Geotechnical Assessment Report

JOB NUMBER: 23-1883

Waikato Thoroughbred Racing Greenfield Racing Hub

PROJECT

Waikato Thoroughbred Racing

CLIENT

Referral Application – REV 5
17 April 2026

23-1883 Waikato Thoroughbred Racing – Greenfield Racing Hub

Prepared for: Waikato Thoroughbred Racing **Project no:** 23-1883

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Revision	Date	Status	Authorised by:
3	06/03/2025	Draft Referral	**Mike Trigger | Environmental and Infrastructure Manager BSc, MEngSc, CPEng, Int PE**
4	02/04/2026	Draft Referral - updated	**Mike Trigger | Environmental and Infrastructure Manager BSc, MEngSc, CPEng, Int PE**
5	17/04/2026	Referral Application	**Mike Trigger | Environmental and Infrastructure Manager BSc, MEngSc, CPEng, Int PE**

EXECUTIVE SUMMARY

Waikato Thoroughbred Racing is master planning a new racecourse on Pencarrow Road, Tamahere. BCD Group Limited (BCD) has been requested to provide geotechnical engineering services for the project. This report presents a summary of our assessments, provides recommendations, and next steps for Waikato Thoroughbred Racing. This report is to help inform Waikato Thoroughbred Racing of the geotechnical risk and geotechnical next steps for the project.

Sufficient testing geotechnical assessment has been undertaken for the referral application to identify that there are no significant geotechnical issues that would prevent this development proceeding. The key risks are liquefaction and shallow groundwater. Both can be managed through design and construction with geotechnical input. Accordingly no offsite geotechnical effects are anticipated as a result of this development.

	Item	Comments
Our key findings	Services	BeforeUDig and council GIS indicates that there are no public or network utilities within the site or close to the boundary that would affect the proposal
	'Good ground'	The site is not considered to be 'Good Ground' due to the liquefaction and static settlement risk on the site.
	Liquefaction risk	The site is susceptible to liquefaction. The results for Importance Levels 1 to 3 are discussed in Section 6.1. This risk can be addressed through the implementation of detailed geotechnical design and construction methodologies.
	Lateral spread risk	Lateral spread is not specifically assessed in this report. The primary risk is related to the stormwater detention ponds proposed for the development. Once the preliminary design of the stormwater detention ponds have been completed and levels and location are known, a lateral spread risk assessment should be undertaken. This risk can be addressed through the implementation of detailed geotechnical design and construction methodologies.
	Slope stability risk	The slopes on site are generally no steeper than 1V:6H and are not considered to have a risk of slope instability. New slopes should be specifically assessed, although 1V:2.5H can be adopted for preliminary purposes for dry slopes. For ponds or other areas where cuts may be below the water table, shallower slope angles may be required. This risk can be addressed through the implementation of detailed geotechnical design and construction methodologies.
	Expansive soils	The near surface soils are non-cohesive sands or silts. They are not considered to be expansive as defined in B1.
	Settlement	The site has a relatively low static settlement risk due to the underlying sandy soils. However, there are softer clay and silt layers in the soil profile that are compressible. If necessary, these can be managed by excavation and replacement or rolling pre-loads.
	Bearing Strength	For IL2 and IL3 structures, due to liquefaction risk, the bearing capacity of the natural soils is unlikely to govern the foundation design and will therefore require specific design For light weight IL1 structures, an ultimate geotechnical bearing capacity of (qu) 300kPa may be used for design of shallow foundations with vertical central loads.

Discussion	Earthworks	Some earthworks will be required for the site to form the landscape and provide a level platform for structures. Earthworks discussion is in Section 7.1
	Horse Tracks	Track surfaces are yet to be determined. The main consideration will be depth to groundwater. Other key considerations will be subgrade type and strength, which will vary across the track and drainage of surface water.
	Building and Structures	Buildings and structures on the site will need to consider liquefaction risk and consequences appropriate for the importance level, construction type and intended use. Section 7.4 provides commentary.
	Infrastructure	The sites facilities will have infrastructure such as ponds, stormwater and wastewater systems and inground infrastructure. High ground water and potential for liquefaction are considerations for both design and construction. Key details are discussed in Section 0.
Next Steps	Substantive Application and Post Resource Consent	Future stages will need further geotechnical investigations and assessment as outlined in Section 0 of this report

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1 INTRODUCTION

Waikato Thoroughbred Racing (WTR) is master planning for a new racecourse at Pencarrow Road, Tamahere. BCD Group Limited (BCD) has been requested to provide geotechnical engineering services for the project. This report presents a summary of our assessments and recommendations for the referral application.

The subject site is a collection of titles, the legal descriptions and usage follow:

- 636 Pencarrow Road, Tamahere, Hamilton (1)
  - Section 49 SO 457609 – approximately 37.6 ha
- 592 Pencarrow Road, Tamahere, Hamilton (2)
  - Lot 1 DP 471383 – approximately 23.8 ha
- 536 Pencarrow Road, Tamahere, Hamilton (3)
  - Lot 2 DP 471383 – approximately 18.5 ha
- 37 Hooker Road & 38 Duncan Road, Tamahere, Hamilton (4)
  - Section 2 SO 547526 – approximately 69.7 ha
- 90 Duncan Road, Tamahere, Hamilton (5)
  - Lot 2 DP 16925 – approximately 14.2 ha

Figure 1: Aerial view of site and surrounding area

The site is within the jurisdictions of Waikato Regional Council (WRC) and Waikato District Council (WDC).

The scope of this assessment was carried out in accordance with our Short Form Agreement dated 11/11/2025 and may be used to help inform Waikato Thoroughbred Racing of the geotechnical risk and geotechnical next steps for the project.

1.1 Revision History

Revision	Status	Reason
1	Master Planning	Original Document.
2	Master Planning	Updated to reflect draft master plan by Designgroup Stapleton Elliott + COX dated 15 December 2025.
3	Draft Referral	Updated to reflect draft master plan V2 rev 2 by Designgroup Stapleton Elliott + COX dated 24 February 2026 and provide additional comments around a proposed residential subdivision for the Fast Track Referral Application.
4	Draft Referral update	Updated to include geotechnical investigations at 90 Duncan Road Tamahere and include commentary on ponds near the Waikato Expressway.
5	Referral Application	Updated for Referral Application and inclusion of the updated proposed site layout plan by Designgroup Stapleton Elliott + COX dated April 2026.

2 PROJECT DESCRIPTION

The purpose of the Project is to create a unique, world class greenfield racing hub designed for horse training, racing and other equine related activities, while bringing the expertise and strength of the local racing fraternity together in a centralised location.

This enables the local racing industry to be more streamlined, competitive, sustainable and future focused while bringing potential international investment and creating a 'destination' for horse racing in New Zealand, also increasing tourism opportunities for the wider region.

A key driver behind the proposed greenfield equine hub and racecourses is enabling the consolidation of four separate racecourse facilities (Te Rapa, Waipa and Cambridge thoroughbred courses, and the Cambridge harness track).

These facilities duplicate assets and resources and, given their current condition require significant levels of upgrades and investment to provide fit-for-purpose facilities that meet the higher standards of the modern-day racecourse experience. The retirement of these areas also frees up significant tracts of land within existing urban areas for future development, increasing housing supply.

To support the development's financial viability and enhance the site's long-term vibrancy as a racing, entertainment, commercial and community precinct, the proposal includes a range of complementary activities on the remaining land. These include equine support services, rural residential housing, a retirement living community, a village centre and a bloodstock sales precinct.

The Proposed Site Layout Plan by Designgroup Stapleton Elliott + COX dated April 2026 are included in Appendix A. The plan shows the development area for the project and the location for:

- Four different tracks which include a horse racetrack, training track, warm up track, and trotting track.
- Facilities such as stables and spectator/course management facilities, commercial areas, and sports facilities.
- Infrastructure which consists of three stormwater detention / irrigation storage ponds and track underpasses and a network of internal roads.
- Commercial and Residential Areas.

Preliminary cut and fill depths and volumes associated with the development of the site are discussed in a BCD Civil Report.

3 SITE DESCRIPTION

The site is located in the Tamahere area, approximately 7km southeast of the urban boundary of Hamilton City and 5km northwest of Cambridge. The site location, topography and geological plans are in Appendix B.

The site is zoned rural and is primarily used as a dairy farm. Several farm buildings are present across the site. Vegetation cover across the property is predominantly pasture with medium sized trees scattered predominantly across the southern half of the site with farm tracks generally following the boundaries of the properties and points between buildings. Farm drains are scattered throughout the properties.

The site has several existing access locations from Pencarrow Road, Hooker Road and Duncan Road. The site appears to be relatively level to very gently rolling. However, there is approximately four metres of fall from south-east to north-west. The toe of a rolling hill typical of the Waikato Basin is present adjacent to Pencarrow Road.

Based on LiDAR from LINZ the elevation of the existing ground surface at the site varies from approximately RL[1] 53m to 57m across the general site and RL 54.5m to 59m along the Pencarrow Road corridor boundary.

The site does not have connections to council reticulation for wastewater and stormwater which are likely managed locally within the properties via soakholes, septic tanks and wastewater soakage fields.

Overland flow would flow from the south side of the site towards the north. A separate flood assessment has been prepared by BCD.

4 DESKTOP REVIEW

The WDC/WRC GIS system[2] and the GNS website[3] were checked by BCD on 27/11/2025 for mapped natural hazards and buried services. Aerial photographs of the site were reviewed using the Council Acronym GIS system, Retrolens and Google Earth Pro.

4.1 Geological Setting

The 1:63:000 geological map has been reviewed which shows that the sites are underlain by Hinuera Formation. The Hinuera Formation was deposited progressively between 50 and 17 thousand years ago by a braided river system over and around the older hill topography in the Waikato Basin. The Hinuera Formation consists of volcanogenic gravel, sand and silt that can also contain pumice. Surface and subsurface peat or organic silt deposits can be present. There is distinct crossbedding throughout the formation, and soil conditions can be highly variable vertically and laterally.

The low hills of the Waikato Basin consist of several meters of airfall tephra from multiple events, collectively termed the Hamilton Ash, which in turn overlies the pre-Hamilton Ash deposits collectively known as the Walton subgroup.

4.1.1 Close Proximity Active Faults

The GNS active fault database indicates that the nearest active fault is the Kerepehi Fault located approximately 40km northeast to east of the site. The risk of fault rupture is considered low based on current information.

4.2 Historic Aerial Imagery

BCD has reviewed predevelopment imagery on Retrolens and more recent images on Google Earth Pro which indicated that the properties have generally been used for farming. No geological features or ground modification, beyond farming activities were identified.

[1] Reduced Level to New Zealand Vertical Datum 2016 (NZVD2016)
[2] Waikato District Council Maps & Maps | Waikato Regional Council
[3] https://data.gns.cri.nz/af/ (checked on 27/03/2025)

4.3 Council GIS

The WRC Hazard Portal shows that a Level A Liquefaction desktop study has been conducted for the site. The Level A assessment indicates that the liquefaction risk for the site has been determined to be "Possible". However, around the elevated areas along Pencarrow Road and Hooker Road located west and south of the site is considered "Unlikely" based on the geology of the area.

We have undertaken a site-specific assessment which is detailed in Section 6.1.

4.4 Minimum Floor Level and Flooding

The site is located outside the Waikato District Council mapped flood hazard areas. A site-specific flood hazard assessment has been prepared by BCD.

4.5 Buried Services

BeforeUDig and council GIS indicates that there are no public or network utilities within the site or close to the boundary that would affect the proposal.

5 GEOTECHNICAL INVESTIGATIONS

5.1 Investigation Procedure

The following investigations were undertaken by BCD to evaluate the subsurface conditions at the site on 10-14/11/2025. Investigation data can be found in Appendix C. CPT data have not been attached and may be made available on request.

- 14x hand augers (HA) up to 3m depth over area of the proposed property.
- 10x cone penetrometer tests (CPT) up to 20m deep over the area of the proposed property
- Soil permeability tests up to 2m depth for stormwater management.
- 10x Piezometers were installed up to 3m deep[4].
- Three additional hand augers were undertaken on 18/12/2025.
- Four additional hand augers and two CPT were undertaken on 24/03/2026 on 90 Duncan Road

5.2 Subsoil Profile

The subsoil profile encountered at the site is typical of the area surrounding the site and is consistent with the mapped regional geology.

5.2.1 Surficial Soils

The near surface conditions as encountered in the hand augers consist of 100-300mm of Topsoil.

Below the topsoil, the general soil profile consisted of a 0.3m to 0.5m thick layer of stiff to very stiff silts overlaying interbedded sands and silts. The sands generally dominated the soil profile and were loose to dense (Hinuera Formation).

Due to poor soil recovery, Scala penetrometer testing was continued below the hand auger depths and is shown on the logs.

HA06 was undertaken on the low-lying hill located near the western boundary. The soil profile consisted of clayey silts through to the base of the investigation.

[4] Waikato Regional Council consent AUTH148356.01.01

5.2.2 Deeper soils

The CPTs indicate the deeper soil profile consists of sands, with varying thickness of silt and clay lenses through to the base of the CPTs.

5.3 Groundwater

Groundwater was encountered at depths of 0.9m to 2.8m below ground level (bgl) at the time of the investigation in November. The groundwater was shallowest on the northeastern part of the site with groundwater progressively deepening towards the west and south. However, the depth variation is also a function of the changes in the ground surface elevation. When converted to reduced levels the groundwater is between RL 52m to 53.5m which is considered typical of spring levels in the area and is likely to be higher following periods of prolonged or intense rainfall.

BCD have installed piezometers in selected locations across the site and will be periodically monitoring them over the duration of the design works. Over the period from December 2025 to mid-March 2026, we have found groundwater fluctuations between 200mm to 300mm.

A groundwater table of 1m bgl has been used in our preliminary assessment of liquefaction for uniformity.

6 GEOTECHNICAL ASSESSMENT

The following recommendations and opinions are based upon data from observations made on-site, and the investigations undertaken. Inferences about the nature and continuity of subsoils away from the exploration holes are made but cannot be guaranteed.

This section outlines our assessment of the site with respect to geotechnical natural hazards and the assessment of 'good ground' as defined by MBIE AS/VM B1 (2025) and referred to in NZS3604:2011.

At the time of writing BCD understand that the NZS3604 is currently under review and the new version is likely to be available during the development design phase. This would be incorporated into future assessment and design if made available.

6.1 Seismic Soil Behaviour

Seismic shaking can result in changes in soil strength. In saturated soils pore water increases, which lowers the strength of the soil to imposed load. If the pore water pressure increases sufficiently then soil liquefaction can occur. This is typically associated with loose sands and soft silts. Soil liquefaction can manifest at the ground surface and result in ground deformation and differential settlement, ground rupture or ejecta such as water and soil particles. Where localised slopes or free faces are present, lateral spread can also occur. Surface manifestations usually occur where liquefiable soils are present near the ground surface and where there is an absence of a sufficient surface crust of strong or dense material.

When buildings are constructed on liquefiable soils, it is possible for them to settle further than the adjacent land. This is due to a bearing strength reduction and the displacement of the liquefied soil under the building load.

BCD has undertaken a site-specific assessment of liquefaction which is summarised below. General discussion on the mechanism and a selection of assessment methods is included in Appendix D. Additional data can be provided on request.

This section outlines our geotechnical assessment of the site with respect to geotechnical natural hazards and the assessment of ground conditions with respect to the proposed development.

6.1.1 Site Subsoil Class

The site is considered to be subsoil class D 'Deep or soft soil sites' based on the investigations undertaken. This is in line with our knowledge of the surrounding area.

6.1.2 Seismic Assessment

The liquefaction assessment was carried out using CPT data and the software CLiq, produced by Geologomiski using the methodology in general accordance with the document MBIE (2021) Module 1 and Module 3. Two performance criteria are specifically analysed: Serviceability Limit State (SLS) and the Ultimate Limit State (ULS). Intermediate level events (IE) have also been considered.

- Boulanger and De Jong 2018 thin layer correction filter has been applied.
- PGA and earthquake magnitude has been taken from MBIE (2021).

Our understanding is the development will have Importance Level 1, 2 and 3 (IL1 to IL3) structures as described in NZS1170.

Table 1: Seismic assessment parameters

Importance Level	Design Life (years)	Earthquake Magnitude	Limit State	Annual Exceedance Probability (AEP)	Return Period Factor (R_u)	PGA (g)
2 and 3	50	5.9	SLS	1/25	0.25	0.07
1			ULS	1/100	0.75	0.14
2			ULS	1/500	1.0	0.28
3			ULS	1/1000	1.25	0.36

6.1.3 Soil Liquefaction

The results of the liquefaction assessment are summarised in Table 2 and discussed in the following sections. Typical liquefaction analysis plots and maps are included in Appendix D.

For comparison with the MBIE guidelines prepared for residential structures in Canterbury and now referenced in MBIE Module 4 (2021) we have also considered free field settlement in the upper 10m.

Table 2: Liquefaction Settlement Results

Seismic Event	LSN	Effect[1]	Total Freefield Settlement (mm)	Upper 10m Freefield Settlement (mm)	Thickness of Non-Liquefiable Crust (m)
SLS	0	Insignificant	0	0	20+
ULS IL1	2 - 20	Insignificant to High	10 – 130	5 – 60	2 – 4
ULS IL2	14 - 46	Mild to Severe	95 – 280	50 – 120	1 – 2
ULS IL3	18 - 49	Moderate to Severe	115 – 320	60 - 130	1 – 2

[1]See Appendix D for consequence of effect description based on the Liquefaction Severity Number (LSN)

SLS Event

The result of the liquefaction analyses indicates that the site subsoils to a depth of 20m are unlikely to liquefy. The liquefaction effect is anticipated to be insignificant.

IL1 ULS Event

The analysis indicates that during a IL1 ULS seismic event, liquefaction is likely to occur within thin layers of loose sands and silts. Liquefaction induced freefield settlement is likely to be insignificant to high with up to 130mm of settlement occurring within the soil profile and up to 60mm in the upper 10m of the soil profile.

IL2 ULS Event

During a IL2 ULS seismic event, the analyses indicates that liquefaction is likely to occur within thick layers of sands and silts throughout the soil profile. The liquefaction effect is anticipated to be mild in some localised areas along the northern site boundaries (CPT08 and 09). Towards the east half of the site (CPT01, 02, 03, and 04) liquefaction was found to be high to severe with up to 280mm of settlement occurring in these areas under ULS conditions and would result in significant movement of the ground's surface resulting in significant deformation at the ground surface. To the west of the site (CPT05, 06, 07 and 10), liquefaction was found to be high, with up to 200mm settlement occurring.

It is anticipated that some IL2 buildings may be of similar structure and purpose to those referenced in the Canterbury Guidelines, in these circumstances they would be considered Technical Category (TC) 2 or TC2/TC3 hybrids which is considered typical for much of the Waikato Basin.

IL3 ULS Event

The IL3 seismic event analysis indicates that liquefaction is likely to be high to severe throughout the site with up to 320mm of liquefaction induced settlement occurring. Significant deformation of the grounds surface is likely to occur. The liquefaction effect is anticipated to be mild to moderate in some localised areas along the northern site boundaries (CPT08 and 09).

6.1.4 Liquefaction Induced Lateral Spreading

Lateral spread has not been addressed in this preliminary report however we understand that a stormwater retention pond is proposed for the development which may be located within the bounds of the racecourse track. Once the preliminary design of locations and depth is complete then a lateral spread risk assessment should be undertaken.

Ponds and open drains which may enable lateral spreading during an event that results in liquefaction are likely to be a reasonable distance from proposed buildings and effects may be limited. However, if lateral spreading is identified as a risk there are a number of solutions that can be adopted, ranging from preventing lateral spread at the pond location to mitigating it at the building. Preferred mitigation methods would depend on extent of risk area, degree of risk, and types of buildings or infrastructure at risk.

For ponds located within close proximity of the Waikato Expressway, the NZTA Bridge Manuel will govern the lateral spread assessment for the pond face adjacent to the Expressway. Due the classification of this road, significantly higher earthquake parameters will need to be considered, including repeat events with already liquified soil. Mitigation measures will be possible; however, the costs will warrant looking at alternative pond locations.

6.1.5 Site Seismic Performance

Based on our assessment, we consider the site to be susceptible to liquefaction. The performance criteria for each Importance level has been discussed below in Table 3 and has incorporated MBIE Canterbury Guidance documents (2012 – 2015), noting that this guideline is for residential, timber-framed buildings and the MBIE Modules (2021) are for structures which do not fit the scope of the guidance documents.

Table 3: Performance Criteria

Importance Level	Performance Level	Technical Category[5]	Likelihood	Consequence level	Risk	Differential Settlement (mm)
1	0 – 2	TC2	Unlikely	Minor	Low	53
2	1 – 4	TC2 or TC2/3 hybrid	Unlikely	Minor to Major	Low Medium	190
3	2 – 4	N/A	Rare	Major	Medium	215

For structures outside the scope of the guidance documents, foundations and buildings will need to be specifically engineered to tolerate differential settlement across the building platform without collapse. As recommended within the MBIE Modules (2021), the buildings foundations are to be well tied together with no isolated strip or pad foundations.

In line with the National Policy Statement for Natural Hazards 2025 (NPS2025), the likelihood of liquefiable events for importance level 1-3 structures are considered to be unlikely to rare with the consequences being minor for IL1-2 structures and Major for IL2-3 structures. Figure 1 of the NPS2025 considers the risk to be low to medium.

6.2 Slope Stability

The existing slopes are generally no steeper than 1V:6H and not considered to have a risk of slope instability. A natural slope is located within the western boundary which runs along Pencarrow Road.

New slopes should be specifically assessed, although 1V:2.5H can be adopted for preliminary purposes for slopes not intercepting the water table. For ponds or other areas where cuts may be below the water table, shallower slope angles may be required or retaining / slope reinforcement incorporated into the design.

6.3 Soil Expansivity

The near surface soils are non-cohesive sands or silts. They are not considered to be expansive as defined in the New Zealand Building Code B1 and considered a low risk.

[5] Canterbury technical category applicable for NZS3604 type structures with similar usage to the intent of the Canterbury guidance documents.

6.4 Static Settlement

Primary settlement occurs when soil materials compress and consolidate under static loading, such as filling placed at the ground surface or the weight of a new structure. Soils may also settle over time under their own weight, termed secondary settlement (creep). Secondary settlement is not related to the load or the size of the loading.

Preliminary screening for the potential for static settlement has been undertaken in CPeT-IT. Wide loads can stress soils to considerable depth. We have considered 3 cases applied to the existing ground surface for the preliminary assessment with a widespread load 30m x 30m with 10kPa, 20kPa and 40kPa applied.

Table 4: Static Settlement Estimates

Load	Dimensions WxL (m)	SLS Design Pressure (kPa)	Primary Settlement (mm)	Secondary Settlement (mm)
Widespread Load	30x30	10	8 - 35	7 - 121
		20	15 - 70	
		40	45 - 135	

Typical engineered fills have a load in the order of 18-22kPa per metre of fill placed. Building loads are typically in the order of 5-10kPa per floor depending on structure type.

In general, the site has a relatively low static settlement risk due to the underlying sandy soils. However, there are softer clay and silt layers in the soil profile that are compressible. The CPT assessment is generally conservative as it doesn't account for stress history and if pumice soils are present, it overestimates the settlement.

Based on the assessment undertaken both Options 1 and 2 have similar static settlement characteristics in the areas that structures are proposed.

Secondary settlements are generally widespread and not influenced by building or fill loads. Secondary settlement would impact the entire building and not result in differential settlement effects.

6.5 Bearing Capacity of Natural Soils

For IL2 and IL3 structures, due to liquefaction risk, the bearing capacity of the natural soils is unlikely to govern the foundation design and will therefore require specific design. Foundation types for the various building typologies are discussed in Section 7.4 and 7.6

For light weight IL1 structures an ultimate geotechnical bearing capacity of (q_u) 300kPa may be used for design of shallow foundations with vertical central loads; however, some shallow ground remediation may be needed which is typical in Waikato alluvial soils.

7 DISCUSSION

7.1 Earthworks

Earthworks will be required to level the general site and areas where buildings will be placed. In general, the site has a relatively low static settlement risk due to the underlying sandy soils. Some structures and infrastructure are less tolerable to settlement and further assessment should be undertaken. The most effective means of controlling static settlement will be during bulk earthworks and adopting rolling pre-loads targeting the areas that need management.

Earthworks can also materially affect the liquefaction assessment. If fill is placed this will reduce the liquefaction risk, by increasing the thickness of the non-liquifiable soils and increasing the confining pressure. In areas of cut the confining pressure is reduced and the thickness of the crust is reduced.

Suitability of the surficial silts for use as engineered fill has not been assessed at this point, however they have a relatively high-water content and would likely require significant conditioning and possibly chemical stabilisation.

The underlying sands, although saturated would have good compaction properties and a borrow area could be established with appropriate dewatering considerations. Dewatering is discussed below in Section 7.2.

Retaining walls may be required for the development where a change of levels cannot be achieved through slope battering.

Overall, fills are considered preferable to cuts where level changes are required, due the benefits associated with filling and the disadvantages associated with cuts. Further discussion on cut/fills and approximate quantities are discussed within a BCD Civil Report.

7.2 Groundwater and Dewatering

Due to the shallow groundwater depth, it is anticipated that excavations for infrastructure or foundations will extend below the water table in parts of the site. Saturated sands are likely to be encountered in these scenarios which will impact the stability of the excavations.

The stability of temporary excavations below the groundwater can be managed through, slope design, dewatering, trench shields and temporary retaining, depending on location and depth of the excavation.

Dewatering the shallow groundwater table is unlikely to result in ground surface settlement due to the sandy nature of the zone being dewatered. Water from well points or sump pumps can be diverted away from the excavation and spread over the ground to recharge via infiltration, or to a designated recharge well.

During design phases dewatering needs will be assessed for compliance with the Waikato Regional Plan and any necessary consent will be obtained.

7.3 Racecourse, Trotting and Training Tracks

Track surfaces have yet to be determined. The track areas have 2 to 3 metres of elevation difference end to end. There are no strict requirements on longitudinal fall for horse tracks, and this level of elevation difference is similar to other established New Zealand tracks.

The groundwater monitoring data is limited and there is potential for higher groundwater levels to be recorded during the wetter months and into September. Given the shallow depth to ground water, particularly in the vicinity of P2, P6 and P7 we recommend the southern end of the Racecourse, and the northern end of the Training Track have a preliminary design level not less than RL 54.75m to provide approximately 1.5m clearance above the preliminary ground water level. Levels around the rest of the track should be checked against the groundwater to achieve at least the same clearance.

As more groundwater data becomes available and more information regarding the track build up and track drainage requirements become available these recommendations may change.

Other key considerations will be the subgrade type and strength, which is likely to be variable as the tracks will span areas of sand, silt, and fill and drainage of surface water.

7.4 Racecourse Buildings and Structures

As buildings and structures on the site are subject to scaled liquefaction risks based on their importance level and site constraints, the following recommendations may aid in the master planning of proposed building on the site. The following is subject to additional testing in the locations of buildings and structures.

Consideration should be given to locating structures in areas where fills will be placed, however it is recognised that this will not be possible for all structures.

7.4.1 Importance Level 1

For IL1 buildings, structures such as horse tie up areas, small stables and storage facilities or building which are not normally occupied, it may be acceptable to take a risk-based approach depending on their use case and adopt standard foundations designed with an ultimate geotechnical bearing capacity of 300kPa, subject to excavation and replacement of any soft or unsuitable soils and replacement with hardfill.

Where a risk-based approach is not acceptable, or a resilient structure is preferred, TC2 type foundations which include shallow ground improvement or a stiffened structural concrete raft or TC2 piles can be adopted for NZS3604:2011 structures.

7.4.2 Importance Level 2 & 3

For buildings which are IL2, such as offices, amenities, accommodation, industrial sheds etc, the foundation types will depend on the structure type and usage. For example, a small office building that is NZS3604 compliant may be able to adopt liquefaction resilient foundation solutions from the Canterbury technical guidelines.

Structures outside the scope of these documents will require specific risk assessment based on usage and building type. The building code requires that these are designed to avoid collapse or loss of life; however, a higher level of resilience may be readily achievable without significant additional cost.

The preliminary liquefaction assessment indicates that there is not a reliable, non-liquifiable layer, across the site for founding end-bearing piles within the upper 20 metres of the strata.

For IL3 structures such as grandstand or event centres deeper investigations should be considered to determine if piling with screw piles or similar is suitable.

Other options that can be investigated for IL2 and IL3 structures include shallow ground improvement, such as excavate and replace for low-risk structures, or deep ground improvement such as aggregate piers, physical densification piles, or chemical stabilisation piles. The depth of ground improvement will depend on performance and loading requirements.

7.4.3 Towers

Racecourses often have towers for commentary and lighting. Foundation systems for these are typically governed by wind loading; however, the temporary loss of support due to liquefaction will need to be considered.

7.4.4 Bridges

Bridges need to be designed in accordance with the NZTA Bridge Manual where high volumes of traffic can be expected such as main entrances.

7.5 Racecourse Infrastructure

7.5.1 Ponds

Ponds will require specific slope stability assessment and may require stabilisation or shallower slopes if below the water table as sands below the water table will have low stable angles (1V:4H or less). The stability assessment should also consider the potential for lateral spread and the potential effects on structures and infrastructure.

The potential for a water pressure imbalance affecting the lining also requires consideration in design. To reduce the pressure differential, it is recommended that ponds are constructed with the edges at or above (applicable if mass filling around the location) the existing ground level at each pond location.

To steepen or eliminate the batters, pond sides may be constructed with mass concrete blocks or green faced mechanically stabilised earth (MSE) retaining walls. These can also have a ballasting benefit if constructed above the lining system. Timber pole retaining walls are likely to be incompatible with the lining system. Both systems can be terraced to reduce visual impact, and concrete blocks can have custom patterns included.

Construction of ponds will likely require local dewatering through well pointing or similar.

Once the extent and depth of the ponds are known, stability checks will be undertaken for the proposed option.

Lateral spread assessment has yet to be undertaken, however the design criteria for ponds adjacent to the express way is likely to have significant cost implications. Preliminary assessment will be undertaken in the next design phase, and options for mitigation / relocation can be considered.

7.5.2 Stormwater and Wastewater Considerations

The site has a relatively shallow groundwater table, and the upper soils are low permeability based on physical characteristics.

Earthworks will also affect stormwater management solutions as engineered fills are typically low permeability due to the compaction. In areas of cut the groundwater will be closer to the surface and may restrict options for stormwater and wastewater management.

7.5.3 Inground Infrastructure

High groundwater will need to be considered in the design of inground infrastructure, including deep infrastructure such as tanks, pump stations, and underpasses. These will likely require sheet piling and dewatering during construction to enable construction.

Design of these should consider buoyancy of buried infrastructure under both static and liquified conditions.

7.6 Residential Lifestyle blocks and Retirement Village

The land within the southern corner of the property between Hooker and Duncan Road is proposed to be subdivided into lifestyle blocks and a retirement village in the latest edition of the master plan. Further geotechnical testing should be completed once the proposed sections have been confirmed. The following considerations for the proposed should be made below for TC2/TC3 hybrid sites.

7.6.1 Foundations

At this early stage, the typology of buildings for the proposed lifestyle blocks and retirement will likely only be known at a building consent stage for each Lot. However, it is likely that buildings will be designed in general accordance with NZS3604.

The preliminary liquefaction assessment indicates the site is likely TC2 to TC2/TC3 hybrid classification. Both classifications have standard solutions for residential foundations in the Rebuild Canterbury guidelines. In the Waikato Basin the most common are shallow ground improvement and/or structural raft foundation.

For timber floor buildings, NZS3604 is appropriate for TC2, or a surface structure or specific design is appropriate for TC2/TC3 hybrid sites.

For buildings outside the scope of NZS3604 specific engineering design will be required.

7.6.2 Stormwater Management Considerations

The site does not have any connections to a council stormwater reticulated network and therefore stormwater will need to be managed on each allotment. The following needs to be considered for the proposed lots:

- Proximity to groundwater.
- Permeability testing should be undertaken to determine a design rate and size of soakage system.
- Where soakage is not suitable, detention tanks will be required to attenuate stormwater at predevelopment rates.
- Below ground stormwater system should be located no closer than 1V:1H from building foundations.
- A central stormwater management system may be an option; this is likely to be more feasible for a retirement village where buildings are usually located at close proximity to each other together.

7.6.3 Wastewater Management Considerations

The site is located in a rural setting with no connections to a council owned wastewater reticulated network and will need to be managed on each allotment.

On-site wastewater management systems need to be designed in accordance with NZS1547 which includes the setbacks from boundaries, buildings, groundwater retaining walls and surface water. Where setbacks cannot be maintained, higher treatment of the wastewater may be required to minimise the footprint.

8 FUTURE INVESTIGATIONS AND ASSESSMENT

The investigations and assessment in this report have been undertaken to provide a high-level assessment across the site to assist master-planning.

As the project progresses additional investigations and assessments will be required to provide more specific commentary with respect to the elements within the development.

We recommend that the next round of investigations and assessment targets the preferred masterplan layout and provides specific, preliminary assessments for structure types and key infrastructure. Assessments should include pond slope stability, detailed settlement assessment, bearing capacity, pile capacity and refined liquefaction assessments.

Additional site investigations are listed in Table 5. It is important to note that the staging showing is indicative for when we consider the next round of the testing should be undertaken for each type. Additional testing of the types listed in the Substantive sections will likely be needed at later stages of the development to fill data gaps or achieve a suitable density for design.

Table 5: Indicative Investigations

Stage	Investigation Method	Reason
Substantive Application	Seismic Cone Penetration Test (SCPT)	SCPT's allow liquefaction assessment to be undertaken using an alternative method that can be adjusted for pumice content. The SCPT data can be used for a Site-Specific Seismic Hazard Assessment, which can be beneficial for both structural and geotechnical design.
	Hand Augers	Shallow soil conditions to assist with bearing capacity and undercut depths, and pavement CBR's.
	Test Pits	Test pits can be used to obtain soils for compaction characteristics and CBR tests on compacted samples.
	Laboratory Testing - Atterberg limits - Particle size Distribution - Compaction testing - Solid density testing - CBR testing	These tests are used to inform the potential re-use of site won materials as engineered fills, and as pavement materials.
Post Resource consent	Site Specific Seismic Hazard Model (SSSHM)	Site specific seismic hazard assessments can be used instead of the standardised earthquake data. These can be beneficial for both structural and geotechnical design.
	Dilatometer Testing	Can get in-situ measurements of potential settlement around critical areas and target zones based on CPT assessment.
	Bore Holes	Bore holes are recommended around high importance structures to obtain samples of any critical layers for lab testing during design.

	Laboratory Testing - Triaxial testing - 1-D Consolidation tests	These tests can be beneficial in design of earthworks, buildings and temporary works, reducing construction costs.

9 REFERENCES

AS/NZS 1547:2012 - Australia / New Zealand Standard On-site domestic wastewater standard, New Zealand, Standards New Zealand, Wellington

MBIE (2012-2015). Ministry of Business, Innovation & Development. Repairing and rebuilding houses affected by the Canterbury earthquakes, Part A - E Technical Guidance.

MBIE (2021). Ministry of Business, Innovation & Development & New Zealand Geotechnical Society (NZGS), Earthquake Geotechnical Engineering Practice, Modules 1 – 6.

MBIE AS/VM B1 (2025). Ministry of Business, Innovation & Employment. Acceptable Solutions and Verification Methods for New Zealand Building Code Clause B1 Structure. 2nd edition.

NZS 3604:2011. Timber Framed buildings. Standards New Zealand.

NZS 1170.5:2004 – New Zealand Standard, Structural design actions Part 5: Earthquake actions – New Zealand, Standards New Zealand, Wellington.

Wotherspoon, L. Jeong, S. (2019). Development of a Waikato Basin T0 and depth model by the H/V spectral ratio method.

10 REPORT LIMITATIONS

The recommendations and opinions made in this report are based upon data from observations made on-site, conducted hand augers, and in-situ soil strength testing at discrete locations. Inferences about the nature and continuity of subsoils away from the exploration holes are made but cannot be guaranteed. Actual conditions onsite may vary more gradually or abruptly than that inferred from the investigations. Steps can be taken to reduce the likelihood of unexpected conditions arising onsite. As the soil conditions are created and vary by natural processes and human activity, the report is based on soil conditions at the time of the investigation. Soil conditions onsite can change, particularly after long periods of time from the date of investigation.

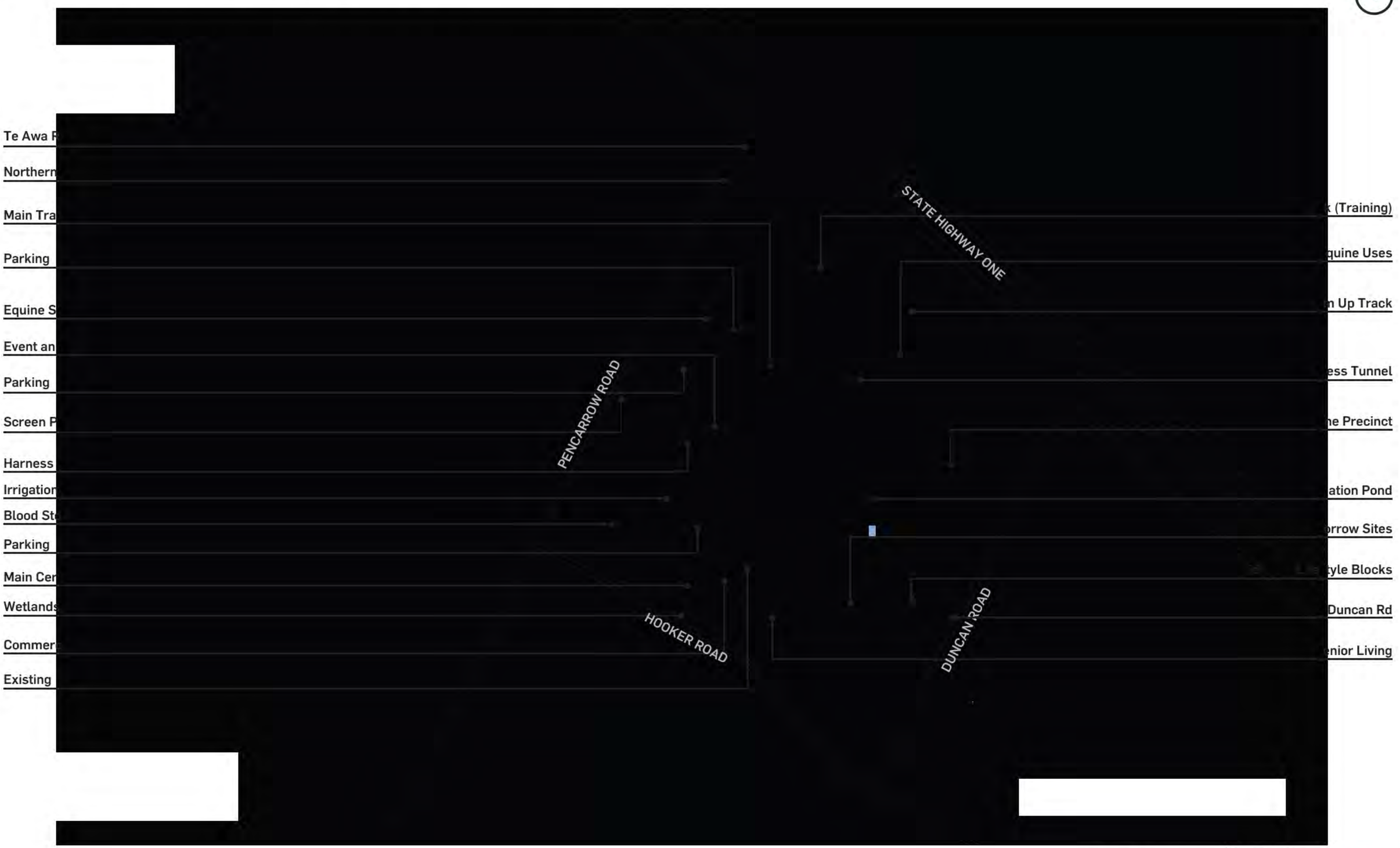
This report has been prepared for our client for their purposes and the regulatory authority in relation to the consent application within the scope of this report. It is based on our understanding of the proposed development. Should any changes to the nature of the development occur, BCD should be asked to provide comment on the ongoing applicability of recommendations made in this report. It is not to be relied upon or used out of context by any other person without reference to BCD Group Ltd. The reliance by other parties on the information or opinions contained in this report shall, without prior review and agreement in writing, be at such parties' sole risk. To avoid misinterpreting this report, we recommend that the assistance of geotechnical professional's familiar with the project and scope of this report is maintained.

Engineering design recommendations have been made based on the information provided to BCD. Should these recommendations be used for construction, BCD are to sight approved Building Consent drawings to ensure compliance with recommendations made within this report. If a Producer Statement 4 or construction observation is required from BCD (see BCD report and/or consent requirements from council), we are to be contacted prior to construction to outline appropriate inspection milestones.

This report covers geotechnical/wastewater/stormwater considerations only. This report does not assess risk of contamination of soils or provide an assessment of flood risk and FFL recommendation. We recommend the proposed works be checked against current District and Regional Council plans or checked by a registered planner.

Appendix A Master Plans

1.3 INDICATIVE PROPOSED SITE LAYOUT PLAN



designgroup
stapleton elliott

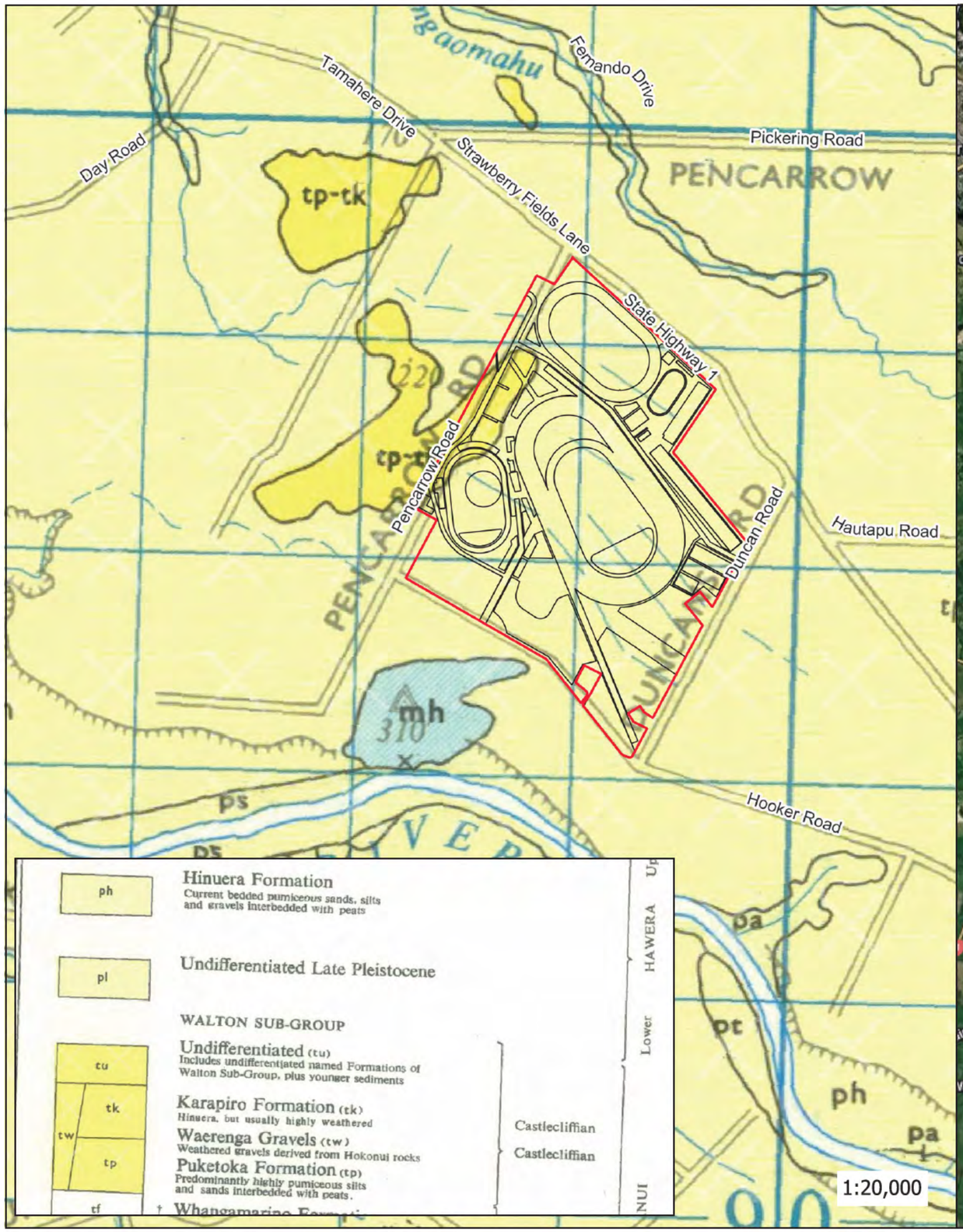
1.4 INDICATIVE COMMERCIAL ZONES

N

1	**Commercial Equire Services**	Area ~26,500m2 GFA - 18,000m2. Max 2 floors
2	**Bloodstock**	Areas ~63,200m2 GFA - 20,000m2. Max 2 floors
3	**Village Centre**	Area - 15,000m2 GFA - 15,000m2. Max 4 floors
4	**Training Areas**	Area ~150,000m2 GFA - 100,000m2. Max 2 floors
5	**Rural Residential Development**	Area ~153,600m2 40-50 2,500m2 Lots GFA per lot 800m2. Max 2 storey buildings
6	**Comprehensive Residential Development for Senior Living**	Area ~68,000m2 70 Villas @ average 100m2 GFA - 7,000m2. Single storey 200 apartments @ average 50m2 GFA - 10,000m2. Max 4 floors Community Centre GFA - 500m2. Max 2 floors

All figures are approximate. Indicative only.

Appendix B Site Details



Client: WAIKATO THOROUGHBRED RACING — TE RAPA · CAMBRIDGE · WAIPA

Contractor

BCD GROUP

Sheet: Geological and Site Location Plan

Project Title: Waikato Thoroughbred Racing
Pencarrow, Hooker & Duncan Roads

Revision	Date	By	Reason
02	20/02/2026	BB	Master Planning
01	25/11/2025	BB	Master Planning

Drawn: BB
Engineer: BB
Scale: As Shown
At: A3
Job Number: 23-1883
Sheet Number: B-01
Revision: 02

All dimensions to be verified on site before making any shop drawings or commencing any work

Notes:
Site Layout based on the Designgroup Stapleton Elliot + COX Proposed Master Plan V2 Revision 1 Draft for WTR Greenfields Racecourse Dated 12/02/2026

Client: WAIKATO THOROUGHBRED RACING — TE RAPA · CAMBRIDGE · WAIPA

Contractor

BCD GROUP

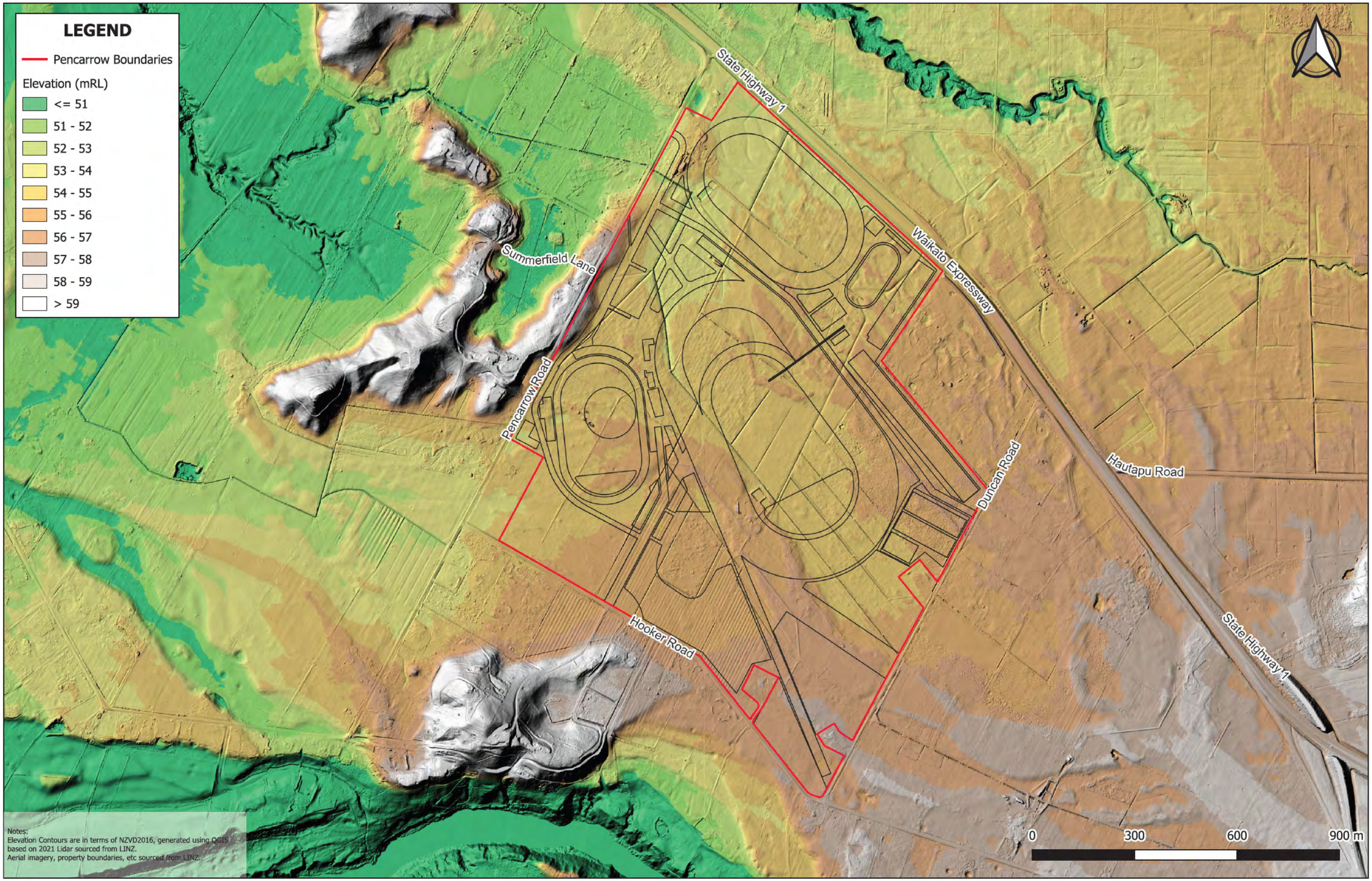
Sheet: Prposed Site Layout

Project Title: Waikato Thoroughbred Racing
Pencarrow, Hooker & Duncan Roads

Revision	Date	By	Reason
01	20/02/2026	BB	Master Planning

Drawn: BB
Engineer: BB
SCALE: 1:10000
At: A3

Job Number:	Sheet Number:	Revision:
23-1883	B-02	01



Notes:
Elevation Contours are in terms of NZVD2016, generated using QGIS based on 2021 Lidar sourced from LINZ.
Aerial imagery, property boundaries, etc sourced from LINZ.

Client: WAIKATO THOROUGHBRED RACING — TE RAPA · CAMBRIDGE · WAIPA

Contractor:

BCD GROUP

Sheet: Elevation Map

Project Title: Waikato Thoroughbred Racing
Pencarrow, Hooker & Duncan Roads

Revision	Date	By	Reason
01	20/02/2026	BB	Master Planning
01	25/11/2025	BB	Master Planning

Drawn: BB
Engineer: BB
SCALE: 1:10000
At: A3
Job Number: 23-1883
Sheet Number: B-03
Revision: 02

Appendix C Investigation Data

Client: WAIKATO THOROUGHBRED RACING — TE RAPA · CAMBRIDGE · WAIPA

Contractor

BCD GROUP

Sheet: Geotechnical Investigation Plan - Sheet 1

Project Title: Waikato Thoroughbred Racing
Pencarrow, Hooker & Duncan Roads

Revision	Date	By	Reason
04	26/03/2026	BB	Fast Track Referral Application
03	27/02/2026	BB	Fast Track Referral Application
02	16/12/2025	BB	Master Planning
01	25/11/2025	BB	Master Planning

Drawn: BB
Engineer: BB
SCALE: 1:8000
At: A3
Job Number: 23-1883
Sheet Number: C-01
Revision: 04

All dimensions to be verified on site before making any shop drawings or commencing any work

Notes:
Elevation Contours are in terms of NZVD2016, generated using QGIS based on 2021 Lidar sourced from LINZ.
Aerial imagery, property boundaries, etc sourced from LINZ.

Client: WAIKATO THOROUGHBRED RACING — TE RAPA · CAMBRIDGE · WAIPA

Contractor:

BCD GROUP

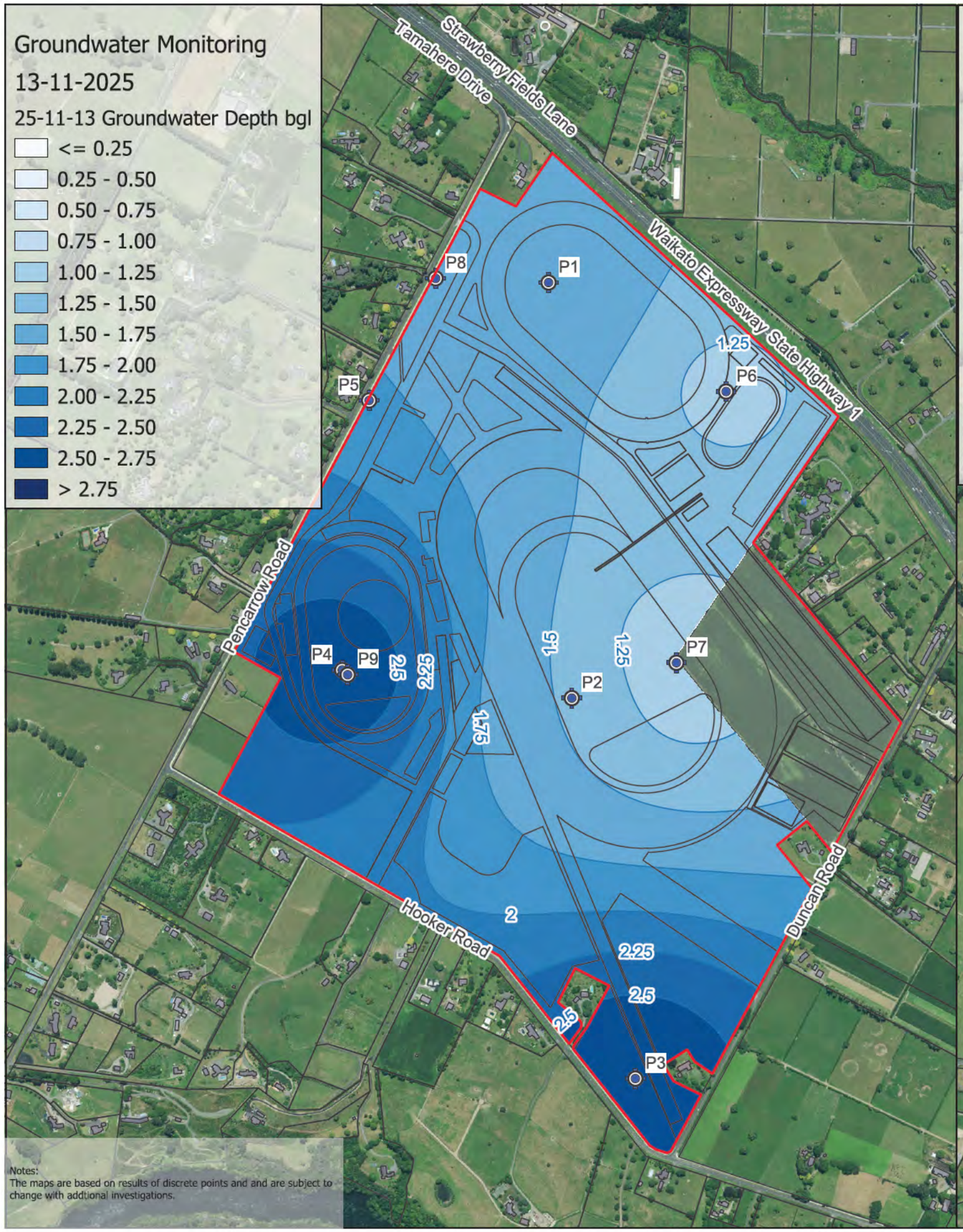
Sheet: Geotechnical Investigation Plan - Sheet 2

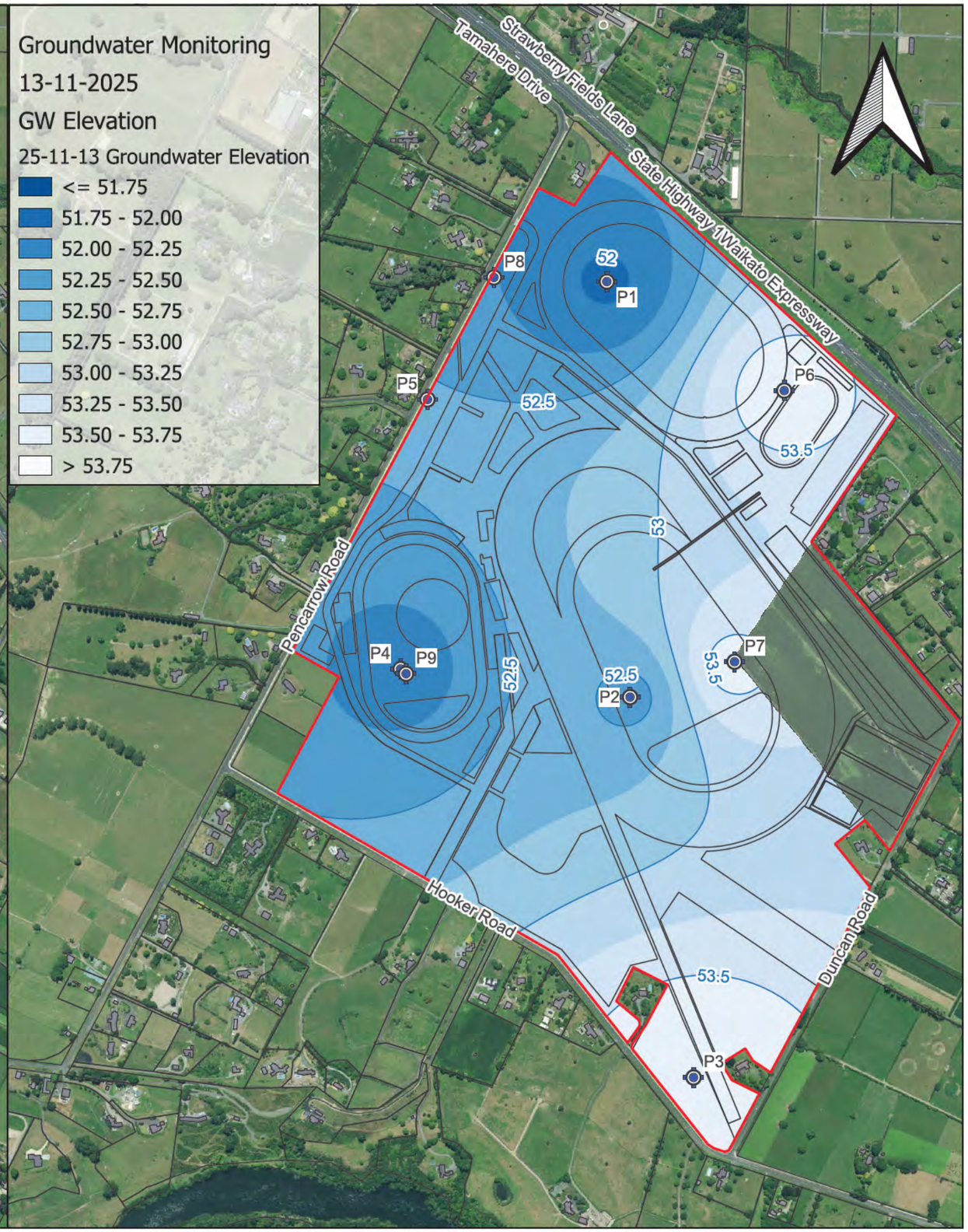
Project Title: Waikato Thoroughbred Racing
Pencarrow, Hooker & Duncan Roads

Revision	Date	By	Reason
04	27/03/2026	BB	Fast Track Referral Application
03	27/02/2026	BB	Fast Track Referral Application
02	16/12/2025	BB	Master Planning
01	25/11/2025	BB	Master Planning

Drawn: BB
Engineer: BB
SCALE: 1:8000
At: A3
Job Number: 23-1883
Sheet Number: C-02
Revision: 04

All dimensions to be verified on site before making any shop drawings or commencing any work





Notes:
The maps are based on results of discrete points and and are subject to change with addtional investigations.

Client: WTR WAIKATO THOROUGHBRED RACING TE RAPA · CAMBRIDGE · WAIPA

Contractor:

BCD GROUP

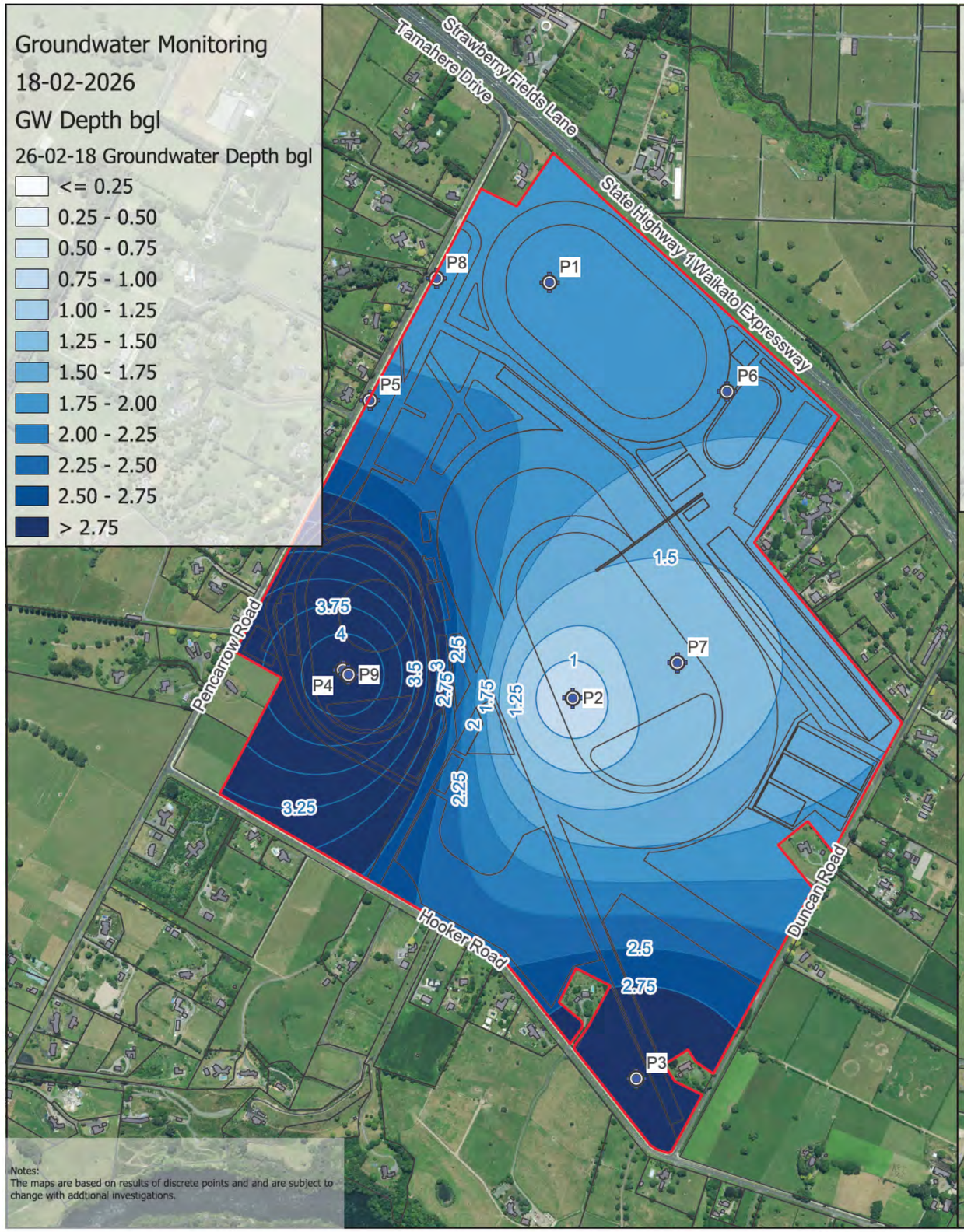
Sheet: Groundwater Map - 13/11/2025

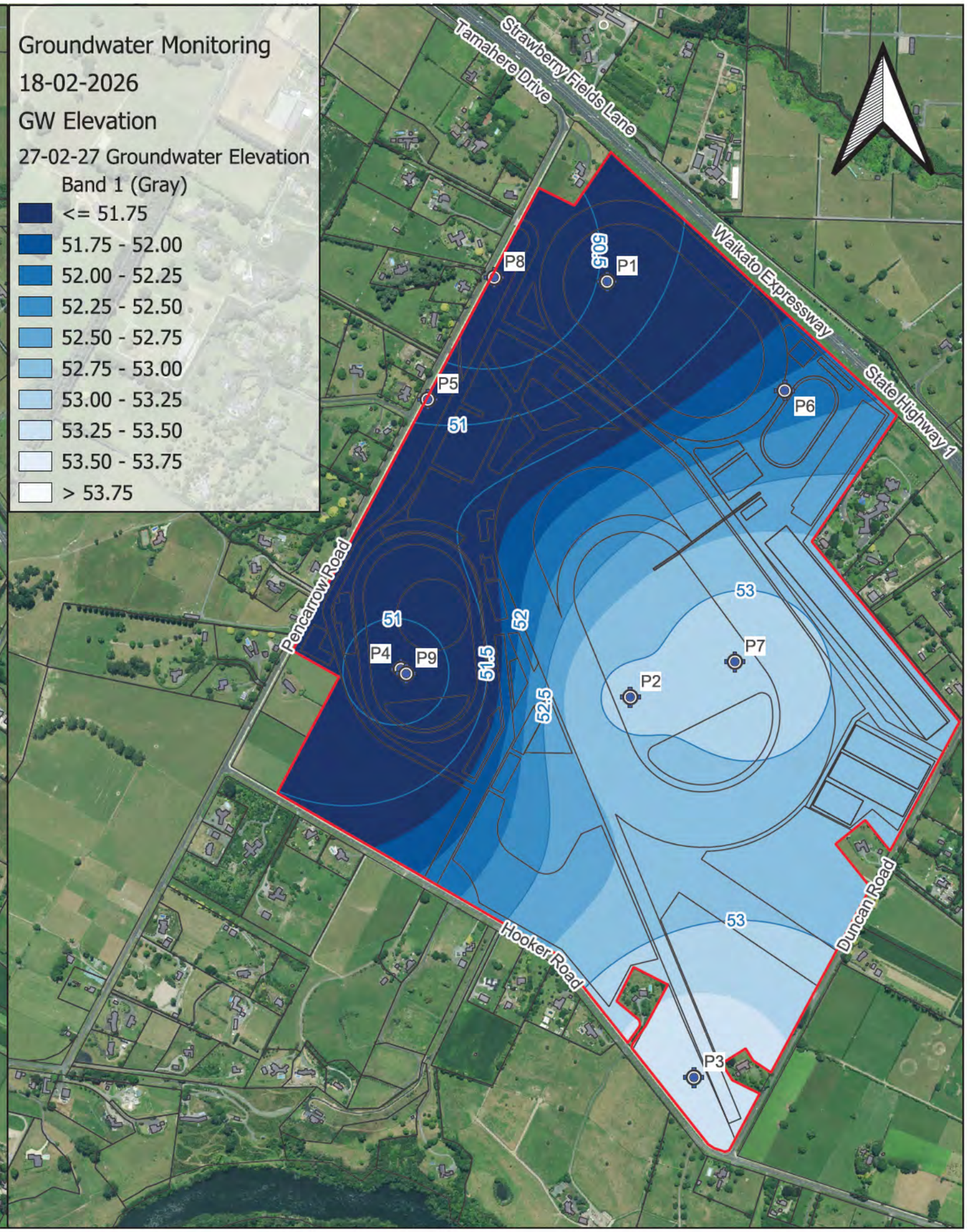
Project Title: Waikato Thoroughbred Racing
Pencarrow, Hooker & Duncan Roads

Revision	Date	By	Reason
03	27/02/2026	BB	Fast Track Referral Application
02	17/12/2025	BB	Master Planning
01	25/11/2025	BB	Master Planning

Drawn: BB
Engineer: BB
Scale: 10,000
At: A3
Job Number: 23-1883
Sheet Number: C-03
Revision: 03

All dimensions to be verified on site before making any shop drawings or commencing any work





Notes:
The maps are based on results of discrete points and and are subject to change with addtional investigations.

Client: WAIKATO THOROUGHBRED RACING — TE RAPA · CAMBRIDGE · WAIPA

Contractor:

BCD GROUP

Sheet: Groundwater Map - 18/02/2026

Project Title: Waikato Thoroughbred Racing
Pencarrow, Hooker & Duncan Roads

Revision	Date	By	Reason
03	27/02/2026	BB	Fast Track Referral Application
02	17/12/2025	BB	Master Planning
01	25/11/2025	BB	Master Planning

Drawn: BB
Engineer: BB
Scale: 10,000
At: A3

Job Number:	Sheet Number:	Revision:
23-1883	C-04	03

Groundwater Monitoring

24-03-2026

GW Depth bgl

26-03-24 Groundwater Depth bgl

- <= 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 1.75
- 1.75 - 2.00
- 2.00 - 2.25
- 2.25 - 2.50
- 2.50 - 2.75
- > 2.75

24-03-2026

GW Elevation

27-03-27 Groundwater Elevation

- <= 51.75
- 51.75 - 52.00
- 52.00 - 52.25
- 52.25 - 52.50
- 52.50 - 52.75
- 52.75 - 53.00
- 53.00 - 53.25
- 53.25 - 53.50
- 53.50 - 53.75
- > 53.75

Notes:
The maps are based on results of discrete points and and are subject to change with addtional investigations.

Client: WAIKATO THOROUGHBRED RACING — TE RAPA · CAMBRIDGE · WAIPA

Contractor

BCD GROUP

Sheet: Groundwater Map - 24/03/2026

Project Title: Waikato Thoroughbred Racing
Pencarrow, Hooker & Duncan Roads

Revision	Date	By	Reason
04	27/03/2026	BB	Fast Track Referral Application
03	27/02/2026	BB	Fast Track Referral Application
02	17/12/2025	BB	Master Planning
01	25/11/2025	BB	Master Planning

Drawn: BB	Scale:	At:
Engineer: BB	10,000	A3
Job Number:	Sheet Number:	Revision:
23-1883	C-05	04

Soil Description

Log Identification: HA01

R.L.
NZVD2016: 54m

Coordinates (NZTM):
N: 5807874.40, E: 1809849.35

Field Test Data

Investigation method	Depth (meters)	Field Description	Geological Unit	Depth (meters)	Peak Vane Shear Strength (kPa)	Residual Vane Shear Strength (kPa)	Sensitivity	Blow count	Scala Penetrometer (blows per 100mm drop) Plot of Scala results (Very loose / Loose / Medium Dense / Dense)	Groundwater Level
Hand Auger (50mm)	0	**TOPSOIL**; dark brown. Moist.	TS	0				1		
								1		
		SILT with some fine sand; light grey. Stiff, moist, sensitive, non-plastic.	Hinuera Formation					2		
					94	15	6.2	3		
	0.5			0.5				3		
		Silty fine **SAND**; light grey with trace orange mottles. Medium dense, moist.						3		
								4		
								5		
								4		
	1.0	Sandy **SILT**; light grey. Very stiff, moist, moderately sensitive to sensitive, moist, non-plastic.		1.0				3		
								6		
					106	18	5.8	4		
		- Becomes wet.						5		
								4		
	1.5			1.5	115	42	2.7	5		
								5		
		- Becomes saturated.			179	30	5.9	7		
		- Contains trace subrounded medium pumice gravels.						7		
								4		
	2.0			2.0						
		- Colour includes trace orange mottles.			197	38	5.2			
	2.5			2.5						
		- Sand becomes absent			109	30	3.6			
	3.0	**End of hand auger at 3.0m** - Target depth.		3.0						
	3.5			3.5						
	4.0			4.0						
	4.5			4.5						
	5.0			5.0						
	5.5	Groundwater encountered at 1.7m during testing.		5.5						

Notes:
1. The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
2. OB refers to hand auger over bored. HW refers to scala falling under the weight of the hammer. TS refers to topsoil. * refers to consistency based on diagnostic features
3. Soils have been described in general accordance with NZ Geomechanics Society "Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes", December 2005
4. Vane shear strengths (where reported) have been corrected in general accordance with NZ Geotech Society Inc. "Guideline for Hand Held Shear Vane Test", August 2001.
5. Scala Penetrometer testing (where reported) has been carried out in general accordance with NZS 4402 Test 6.5.2.
6. Coordinates (where reported) are presented in NZTM2000 to an accuracy of ±5m.
7. Shear vane results are multiplied by factor A and plus factor B where applicable

BCD GROUP

Job Number: 23-1883
Client: WTR Waikato Thoroughbred Racing

Shear Vane ID:3294 (19mm blade)
Calibration Expiry Date: 5/08/2026
Shear Vane Factors: A: 1.513

Location: Pencarrow Road / Hooker Road / Duncan Road

Date Of Investigation: 13/11/2025
Logged By: SC
Checked By: LR

Soil Description

Log Identification: HA02

R.L.
NZVD2016: 55m

Coordinates (NZTM):
N: 5807506.46, E: 1810136.80

Investigation method	Depth (meters)	Field Description	Geological Unit	Depth (meters)
		TOPSOIL; dark brown. Moist.	TS	
		SILT with trace fine sand; orange brown. Stiff to very stiff, moist, sensitive, non-plastic.		
	0.5	- Colour becoming greyish orange.		0.5
		Silty fine **SAND**; light grey. Loose to dense, wet	Hinuera Formation	
	1.0	- Becoming saturated - Sand becoming fine to medium.		1.0
		Gravelly fine to medium **SAND**; greyish brown. Medium dense to dense saturated. Gravels fine to medium and subrounded		
	1.5			1.5
		Sandy **SILT**; light greyish brown. Stiff, insensitive, saturated slightly plastic.		
	2.0			2.0
		Fine to medium **SAND**; greyish brown. Medium dense, saturated.		
		End of hand auger at 2.2m - Continual collapse.		
	2.5			2.5
	3.0			3.0
	3.5			3.5
	4.0			4.0
	4.5			4.5
	5.0			5.0
	5.5			5.5
Hand Auger (50mm)		Groundwater encountered at 0.9m after testing.		

Field Test Data

Peak Vane Shear Strength (kPa)	Residual Vane Shear Strength (kPa)	Sensitivity
83	15	5.5
182	35	5.2
64	42	1.5

Scala Penetrometer (blows per 100mm drop)

Blow count: 1 2 2 2 1 | 1 3 2 3 3 | 4 4 7 9 9 | 10 5 4 5 7 | 5 5 6 6 5 | 6 6 4 3

Plot of Scala results: Very loose (1) | Loose (2 3) | Medium Dense (4 5 6) | Dense (7 8 9 10)

Groundwater Level

Notes:
1. The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
2. OB refers to hand auger over bored. HW refers to scala falling under the weight of the hammer. TS refers to topsoil. * refers to consistency based on diagnostic features
3. Soils have been described in general accordance with NZ Geomechanics Society "Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes", December 2005
4. Vane shear strengths (where reported) have been corrected in general accordance with NZ Geotech Society Inc. "Guideline for Hand Held Shear Vane Test", August 2001.
5. Scala Penetrometer testing (where reported) has been carried out in general accordance with NZS 4402 Test 6.5.2.
6. Coordinates (where reported) are presented in NZTM2000 to an accuracy of ±5m.
7. Shear vane results are multiplied by factor A and plus factor B where applicable

BCD GROUP

Job Number: 23-1883
Client: WTR Waikato Thoroughbred Racing

Shear Vane ID:3294 (19mm blade)
Calibration Expiry Date: 5/08/2026
Shear Vane Factors: A: 1.513

Location: Pencarrow Road / Hooker Road / Duncan Road

Date Of Investigation: 13/11/2025
Logged By: OT
Checked By: LR

Soil Description

Log Identification: HA03

R.L.
NZVD2016: 55m

Coordinates (NZTM):
N: 5807064.54, E: 1810112.59

Investigation method	Depth (meters)	Field Description	Geological Unit
Hand Auger (50mm)		**TOPSOIL**; dark brown. Moist.	TS
		Sandy **SILT**; light orange brown with orange streaks. Stiff, moist, moderately sensitive, slightly plastic.	Hinuera Formation
		- becoming moderately plastic and wet.	
	0.5	Silty fine **SAND**; light greyish brown with orange mottles. Loose to medium dense, wet.	
		Sandy **SILT**; light grey. Very stiff, wet, sensitive, moderately plastic. Sand is fine.	
	1.0	Silty fine to medium **SAND**; light grey. Loose to dense, saturated.	
	1.5	- 10mm thick organic silt.	
		Sandy **SILT**; light brown. Stiff to very stiff*, saturated, slightly plastic.	
	2.0	**End of hand auger at 2.0m** - No sample retained.	
	2.5		
	3.0		
	3.5		
	4.0		
	4.5		
	5.0		
	5.5	Groundwater encountered at 1m during testing.	

Field Test Data

Depth (meters)	Peak Vane Shear Strength (kPa)	Residual Vane Shear Strength (kPa)	Sensitivity	Scala Penetrometer (blows per 100mm drop) Blow count	Groundwater Level
				2	
				3	
				2	
	98	30	3.3	2	
0.5				4	
				2	
				2	
				2	
				4	
1.0	106	23	4.7	8	
				5	
				4	
				4	
				3	
1.5				5	
				4	
				3	
				8	
				6	
2.0				5	
				8	
				6	
				4	
				8	
2.5				9	
				4	
3.0					
3.5					
4.0					
4.5					
5.0					
5.5					

Scala Penetrometer (blows per 100mm drop)
Plot of Scala results
0 | Very loose 1 2 3 | Loose 4 | Medium Dense 5 6 7 | Dense 8 9 10

Notes:
1. The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
2. OB refers to hand auger over bored. HW refers to scala falling under the weight of the hammer. TS refers to topsoil. * refers to consistency based on diagnostic features
3. Soils have been described in general accordance with NZ Geomechanics Society "Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes", December 2005
4. Vane shear strengths (where reported) have been corrected in general accordance with NZ Geotech Society Inc. "Guideline for Hand Held Shear Vane Test", August 2001.
5. Scala Penetrometer testing (where reported) has been carried out in general accordance with NZS 4402 Test 6.5.2.
6. Coordinates (where reported) are presented in NZTM2000 to an accuracy of ±5m.
7. Shear vane results are multiplied by factor A and plus factor B where applicable

BCD GROUP

Job Number: 23-1883
Client: WTR Waikato Thoroughbred Racing

Shear Vane ID:3294 (19mm blade)
Calibration Expiry Date: 5/08/2026
Shear Vane Factors: A: 1.513

Location: Pencarrow Road / Hooker Road / Duncan Road

Date Of Investigation: 12/11/2025
Logged By: OT
Checked By: LR

Soil Description

Log Identification: HA04

R.L.
NZVD2016: 54m

Coordinates (NZTM):
N: 5806205.72, E: 1810032.91

Investigation method	Depth (meters)	Field Description	Geological Unit	Depth (meters)
Hand Auger (50mm)	0	**TOPSOIL**; dark brown. Moist.	TS	0
		Sandy **SILT**; orange brown. Stiff to very stiff, moist, insensitive to moderately sensitive. Sand is fine.	Hinuera Formation	
	0.5			0.5
		Fine to medium **SAND** with some silt; light orange brown. Loose to dense, moist.		
	1.0	- Sand becoming medium to coarse. Containing reddish orange staining.		1.0
		Gravelly coarse **SAND**; light brownish grey. Dense, moist to wet.		
	1.5			1.5
Hand Auger (100mm)	2.0	End of 50mm hand auger at 2.0m - Obstruction due to gravels. Hole rebored with 100mm auger.		2.0
	2.5	- Becoming saturated.		2.5
		SILT; light orange brown. Stiff, saturated, slightly plastic.		
	3.0			3.0
		End of hand auger at 3.2m - Target depth.		
	3.5			3.5
	4.0			4.0
	4.5			4.5
	5.0			5.0
	5.5	Groundwater encountered at 2.7m during testing.		5.5

Field Test Data

Depth (meters)	Peak Vane Shear Strength (kPa)	Residual Vane Shear Strength (kPa)	Sensitivity	Scala Penetrometer (blows per 100mm drop) Blow count
0				2
				2
				2
	121	42	2.9	3
0.5				1
	61	38	1.6	1
				2
				2
1.0				2
				3
				6
				17
				11
1.5				11
				8
				12
				12
				10
2.0				10
				6
				6
				4
2.5				3
				5
				3
3.0				4
				3
				1
				2
3.5				
4.0				
4.5				
5.0				
5.5				

Scala Penetrometer (blows per 100mm drop) — Plot of Scala results: Very loose | Loose | Medium Dense | Dense (0 1 2 3 4 5 6 7 8 9 10)

Groundwater Level

Notes:
1. The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
2. OB refers to hand auger over bored. HW refers to scala falling under the weight of the hammer. TS refers to topsoil. * refers to consistency based on diagnostic features
3. Soils have been described in general accordance with NZ Geomechanics Society "Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes", December 2005
4. Vane shear strengths (where reported) have been corrected in general accordance with NZ Geotech Society Inc. "Guideline for Hand Held Shear Vane Test", August 2001.
5. Scala Penetrometer testing (where reported) has been carried out in general accordance with NZS 4402 Test 6.5.2.
6. Coordinates (where reported) are presented in NZTM2000 to an accuracy of ±5m.
7. Shear vane results are multiplied by factor A and plus factor B where applicable

BCD GROUP

Job Number: 23-1883
Client: WTR Waikato Thoroughbred Racing

Shear Vane ID:3294 (19mm blade)
Calibration Expiry Date: 5/08/2026
Shear Vane Factors: A: 1.513

Location: Pencarrow Road / Hooker Road / Duncan Road

Date Of Investigation: 10/11/2025
Logged By: SL
Checked By: LR

Soil Description

Log Identification: HA05

R.L.
NZVD2016: 55m

Coordinates (NZTM):
N: 5807062.36, E:1809416.68

Investigation method	Depth (meters)	Field Description	Geological Unit	Depth (meters)
Hand Auger (50mm)	0	**TOPSOIL**; dark brown. Moist.	TS	0
	0.5	**SILT**; dark orange brown. Very stiff, moist, moderately sensitive, slightly plastic.	Hinuera Formation	0.5
	1.0	Fine to medium **SAND** with trace silt; orange brown. Loose to dense, moist.		1.0
	1.5	- Sand becoming medium to coarse.		1.5
	2.0	- containing trace fine to medium subrounded gravel. Colour becoming light greyish brown.		2.0
	2.5	- Becoming wet.		2.5
	3.0	**SILT**; light grey. Stiff to very stiff*, moist to wet, slightly plastic.		3.0
	3.5	- Becoming saturated		3.5
	4.0	Silty medium **SAND**; light grey. Medium dense, saturated.		4.0
	4.5	**End of hand auger at 3.0m** - Target depth.		4.5
	5.0			5.0
	5.5	Groundwater encountered at 2.7m during testing.		5.5

Field Test Data

Depth (meters)	Peak Vane Shear Strength (kPa)	Residual Vane Shear Strength (kPa)	Sensitivity	Blow count	Scala Penetrometer (blows per 100mm drop)
0				1	
				1	
				2	
				3	
0.5	182	45	4.0	1	
				1	
				1	
				1	
				2	
1.0				5	
				9	
				9	
				8	
				7	
1.5				6	
				8	
				4	
				4	
				5	
2.0				5	
				6	
				5	
				5	
				5	
2.5				6	
				3	
				3	
				4	
				5	
3.0				4	
3.5					
4.0					
4.5					
5.0					
5.5					

Plot of Scala results: Very loose | Loose | Medium Dense | Dense (0 1 2 3 4 5 6 7 8 9 10)

Groundwater Level

Notes:
1. The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
2. OB refers to hand auger over bored. HW refers to scala falling under the weight of the hammer. TS refers to topsoil. * refers to consistency based on diagnostic features
3. Soils have been described in general accordance with NZ Geomechanics Society "Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes", December 2005
4. Vane shear strengths (where reported) have been corrected in general accordance with NZ Geotech Society Inc. "Guideline for Hand Held Shear Vane Test", August 2001.
5. Scala Penetrometer testing (where reported) has been carried out in general accordance with NZS 4402 Test 6.5.2.
6. Coordinates (where reported) are presented in NZTM2000 to an accuracy of ±5m.
7. Shear vane results are multiplied by factor A and plus factor B where applicable

BCD GROUP

Job Number: 23-1883
Client: WTR Waikato Thoroughbred Racing

Shear Vane ID:3294 (19mm blade)
Calibration Expiry Date: 5/08/2026
Shear Vane Factors: A: 1.513

Location: Pencarrow Road / Hooker Road / Duncan Road

Date Of Investigation: 14/11/2025
Logged By: SL
Checked By: LR

Soil Description

Log Identification: HA06

R.L.
NZVD2016: 58m

Coordinates (NZTM):
N: 5807604.09, E: 1809477.59

Investigation method	Depth (meters)	Field Description	Geological Unit	Depth (meters)	Peak Vane Shear Strength (kPa)	Residual Vane Shear Strength (kPa)	Sensitivity	Field Test Data: Scala Penetrometer (blows per 100mm drop) — Blow count	Plot of Scala results: Very loose / Loose / Medium Dense / Dense (0 1 2 3 4 5 6 7 8 9 10)	Groundwater Level
Hand Auger (50mm)	0	**TOPSOIL**; dark brown. Moist.	TS	0						
		Clayey **SILT**; dark brown. Stiff to very stiff, moist, insensitive to sensitive, slightly plastic.	Walton Subgroup		182	68	2.7			
	0.5			0.5	174	91	1.9			
		- Becoming light brown.			197	106	1.9			
	1.0			1.0	166	68	2.4			
	1.5			1.5	166	53	3.1			
					144	45	3.2			
	2.0			2.0	136	45	3.0			
	2.5			2.5	76	23	3.3			
		- becoming moderately plastic.			76	30	2.5			
	3.0	**End of hand auger at 3.0m** - Target depth.		3.0						
	3.5			3.5						
	4.0			4.0						
	4.5			4.5						
	5.0			5.0						
	5.5	Groundwater not encountered during testing		5.5						

Notes:
1. The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
2. OB refers to hand auger over bored. HW refers to scala falling under the weight of the hammer. TS refers to topsoil. * refers to consistency based on diagnostic features
3. Soils have been described in general accordance with NZ Geomechanics Society "Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes", December 2005
4. Vane shear strengths (where reported) have been corrected in general accordance with NZ Geotech Society Inc. "Guideline for Hand Held Shear Vane Test", August 2001.
5. Scala Penetrometer testing (where reported) has been carried out in general accordance with NZS 4402 Test 6.5.2.
6. Coordinates (where reported) are presented in NZTM2000 to an accuracy of ±5m.
7. Shear vane results are multiplied by factor A and plus factor B where applicable

BCD GROUP

Job Number: 23-1883
Client: WTR Waikato Thoroughbred Racing

Shear Vane ID:3294 (19mm blade)
Calibration Expiry Date: 5/08/2026
Shear Vane Factors: A: 1.513

Location: Pencarrow Road / Hooker Road / Duncan Road

Date Of Investigation: 14/11/2025
Logged By: SL
Checked By: LR

Soil Description

Log Identification: HA07

R.L.
NZVD2016: 54m

Coordinates (NZTM):
N: 5807673.70, E: 1809818.62

Investigation method: Hand Auger (50mm)

Depth (meters)	Field Description	Geological Unit
0.0	**TOPSOIL**; dark brown. Moist.	TS
	SILT; light orange brown. Stiff to very stiff, moist, moderately sensitive to sensitive, non-plastic.	Hinuera Formation
0.5	- colour becoming light brown with trace orange mottles.	
	Fine to medium **SAND**; light grey with trace orange mottles. Loose to dense, moist.	
1.0	- 100mm thick SILT lens. - Sand becoming silty fine sand.	
1.5		
2.0	- Becoming wet. - Becoming saturated.	
2.5		
	End of hand auger at 2.8m - No sample retained.	
3.0		
3.5		
4.0		
4.5		
5.0		
5.5	Groundwater encountered at 2.2m during testing.	

Field Test Data

Depth (meters)	Peak Vane Shear Strength (kPa)	Residual Vane Shear Strength (kPa)	Sensitivity
0.0			
	106	23	4.7
0.5			
	91	38	2.4
1.0			
1.5			
2.0			
2.5			
3.0			
3.5			
4.0			
4.5			
5.0			
5.5			

Scala Penetrometer (blows per 100mm drop)

Blow count	Plot of Scala results (Very loose 1 2 3 / Loose 4 / Medium Dense 5 6 7 / Dense 8 9 10)
1 2 2 2 2	
4 2 1 2 5	
6 4 5 5 4	
5 5 6 5 9	
6 7 7 6 8	
5 6 7 6	

Groundwater Level

Notes:
1. The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
2. OB refers to hand auger over bored. HW refers to scala falling under the weight of the hammer. TS refers to topsoil. * refers to consistency based on diagnostic features
3. Soils have been described in general accordance with NZ Geomechanics Society "Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes", December 2005
4. Vane shear strengths (where reported) have been corrected in general accordance with NZ Geotech Society Inc. "Guideline for Hand Held Shear Vane Test", August 2001.
5. Scala Penetrometer testing (where reported) has been carried out in general accordance with NZS 4402 Test 6.5.2.
6. Coordinates (where reported) are presented in NZTM2000 to an accuracy of ±5m.
7. Shear vane results are multiplied by factor A and plus factor B where applicable

BCD GROUP

Job Number: 23-1883
Client: WTR Waikato Thoroughbred Racing

Shear Vane ID:3294 (19mm blade)
Calibration Expiry Date: 5/08/2026
Shear Vane Factors: A: 1.513

Location: Pencarrow Road / Hooker Road / Duncan Road

Date Of Investigation: 14/11/2025
Logged By: SL
Checked By: LR

Soil Description

Log Identification: HA08

R.L.
NZVD2016: 55m

Coordinates (NZTM):
N: 5807643.79, E: 1810221.65

Investigation method: Hand Auger (50mm)

Depth (meters)	Field Description	Geological Unit
0.0	**TOPSOIL**; dark brown. Moist.	TS
	SILT with trace fine sand; orange brown. Stiff, dry to moist, sensitive, non-plastic to slightly plastic.	Hinuera Formation
0.5		
	SILT; light grey. Very stiff, moist, sensitive, slightly plastic.	
1.0	- Becoming sandy and moist to wet.	
	Silty fine to coarse **SAND**; light grey. Loose to dense, saturated.	
1.5	- Colour becomes reddish brown. - Colour becomes brownish grey.	
	End of hand auger at 1.8m - Continual collapse.	
2.0		
2.5		
3.0		
3.5		
4.0		
4.5		
5.0		
5.5	Groundwater encountered at 1.2m during testing.	

Field Test Data

Depth (meters)	Peak Vane Shear Strength (kPa)	Residual Vane Shear Strength (kPa)	Sensitivity	Blow count
0.0				1
				2
				2
	95	23	4.2	2
0.5				2
				2
	148	30	4.9	4
				2
	156	20	7.9	2
1.0				4
				2
				4
				5
				6
1.5				12
				13
				15
				6
				4
				3
2.0				4
				3
				4
				6
2.5				3
				5
				7
				5
				5
3.0				
3.5				
4.0				
4.5				
5.0				
5.5				

Scala Penetrometer (blows per 100mm drop)

Plot of Scala results: Very loose | Loose | Medium Dense | Dense (0 1 2 3 4 5 6 7 8 9 10)

Groundwater Level

Notes:
1. The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
2. OB refers to hand auger over bored. HW refers to scala falling under the weight of the hammer. TS refers to topsoil. * refers to consistency based on diagnostic features
3. Soils have been described in general accordance with NZ Geomechanics Society "Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes", December 2005
4. Vane shear strengths (where reported) have been corrected in general accordance with NZ Geotech Society Inc. "Guideline for Hand Held Shear Vane Test", August 2001.
5. Scala Penetrometer testing (where reported) has been carried out in general accordance with NZS 4402 Test 6.5.2.
6. Coordinates (where reported) are presented in NZTM2000 to an accuracy of ±5m.
7. Shear vane results are multiplied by factor A and plus factor B where applicable

BCD GROUP

Job Number: 23-1883
Client: WTR Waikato Thoroughbred Racing

Shear Vane ID:3294 (19mm blade)
Calibration Expiry Date: 5/08/2026
Shear Vane Factors: A: 1.513

Location: Pencarrow Road / Hooker Road / Duncan Road

Date Of Investigation: 13/11/2025
Logged By: OT
Checked By: LR

Soil Description

Log Identification: HA09

R.L.
NZVD2016: 54m

Coordinates (NZTM):
N: 5806999.101, E: 1809890.037

Investigation method	Depth (meters)	Field Description	Geological Unit	Depth (meters)	Peak Vane Shear Strength (kPa)	Residual Vane Shear Strength (kPa)	Sensitivity	Blow count	Scala Penetrometer (blows per 100mm drop) Plot of Scala results (Very loose / Loose / Medium Dense / Dense)	Groundwater Level
Hand Auger (50mm)	0.0	**TOPSOIL**; dark brown. Moist.	TS	0.0				2		
		SILT; light orange brown with orange streaks. Stiff to very stiff*, dry, non-plastic.	Hinuera Formation					3		
								1		
								2		
	0.5			0.5				3		
		Fine **SAND**; light orange grey. Medium dense, moist.						5		
								4		
		Sandy **SILT**; light orange grey. Stiff to very stiff, moist, moderately sensitive to sensitive, slightly plastic.			189	30	6.3	4		
	1.0			1.0				5		
								4		
		- Colour becoming brownish grey.			61	23	2.7	4		
								3		
								2		
	1.5			1.5				2		
		Fine **SAND** with some silt; light grey. Medium dense to dense, saturated.						4		
								6		
		- poor sample return						6		
	2.0			2.0				6		
		End of hand auger at 2.0m - No sample retained.						10		
								7		
								9		
								10		
	2.5			2.5				7		
								7		
								6		
								7		
								8		
	3.0			3.0				5		
								5		
	3.5			3.5						
	4.0			4.0						
	4.5			4.5						
	5.0			5.0						
	5.5			5.5						
		Groundwater encountered at 1.5m during testing.								

Notes:
1. The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
2. OB refers to hand auger over bored. HW refers to scala falling under the weight of the hammer. TS refers to topsoil. * refers to consistency based on diagnostic features
3. Soils have been described in general accordance with NZ Geomechanics Society "Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes", December 2005
4. Vane shear strengths (where reported) have been corrected in general accordance with NZ Geotech Society Inc. "Guideline for Hand Held Shear Vane Test", August 2001.
5. Scala Penetrometer testing (where reported) has been carried out in general accordance with NZS 4402 Test 6.5.2.
6. Coordinates (where reported) are presented in NZTM2000 to an accuracy of ±5m.
7. Shear vane results are multiplied by factor A and plus factor B where applicable

BCD GROUP

Job Number: 23-1883
Client: WTR Waikato Thoroughbred Racing

Shear Vane ID:3294 (19mm blade)
Calibration Expiry Date: 5/08/2026
Shear Vane Factors: A: 1.513

Location: Pencarrow Road / Hooker Road / Duncan Road

Date Of Investigation: 12/11/2025
Logged By: SL
Checked By: LR

Soil Description

Log Identification: HA10

R.L.
NZVD2016: 55m

Coordinates (NZTM):
N: 5806635.13, E: 1810217.40

Investigation method: Hand Auger (50mm)

Depth (meters)	Field Description	Geological Unit
0.0	**TOPSOIL**; dark brown. Moist.	TS
0.5	Sandy **SILT**; dark orange brown. Stiff*, moist, slightly plastic. Sand is fine. - colour becoming light orange brown with orange mottling.	Hinuera Formation
	Silty fine **SAND**; light brown with orange streaks. Loose, moist.	
1.0	Sandy **SILT**; light brownish grey. Very stiff, moist, sensitive, slightly plastic.	
1.5	Silty fine to medium **SAND**; light brownish grey. Medium dense to dense, moist. - Colour includes orange mottling and brown streaks.	
2.0	- Colour becoming dark brown. - Becoming wet. - Becoming saturated. - Sand becoming fine	
2.5		
3.0	**End of hand auger at 2.7m** - No sample retained.	
3.5		
4.0		
4.5		
5.0		
5.5	Groundwater encountered at 2.1m during testing.	

Field Test Data

Depth (meters)	Peak Vane Shear Strength (kPa)	Residual Vane Shear Strength (kPa)	Sensitivity	Scala Penetrometer (blows per 100mm drop)
0.0				4 3 2 2 1
0.5				4 2 3 2 3
1.0	159	23	7.0	6 8 17 18 8
1.5				16 12 6 7 8
2.0				6 10 12 12 18
2.5				
3.0				
3.5				
4.0				
4.5				
5.0				
5.5				

Plot of Scala results: Very loose (0–1), Loose (2–3), Medium Dense (4–6), Dense (7–8), (9–10)

Groundwater Level

Notes:
1. The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
2. OB refers to hand auger over bored. HW refers to scala falling under the weight of the hammer. TS refers to topsoil. * refers to consistency based on diagnostic features
3. Soils have been described in general accordance with NZ Geomechanics Society "Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes", December 2005
4. Vane shear strengths (where reported) have been corrected in general accordance with NZ Geotech Society Inc. "Guideline for Hand Held Shear Vane Test", August 2001.
5. Scala Penetrometer testing (where reported) has been carried out in general accordance with NZS 4402 Test 6.5.2.
6. Coordinates (where reported) are presented in NZTM2000 to an accuracy of ±5m.
7. Shear vane results are multiplied by factor A and plus factor B where applicable

BCD GROUP

Job Number: 23-1883
Client: WTR Waikato Thoroughbred Racing

Shear Vane ID:3294 (19mm blade)
Calibration Expiry Date: 5/08/2026
Shear Vane Factors: A: 1.513

Location: Pencarrow Road / Hooker Road / Duncan Road

Date Of Investigation: 12/11/2025
Logged By: OT
Checked By: LR

Soil Description

Log Identification: HA11

R.L.
NZVD2016: 56m

Coordinates (NZTM):
N: 5806630.24, E: 1809912.81

Investigation method	Depth (meters)	Field Description	Geological Unit	Depth (meters)
Hand Auger (50mm)	0	Sandy **TOPSOIL**; dark brown. Moist.	TS	0
	0.5	Fine to medium **SAND** with some silt; greyish brown orange brown mottling. Loose to dense, moist.	Hinuera Formation	0.5
	1.0	- Sand becoming coarse and containing trace fine subrounded to sub angler gravel. Containing orange brown staining. - Sand becoming fine to medium and wet.		1.0
	1.5	**SILT**; whitish grey. Stiff, moist, moderately sensitive, slightly plastic.		1.5
	2.0	Fine **SAND** with some silt; light brown. Loose to medium dense, wet to saturated. - becoming saturated.		2.0
	2.5	**SILT** with trace fine sand; light grey with dark brown speckles. Stiff to very stiff*, moist to wet, slightly plastic. Fine to medium **SAND**; light grey. Medium dense, saturated.		2.5
	3.0	**End of hand auger at 2.7m** - Continual collapse		3.0
	3.5			3.5
	4.0			4.0
	4.5			4.5
	5.0			5.0
	5.5	Groundwater encountered at 1.7m after testing.		5.5

Field Test Data

Depth (meters)	Peak Vane Shear Strength (kPa)	Residual Vane Shear Strength (kPa)	Sensitivity	Blow count
0				3
				4
				5
				3
0.5				5
				8
				4
				5
				5
1.0				5
				8
				9
				4
				5
1.5	91	30	3.0	6
				4
				5
				5
2.0				2
				1
				4
				5
				7
2.5				6
				5
				5
				5
3.0				4
3.5				
4.0				
4.5				
5.0				
5.5				

Scala Penetrometer (blows per 100mm drop)

Plot of Scala results

Very loose | Loose | Medium Dense | Dense

0 1 2 3 4 5 6 7 8 9 10

Groundwater Level

Notes:
1. The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
2. OB refers to hand auger over bored. HW refers to scala falling under the weight of the hammer. TS refers to topsoil. * refers to consistency based on diagnostic features
3. Soils have been described in general accordance with NZ Geomechanics Society "Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes", December 2005
4. Vane shear strengths (where reported) have been corrected in general accordance with NZ Geotech Society Inc. "Guideline for Hand Held Shear Vane Test", August 2001.
5. Scala Penetrometer testing (where reported) has been carried out in general accordance with NZS 4402 Test 6.5.2.
6. Coordinates (where reported) are presented in NZTM2000 to an accuracy of ±5m.
7. Shear vane results are multiplied by factor A and plus factor B where applicable

BCD GROUP

Job Number: 23-1883
Client: WTR Waikato Thoroughbred Racing

Shear Vane ID:3294 (19mm blade)
Calibration Expiry Date: 5/08/2026
Shear Vane Factors: A: 1.513

Location: Pencarrow Road / Hooker Road / Duncan Road

Date Of Investigation: 10/11/2025
Logged By: SL
Checked By: LR

Soil Description

Log Identification: HA12

R.L.
NZVD2016: 55m

Coordinates (NZTM):
N: 5806676.19, E: 1809501.35

Investigation method	Depth (meters)	Field Description	Geological Unit	Depth (meters)
		TOPSOIL; dark brown. Moist.	TS	
		SILT; light orange grey. Very Stiff, dry to moist, moderately sensitive, slightly plastic.		
	0.5			0.5
		Silty medium **SAND**; light greyish brown with dark orange brown inclusions. Medium dense, moist.		
		Medium to coarse **SAND** with trace silt; Light greyish brown. Medium dense, wet.		
	1.0			1.0
Hand Auger (50mm)		- Becoming wet to saturated.	Hinuera Formation	
	1.5			1.5
	2.0	Fine to medium **SAND**; light grey. Loose to medium dense, wet to saturated. Dilatant.		2.0
		Sandy **SILT**; light grey. Stiff, wet to saturated, moderately sensitive, slightly plastic. Dilatant.		
	2.5	- 50mm fine sand lens. - 50mm organic silt lens		2.5
		Silty fine **SAND**; light grey with orange mottling. Medium dense to dense, saturated		
		- Silt absent. Sand becoming coarse and dark brown.		
	3.0	**End of hand auger at 2.9m** - No sample retained.		3.0
	3.5			3.5
	4.0			4.0
	4.5			4.5
	5.0			5.0
	5.5	Groundwater encountered at 1.8m during testing.		5.5

Field Test Data

Depth (meters)	Peak Vane Shear Strength (kPa)	Residual Vane Shear Strength (kPa)	Sensitivity	Blow count
0.5	166	42	3.9	2, 4, 2, 3, 1, 3, 6, 5, 5, 5
1.0				5, 6, 4, 5, 6
1.5				4, 3, 4, 4, 4
2.0				2, 3, 2, 4, 6
2.5	53	23	2.3	7, 6, 9, 10
3.0				
3.5				
4.0				
4.5				
5.0				
5.5				

Scala Penetrometer (blows per 100mm drop)

Plot of Scala results: Very loose (0–1), Loose (2–3), Medium Dense (4–6), Dense (7–10)

Groundwater Level

Notes:
1. The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
2. OB refers to hand auger over bored. HW refers to scala falling under the weight of the hammer. TS refers to topsoil. * refers to consistency based on diagnostic features
3. Soils have been described in general accordance with NZ Geomechanics Society "Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes", December 2005
4. Vane shear strengths (where reported) have been corrected in general accordance with NZ Geotech Society Inc. "Guideline for Hand Held Shear Vane Test", August 2001.
5. Scala Penetrometer testing (where reported) has been carried out in general accordance with NZS 4402 Test 6.5.2.
6. Coordinates (where reported) are presented in NZTM2000 to an accuracy of ±5m.
7. Shear vane results are multiplied by factor A and plus factor B where applicable

BCD GROUP

Job Number: 23-1883
Client: WTR Waikato Thoroughbred Racing

Shear Vane ID:3294 (19mm blade)
Calibration Expiry Date: 5/08/2026
Shear Vane Factors: A: 1.513

Location: Pencarrow Road / Hooker Road / Duncan Road

Date Of Investigation: 10/11/2025
Logged By: SL
Checked By: LR

Soil Description

Log Identification: HA13

R.L.
NZVD2016: 55m

Coordinates (NZTM):
N: 5807337.17, E:1809796.55

Investigation method	Depth (meters)	Field Description	Geological Unit
Hand Auger (50mm)	0	**TOPSOIL**; dark brown. Moist.	TS
	0.5	Silty fine to medium **SAND**; light brown with orange streaks. Loose to medium dense, moist - Silt absent. Sand becomes fine.	Hinuera Formation
	1.0	**SILT**; light brown. Very Stiff, most, sensitive, slightly plastic.	
	1.5	Fine to medium **SAND**; light grey. Medium dense to dense, wet. - becomes saturated.	
	2.0	**SILT**; light grey. Stiff to very stiff*, saturated, slightly plastic. - 50mm organic silt lens.	
	2.5	**End of hand auger at 2.2m** - No sample retained.	
	3.0		
	3.5		
	4.0		
	4.5		
	5.0		
	5.5	Groundwater encountered at 1.6m during testing.	

Field Test Data

Depth (meters)	Peak Vane Shear Strength (kPa)	Residual Vane Shear Strength (kPa)	Sensitivity	Scala Penetrometer (blows per 100mm drop) Blow count	Plot of Scala results (Very loose / Loose / Medium Dense / Dense)	Groundwater Level
0				3		
				1		
				2		
				4		
0.5				3		
				4		
				4		
				4		
1.0				3		
				4		
	136	30	4.5	3		
				3		
				6		
1.5				9		
				10		
				12		
				7		
				5		
				6		
2.0				6		
				3		
				4		
				3		
				6		
2.5				9		
				7		
				7		
				7		
3.0				8		
3.5						
4.0						
4.5						
5.0						
5.5						

Notes:
1. The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
2. OB refers to hand auger over bored. HW refers to scala falling under the weight of the hammer. TS refers to topsoil. * refers to consistency based on diagnostic features
3. Soils have been described in general accordance with NZ Geomechanics Society "Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes", December 2005
4. Vane shear strengths (where reported) have been corrected in general accordance with NZ Geotech Society Inc. "Guideline for Hand Held Shear Vane Test", August 2001.
5. Scala Penetrometer testing (where reported) has been carried out in general accordance with NZS 4402 Test 6.5.2.
6. Coordinates (where reported) are presented in NZTM2000 to an accuracy of ±5m.
7. Shear vane results are multiplied by factor A and plus factor B where applicable

BCD GROUP

Job Number: 23-1883
Client: WTR Waikato Thoroughbred Racing

Shear Vane ID:3294 (19mm blade)
Calibration Expiry Date: 5/08/2026
Shear Vane Factors: A: 1.513

Location: Pencarrow Road / Hooker Road / Duncan Road

Date Of Investigation: 14/11/2025
Logged By: SL
Checked By: LR

Soil Description

Log Identification: HA14

R.L.
NZVD2016: 55m

Coordinates (NZTM):
N: 5807208.26, E: 1809494.55

Investigation method	Depth (meters)	Field Description	Geological Unit	Depth (meters)
Hand Auger (50mm)	0	**TOPSOIL**; dark brown with trace fine to medium subangular gravel. Dry.	TS	0
	0.5	**SILT** with trace fine sand; greyish brown with light grey, orange brown and dark brown streaks. Stiff to very stiff, moist, moderately sensitive, slightly plastic.	Hinuera Formation	0.5
	1.0	- Becoming sandy and moist to wet. Sand is fine. - 100mm thick organic silt layer; dark brown.		1.0
	1.5	Coarse **SAND** with some silt; light grey. Loose to medium dense, moist to wet. - Becoming saturated.		1.5
	2.0	Sandy **SILT**; light grey. Stiff to very stiff*, wet, non-plastic.		2.0
	2.5	Silty fine **SAND**; light grey. Medium dense to dense, wet. - becoming saturated.		2.5
	3.0	**End of hand auger at 2.4m** - No sample retained.		3.0
	3.5			3.5
	4.0			4.0
	4.5			4.5
	5.0			5.0
	5.5	Groundwater encountered at 1.5m during testing.		5.5

Field Test Data

Depth (meters)	Peak Vane Shear Strength (kPa)	Residual Vane Shear Strength (kPa)	Sensitivity	Blow count
0				2
				2
				2
				2
0.5	182	30	6.0	2
				3
	91	15	6.0	3
				4
1.0				4
				3
				4
				7
				4
1.5				3
				3
				3
				3
				6
2.0				OB
				OB
				5
				4
				6
2.5				6
				9
				6
				7
3.0				7
3.5				
4.0				
4.5				
5.0				
5.5				

Scala Penetrometer (blows per 100mm drop)

Plot of Scala results: 0 | 1 Very loose | 2 3 Loose | 4 5 Medium Dense | 6 7 8 Dense | 9 10

Groundwater Level

Notes:
1. The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
2. OB refers to hand auger over bored. HW refers to scala falling under the weight of the hammer. TS refers to topsoil. * refers to consistency based on diagnostic features
3. Soils have been described in general accordance with NZ Geomechanics Society "Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes", December 2005
4. Vane shear strengths (where reported) have been corrected in general accordance with NZ Geotech Society Inc. "Guideline for Hand Held Shear Vane Test", August 2001.
5. Scala Penetrometer testing (where reported) has been carried out in general accordance with NZS 4402 Test 6.5.2.
6. Coordinates (where reported) are presented in NZTM2000 to an accuracy of ±5m.
7. Shear vane results are multiplied by factor A and plus factor B where applicable

BCD GROUP

Job Number: 23-1883
Client: WTR Waikato Thoroughbred Racing

Shear Vane ID:3294 (19mm blade)
Calibration Expiry Date: 5/08/2026
Shear Vane Factors: A: 1.513

Location: Pencarrow Road / Hooker Road / Duncan Road

Date Of Investigation: 14/11/2025
Logged By: SL
Checked By: LR

Soil Description

Log Identification: HA15

R.L.
NZVD2016: 55m

Coordinates (NZTM):
5807052.6N, 1809428.7E

Investigation method	Depth (meters)	Field Description	Geological Unit	Depth (meters)
Hand Auger (50mm)	0.0	**TOPSOIL**; dark brown. Dry.	TS	0.0
		SILT, with trace sand; light orangish brown. Firm, dry, non-plastic. Sand is fine.	Hinuera Formation	
	0.5	Fine to medium **SAND**, with trace gravel; light brown. Loose, dry. Gravel is fine, sub-rounded.		0.5
		- at 0.8m, sand becomes fine to coarse.		
	1.0	Medium to coarse **SAND**, with trace gravel; brown. Medium dense to dense, moist. Gravel is fine to medium, sub-rounded.		1.0
	1.5	- at 1.5m, 50mm light brown silt lense.		1.5
		- at 1.7m, 50mm light brown silt lense.		
	2.0	Fine to medium **SAND**; light brown. Medium dense, moist.		2.0
		- at 2.1m, 50mm light brown silt lense.		
	2.5	-at 2.5m, becomes light grey.		2.5
		- at 2.8m, contains some fine to medium, sub-rounded gravel.		
	3.0	- End of 50mm hand auger at 3.0m - Target depth. 100mm hand auger continued		3.0
Hand Auger (100mm)	3.5			3.5
	4.0	- at 4.0m, becoming wet - at 4.1m, becoming saturated		4.0
		End of 100mm hand auger at 4.2m - No sample retained.		
	4.5			4.5
	5.0			5.0
	5.5	Groundwater encountered at 4.1m during testing.		5.5

Field Test Data

Depth (meters)	Peak Vane Shear Strength (kPa)	Residual Vane Shear Strength (kPa)	Sensitivity	Scala Penetrometer (blows per 100mm drop) Blow count
0.0				2
				3
				4
0.5	79	24	3.3	3
				2
				2
				2
				3
1.0				5
				8
				5
				8
				4
1.5				3
				2
				2
				3
				4
2.0				5
				4
				4
				4
				4
2.5				5
				6
				6
				7
				10
3.0				13
3.5				
4.0				
4.5				
5.0				
5.5				

Scala Penetrometer (blows per 100mm drop)
Plot of Scala results
0 1 2 3 4 5 6 7 8 9 10
Very loose | Loose | Medium Dense | Dense

Groundwater Level

Notes:
1. The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
2. OB refers to hand auger over bored. HW refers to scala falling under the weight of the hammer. TS refers to topsoil.
3. Soils have been described in general accordance with NZ Geomechanics Society "Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes", December 2005
4. Vane shear strengths (where reported) have been corrected in general accordance with NZ Geotech Society Inc. "Guideline for Hand Held Shear Vane Test", August 2001.
5. Scala Penetrometer testing (where reported) has been carried out in general accordance with NZS 4402 Test 6.5.2.
6. Coordinates (where reported) are presented in NZTM2000 to an accuracy of ±5m.
7. Shear vane results are multiplied by factor A and plus factor B where applicable

BCD GROUP

Job Number: 23-1883
Client: WTR Waikato Thoroughbred Racing

Shear Vane ID:3294 (19mm blade)
Calibration Expiry Date: 5/08/2026
Shear Vane Factors: A: 1.513

Location: Pencarrow Road / Hooker Road / Duncan Road

Date Of Investigation: 18/12/2025
Logged By: EB **Checked By: BB**

Soil Description

Log Identification: HA16

R.L.
NZVD2016: 53m

Coordinates (NZTM):
5807883.2N, 1809613.1E

Investigation method	Depth (meters)	Field Description	Geological Unit	Depth (meters)
Hand Auger (50mm)		**TOPSOIL**; light brown. Dry.	FILL	
		Sandy **SILT**; light brown. Very stiff*, dry to moist, non-plastic. Sand is medium to coarse. Pale grey and orange inclusions.		
	0.5	Sandy **SILT**; pale brownish grey. Very stiff, moist, slightly plastic, sensitive. Sand is medium to coarse. Orange inclusions.		0.5
	1.0	**SILT**, with trace clay and sand; light brown. Firm, moist, moderately plastic, moderately sensitive. Sand is coarse. Black streaks.		1.0
	1.5	**SILT**, with some clay; light orange brown. Very stiff, Saturated, moderately plastic, sensitive.	Walton Subgroup	1.5
	2.0	Clayey **SILT**, pale orange brown. Firm to very stiff, moist, moderately plastic, sensitive.		2.0
	2.5	Clayey **SILT**, grey. Firm, moist, moderately plastic, extra sensitive.		2.5
	3.0	**End of Hand Auger at 2.7m - No sample return** * strength inferred from field characteristics.		3.0
	3.5			3.5
	4.0			4.0
	4.5			4.5
	5.0			5.0
	5.5	Groundwater encountered at 1.5m during testing.		5.5

Field Test Data

Depth (meters)	Peak Vane Shear Strength (kPa)	Residual Vane Shear Strength (kPa)	Sensitivity
0.5	106	23	4.7
	121	30	4.0
1.0			
	91	30	3.0
1.5			
2.0	106	15	7.0
2.5	98	8	13.0
3.0	15	8	2.0
3.5			
4.0			
4.5			
5.0			
5.5			

Scala Penetrometer (blows per 100mm drop)

Plot of Scala results

Blow count	0	1	2	3	4	5	6	7	8	9	10
		Very loose	Loose			Medium Dense			Dense		

Groundwater Level

Notes:
1. The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
2. OB refers to hand auger over bored. HW refers to scala falling under the weight of the hammer. TS refers to topsoil.
3. Soils have been described in general accordance with NZ Geomechanics Society "Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes", December 2005
4. Vane shear strengths (where reported) have been corrected in general accordance with NZ Geotech Society Inc. "Guideline for Hand Held Shear Vane Test", August 2001.
5. Scala Penetrometer testing (where reported) has been carried out in general accordance with NZS 4402 Test 6.5.2.
6. Coordinates (where reported) are presented in NZTM2000 to an accuracy of ±5m.
7. Shear vane results are multiplied by factor A and plus factor B where applicable

BCD GROUP

Job Number: 23-1883
Client: WTR Waikato Thoroughbred Racing

Shear Vane ID:3294 (19mm blade)
Calibration Expiry Date: 5/08/2026
Shear Vane Factors: A: 1.513

Location: Pencarrow Road / Hooker Road / Duncan Road

Date Of Investigation: 18/12/2025
Logged By: EB **Checked By: BB**

Soil Description

Log Identification: HA17

R.L. **NZVD2016**: 55.2m

Coordinates (NZTM): E: 1810288.67, N: 5807259.7

Investigation method	Depth (meters)	Field Description	Geological Unit
Hand Auger (50mm)	0	**TOPSOIL**; dark brown. Dry to moist.	TS
		Sandy **SILT**; light greyish orange. Stiff* to very stiff*, moist, non-plastic.	Hinuera Formation
	0.5	Fine to coarse **SAND**; orange brown. Loose to dense, moist.	
	1.0	- Containing trace fine sub-rounded gravel.	
	1.5	Medium to coarse **SAND** with trace gravel and trace silt; light greyish brown. Very loose to medium dense, wet.	
		- Colour becoming dark brown, wet to saturated.	
	2.0	**End of hand auger at 1.9m** - No sample retained.	
	2.5		
	3.0		
	3.5		
	4.0		
	4.5		
	5.0		
	5.5	Groundwater encountered at 1.8m during testing.	

Field Test Data

Depth (meters)	Peak Vane Shear Strength (kPa)	Residual Vane Shear Strength (kPa)	Sensitivity	Scala Penetrometer (blows per 100mm drop) Blow count	Plot of Scala results (Very loose / Loose / Medium Dense / Dense)	Groundwater Level
0				2 2 3 5		
0.5				5 3 4 3 5		
1.0				4 6 6 10 3		
1.5				1 2 5 4 4		
2.0				0.5 0.5 3 2 2		
2.5				1 1 2 3 3		
3.0						
3.5						
4.0						
4.5						
5.0						
5.5						

Notes:
1. The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
2. OB refers to hand auger over bored. HW refers to scala falling under the weight of the hammer. TS refers to topsoil.
3. Soils have been described in general accordance with NZ Geomechanics Society "Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes", December 2005
4. Vane shear strengths (where reported) have been corrected in general accordance with NZ Geotech Society Inc. "Guideline for Hand Held Shear Vane Test", August 2001.
5. Scala Penetrometer testing (where reported) has been carried out in general accordance with NZS 4402 Test 6.5.2.
6. Coordinates (where reported) are presented in NZTM2000 to an accuracy of ±5m.
7. Shear vane results are multiplied by factor A and plus factor B where applicable

BCD GROUP

Job Number: 23-1883

Client: WTR Waikato Thoroughbred Racing

Shear Vane ID: N/A

Calibration Expiry Date: N/A

Shear Vane Factors: A: N/A

Location: 90 Duncan Road, Tamahere

Date Of Investigation: 24/03/2026

Logged By: SL **Checked By: BB**

Soil Description

Log Identification: HA18

Investigation method	Depth (meters)	R.L. / Coordinates	Field Description	Geological Unit	Depth (meters)
		R.L. **NZVD2016:** 56m	**Coordinates (NZTM):** E: 1810519.89, N: 5806968.2		
Hand Auger (50mm)			**TOPSOIL**; brown. Dry.	TS	
			Silty fine to medium **SAND**; orange brown. Loose to medium dense, dry.	Hinuera Formation	
	0.5		Gravelly **SAND**; orange brown. Loose, dry to moist.		0.5
			End of hand auger at 0.6m - Obstruction.		
	1.0				1.0
	1.5				1.5
	2.0				2.0
	2.5				2.5
	3.0				3.0
	3.5				3.5
	4.0				4.0
	4.5				4.5
	5.0				5.0
	5.5		Groundwater not encountered during testing		5.5

Field Test Data

Peak Vane Shear Strength (kPa)	Residual Vane Shear Strength (kPa)	Sensitivity	Scala Penetrometer (blows per 100mm drop) Blow count	Plot of Scala results (Very loose / Loose / Medium Dense / Dense; 0 1 2 3 4 5 6 7 8 9 10)	Groundwater Level
			1 1 3 4 3		
			2 2 2 1 1		
			1 2 3 3 5		
			6 7 5 3 5		

Notes:
1. The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
2. OB refers to hand auger over bored. HW refers to scala falling under the weight of the hammer. TS refers to topsoil.
3. Soils have been described in general accordance with NZ Geomechanics Society "Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes", December 2005
4. Vane shear strengths (where reported) have been corrected in general accordance with NZ Geotech Society Inc. "Guideline for Hand Held Shear Vane Test", August 2001.
5. Scala Penetrometer testing (where reported) has been carried out in general accordance with NZS 4402 Test 6.5.2.
6. Coordinates (where reported) are presented in NZTM2000 to an accuracy of ±5m.
7. Shear vane results are multiplied by factor A and plus factor B where applicable

BCD GROUP

Job Number: 23-1883

Client: WTR Waikato Thoroughbred Racing

Shear Vane ID: N/A

Calibration Expiry Date: N/A

Shear Vane Factors: A: N/A

Location: 90 Duncan Road, Tamahere

Date Of Investigation: 24/03/2026

Logged By: SL **Checked By: BB**

Soil Description

Log Identification: HA19

R.L.
NZVD2016: 55.5m

Coordinates (NZTM):
E: 1810295.77 , N: 5806963.2

Investigation method	Depth (meters)	Field Description	Geological Unit
Hand Auger (50mm)		**TOPSOIL**; brown. Dry	TS
		SILT with trace sand; light greyish orange. Very stiff*, dry, non-plastic.	Hinuera Formation
	0.5	Silty fine to coarse **SAND**; light grey with minor orange brown staining. Medium dense, moist.	
	1.0	**SILT** with trace sand, light grey. Stiff* to very stiff*, moist to wet, dilatant. Sand is fine to medium.	
		Fine to medium **SAND**; light grey. Medium dense, wet.	
	1.5	- Colour becoming brown, moist.	
		- Colour becoming light grey, wet.	
	2.0	- becoming saturated. - becoming very loose. Poor sample return between 2.0m - 3.0m	
	2.5		
	3.0	**End of hand auger at 3.0m** - Target depth.	
	3.5		
	4.0		
	4.5		
	5.0		
	5.5	Groundwater encountered at 1.9m during testing.	

Field Test Data

Depth (meters)	Peak Vane Shear Strength (kPa)	Residual Vane Shear Strength (kPa)	Sensitivity	Scala Penetrometer (blows per 100mm drop) Blow count	Groundwater Level
				1 2 5 6	
0.5				5 5 5 5 2	
1.0				4 3 7 6 5	
1.5				6 7 6 6 3	
2.0				OB OB 1 1 1	
2.5				1 4 6 4 5	
3.0					
3.5					
4.0					
4.5					
5.0					
5.5					

Plot of Scala results: Very loose | Loose | Medium Dense | Dense (0 1 2 3 4 5 6 7 8 9 10)

Notes:
1. The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
2. OB refers to hand auger over bored. HW refers to scala falling under the weight of the hammer. TS refers to topsoil.
3. Soils have been described in general accordance with NZ Geomechanics Society "Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes", December 2005
4. Vane shear strengths (where reported) have been corrected in general accordance with NZ Geotech Society Inc. "Guideline for Hand Held Shear Vane Test", August 2001.
5. Scala Penetrometer testing (where reported) has been carried out in general accordance with NZS 4402 Test 6.5.2.
6. Coordinates (where reported) are presented in NZTM2000 to an accuracy of ±5m.
7. Shear vane results are multiplied by factor A and plus factor B where applicable

BCD GROUP

Job Number: 23-1883
Client: WTR Waikato Thoroughbred Racing

Shear Vane ID: N/A
Calibration Expiry Date: N/A
Shear Vane Factors: A: N/A

Location: 90 Duncan Road, Tamahere

Date Of Investigation: 24/03/2026
Logged By: SL **Checked By: BB**

Soil Description

Log Identification: HA20

R.L.
NZVD2016: 55.8m

Coordinates (NZTM):
E: 1810486.29, N: 5806767.1

Investigation method	Depth (meters)	Field Description	Geological Unit
Hand Auger (50mm/100mm)		**TOPSOIL**; dark brown. Moist.	TS
	0.5	Fine to coarse **SAND**; orange brown. Loose, moist.	Hinuera Formation
		SILT; light grey. Stiff, moist, slightly plastic.	
	1.0	Coarse **SAND**; light brownish grey. Medium dense, moist.	
	1.5	- Becoming moist to wet.	
	2.0	Medium to coarse **SAND** with trace silt; light grey with green staining. Loose to dense.	
	3.0	**End of hand auger at 3.0m** - Target depth.	
	3.5		
	4.0		
	4.5		
	5.0		
	5.5	Groundwater encountered at 2m during testing.	

Field Test Data

Depth (meters)	Peak Vane Shear Strength (kPa)	Residual Vane Shear Strength (kPa)	Sensitivity	Scala Penetrometer (blows per 100mm drop) Blow count	Groundwater Level
				HW	
				4	
				3	
				2	
0.5				2	
				2	
				3	
				3	
1.0				5	
				5	
				6	
				6	
1.5				5	
				6	
				6	
				5	
2.0				6	
				5	
				6	
				5	
2.5				5	
				OB	
				OB	
				3	
				4	
3.0				4	
				7	
				8	
3.5				7	
				8	
				8	
4.0					
4.5					
5.0					
5.5					

Plot of Scala results: Very loose 0 1 | Loose 2 3 | Medium Dense 4 5 6 7 | Dense 8 9 10

Notes:
1. The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
2. OB refers to hand auger over bored. HW refers to scala falling under the weight of the hammer. TS refers to topsoil.
3. Soils have been described in general accordance with NZ Geomechanics Society "Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes", December 2005
4. Vane shear strengths (where reported) have been corrected in general accordance with NZ Geotech Society Inc. "Guideline for Hand Held Shear Vane Test", August 2001.
5. Scala Penetrometer testing (where reported) has been carried out in general accordance with NZS 4402 Test 6.5.2.
6. Coordinates (where reported) are presented in NZTM2000 to an accuracy of ±5m.
7. Shear vane results are multiplied by factor A and plus factor B where applicable

BCD GROUP

Job Number: 23-1883
Client: WTR Waikato Thoroughbred Racing

Shear Vane ID: N/A
Calibration Expiry Date: N/A
Shear Vane Factors: A: N/A

Location: 90 Duncan Road, Tamahere

Date Of Investigation: 24/03/2026
Logged By: SL **Checked By: BB**

Appendix D Liquefaction Assessment

LIQUEFACTION ANALYSIS PROCEDURES

Liquefaction can occur in saturated soils during earthquakes and results in soil strength loss. Soils most susceptible to liquefaction are clean, loose, saturated, uniformly graded fine-grained cohesionless materials. Loose to medium dense gravels, sands, silty sands, low-plasticity silts, and some low-plasticity clays are also potentially liquefiable.

Soil liquefaction can manifest at the ground surface and result in ground deformation and differential settlement, foundation bearing failure, ground rupture or ejecta of water and soil at the ground surface. Where slopes or free faces are present lateral spreading or slope failures can also occur.

Performance Levels from Liquefaction Analyses

Table 6: Performance levels from liquefaction analysis. From MBIE (2021) Module 3 guidelines.

Parameter	Performance Level	Effect	Consequence
LSN < 10	L0	Insignificant	No significant excess pore water pressures (no liquefaction).
LSN 5 - 15	L1	Mild	Limited excess pore water pressures; negligible deformation of the ground and small settlements. *Structural damage unlikely to occur.*
LSN 10 - 25	L2	Moderate	Liquefaction occurs in layers of limited thickness (small proportion of the deposit, say 10 percent or less) and lateral extent; ground deformation results relatively small in differential settlements. *Some structural damage may occur.*
LSN 15 - 35	L3	High	Liquefaction occurs in significant portion of the deposit (30% - 50 %) resulting in transient lateral displacements, moderate differential movements, and settlement in the order of 100mm to 200mm. *Structural damage likely to occur.*
LSN > 30	L4	Severe	Complete liquefaction develops in most of the deposit resulting in large lateral displacements of the ground, excessive differential settlements and total settlement of over 200mm. *Large structural damage likely to occur.*
	L5	Very Severe	Liquefaction resulting in lateral spreading (flow), large permanent lateral ground displacements and/or significant ground distortion (lateral strains/stretch, vertical offsets and angular distortion). *Severe structural damage likely to occur.*

Differential Settlement

Differential settlements in liquefied soils are typically assumed to be proportional to the estimated total free field settlement. For evaluation of differential settlement, MBIE (2021) Module 3 references the Guidelines for Analysing and Mitigating Liquefaction Hazards in California (Martin & Lew, 1999).

Lateral Spreading

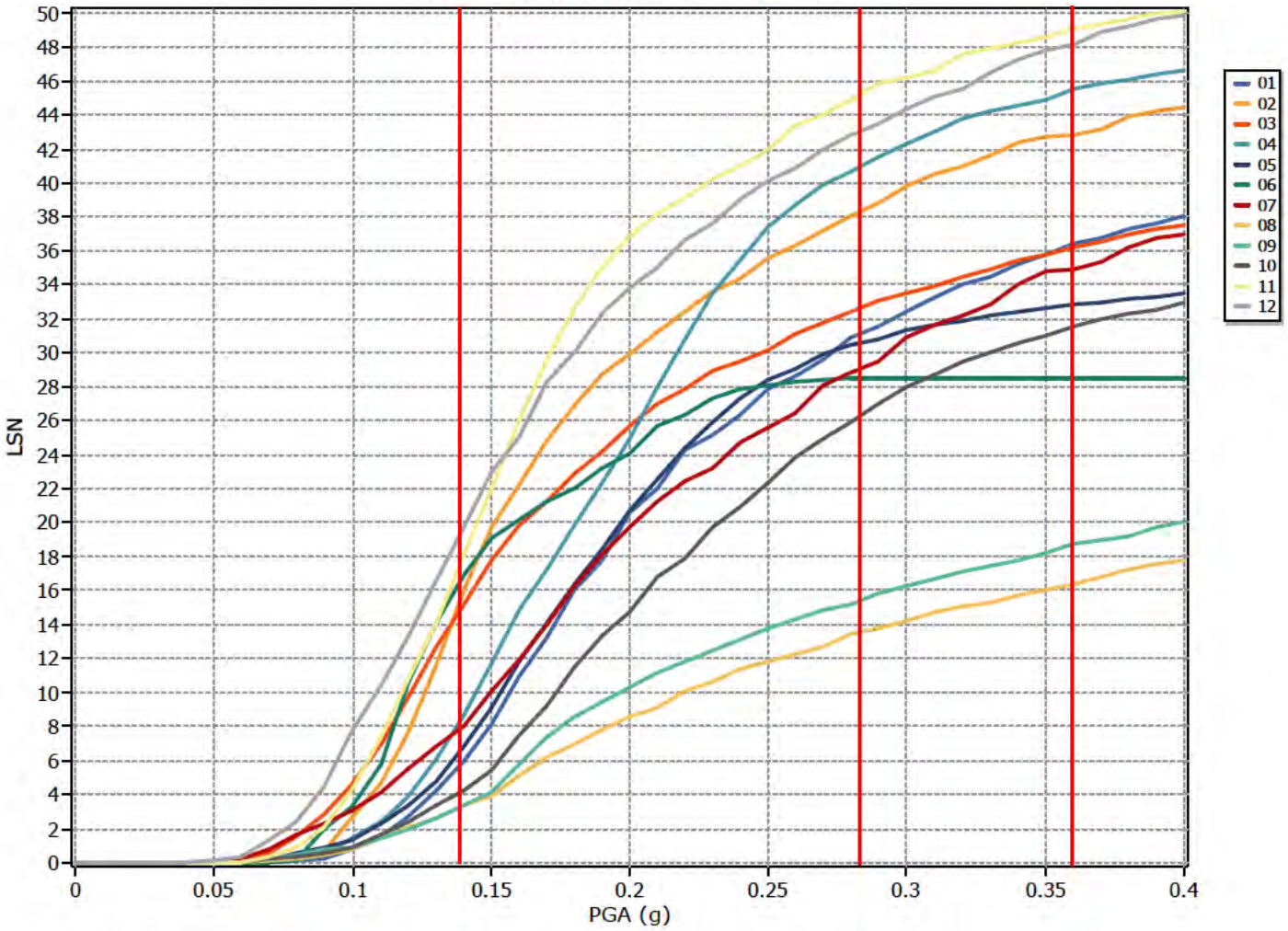
Lateral spreading during a seismic event is typically associated with the movement of a soil mass towards a free face or slope (i.e. gully or river). The magnitude of lateral displacement decreases with distance from the free face or slope. Where a significant difference in lateral spreading magnitude occurs at a site, 'stretching' of foundations can cause significant damage. Lateral spreading can result in significant lateral displacements and lateral pressure to buried structures or piles within the zone of lateral movement.

Non-Liquefiable Crust

Work from Ishihara (1985) and observations after the Canterbury earthquakes from Bowen (2013) and Henderson (2013) consider the benefits of a non-liquefiable crust of 3.5 to 4.0m has major benefits to foundation performance and is sufficient to prevent liquefaction induced damage even with significant thickness of liquefied soil below. Also, once the non-liquefiable crust is greater than 2.5m, sand boils or differential settlements still may be expected in this situation, however adequate bearing capacity for timber framed houses is likely to be maintained.

PGA Based Parametric Analysis

Liquefaction Severity Number vs PGA



:: CPT main liquefaction parameters details ::

CPT Name	Assesment method	Earthquake Mag.	GWT in situ (m)	GWT earthq. (m)
01	Boulanger & Idriss (2014)	5.90	1.00	1.00
02	Boulanger & Idriss (2014)	5.90	1.00	1.00
03	Boulanger & Idriss (2014)	5.90	1.00	1.00
04	Boulanger & Idriss (2014)	5.90	1.00	1.00
05	Boulanger & Idriss (2014)	5.90	1.00	1.00
06	Boulanger & Idriss (2014)	5.90	1.00	1.00
07	Boulanger & Idriss (2014)	5.90	1.00	1.00
08	Boulanger & Idriss (2014)	5.90	1.00	1.00
09	Boulanger & Idriss (2014)	5.90	1.00	1.00
10	Boulanger & Idriss (2014)	5.90	1.00	1.00
11	Boulanger & Idriss (2014)	5.90	1.00	1.00
12	Boulanger & Idriss (2014)	5.90	1.00	1.00

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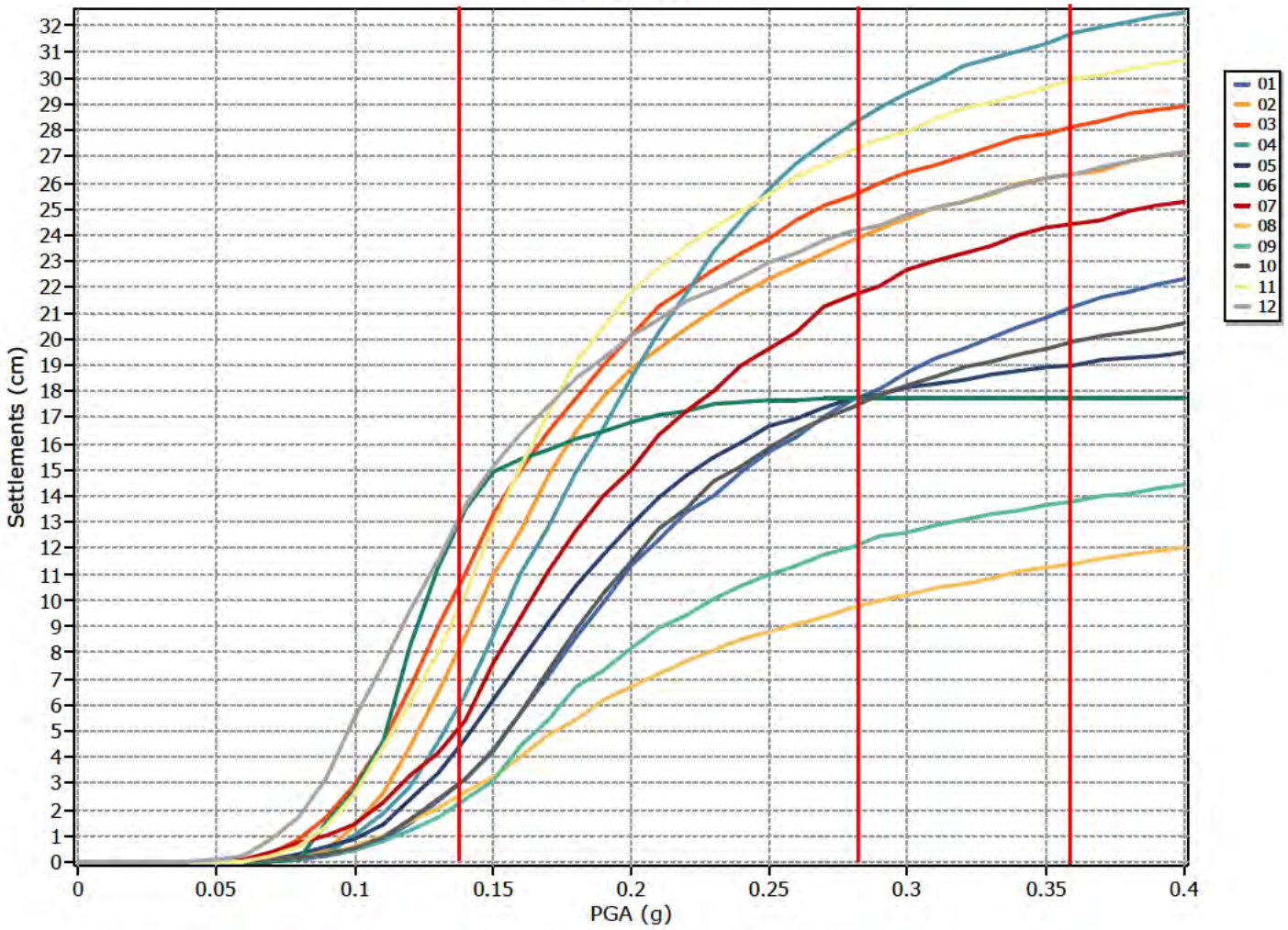
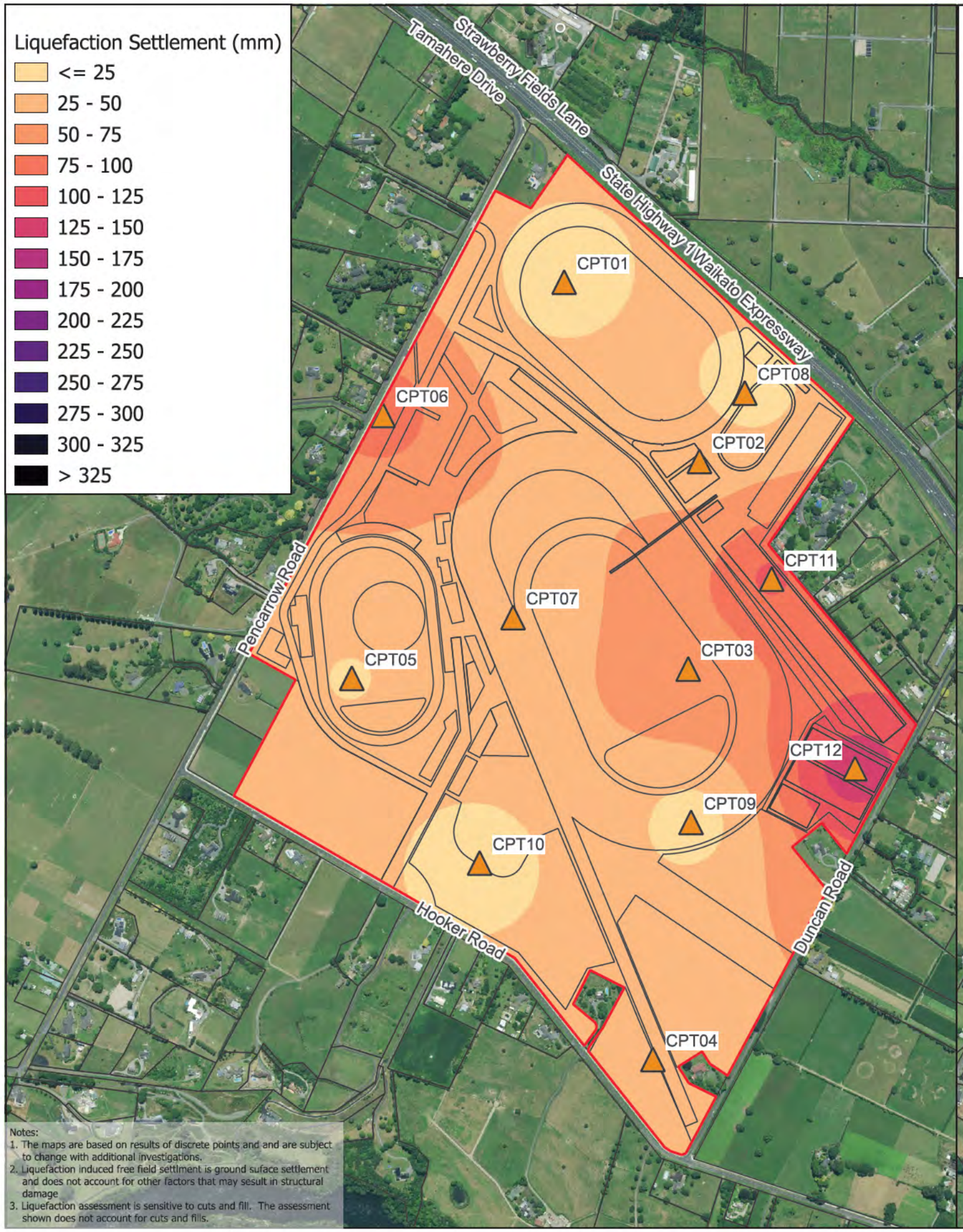
PGA Based Parametric Analysis

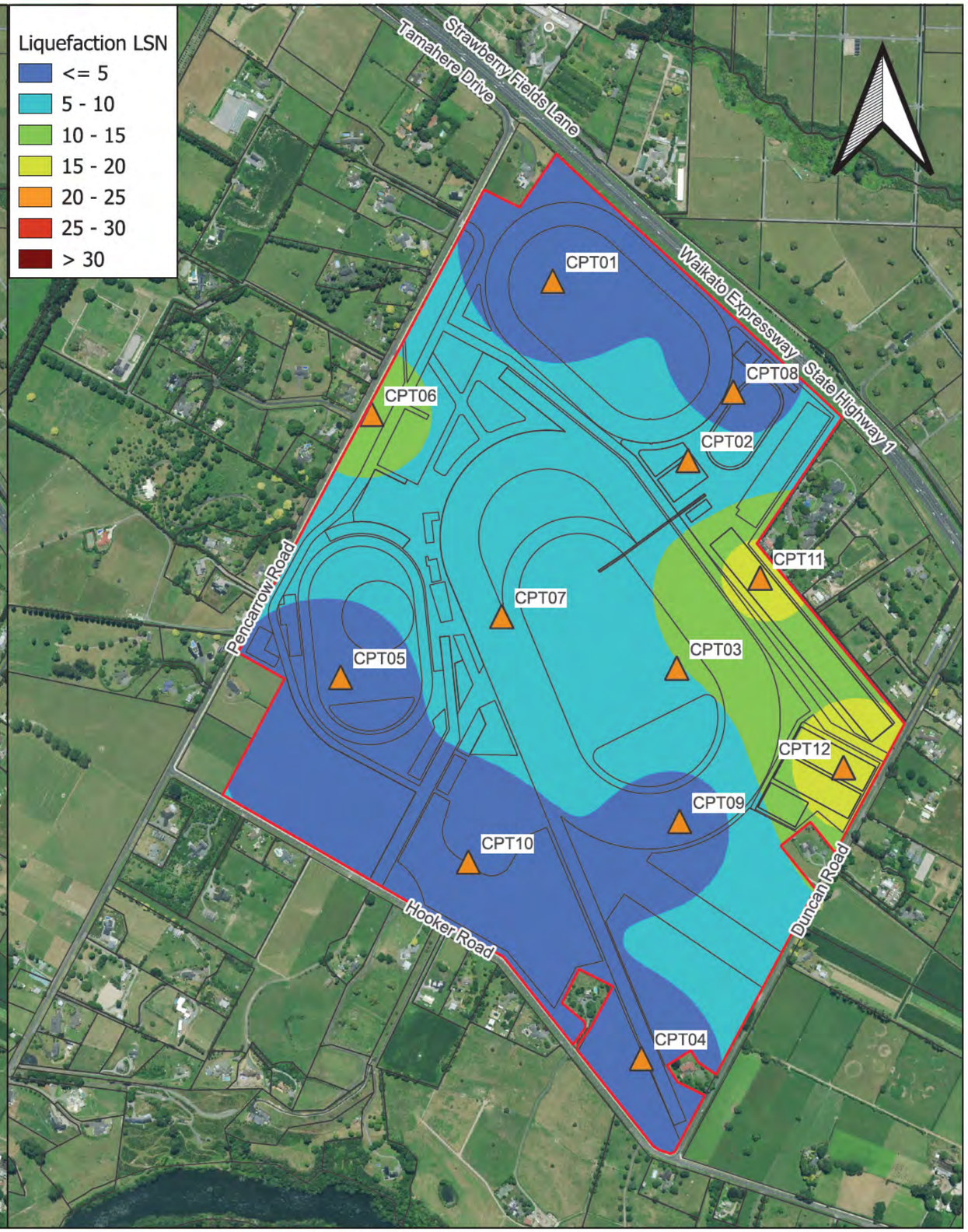
Settlements vs PGA



:: CPT main liquefaction parameters details ::

CPT Name	Assesment method	Earthquake Mag.	GWT in situ (m)	GWT earthq. (m)
01	Boulanger & Idriss (2014)	5.90	1.00	1.00
02	Boulanger & Idriss (2014)	5.90	1.00	1.00
03	Boulanger & Idriss (2014)	5.90	1.00	1.00
04	Boulanger & Idriss (2014)	5.90	1.00	1.00
05	Boulanger & Idriss (2014)	5.90	1.00	1.00
06	Boulanger & Idriss (2014)	5.90	1.00	1.00
07	Boulanger & Idriss (2014)	5.90	1.00	1.00
08	Boulanger & Idriss (2014)	5.90	1.00	1.00
09	Boulanger & Idriss (2014)	5.90	1.00	1.00
10	Boulanger & Idriss (2014)	5.90	1.00	1.00
11	Boulanger & Idriss (2014)	5.90	1.00	1.00
12	Boulanger & Idriss (2014)	5.90	1.00	1.00





Notes:
1. The maps are based on results of discrete points and and are subject to change with additional investigations.
2. Liquefaction induced free field settlment is ground suface settlement and does not account for other factors that may sesult in structural damage
3. Liquefaction assessment is sensitive to cuts and fill. The assessment shown does not account for cuts and fills.

Client: WAIKATO THOROUGHBRED RACING — TE RAPA / CAMBRIDGE / WAIPA

Contractor:

BCD GROUP

Sheet: IL1 - Liquefaction Map

Project Title: Waikato Thoroughbred Racing
Pencarrow, Hooker & Duncan Roads

Revision	Date	By	Reason
04	26/03/2026	BB	Fast Track Referral Application
03	27/02/2026	BB	Fast Track Referral Application
02	16/12/2025	BB	Master Planning
01	25/11/2025	BB	Master Planning

Drawn: BB	Scale:	At:
Engineer: BB	10,000	A3
Job Number:	Sheet Number:	Revision:
23-1883	D-01	04

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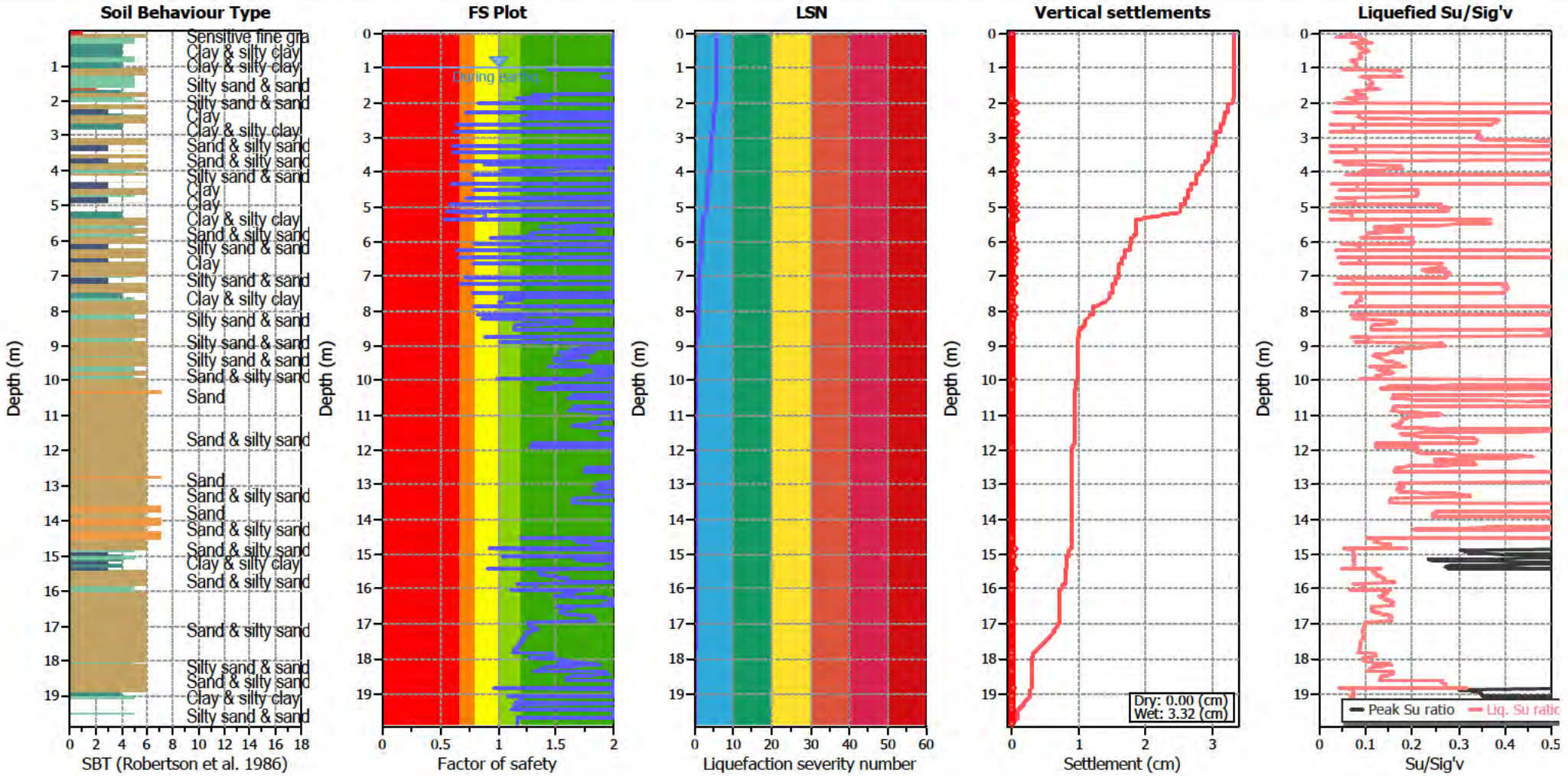
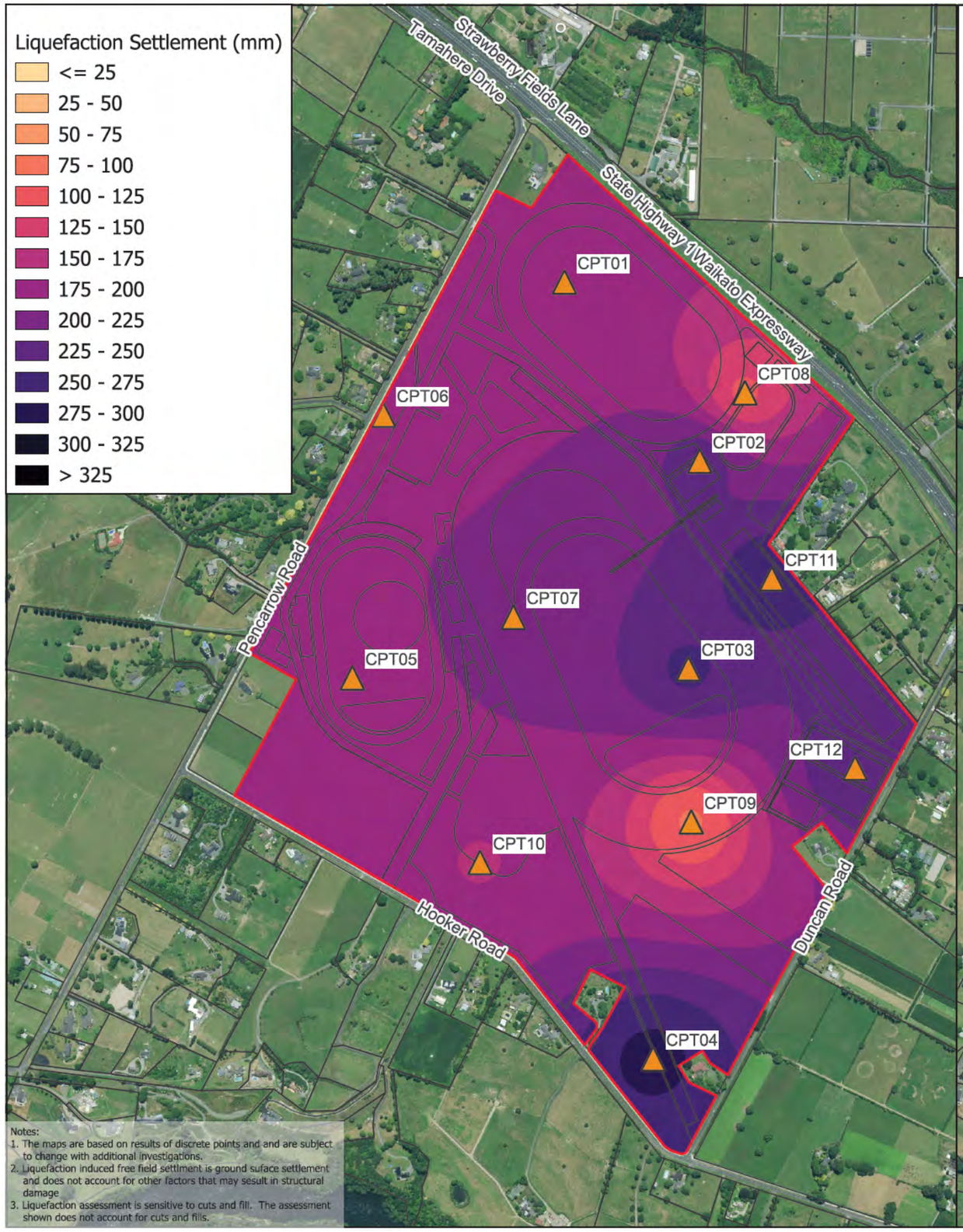
Note: Liquefaction data can be provided on request

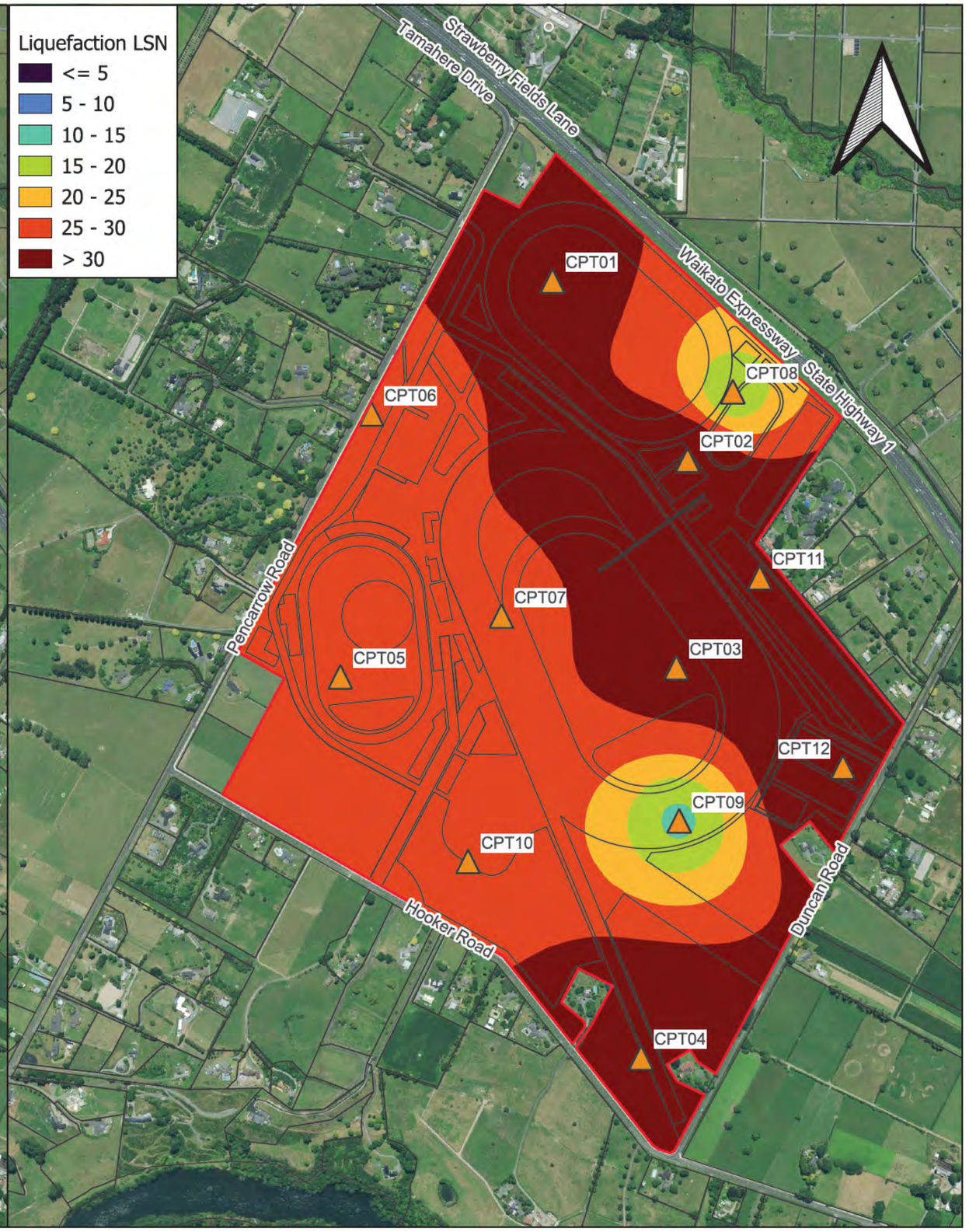
Project: **Waikato Thoroughbred Racing | 23-1883**
Location: **Pencarrow, Hooker and Duncan Road, Tamahere**

CPT: 7.00
Total depth: 19.86 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.12	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based





Notes:
1. The maps are based on results of discrete points and and are subject to change with additional investigations.
2. Liquefaction induced free field settlment is ground suface settlement and does not account for other factors that may sesult in structural damage
3. Liquefaction assessment is sensitive to cuts and fill. The assessment shown does not account for cuts and fills.

Client: WAIKATO THOROUGHBRED RACING — TE RAPA · CAMBRIDGE · WAIPA

Contractor:

BCD GROUP

Sheet: IL2 - Liquefaction Map

Project Title: Waikato Thoroughbred Racing
Pencarrow, Hooker & Duncan Roads

Revision	Date	By	Reason
04	26/03/2026	BB	Fast Track Referral Application
03	27/02/2026	BB	Fast Track Referral Application
02	25/12/2025	BB	Master Planning
01	25/11/2025	BB	Master Planning

Drawn: BB
Engineer: BB
Scale: 10,000
At: A3

Job Number:	Sheet Number:	Revision:
23-1883	D-02	04

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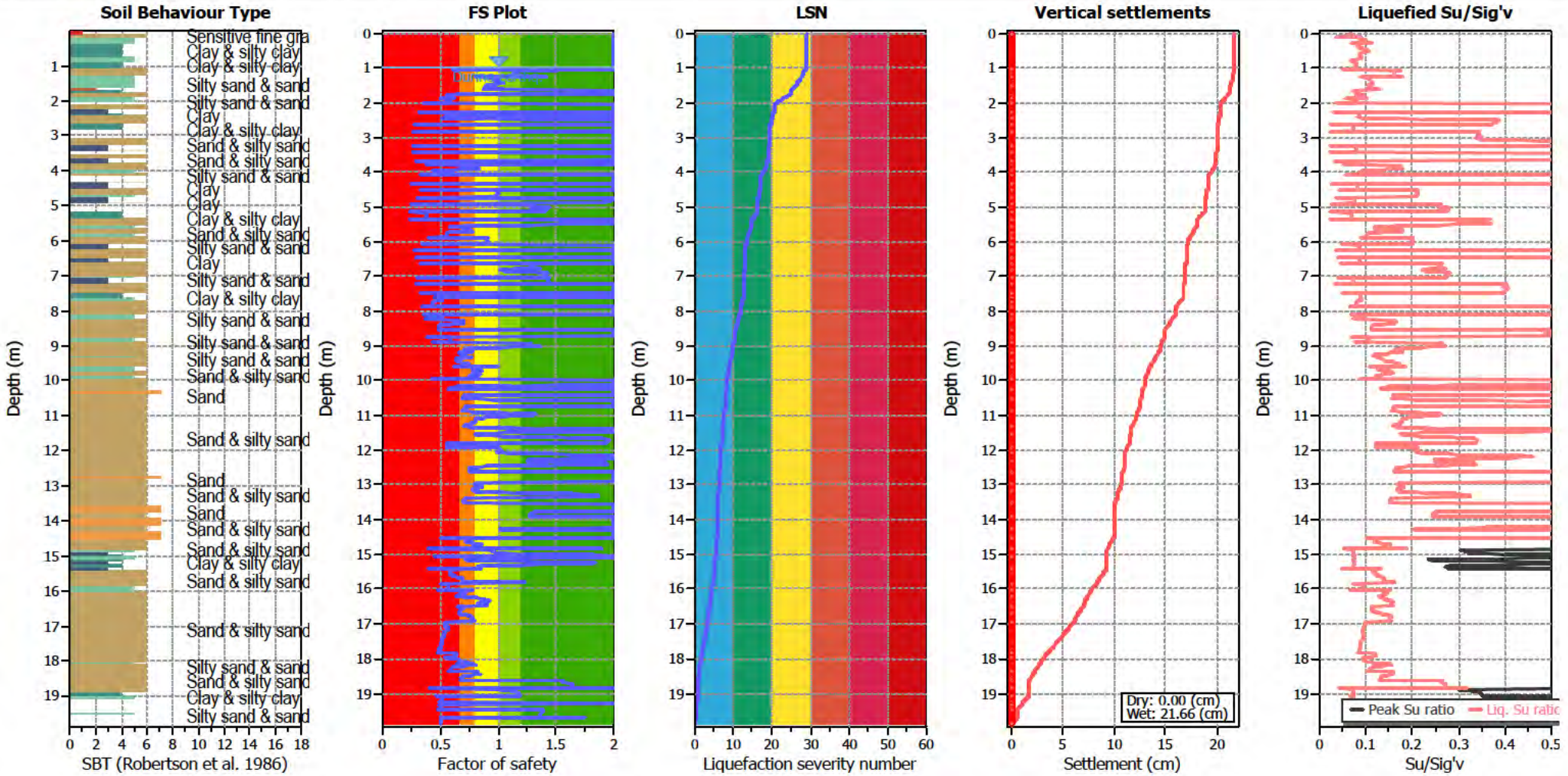
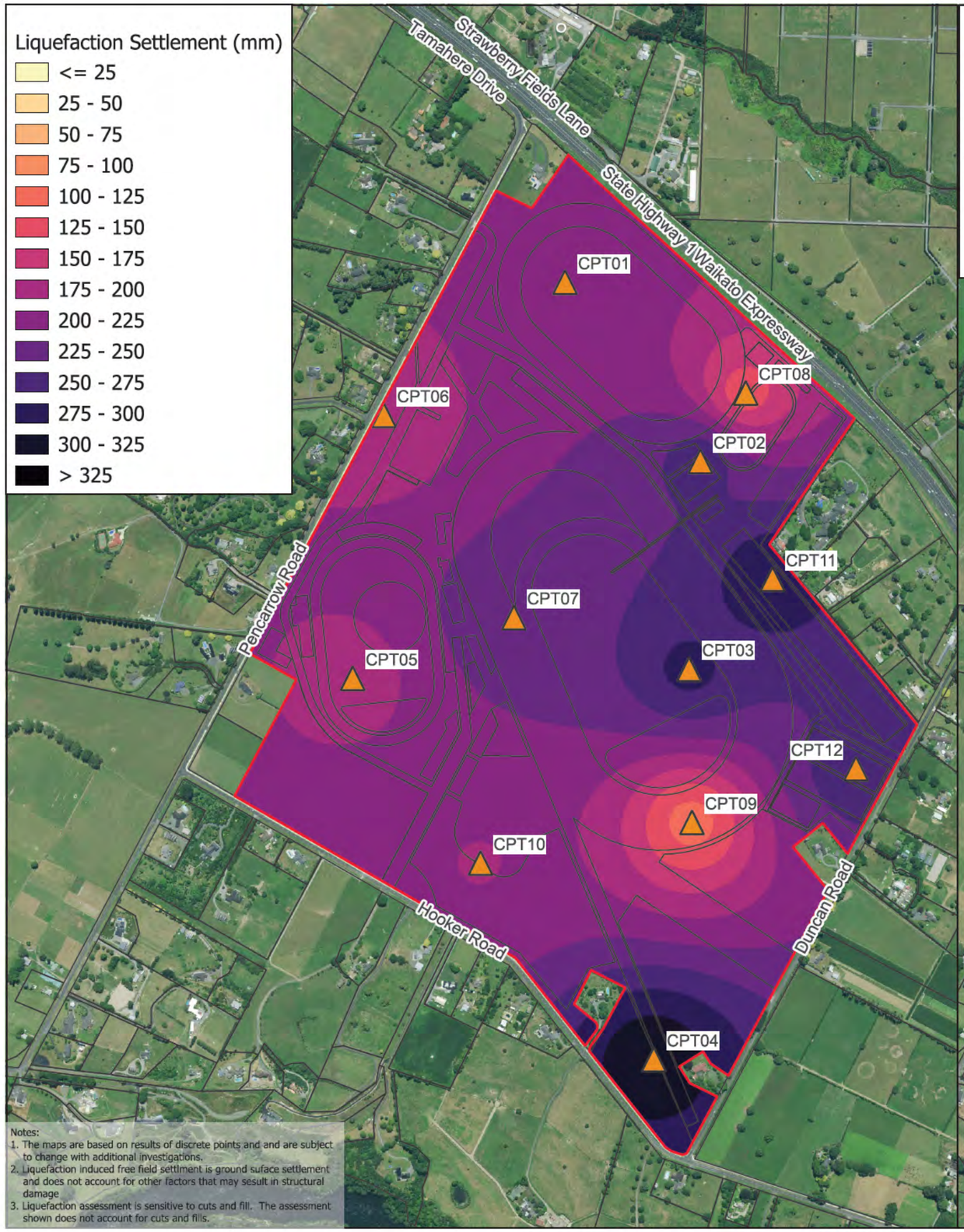
Note: Liquefaction data can be provided on request

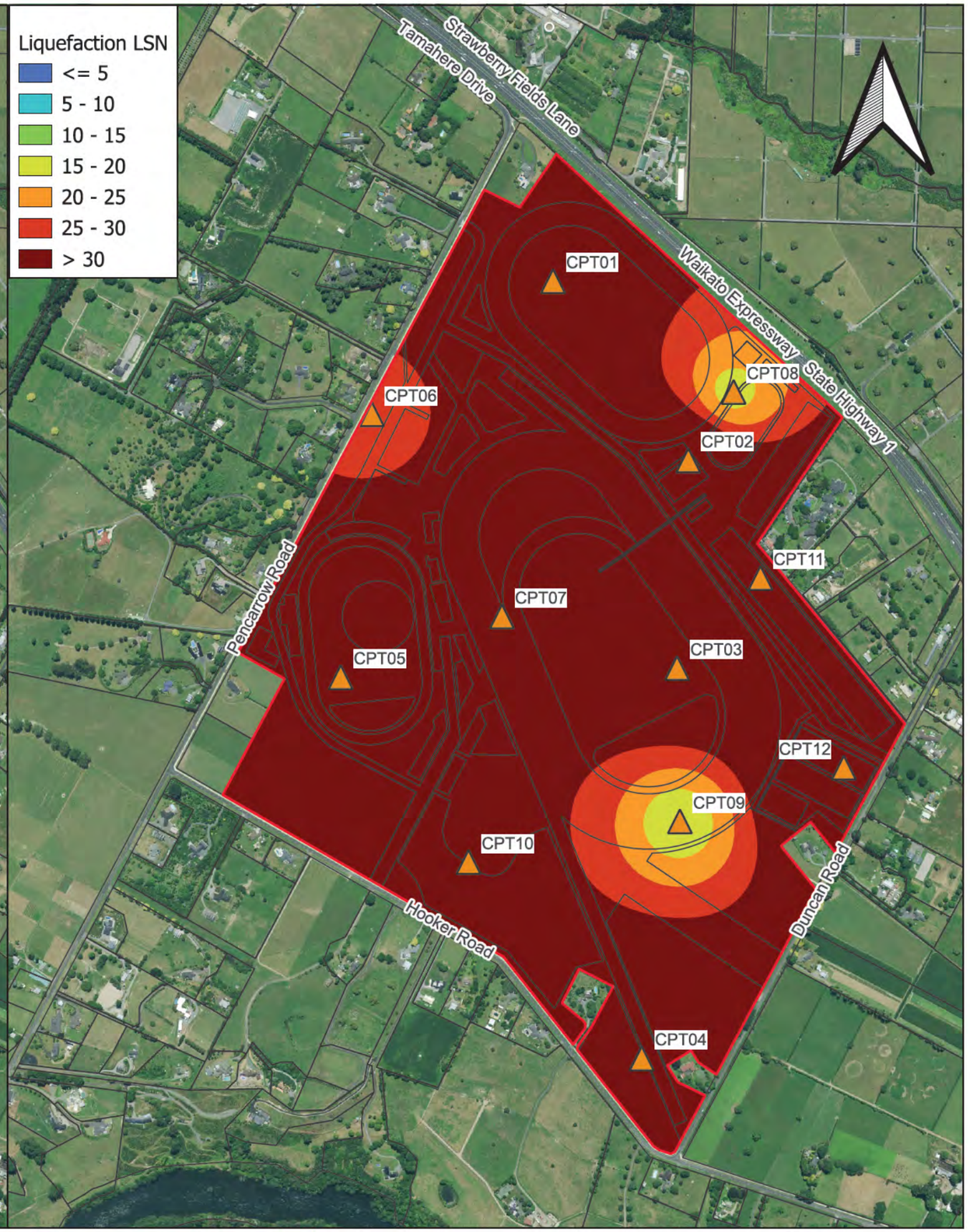
Project: **Waikato Thoroughbred Racing | 23-1883**
Location: **Pencarrow, Hooker and Duncan Road, Tamahere**

CPT: 7.00
Total depth: 19.86 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.28	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based





Notes:
1. The maps are based on results of discrete points and and are subject to change with additional investigations.
2. Liquefaction induced free field settlment is ground suface settlement and does not account for other factors that may sesult in structural damage
3. Liquefaction assessment is sensitive to cuts and fill. The assessment shown does not account for cuts and fills.

Client: WAIKATO THOROUGHBRED RACING — TE RAPA · CAMBRIDGE · WAIPA

Contractor:

BCD GROUP

Sheet: IL3 - Liquefaction Map

Project Title: Waikato Thoroughbred Racing
Pencarrow, Hooker & Duncan Roads

Revision	Date	By	Reason
04	26/03/2026	BB	Fast Track Referral Application
03	27/02/2026	BB	Fast Track Referral Application
02	25/11/2025	BB	Master Planning
01	25/11/2025	BB	Master Planning

Drawn: BB
Engineer: BB
Scale: 10,000
At: A3
Job Number: 23-1883
Sheet Number: D-03
Revision: 04

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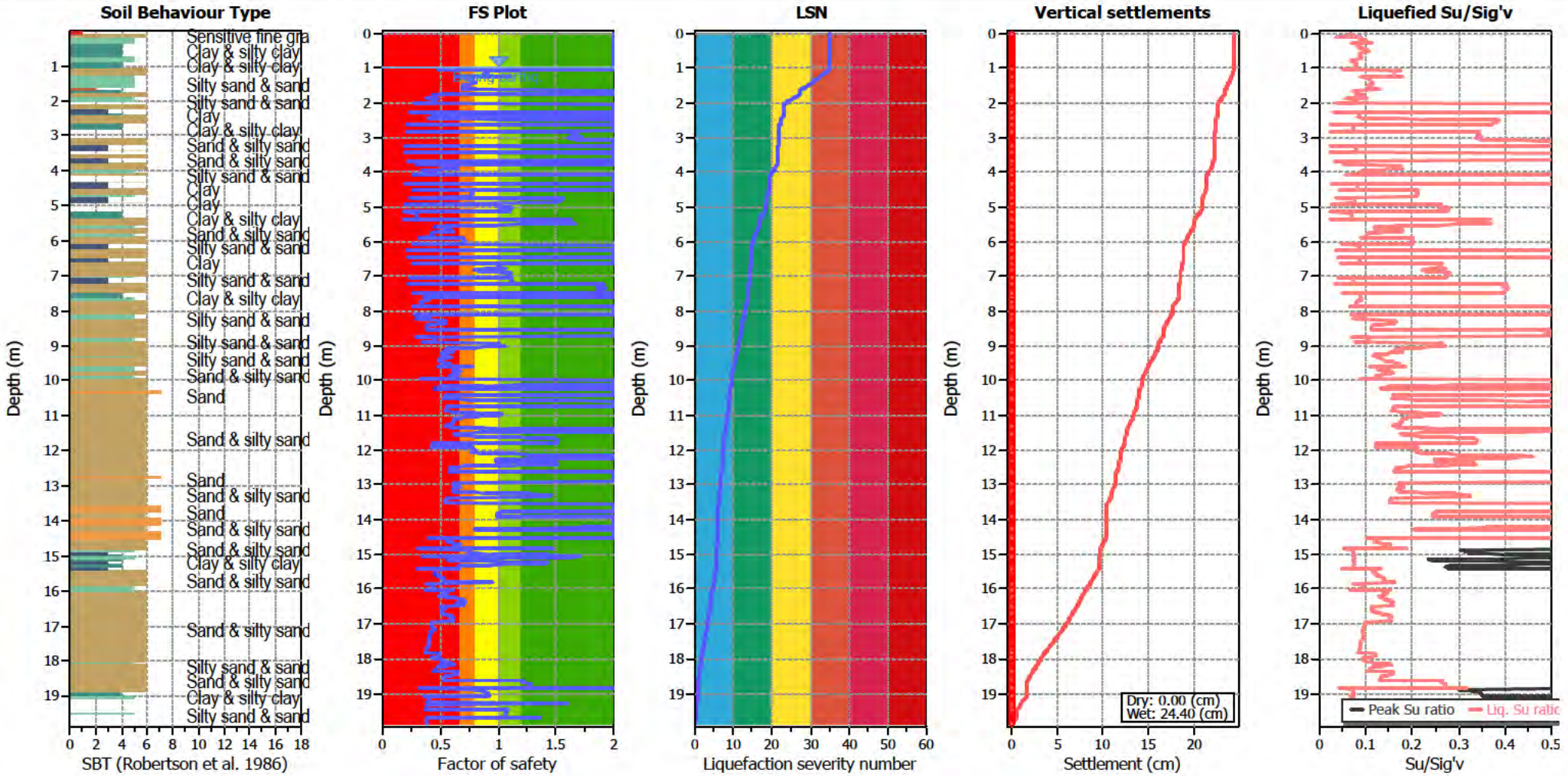
Note: Liquefaction data can be provided on request

Project: **Waikato Thoroughbred Racing | 23-1883**
Location: **Pencarrow, Hooker and Duncan Road, Tamahere**

CPT: 7.00
Total depth: 19.86 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.36	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based

Appendix E Settlement Assessment

Static Settlement (mm)
- <= 25
- 25 - 50
- 50 - 75
- 75 - 100
- > 100

Tamahere Drive
Strawberry Fields Lane
State Highway 1 Waikato Expressway
Pencarrow Road
Hooker Road
Duncan Road
CPT01
CPT02
CPT03
CPT04
CPT05
CPT06
CPT07
CPT08
CPT09
CPT10
CPT11
CPT12

Notes:
1. The maps are based on results of discrete points and and are subject to change with additional investigations.
2. The assessment is based on a 30m x 30m square load

Client: WAIKATO THOROUGHBRED RACING — TE RAPA · CAMBRIDGE · WAIPA
Contractor:
BCD GROUP

Sheet: Static Settlment Map - 20kPa & 40kPa Loads
Project Title: Waikato Thoroughbred Racing
Pencarrow, Hooker & Duncan Roads

Revision	Date	By	Reason
04	26/03/2026	BB	Fast Track Referral Application
03	27/02/2026	BB	Fast Track Referral Application
02	16/12/2025	BB	Master Planning
01	25/11/2025	BB	Master Planning

Drawn: BB
Engineer: BB
Scale: 10,000
At: A3
Job Number: 23-1883
Sheet Number: E-01
Revision: 04

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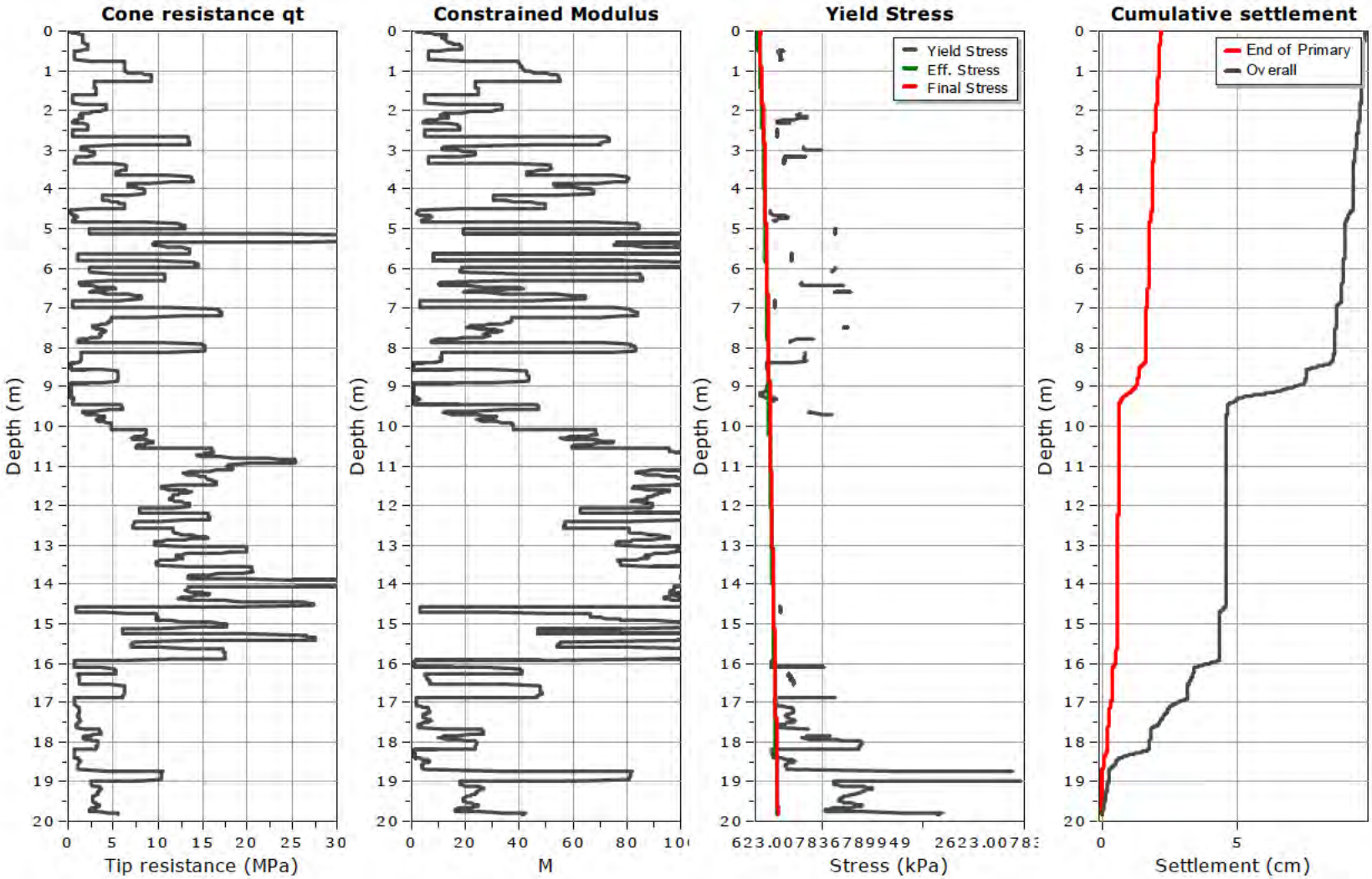
Note: static settlement data can be provided on request

CPT: 05
Total depth: 19.85 m, Date: 19/11/2025
Surface Elevation: 55.00 m, Est. GWL: 2.90 m
Coords: X:1809405.49, Y:5807048.97
Cone Type: P-TC000939
Cone Operator: G.Lannam (GroundLink)

Project: Waikato Thoroughbred Racing | 23-1883
Location: Pencarrow, Hooker and Duncan Road, Tamahere

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 30.00 (m)
L/B: 1.0
Footing pressure: 10.00 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 1 months
Time period for second. settlements: 599 months

* Primary settlement calculation is performed according to the following formula:

$$S = \sum \frac{\Delta\sigma_v}{M_{CPT}} \Delta z$$

* Secondary (creep) settlement calculation is performed according to the following formula:

$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

where t_p is the duration of primary consolidation

Total primary settlement: 2.17
Total secondary settlement: 7.53

Total calculated settlement: 9.69

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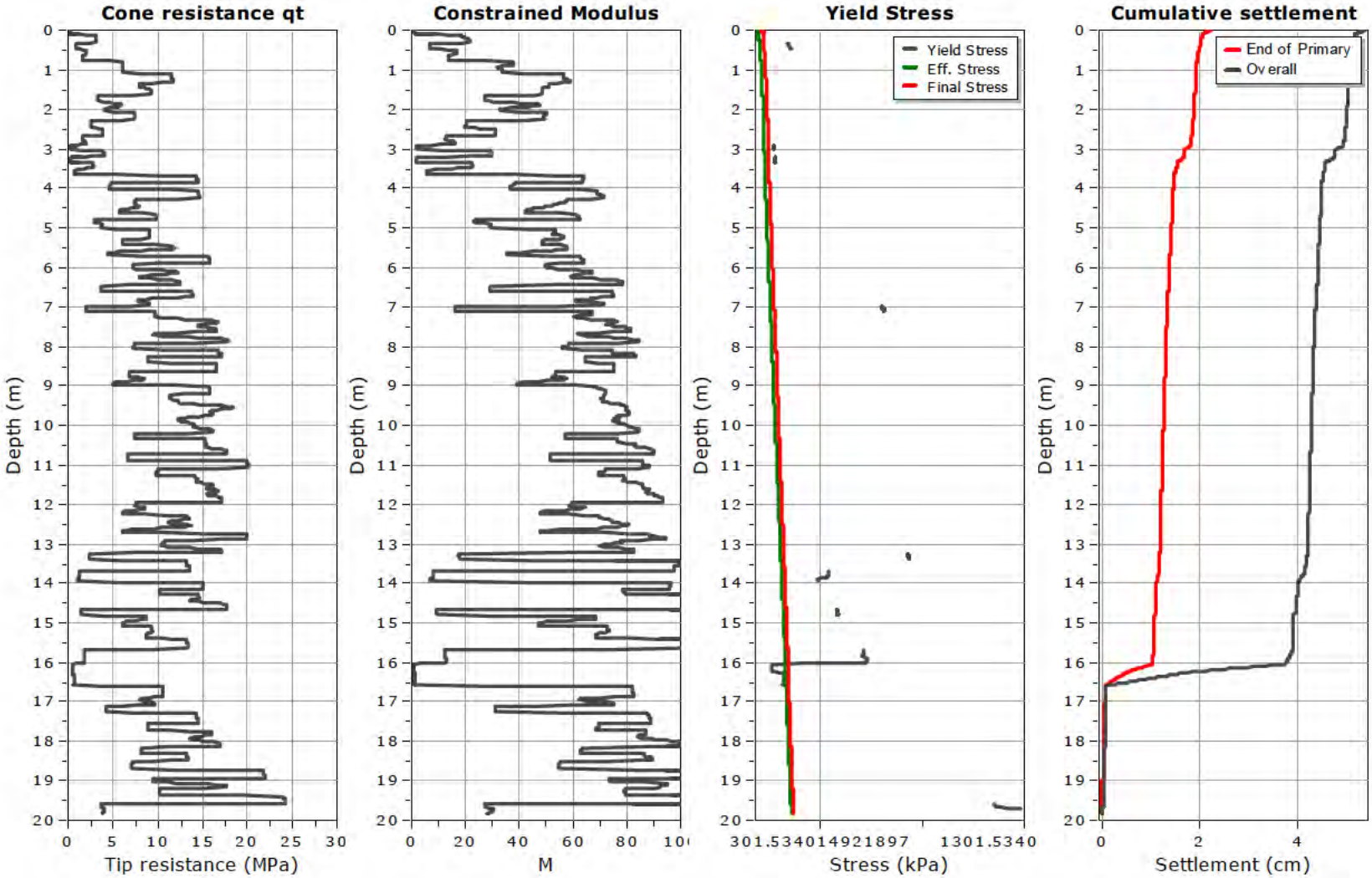
Note: static settlement data can be provided on request

CPT: 02
Total depth: 19.85 m, Date: 19/11/2025
Surface Elevation: 55.00 m, Est. GWL: 0.93 m
Coords: X:1810134.72, Y:5807503.19
Cone Type: P-TC000939
Cone Operator: G.Lannam (GroundLink)

Project: Waikato Thoroughbred Racing | 23-1883
Location: Pencarrow, Hooker and Duncan Road, Tamahere

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 30.00 (m)
L/B: 1.0
Footing pressure: 20.00 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 1 months
Time period for second. settlements: 599 months

* Primary settlement calculation is performed according to the following formula:

$$S = \sum \frac{\Delta\sigma_v}{M_{CPT}} \Delta z$$

* Secondary (creep) settlement calculation is performed according to the following formula:

$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

where t_p is the duration of primary consolidation

Total primary settlement: 2.24
Total secondary settlement: 3.15

Total calculated settlement: 5.39

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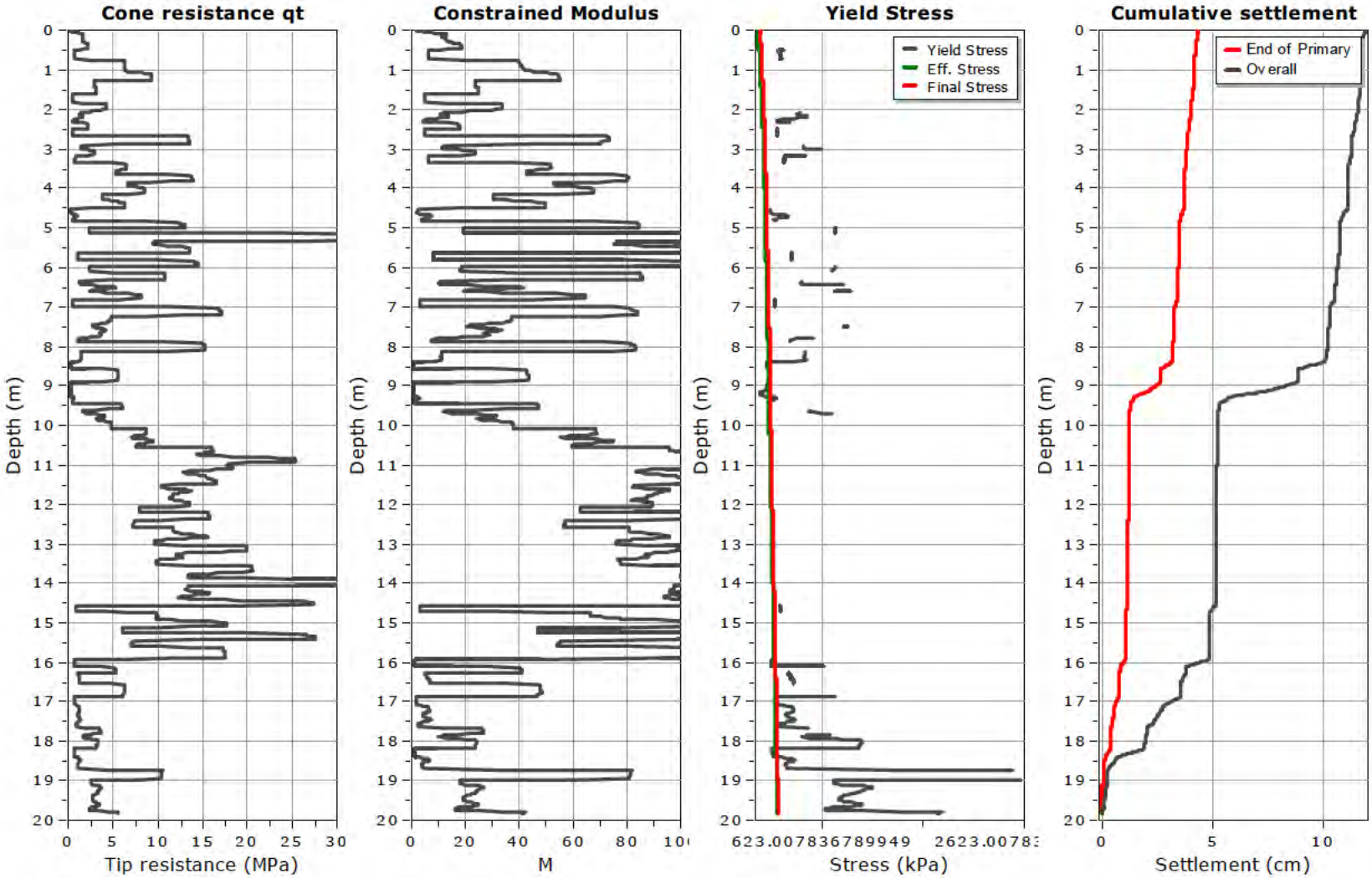
Note: static settlement data can be provided on request

CPT: 05
Total depth: 19.85 m, Date: 19/11/2025
Surface Elevation: 55.00 m, Est. GWL: 2.90 m
Coords: X:1809405.49, Y:5807048.97
Cone Type: P-TC000939
Cone Operator: G.Lannam (GroundLink)

Project: Waikato Thoroughbred Racing | 23-1883
Location: Pencarrow, Hooker and Duncan Road, Tamahere

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 30.00 (m)
L/B: 1.0
Footing pressure: 20.00 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 1 months
Time period for second. settlements: 599 months

* Primary settlement calculation is performed according to the following formula:

$$S = \sum \frac{\Delta\sigma_v}{M_{CPT}} \Delta z$$

* Secondary (creep) settlement calculation is performed according to the following formula:

$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

where t_p is the duration of primary consolidation

Total primary settlement: 4.33
Total secondary settlement: 7.53

Total calculated settlement: 11.86