

Photo 1) NAP-PRIS-RW17 view.

Photo 2) NAP-PRIS-RW17 view. Note concrete block wall appears to be recently constructed.

Photo 3) Cracking observed in wall face.

Photo 4) Mass concrete wall observed adjacent to NAP-PRIS-RW17.

Photo 5) Erosion of stone blocks and mortar observed.

Photo 6) Erosion of stone blocks and mortar observed.

Retaining Wall – NAP-PRIS-RW18

Photo 1) NAP-PRIS-RW18 view.

Photo 2) NAP-PRIS-RW18 view, section used for landscaping.

Photo 3) NAP-PRIS-RW18 view. Located approximately 1.7m off house.

Photo 4) Top tier of wall almost completely collapsed.

Photo 5) Bulging of wall observed.

Photo 6) Loosely stacked rocks of wall face.

Retaining Wall – NAP-PRIS-RW19

Photo 1) NAP-PRIS-RW19 view. Note steep toe slope.

Photo 2) NAP-PRIS-RW19 view. Located above NAP-PRIS-RW20.

Photo 3) Cracking observed in wall face.

Photo 4) Typical wall face condition.

Photo 5) Top of wall. Note edge of prison building shown on right.

Photo 6) Manhole observed immediately behind top of wall.

Retaining Wall – NAP-PRIS-RW20

Photo 1) NAP-PRIS-RW20 view.

Photo 2) NAP-PRIS-RW20 view.

Photo 3) Cracking and partial collapse of wall observed.

Photo 4) Cracking and partial collapse of wall observed.

Photo 5) Raw sewage leaking from sump in front of wall.

Photo 6) Collapsed section of wall immediately upslope of sewage leak.

Retaining Wall – NAP-PRIS-RW21

Photo 1) NAP-PRIS-RW21 view. Note Coote Road in foreground.

Photo 2) NAP-PRIS-RW21 view. Note Coote Road in foreground.

Photo 3) Cracking observed in wall face.

Photo 4) Cracking observed in wall face.

Photo 5) Section appears to have been re-mortared recently.

Photo 6) Section of wall appears to have been re-grouted recently.

Retaining Wall – NAP-PRIS-RW22

Photo 1) NAP-PRIS-RW22 view. Note Marine Parade in foreground. Prison site/buildings upslope.

Photo 3) Loose blocks/mortar eroded between blocks.

Photo 4) Cracking observed between stone blocks.

Photo 5) Entrance way for old walkway upslope to prison site.

Photo 6) Old drainage pipes appear to have been recently asphalted over in places.

Retaining Wall – NAP-PRIS-RW23

Photo 1) NAP-PRIS-RW23 view. Parking terraces.

Photo 2) NAP-PRIS-RW23 view.

Photo 3) Cracking and top barrier broken off top of wall.

Photo 4) Cracking observed in wall face.

Photo 5) Erosion, wall collapse and broken top barrier.

Photo 6) Broken top barrier.

Appendix D
Perimeter Wall Structural Assessment Memo

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8 September 2022

Sarah Child
Land Information NZ
112 Tuam Street
Christchurch 8011

Dear Sarah,

Napier Ex-Prison – Perimeter Wall – Condition Survey Report

A structural engineer from Aurecon visited the perimeter wall to the Napier Ex-Prison located at 57 Coote Road on 5 July 2022 to carry out a non-intrusive visual condition inspection. As part of this inspection, we took measurements of the typical dimensions of the wall and conducted some spot measurements of the verticality of the wall.

Introduction

Land Information New Zealand (LINZ) has engaged Aurecon New Zealand (Aurecon) to undertake a structural condition assessment of the perimeter wall at their site located at 55 Coote Road, Napier. The site is a Napier City Council Heritage Site containing the old Napier Prison and is currently being used as a tourist attraction.

A structural engineer from Aurecon visited the perimeter wall to the Napier Ex-Prison located at 57 Coote Road on 5 July 2022 to carry out a non-intrusive visual condition inspection. As part of this inspection, we have taken measurements of the typical dimensions of the wall and conducted some spot checks on the verticality of the wall.

The purpose of this memorandum is to;

Provide a qualitative condition assessment of the perimeter wall.
Provide high-level remedial concept options for the perimeter wall.

Our work has been undertaken as a variation to the existing agreement between LINZ and Aurecon dated 24 November 2021. Approval was given to proceed by Sarah Child on 30 May 2022.

Information provided

We have not been provided with any existing plans or documentation for the existing wall.

Property Description

The property can be described as follows:

Address	57 Coote Road, Bluff Hill, Napier
Date of Assessment	5 July 2022.

Occupation	At the time of our site visit the property was occupied and used for tourism.
Site Description	The Napier prison site is situated on a land generally sloping upwards from North to south. There are several single storey buildings on the site, bounded by retaining walls to the southern, eastern and western elevations and a perimeter stone wall to the northern elevation. At the western end, the stone wall foundations retain approximately 1m of ground, the height of retained ground tapers down to the east with the foundation generally level with and stepping up with the slope of the ground for approximately 12m at the eastern end of the wall. The stone wall itself is not a retaining structure.
Wall Dimensions	The wall is approximately 54m in length on the northern elevation with a 13m long return at the eastern end that abuts one of the prison buildings and a 4m return at the western end that tapers up into the main western retaining wall. The total thickness of the wall is approximately 800mm. There did not appear to be any vertical joints along the length of the wall. The wall is typically 4.7m high with a step up to 4.9m towards the eastern end to allow the base of the wall to slope up to the eastern end of the wall with the natural ground level.
Material / Wall Construction	The wall is constructed from stone blocks with a smooth face on the internal side of the wall and a textured face on the external side of the wall. It is considered likely that the wall construction consists of concrete or rubble infill between the outer stone blocks however this would require core samples to be taken to verify. There are pilasters on both elevations of the wall typically located at 4.0m spacing along the length of the wall. The pilasters are approximately 630mm wide by 550mm deep at the base and 3.1m high, tapering to 300mm deep at the top. On the internal elevation the pilasters are of cast in-situ concrete construction. On the external elevation the pilasters are constructed from stone blocks and are likely to have concrete or rubble infill. One of the internal pilasters has separated from the face of the wall opening a gap of roughly 95mm at the top of the pilaster. 4x round steel dowels were observed in this gap tying the pilaster to the wall with 2x dowels at 2.0m height above ground level and 2x dowels at 2.6m height. The wall foundations are concrete strip footings with pad thickenings at the pilaster locations. The strip footing appears to be approximately 1.3m in width with the pad foundations approximately 1.2m long by 2.2m wide. We were not able to determine if the foundation contained reinforcing steel. There is razor wire running the length of the top of the wall.

Asbestos and Mould Identification	At the time of writing the report we have not seen any asbestos or mould reports for the prison wall. We consider it unlikely that the wall contains any asbestos.
Retaining Walls on site?	Refer to the retaining wall assessment undertaken by Aurecon titled 520969 – Napier Ex-Prison – RW Assessment Stage 2 Risk Assessment.

Condition of Existing Wall

A site visit to inspect the perimeter wall to the Napier Ex-Prison was carried out on 5 July 2022. As part of this inspection, we took measurements of the typical dimensions of the wall and conducted some spot measurements of the verticality of the wall. The inspection was limited to a visual inspection of those areas accessible at the time and did not include any intrusive investigations or testing of structural elements of the wall.

The wall appears in reasonable condition with the majority of damaged observed to be expected given the age of the wall. Typical damage noted can be summarised as follows:

- Minor deviation of the wall from vertical, typically measured at less than 1 degree from vertical (approximately 80mm over the hight of the wall) and within the expected tolerance given the type of construction and age of the wall. The greatest deviation from vertical was measured at the pilaster located approximately 8m to the east of the entrance. In this location the outer face of the wall was measured leaning 1.4 degrees to the south while the inner face was 0.77 degrees to the south.
- Some separation of the internal pilasters from the face of the wall was observed. The worst-case separation was observed at the location indicated by photo 19 with a gap of approximately 95mm at the top of the pilaster tapering down to 0mm at the base. This likely indicates some settlement of the foundations in this location. It was noted that verticality of the wall in this location was measured at approximately 0.8 degrees leaning to the south on both sides of the wall (approximately 65mm over the height of the wall) was similar at the pilaster immediately to the west of this location indicating that the rotation of the pilaster has not significantly impacted the wall.
- A crack of approximately 5mm in width was observed to the foundation on the north elevation.
- Minor cracking to the perimeter foundation in a number of locations.
- Damage to a stone block and cracking to mortar to a pilaster on the northern elevation.
- Missing mortar and minor cracking to stone blocks observed in a number of locations.
- Minor undermining of the foundation to east end return of the prison wall on the internal elevation.
- Vegetation is growing on the wall in a number of locations and appears to have caused some loss of mortar.
- Localised cracking to retaining wall at interface with perimeter wall indicating likely differential movement.
- Minor settlement and cracking of external concrete paths and stairs immediately adjacent the wall was also observed.

Specific examples of damaged noted during our inspection are provided below and in the attached photos:

Photo 4 – Localised cracking to retaining wall at interface with perimeter wall indicating likely differential movement.

Photo 6 – Missing mortar and minor cracking to stone blocks on the north elevation.

Photo 7 – Typical minor cracking to foundation on north elevation.

Photo 8 – Damage to a stone block and cracking to mortar to a pilaster on the northern elevation.

Photo 9 – Cracking to foundation on north elevation. Approximately 5mm wide.

Photos 12, 19, 20, 21 & 22 –Concrete pilaster rotated and leaning out from face of wall.

Photo 18 – Cracking to mortar joints on the internal elevation of the western end return of the wall.

Photo 25 – Minor undermining of the foundation to east end return of the prison wall on the internal elevation.

Photo 27 – South elevation of the prison wall looking east. Note concrete pilaster leaning out from face of wall.

Recommendations

Based on our visual inspection on the 5 July 2022 the observed structural damage is generally minor in nature and does not pose a significant immediate risk to the occupants of the site or the general public, however we recommend that repairs are undertaken on the rotated and displaced pilaster. This may consist of installing steel ties through the pilaster to tie it back to the wall and in filling the gap between the pilaster and wall with grout to prevent further movement.

We also recommend that general maintenance of damaged mortar joints and broken stonework is undertaken to prevent further deterioration due to weathering and vegetation growth.

Explanatory Statement

This report has been prepared by Aurecon at the request of LINZ ("Client") exclusively for the use of the Client. It is not possible to make a proper assessment of this review without a clear understanding of the terms of engagement under which it has been prepared, including the scope of the instructions and directions given to and the assumptions made by Aurecon. The report will not address issues which would need to be considered for another party if that party's particular circumstances, requirements and experience were known and, further, may make assumptions about matters of which a third party is not aware. Data contained within the report and associated maps may not be used for any other purpose without our prior review and agreement. Aurecon does not assume responsibility or liability for the use of, or reliance on, the report by any third party and the use of, or reliance on, the report by any third party is at the risk of that party. This report and the associated is not to be reproduced wholly or in part without our prior written permission, and this explanatory note must accompany every copy of this report.

The nature of the ground and structures has been inferred using experience and engineering judgment and it must be appreciated that actual conditions could vary from the assumed model. In addition, structure conditions and ground conditions such as slope conditions change over time. Hence hazard areas and features may be subject to change particularly if this information is used after a protracted delay.

The inspections of the structure discussed in this report have been undertaken to assess structural damage. No analysis has been undertaken to assess the strength of the structure or to determine whether or not it complies with the relevant building codes, except to the extent that Aurecon expressly indicates otherwise in the report.

The report does not address defects that are not reasonably discoverable on visual inspection, including defects in inaccessible places and latent defects. Where site inspections were made, they were restricted to visual external and internal inspections.

The report may contain various remarks about and observations on legal requirements, legislation, regulations, consents, permits and authorities. A consulting engineer can make remarks and observations about the technical aspects and implications of those documents and general remarks and observations of a non-legal nature about the requirements or contents of those documents. However, as a consulting engineer, Aurecon is not qualified, cannot express and should not be taken as in any way expressing any opinion or conclusion about the legal status, validity, enforceability, effect, compliance requirements of those arrangements or documents or whether what is provided for is effectively provided for. They are matters for legal advice.

Without limiting any of the above, Aurecon's liability, whether under the law of contract, tort, statute, equity or otherwise, is limited as set out in the terms of the engagement with the client.

Please let me know if you require any further information.

Yours sincerely,

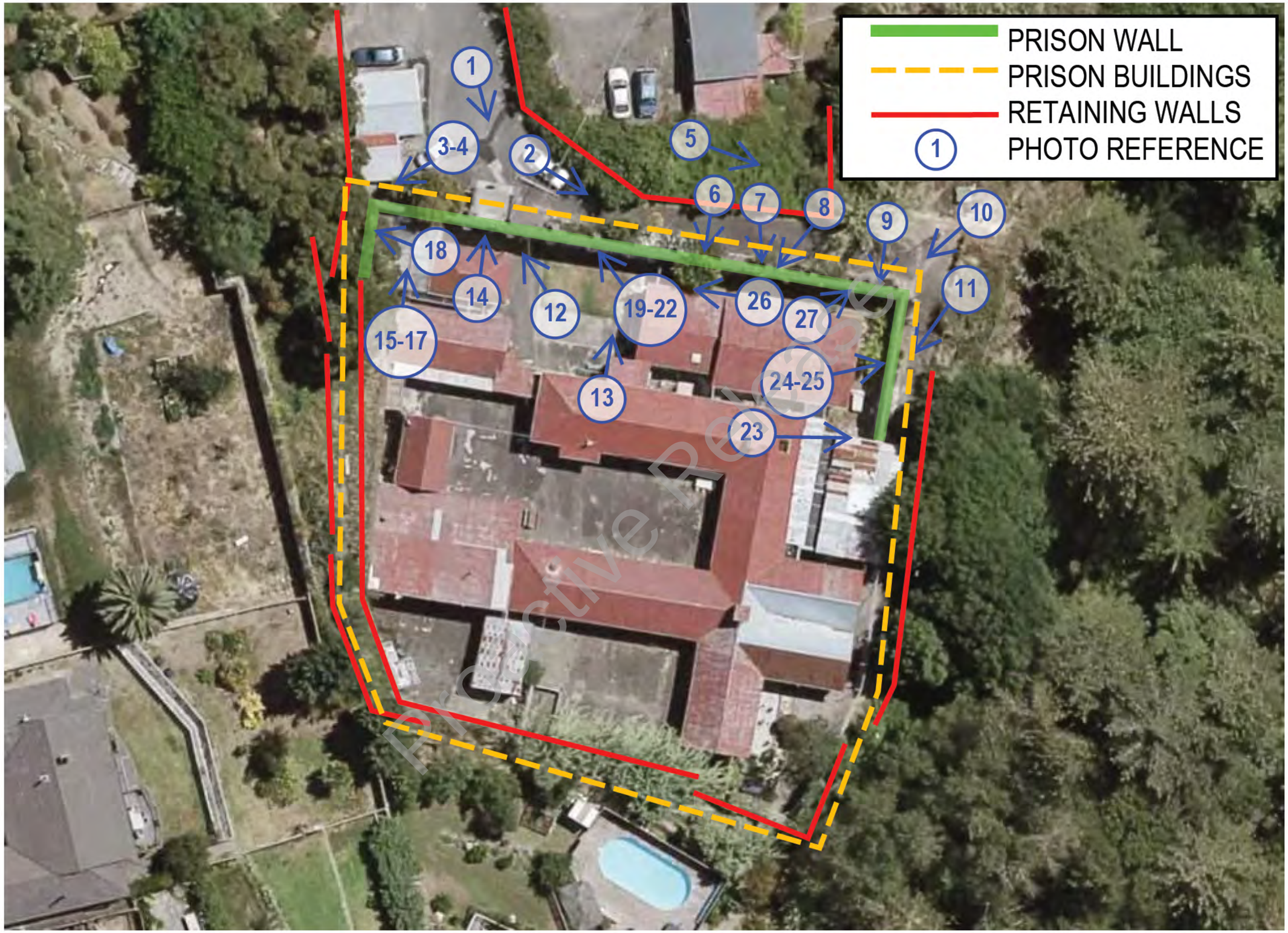
[redacted]

Senior Structural Engineer

Lead Structural Engineer

Encl: Site identification photograph
Site plan
Example existing condition photographs

Site Identification Photograph – Northern Elevation of the Prison Wall (External)



aurecon
www.aurecongroup.com

CLIENT
Land Information New Zealand
Toitū te whenua

REV	DATE	REVISION DETAILS	APPROVAL
A	8.09.22	ISSUE FOR INFORMATION	W.PHILLIPS

SCALE	SIZE A1
DRAWN	H.BURNETT
DESIGNED	H.BURNETT
CHECKED	W.PHILLIPS
APPROVED	W.PHILLIPS
DATE	

FOR INFORMATION

PROJECT: NAPIER PRISON WALL

TITLE: SITE LOCATION PLAN

DRAWING No. PROJECT No 520969 - WBS 000 - TYPE DRG - DISC - NUMBER ST-01 - REV A

Example Existing Condition Photographs		
1	General view of the main entrance to the prison in the northern elevation of the wall.	
2	North elevation of the prison wall looking east.	
3	North elevation of the prison wall looking West. Note the foundations for the wall are retaining approximately 1m of ground on the prison side. This tapers down to zero at the eastern end of the wall.	

Example Existing Condition Photographs		
4	Localised cracking to retaining wall at interface with perimeter wall indicating likely differential movement.	
5	North elevation of the prison wall looking east.	
6	Missing mortar and minor cracking to stone blocks on the north elevation.	

Example Existing Condition Photographs		
7	Typical minor cracking to foundation on north elevation.	
8	Damage to stone block and cracking to mortar to a pilaster on the northern elevation.	
9	Cracking to foundation on north elevation. Approximately 5mm wide.	

Example Existing Condition Photographs		
10	North side of the prison wall looking west.	
11	External elevation of the east end return of the prison wall looking south.	
12	South elevation of the prison wall looking west. Note concrete pilaster leaning out and separating from the face of the wall.	

Example Existing Condition Photographs		
13	South elevation of the prison wall.	
14	View of the entrance showing overall thickness of wall.	
15	Internal elevation of the western corner of the prison wall looking North.	

Example Existing Condition Photographs		
16	General view of the interface between the internal concrete pilasters and the stone wall. Note laser line indicates wall and pilaster are vertical.	
17	General view of the interface between the internal concrete pilasters and the stone wall. Note laser line indicates thickness of pilaster at top.	
18	Cracking to mortar joints on the internal elevation of the western end return of the wall.	

Example Existing Condition Photographs		
19	Damage to stone blocks due to rotation and separation of the concrete pilaster from the wall on the southern elevation.	
20	Top view of the concrete pilaster which has rotated and separated from the wall on the southern elevation.	
21	Bottom view of the concrete pilaster which has rotated and separated from the wall on the southern elevation. Laser line shows the width of the gap at the top of the pilaster.	

Example Existing Condition Photographs		
22	4x steel dowel bars observed tying the rotated concrete pilaster to the stone wall. The dowels were observed have undergone significant corrosion.	
23	Internal elevation of the east end return of the prison wall where it abuts one of the prison buildings.	
24	Internal elevation of the east end return of the prison wall looking north.	

Example Existing Condition Photographs		
25	Minor undermining of the foundation to east end return of the prison wall on the internal elevation.	
26	South elevation of the prison wall looking west.	
27	South elevation of the prison wall looking east. Note concrete pilaster leaning out from face of wall.	

Example Existing Condition Photographs		
28	Closeup photo of a typical stone facing block.	

Appendix E
Laser Scan Survey Memo

Aurecon New Zealand Limited
Ground Level
247 Cameron Road
Tauranga 3110
New Zealand

Memorandum

To	**Toitū Te Whenua - LINZ**	From	**Aurecon NZ Ltd**
Copy	[redacted]	Reference	**520969-0000-MEM-UU-0001**
Date	**2022-05-09**	Pages (including this page)	**4**
Subject	**Napier Prison Retaining Wall Assessment – Laser Scan Survey**		

1. Overview

The Aurecon Tauranga survey team were engaged by Land Information New Zealand to undertake a site scan of the Napier Prison property on Coote Road to determine the proximity of 9 retaining walls to the parcel boundary.

The survey involved observing nearby geodetic marks to strengthen the boundary definition of the site. Establishing control across the site in terms of the nearby marks. Completion of a laser scan capture covering the retaining walls and placed control marks. Producing a mark-up detailing the offset between the walls and boundary. Survey site capture was undertaken on 15-19 August 2022 and has been processed through 12d, Civil3D, Register360 and Recap Pro to produce the required deliverables. The below figure outlines the retaining walls on site.

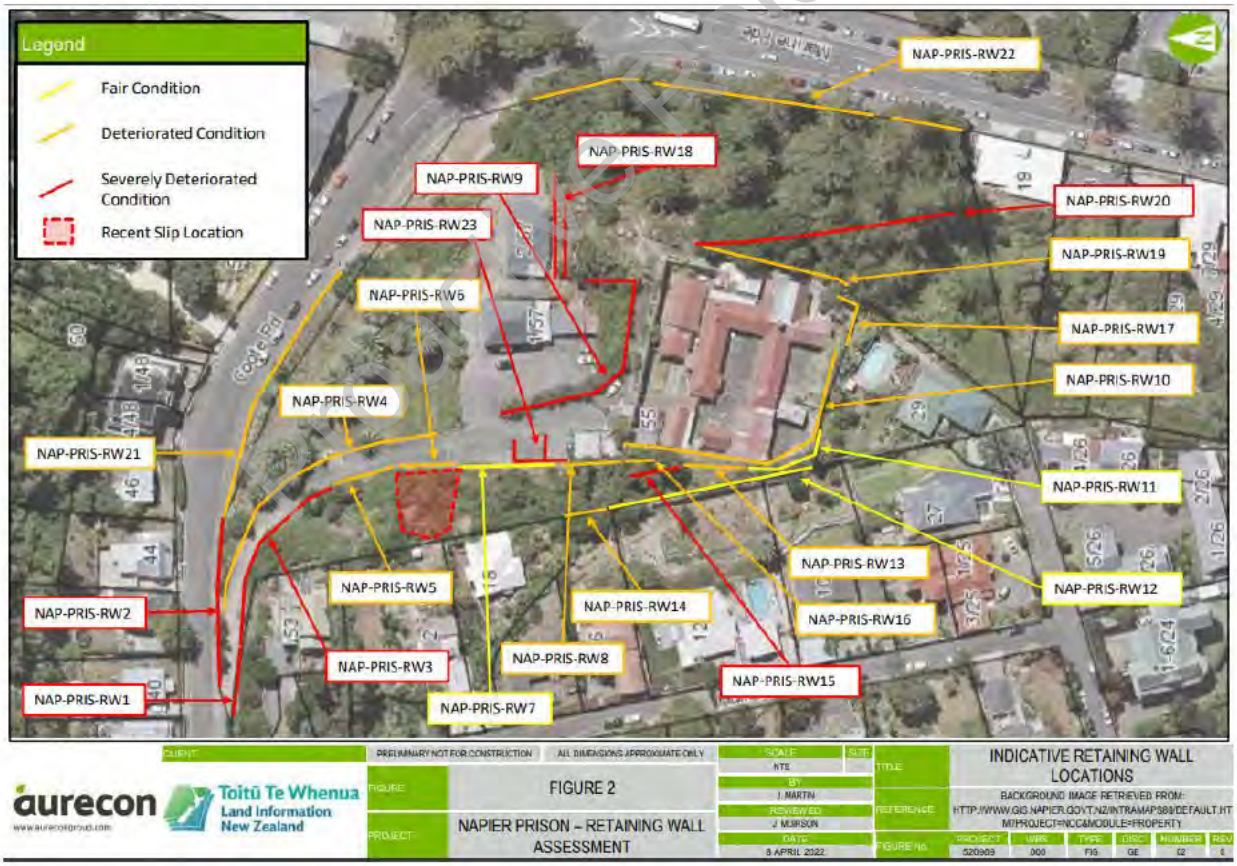


Figure 1: Retaining walls on site

2. Methodology

Capture was undertaken using Leica GS18T Global Navigation Satellite System (GNSS) Rover and GS14 GNSS base station. Several reference marks were placed and coordinated as part of the survey and are detailed in table 1 of this memo. GPS survey capture was processed using 12d model software and a control model was exported to orientate the scan data in terms of Hawkes Bay2000 and NZVD16.

Laser Scan Survey was undertaken covering the retaining walls, structures and surrounding buildings. The extent of retaining walls RW1, RW2, RW3, RW10, RW11, RW12, RW14, RW17, RW22 were all captured using a Leica RTC360 Laser scanner. A total of 87 scans were taken of the site and registered together with the use of temporary black and white targets and cloud-to cloud processing methods. Laser scan data was processed and registered using Leica Register360 and Leica Cyclone Core. Where possible polylines along the wall tops, faces and backs were created within Cyclone Core and imported into Civil3D to provide a visual summary of the wall's proximity to the boundary.

The registered point cloud has been output in Autodesk Recap (.rcp) point cloud format for visualisation and design.

Survey control information was obtained from the LINZ Geodetic Database.

Additional processing in Civil3D was completed to deliver a simplified dwg with polylines, point cloud data and the parcel boundary information.

3. Survey Origin

Survey Origin information for the survey is as follows:

Horizontal Coordinates are in terms of New Zealand Geodetic Datum 2000 – Hawkes Bay Circuit

- Origin of Coordinates: SS VIIIB SO 2216 818837.236 mN 421320.590 mE

Levels are in terms of New Zealand Vertical Datum 2016

- Origin of Levels: SS VIIIB SO 2216 RL 7.418 m

The following survey control points were used and/or established as part of the survey:

Point ID	mE	mN	mH	Description
SS VIIIB SO 2216	421320.59	818837.24	7.418	LINZ ORIGIN – Brass spike set in concrete under cast iron cover
543 SO 4874	420917.94	818462.09	65.33	SS Pin in conc block under cast iron cover.
159 SO 4874	421082.02	818543.87	20.21	SS Pin in conc block under cast iron cover.
158 SO 4874	421190.68	818473.77	0	SS Pin in conc block under cast iron cover.
547 SO 4874	421044.17	818315.39	0	547 SO 4874
IT 3 SO 396199	421230.69	818100.88	5.49	Iron tube flush in grass behind path
RN1	421080.94	818491.01	32.345	ROAD NAIL 1
RN2	421072.54	818511.91	32.715	ROAD NAIL 2
RN3	421053.90	818528.67	27.916	ROAD NAIL 3

RN4	421006.17	818531.91	27.758	ROAD NAIL 4
RN5	421067.98	818534.44	21.719	ROAD NAIL 5
RN6	421165.37	818479.63	12.05	ROAD NAIL 6
RN101	421190.24	818442.60	9.88	ROAD NAIL 101
RN102	421178.69	818412.49	9.4425	ROAD NAIL 102
RN103	421174.58	818377.39	8.9718	ROAD NAIL 103
RN104	421171.22	818354.29	8.7743	ROAD NAIL 104
RN10	421102.55	818387.72	42.794	ROAD NAIL 10
RN11	421086.99	818389.98	42.898	ROAD NAIL 11
RN12	421091.61	818409.64	42.619	ROAD NAIL 12
RN13	421078.16	818410.05	48.897	ROAD NAIL 13
RN14	421119.16	818384.07	43.065	ROAD NAIL 14
RN15	421117.56	818380.7	43.063	ROAD NAIL 15
RN16	421119.38	818378.43	43.185	ROAD NAIL 16

Table 1: Survey Control Points

4. Accuracy

The estimated accuracy of Site Reference Marks is ±15mm horizontally and vertically, relative to the respective LINZ 4th Order origin mark @ 95% C.I based on standard error propagation, at time of survey.

The accuracy of the point cloud is estimated to be to ±5mm horizontally and vertically relative to the scan station location from which it was captured, @ 95% C.I based on standard error propagation, at time of survey.

The relative accuracy of the compiled point cloud dataset (I.e. between adjacent scan stations) is estimated to be to ±15mm @ 95% C.I based on standard error propagation, at time of survey.

The absolute accuracy of the point cloud is estimated to be to ±25mm horizontally and vertically around the walls and buildings, relative to the nearest survey control point, @ 95% C.I based on standard error propagation, at time of survey.

5. Delivery

The following deliverables accompany this memorandum.

- Drafted PDF Plan
  - 520969-0000-DRG-UU-0002
- Combined Civil 3D Drawing (zipped)
  - 520969-0000-DRG-UU-0003 (DWG format)
- Point Cloud
  - 520969-0000-MDM-UU-0004 (RCS Format)
  - 520969-0000-MDM-UU-0005 (RCP Format)

Figure 2 – LINZ Napier Ex-Prison Point Cloud Sample

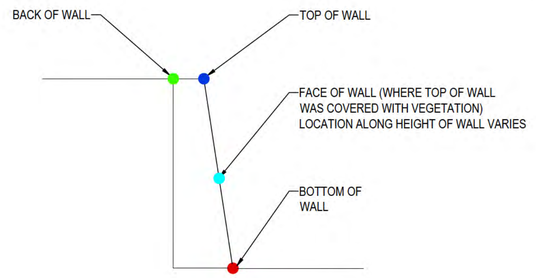
Figure 3 LINZ Napier Ex-Prison RW10, RW11, RW12 Point Cloud Sample

RW1
RW3
RW2
RW21
0.03 m TOP OF WALL OUTSIDE BDY
0.49 m BACK OF WALL OUTSIDE BDY
0.43 m TOP OF WALL INSIDE BDY
0.66 m FACE OF WALL INSIDE BDY
0.19 m FACE OF WALL OUTSIDE BDY
0.31 m FACE OF WALL OUTSIDE BDY
0.2m FACE OF WALL OUTSIDE BOUNDARY
3.9
17.1
APPROXIMATE LOCATION OF SLIP EXTENTS

Lot 1 DP 17935 1096m² HBK3/1158
Lot 2 DP 17935 977m² HBK3/1159
Lot 3 DP 17935 612m² HBK3/1160
Lot 13 DP 633 1183m² HBG1/1168
Lot 4 DP 7527 508m² HB123/52
Lot 4 DP 17935 1086m² HBK3/1160
Lot 6 DP 7527 1172m² HBA2/1415
Lot 1 DP 7910 832m² HBA3/766 HBV3/267
Lot 1 DP 11192 553m² HBP4/115
Lot 2 DP 11192 794m² HBV3/307
Lot 3 DP 7910 1947m² HBA3/766
Lot 1 DP 13460 384m² HBF1/236
Marked A DP 348560
Lot 1 DP 348560 500m² 199328
Lot 2 DP 348560 396m² 199329 HB41/264
Lot 2 DP 13460 1163m² HBF1/237
Lot 2 DP 4869 1126m² HBC1/1263
Lot 1 DP 7110 1004m² HB127/14
Lot 2 DP 7110 1388m² HB127/13
Lot 1 DP 6860 594m² HB106/181
Lot 2 DP 6860 748m² HB105/221
Lot 3 DP 6860 591m² HB106/259
Lot 4 DP 6860 1026m² HB108/252
Lot 5 DP 6860 591m² HB105/220
Lot 1 DP 6941 986m² HBP3/106
Part Lot 2 DP 167m² HBP3/106
Part Lot 2 DP 397m² HB177/28
Lot 3 DP 6941 558m²
Lot 1 DP 27863 876m² HBW4/1005
Lot 2 DP 27863 90m² HBW4/1006
Lot 2 DP 22991 1168m² HBW4/1006
Lot 1 DP 22991 16146m² HBP3/1127
715 Napier 1129m² HBY1/438
Area A DP 459141
Area B DP 459141 DP 4594 786m² 599358 HBL4/730
Area C DP 459141
Lot 2 DP 459141 168m² 599358

0.58 m FACE OF FENCE INSIDE OF BDY
0.65 m FACE OF FENCE INSIDE OF BDY
0.56 m FACE OF WALL OUTSIDE OF BDY
RW14
RW12
RW10
RW11
RW17
RW22
0.44 m BOTTOM OF WALL OUTSIDE OF BDY
3.62 m FACE OF WALL OUTSIDE OF BDY
0.45 m BOTTOM OF WALL OUTSIDE OF BDY
1.15 m TOP OF WALL OUTSIDE OF BDY
1.1
2.2
RW12 COVERED BY VEGETATION IN THIS AREA (DASHED LINE SHOWING EXTRAPOLATED POSITION)
0.34 m TOP OF WALL INSIDE OF BDY
0.45 m TOP OF WALL OUTSIDE OF BDY
0.96 m TOP OF WALL INSIDE OF BDY
0.95 m TOP OF WALL INSIDE OF BDY
1.49 m TOP OF WALL OUTSIDE BDY
0.42 m TOP OF WALL INSIDE BDY
0.10 m TOP OF WALL OUTSIDE BDY

TYPICAL SECTION OF RETAINING WALL SCAN



Job reference: P520969 LINZ Ex Napier Prison Retaining Wall Assessment

Date of Survey: 15/03/2022 - 19/03/2022

Primary Survey Equipment: RTC Laser Scanner

Secondary Survey Equipment: Leica GPS

Datums: Horizontal: Hawkes Bay 2000
Vertical: New Zealand Vertical Datum 2016

Origin point: DJMA, 4th order, source LINZ Geodetic database.

Adjacent parcel boundaries shown have been sourced from LINZ on the 28/06/2022 and are indicative only. Napier Prison boundary shown is accurate to +/-50mm based on traversed positions.

Absolute accuracy of the point cloud is estimated to be to ±25mm horizontally and vertically around the walls and buildings, relative to the nearest survey control point, @ 95% C.I based on standard error propagation, at time of survey.

aurecon

Toitū Te Whenua Land Information New Zealand

REV	DATE	REVISION DETAILS	APPROVED
0	2022-08-26	ISSUED FOR REVIEW	B.TOMS

CLIENT

SCALE	SIZE
1:400	A1

DRAWN: A.HICKS
DESIGNED: -
REVIEWED: G.ROBINSON

SKETCH PLAN

APPROVED
DATE
B.TOMS

PROJECT: NAPIER EX PRISON

TITLE: SHEET 1

DRAWING No. | PROJECT No. 520969 | AREA | TYPE DRG | DISC AL | NUMBER 1 | REV 0