KHANDALLAH POOL
SITE ASSESSMENT REPORT

ARCHITECTURE HDT| TONKIN AND TAYLOR |POWELL FENWICK I ADAMSON & SHAW

EXECUTIVE SUMMARY

The existing Khandallah Pool facility is a seasonal outdoor pool facility which has operated for close to 100 years. It is a valued facility in the local community. It is showing its age, and is considered not fit for purpose for its predominantly aquatic leisure usage.

Architecture HDT Ltd has been engaged by Wellington City Council to undertake a detailed site analysis of the current Khandallah Pool site. A number of technical reports have been prepared by Architecture HDT and subconsultants Tonkin and Taylor Ltd and Powell Fenwick Ltd. The purpose of these investigations is to assess the viability of the site for redevelopment. The technical reports and detailed site assessment identifies a number of site specific challenges that will need to be addressed in the new development, as outlined below;

Tonkin & Taylor Flood Modelling

- There is a known flood risk on the site, and climate change modelling predicts that this risk will increase. Flood risk can be mitigated by removing obstruction (building less), or building above predicted flood plane levels and providing alternative flow paths. Building above predicted flood planes requires a significant elevation of building platform level (1.8 metres) which will be costly, and affects the accessibility of the site. Regardless of the approach taken to mitigate flood risk, the downstream capacity of stormwater infrastructure will need to be addressed.

Tonkin & Taylor Geotechnical Report

- Geotechnical testing identifies the potential for slope instability on the adjacent northern slopes, and expected instability in the stream bed below the pool between 0.5 and 1m deep. It is therefore recommended that any new development be positioned as far away as possible from the slope base as possible. Groundwater is unlikely to be a significant issue on the site.

Powell Fenwick Ltd Infrastructure Review

- The electrical supply to the site is constrained. Development which increases electrical demand will require a dedicated transformer to be provided to the site, with an estimated capacity of 300 kVa. The cost of undertaking this is estimated to be between $400k and $500k by Wellington Electricity.
- Discharge to sewer from any new pool development will need to managed, and this will require attenuation tanks to be provided. The constrained nature of the site is likely to require below ground attenuation tanks be provided in the existing carpark at a cost of between $100k-$200k.

Architecture HDT Ltd Site Analysis

- The Southern and South-Eastern corners of the existing site provide the most attractive and sunny points to develop, as the site is significantly overshadowed by mature trees. Trees will pose an ongoing maintenance issue, both in terms of sunlight access and pool filtration.
- If the level of service in any new development is to be increased, the parking effects on neighbouring residential properties in Woodmancote Road will need to be carefully considered. Parking provision along the northern side of the carpark is likely to be compromised by providing the required flood path to Tyers Stream.
- The site is physically constrained in the valley floor, and existing buildings currently extend into land designated as Scenic Reserve. New development could be constrained within the parcel of land designated as Open Space B in the Operative district Plan, or Sport and Recreation Zone in the Proposed District Plan. The planning restrictions applying to these zones (building height, site coverage etc.) are unlikely to prohibit development. The constrained nature of the site means that development of some areas of adjacent Scenic Reserve land may be required. This will require resource consent.

The technical reports identify significant challenges and cost associated with mitigating the resilience and vulnerability issues identified on the site, demonstrated graphically on the adjacent page. Mitigating these challenges greatly reduces the useful available space (approximately 20% of the site area) for development of aquatic provision.

Signed

Mark Bates
Director Architecture HDT Ltd
For and on behalf of the Design Team
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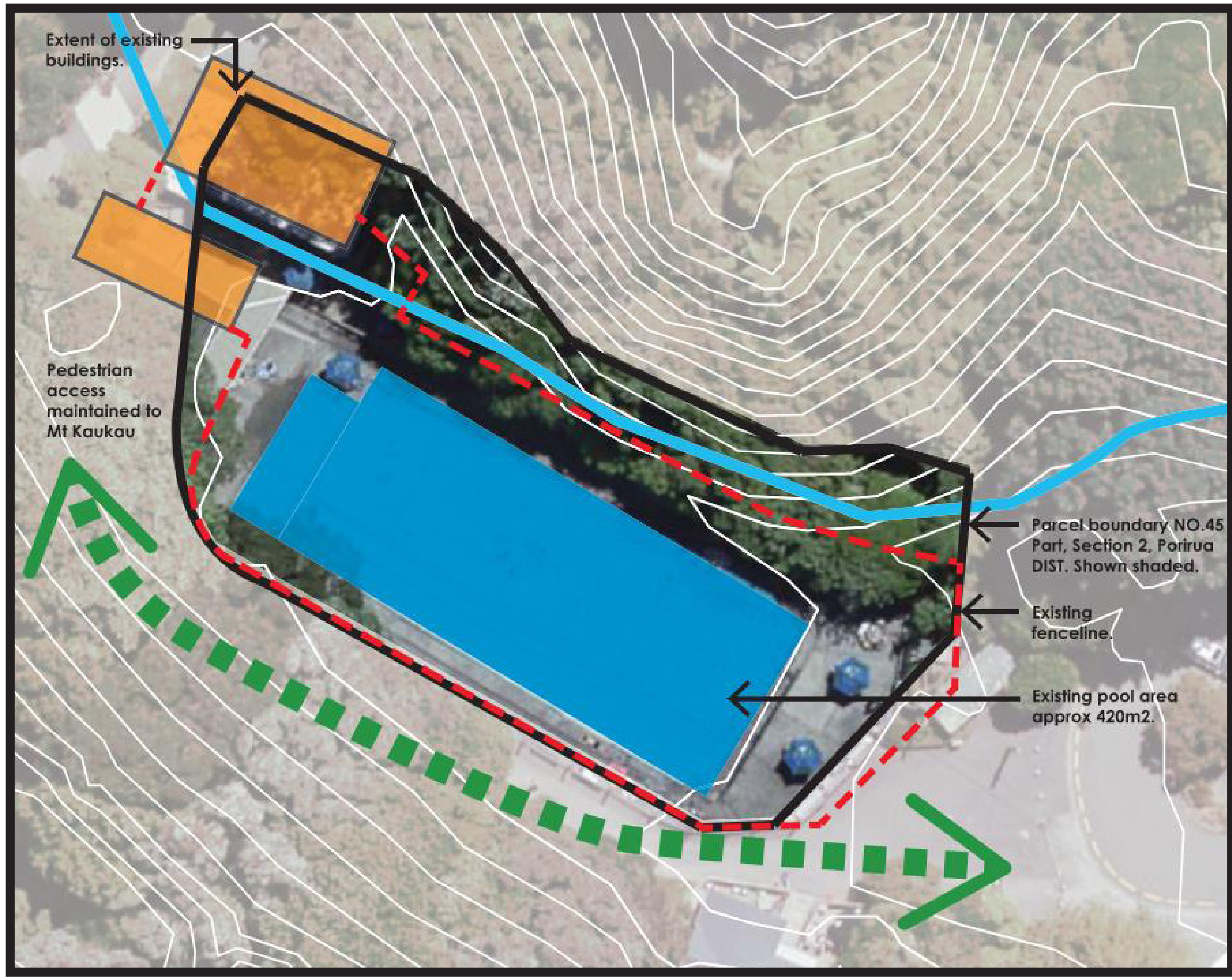
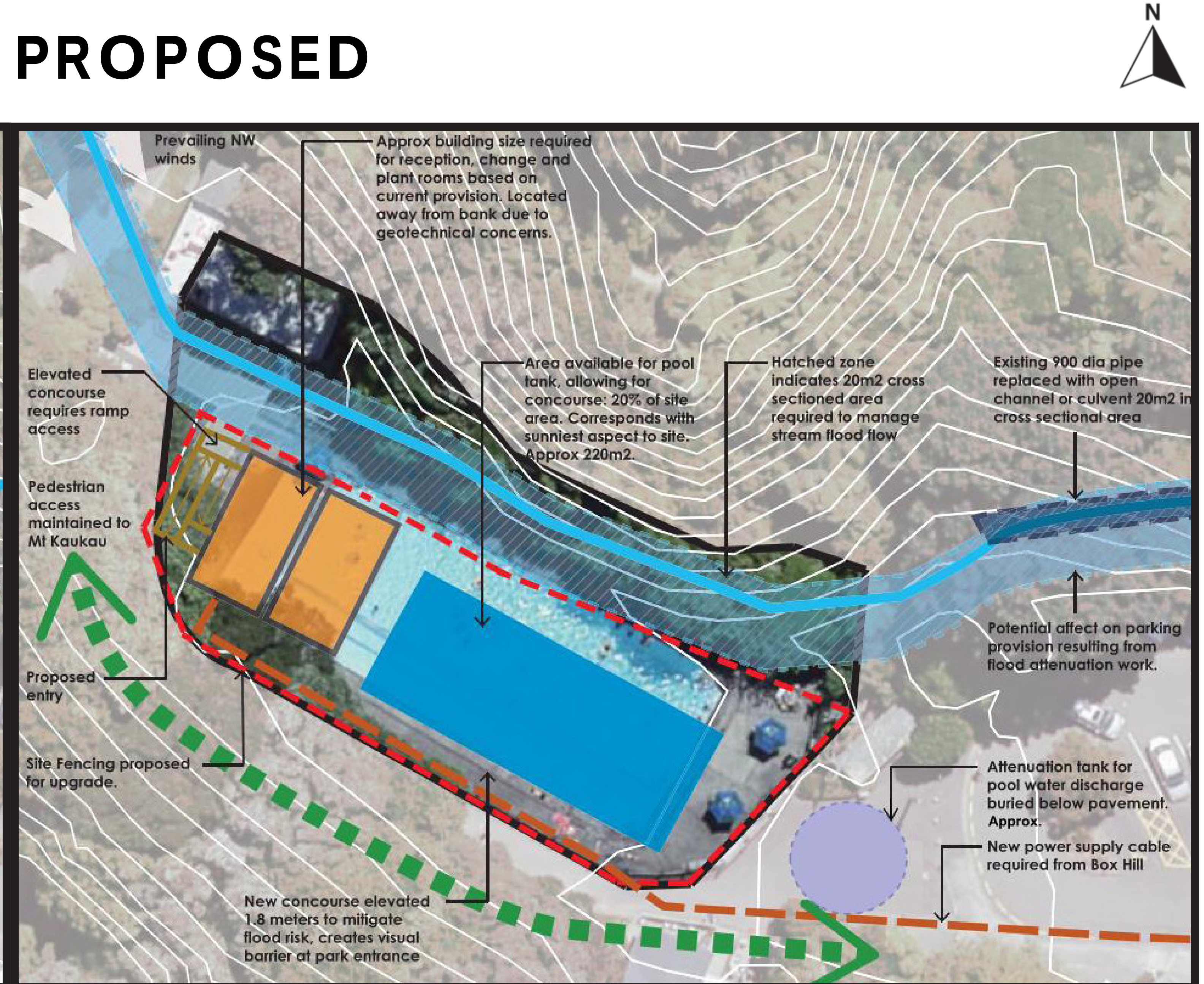
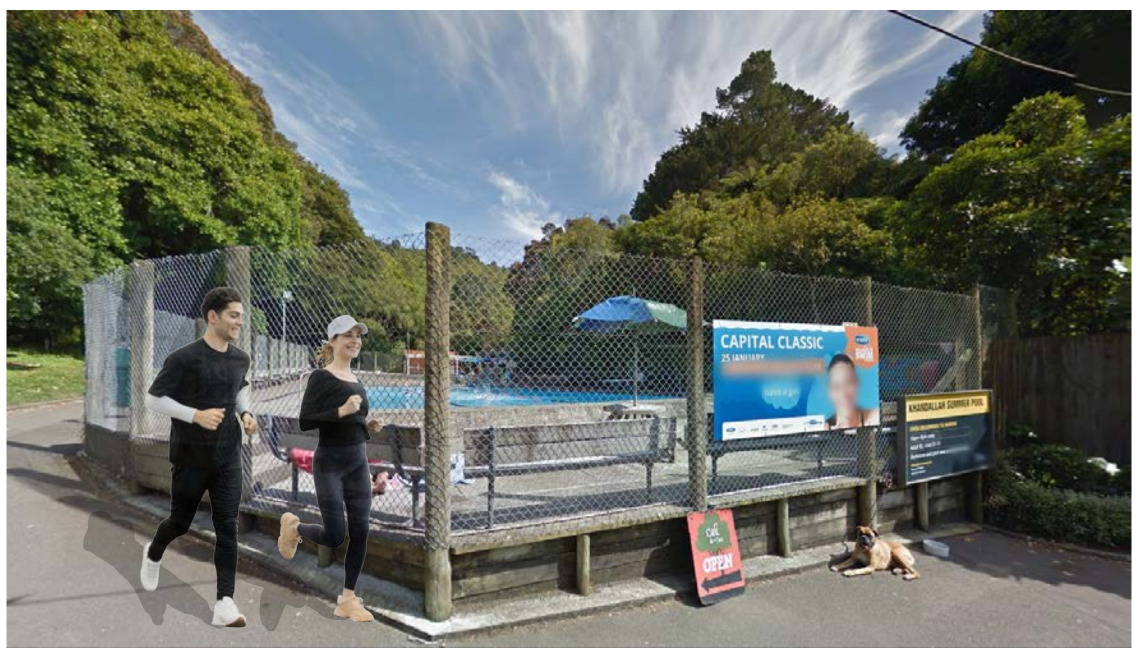
EXISTING



PROPOSED





Red dashed zone in diagram indicates approximate extent of pool concourse raised to mitigate flood risk.

CONTENTS

1. INTRODUCTION

Architecture HDT Ltd, along with subconsultants Tonkin and Taylor Ltd, Powell Fenwick Ltd and Adamson and Shaw Ltd have been engaged by Wellington City Council to undertake a detailed site analysis of the current Khandallah Pool site.

With Wellington City Council having approved funding for the redevelopment of Khandallah Pool, the purpose of this work is to understand in detail the site constraints and opportunities offered by the current site and the feasibility of redevelopment. Specifically, this work has involved the following assessments;

- -A detailed geotechnical investigation
- -An Infrastructure review
- -A flood risk assessment
- -A topographical survey
- -A detailed site analysis
- -A high level planning assessment

2. SITE HISTORY

The original outdoor pool was opened in 1925 by the Khandallah Progressive Association on Khandallah Reserve, and was partially funded by local residents. It was originally a freshwater pool filled from the adjacent Tyers Stream.

In the 1960's, new filtration was installed and the pool was connected to the mains water supply. Backwash and emptying of the pool however remains via Tyers Stream. A new plantroom, changerooms and an administration building were also constructed at this time.

Early photos show the new facility located in a largely open valley at the end of Woodmancote Road. In the nearly 100 years since its construction, significant vegetation has grown on the surrounding hills.

The existing buildings on the site are known to be seismically prone. The brick administration / female change building is 22% NBS and the plant-room/ male change is 14% NBS. They are therefore considered seismically prone and have been issued with an Earthquake-Prone Building Notice under Section 133AL of the Building Act 2004. The deadline to rectify the buildings is 9 January 2030.

Practically there is little value in the retention of the existing buildings within any new development.

3. FLOOD RISK ASSESSMENT

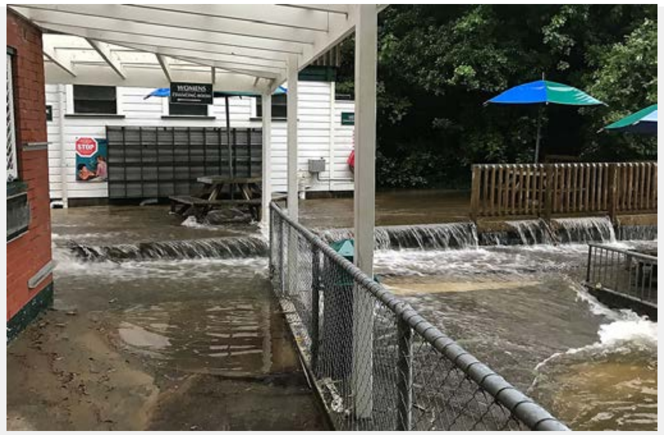
Refer to the full Tonkin and Taylor Flood Risk Assessment Report included in the appendices.

The site of the current facility has a catchment area of approximately 60.6 hectares, and has historically been the source of flooding. Flooding events are recorded in 2016, 2017 and 2021.

Modelling undertaken by Wellington Water in a 10%AEP (annual exceedance probability, i.e. a 10% AEP means that there is a 10% chance in any given year of the event occurring) scenario does not highlight a flood risk, despite the events above known to have occurred in 20%AEP events. It is likely that the Wellington Water modelling takes no account of the flow constraints resulting from the existing footbridge (North-West of the site) and where flow is constrained below the existing pool deck. The Wellington Water model does identify the stream transition from an open channel to the existing 900mm pipe in the pool parking lot as a constraint causing flooding of the carpark.

The Tonkin and Taylor report identifies that the existing stream may have sufficient capacity to control short term flood risk up to a 10%AEP rain event, provided that existing restrictions to Tyers stream are removed.

Recent flooding events throughout the country have highlighted the importance of considering the effects of increased rainfall brought about by climate change.

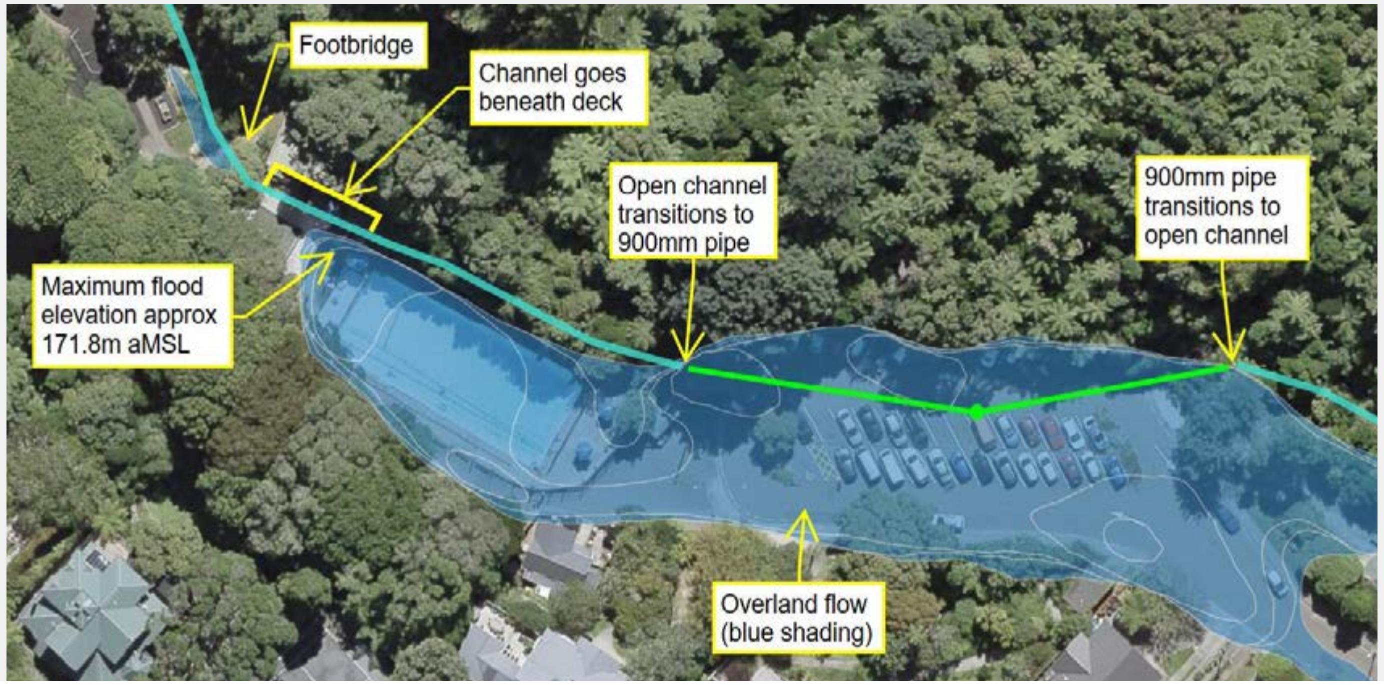


With climate change in mind, two additional scenarios were reviewed by Tonkin and Taylor.

1% AEP rain event +20% rainfall
Wellington Water have flood hazard modelling for a 1% AEP rain event +20% rainfall depth to allow for climate change. Flood hazard modelling for this scenario is given below, with the purpose to identify a safe building platform level and how high rainfall stream flows can be accommodated.

Based on this scenario and modelling, Wellington Water recommends that a level of RL 171.8 be used with appropriate free-board. The Wellington Water Regional Standards for Water Services gives guidance that the minimum free board (top of peak flood level to underside of floor joists/structure) should be 200mm, which suggests that the floor level of any new development be at RL 172.00.

It should be noted that the level of the existing pool concourse is approximately RL 170.00. Mitigating flood risk identified by this modelling would require the site platform to be built up by 1.8-2 metres, or an acceptance that structures with a floor level below RL 171.8 may be subject to flood damage in the future.



This modelling also gives guidance on the minimum cross sectional area required to accommodate the modelled stream flows in this rain event. A cross sectional area of 20m2 is required, in contrast to the 1.82 m2 currently provided. This provision is in addition to the building platform elevation. Further modelling of stream flow and downstream capacity may allow a lower building platform if flow paths can be improved.

1%AEP + RCP 8.5 Climate Change Scenario
Tonkin and Taylor undertook their own modelling using the RCP 8.5 climate change scenario. The RCP 8.5 scenario is considered a 'worst case' climate change scenario if current trends were to continue.

This modelling gave a less conservative view on the flood hazard than the 1%AEP+20% scenario above. The modelling suggests a flood level elevation of RL 171.48, requiring a building platform level of approximately RL 171.68. This scenario also suggests a reduced cross sectional area of 6m2 required to accommodated modelled flows.

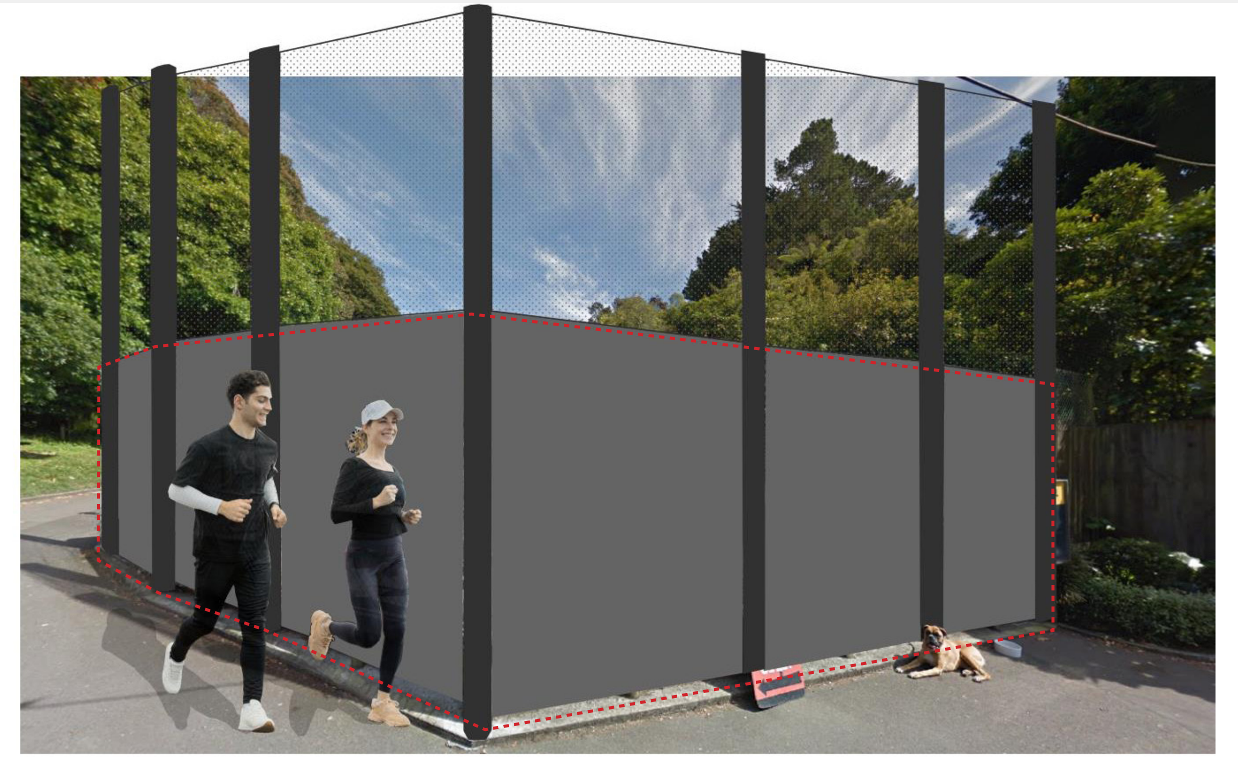
Commentary
The flood hazard modelling identifies a number of issues that any future development of the site will need to consider.

1. Based on the Wellington Water 10% AEP model, it is reasonable to assume that additional flood resilience will be provided to the site by removing the obstruction at the footbridge and where the existing stream runs under the deck. In addition to this, the downstream 900mm diam SW pipe would need to be removed to an open channel or increased in size.

2. At a big picture level, there are two approaches to dealing with the flood risk;
   a. Elevate concourse and building level above expected flood risk. When climate change is considered, both modelled scenarios identified the need to increase building platform level to mitigate flooding risk, and the need to increase the cross sectional area of Tyers Stream to increase capacity. The adjacent image gives a graphical representation of the extent of concourse elevation.
   b. Reduce obstruction to flood path by opening up the park entrance and minimising new construction.

4. Elevating the concourse and building level presents some challenges. If the general building level were raised by 1m, additional protection to property could be provided with the use of durable, flood resistant construction at low level to RL 17.68. Any increase in building platform to mitigate flooding has two implications. The concourse level is already elevated in relation to Woodmancote Road, and further elevation risks creating a visual barrier to the park entrance. Secondly, accessibility is affected. Every metre that the concourse is raised requires an additional 14.4m of accessible ramp length (once landings are considered). This effectively reduces the area for development within what is already a tight site. It is worth noting that the climate change scenarios modelled above both require work to remove the downstream obstruction to Tyers Stream to improve resilience.

5. Any new design will need to consider adequate secondary flow paths so storm event bypass the facility rather than flowing through the facility.



4. GEOTECHNICAL INVESTIGATION

Refer to the full Tonkin and Taylor geotechnical report included in the appendix.

Tonkin and Taylor were engaged to undertake geotechnical investigations on the site. The primary purpose of these initial investigations were to establish the following;

a. The subsoil profile and class in terms of NZS 1170.5:2004
b. The potential for liquefaction and other geotechnical hazards on the site.
c. Possible foundation options for the site.

The adjacent plan gives the locations of the testing undertaken.

The investigations undertaken by Tonkin and Taylor identified the following geotechnical conditions;

a. **Slope Instability**
There is potential for slope instability on the steeper vegetated slopes to the north of the existing pool. There is also expected instability along the stream beds, with fill and/or alluvium present between 0.5 and 1 metre deep. The recommendation from Tonkin and Taylor is that buildings be positioned as far away as possible from the slope base as possible. A significant regional earthquake event may bring about deep seated rock mass failure. Any redevelopment of the site will need to consider the likelihood that the slope instability may lead to damage to buildings, and design accordingly.

b. **The Presence of Groundwater**
Expected groundwater levels are given in the site sections given on the following page. The results at BH01 indicate that the groundwater level increases by 1.2 metres when the pool is full of water.

c. **Soil Conditions**
In the area of the existing pool (valley floor), soil was found to be a mixture of silt (0-1.6m deep), alluvium (between 0.8 and 2.4m deep) and greywacke (between 2.4 to 4m deep). On the Northern slopes adjacent to the pool, soil was found to be a mix of non engineered fill, topsoil and weathered greywacke.

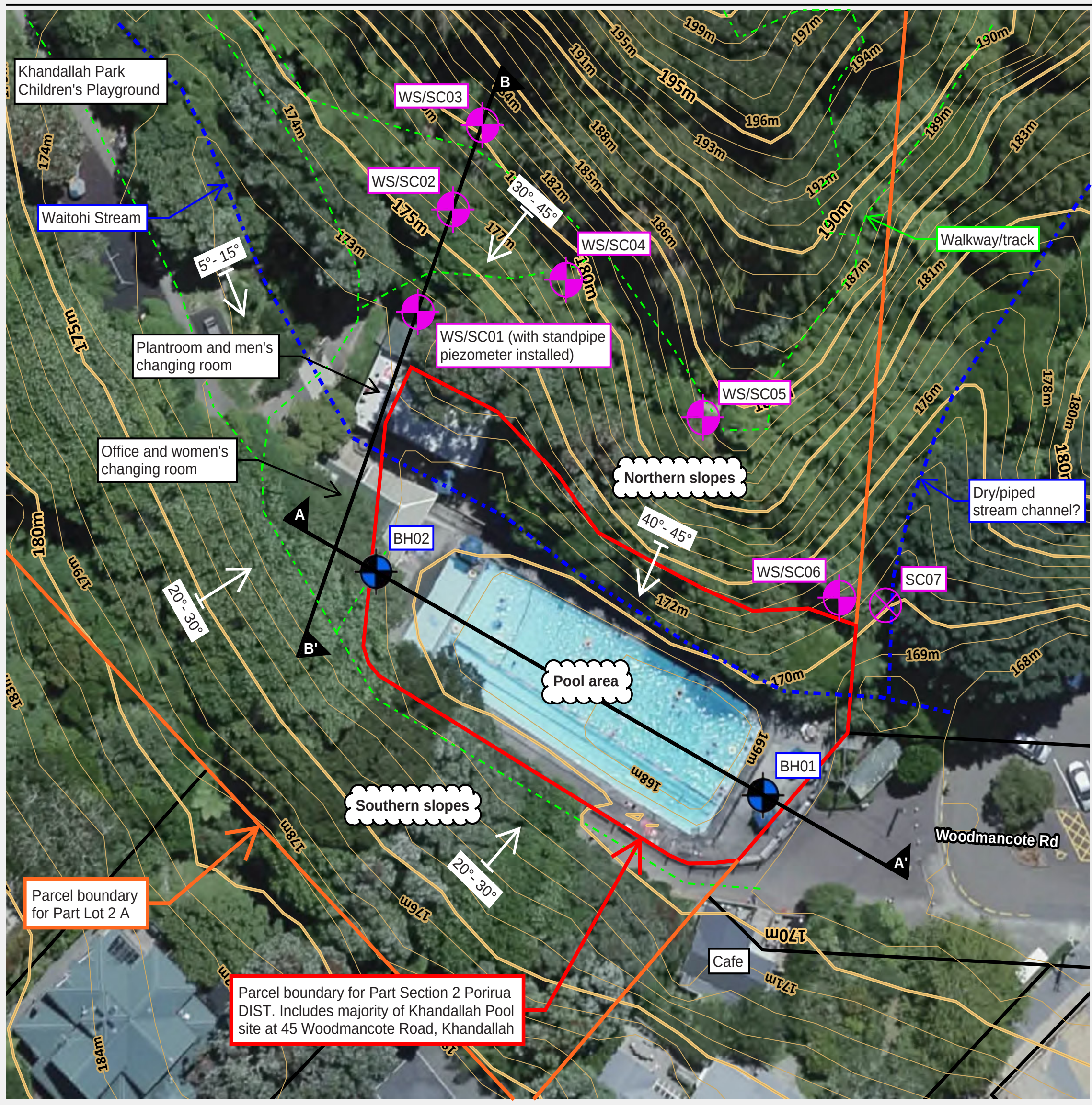
d. **Ground Shaking Hazard**
The seismic hazard has been assessed for the site, with the peak ground acceleration (PGA) and magnitude assessed based on NZS 1170.5:2004 and the 2022 NSHM (new national seismic model).

It is considered that the code minimum seismic design loadings will increase in the updated compliance documents. Tonkin and Taylor have assessed that geotechnical and structural design would need to consider any new design to the following ULS and SLS under a building importance level of IL2.

NZS 1170.5	**PGA**	**Return Period**
Serviceability Limit State (SLS)	0.13 (magnitude 6.5)	25
Ultimate Level State ULS	0.68 (magnitude 7.7)	500
2022 NSHM		
Serviceability Limit State	0.11-0.16	25
Ultimate Limit State	0.85-0.91	500

e. **Liquefaction Potential**
Liquefaction is not expected on the northern slopes.
In the area of the pool (valley floor), there is no liquefaction expected above ground water level. Liquefaction is considered a possibility in weak/lose material. There is no liquefaction expected in the alluvium and bedrock layers at ULS shaking identified in the table above.

f. **Possible Foundation Options**
Well tied shallow pad/strip and raft foundations founded on alluvium or rock are considered the most appropriate for the site.



LEGEND

- 1m Contour
- 5m Contour
- Property Boundary
- Parcel Boundary
- Parcel boundary for Part Section 2 Porirua DIST, includes majority of the Khandallah Pool site.
- Parcel boundary for Part Lot 2 A 1093
- Walkway/track
- Waitohi Stream
- Geological cross-sections (refer Figures A3 and A4)
- Approximate slope direction and angle

Geotechnical investigation by T+T (November 2022)

- Boreholes (BH) + standpipe piezometer with level logger
- Window Sampler (WS) + Scala Penetrometer Test (SC) + standpipe piezometer at location indicated
- Scala Penetrometer Test (SC) only

Notes:
1. Investigation locations are approximate only.

A4 SCALE: 1:500
0 5 10 15 20 (m)

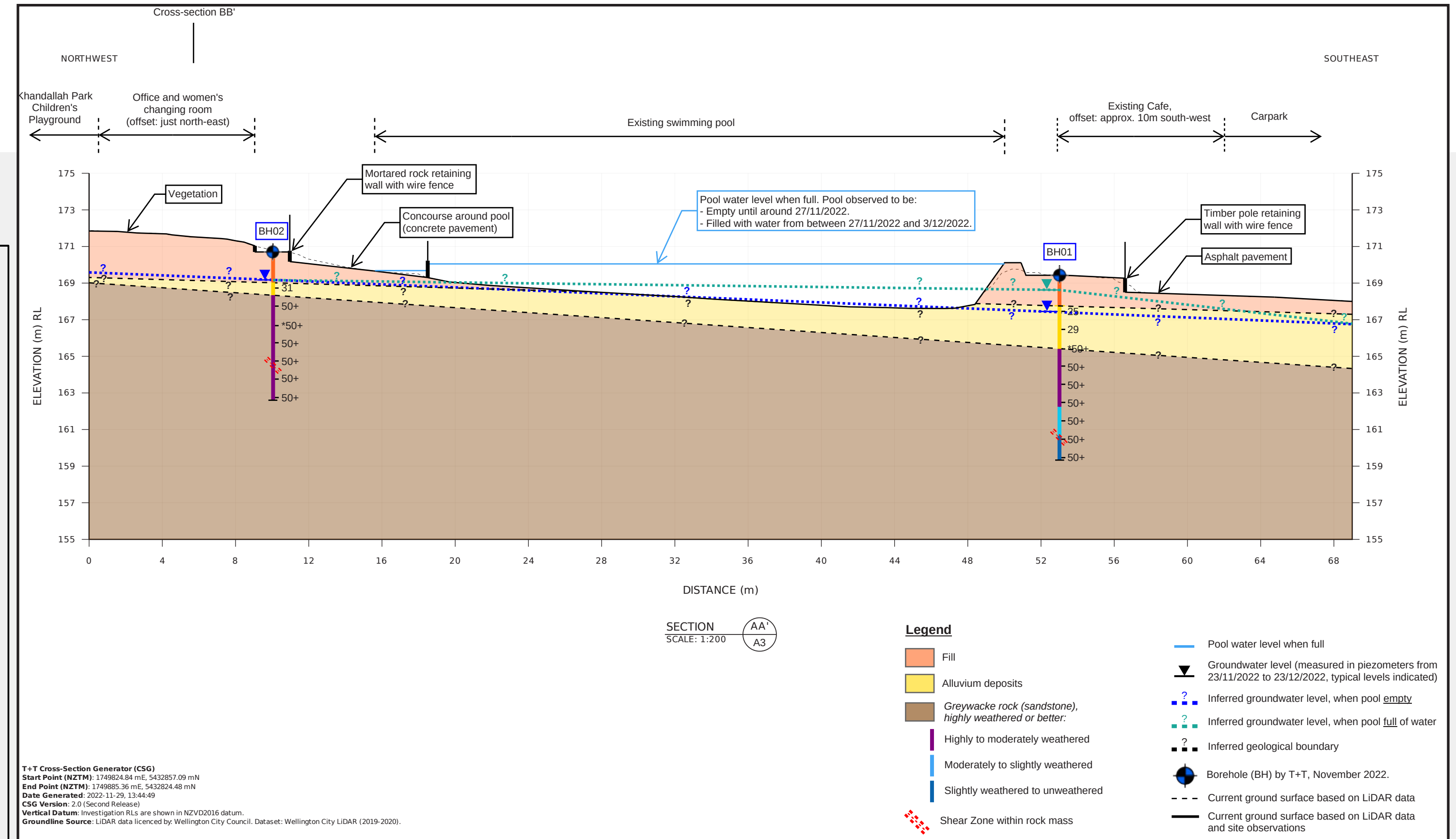
1. Parcel Boundary,Property Boundary,Street Name sourced from the LINZ Data Service and licensed for re-use under the Creative Commons Attribution 3.0 New Zealand licence.
2. LINZ Aerial Basemap Copyright LINZ CC BY 4.0. www.linz.govt.nz/linz-copyright Imagery Basemap Contributors. https://www.linz.govt.nz/data/linz-data/linz-basemaps/data-attribution

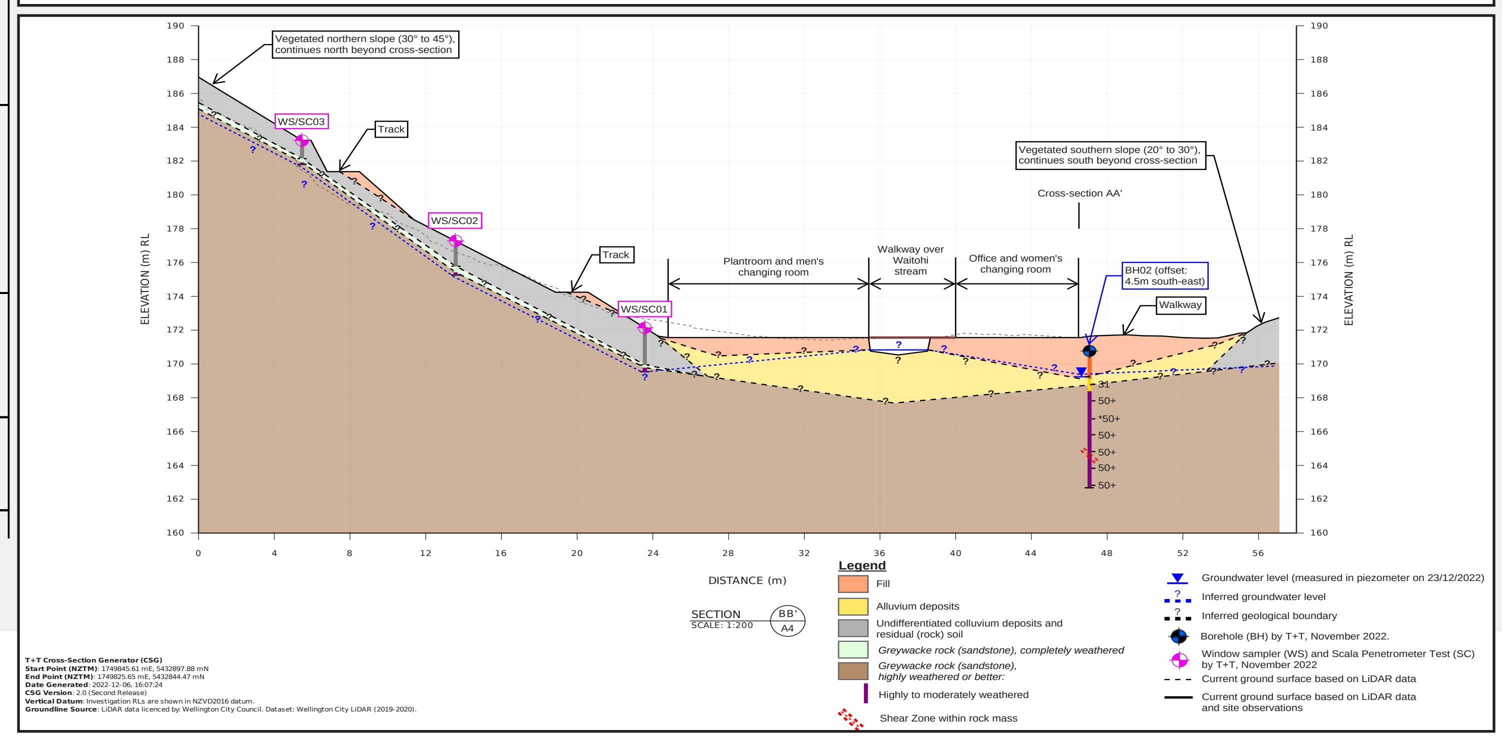
Created On:	28/10/2022
Created By:	ARolfe
Approved By:	BRama
TT Proj Ref:	1089174.0001
TT Map Ref:	TTMAPREF1433463001.902

Tonkin+Taylor
1 Fanshawe Street, Auckland
www.tonkintaylor.co.nz

Architecture HDT Ltd
Khandallah Pool Redevelopment
Geotechnical Seismic Assessment
Site Plan - Geotechnical Investigation

FIGURE No. **A2**





5. PLANNING IMPLICATIONS

The majority of the Khandallah Pool complex is held in land parcel: Part Section 2 Porirua DIST (parcel id 3929966).

The parcel was gazetted in 1989 as Recreation Reserve under the Reserves Act 1977. The site is currently mis-classified as Scenic Reserve in the Wellington City Council Outer Green Belt Management Plan 2019. Under Section 17 of the Reserve Act 1977, Recreation Reserves provide for recreation and sporting activities, protection of the natural environment, retention of open spaces and outdoor recreational activities.

A portion of the Khandallah Pool is located within a much larger parcel Part Lot 2 A 1093 (parcel id 3763844). This parcel was gazetted in 1989 as Scenic Reserve. The purpose of Scenic Reserves under Section 19 of the Reserves Act are to protect and preserve areas of scenic interest, beauty, and natural features or landscapes.

Under Section 19(2)(c) open portions of Scenic Reserve may be developed for amenities and facilities where necessary to enable the public to obtain benefit and enjoyment from the reserve. Under Section 55(2)(d), pools referred as “baths” can be located in open portions of the Scenic Reserve.

The Minister has delegated the Council (as the reserve administering body) the ability to provide consent for use of scenic reserves for this purpose. In providing consent, the Council must:

- Be satisfied the facilities are necessary and cannot readily be provided outside or in close proximity to the scenic reserve; and
- Consider the extent that the pools are compatible with the principal or primary purposes of the retention and preservation of the natural or scenic values (s19(2)(c)); and
- Have regard to the conservation of natural vegetation and features (s55(2)(d)).

In doing so, Council will need to undertake an Environmental Impact Assessment and consider the necessity of development on the Scenic Reserve.

The site (Part Section 2 Porirua DIST (parcel id 3929966) is zoned ***Open Space B*** under the Operative District Plan and is ***Sport and Active Recreation Zone under the*** Proposed District Plan

OPERATIVE DISTRICT PLAN (Open Space B)

The following activities are permitted within the Operative District Plan for Open Space B *‘The construction, alteration of and addition to buildings and structures, for recreation purposes, of less than 30m in floor area and less than 4m in height in Open Space B and Open Space C are Permitted Activities provided that they comply with the following conditions:*

PC37

17.1.10.1 The aggregate area of all structures must not exceed the total nett coverage of 200m per hectare.²

17.1.10.2 No structure may be located within 10 metres of a residential boundary.

17.1.10.3 No structure may be erected within 20m of a Conservation Site.

PROPOSED DISTRICT PLAN (Sport & Recreation Zone)

This zone permits a range of buildings and structures that are compatible with the purpose, character and amenity value of the zone while ensuring that an overall predominance of open space is retained.

Consideration needs to be given to whether;

- The development is consistent with the relevant reserve management plan for the site.
- The building or structure supports or is ancillary to recreation activities, or there is a functional need for a location at that site;
- The siting, design and external appearance of the buildings and structures is compatible with the area in which they will be located;
- Streetscape amenity will be maintained or enhanced;
- There are opportunities to locate or cluster buildings to minimise the loss of spaciousness;
- Building design maximises opportunities for multi-functional recreational use;
- Hard surfacing is minimised, and indigenous vegetation and visually prominent trees are retained where practicable; and
- Public accessibility will be maintained or enhanced, including through connections to

walkways, cycleways and pedestrian access points.

Key aspects of this zoning relative to future activity on the site are as follows;

- Taranaki Whānui and Ngāti Toa Rangatira are acknowledged as the mana whenua of Te Whanganui ā Tara (Wellington). Their cultural associations with and role in exercising kaitiakitanga over Wellington's parks and reserves are recognised and will require consultation in regards to proposed development.
- Commercial activity is permitted where it is located within an existing building, and no more than 50m2 of the building is utilised, or in a mobile structure or vehicle.

The following planning restrictions apply to buildings within the Sport and recreation zone. Buildings are permitted where;

- Maximum Building Height does not exceed10 metres
- All parts of a building or structure shall be contained within a 45 degree plane commencing at a point 2.5m above ground level inclined inwards at right angles in plan from all parts of the site's boundaries that abut a Residential or Future Urban Zone
- Each individual building and /or structure on a site, including any external alterations or additions, must not exceed a maximum gross floor area of 300m2.
- Maximum building coverage is 30%.

COMMENTARY

The rules above are unlikely to affect proposed future development on the site, however a Resource Consent will likely be required. As noted earlier in the report, there may be a need to build up the concourse level to mitigate flood risk. The height of the buildup may necessitate the need for imported fill and an earthworks consent.

Parking will be an important issue requiring consideration on the site. There is no requirement to provide a minimum number of on-site carparks for any activity or development in Wellington. Regardless, the nature of the site means that onsite parking is not possible.

Current street parking in Woodmancote Road serves both the existing pool and as a gateway to the Skyline walking track and Mount Kaukau. There are 42 standard parks and 2 accessible parks currently provided. The negative parking effects on neighbouring residential properties in Woodmancote Road will need to be considered if the level of service in any new development is to be increased.

6. SUN and WIND ANALYSIS

An analysis of wind and sun shading was undertaken. The purpose of this investigation is to identify at a detailed level the most desirable locations on the current site to inform future development.

A detailed site topographical survey has been undertaken by Adamson and Shaw. This survey identifies the height and extent of the existing tree canopy to allow the sun shading analysis to be undertaken.

SUN SHADING ANALYSIS

The sun shade analysis considers the typical opening period of the current facility, from October through to April. Four times of day are considered (9am, Midday, 3pm and 6pm) over this period.

Key Findings of the Sun Study

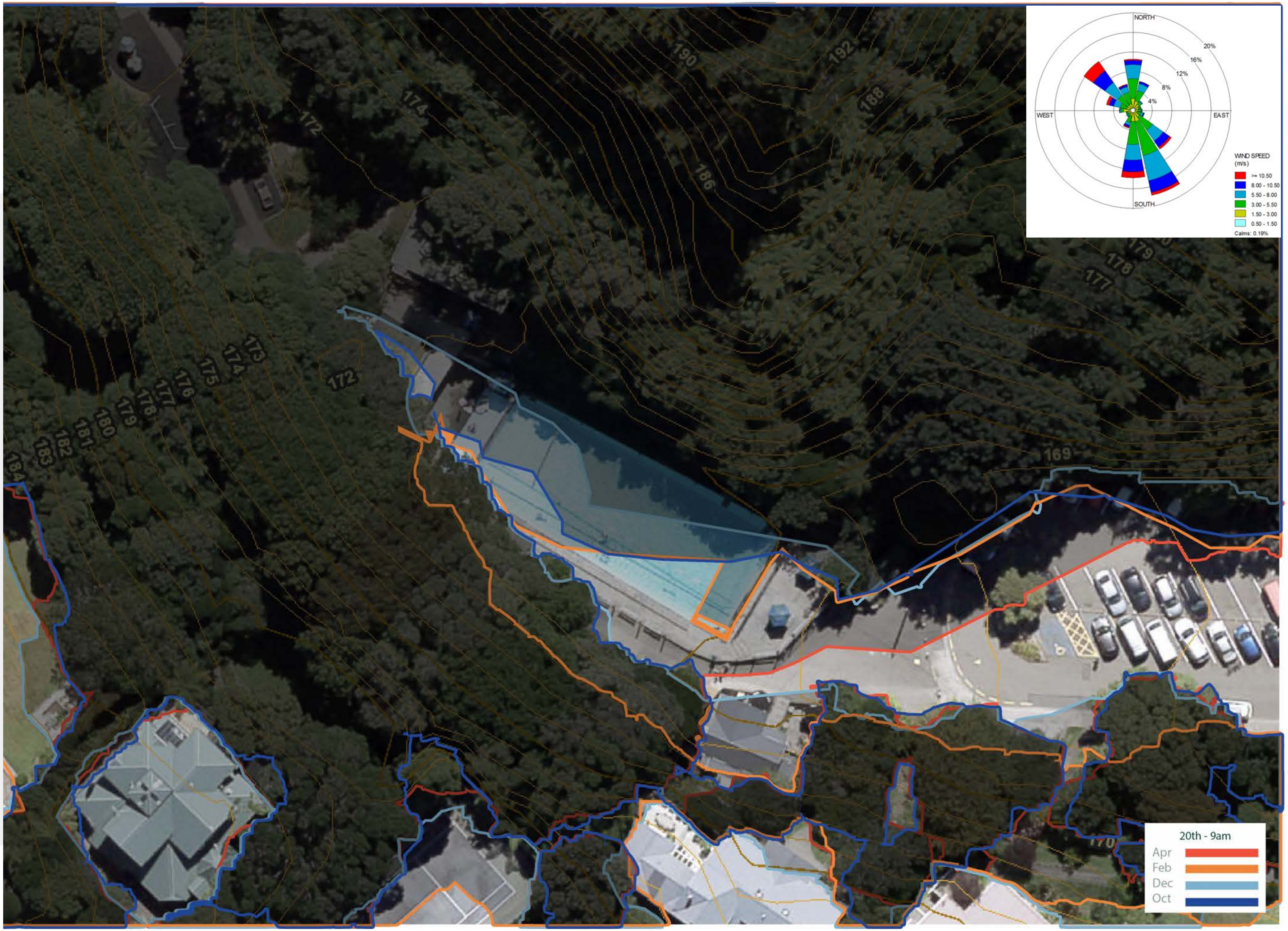
- At 9am in the morning, the site is fully shaded in April, heavily shaded in October and February (60-70% coverage) and only partially shaded in December (approximately 25% shaded)
- At midday, the site is approximately 90% shaded in April, and only minimally shaded (approx 15-20%) in the period between October and February.
- At 3pm in the afternoon, the site is partially shaded in April (approximately 30%), and sunny for the remainder of the period between October and February.
- At 6pm, the site is fully shaded in the period between October and April.

The most desirable position on the site to attract sun is the southern and eastern corners, adjacent to the existing carpark. Consideration could be given to cutting back some of the existing trees to reduce shading and limit leaves and other detritus from affecting pool filtration, noting that this will be an ongoing maintenance issue.

WIND ANALYSIS

A NIWA wind rose included on the plans that follow identify the orientation and strength of the wind. Unsurprisingly, the predominant (and stronger) wind directions are from the North-West and South-East directions.

The valley currently funnels the North-West wind. New development should consider wind screening or the position of new buildings to provide wind protection. Neighbouring houses and planting to the south of the site provide good wind protection from this direction.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SOUTH
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8%
12%
16%
20%
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5.50 - 8.00
3.00 - 5.50
1.50 - 3.00
0.50 - 1.50
Calms: 0.19%
20th - 9am
Apr
Feb
Dec
Oct

NORTH
WEST
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SOUTH
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12%
16%
20%
WIND SPEED (m/s)
>= 10.50
8.00 - 10.50
5.50 - 8.00
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Calms: 0.19%
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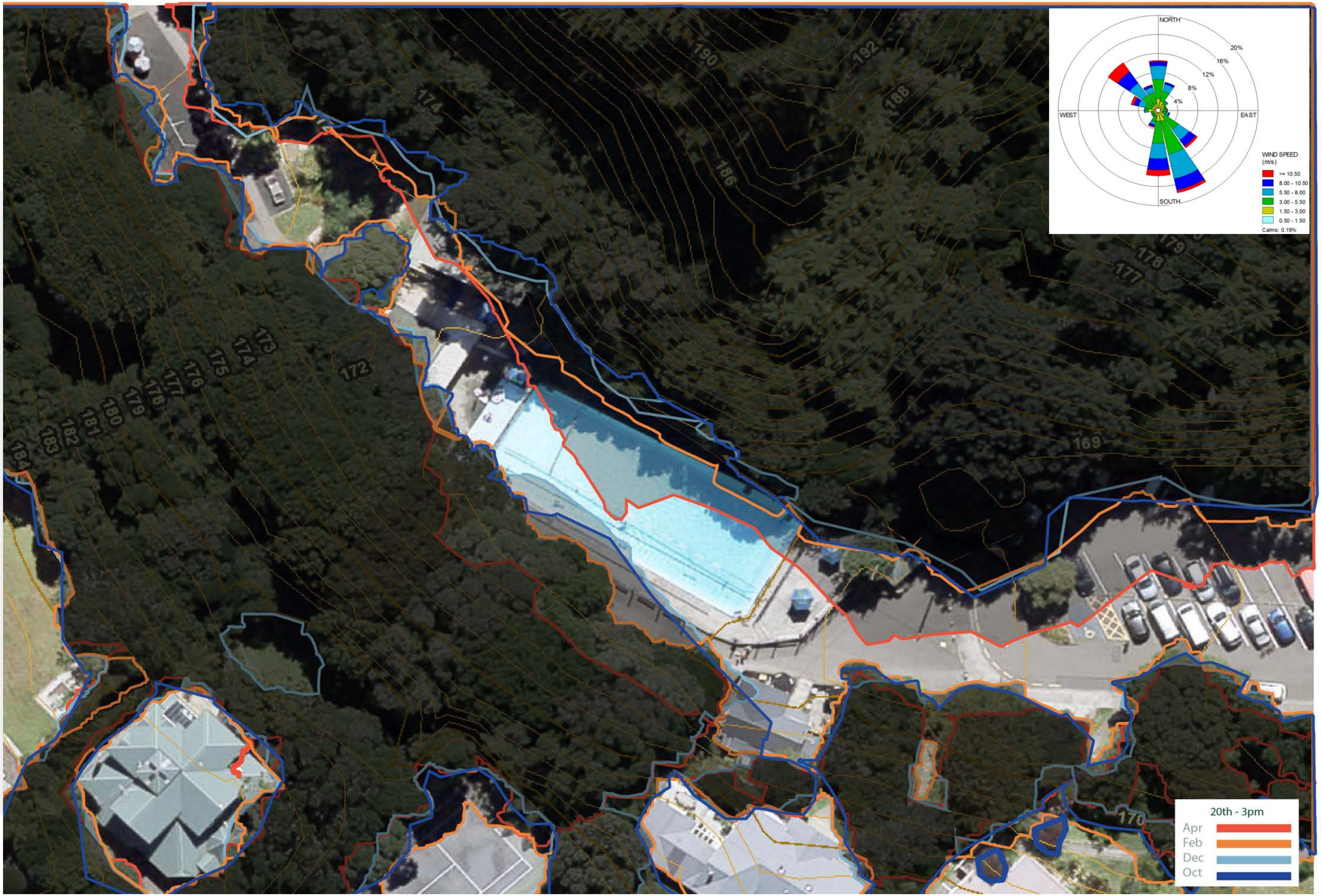

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WIND SPEED
(m/s)
>= 10.50
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5.50 - 8.00
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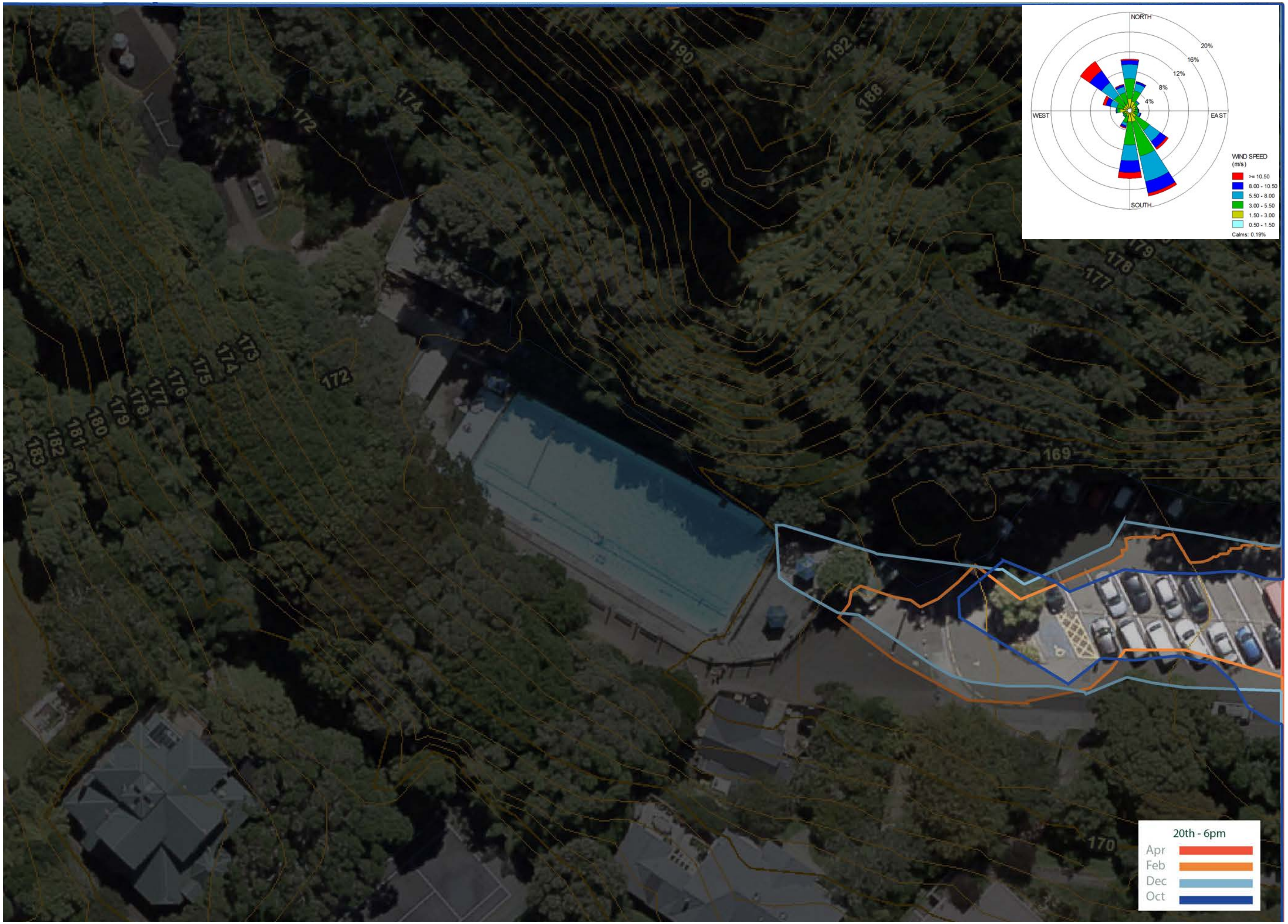

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8%
4%
WIND SPEED
(m/s)
>= 10.50
8.00 - 10.50
5.50 - 8.00
3.00 - 5.50
1.50 - 3.00
0.50 - 1.50
Calms: 0.19%
20th - 6pm
Apr
Feb
Dec
Oct

7. SITE INFRASTRUCTURE

Existing site infrastructure has been reviewed, and its suitability for a new pool facility evaluated.

Electrical Infrastructure
Khandallah Pool is located at the end of the network feed from the street and more than 400m from the transformer. A limited supply of approximately 3-phase 100 amps can be supplied to the site. This will limit the amount of water/pool heating that can be achieved through an air sourced heat-pump. This means only small sized pools can be heated.

It is likely that a dedicated transformer with a capacity of 300 kVa would be required to service a pool site with heat pumps. Wellington Electricity have provided an estimate of between $400-500k to bring the 11kV cable in from closest supply in Box Hill.

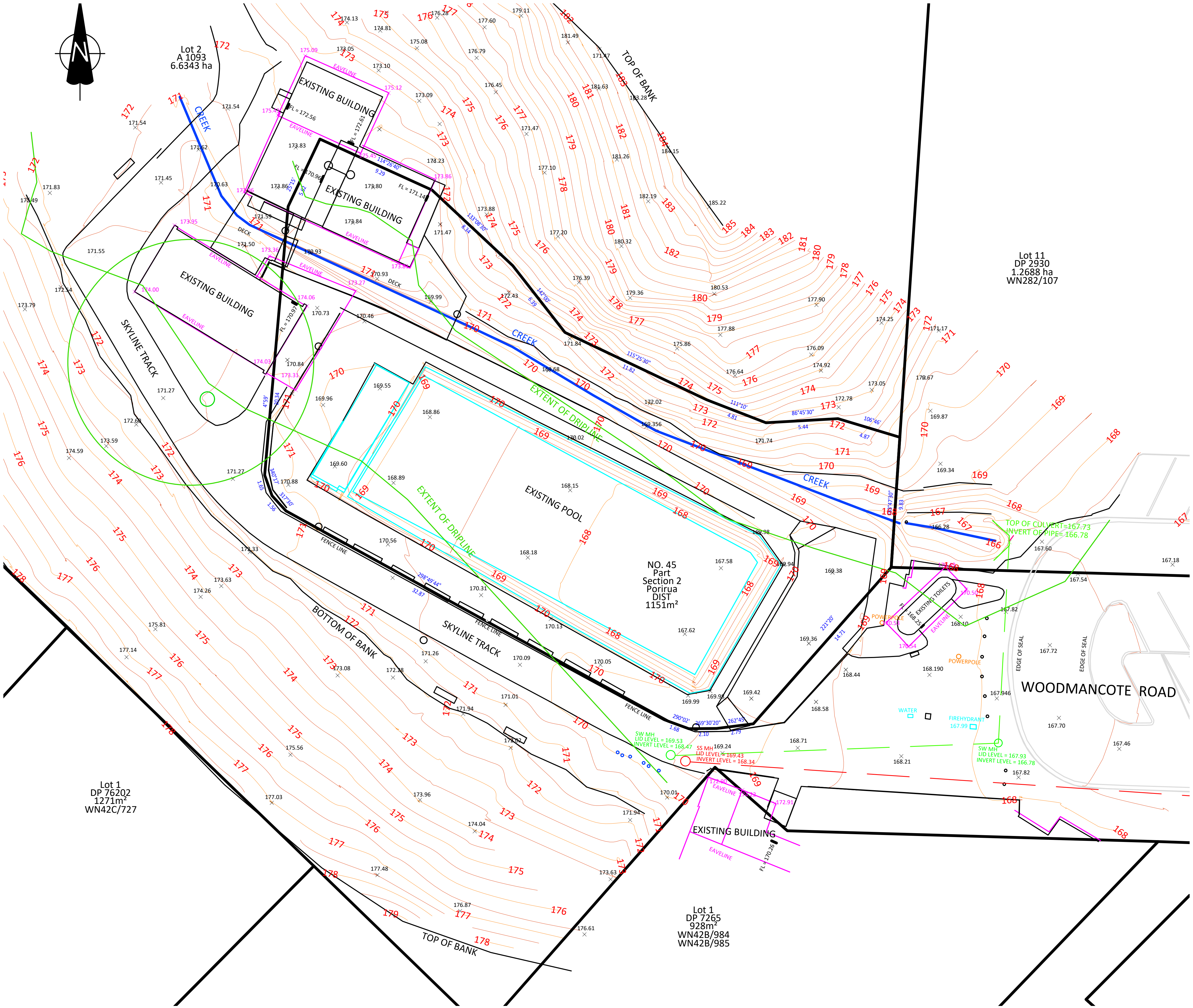
Water Infrastructure
There is an existing 100mm water main located in the carpark and will suffice for any development, which is adequate for filling of the pools.

Sewer Infrastructure
There is an existing gravity main located on the south east of the site, which is adequate for general operations. A maximum discharge flow will need to be determined which may be required for backwashing filters and draining pools. Attenuation tanks are likely to be required to manage flows. There is unlikely to be room for above ground tanks so below ground attenuation tanks (beneath carpark) are likely to cost anywhere from $100,000-$200,000. If a quicker discharge is required then a 2 week isolation period would be required to discharge to the stormwater system (stream). Provided chlorine has dissipated then discharge to the stormwater network is a permitted activity.

Stormwater infrastructure
While there is significant stormwater infrastructure onsite with existing streams flowing into a 900mm stormwater pipe, the flood modelling undertaken by Tonkin and Taylor has indicated the inadequacy of this capacity to deal with anticipated climate change rainfall scenarios.

APPENDICES

Topographical Survey
Tonkin & Taylor Flood Risk Assessment
Tonkin and Taylor Geotechnical Report



Project

TOPOGRAPHICAL SURVEY PLAN OF PART SECTION 2 PORIRUA DIST

Site

Local Authority: Wellington City Council

Physical Address: 45 Woodmancote Road

Client

Architecture HDT Ltd

NOTES:

1. LEVELS ARE IN TERMS OF AN ASSUMED DATUM 2016
2. BENCHMARK: OIS 1 DP20529 RL = 166.02
3. CONTOUR INTERVAL: MAJOR = 0.5m; MINOR = 1m
4. Open Space B OR Sport and Active Recreation Zone
5. UNLESS LEVELS ARE SHOWN AS BEING ON THE BOUNDARY THEY SHOULD NOT BE USED FOR DETERMINING THE CLEARANCES THROUGH SUNLIGHT ACCESS PLANES
6. ADDITIONAL BOUNDARY LEVELS MAY BE REQUIRED TO DETERMINE THE CLEARANCES FROM PROPOSED BUILDINGS TO SUNLIGHT ACCESS PLANES
5. DO NOT SCALE, PLEASE ASK!

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Date	Scale (A3 Original)	
23/11/22	1:300	
Project No	**Drawing No**	**Revision**
21455	TP - 01	

2 February 2023
Job No: 1089174.0001

Architecture Hdt Limited
1 Wright Street
Ahuriri
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Attention: Mark Bates

Dear Mark

Khandallah Pool Flood Risk Assessment

1 Introduction

The Khandallah Pool is near the end of its useful life, and it is being considered for renovation or redevelopment. The Tyers Stream, whose headwaters start from the catchment north of the Khandallah Pool and end at the harbour, flows beneath the pool deck and adjacent to the pool site. The stream poses a flood risk for the pool site, and it has been known to flood the site during large rain events. Tonkin & Taylor Ltd (T+T) have been asked to provide a flood risk assessment to inform future plans for the site.

This flood assessment includes a review of specific past flood events, identification of the required channel dimensions (area) to convey the 10% and 1% AEP + RCP 8.5 2090 climate change scenario including freeboard requirements per the Wellington Water Regional Standard for Water Services (December 2021, Version 3.0), and estimated flood level elevations on the upstream end of the pool site. Other risk factors are also described in further detail below.

2 Existing site and catchment

The Khandallah Pool opened in 1925 and comprises an outdoor unheated pool with limited landscaping and two buildings. The facility is located to the south of Khandallah park and is seasonally operated. The Tyers stream flows beneath a footbridge before continuing through the site beneath the pool deck and adjacent to the northern side of the pool structure. The footbridge and pool deck are the primary constraints for the stream's flow, and they are highly likely to fully block from local debris during large rain events causing water to flow outside of the stream/channel and into the pool site. The stormwater catchment and pool site are shown in Figure 2.1 and Figure 2.2. The photos and dimensions of the existing stream at the footbridge and at the pool deck are shown in Figure 2.3, Figure 2.4 and Table 2.1.

Figure 2.1 Khandallah pool stormwater catchment.

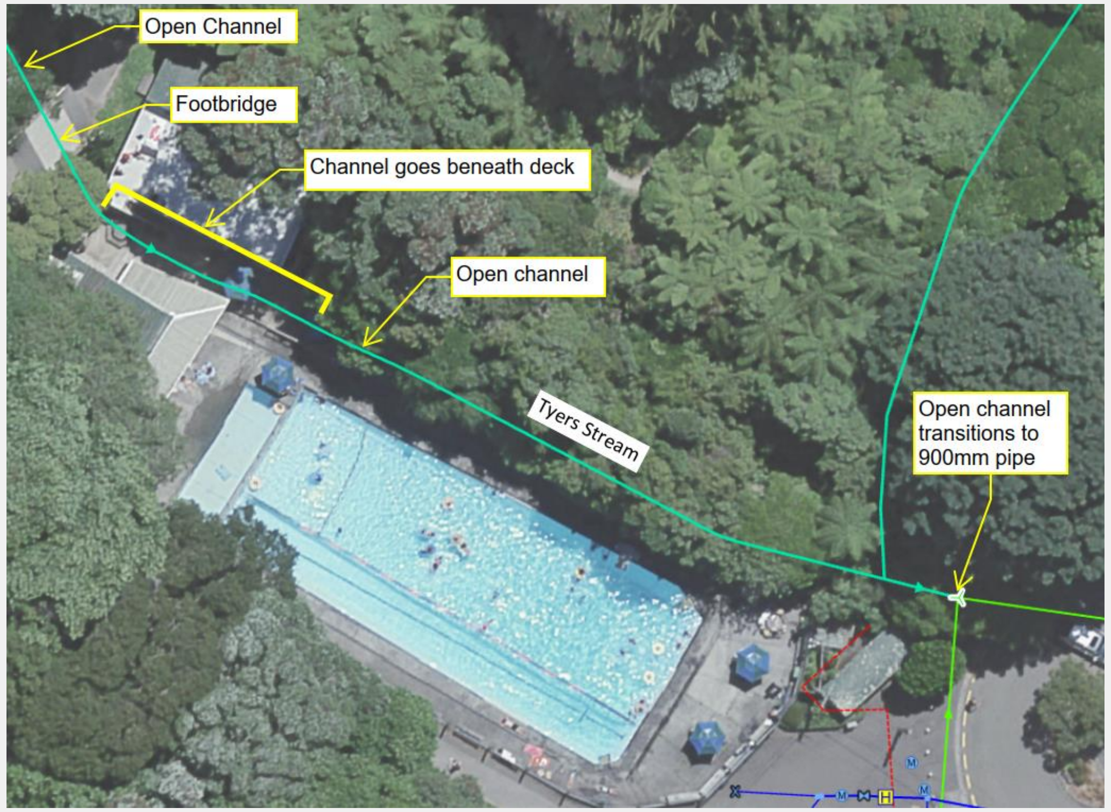

Figure 2.2 Plan view of Khandallah pool and site constraints.

Figure 2.3 Existing footbridge and Tyers Stream located to the west of the site.

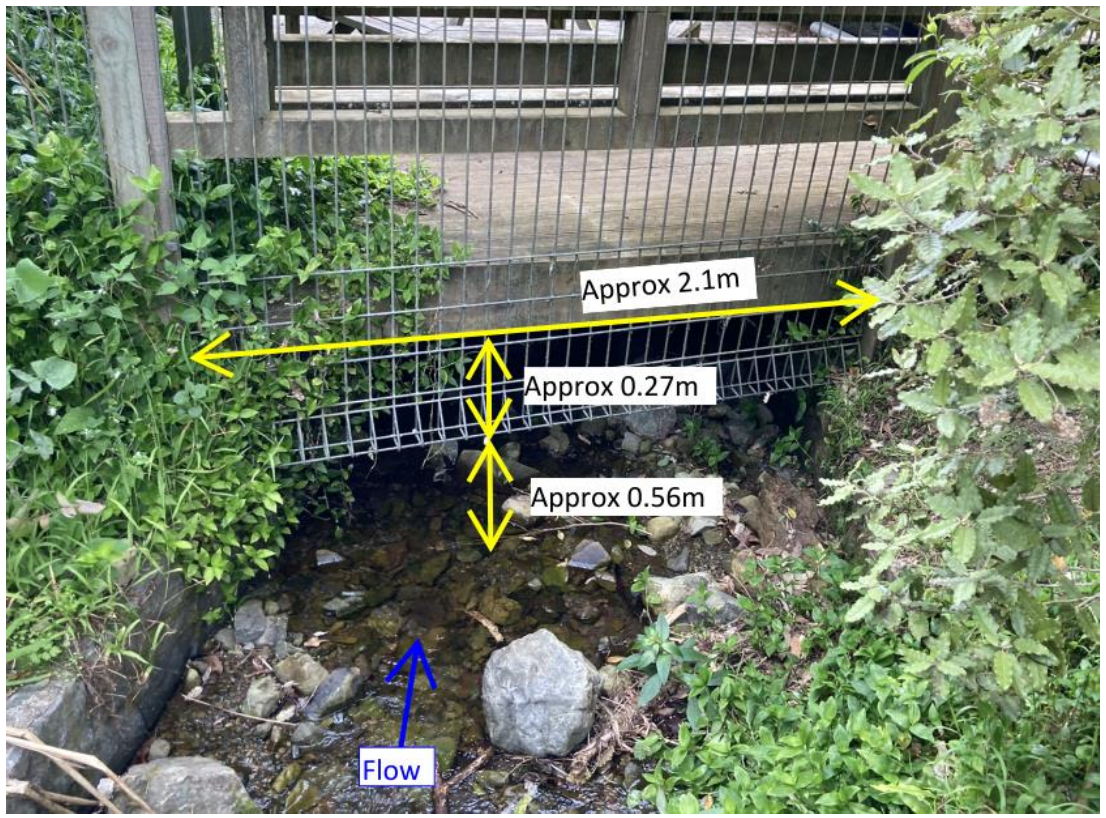

Figure 2.4 Tyers Stream where it flows beneath the pool deck.

Table 2.1 Tyers Stream dimensions

Stream location	Approximate dimensions
Beneath footbridge	2.7 m wide x 0.86 m tall = 2.32 m^2 area
Beneath pool deck (assuming 0% blockage of wire screen)	2.1 m wide x 0.83 m tall = 1.74 m^2 area
Beneath pool deck (assuming 100% blockage of wire screen)	2.1 m wide x 0.56 m tall = 1.18 m^2 area

3 Flood risk

3.1 Past flood events

The Tyers Stream catchment is approximately 60.6 hectares (as determined by Wellington Water) and has historically been the source of flooding of the pool site on multiple occasions as observed in 2016, 2017, and 2021. It is unknown when the pool has flooded on other occasions, however the rainfall depths associated with the known occurrences were researched using the Greater Water Environmental Data Dashboard to compare the rainfall depth and intensity with the publicly available HIRDS (High Intensity Rainfall Design System) rainfall data. Based on this research, the observed flooding occurred approximately during present-day 20% AEP rain events. See Table 3.1 and Figure 3.1 to Figure 3.4 below for reference.

Table 3.1: Observed flooding rain events

Rain event date	Rain depth measured	Interval (and time of day)	Closest AEP storm event*	Notes
12 Nov 2016	24.1 mm	1 hour (4:00)	20% AEP (26.2mm/hr)	Approx. 42 mm of rain had fallen the prior 48 hours (ground saturation), and approx. 38.7 mm of rain fell the following 15 hours
5 April 2017 to 6 April 2017	87.8 mm	24 hours (17:00 – 16:00)	20% AEP (97mm/24hr)	Approx. 42 mm of rain had fallen the prior 68 hours (ground saturation)
17 July 2021	24.5 mm	1 Hour (15:00)	20% AEP (26.2mm/hr)	Approx. 42 mm of rain had fallen the prior 24 hours (ground saturation)

*HIRDS rainfall data from the Khandallah Library Rain Gauge was used.

Figure 3.1 Khandallah pool flooding, photo uploaded to Facebook on 15 Nov 2016, photo by Maatten Holl.

Figure 3.2 Flooding at the Khandallah Pool 06 April 2017. Photo copyright Marty Melville.

Figure 3.3 Flooding aftermath at the Khandallah Pool, photo published on Facebook 18 July 2021 by Diane Calvert.

Figure 3.4 Flooding aftermath upstream of the Khandallah Pool, photo published on Facebook 18 July 2021 by Diane Calvert.

3.2 Modelled flood risk – Wellington Water

Wellington Water have developed flood hazard maps for the Wellington City region, and flood hazard data for the Khandallah Pool site were provided upon request by the Wellington Water modelling team for the present-day 10% AEP rain event and the 1% AEP + 20% climate scenario (the 20% increase to rainfall depth accounts for climate change as per the Wellington Water Reference Guide for Design Storm Hydrology). The following data was provided by Wellington Water:

Table 3.2: Modelling data provided by Wellington Water

Wellington Water modelling data					Reference information	
Rain event	**Flow**	**Velocity**	**Assumed stream/channel area required****	**Flood level elevation (northwest end of pool site)**	**Existing stream/channel at pool deck**	**Existing ground level (northwest end of pool site)**
10% AEP	3.2 m^3/s	N/A*	N/A*	N/A*	1.18 m^2 (assuming 100% blockage of wire screen)	Approx 171 m based on contour mapping
1% AEP + 20% climate change	10 m^3/s	0.5 m/s	20 m^2	171.8 m aMSL (above average mean sea level)		

*Modelled flows for the 10% AEP did not result in flooding of the pool site.

**Based on the equation Flow = Area x Velocity.

3.2.1 Modelled 10% AEP rain event

Wellington Water's model results did not show flooding at the pool site for the 10% AEP rain event, despite the observed flooding events (as described in section 3.1) occurring during approximately 20% AEP rain events. This discrepancy is due to their model not taking into account the stream constraints at the footbridge and where it flows beneath the pool deck at the northwest end of the pool. Rather, the model determined that the stream transition into the 900 mm pipe at the pool parking causes flooding of the pool parking lot (rather than the pool site), as shown by the overtopping and overland flow in Figure 3.5 below. It can be inferred from the Wellington Water model that if the constraints on the northwest end of the pool were non-existent, the Tyers stream may have sufficient capacity for the 10% AEP rain event until it transitions into the piped network at the pool parking lot (where spillover and overland flow occurs at a level lower than the pool infrastructure). However, the recent flooding history demonstrates that the upstream constraints and debris within the channel do appear to cause flooding in at least a 20% AEP rain event and potentially during more frequent rain events.

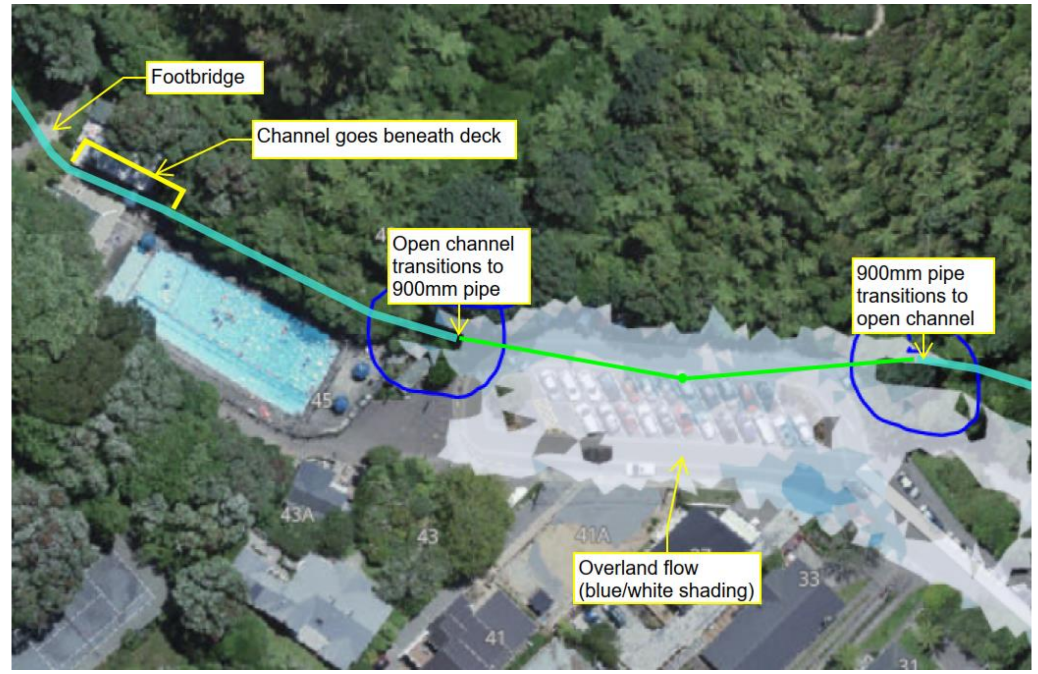

Figure 3.5 Wellington Water model results for the present-day 10% AEP rain event, provided by Wellington Water and marked up by T+T.

3.2.2 Modelled 1% AEP + 20% climate change rain event

Wellington Water's model results show that the 1% AEP + 20% climate change rain event would cause significant flooding of the pool site. Figure 3.6 below shows the flooding extents for a 1% AEP + 20% climate change based on Wellington Water's model.

Similar to the model results for the 10% AEP event, the stream constraints of the footbridge and where it flows beneath the pool deck are not incorporated into the model. However, the extent of the flooding that would occur during a 1% AEP + 20% rain event would be large enough that incorporating the constraints into the model may not provide a significant change to the resulting flood elevation level. As such, Wellington Water have confirmed that the modelled flood elevation level for this rain event (171.8 m aMSL at the northwest end of the pool site) may be used when determining required flood elevations for potential future site development, along with the appropriate freeboard (covered in section 4). This flood level is approximately 0.8 m higher than the existing ground elevation, assuming an approximate 171 m aMSL pool deck elevation based on available contour mapping.

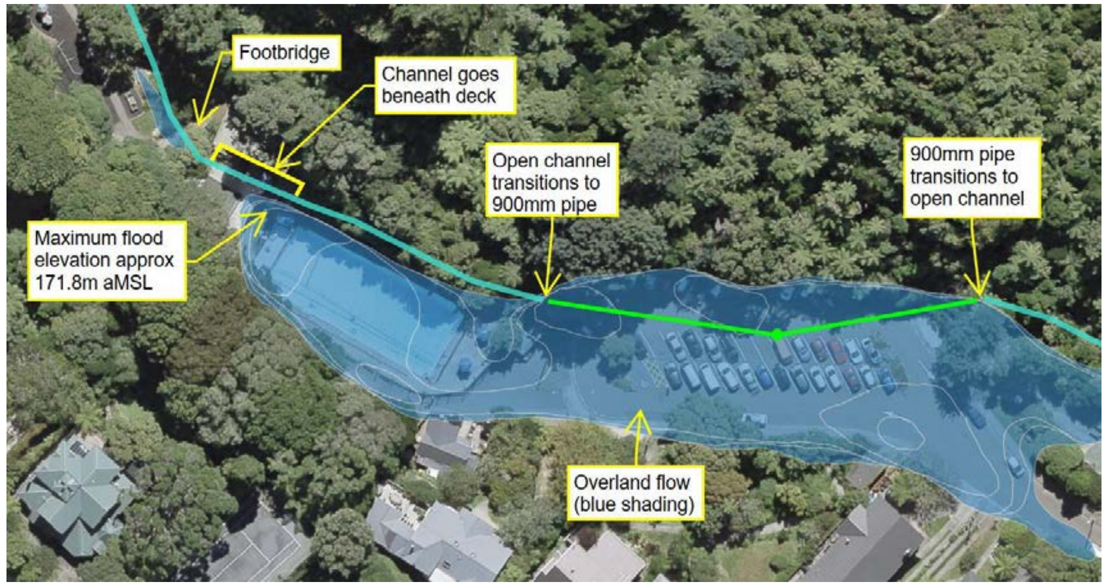

Figure 3.6 Flood Hazard Modelling completed by Wellington Water for the 1% AEP rain event + 20% rainfall depth for climate change, sourced from publicly available flood hazard mapping. Graphic marked up by T+T.

3.3 Modelled flood risk by T+T

T+T developed a separate model to compare climate change methodologies for the 1% AEP rain event. Wellington Water's model increased rainfall depths by 20% to account for climate change, whereas the T+T methodology uses the RCP 8.5 scenario. The RCP 8.5 is considered a 'worst case scenario' for the greenhouse gas concentration and associated climate impacts if current-day trends were to continue, and NIWA (National Institute of Water and Atmospheric Research) provides estimated RCP 8.5 rainfall intensities for future AEP rain events for the periods 2031-2050 and 2081-2100. For T+T's modelling exercise, the 1% AEP RCP 8.5 scenario for the more conservative period 2081-2100 was used to account for climate change using HEC-HMS and Openflows Flowmaster modelling software.

First, a HEC-HMS model was developed using rainfall data available on NIWA's HIRDS site. The catchment and parameters for the model were then developed in accordance with the Wellington Water Reference Guide for Design Storm Hydrology. The catchment size was determined to be 60.76 hectares, which is similar to what Wellington Water's model used (60.6 hectares), and the HEC-HMS modelling calculated stream flows for the rain event. Openflows Flowmaster was then used to calculate the flow velocity and maximum flood level elevation at the Khandallah Pool catchment. Lidar was used for the catchment surface data, and the pool constraints to the northwest (where the stream flows beneath the footbridge and pool deck) were not incorporated in order to compare with the Wellington Water model. See Figure 3.7 and Figure 3.8 for a cross-sectional view of the assessed portion of the pool site.

Figure 3.7 HEC-HMS model cross-section location.

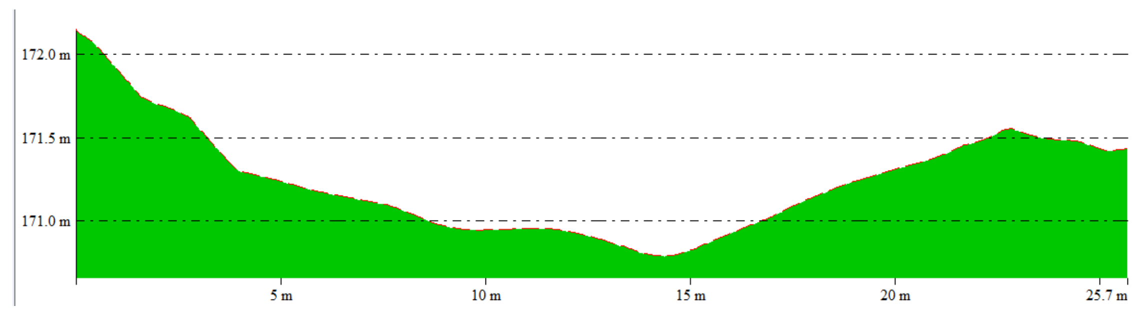

Figure 3.8 HEC-HMS model cross-section (looking downstream). Note, the topography is shown in green based on lidar, which has limited accuracy. The pool deck or buildings have not been incorporated in the model as a constraint in order to compare with Wellington Water's model results.

The main purpose for this modelling exercise was to compare climate change methodologies, and it was anticipated that the RCP 8.5 scenario would yield a more conservative result. However, the results showed that Wellington Water's model provided more conservative values for stream flow and flood elevation level based on their climate change methodology (adding 20% to rainfall depths). Accordingly, the Wellington Water data has been used for the flood assessment at this site and will form the basis for determining first floor elevations for any future development. For informational purposes, T+T's model results are summarised in Table 3.2 below but will not be used for this flood assessment.

Table 3.3: T+T Modelling results

T+T Modelling data					Reference Information	
Rain event	**Flow**	**Velocity**	**Assumed stream/channel area required****	**Flood level elevation (northwest end of pool site)**	**Existing stream/channel area at pool deck**	**Existing ground level (northwest end of pool site)**
1% AEP + RCP 8.5 2081-2100	9.56 m^3/s	1.6 m/s	6.0 m^2	171.48 m	1.18 m^2 (assuming 100% blockage of wire screen)	Approx 171 m

**Based on the equation Flow = Area x Velocity.

3.4 Summary of modelling results

In summary, the observed flooding of the pool site indicates that flooding occurs with at least the present-day 20% AEP rain events, and possibly more frequently. Flood model results were obtained from Wellington Water for both the present-day 10% AEP and 1% AEP + 20% climate change rain events.

The Wellington Water results for the 10% AEP event did not show flooding of the pool site, likely due to their model not incorporating the existing site constraints such as the footbridge and the channel going beneath the deck to the northwest of the site. This may indicate that the constraints are the primary reason for the observed pool site flooding during smaller rain events, and that the existing stream dimensions (as measured from lidar) are sufficient to accommodate flows during this rain event (assuming no blockage of the stream occurs due to debris, land slips, etc).

The results for the 1% AEP (+ 20% climate change) rain event yielded a flood elevation level of 171.8 m aMSL at the northwest end of the pool site, and Wellington Water recommends this flood level be used with the appropriate freeboard to determine first floor elevations for any potential future development. Despite the existing stream constraints (flowing beneath the footbridge and pool deck) being absent from the model, the extent of the flooding would be large enough that including the constraints into the model would not significantly change the flood results. The stream requires an assumed area of 20 m^2 to accommodate the modelled flows for this rain event (based on the equation Flow = Area x Velocity, rather than manning's equation due to lack of survey information). The existing stream/channel at the pool deck constraint has an area of only approximately 1.82 m^2 (assuming 100% blockage of the wire screen).

T+T's model was developed using HEC-HMS and Openflows Flowmaster for the 1% AEP + RCP 8.5 climate change scenario in order to compare results with Wellington Water's model which utilised a different approach to incorporating climate change (by adding 20% to the rainfall depths). It was originally anticipated that the RCP 8.5 scenario would yield more conservative values than Wellington Water's methodology. However, the result showed that Wellington Water's model results were more conservative than T+T's, and so their data will be relied upon for this flood assessment.

4 Conclusion and considerations

Short-term flood risk

Flooding has been observed during present-day 20% AEP rain events and may occur during more frequent rain events. Flood risk is greatest where there is a greater chance for debris (such as tree

branches, logs, etc) to collect and block stream flows. Removing or mitigating these potential obstructions would reduce flood risk for the existing stream channel. If the Tyers stream restrictions are removed (such as where it flows beneath the pool deck), then there is an opportunity that the stream may have sufficient capacity to control flood risk up to the present-day 10% AEP rain event. Because lidar-based models were used and did not fully incorporate the existing stream dimensions or restrictions, the stream capacity needs to be modelled using more accurate survey once a preferred development option is selected for the pool site.

Some considerations for addressing the short-term flood risk include:

- Acceptance of this risk (make no improvements to the channel capacity or overland flow path). Depending on the preferred development option, this may not be viable.
- Increase stream capacity by removing constraints such as the pool deck and footbridge and/or enlarging the stream channel (by deepening or widening) to manage up to the 10% AEP rain event.

Long-term flood risk

Regarding long-term risk, rain events above the 10% AEP and beyond the 1% AEP rain event + climate change will cause significant flooding to the site. These events are less frequent but can inundate the pool site with overland flows. However, designing the stream to accommodate the full capacity of these events may not be a viable use of the site as a significant area would be required. Rather, a practical solution would be to design the site so that flooding events do minimal or no damage for future developments while allowing for easy clean-up for the leftover sediment and debris.

Here are some considerations for addressing long-term flood risk:

- Acceptance of this risk (make no improvements to the channel capacity or overland flow path). Depending on the preferred development option, this may not be viable.
- Design the site so that flooding would cause minimal damage and can be cleaned relatively easily. For example, using materials that are resilient to flood damage (such as concrete) and placing important structures or facilities on higher ground away from the stream.
- Raising or protecting structures against stream flows and overland flow paths.

General considerations

Based on the observed pool floodings and flood model results, there are several general considerations for any potential future site development option:

- Any preferred development or renovation option should consider the removal of the footbridge and deck to reduce blockage risk, as well as upgrading the channel as needed so it has capacity for the 10% AEP rain event (or some other specified design event that can be practically achieved).
- Regrade the site so that is sloped towards the existing stream, which would help guide overland flows towards the stream and create areas of higher ground that can be utilised for important facilities or structures. This may not be viable for every development option.
- During large rain events, debris may accumulate at other locations in the open channel portion of the stream along the northern end of the pool site. This may be caused by foliage that collects along the hillside slope or a land slip. Solutions may include a debris trap, relocating the stream away from the hillside, maintaining regular maintenance to clean out any accumulating debris, deepening the stream/channel, or raising the walls of the channel along the north side of the pool.

- The flood water level elevation for a 1% AEP + 20% climate change event is 171.8 m aMSL at the northwest end of the pool site (as modelled by Wellington Water). As per the Wellington Water Regional Standard for Water Services section 4.2.8, the minimum freeboard measured from the top of the peak flood water level to the building platform or underside of floor joists/structural concrete slab of the building are summarised in Table 4.1 below.

Table 4.1 Minimum freeboard requirements

Type of structure	Freeboard allowance
Habitable building floors	0.5 m
Commercial and industrial buildings	0.3 m
All other buildings	0.2 m
Open channels and streams	0.5 m
Vehicle bridges	0.6 m

5 Next steps

The following next steps have been identified:

1 T+T to provide hydraulic advice to inform the master planning of the development.

2 Because this flood assessment was largely based on lidar-based modelling, further design investigations (such as site survey) will be required to determine accurate dimensions of the stream channel including slope, configuration of the channel, and channel type.

3 Once a preferred development option is selected, additional steps may be identified.

6 Applicability

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

Tonkin & Taylor Ltd

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2-Feb-23
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Tonkin+Taylor

27 January 2023
Job No: 1089174.0001

Architecture HDT Ltd
Level 2, The Woolstore Building
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Attention: Mark Bates

Dear Mark

Khandallah Pool Redevelopment
Geotechnical Assessment Report

1 Introduction

This report presents the geotechnical assessment for the proposed Khandallah Pool redevelopment, located at 45 Woodmancote Road in Khandallah, Wellington (the Site). This work was undertaken by Tonkin & Taylor Ltd (T+T) at the request of Architecture HDT Ltd (AHDT), in accordance with our letter of engagement[1].

This report forms part of the project feasibility stage for the proposed redevelopment and presents the following. This report does not include assessment of any existing structures at the Site.

- A summary of the site investigation undertaken to inform the likely soil/rock profile and the site seismic subsoil class in terms of NZS1170.5:2004.
- Potential for liquefaction at the Site and associated geotechnical consequences.
- Potential for other geotechnical hazards at the Site.
- An outline of possible foundation options for single storey, light-weight structures.

2 Proposed redevelopment

We understand that three options are being considered for the proposed redevelopment at the Site:

a Maintain level of service: replacement of existing buildings and maintenance of the pool.
b Enhanced level of services: replacement of the existing buildings and a complete redevelopment of the pool area.
c Changed type of service: removal of the existing facility including demolition of existing buildings and provision of a landscaped park with ancillary structures.

[1] T+T (19 August 2022). Letter of Engagement. *Proposal for Engineering Services. Khandallah Pool Redevelopment.* (T+T ref: 1089174.0001, Rev 1).

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3 Assessment and interpretation of site conditions

Depths reported in this section are measured from the current ground surface. Site plans and geological cross-sections (Figures A1 to A4) are included in **Appendix A.** These show the Site location, geotechnical investigations and other geological information discussed in this section.

3.1 Site description

Conclusion	Information reviewed
• The Site is located at 45 Woodmancote Road, Khandallah, Wellington. • The Site extends across two land parcels described as: a. Part Section 2 Porirua DIST, approx. 1150 m² (contains majority of the Site). b. Part Lot 2 A 1093, approx. 66500 m². • The Site is currently occupied by an outdoor swimming pool (approx. 13 m x 34 m) and two single-storey buildings containing: office, plantroom, and changing rooms. • The Site is located in a valley bound by steep slopes to the north and moderately steep slopes to the south. The valley floor gently slopes down from the northwest, i.e. from Khandallah Park Children's Playground, but the Site has been filled and is relatively flat. • The Waitohi Stream (stream) extends along the valley floor to between the pool area and the northern slopes, and into a piped system further east of the Site. • Several walkways extends across the valley floor and sides.	• Aerial photograph, Contours, Property details (refer Figures A1 and A2 in **Appendix A** for source information. • LiDAR data sourced from LINZ data service. • Elevations are reported in terms of the New Zealand Vertical Datum, (NZVD2016).

3.2 Geotechnical investigations

There is no previous geotechnical data available at or near the Site in the public domain or T+T database. Accordingly, T+T undertook the following site-specific geotechnical investigations in November 2022:

- In the pool area: two boreholes (BH01 and BH02) into rock, up to a maximum depth of 10 m.
- On the northern slopes: six window sampler boreholes with accompanying handheld shear-vane testing (in fine-grained soils) and scala penetrometer testing (WS/SC01 to WS/SC06). One additional scala penetrometer test (SC07) was undertaken. All investigations refused within rock, at a maximum depth of 2.6 m.
- Standpipe piezometers (for groundwater monitoring) were installed in BH01, BH02 and WS01. Level loggers (for continuous monitoring) were installed in BH01 and BH02.

Investigation logs and groundwater monitoring records are included in **Appendix B.**

3.3 Ground and groundwater conditions

Conclusion	Information reviewed
• The inferred soil profile at the Site is presented below in **Table 3-1** (the pool area) and **Table 3-2** (the northern slopes). Also refer geological cross-sections presented on Figures A3 and A4 in **Appendix A.** • Groundwater level considered in this assessment: – Monitoring data indicates the groundwater level dipping southeast, along the valley floor. – The groundwater level appears to dip away from the stream i.e. groundwater level is elevated at the stream. – Monitoring data at BH01 indicates that the groundwater level increases by 1.2m when the pool is full of water, compared to when the pool is empty. – Groundwater was not encountered on the northern slopes. The groundwater level is inferred to be just below the depth of investigation (approx. soil-rock interface).	• 1:50,000 geological map 22 (Begg, J.G.; Mazengarb, C., 1996). • T+T's recent geotechnical investigation (November 2022), refer **Section 3.2**.

Table 3-1: Inferred soil profile at the pool area (on valley floor)

Layer no.	Geological unit and description	Depth to top of layer (m)	Layer thickness (m)	SPT 'N' value
P1	Fill[1] (non-engineered) Sandy or clayey SILT, with some gravel and cobble- to boulder-sized fragments of rock, brick and concrete. Silt has variable plasticity. Layer has variable density/strength.	0	1.6	Not tested.
P2	Alluvium Sandy SILT and GRAVEL, with some cobbles and boulders. Medium dense to dense. Silt has low to moderate plasticity.	1.6	0.8 to 2.4	25 to 31
P3	Bedrock[2] SANDSTONE (Greywacke). Highly to moderately weathered or better. Typically weak to moderately strong.	2.4 to 4	Proven 6 m	50+

Note 1: Service clearance extended through most of the fill layer. Descriptions are based on observations of the side walls of service clearance pits.

Note 2: Shear zones were found in BH01 and BH02.

Table 3-2: Inferred soil profile on the northern slopes (on side of valley)

Layer no.	Geological unit and description	Depth to top of layer (m)	Layer thickness (m)	Scala testing (blows/50mm)	Su[1] (kPa), peak/residual
S1	Fill (non-engineered) Forms walkways/tracks. Inferred to comprise mixed, loose granular and cohesive material. Not investigated/tested.	0	0 to 1	Not tested.	Not tested.
S2	Topsoil Sandy SILT, trace rootlets. Firm to stiff. Low plasticity. Local peat, very soft to soft.	0	0 to 0.5 *(typ. 0.1)*	0.3 to 4 *(typ. 0.5 to 2)*	69/13
S3[2]	Undifferentiated colluvium and residual soil SILT with some sand. Stiff to very stiff. Low plasticity. Locally firm to stiff.	0 to 0.5 *(typ. 0.1)*	0 to 1.7 *(typ. 1.5)*	0.3 to 10 *(typ. 1 to 3)*	108 to 197/ 16 to 46
S4	Bedrock SANDSTONE (Greywacke).	See below.			
a	Completely weathered, very weak.	0.6 to 2.2 *(typ. 1 to 2)*	0 to 0.4 *(typ. 0.2)*	8+	N/A
b	Highly weathered, weak or better.	0.2 to 2.4 *(typ. 1 to 2)*	Proven 0.2 m	Not tested.	N/A

Note 1: Su = undrained shear strength tested within fine-grained soils using a handheld shear vane.

Note 2: Medium dense to dense SAND and GRAVEL encountered at WS03 (approx. 0.6 m to 1.1 m) and at WS06 (approx. 0.2 m to 0.6 m).

3.4 Active faults

Conclusion	Information reviewed
• The Wellington Fault lies approximately 2 km southeast of the Site. – Included in Table 3.6 of NZS 1170.5:2004 as a major fault requiring near fault factors when assessing structural design actions. • The Ohariu Fault lies approximately 3.3 km northwest of the Site. – Not considered a major fault according to NZS 1170.5:2004. • An inactive fault is located approx. 30 m west of the Site. It extends in a north-south direction across the valley (refer Figure A1 in **Appendix A**).	• GNS Online database of active faults. • NZS 1170.5:2004, Section 3.1.3.

3.5 Previous earthquakes

Conclusion	Information reviewed
The following recent earthquakes were felt at the Site: • Kaikoura Earthquake (14 November 2016 at 0.02am) Location: 15 km northeast of Culverden, approx. 230 km from Site Magnitude: M_L 7.8 Focal depth: 15 km Intensity felt at the Site: PGA 0.10g recorded at Newlands (Station: NEWS), approx. 3 km northeast of the Site. • Lake Grassmere Earthquake (16 August 2013 at 2.31pm) Location: Lake Grassmere, approx. 75 km from the Site Magnitude: M_L 6.5 Focal depth: 7 km Intensity felt at the Site: PGA 0.03g recorded at Newlands (Station: NEWS), approx. 3 km northeast of the Site. • Cook Straight Earthquake (21 July 2013 at 5.09pm) Location: Cook Straight, approx. 62 km from the Site Magnitude: M_L 6.5 Focal depth: 16 km Intensity felt at the Site: PGA 0.06g recorded at Newlands (Station: NEWS), approx. 3 km northeast of the Site. • There is no known evidence of ground damage at the Site as a consequence of these earthquakes.	• Earthquake magnitude source of data: http://geonet.org.nz/

4 Geotechnical engineering considerations

4.1 Seismic shaking hazard

4.1.1 Seismic site subsoil class

Conclusion	Information reviewed
• The site subsoil class is assessed to vary across the Site between *Class B (Rock site)* and *Class C (Shallow soil site),* based on depth to rockhead from boreholes. • Level of certainty in the above assessment is *high,* but the level of certainty for the demarcation between Class B and C is low. • We recommended that Class C should be adopted for structural design in the absence of further testing. If proved critical, further investigation/testing can be considered at building locations to prove Class B.	• Refer **Sections 3.2** (investigations) & **3.3** (inferred soil profile). • NZS 1170.5:2004, Section 3.1.3 and Table 3.6.

4.1.2 National Seismic Hazard Model

In October 2022, GNS Science released the revised National Seismic Hazard Model (NSHM)[2]. This represents the latest scientific knowledge in earthquake hazard and is an important input into managing earthquake risk in the built environment.

While the NSHM will inform future design standards, it does not provide information on shaking hazard which can be directly applied to design. This means that the current minimum compliance pathway with the Building Code has not changed[3]. However, important updates to Building Code

[2] Revised NSHM.

[3] Current relevant compliance documents to meet *Clause B1: Structure* of the Building Code are as shown in Verification Method B1/VM1. For structural seismic design this is *NZS 1170.5:2004 – Structural Design Actions Part 5: Earthquake Actions – New Zealand.* For geotechnical design, although not directly referenced in B1/VM1, the Section 175 MBIE/NZGS

compliance documents that will be informed by the NSHM are expected to be released in 2023 and 2025. These are expected to change the current "code minimum" shaking hazards that apply to the Site.

Our high-level assessment of the 2022 NSHM indicates that for the Site it is likely that code minimum seismic design loadings will **increase** in the updated compliance documents. This may not significantly change our liquefaction assessment (as the current ULS seismic design actions are insufficient to trigger liquefaction in potentially susceptible soils), but **it will affect structural design** of the buildings.

We note that any seismic hazard model carries an inherent amount of uncertainty, but more important than that is the uncertainty in what shaking the Site will actually be subject to during its design life. It all depends on which specific earthquake(s) will occur. Therefore, building designers are strongly encouraged to concentrate on resilient design practices rather than the specific code minimum demand.

4.1.3 Ground shaking hazard

The seismic hazard in terms of peak ground acceleration (PGA) and magnitude (M) for the Site has been assessed based on MBIE Module 1 (2021)[4] and NZS1170.5:2004[5]. **Table 4-1** below presents the return periods for earthquakes with various peak ground accelerations (PGA) with a corresponding earthquake magnitude (M).

Table 4-1: Ground shaking hazard at the Site

NZS 1170.5 Limit State	PGA (g)	Magnitude, M	Return period (years)
Serviceability limit state (SLS)	0.13	6.5	25
Ultimate limit state (ULS)	0.68	7.7	500

Note 1: PGA and magnitude have been assessed based on NZGS/MBIE Module 1 (2021): Method 1 for the following:

Building Design life	50 years - assumed. To be confirmed with structural engineer.
Building importance level	IL2 (NZS 1170.5:2004, Table 3.2). To be confirmed with structural engineer.
PGA and magnitude (M)	Table A1, MBIE Module 1 (2021): Method 1.

4.1.4 2022 NHSM and ground shaking hazard

It seems likely that the new national seismic hazard model will require design for greater seismic accelerations than the current codes. It therefore seems possible that buildings designed to current codes could end up being "viewed as under-designed" in terms of the new codes. As mitigation against this outcome, the geotechnical and structural design could be carried out for the 2022 NSHM PGA range shown in **Table 4-2** below.

Table 4-2: 2022 NSHM ground shaking hazard at the Site

NZS 1170.5 Limit State	PGA (g)	Magnitude, M	Return period (years)
Serviceability limit state (SLS)	0.11 to 0.16	-	25
Ultimate limit state (ULS)	0.85 to 0.91	-	500

Note 1: Average PGA values based on the 2022 NSHM online tool assumes a V_{s30} range of 300 m/s to 750 m/s.

guidance document *Earthquake Geotechnical Engineering Practice: Module 1 (November 2021)* is to be continued to be used for seismic design loadings.
[4] NZGS/MBIE. Earthquake geotechnical engineering practice. Module 1: Overview of the guidelines. November 2021.
[5] NZS1170.5:2004 New Zealand Standard Structural design actions, Part 5: Earthquake actions – New Zealand

It must be appreciated that we do not know what the exact design PGA figure would be in any forthcoming codes or guidance; however design for this higher PGA would provide much greater resilience than design for 0.68g (refer **Table 4-1**).

4.2 Liquefaction potential

The triggering of liquefaction, for each soil layer identified as being susceptible to liquefaction, has been assessed in accordance with the procedure of Idriss and Boulanger (2014)[6]. This method is based on empirical relationship with the SPT 'N' and fines content. SPT data from BH01 and BH02 (refer **Section 3.2**) have been assessed. Conclusions are summarised below in **Table 4-3**.

Table 4-3: Liquefaction potential at the pool area (on valley floor)

Layer no.	Geological unit	Conclusion
P1	Fill (non-engineered)	• No borehole data to assess liquefaction. • Above the groundwater level, the fill is not expected to liquefy. • Below groundwater level, the fill is expected to be weak/loose, and liquefaction is considered possible. This scenario is noted when the pool is full of water, i.e. with elevated groundwater level (refer **Section 3.3**).
P2	Alluvium	• Generally medium dense to dense SILT and GRAVEL: not expected to liquefy at ULS earthquake shaking reported in **Table 4-1** and **Table 4-2.**
P3	Bedrock	• N/A.

All soils (refer **Table 3-2**) on the northern slopes are located below the groundwater level. Accordingly, liquefaction is not expected within these soils.

4.3 Slope instability

4.3.1 Instability on the main slopes

Potential instability on the steep, vegetated northern slopes could negatively impact the proposed redevelopment downslope. A qualitative slope stability assessment identified three scenarios presented in **Table 4-4** below, and is illustrated on Figure C1 included in **Appendix C.** This assessment is based on the inferred soil profile presented in **Table 3-2** (northern slopes).

Table 4-4: Qualitative slope stability assessment of the slopes

Scenario	Comments
1. Translation, sliding failure within surficial soils (shallow surface slips) during a somewhat adverse rainfall event or a small earthquake event.	• Position buildings as far away from slope base as possible. • For buildings positioned at or close to the slope base, consequences could include routine clearing up and localised, impact damage to buildings. • For buildings positioned further away from slope base, consequences could include routine clearing up and minor (possibly cosmetic) damage to buildings.

[6] Boulanger, R.W and Idriss, I.M., 2014. CPT and SPT based liquefaction triggering procedures." Report No. UCD/CGM-14/01, Center for Geotechnical Modeling, Department of Civil and Environmental Engineering, University of California, Davis, CA, 134 pp.

2. Translational, sliding of surficial soils over rock during an adverse rainfall event or a moderate to large earthquake event.	• Position buildings as far away from slope base as possible. • For buildings positioned at or close to the slope base consequences could include more extensive clearing up compared to Scenario 1 above and impact damage to buildings. • For buildings positioned further away from slope base, consequences could include clearing up and localised, impact damage to buildings.
3. Deep-seated rock-mass failure during a significant regional earthquake event.	• Depends on the severity of the deep-seated failure but it can be expected that buildings close to slope will suffer extensive damage. Damage is likely to be less extensive further away from the slope base but could still be severe.

4.3.2 Instability along the Waitohi Stream

Based on the inferred soil profile presented in **Table 4-3**, the stream banks are expected to comprise fill and/or alluvium and are in the order of 0.5 m to 1 m high. Buildings located near the stream could be at risk of undermining in the event of instability of the stream banks. This instability could occur due to scouring along the stream sides and/or additional loading from new building foundations. Buildings should be sufficiently set back or suitable foundations considered in conjunction with the Geotechnical and Hydraulics engineer.

5 Geotechnical issues identified

Several geotechnical issues associated with the Site have been identified and are listed in **Table 5-1** below. These could impact the proposed redevelopment and should be considered in the location of new buildings, and foundation selection and design.

Table 5-1: Geotechnical issues identified

Issue	Comments
Founding capacity and static settlement	• Fill (Layer P1): due to the possible variable nature of these soils and placement quality, this layer is unlikely to be a reliable founding stratum. • Alluvium (Layer P2) and Rock (Layer P3) are likely reliable founding strata.
Instability on the northern slopes	• Refer **Section 4.3.1.**
Instability of the stream banks	• Refer **Section 4.3.2**.
Existing foundations	• Depending on type, can be an obstruction to future foundations. • Remove if shallow foundations.
Soil contamination	• The fill could contain contaminants (e.g. asbestos) requiring management during any excavation and offsite disposal. May need to be addressed as part of Resource Consent. For offsite disposal, receiving site likely to require laboratory testing to demonstrate the soils meet acceptance criteria.

6 Possible foundation options

Well-tied shallow pad/strip and raft foundations founded on the Alluvium or Rock (Layer P2 or P3) are considered appropriate for the proposed new single storey, light-weight structures buildings at the Site. This foundation type is likely to be more cost-effective solution than other foundation options such as deep foundations (piles). Accordingly, other foundation options are not considered further.

7 Further work

The following stages of further work have been identified:

- Consider the challenges and opportunities presented in this report for the master planning for redevelopment. Involve/consult the geotechnical engineer to optimise asset placement e.g. identifying best location on site to place buildings or expensive assets.
- Within the project team, jointly select and develop a preferred foundation. Building-specific investigations to verify inferred ground conditions (if required).
- Preliminary design.
- Developed design.
- Detailed design.
- Construction monitoring.

8 Applicability

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

Recommendations and opinions in this report are based on data from boreholes, window sampler boreholes and scala penetrometer testing. The nature and continuity of subsoil away from the investigation/testing locations are inferred and it must be appreciated that actual conditions could vary from the assumed model.

Tonkin & Taylor Ltd

Report prepared by:

....

Anthony Rolfe
Geotechnical Engineer

Authorised for Tonkin & Taylor Ltd by:

....

Dr. Eng Liang Chin
Project Director

Appendices

Appendix A Site plans and cross-sections

Appendix B Recent geotechnical investigation

Appendix C Slope stability assessment

27-Jan-23
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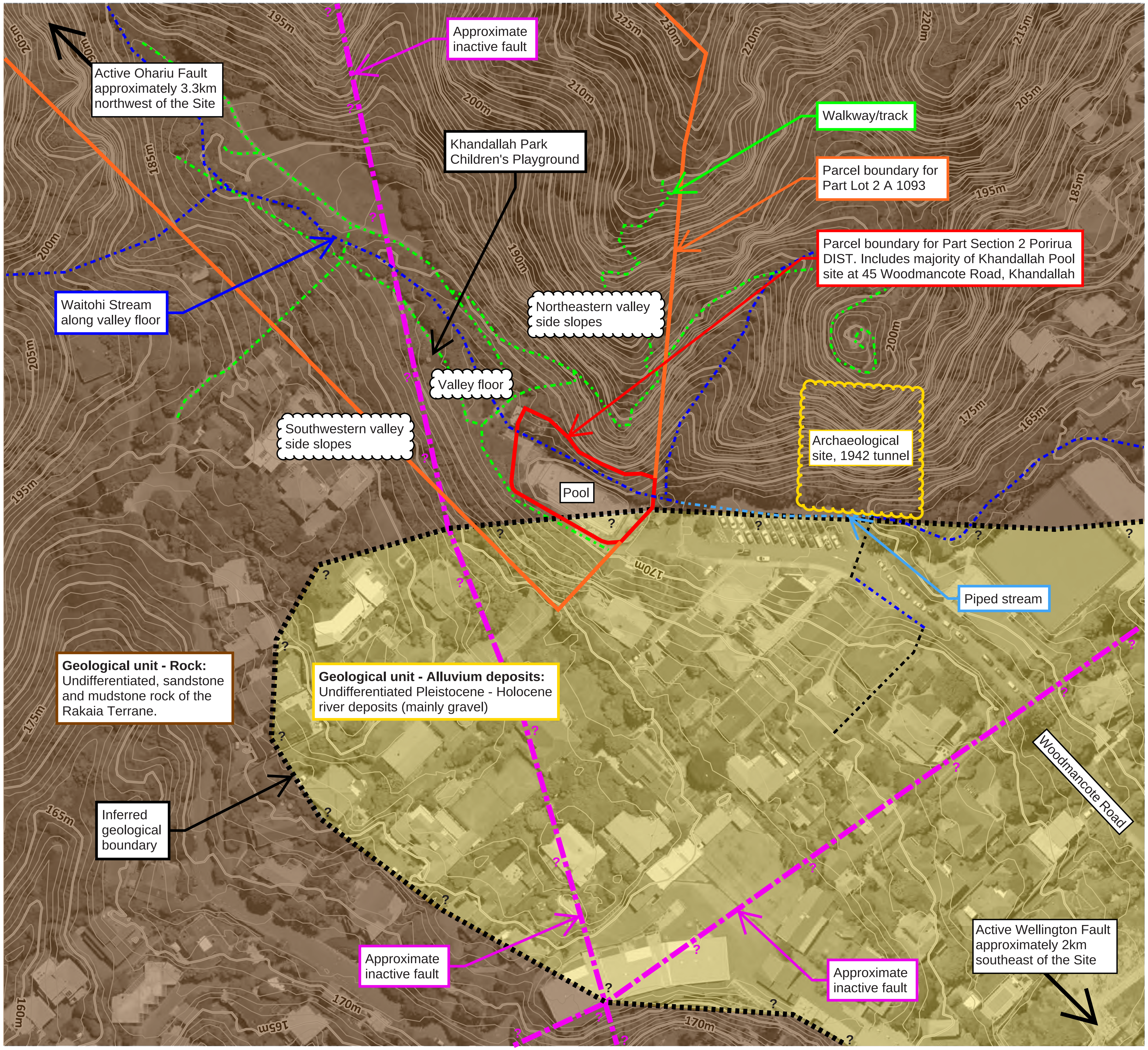
Appendix A Site plans and cross-sections

- Figure A1 – Site plan (larger scale), presenting published geological information.
- Figure A2 – Site plan (smaller scale), presenting recent geotechnical investigations.
- Figure A3 – Geological cross-section AA’
- Figure A4 – Geological cross-section BB’



LEGEND

1m Contour

5m Contour

Published geology

Based on GNS fault database and 1:50,000 geological map 22 (Begg, J.G; Mazengarb, C., 1996)

Undifferentiated, sandstone and mudstone rock of the Rakaia Terrane

Undifferentiated Pleistocene - Holocene river deposits

Inferred geological boundary

Approximate inactive fault

Nearest active faults as indicated.

Nearby Archaeological site

Based on Archsite database. Not recorded on the NZ Heritage List (formerly the Register).

H-shaped tunnel built in early 1942 to house the Army Headquarters Staff in the event of an invasion (record: NZAA Id R27/585)

Other details

Parcel boundary for Part Section 2 Porirua DIST, includes majority of the Khandallah Pool site.

Parcel boundary for Part Lot 2 A 1093

Waitohi Stream (piped in some areas)

Walkway/track

A3 SCALE: 1:1,250

0 10 20 30 40 50 (m)

N

1. Geological Boundaries,Veins,Landslide Units,Landslide Boundaries,Inactive Faults,Active Faults GNS Science, Lower Hutt, New Zealand.
2. Parcel Boundary,Property Boundary,Titles,Street Name,Street Number sourced from the LINZ Data Service and licensed for re-use under the Creative Commons Attribution 3.0 New Zealand licence.
3. LINZ Aerial Basemap Copyright LINZ CC BY 4.0. www.linz.govt.nz/linz-copyright Imagery Basemap Contributors. https://www.linz.govt.nz/data/linz-data/linz-basemaps/data-attribution

Created On:	17/10/2022
Created By:	ARolfe
Approved By:	BRama
TT Proj Ref:	
TT Map Ref: TTMAPREF1433463001.902	

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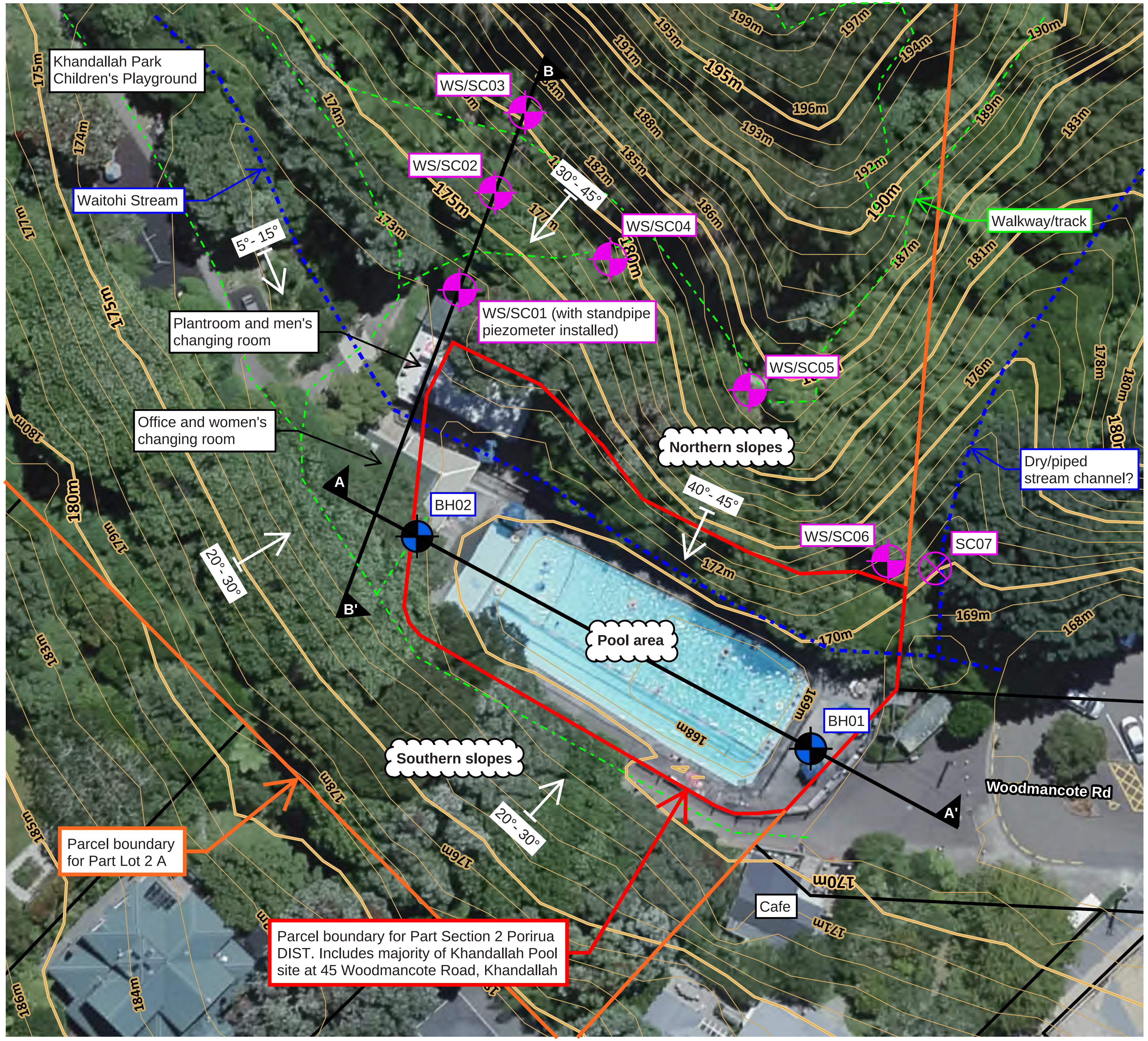
Khandallah Pool Redevelopment
Geotechnical Seismic Assessment
Site Plan - Published Surface Geology

FIGURE No. **A1**



LEGEND

- 1m Contour
- 5m Contour
- Property Boundary
- Parcel Boundary
- Parcel boundary for Part Section 2 Porirua DIST, includes majority of the Khandallah Pool site.
- Parcel boundary for Part Lot 2 A 1093
- Walkway/track
- Waitohi Stream
- Geological cross-sections (refer Figures A3 and A4)
- Approximate slope direction and angle

Geotechnical investigation by T+T (November 2022)

- Boreholes (BH) + standpipe piezometer with level logger
- Window Sampler (WS) + Scala Penetrometer Test (SC) + standpipe piezometer at location indicated
- Scala Penetrometer Test (SC) only

Notes:
1. Investigation locations are approximate only.

A4 SCALE: 1:500

0 5 10 15 20 (m)

N

1. Parcel Boundary,Property Boundary,Street Name sourced from the LINZ Data Service and licensed for re-use under the Creative Commons Attribution 3.0 New Zealand licence.
2. LINZ Aerial Basemap Copyright LINZ CC BY 4.0. www.linz.govt.nz/linz-copyright Imagery Basemap Contributors. https://www.linz.govt.nz/data/linz-data/linz-basemaps/data-attribution

Created On:	28/10/2022
Created By:	ARolfe
Approved By:	BRama
TT Proj Ref: 1089174.0001	
TT Map Ref: TTMAPREF1433463001.902	

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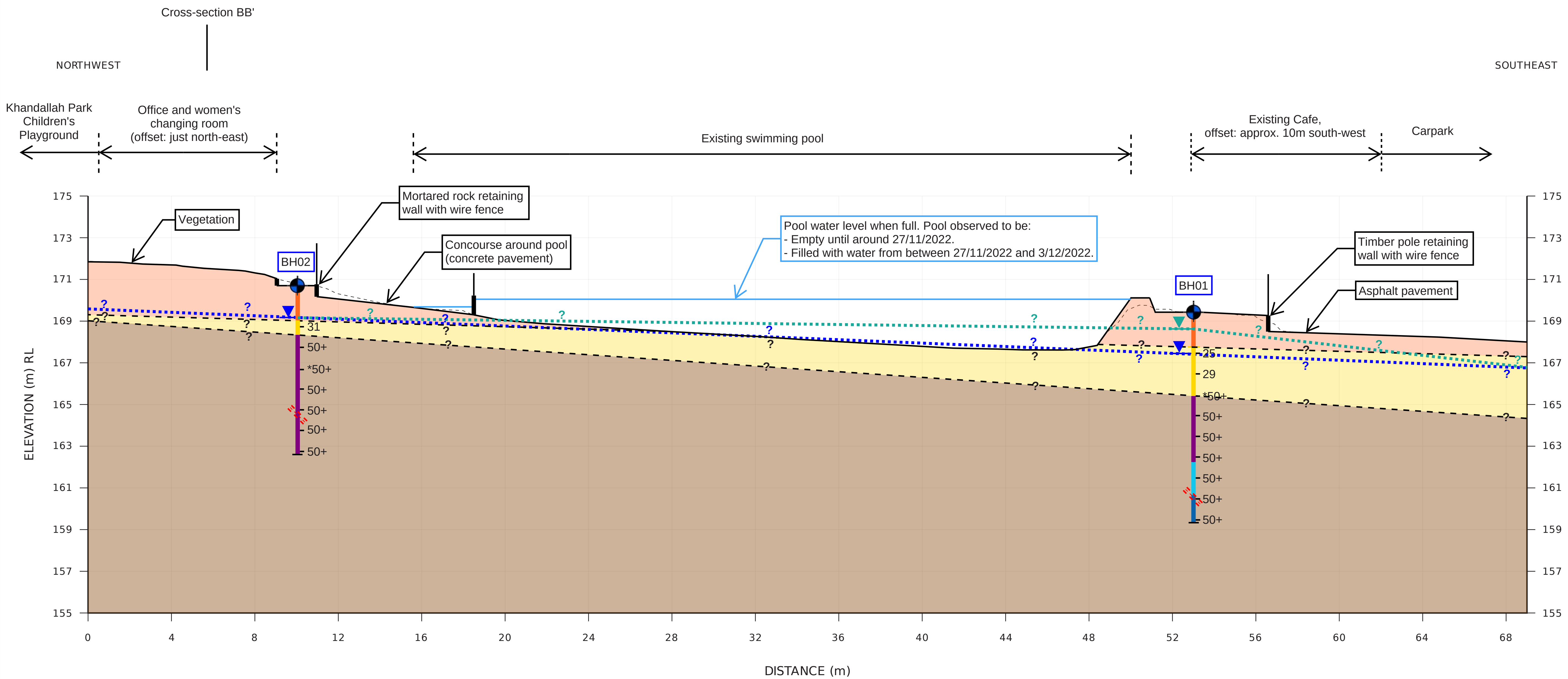
FIGURE No. A2

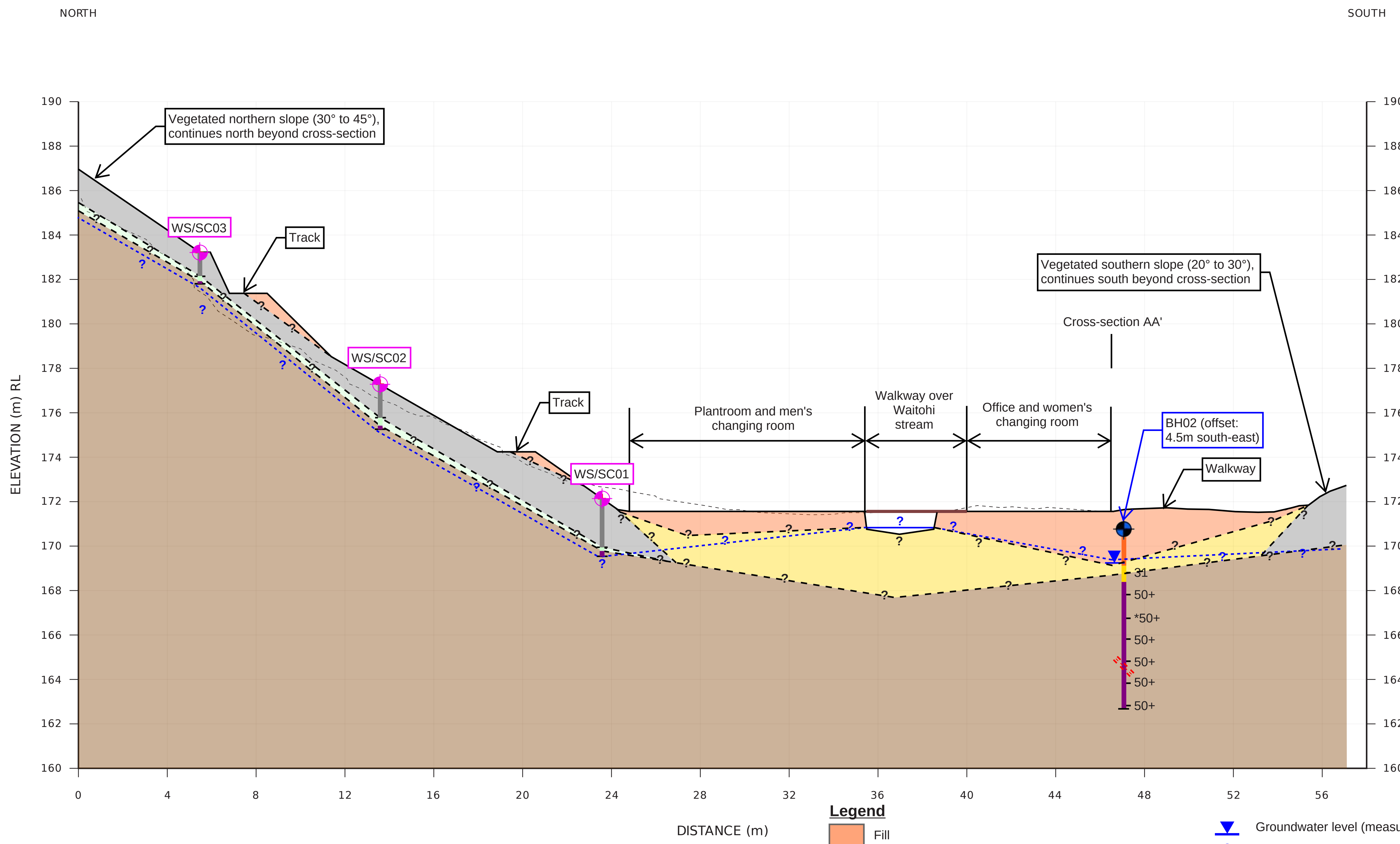


SECTION AA'
SCALE: 1:200 A3

Legend

- Fill
- Alluvium deposits
- *Greywacke rock (sandstone), highly weathered or better:*
  - Highly to moderately weathered
  - Moderately to slightly weathered
  - Slightly weathered to unweathered
- Shear Zone within rock mass
- Pool water level when full
- Groundwater level (measured in piezome 23/11/2022 to 23/12/2022, typical levels i
- Inferred groundwater level, when pool em
- Inferred groundwater level, when pool full
- Inferred geological boundary
- Borehole (BH) by T+T, November 2022.
- Current ground surface based on LiDAR
- Current ground surface based on LiDAR and site observations

T+T Cross-Section Generator (CSG)
Start Point (NZTM): 1749824.84 mE, 5432857.09 mN
End Point (NZTM): 1749885.36 mE, 5432824.48 mN
Date Generated: 2022-11-29, 13:44:49
CSG Version: 2.0 (Second Release)
Vertical Datum: Investigation RLs are shown in NZVD2016 datum.
Groundline Source: LiDAR data licenced by: Wellington City Council. Dataset: Wellington City LiDAR (2019-2020).



SECTION BB'
SCALE: 1:200 A4

Legend

- Fill
- Alluvium deposits
- Undifferentiated colluvium deposits and residual (rock) soil
- *Greywacke rock (sandstone), completely weathered*
- *Greywacke rock (sandstone), highly weathered or better:*
- Highly to moderately weathered
- Shear Zone within rock mass
- Groundwater level (measure
- Inferred groundwater level
- Inferred geological boundar
- Borehole (BH) by T+T, Nove
- Window sampler (WS) and by T+T, November 2022
- Current ground surface bas
- Current ground surface bas and site observations

T+T Cross-Section Generator (CSG)
Start Point (NZTM): 1749845.61 mE, 5432897.88 mN
End Point (NZTM): 1749825.65 mE, 5432844.47 mN
Date Generated: 2022-12-06, 16:07:24
CSG Version: 2.0 (Second Release)
Vertical Datum: Investigation RLs are shown in NZVD2016 datum.
Groundline Source: LiDAR data licenced by: Wellington City Council. Dataset: Wellington City LiDAR (2019-2020).

Appendix B Recent geotechnical investigation

- **Geotechnical investigations within the pool area (from 17/11/2022 to 22/11/2022)**
  - **T+T engineering log terminology.**
  - **Borehole logs and core photographs for BH01 and BH02.**
- **Geotechnical investigations across the steep slopes just north of the pool area (from 14/11/2022 to 15/11/2022)**
  - **Report by Geotechnics Ltd presenting logs for window sampler boreholes and scalar penetrometer tests (WS/SC01 to WS/SC06, and SC07).**
- **Figure B1 – Plot presenting continuous groundwater monitoring at BH01 and BH02 (from 23/11/2022 to 23/12/2022).**

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Engineering log terminology

General

Soil and rock descriptions follow the "Guidelines for the field classification and description of soil and rock for engineering purposes" by the New Zealand Geotechnical Society (2005). Refer to this document for methods of field determination.

Water

- Water level on date shown
- Water inflow
- Water outflow

Core recovery

Expressed as percentage of the length of the core run recovered.

Drilling method/casing

Common types:

OB	Open barrel
W	Wash
HQ3	HQ triple tube
PQ3	PQ triple tube
HSA	Hollow Stem Auger
WS	Window Sampler
HA	Hand Auger
HFS	High Frequency Sonic Drilling
LFS	Low Frequency Sonic Drilling

Graphic logs

The graphic log shows soil and rock types. The defect log indicates the location, orientation and abundance of defects of all types.

Typical material symbols:

- Organic material
- Igneous rock
- Clay
- Mudstone
- Silt
- Siltstone
- Sand
- Sandstone
- Gravel or Conglomerate
- Metamorphic Rock

Tests

- **N=22:**SPT uncorrected blow count for 300 mm
- **75/12:**Undrained shear strength (peak /residual as measured by field vane.

Laboratory test(s) carried out:

PMT	Pressuremeter test
LT	Lugeon test
LV	Laboratory vane
AL	Atterburg limits
UU	Undrained triaxial
PSD	Particle size distribution
c' Ø'	Effective stress
CONS	Consolidation
DS	Direct shear
COMP	Compaction
UCS	Unconfined compression
IS_{50}	Point load

Installation type

- Standpipe
- Slotted screen
- VWP
- Bentonite seal
- Filter pack

Sample type

- SPT
- Core
- Thin-wall tube
- Other
- Bulk sample
- Core or Sample loss

Soil description

Moisture content

D	Dry, looks and feels dry
M	Moist, no free water on hand when remoulding
W	Wet, free water on hand when remoulding
S	Saturated, free water present on sample

Consistency/undrained shear strength

		S_u(kPa)
VS	Very soft	< 12
S	Soft	12 to 25
F	Firm	25 to 50
St	Stiff	50 to 100
VSt	Very stiff	100 to 200
H	Hard	> 200

Density index

		SPT(N) - uncorrected
VL	Very loose	0 to 4
L	Loose	4 to 10
MD	Medium dense	10 to 30
D	Dense	30 to 50
VD	Very dense	> 50

Proportional terms definition (Coarse soils)

Fraction	Term	% of soil mass	Example
Major	(UPPER CASE)	Major constituent	GRAVEL
Subordinate	(lower case)	> 20	Sandy
Minor	with some... with minor...	12 - 20 5 - 12	with some sand with minor sand
	with trace of... (or slightly)...	< 5	with trace of sand (slightly sandy)

Grain size criteria

Type	Coarse									Fine	
	Boulders	Cobbles	Gravel			Sand				Silt	Clay
			Coarse	Medium	Fine	Coarse	Medium	Fine			
Size range (mm)	200	60	20	6	2	0.6	0.2	0.06	0.002		

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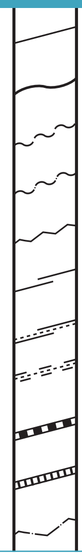
Engineering log terminology

Rock description

Signifcant defects

B	Bedding
J	Joint
Sc	Schistosity
Cl	Cleavage
BZ	Broken zone/crushed zone
F	Fault
Fg	Fault with gouge
SZ	Shear zone
Iz	Infilled seam
XD	Extremely weathered seam
DD	Drilling - induced defect



Weathering

UW	Unweathered
SW	Slightly weathered
MW	Moderately weathered
HW	Highly weathered
CW	Completely weathered
RS	Residual soil

Defect shape

ST	Stepped
UN	Undulating
PL	Planar

Roughness of defect surface

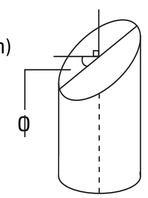
R	Rough
SM	Smooth
SL	Slickensided

Field strength

		UCS (MPa)	$I_{S(50)}$ (MPa)
EW	Extremely weak	< 1	N/A
VW	Very weak	1 - 5	N/A
W	Weak	5 - 20	N/A
MS	Moderately strong	20 - 50	1 - 2
S	Strong	50 - 100	2 - 5
VS	Very strong	100 - 250	5 - 10
ES	Extremely strong	> 250	> 10

Defect coding

┌ Type
│ ┌ Angle (perpendicular to core axis)
J 60˚, PL, SL, T, CV, STIFF GREEN CLAY
Infilling description (as per soil description)
└ Infilling/coating type
└ Aperture
└ Roughness
└ Shape



Defect Orientation: for vertical unoriented boreholes defect orientation is measured normal to core axis e.g horizontal = 0˚(see diagram). For angled boreholes defect orientation is measured relative to core axis e.g parallel to core axis = 0˚.

Aperture

		Aperture (mm)
T	Tight	nil
VN	Very narrow	0 - 2
N	Narrow	2 - 6
MN	Moderately narrow	6 - 20
MW	Moderately wide	20 - 60
W	Wide	60 - 200
VW	Very wide	> 200

Infillings and coatings

CG	Clay gouge	Joints have openings between opposing faces of intact rock substance in excess of 1 mm filled with clay gouge. Clay is generally described in terms of soil properties.
CV	Clay veneers	Joints contain clay coating whose maximum thickness does not exceed 1 mm. Note: Describe clay in terms of soil properties.
PL	Penetrative limonite	Joint traces are marked in terms of well defined zones of slightly to moderately weathered ferruginised rock-substance in the adjacent rock.
FeSt	Limonite stained	Joint surfaces are stained or coated with limonite, although the rock substance immediately adjacent to the joints is fresh.
CT, SC	Coated	Joints exhibit coatings other than clay or limonite, e.g. Carbonate (CT) or Silica (SC).
CL, CS, CC	Cemented	Joints are cemented with limonite (CL), Silica (CS), or Carbonates (CC).
CN	Clean	Joint surface show no trace of clay, limonite, or other coatings.

Spacing

Term	Spacing
Very wide	> 2 m
Wide	0.6 - 2 m
Moderately wide	200 - 600 mm
Close	60 - 200 mm
Very close	20 - 60 mm
Extremely close	> 20 mm

Excavator penetration

Easy	1
Moderate	2
Difficult	3

RQD: Rock Quality Designation - percentage of core run consisting of sound rock longer than 10 cm.

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BOREHOLE LOG

BOREHOLE No.: **BH01**

SHEET: 1 OF 2

PROJECT: Khandallah Pool Redevelopment	CO-ORDINATES: (NZTM2000) 5432832 mN 1749871 mE	R.L. GROUND: 169.40m	DRILLED BY: Tyler
JOB No.: 1089174.0001		R.L. COLLAR: 169.40m	LOGGED BY: ANRO
LOCATION: South-eastern side of existing public pool. About halfway between pool and existing wire and post fence.	DIRECTION: N/A	DATUM: NZVD2016	CHECKED: NCP
	ANGLE FROM HORIZ.: -90°	SURVEY: GIS\Web map viewer	START DATE: 17/11/2022
			FINISH DATE: 18/11/2022
			CONTRACTOR: ProDrill

Column headings: GEOLOGICAL UNIT | MATERIAL DESCRIPTION (SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, colour, fabric, name, strength, cementation) | Rock Weathering (UW SW MW HW CW RS) | Rock Strength (VS+ S MS W VW EW) | Sampling Method | Core Recovery (%) | Testing | RL (m) | Depth (m) | Graphic Log | ROCK MASS DISCONTINUITIES: Defect Log | Fracture Spacing (mm) (2000 600 200 60 20) | RQD (%) | Description & Additional Observations | Water Level / Fluid Loss (%) (25 50 75) | Casing | Installation | Core Box No

Fill

0.00m: NO RECOVERY - Hydrovac excavation. Observed sub-surface material described below.
0.00 - 0.14m: Concrete pavement slab.
0.14 - 1.25m: Gravelly, sandy SILT, with frequent cobble- to boulder-sized fragments of rock and concrete; light brown. Tightly packed, low plasticity; gravel, fine to coarse.

1.25m: CORE LOSS.

1.50m: Tightly packed. Mixture of coarse to cobble-sized concrete fragments and silty medium to coarse SAND; brown.

Alluvial Deposits

1.65m: Gravelly SILT, some sand and some cobbles, trace boulders; brown. Medium dense to dense. Gravel, medium to coarse, sub-rounded to sub-angular, slightly to moderately weathered, moderately strong, black and grey, fine grained sandstone; sand, fine to medium; cobbles, sub-rounded to sub-angular.

2.45m: CORE LOSS.

2.80m: Medium dense to dense. Recovered as: gravel, some cobbles, trace boulders. Gravel, medium to coarse, sub-rounded to sub-angular, slightly to moderately weathered, moderately strong, black and grey, fine grained sandstone; sand, fine to medium; cobbles, sub-rounded to sub-angular.

3.45m: CORE LOSS.

3.75m: Dense. Recovered as: gravel, some cobbles, trace boulders. Gravel, medium to coarse, sub-rounded to sub-angular, slightly to moderately weathered, moderately strong, black and grey, fine grained sandstone; sand, fine to medium; cobbles, sub-rounded to sub-angular.

Greywacke

4.00m: Moderately to highly weathered, brown, SANDSTONE. Weak, fine grained.

4.24m: CORE LOSS.

4.60m: Moderately to highly weathered, brown, SANDSTONE. Weak, fine grained.
5.19 - 5.29m: Crushed above joint.
5.29 - 5.54m: Streaked dark grey.
5.70 - 6.00m: Shattered. Recovered as: medium to coarse, angular gravel.

Sampling Method / Core Recovery (%) / Testing:

Sampling Method	Core Recovery (%)	Testing
HVAC	0	
PQTT	67	
SPT	78	4/4// 6/6/6/7 **N=25**
PQTT	36	
SPT	56	3/5// 6/5/8/10 **N=29**
PQTT	45	
SPT	83	5/7// 8/12 for 10mm **N>=50** Bouncing
PQTT	53	
SPT	100	24/26// for 15mm **N>=50**
PQTT	100	

RL (m): 169, 168, 167, 166, 165, 164
Depth (m): 1, 2, 3, 4, 5

RQD (%): 0, 0

Description & Additional Observations:

4.00 - 7.23m: Steeply inclined, extremely closely spaced (VN) and very closely spaced (N-MN) joints, undulating, rough to smooth, stained black and orange. Frequent zeolite infill, abundant infill at 5.5m to 5.7 m and 6.3m to 6.5m.

4.60-4.70m: J, 31-60°, UN-ST, R-SM, MN, Infill: brown, sandy silt, hard.

5.09-5.54m: J, , 31-60°, PL-UN, R-SM, N-MN, Infill: zeolite., 5 no. joints spaced at approx. 60 mm

Water Level: 23/11/2022 @ 13:10

Casing: 1.3m PWT; 10.1m PQ

Installation: Metal, lockable flush toby; Bentonite; Blinding sand; Slotted, 32mm dia. PVC pipe to 7m depth, for standpipe piezometer

Core Box No: Box 0.00-1.25m: HVAC; Box 1.25-5.54m

COMMENTS: 1) Logged to NZGS 2005 Standards; 2) Raw SPT values shown, Energy Transfer Ratio of 81.7%; 3) Photos of HVAC hole, SPT and core samples attached; 4) Standpipe piezometer installed as shown in log; 5) Water level shown is from dip-meter measurement in standpipe.

Hole Depth 10.08m

Scale 1:30

Rev.: A

TTNZ_20220309 - General Log - 14/12/2022 12:49:11 pm - Produced with Core-GS by GeRoc V4.0.01

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.: BH01

SHEET: 2 OF 2

PROJECT: Khandallah Pool Redevelopment	CO-ORDINATES: (NZTM2000) 5432832 mN 1749871 mE
JOB No.: 1089174.0001	DIRECTION: N/A
LOCATION: South-eastern side of existing public pool. About halfway between pool and existing wire and post fence.	ANGLE FROM HORIZ.: -90°
R.L. GROUND: 169.40m	DRILLED BY: Tyler
R.L. COLLAR: 169.40m	LOGGED BY: ANRO
DATUM: NZVD2016	CHECKED: NCP
SURVEY: GIS\Web map viewer	START DATE: 17/11/2022
	FINISH DATE: 18/11/2022
	CONTRACTOR: ProDrill

MATERIAL DESCRIPTION — GEOLOGICAL UNIT; SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, colour, fabric, name, strength, cementation | Rock Weathering (UW SW MW HW CW RS) | Rock Strength (VS+ S MS W VW EW) | Sampling Method | Core Recovery (%) | Testing | RL (m) | Depth (m) | Graphic Log | ROCK MASS DISCONTINUITIES: Defect Log | Fracture Spacing (mm) (2000 600 200 60 20) | RQD (%) | Description & Additional Observations | Water Level / Fluid Loss (%) (25 50 75) | Casing | Installation | Core Box No

Geological unit: Greywacke

[CONT] *4.60m:* Moderately to highly weathered, brown, SANDSTONE. Weak, fine grained.
6.12 - 6.27m: Recovered as: sandy silt, with minor gravel. Sand, medium; gravel, fine to medium, angular. Possibly damaged by SPT.
7.08 - 7.23m: Highly to completely weathered, brown. Extremely weak to very weak. Recovered as: sandy, fine to medium gravel, with some silt. Gravel, angular; sand, fine to medium. Possibly shattered.

7.23m: Slightly to moderately weathered, brown and grey, increasing grey with depth, SANDSTONE. Moderately strong, fine grained.
8.00 - 8.80m: Grey, more slightly weathered.

8.80m: Unweathered to slightly weathered, grey, SANDSTONE. Moderately strong, fine grained.
9.12 - 9.47m: Crushed below shear zone.

10.08m: END OF BOREHOLE. Target depth.

Sampling Method	Core Recovery (%)	Testing
SPT	100	17/33// for 45mm N>=50
PQTT	100	
SPTC	0	38/12// for 5 mm N>=50 Solid Cone
PQTT	100	
SPTC	0	40/10// for 10mm N>=50 Solid Cone
PQTT	100	
SPTC	0	28/22// for 55mm N>=50 Solid Cone
PQTT	100	
SPTC	0	42/8// for 5 mm N>=50 Solid Cone

RL (m): 163, 162, 161, 160, 159, 158
Depth (m): 7, 8, 9, 10, 11

RQD (%): 22, 48, 87, 51

Description & Additional Observations:

6.50-6.70m: J, 81-90°, PL-UN, R-SM, MW, Infill: grey, clayey silt, hard
7.23-7.33m: J, 31-60°, PL-UN, R-SM, VN, Infill: zeolite
7.23 - 8.80m: Steeply inclined, extremely closely spaced (T) and very closely spaced (VN-N) joints, undulating, rough to smooth, stained orange, mottled black. Frequent zeolite infill.
7.58-7.68m: J, 31-60°, PL-UN, R-SM, VN, Infill: zeolite
8.35-8.45m: J, 16-30°, UN, SM, N, Infill: zeolite
8.80-9.00m: SZ, , 31-60°, UN, SL, W, 10mm to 30mm grey clasts in matrix of black, dry, stiff, highly plastic, silty clay. Joint at 8.9m.,
9.00 - 10.08m: Steeply inclined, extremely closely spaced (T) and very closely spaced (VN) joints, undulating, smooth. Infill: zeolite or grey, high plasticity, clayey silt.

Casing: 10.1m PQ

Installation: Blinding sand; Bentonite; Bentonite pellets and gravel

Core Box No: Box 5.54-7.68m; Box 7.68-9.72m; Box 9.72-10.08m

COMMENTS: 1) Logged to NZGS 2005 Standards; 2) Raw SPT values shown, Energy Transfer Ratio of 81.7%; 3) Photos of HVAC hole, SPT and core samples attached; 4) Standpipe piezometer installed as shown in log; 5) Water level shown is from dip-meter measurement in standpipe.

Hole Depth 10.08m

Scale 1:30

Rev.: A

CORE PHOTOS

Tonkin+Taylor

BOREHOLE No.: **BH01**

Hole Location: South-eastern side of existing public pool. About halfway between pool and existing wire and post fence.

SHEET: 1 OF 4

PROJECT: Khandallah Pool Redevelopment	LOCATION: 45 Woodmancote Road, Khandallah, \	JOB No.: 1089174.0001
CO-ORDINATES: (NZTM2000) 5432832 mN 1749871 mE	DRILL TYPE: Fraste SL.G 3	HOLE STARTED: 17/11/2022
R.L.: 169.40m	METHOD: Rotary cored	HOLE FINISHED: 18/11/2022
DATUM: NZVD2016		DRILLED BY: ProDrill
		LOGGED BY: ANRO CHECKED: NCP

0.00-1.25m: HVAC

1.25-5.54m

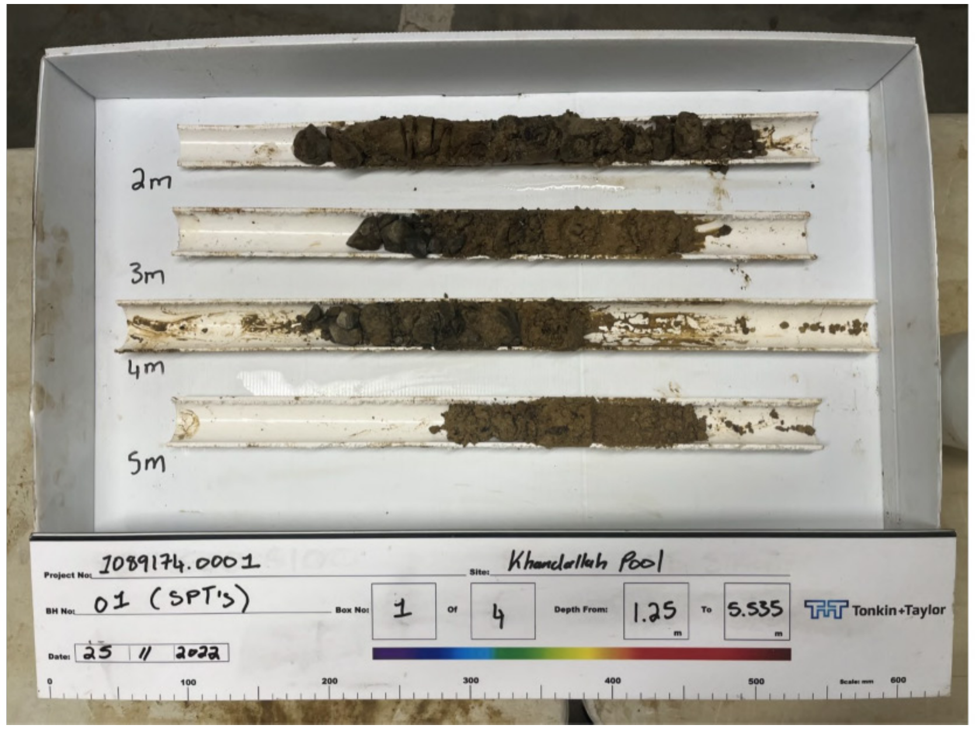
Tonkin+Taylor

CORE PHOTOS

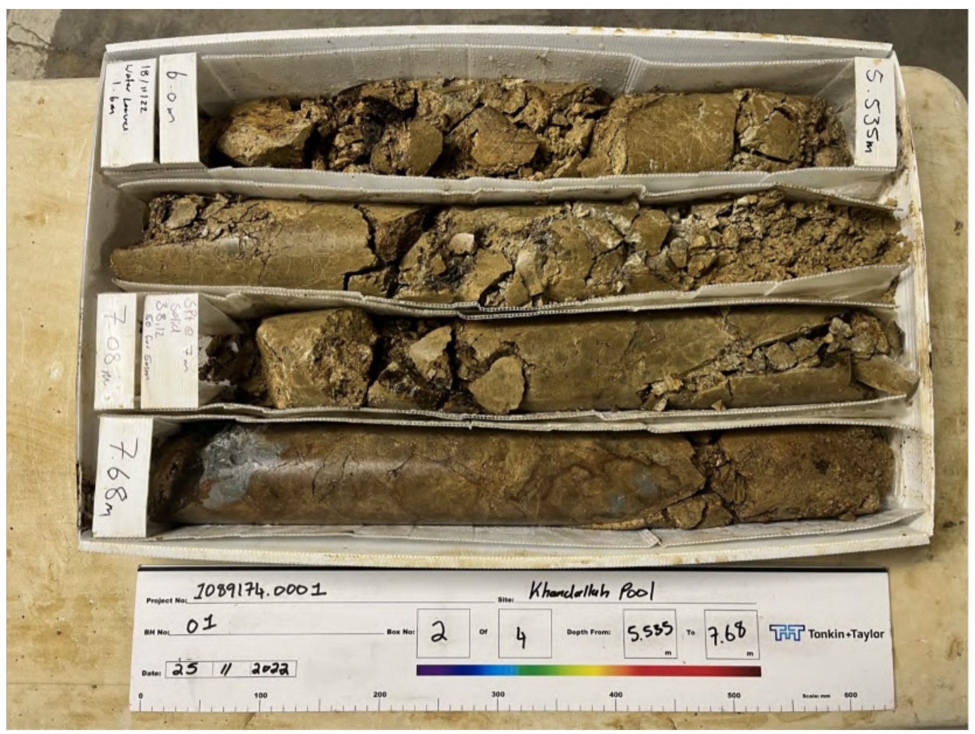
BOREHOLE No.: **BH01**

Hole Location: South-eastern side of existing public pool. About halfway between pool and existing wire and post fence.

PROJECT: Khandallah Pool Redevelopment	LOCATION: 45 Woodmancote Road, Khandallah, \	JOB No.: 1089174.0001
CO-ORDINATES: (NZTM2000) 5432832 mN 1749871 mE R.L.: 169.40m DATUM: NZVD2016	DRILL TYPE: Fraste SL.G 3 METHOD: Rotary cored	HOLE STARTED: 17/11/2022 HOLE FINISHED: 18/11/2022 DRILLED BY: ProDrill LOGGED BY: ANRO CHECKED: NCP



2.00-5.09m: SPT



5.54-7.68m

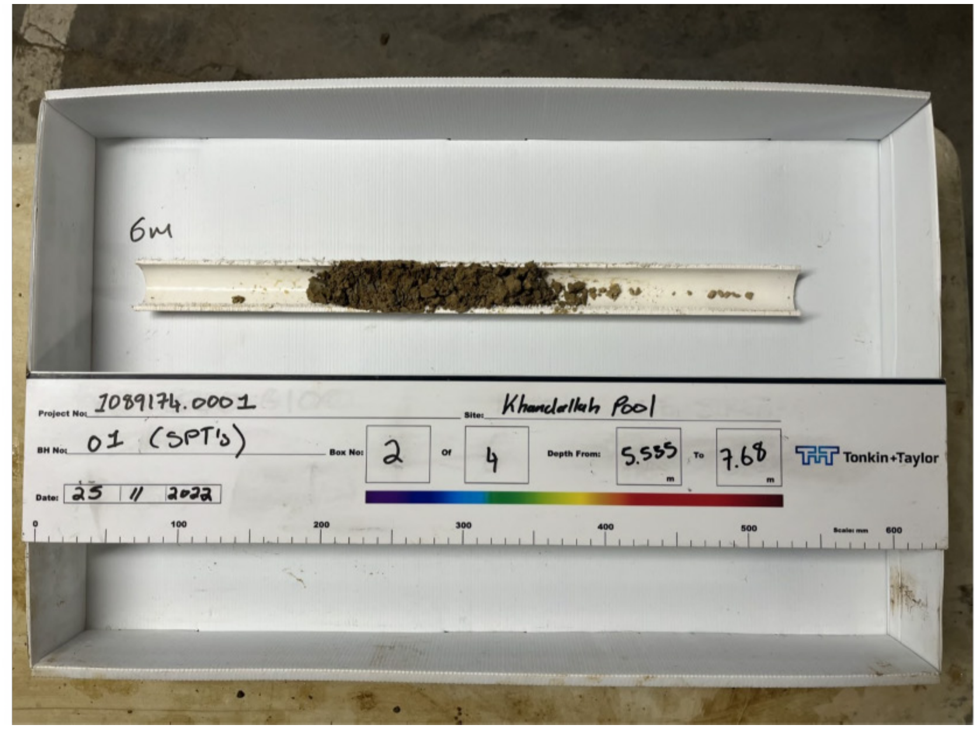
Tonkin+Taylor

CORE PHOTOS

BOREHOLE No.: **BH01**

Hole Location: South-eastern side of existing public pool. About halfway between pool and existing wire and post fence.

PROJECT: Khandallah Pool Redevelopment	LOCATION: 45 Woodmancote Road, Khandallah, \	JOB No.: 1089174.0001
CO-ORDINATES: (NZTM2000) 5432832 mN 1749871 mE R.L.: 169.40m DATUM: NZVD2016	DRILL TYPE: Fraste SL.G 3 METHOD: Rotary cored	HOLE STARTED: 17/11/2022 HOLE FINISHED: 18/11/2022 DRILLED BY: ProDrill LOGGED BY: ANRO CHECKED: NCP



6.00-6.12m: SPT

7.68-9.72m

Tonkin+Taylor

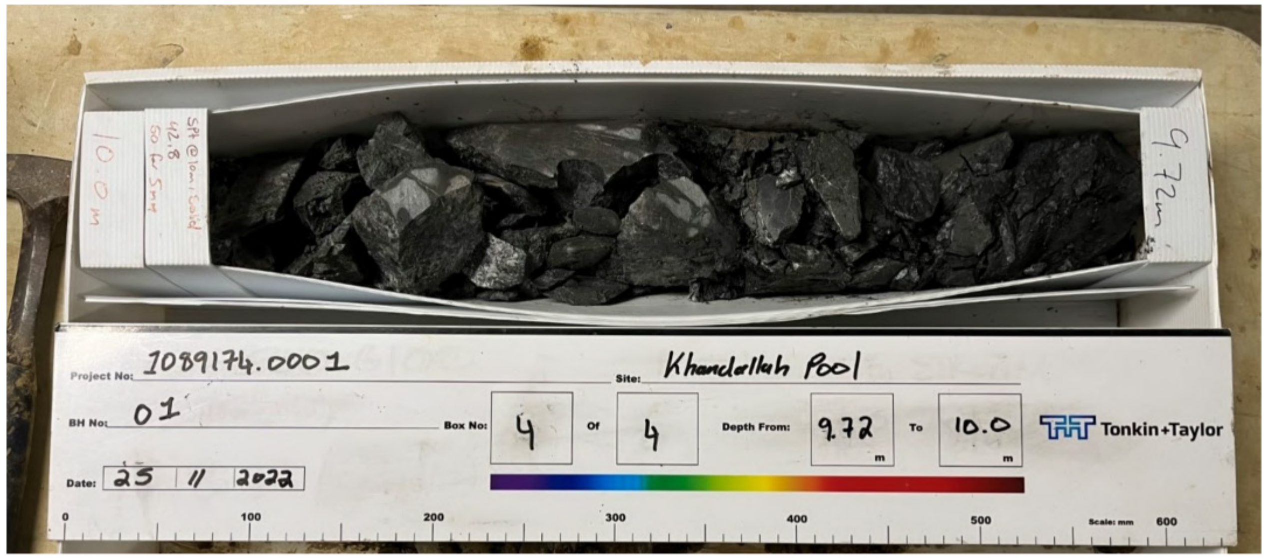
CORE PHOTOS

BOREHOLE No.: **BH01**

Hole Location: South-eastern side of existing public pool. About halfway between pool and existing wire and post fence.

SHEET: 4 OF 4

PROJECT: Khandallah Pool Redevelopment	LOCATION: 45 Woodmancote Road, Khandallah, \	JOB No.: 1089174.0001
CO-ORDINATES: (NZTM2000) 5432832 mN 1749871 mE	DRILL TYPE: Fraste SL.G 3	HOLE STARTED: 17/11/2022
R.L.: 169.40m	METHOD: Rotary cored	HOLE FINISHED: 18/11/2022
DATUM: NZVD2016		DRILLED BY: ProDrill
		LOGGED BY: ANRO CHECKED: NCP



9.72-10.08m

Tonkin+Taylor

BOREHOLE LOG

BOREHOLE No.: BH02

SHEET: 1 OF 2

PROJECT: Khandallah Pool Redevelopment	CO-ORDINATES: (NZTM2000) 5432852 mN 1749834 mE	R.L. GROUND: 170.80m	DRILLED BY: Tyler
JOB No.: 1089174.0001		R.L. COLLAR: 170.80m	LOGGED BY: ANRO
LOCATION: North-western side of existing public pool. In middle of footpath into pool area, just outside (south-west) of gateway.	DIRECTION: N/A	DATUM: NZVD2016	CHECKED: NCP
	ANGLE FROM HORIZ.: -90°	SURVEY: GIS\Web map viewer	START DATE: 21/11/2022
			FINISH DATE: 22/11/2022
			CONTRACTOR: ProDrill

MATERIAL DESCRIPTION — SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, colour, fabric, name, strength, cementation

ROCK MASS DISCONTINUITIES — Description & Additional Observations

Geological Unit	Material Description	Sampling Method	Core Recovery (%)	Testing	RQD (%)	Defect Description & Additional Observations
Fill	*0.00m:* NO RECOVERY - Hydrovac excavation. Observed sub-surface material described below. *0.00 - 0.03m:* Asphalt. *0.03 - 0.13m:* Concrete. *0.13 - 0.30m:* Clayey SILT, with up to cobble-sized fragments of rock, concrete and brick; light brown. Loosely packed. *0.30 - 0.60m:* Concrete. *0.60 - 1.40m:* Clayey SILT, with some sand, gravel and cobbles; dark brown. Soft to firm, moderate to high plasticity.	HVAC	0			
Fill	*1.40m:* Clayey SILT, minor gravel; grey. Soft to firm, moist to wet, medium plasticity. Gravel, fine to coarse, sub-rounded to sub-angular, slightly weathered, moderately strong, grey. Inferred to be fill.	PQTT	100			
Alluvial Deposits	*1.50m:* Sandy fine to coarse GRAVEL, some silt, trace cobbles; grey. Moist to wet. Sand, coarse. Inferred to be fill.					
Alluvial Deposits	*1.65m:* Silty sandy fine to coarse GRAVEL, minor cobbles; light brown, streaked grey and orange. Dense, moist to wet. Gravel, sub-rounded to sub-angular, unweathered to slightly weathered, moderately strong, grey; sand, fine to coarse.	SPT	80	5/5// 6/6/8/11 **N=31**		
Greywacke	*2.45m:* Moderately weathered, brownish grey, SANDSTONE. Moderately strong, fine grained. *2.45 - 3.00m:* Recovered as: coarse gravel, cobbles and some boulders. Gravel, sub-rounded to sub-angular, unweathered to slightly weathered, moderately strong, grey.	PQTT	82			*2.45 - 4.35m:* Steeply inclined, extremely closely spaced (T) and very closely spaced (N-VN) joints, undulating, rough to smooth, stained orange and mottled black. Occasional infill: zeolite or clayey silt.
Greywacke		SPT	70	4/10// 11/13/18/8 for 55mm **N>=50**		
Greywacke		PQTT	88		70	*3.55-3.65m:* J, 31-60°, UN, SM, VN
Greywacke	*4.03 - 4.18m:* Recovered as: medium to coarse, angular gravel.			15 for 30mm **N>=50** Bouncing		
Greywacke	*4.35m:* Moderately to highly weathered, greyish brown, SANDSTONE. Weak to moderately strong, fine grained. *4.35 - 4.50m:* Highly to completely weathered, brown. Extremely weak to very weak. Crushed.	PQTT	100		25	*4.35-5.10m:* BZ, Infill: zeolite or clayey silt.
Greywacke	*5.00 - 5.10m:* Highly to completely weathered, brown. Extremely weak to very weak. Recovered as: silty sand, with some gravel. Crushed.	SPTC	0	33/17// for 10mm **N>=50** Solid Cone		
Greywacke		PQTT	100		32	*5.10 - 6.20m:* Steeply inclined, extremely closely spaced (VN) and very closely spaced (VN-N) joints, undulating, rough to smooth, stained orange and mottled black. Abundant infill: zeolite or clayey silt. *5.50-5.60m:* J, 31-60°, UN, R-SM, VN

Water Level / Fluid Loss (%): 23/11/2022; @ 12:55

Casing: 3.0m PWT; 8.1m PQ

Installation: Metal, lockable flush toby; Bentonite; Blinding sand; Slotted, 32mm dia. PVC pipe to 7m depth, for standpipe piezometer

Core Box No: Box 0.00-1.40m: HVAC; Box 1.40-4.60m

COMMENTS: 1) Logged to NZGS 2005 Standards; 2) Raw SPT values shown, Energy Transfer Ratio of 81.7%; 3) Photos of HVAC hole, SPT and core samples attached; 4) Standpipe piezometer installed as shown in log; 5) Water level shown is from dip-meter measurement in standpipe.

Hole Depth 8.11m

Scale 1:30

Rev.: A

Tonkin+Taylor

BOREHOLE LOG

BOREHOLE No.: BH02

PROJECT: Khandallah Pool Redevelopment	CO-ORDINATES: 5432852 mN (NZTM2000) 1749834 mE	R.L. GROUND: 170.80m	DRILLED BY: Tyler
JOB No.: 1089174.0001		R.L. COLLAR: 170.80m	LOGGED BY: ANRO
LOCATION: North-western side of existing public pool. In middle of footpath into pool area, just outside (south-west) of gateway.	DIRECTION: N/A	DATUM: NZVD2016	CHECKED: NCP
	ANGLE FROM HORIZ.: -90°	SURVEY: GIS\Web map viewer	START DATE: 21/11/2022
			FINISH DATE: 22/11/2022
			CONTRACTOR: ProDrill

MATERIAL DESCRIPTION

SOIL: Classification, colour, consistency / density, moisture, plasticity

ROCK: Weathering, colour, fabric, name, strength, cementation

Columns: GEOLOGICAL UNIT; Rock Weathering (UW, SW, MW, HW, CW, RS); Rock Strength (VS+, S, MS, W, VW, EW); Sampling Method; Core Recovery (%); Testing; RL (m); Depth (m); Graphic Log; ROCK MASS DISCONTINUITIES: Defect Log; Fracture Spacing (mm) (2000, 600, 200, 60, 20); RQD (%); Description & Additional Observations; Water Level / Fluid Loss (%) (25, 50, 75); Casing; Installation; Core Box No

Geological unit: Greywacke

[CONT] *4.35m:* Moderately to highly weathered, greyish brown, SANDSTONE. Weak to moderately strong, fine grained.

6.20m: Moderately to highly weathered, black, streaked greyish brown, SANDSTONE. Weak, fine grained.

6.80m: Moderately to highly weathered, greyish brown, SANDSTONE. Weak, fine grained.

6.85 - 7.00m: Recovered as: sandy, fine to coarse, angular gravel, with some silt; sand, fine to coarse.

7.11 - 7.31m: Highly weathered, brown. Extremely weak to very weak. Shattered.

7.85 - 7.90m: Recovered as: sandy, fine to coarse, angular gravel, with some silt; sand, fine to coarse.

8.11m: END OF BOREHOLE. Target depth.

Sampling Method	Core Recovery (%)	Testing
SPTC	0	31/19// for 15mm **N>=50** Solid Cone
PQTT	100	
SPTC	0	26/24// for 30mm **N>=50** Solid Cone
PQTT	100	
SPTC	0	28/22// for 30mm **N>=50** Solid Cone

RL (m): 164, 163, 162, 161, 160, 159

Depth (m): 7, 8, 9, 10, 11

RQD (%): 0, 0

Description & Additional Observations:

6.10-6.30m: SZ, 61-80°, UN, SL, W, Infill: brownish grey, high plasticity, clayey silt, approx. 100m thick

6.30-6.80m: J, 31-60°, ST, SL, VN, Infill: zeolite or high plasticity, clayey silt, 6 no. joints spaced approx. 100mm.

6.80 - 8.11m: Sub-vertical to steeply inclined, extremely closely spaced (VN) and very closely spaced (N) joints, undulating, rough to smooth, mottled orange and black. Infill: zeolite, clayey silt, or quartz.

7.11-7.31m: BZ

Casing: 8.1m PQ

Installation: Blinding sand; Bentonite

Core Box No: Box 4.60-6.70m; Box 6.70-8.11m

COMMENTS: 1) Logged to NZGS 2005 Standards; 2) Raw SPT values shown, Energy Transfer Ratio of 81.7%; 3) Photos of HVAC hole, SPT and core samples attached; 4) Standpipe piezometer installed as shown in log; 5) Water level shown is from dip-meter measurement in standpipe.

Hole Depth 8.11m

Scale 1:30

Rev.: A

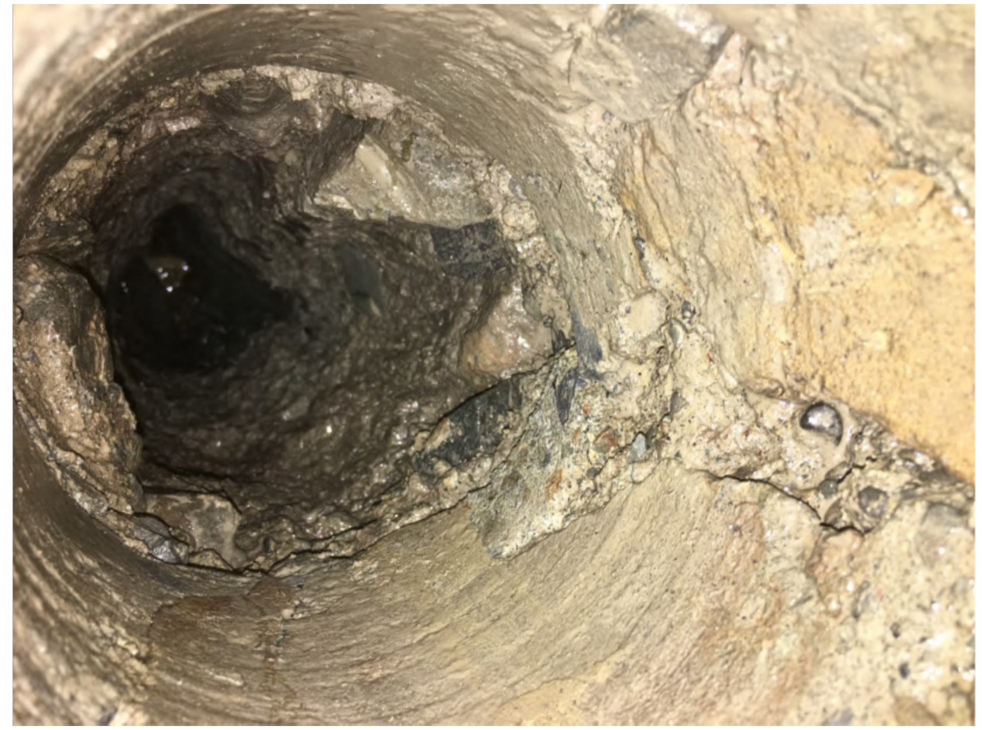
Tonkin+Taylor

CORE PHOTOS

BOREHOLE No.: **BH02**

Hole Location: North-western side of existing public pool. In middle of footpath into pool area, just outside (south-west) of gateway.

PROJECT: Khandallah Pool Redevelopment	LOCATION: 45 Woodmancote Road, Khandallah, \	JOB No.: 1089174.0001
CO-ORDINATES: 5432852 mN (NZTM2000) 1749834 mE	DRILL TYPE: Fraste SL.G 3	HOLE STARTED: 21/11/2022
R.L.: 170.80m	METHOD: Rotary cored	HOLE FINISHED: 22/11/2022
DATUM: NZVD2016		DRILLED BY: ProDrill
		LOGGED BY: ANRO CHECKED: NCP



0.00-1.40m: HVAC

1.40-4.60m

CORE PHOTOS

BOREHOLE No.: **BH02**
Hole Location: North-western side of existing public pool. In middle of footpath into pool area, just outside (south-west) of gateway.
SHEET: 2 OF 3

PROJECT: Khandallah Pool Redevelopment	LOCATION: 45 Woodmancote Road, Khandallah, \	JOB No.: 1089174.0001
CO-ORDINATES: (NZTM2000) 5432852 mN 1749834 mE R.L.: 170.80m DATUM: NZVD2016	DRILL TYPE: Fraste SL.G 3 METHOD: Rotary cored	HOLE STARTED: 21/11/2022 HOLE FINISHED: 22/11/2022 DRILLED BY: ProDrill LOGGED BY: ANRO CHECKED: NCP

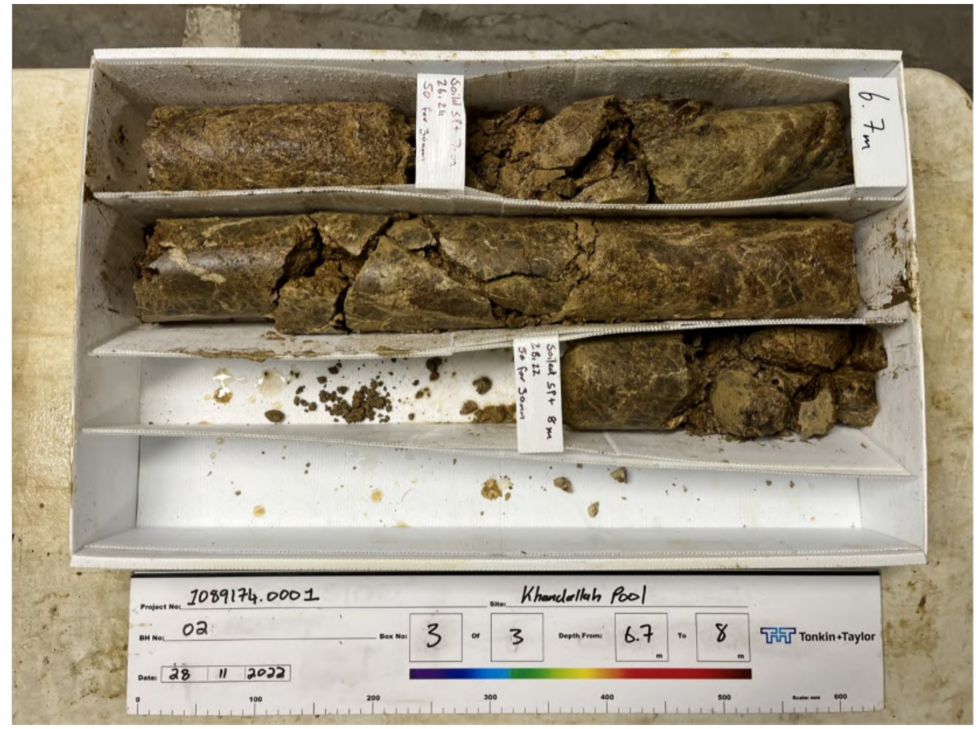
2.00-4.03m: SPT

4.60-6.70m

CORE PHOTOS

BOREHOLE No.: **BH02**
Hole Location: North-western side of existing public pool. In middle of footpath into pool area, just outside (south-west) of gateway.
SHEET: 3 OF 3

PROJECT: Khandallah Pool Redevelopment	LOCATION: 45 Woodmancote Road, Khandallah, \	JOB No.: 1089174.0001
CO-ORDINATES: (NZTM2000) 5432852 mN 1749834 mE R.L.: 170.80m DATUM: NZVD2016	DRILL TYPE: Fraste SL.G 3 METHOD: Rotary cored	HOLE STARTED: 21/11/2022 HOLE FINISHED: 22/11/2022 DRILLED BY: ProDrill LOGGED BY: ANRO CHECKED: NCP



6.70-8.11m

GEOTECHNICS

7 December 2022
Our Ref: 1089230.0000.1.0/Rep1
Customer Ref: 1089174.0001

Tonkin & Taylor Limited
PO Box 5271
Wellesley St
Auckland 1141

Attention: Bhavesh Rama

Dear Bhavesh

Khandallah Pool

Site Report – Geotechnical Investigation

Customer's Instructions

We were instructed to complete:

- The drilling of six window sampler boreholes to refusal.
- Associated down-hole Scala Penetrometer and shear vane testing.
- Log, photograph, and sample recovered material.
- Installation of standpipe piezometer in WS01

Dates of Procedures

14^{th}-15^{th} November 2022.

Locations

Test Locations were determined by Tonkin & Taylor Ltd.

The attached plan provides indicative locations only and is not to scale. All other information we provide regarding location should be referenced to the asset owner.

Coordinates are provided in the bore logs.

a Method used to determine locations: Google Earth
b Method used to determine RL: Estimated from contours
c Expected accuracy for location: ±5 m
d Expected accuracy for elevation: ±5 m

Methods

NZS 4402:1988 Test 6.5.2 - Determination of the penetration resistance of a soil (Hand method using a dynamic cone penetrometer) - Scala

NZGS 8:2001 - Test method for determining the vane shear strength of a cohesive soil using a hand held shear vane

Material Description

Refer to window sampler borehole logs.

Results

The following is attached:

- Test location plan
- Window sampler borehole logs
- Standpipe piezometer instrumentation log
- Scala Penetrometer tabulated results

Photos can be downloaded from the following link:

Khandallah Pool photographs

This link will expire on 28/02/2023 after which we can provide the photos upon request. Whilst we provide this information via link for your convenience, please note that once downloaded, we consider the information uncontrolled.

Test Remarks

Material Logging

Material logging and descriptions in the field are in general accordance with the New Zealand Geotechnical Society Inc in 'Guideline for the Field Classification of Soil and Rock for Engineering Purposes' (December 2005), excluding geological information and are based on the observational behaviour of the recovered material.

Scala

The estimated CBR values are based on Figure 5.3, Correlation of Dynamic Cone Penetration and CBR AUSTROADS (2019) "Pavement Design - A Guide to the Structural Design of Road Pavements".

Our standard test procedure is to over-drill Scala penetrometer tests every 1 m.

Shear Vane

Shear Vane tests are potentially unsuitable for material described in the borehole logs as 'non-plastic', 'sandy SILT' or 'silty SAND'. Tests in these materials may not be compliant with the stated test method.

General Remarks

This report has been prepared for the benefit of Tonkin & Taylor Limited, with respect to the particular brief given to us and it cannot be relied upon in other contexts or for any other purpose without our prior review and agreement.

The inherent uncertainties of site investigation work, mean the nature and continuity of subsoil away from the test location could vary from the data logged.

Sample(s) not destroyed during testing will be retained for one month from the date of this report before being discarded.

Please reproduce this report in full when transmitting to others or including in internal reports.

If we can be of any further assistance, feel free to get in touch. Contact details are provided at the bottom of the letterhead page.

GEOTECHNICS LTD

Report approved by:	Authorised for Geotechnics by:
	Digitally signed by Corey Papu-Gread DN: cn=Corey Papu-Gread, c=NZ, o=Geotechnics, email=cpapu-gread@geotechnics.co.nz Date: 2022.12.09 09:45:08 +13'00'
....	....
Alan Benton Geotechnics Wellington Manager	Corey Papu-Gread Project Director

7-Dec-22
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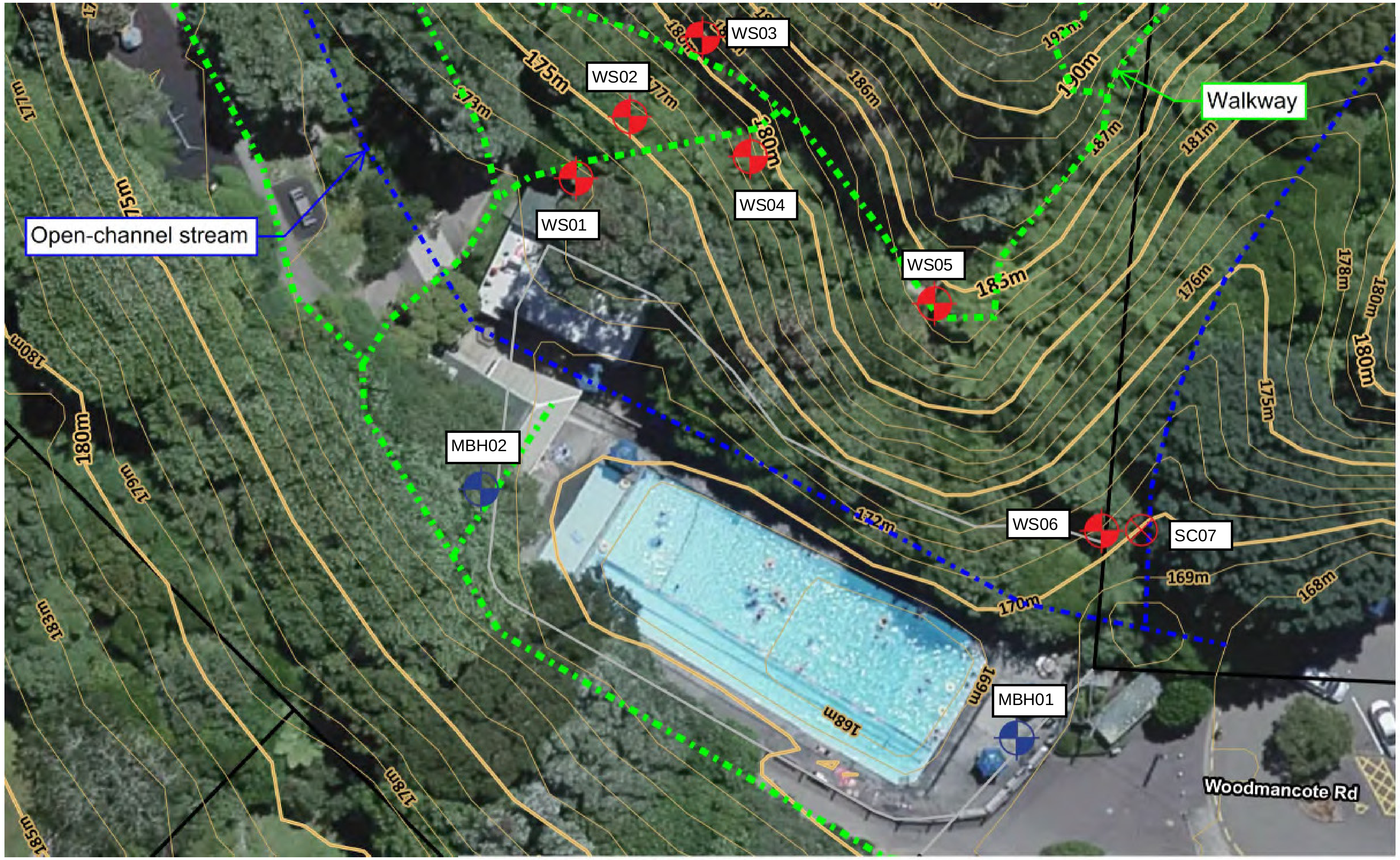

Legend	
Window sample BH	
Machine Bore hole	
Scala Penetrometer	

LOCATION PLAN

Locations are indicative only

GEOTECHNICS

Level 4, 2 Hunter Street
Wellington, 6011

Site	Site investigation	Our Ref	1089230.0000.1.0/Rep1	Drawn By	JATA	Date	29/11/22
Location	45 Woodmancote Road, Khandallah	Customer Ref	1089174.0001	Checked By	SELO	Date	29/11/22
Project	Khandallah Pool	Lab Ref	N/A	Scale	Not to Scale		

N

Aerial photograph(s) sourced from Google T&T Map Viewer (Copyright 2022)

GEOTECHNICS

BOREHOLE LOG

BOREHOLE No.: **WS01**

Hole Location: Refer to test location plan

SHEET: 1 OF 1

PROJECT: GWN KHANDALLAH POOL | LOCATION: 45 Woodmancote Road, Khandallah | JOB No.: 1089230.0000

CO-ORDINATES: (NZTM2000) 5432875.30 mN 1749838.60 mE
R.L.: 173.00m
DATUM: NZVD2016

DRILL TYPE: Window sampler
DRILL METHOD: WS
DRILL FLUID: N/A

HOLE STARTED: 15/11/2022
HOLE FINISHED: 15/11/2022
DRILLED BY: Geotechnics Ltd
LOGGED BY: SELO
CHECKED: JMG

GEOLOGICAL — GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.

FLUID LOSS (%) | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | RL (m) | DEPTH (m)

ENGINEERING DESCRIPTION — GRAPHIC LOG | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) | COMPRESSIVE STRENGTH (MPa) | DEFECT SPACING (cm) | Description and Additional Observations

Depth (m)	RL (m)	Core recovery (%)	Method	Casing	Tests	Moisture / Weathering	Strength	Description and Additional Observations
0.00		100	WS	60mm	● 69/13 kPa	M	F-St	*0.00m:* Sandy SILT, minor gravel; greyish brown. Firm to stiff, moist, low plasticity; sand, fine to coarse; gravel, fine to medium, angular to subangular. *0.20 - 0.50m:* Brown.
0.50							St	*0.50m:* SILT, minor sand; light brown. Stiff, moist, low plasticity; sand, fine.
1.0	172	100	WS	60mm	● 197/46 kPa		VSt	*1.00 - 1.80m:* Very stiff.
1.80								*1.80m:* SILT, some sand, minor gravel; brown. Very stiff, moist, low plasticity; sand, fine to coarse; gravel, fine, angular to subangular.
2.0	171	100	WS	45mm				
2.20						CW		*2.20m:* Completely weathered, brown, SANDSTONE. Very Weak.
2.40						HW		*2.40 - 2.60m:* Highly weathered. Weak.
2.6								2.6m: Refusal

Water: DRY 14/11/2022

COMMENTS:

Hole Depth 2.6m

Scale 1:15 — Rev.: A

BoreLog - 7/12/2022 3:38:54 pm - Produced with Core-GS by GeRoc

GEOTECHNICS

BOREHOLE INSTRUMENTATION SHEET

BOREHOLE No.: **WS01-Install**

Piezometer Type: Standpipe piezometer

SHEET: 1 OF 1

PROJECT: GWN KHANDALLAH POOL | LOCATION: 45 Woodmancote Road, Khandallah | JOB No.: 1089230.0000

CO-ORDINATES: (NZTM2000) 5432875.30 mN 1749838.60 mE
DIRECTION:
ANGLE FROM HORIZ.: -90°

DRILL TYPE: Window sampler
DATUM: NZVD2016
DRILLING DATUM R.L.: 173.00m
INSTRUMENT DATUM R.L.:

HOLE DRILLING FINISHED: 15/11/2022
INSTRUMENT COMPLETE: 15/11/2022
DRILLED BY: Geotechnics Ltd
INSTALLED: JATA/SELO
CHECKED: JMG

SUMMARY LOG — GEOLOGICAL UNIT | SUMMARY OF MATERIAL PROPERTIES (for a more detailed description of material, refer to the appropriate borehole log.) | DEPTH (m) | GRAPHIC LOG | ROCK WEATHERING | ROCK STRENGTH | FRACTURE LOG spacing of natural fractures (cm) | RQD (%) | DRILLING WATER LEVEL

INSTRUMENT DETAILS — INSTALLATION GRAPHIC LOG | INSTALLATION DATA, TYPE OF MONITORING INSTALLED, PIEZOMETER DETAILS, INCLINOMETER DETAILS ETC | RL (m)

Depth (m)	Summary of material properties	Installation data	RL (m)
0.00	*0.00m:* Sandy SILT, minor gravel; greyish brown. Firm to stiff, moist, low plasticity; sand, fine to coarse; gravel, fine to medium, angular to subangular.	Bentonite *[Device 1] Diameter: 32mm. Plain (impervious) pipe*	
0.5	*0.50m:* SILT, minor sand; light brown. Stiff, moist, low plasticity; sand, fine.	Sand	
1.0			172
1.80	*1.80m:* SILT, some sand, minor gravel; brown. Very stiff, moist, low plasticity; sand, fine to coarse; gravel, fine, angular to subangular.	*[Device 1] Diameter: 32mm. Slotted pipe*	
2.0			171
2.20	*2.20m:* Completely weathered, brown, SANDSTONE. Very Weak.		
2.6	2.6m: Refusal		

Drilling water level: DRY 14/11/2022

NOTES: **Piezometer 1:**

Hole Depth 2.6m

Scale 1:15 — Rev.: A

Instrument Log - 7/12/2022 3:38:57 pm - Produced with Core-GS by GeRoc

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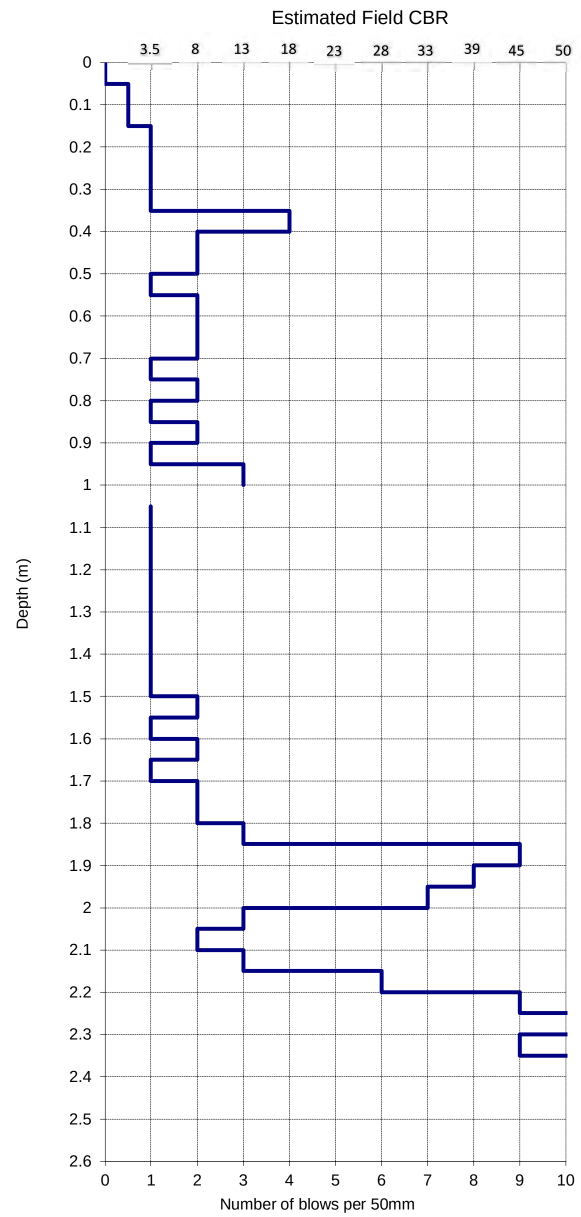
Lab Ref/URN: N/A

NZS 4402: 1988 Test 6.5.2 Dynamic Cone Penetrometer - Scala

Project Name	GWN KHANDALLAH POOL	Project ID	1089230.0000
Customer Project ID	1089174	Equipment ID	WGN 850
Site Location	45 Woodmancote Road, Khandallah, Wellington 6035	Material Source	N/A
Material Description	Refer to borehole WS01	Test Series	N/A
Depth from ground surface to commencement of penetration (m)		Test Number	SC1

Coordinate system		Datum
NZTM2000		NZVD2016
Northing	Easting	R.L.
5432875.30	1749838.60	173

Vertical distance driven (mm)	Depth (mm)	Number of blows	Vertical distance driven (mm)	Depth (mm)	Number of blows	Vertical distance driven (mm)	Depth (mm)	Number of blows
50	50	0	1750	1750	2	3450	3450	
100	100	0.5	1800	1800	2	3500	3500	
150	150	0.5	1850	1850	3	3550	3550	
200	200	1	1900	1900	9	3600	3600	
250	250	1	1950	1950	8	3650	3650	
300	300	1	2000	2000	7	3700	3700	
350	350	1	2050	2050	3	3750	3750	
400	400	4	2100	2100	2	3800	3800	
450	450	2	2150	2150	3	3850	3850	
500	500	2	2200	2200	6	3900	3900	
550	550	1	2250	2250	9	3950	3950	
600	600	2	2300	2300	11	4000	4000	
650	650	2	2350	2350	9	4050	4050	
700	700	2	2400	2400	11	4100	4100	
750	750	1	2450	2450		4150	4150	
800	800	2	2500	2500		4200	4200	
850	850	1	2550	2550		4250	4250	
900	900	2	2600	2600		4300	4300	
950	950	1	2650	2650		4350	4350	
1000	1000	3	2700	2700		4400	4400	
1050	1050	ws	2750	2750		4450	4450	
1100	1100	1	2800	2800		4500	4500	
1150	1150	1	2850	2850		4550	4550	
1200	1200	1	2900	2900		4600	4600	
1250	1250	1	2950	2950		4650	4650	
1300	1300	1	3000	3000		4700	4700	
1350	1350	1	3050	3050		4750	4750	
1400	1400	1	3100	3100		4800	4800	
1450	1450	1	3150	3150		4850	4850	
1500	1500	1	3200	3200		4900	4900	
1550	1550	2	3250	3250		4950	4950	
1600	1600	1	3300	3300		5000	5000	
1650	1650	2	3350	3350		5050	5050	
1700	1700	1	3400	3400		5100	5100	



Test Remarks

"WS" represents the window sampler over running and /or drilling beyond Scala Penetrometer refusal

The estimated CBR values are based on Figure 5.3, Correlation of Dynamic Cone Penetration and CBR AUSTROADS (2004) "Pavement Design - A Guide to the Structural Design of Road Pavements".
Please note Estimated Field CBR cannot be calculated over 10 blows.

Tested By	SELO/JATA	Date	15/11/2022
Data Entry By	JATA	Date	24/11/2022
Checked by	BBUR	Date	28/11/2022

GEOTECHNICS

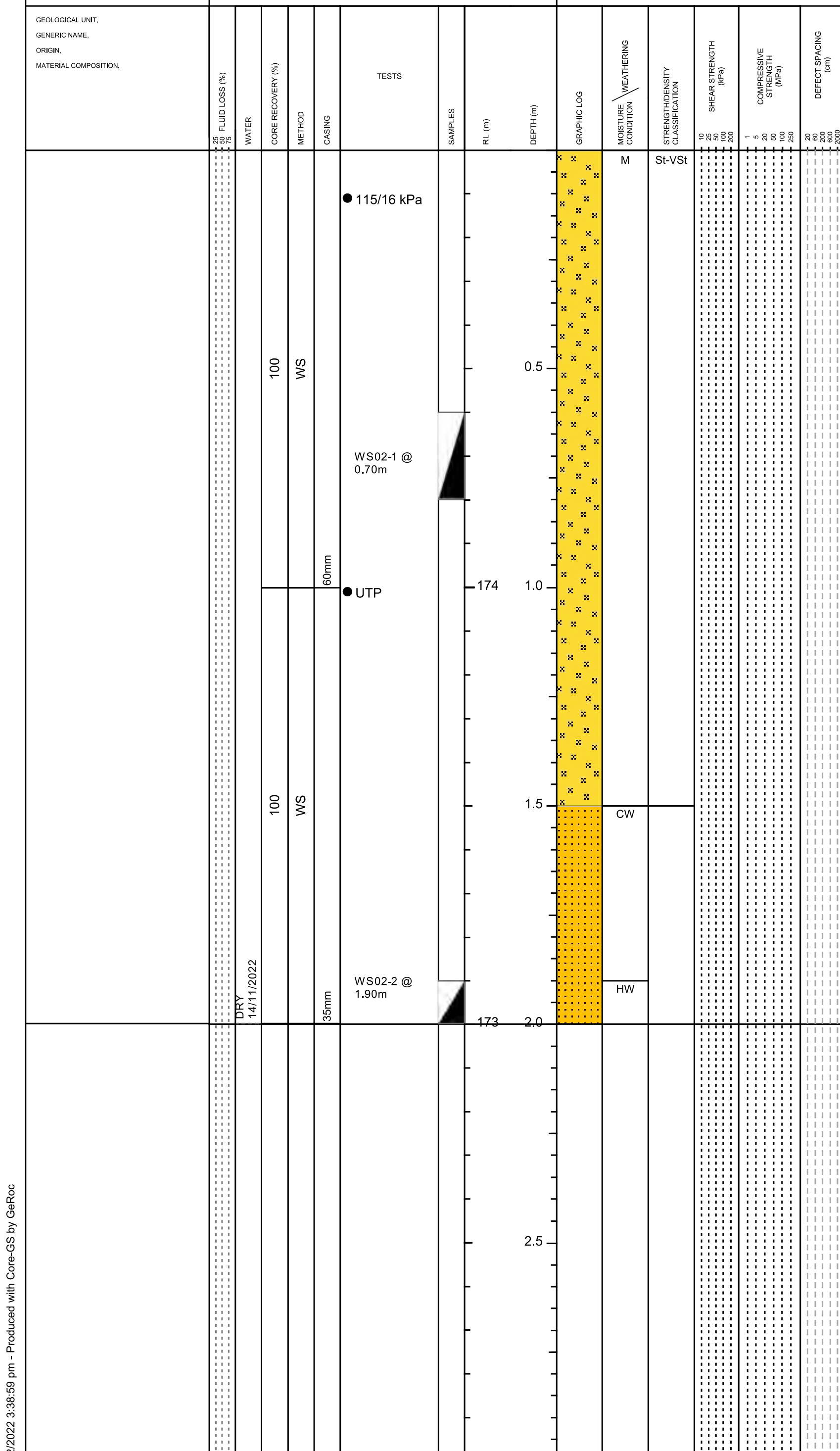
BOREHOLE LOG

BOREHOLE No.: **WS02**
Hole Location: Refer to test location plan
SHEET: 1 OF 1

PROJECT: GWN KHANDALLAH POOL — LOCATION: 45 Woodmancote Road, Khandallah — JOB No.: 1089230.0000

CO-ORDINATES: (NZTM2000)	5432881.15 mN 1749842.83 mE	DRILL TYPE: Window sampler	HOLE STARTED: 14/11/2022
R.L.:	175.00m	DRILL METHOD: WS	HOLE FINISHED: 14/11/2022
			DRILLED BY: Geotechnics Ltd
DATUM:	NZVD2016	DRILL FLUID: N/A	LOGGED BY: SELO CHECKED: JMG

GEOLOGICAL — ENGINEERING DESCRIPTION



Description and Additional Observations

0.00m: SILT, minor sand, trace gravel; light orange brown. Stiff to very stiff, moist, low plasticity; sand, fine to coarse; gravel, fine to coarse, angular to subangular.

0.50 - 1.50m: Some gravel. (highly weathered Sandstone).

1.50m: Completely weathered, light orange brown, SANDSTONE. Very Weak.

1.90 - 2.00m: Highly weathered. Weak.

2m: Refusal

COMMENTS:

Hole Depth 2m

Scale 1:15

BoreLog - 7/12/2022 3:38:59 pm - Produced with Core-GS by GeRoc

Rev.: A

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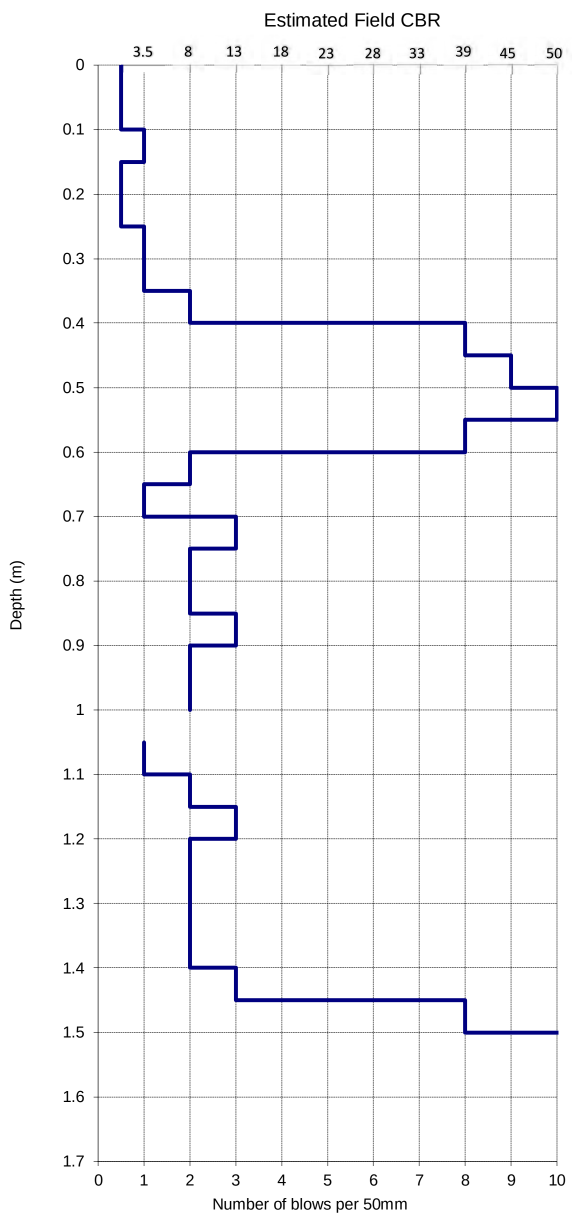
Lab Ref/URN: N/A

NZS 4402: 1988 Test 6.5.2 Dynamic Cone Penetrometer - Scala

Project Name	GWN KHANDALLAH POOL	Project ID	1089230.0000
Customer Project ID	1089174	Equipment ID	WGN 850
Site Location	45 Woodmancote Road, Khandallah, Wellington 6035	Material Source	N/A
Material Description	Refer to borehole WS02	Test Series	N/A
Depth from ground surface to commencement of penetration (m)		Test Number	SC2

Coordinate system		Datum
NZTM2000		NZVD2016
Northing	Easting	R.L.
5432881.15	1749842.83	175

Vertical distance driven (mm)	Depth (mm)	Number of blows	Vertical distance driven (mm)	Depth (mm)	Number of blows	Vertical distance driven (mm)	Depth (mm)	Number of blows
50	50	0.5	1750	1750		3450	3450	
100	100	0.5	1800	1800		3500	3500	
150	150	1	1850	1850		3550	3550	
200	200	0.5	1900	1900		3600	3600	
250	250	0.5	1950	1950		3650	3650	
300	300	1	2000	2000		3700	3700	
350	350	1	2050	2050		3750	3750	
400	400	2	2100	2100		3800	3800	
450	450	8	2150	2150		3850	3850	
500	500	9	2200	2200		3900	3900	
550	550	10	2250	2250		3950	3950	
600	600	8	2300	2300		4000	4000	
650	650	2	2350	2350		4050	4050	
700	700	1	2400	2400		4100	4100	
750	750	3	2450	2450		4150	4150	
800	800	2	2500	2500		4200	4200	
850	850	2	2550	2550		4250	4250	
900	900	3	2600	2600		4300	4300	
950	950	2	2650	2650		4350	4350	
1000	1000	2	2700	2700		4400	4400	
1050	1050	ws	2750	2750		4450	4450	
1100	1100	1	2800	2800		4500	4500	
1150	1150	2	2850	2850		4550	4550	
1200	1200	3	2900	2900		4600	4600	
1250	1250	2	2950	2950		4650	4650	
1300	1300	2	3000	3000		4700	4700	
1350	1350	2	3050	3050		4750	4750	
1400	1400	2	3100	3100		4800	4800	
1450	1450	3	3150	3150		4850	4850	
1500	1500	8	3200	3200		4900	4900	
1550	1550	13	3250	3250		4950	4950	
1600	1600	18	3300	3300		5000	5000	
1650	1650		3350	3350		5050	5050	
1700	1700		3400	3400		5100	5100	



Test Remarks

"WS" represents the window sampler over running and /or drilling beyond Scala Penetrometer refusal

The estimated CBR values are based on Figure 5.3, Correlation of Dynamic Cone Penetration and CBR AUSTROADS (2004) "Pavement Design - A Guide to the Structural Design of Road Pavements".

Please note Estimated Field CBR cannot be calculated over 10 blows.

Tested By	SELO/BBUR/YA	Date	14/11/2022
Data Entry By	JATA	Date	24/11/2022
Checked by	BBUR	Date	28/11/2022

BOREHOLE LOG

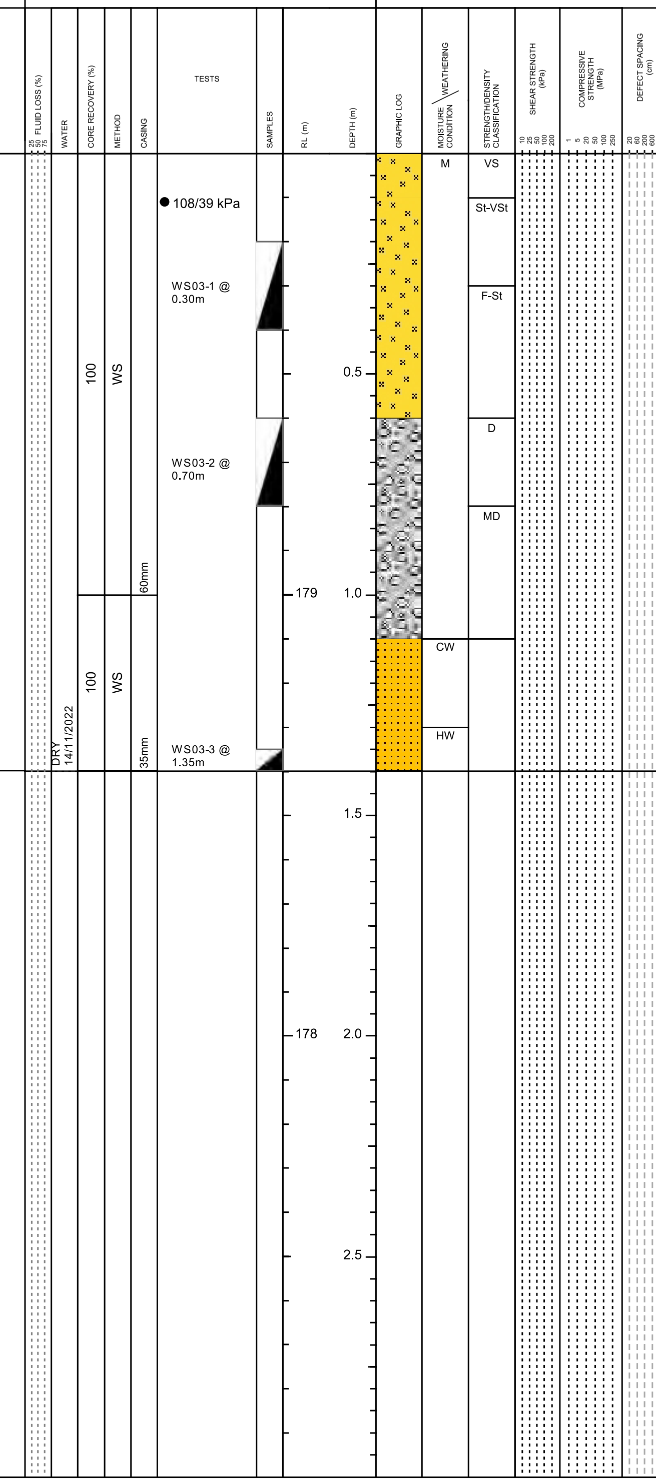
BOREHOLE No.: **WS03**
Hole Location: Refer to test location plan
SHEET: 1 OF 1

PROJECT: GWN KHANDALLAH POOL
LOCATION: 45 Woodmancote Road, Khandallah
JOB No.: 1089230.0000

CO-ORDINATES: (NZTM2000)	5432887.76 mN 1749847.33 mE	DRILL TYPE: Window sampler	HOLE STARTED: 14/11/2022
R.L.:	180.00m	DRILL METHOD: WS	HOLE FINISHED: 14/11/2022
			DRILLED BY: Geotechnics Ltd
DATUM:	NZVD2016	DRILL FLUID: N/A	LOGGED BY: SELO CHECKED: JMG

GEOLOGICAL — GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.

ENGINEERING DESCRIPTION



Description and Additional Observations

0.00m: SILT, trace rootlets and sand; bluish brown. Very soft, moist, low plasticity.

0.10m: SILT, minor sand, trace gravel; brown. Stiff to very stiff, moist, low plasticity; sand, fine to coarse; gravel, fine to medium, angular to subangular.

0.30 - 0.60m: Firm to stiff.

0.60m: Sandy GRAVEL, some silt; light brown. Dense, moist, well graded; gravel, fine to coarse, angular to subangular; sand, fine to coarse; (highly to completely weathered Sandstone) (Residual soil).

0.80 - 1.10m: Medium dense.

1.10m: Completely weathered, light greyish brown, SANDSTONE. Very Weak.

1.30 - 1.40m: Highly weathered. Weak.

1.4m: Refusal

COMMENTS:

Hole Depth 1.4m

Scale 1:15

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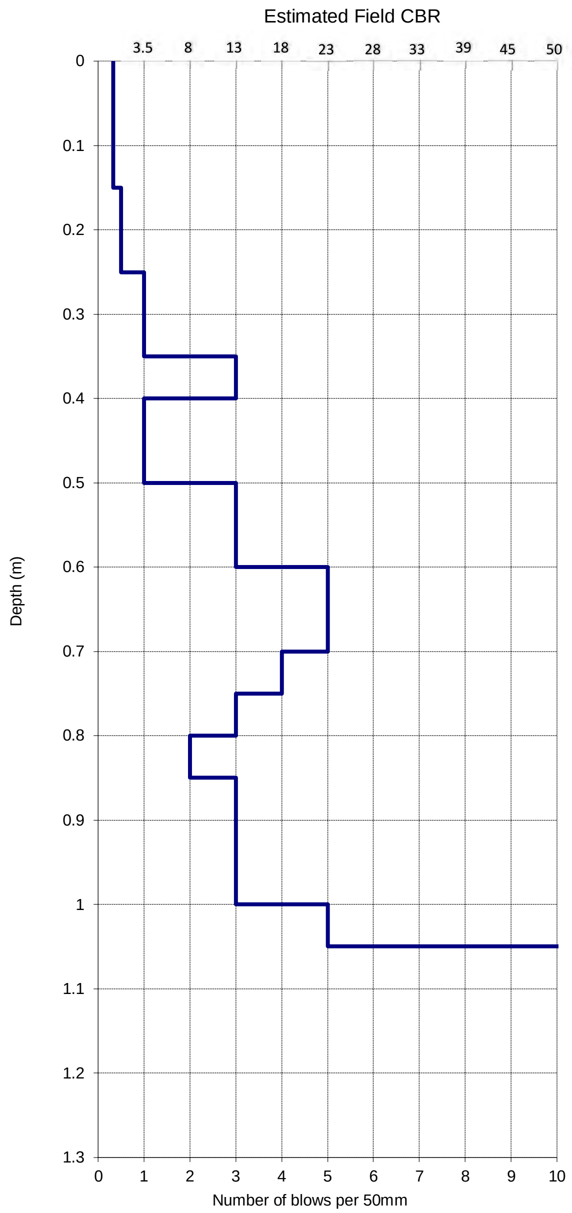
Lab Ref/URN
N/A

NZS 4402: 1988 Test 6.5.2 Dynamic Cone Penetrometer - Scala

Project Name	GWN KHANDALLAH POOL	Project ID	1089230.0000
Customer Project ID	1089174	Equipment ID	WGN 850
Site Location	45 Woodmancote Road, Khandallah, Wellington 6035	Material Source	N/A
Material Description	Refer to borehole WS03	Test Series	N/A
Depth from ground surface to commencement of penetration (m)		Test Number	SC3

Coordinate system		Datum
NZTM2000		NZVD2016
Northing	Easting	R.L.
5432887.76	1749847.33	180

Vertical distance driven (mm)	Depth (mm)	Number of blows	Vertical distance driven (mm)	Depth (mm)	Number of blows	Vertical distance driven (mm)	Depth (mm)	Number of blows
50	50	0.33	1750	1750		3450	3450	
100	100	0.33	1800	1800		3500	3500	
150	150	0.33	1850	1850		3550	3550	
200	200	0.5	1900	1900		3600	3600	
250	250	0.5	1950	1950		3650	3650	
300	300	1	2000	2000		3700	3700	
350	350	1	2050	2050		3750	3750	
400	400	3	2100	2100		3800	3800	
450	450	1	2150	2150		3850	3850	
500	500	1	2200	2200		3900	3900	
550	550	3	2250	2250		3950	3950	
600	600	3	2300	2300		4000	4000	
650	650	5	2350	2350		4050	4050	
700	700	5	2400	2400		4100	4100	
750	750	4	2450	2450		4150	4150	
800	800	3	2500	2500		4200	4200	
850	850	2	2550	2550		4250	4250	
900	900	3	2600	2600		4300	4300	
950	950	3	2650	2650		4350	4350	
1000	1000	3	2700	2700		4400	4400	
1050	1050	5	2750	2750		4450	4450	
1100	1100	16	2800	2800		4500	4500	
1150	1150	15	2850	2850		4550	4550	
1200	1200		2900	2900		4600	4600	
1250	1250		2950	2950		4650	4650	
1300	1300		3000	3000		4700	4700	
1350	1350		3050	3050		4750	4750	
1400	1400		3100	3100		4800	4800	
1450	1450		3150	3150		4850	4850	
1500	1500		3200	3200		4900	4900	
1550	1550		3250	3250		4950	4950	
1600	1600		3300	3300		5000	5000	
1650	1650		3350	3350		5050	5050	
1700	1700		3400	3400		5100	5100	



Test Remarks

The estimated CBR values are based on Figure 5.3, Correlation of Dynamic Cone Penetration and CBR AUSTROADS (2004) "Pavement Design - A Guide to the Structural Design of Road Pavements".
Please note Estimated Field CBR cannot be calculated over 10 blows.

Tested By	SELO/BBUR/YA	Date	14/11/2022
Data Entry By	JATA	Date	24/11/2022
Checked by	BBUR	Date	28/11/2022

GEOTECHNICS

BOREHOLE LOG

BOREHOLE No.: **WS04**
Hole Location: Refer to test location plan
SHEET: 1 OF 1

PROJECT: GWN KHANDALLAH POOL — LOCATION: 45 Woodmancote Road, Khandallah — JOB No.: 1089230.0000

CO-ORDINATES: (NZTM2000)	5432878.81 mN 1749848.49 mE	DRILL TYPE: Window sampler	HOLE STARTED: 14/11/2022
		DRILL METHOD: WS	HOLE FINISHED: 14/11/2022
R.L.:	177.00m		DRILLED BY: Geotechnics Ltd
DATUM:	NZVD2016	DRILL FLUID: N/A	LOGGED BY: SELO CHECKED: JMG

GEOLOGICAL — ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.

Columns: FLUID LOSS (%) (25, 50, 75) | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | RL (m) | DEPTH (m) | GRAPHIC LOG | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) (10, 25, 50, 100, 200) | COMPRESSIVE STRENGTH (MPa) (1, 5, 20, 50, 100, 250) | DEFECT SPACING (cm) (20, 60, 200, 600, 2000) | Description and Additional Observations

Depth (m)	RL (m)	Water	Core recovery (%)	Method	Casing	Tests	Samples	Moisture / Weathering	Strength/Density	Description and Additional Observations
0.00			100	WS	60mm			M	S	*0.00m:* SILT, minor peat (firm) and sand; dark blackish brown. Soft, moist, low plasticity; sand, fine to medium.
0.10						● 147/16 kPa			St-VSt	*0.10m:* SILT, some sand, trace gravel; dark brown. Stiff to very stiff, moist, low plasticity; sand, fine to coarse; gravel, fine to medium, angular to subangular. *0.30 - 0.80m:* Firm to stiff.
0.30									F-St	
0.80										*0.80m:* SILT, minor sand; light brown. Firm to stiff, moist, low plasticity; sand, fine. *1.00 - 1.65m:* Orange brown.
1.0	176		100	WS						
1.20						WS04-1 @ 1.20m				
1.50										*1.50 - 1.65m:* Trace gravel. Gravel, fine to medium, angular to subangular.
1.65		DRY 14/11/2022			35mm			CW		*1.65m:* Completely weathered, orange brown, SANDSTONE. Very Weak.
1.75						WS04-2 @ 1.75m		HW		*1.75 - 1.80m:* Highly weathered. Weak.
1.8										1.8m: Refusal
2.0	175									
2.5										

COMMENTS:

Hole Depth
1.8m

Scale 1:15

Rev.: A

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Lab Ref/URN: N/A

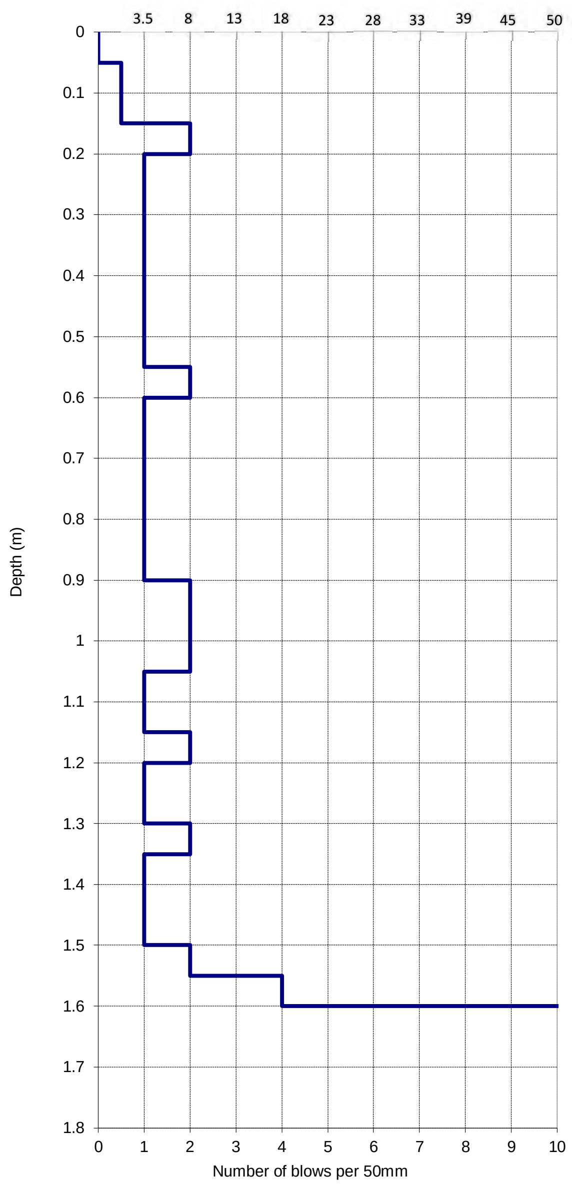
NZS 4402: 1988 Test 6.5.2 Dynamic Cone Penetrometer - Scala

Project Name	GWN KHANDALLAH POOL	Project ID	1089230.0000
Customer Project ID	1089174	Equipment ID	WGN 850
Site Location	45 Woodmancote Road, Khandallah, Wellington 6035	Material Source	N/A
Material Description	Refer to borehole WS04	Test Series	N/A
Depth from ground surface to commencement of penetration (m)		Test Number	SC4

Coordinate system		Datum
NZTM2000		NZVD2016
Northing	Easting	R.L.
5432878.81	1749848.49	177

Vertical distance driven (mm)	Depth (mm)	Number of blows	Vertical distance driven (mm)	Depth (mm)	Number of blows	Vertical distance driven (mm)	Depth (mm)	Number of blows
50	50	0	1750	1750		3450	3450	
100	100	0.5	1800	1800		3500	3500	
150	150	0.5	1850	1850		3550	3550	
200	200	2	1900	1900		3600	3600	
250	250	1	1950	1950		3650	3650	
300	300	1	2000	2000		3700	3700	
350	350	1	2050	2050		3750	3750	
400	400	1	2100	2100		3800	3800	
450	450	1	2150	2150		3850	3850	
500	500	1	2200	2200		3900	3900	
550	550	1	2250	2250		3950	3950	
600	600	2	2300	2300		4000	4000	
650	650	1	2350	2350		4050	4050	
700	700	1	2400	2400		4100	4100	
750	750	1	2450	2450		4150	4150	
800	800	1	2500	2500		4200	4200	
850	850	1	2550	2550		4250	4250	
900	900	1	2600	2600		4300	4300	
950	950	2	2650	2650		4350	4350	
1000	1000	2	2700	2700		4400	4400	
1050	1050	2	2750	2750		4450	4450	
1100	1100	1	2800	2800		4500	4500	
1150	1150	1	2850	2850		4550	4550	
1200	1200	2	2900	2900		4600	4600	
1250	1250	1	2950	2950		4650	4650	
1300	1300	1	3000	3000		4700	4700	
1350	1350	2	3050	3050		4750	4750	
1400	1400	1	3100	3100		4800	4800	
1450	1450	1	3150	3150		4850	4850	
1500	1500	1	3200	3200		4900	4900	
1550	1550	2	3250	3250		4950	4950	
1600	1600	4	3300	3300		5000	5000	
1650	1650	14	3350	3350		5050	5050	
1700	1700	14	3400	3400		5100	5100	

Estimated Field CBR



Test Remarks

The estimated CBR values are based on Figure 5.3, Correlation of Dynamic Cone Penetration and CBR AUSTROADS (2004) "Pavement Design - A Guide to the Structural Design of Road Pavements".
Please note Estimated Field CBR cannot be calculated over 10 blows.

Tested By	SELO/BBUR/YA	Date	14/11/2022
Data Entry By	JATA	Date	24/11/2022
Checked by	BBUR	Date	28/11/2022

GEOTECHNICS

BOREHOLE LOG

BOREHOLE No.: **WS05**
Hole Location: Refer to test location plan
SHEET: 1 OF 1

PROJECT: GWN KHANDALLAH POOL | LOCATION: 45 Woodmancote Road, Khandallah | JOB No.: 1089230.0000

CO-ORDINATES: (NZTM2000)	5432865.88 mN 1749866.29 mE	DRILL TYPE: Window sampler	HOLE STARTED: 14/11/2022
		DRILL METHOD: WS	HOLE FINISHED: 14/11/2022
R.L.:	184.00m		DRILLED BY: Geotechnics Ltd
DATUM:	NZVD2016	DRILL FLUID: N/A	LOGGED BY: SELO CHECKED: JMG

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.	FLUID LOSS (%) 25 50 75	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa) 10 25 50 100 200	COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250	DEFECT SPACING (cm) 20 60 200 600 2000	Description and Additional Observations
		DRY 14/11/2022	100	WS	35mm	WS05-1 @ 0.35m					M	S-F				*0.00m:* SILT, some sand and gravel, trace rootlets; dark brown. Soft to firm, moist, low plasticity; sand, fine to coarse, gravel, fine to coarse, subangular.
											HW					*0.20m:* Highly weathered, orange brown, SANDSTONE. Weak.
																0.4m: Refusal
									0.5							
								183	1.0							
									1.5							
								182	2.0							
									2.5							

COMMENTS:

Hole Depth 0.4m

Scale 1:15

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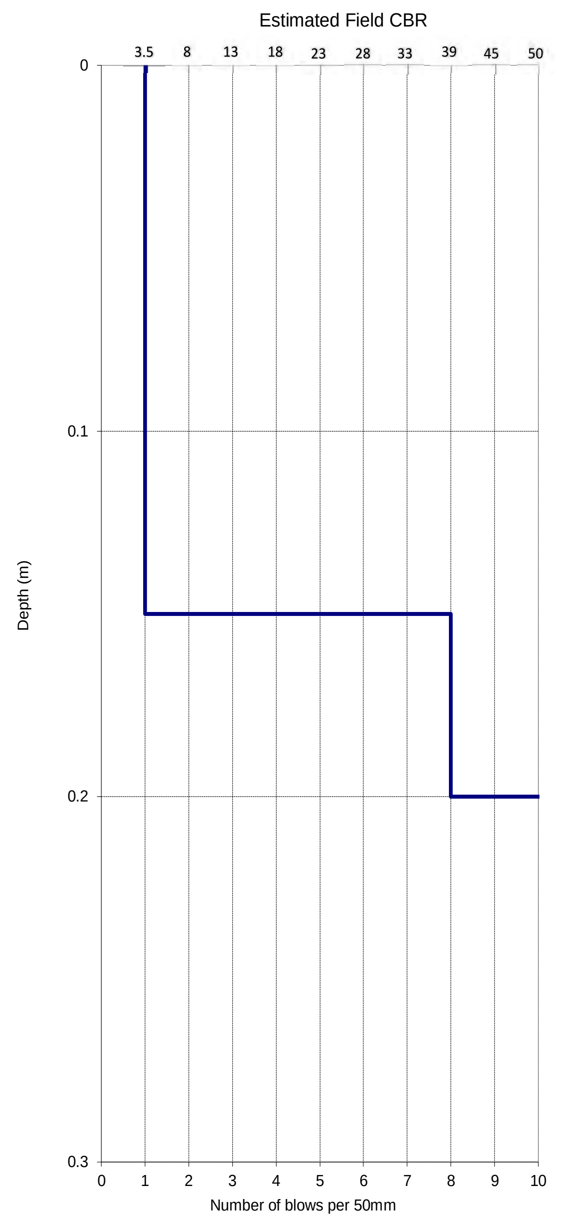
Lab Ref/URN: N/A

NZS 4402: 1988 Test 6.5.2 Dynamic Cone Penetrometer - Scala

Project Name	GWN KHANDALLAH POOL	Project ID	1089230.0000
Customer Project ID	1089174	Equipment ID	WGN 850
Site Location	45 Woodmancote Road, Khandallah, Wellington 6035	Material Source	N/A
Material Description	Refer to borehole WS05	Test Series	N/A
Depth from ground surface to commencement of penetration (m)		Test Number	SC5

Coordinate system		Datum
NZTM2000		NZVD2016
Northing	Easting	R.L.
5432865.88	1749866.29	184

Vertical distance driven (mm)	Depth (mm)	Number of blows	Vertical distance driven (mm)	Depth (mm)	Number of blows	Vertical distance driven (mm)	Depth (mm)	Number of blows
50	50	1	1750	1750		3450	3450	
100	100	1	1800	1800		3500	3500	
150	150	1	1850	1850		3550	3550	
200	200	8	1900	1900		3600	3600	
250	250	30	1950	1950		3650	3650	
300	300		2000	2000		3700	3700	
350	350		2050	2050		3750	3750	
400	400		2100	2100		3800	3800	
450	450		2150	2150		3850	3850	
500	500		2200	2200		3900	3900	
550	550		2250	2250		3950	3950	
600	600		2300	2300		4000	4000	
650	650		2350	2350		4050	4050	
700	700		2400	2400		4100	4100	
750	750		2450	2450		4150	4150	
800	800		2500	2500		4200	4200	
850	850		2550	2550		4250	4250	
900	900		2600	2600		4300	4300	
950	950		2650	2650		4350	4350	
1000	1000		2700	2700		4400	4400	
1050	1050		2750	2750		4450	4450	
1100	1100		2800	2800		4500	4500	
1150	1150		2850	2850		4550	4550	
1200	1200		2900	2900		4600	4600	
1250	1250		2950	2950		4650	4650	
1300	1300		3000	3000		4700	4700	
1350	1350		3050	3050		4750	4750	
1400	1400		3100	3100		4800	4800	
1450	1450		3150	3150		4850	4850	
1500	1500		3200	3200		4900	4900	
1550	1550		3250	3250		4950	4950	
1600	1600		3300	3300		5000	5000	
1650	1650		3350	3350		5050	5050	
1700	1700		3400	3400		5100	5100	



Test Remarks

The estimated CBR values are based on Figure 5.3, Correlation of Dynamic Cone Penetration and CBR AUSTROADS (2004) "Pavement Design - A Guide to the Structural Design of Road Pavements".
Please note Estimated Field CBR cannot be calculated over 10 blows.

Tested By	SELO/BBUR/YA	Date	14/11/2022
Data Entry By	JATA	Date	24/11/2022
Checked by	BBUR	Date	28/11/2022

GEOTECHNICS

BOREHOLE LOG

BOREHOLE No.: **WS06**
Hole Location: Refer to test location plan
SHEET: 1 OF 1

PROJECT: GWN KHANDALLAH POOL
LOCATION: 45 Woodmancote Road, Khandallah
JOB No.: 1089230.0000

CO-ORDINATES: (NZTM2000)	5432848.18 mN 1749880.15 mE	DRILL TYPE: Window sampler	HOLE STARTED: 15/11/2022
		DRILL METHOD: WS	HOLE FINISHED: 15/11/2022
R.L.:	172.00m		DRILLED BY: Geotechnics Ltd
DATUM:	NZVD2016	DRILL FLUID: N/A	LOGGED BY: SELO CHECKED: JMG

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.

FLUID LOSS (%) 25 50 75	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa) 10 25 50 100 200	COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250	DEFECT SPACING (cm) 20 60 200 600 2000	Description and Additional Observations
	DRY 15/11/2022	100	WS	60mm	WS06-1 @ 0.75m			0.5		M	F-St				*0.00m:* SILT, minor sand, trace gravel; brown. Firm to stiff, moist, low plasticity; sand, fine to coarse; gravel, fine to coarse, angular to subangular.
											MD				*0.20m:* Gravelly SAND, some silt; brown. Medium dense, moist, well graded; sand, fine to coarse; gravel, fine to coarse, angular to subangular, Sandstone. *0.40 - 0.60m:* Very dense.
											VD				
										CW					*0.60m:* Completely weathered, brown, SANDSTONE. Very Weak. *0.70 - 0.80m:* Moderately to Highly weathered, Weak to Moderately strong.
										MW-HW					
							171	1.0							0.8m: Refusal
								1.5							
							170	2.0							
								2.5							

COMMENTS:

Hole Depth 0.8m

Scale 1:15

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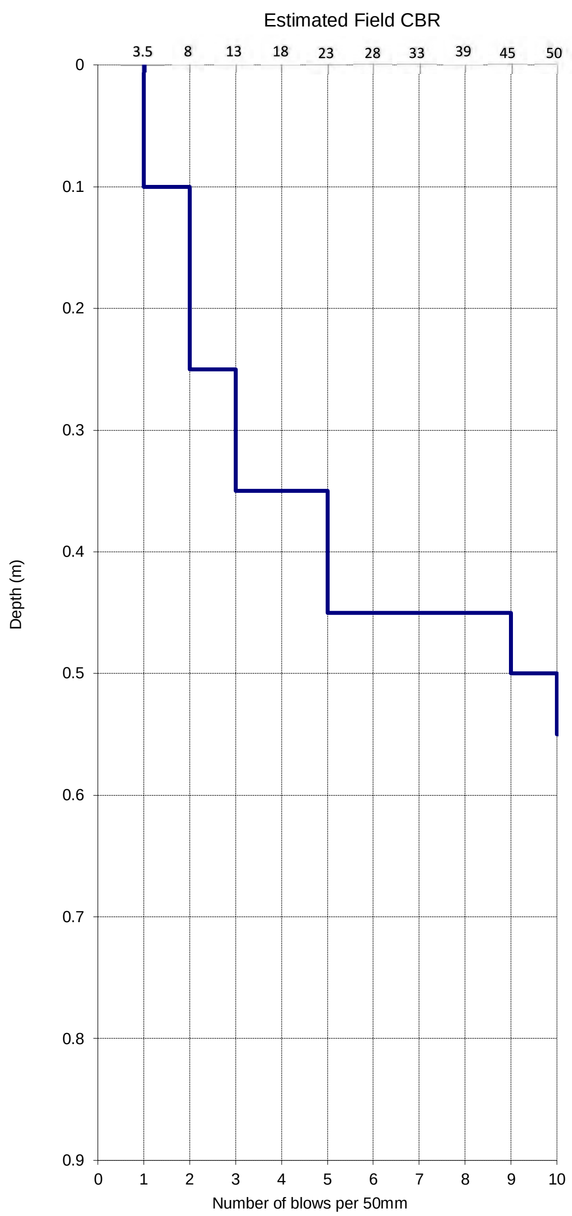
NZS 4402: 1988 Test 6.5.2 Dynamic Cone Penetrometer - Scala

Project Name	GWN KHANDALLAH POOL	Project ID	1089230.0000
Customer Project ID	1089174	Equipment ID	WGN 850
Site Location	45 Woodmancote Road, Khandallah, Wellington 6035	Material Source	N/A
Material Description	Refer to borehole WS06	Test Series	N/A
Depth from ground surface to commencement of penetration (m)		Test Number	SC6

Coordinate system		Datum
NZTM2000		NZVD2016
Northing	Easting	R.L.
5432848.18	1749880.15	172

Vertical distance driven (mm)	Depth (mm)	Number of blows	Vertical distance driven (mm)	Depth (mm)	Number of blows	Vertical distance driven (mm)	Depth (mm)	Number of blows
50	50	1	1750	1750		3450	3450	
100	100	1	1800	1800		3500	3500	
150	150	2	1850	1850		3550	3550	
200	200	2	1900	1900		3600	3600	
250	250	2	1950	1950		3650	3650	
300	300	3	2000	2000		3700	3700	
350	350	3	2050	2050		3750	3750	
400	400	5	2100	2100		3800	3800	
450	450	5	2150	2150		3850	3850	
500	500	9	2200	2200		3900	3900	
550	550	10	2250	2250		3950	3950	
600	600	15	2300	2300		4000	4000	
650	650	ws	2350	2350		4050	4050	
700	700	ws	2400	2400		4100	4100	
750	750	ws	2450	2450		4150	4150	
800	800	17	2500	2500		4200	4200	
850	850	20	2550	2550		4250	4250	
900	900		2600	2600		4300	4300	
950	950		2650	2650		4350	4350	
1000	1000		2700	2700		4400	4400	
1050	1050		2750	2750		4450	4450	
1100	1100		2800	2800		4500	4500	
1150	1150		2850	2850		4550	4550	
1200	1200		2900	2900		4600	4600	
1250	1250		2950	2950		4650	4650	
1300	1300		3000	3000		4700	4700	
1350	1350		3050	3050		4750	4750	
1400	1400		3100	3100		4800	4800	
1450	1450		3150	3150		4850	4850	
1500	1500		3200	3200		4900	4900	
1550	1550		3250	3250		4950	4950	
1600	1600		3300	3300		5000	5000	
1650	1650		3350	3350		5050	5050	
1700	1700		3400	3400		5100	5100	



Test Remarks

"WS" represents the window sampler over running and /or drilling beyond Scala Penetrometer refusal

The estimated CBR values are based on Figure 5.3, Correlation of Dynamic Cone Penetration and CBR AUSTROADS (2004) "Pavement Design - A Guide to the Structural Design of Road Pavements".
Please note Estimated Field CBR cannot be calculated over 10 blows.

Tested By	SELO/JATA	Date	15/11/2022
Data Entry By	JATA	Date	24/11/2022
Checked by	BBUR	Date	28/11/2022

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Lab Ref/URN
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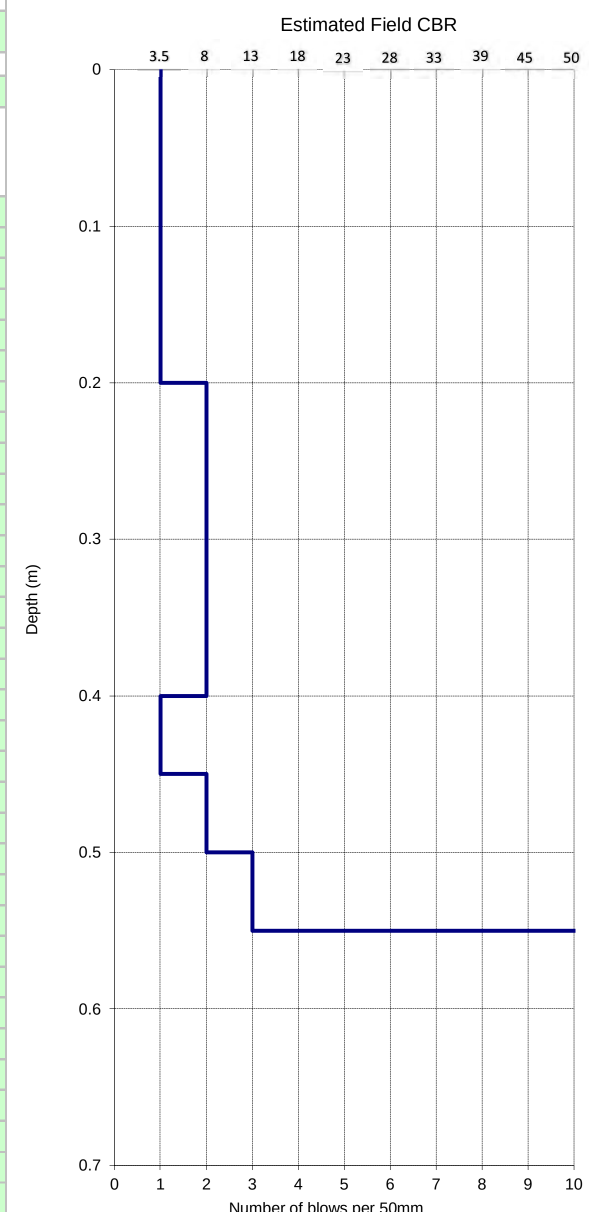
NZS 4402: 1988 Test 6.5.2 Dynamic Cone Penetrometer - Scala

Project Name	GWN KHANDALLAH POOL	Project ID	1089230.0000
Customer Project ID	1089174	Equipment ID	WGN 850
Site Location	45 Woodmancote Road, Khandallah, Wellington 6035	Material Source	N/A
Material Description	Silt & Gravely Sand	Test Series	N/A
Depth from ground surface to commencement of penetration (m)		Test Number	SC7

Coordinate system		Datum
NZTM2000		NZVD2016
Northing	Easting	R.L.
5432848.18	1749880.15	172

Vertical distance driven (mm)	Depth (mm)	Number of blows	Vertical distance driven (mm)	Depth (mm)	Number of blows	Vertical distance driven (mm)	Depth (mm)	Number of blows
50	50	1	1750	1750		3450	3450	
100	100	1	1800	1800		3500	3500	
150	150	1	1850	1850		3550	3550	
200	200	1	1900	1900		3600	3600	
250	250	2	1950	1950		3650	3650	
300	300	2	2000	2000		3700	3700	
350	350	2	2050	2050		3750	3750	
400	400	2	2100	2100		3800	3800	
450	450	1	2150	2150		3850	3850	
500	500	2	2200	2200		3900	3900	
550	550	3	2250	2250		3950	3950	
600	600	15	2300	2300		4000	4000	
650	650	18	2350	2350		4050	4050	
700	700		2400	2400		4100	4100	
750	750		2450	2450		4150	4150	
800	800		2500	2500		4200	4200	
850	850		2550	2550		4250	4250	
900	900		2600	2600		4300	4300	
950	950		2650	2650		4350	4350	
1000	1000		2700	2700		4400	4400	
1050	1050		2750	2750		4450	4450	
1100	1100		2800	2800		4500	4500	
1150	1150		2850	2850		4550	4550	
1200	1200		2900	2900		4600	4600	
1250	1250		2950	2950		4650	4650	
1300	1300		3000	3000		4700	4700	
1350	1350		3050	3050		4750	4750	
1400	1400		3100	3100		4800	4800	
1450	1450		3150	3150		4850	4850	
1500	1500		3200	3200		4900	4900	
1550	1550		3250	3250		4950	4950	
1600	1600		3300	3300		5000	5000	
1650	1650		3350	3350		5050	5050	
1700	1700		3400	3400		5100	5100	

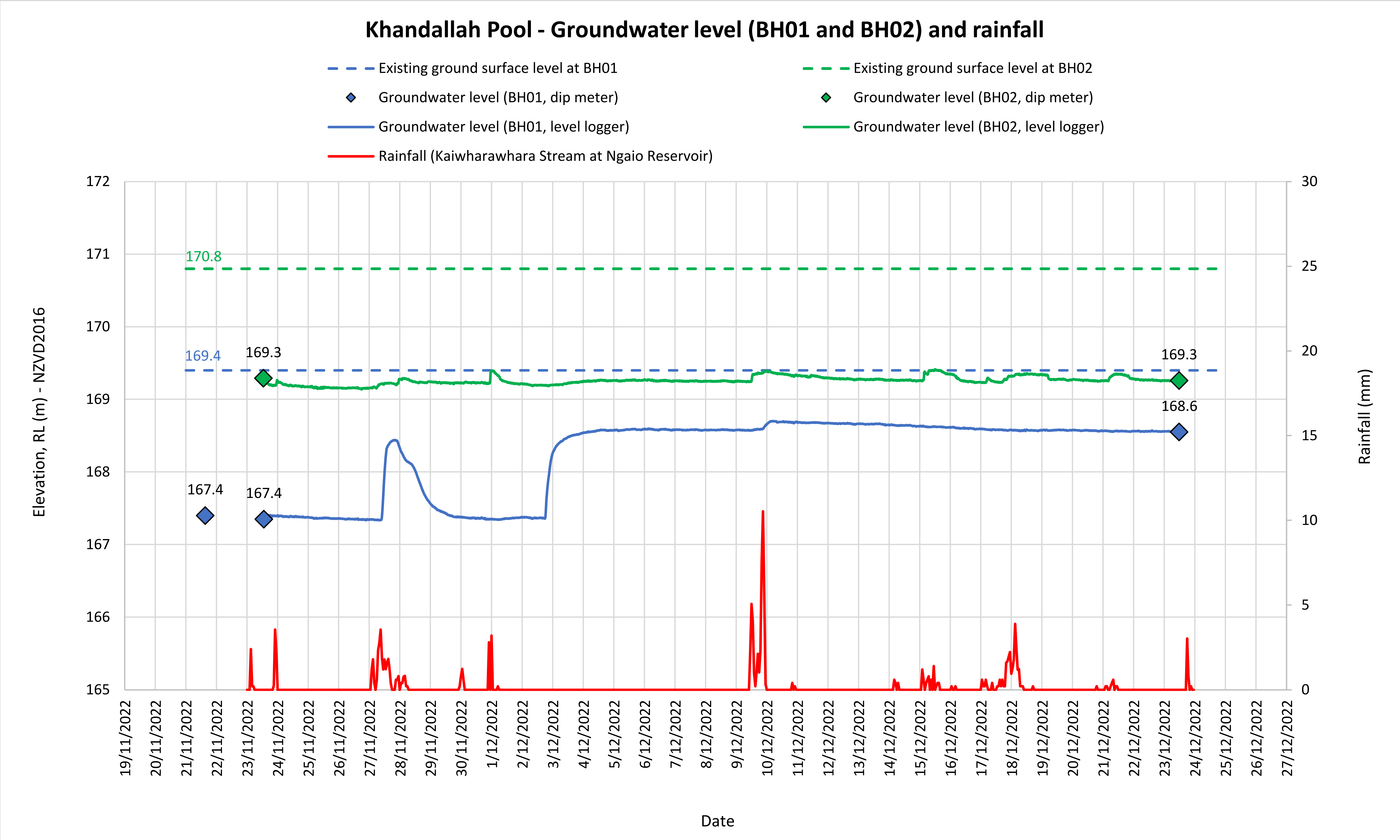


Test Remarks

Adjacent from WS06

The estimated CBR values are based on Figure 5.3, Correlation of Dynamic Cone Penetration and CBR AUSTROADS (2004) "Pavement Design - A Guide to the Structural Design of Road Pavements".
Please note Estimated Field CBR cannot be calculated over 10 blows.

Tested By	SELO/BBUR/YA	Date	15/11/2022
Data Entry By	JATA	Date	24/11/2022
Checked by	BBUR	Date	28/11/2022



Khandallah Pool - Groundwater level (BH01 and BH02) and rainfall
Existing ground surface level at BH01
Existing ground surface level at BH02
Groundwater level (BH01, dip meter)
Groundwater level (BH02, dip meter)
Groundwater level (BH01, level logger)
Groundwater level (BH02, level logger)
Rainfall (Kaiwharawhara Stream at Ngaio Reservoir)
Elevation, RL (m) - NZVD2016
Rainfall (mm)
Date
170.8
169.4
169.3
169.3
168.6
167.4
167.4
172
171
170
169
168
167
166
165
30
25
20
15
10
5
0
19/11/2022
20/11/2022
21/11/2022
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