K260094-1b

29 May 2026

Geotechnical Engineering Appraisal
Proposed Residential Subdivision
Kahikatea Flat Road & Horseshoe Bush Road
Pine Valley
Auckland

Prepared For:

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EXECUTIVE SUMMARY

Geotechnical Engineering Appraisal
Proposed Residential Subdivision
Kahikatea Flat Road & Horseshoe Bush Road
Pine Valley

Scope of Appraisal (refer to Section 1)	KGA has undertaken an initial geotechnical engineering appraisal in support of the Fast-track application for the proposed residential subdivision at Kahikatea Flat Road and Horseshoe Bush Road, Pine Valley. The appraisal is based on a site walkover and review of publicly available geological, geotechnical, geomorphic, and mapping information. No site-specific intrusive investigation has been undertaken at this stage; therefore, the findings are preliminary and subject to future geotechnical investigation, assessment, and detailed design.
Proposed Development (refer to Section 3)	The proposed development comprises a comprehensive residential subdivision of approximately 1,000 to 1,020 lots, with associated internal roads, services, residential development blocks, and retained drainage/green corridors. Significant earthworks are expected to be required, including cut and fill, slope benching, engineered fill placement, and treatment of low-lying or drainage-affected areas.
Inferred Ground Conditions (refer to Section 4)	The ground conditions inferred from available desktop information and walkover observations are grouped as follows: • **Low-lying alluvial areas** o Variable Tauranga Group alluvial deposits are inferred within the central low-lying valley areas. o These materials may include soft, compressible, organic-rich, saturated, and potentially acid sulphate soils from near-surface level. o Shallow groundwater, seepage, and wet ground conditions are anticipated within drainage corridors, ponded areas, and low-lying terrain. • **Sloping ground and ridgeline areas** o Waitemata Group materials are inferred within the northwest ridgeline area. o Northland Allochthon materials are inferred across parts of the northwest, northeast, and southern sloping areas. o The Northland Allochthon materials may comprise highly sheared, moisture-sensitive soils and rock masses with reduced slope stability characteristics. The inferred ground model is preliminary only and requires confirmation by future site-specific geotechnical investigation, laboratory testing, groundwater assessment, and detailed design.
Key Geotechnical Constraints (refer Sections 6 and 7)	The principal geotechnical constraints identified by this appraisal are grouped as follows: • **Slope and geomorphic instability** o Slope instability and relic landslide features, particularly within areas inferred to be underlain by Northland Allochthon materials. o Shallow instability, erosion, and localised slumping along gully banks, drainage corridors, and incised overland flow paths. • **Low-lying alluvial ground conditions** o Soft, compressible, organic-rich, and saturated alluvial soils within the central low-lying valley areas. o Potential acid sulphate soils from near-surface level within low-lying alluvial areas.

	o Shallow groundwater, seepage, and perched water conditions. • **Development and earthworks constraints** o Uncontrolled or disturbed fill, including areas of apparent previous ground disturbance. o Expansive soils requiring confirmation and allowance in future foundation design. o Potential liquefaction-related effects within alluvial deposits. Higher-risk areas are expected to be associated with parts of the Northland Allochthon slopes, incised gullies, drainage corridors, and low-lying alluvial areas.
Development Feasibility	Based on the appraisal completed to date, the proposed subdivision is considered feasible from a geotechnical perspective, provided the identified constraints are addressed through staged site-specific investigation, detailed geotechnical and civil design, and appropriate construction monitoring. Some areas may require appropriately designed mitigation measures, such as setbacks, earthworks treatment, drainage, slope stabilisation and/or retaining, specific foundation design, or localised layout refinement. In our professional opinion, and based on our experience with large-scale land development projects, appropriate mitigation measures should be able to be implemented to provide safe and stable building platforms within the currently proposed development layout, subject to future site-specific investigation and detailed design.
Future Works Required	Future works should include targeted site-specific geotechnical investigation comprising machine boreholes, CPTs, test pits, groundwater observations/monitoring, and laboratory testing. The investigation should confirm the ground model, groundwater regime, shear strength parameters, expansive soil classification, compressibility/settlement behaviour, liquefaction potential, acid sulphate soil risk, slope stability conditions, earthworks requirements, and preliminary foundation options. Acid sulphate soil screening/testing should be specifically allowed for in the low-lying alluvial areas from near-surface level.
Construction Methodology	A detailed construction methodology has not yet been provided. Future methodology should address earthworks staging, treatment/removal of unsuitable soils, engineered fill placement, benching into sloping ground, groundwater and seepage control, acid sulphate soil handling/treatment, erosion and sediment control, works near drainage corridors/wetland areas, gully or slope stabilisation, retaining works where required, and geotechnical observation/testing during construction.
Report Distribution	This appraisal should be provided to the project planner, civil engineer, structural engineer, architect/urban designer, ecologist, environmental/contamination specialist, and other relevant design team members. The geotechnical constraints identified in this report should be considered alongside the civil earthworks strategy, stormwater design, ecological/wetland assessment, planning assessment, and future environmental management requirements.

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1. INTRODUCTION

At the instruction of Tuakiri Property Limited, KGA Geotechnical Group Limited (KGA) has undertaken an initial geotechnical engineering appraisal in support of a resource consent application under the Fast-track Approvals Act 2024 for a proposed residential subdivision of existing properties located along Kahikatea Flat Road and Horseshoe Bush Road, Dairy Flat.

The scope of our assessment was set out in our agreement dated 11 February 2026 and included a detailed walkover inspection of the site and a review of publicly available geotechnical and geological information only. The information obtained has been used to identify potential geotechnical risks and constraints associated with the proposed development and to provide recommendations for further detailed subsurface investigations required to fully assess the site. Preliminary geotechnical considerations and potential mitigation measures have also been identified to inform early-stage design, feasibility assessments, and indicative development costing.

While preparing this report, an initial evaluation of landslide hazard risk was conducted based on Appendix 24 of Auckland Council Plan Change 120 (**PC120**), prior to any site-specific investigations or design work. It is important to note this preliminary assessment is for use in the "Fast-Track" application process only, and the conclusions within may be subject to change following site-specific investigation and detailed design. The PC120 assessment is presented at the rear of this report as Attachment F.

Aspects relating to potential ground contamination have not been addressed in this report as they fall outside the scope of our services. Similarly, detailed assessment of wastewater and stormwater engineering design has not been undertaken. However, limited commentary regarding site-specific management and control of wastewater and stormwater is provided where relevant in the appropriate sections of this report.

2. SITE DESCRIPTION

2.1 Legal Description

The proposed subdivision development comprises the entirety of 10 existing properties located within the Pine Valley area, legally described as follows:

• 61 Kahikatea Flat Road	Lot 1 DP 354161	4.65Ha
• 77 Kahikatea Flat Road	Lot 7 DP 65688	4.24Ha
• 24 Horseshoe Bush Road	Lot 1 DP 62568	4.06Ha
• 42 Horseshoe Bush Road	Lot 3 DP 466485	1.00Ha
• 46 Horseshoe Bush Road	Lot 2 DP 466485	1.00Ha
• 48 Horseshoe Bush Road	Lot 2 DP 623127	16.48Ha
• 82 Horseshoe Bush Road	Lot 2 DP 130668	7.54Ha
• 100 Horseshoe Bush Road	Lot 2 DP 105762	16.25Ha
• (Unnumbered) Horseshoe Bush Road	Lot 1 DP 130668	15.91Ha
• (Unnumbered) Horseshoe Bush Road	Lot 3 DP 130668	6.75Ha

Together, these parcels comprise a total plan area of approximately 77.9 ha and are collectively referred to herein as “the site.”

2.2 Regional Site Topography

Overall, the site is irregular in plan shape and is bounded to the north, west, and east by existing rural properties, comprising a mixture of lifestyle blocks and farmland. It is also bounded by Kahikatea Flat Road to the northeast and Horseshoe Bush Road to the south. At present, each of the existing lots that comprise the site is accessed via its legally established road frontage. In addition, the property at 48 Horseshoe Bush Road benefits from a panhandle accessway connecting to Kahikatea Flat Road at the northwest corner of the site. An indication of the site boundaries is presented in Figure 1 below and on the Site Plan (Drawing KGA 1) included in Attachment A.

The regional topography of the site is controlled by two prominent ridgeline features, one terminating in the northwest corner of the site and the other forming the southern boundary of the site, both trending generally west to east. Ground levels generally fall from these elevated features toward the central portion of the site, which comprises low lying, near-level to gently sloping terrain associated with ancient flood terrace deposits, gently falling toward the east to northeast. A series of incised gully features traverse the lowland areas, generally draining from the southwest and west toward the northeast and east.

The local geomorphology and site-specific topographic features are discussed in further detail in Section 5.

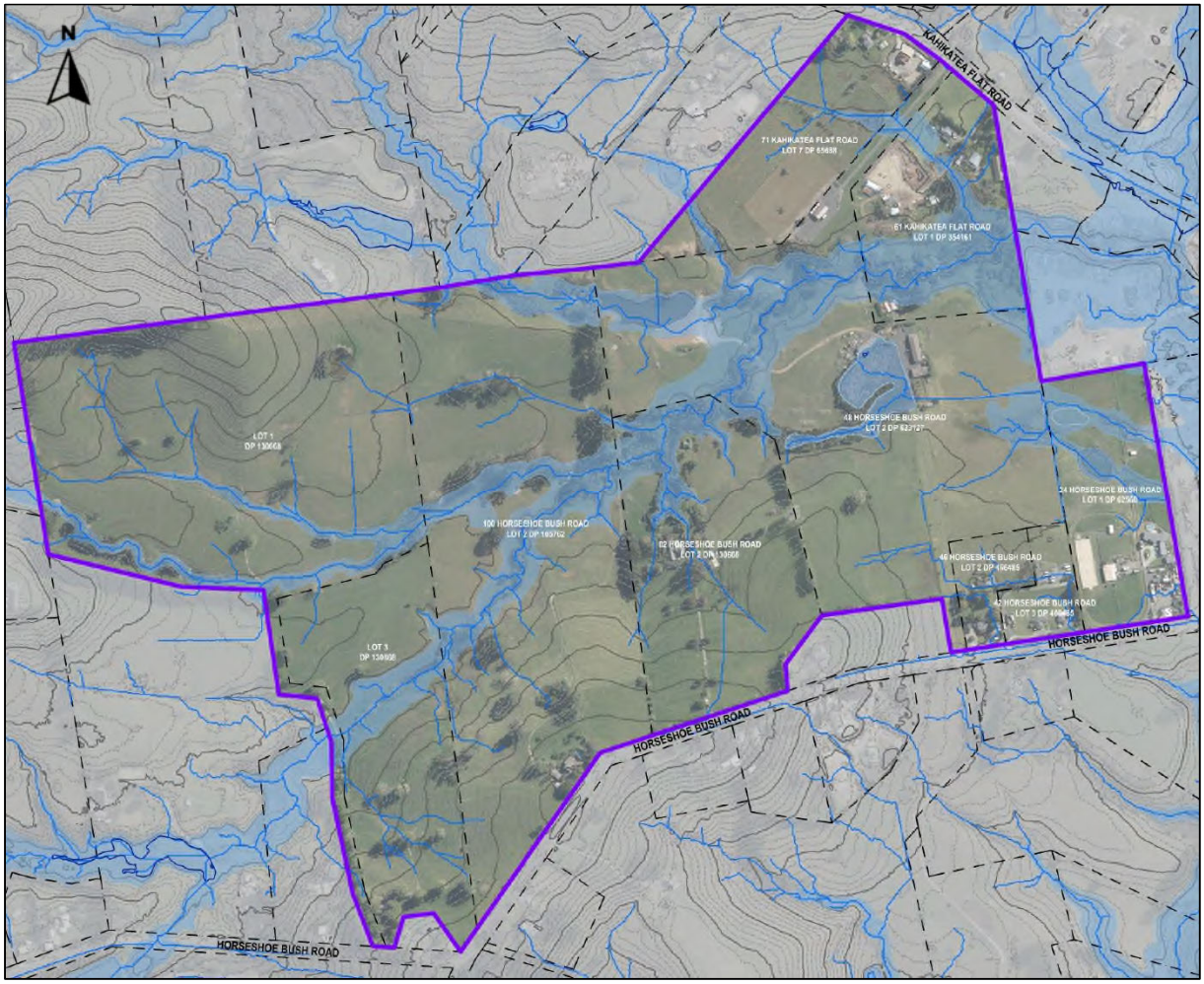


Figure 1: Snippet from KGA Site Plan showing proposed subdivision development extent, existing property boundaries and site cover (not to scale).

3. PROPOSED DEVELOPMENT

As part of preparing this report we have received and reviewed a set of preliminary subdivision layout plans prepared by Isthmus Limited, entitled “Proposed Residential Development – Horseshoe Bush Road & Kahikatea Flat Road, Dairy Flat, Auckland”, reference No. 5202, dated 20 May 2026. The plans show proposed development comprises a comprehensive residential subdivision across the site. The indicative subdivision layout shown in Figure 2, with the layout compared to the current topography indicated on our Subdivision Layout Plan (Drawing KGA 3) presented in Appendix A.

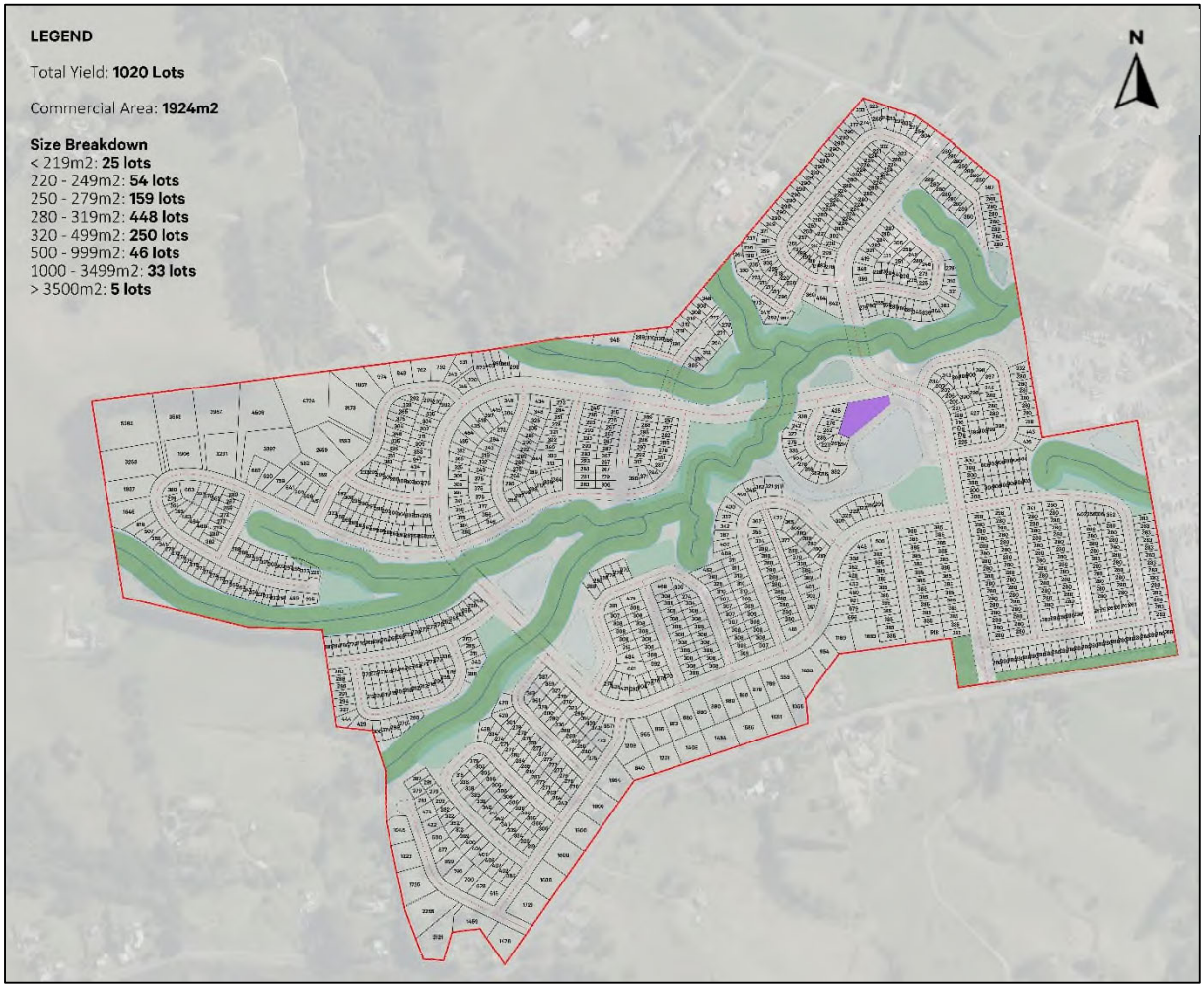


Figure 2: Snippet from Isthmus Limited plans showing proposed subdivision development layout (not to scale).

The subdivision is proposed to comprise approximately 1,000 - 1,100 lots and has been conceptually arranged around the existing stream corridor that traverses the site generally from west to northeast. The development consists of a proposed connected internal road network accessed from Kahikatea Flat Road and Horseshoe Bush Road, providing access to multiple standard residential lots arranged in several development blocks across the site.

The major existing stream channels and its tributaries are to be retained within a central green corridor, which is proposed to accommodate riparian planting, stormwater conveyance, and open space areas. Residential development is generally located on the surrounding lowland and sloping ground on both sides of this corridor.

No preliminary earthworks plans have been provided for review at this stage. However, based on the proposed subdivision layout and the existing site topography, it is anticipated that earthworks comprise a combination of cut and fill earthworks, including benching of slopes and the formation of engineered fill areas will be required to form the internal road network and near-level residential building platforms.

The layout also indicates that localised infilling of minor streams, drainage channels, and ponded areas may be required. The extent and depth of earthworks will need to be confirmed through detailed civil design and supported by site-specific geotechnical investigation and assessment.

4. BACKGROUND INFORMATION

4.1 Sources Consulted

The following third-party information sources were consulted and referred to in this report:

- Published Regional Geology
- Auckland Council GeoMaps Website
- Historic Imagery
- LINZ Geospatial Information
- New Zealand Geotechnical Database (NZGD)
- NZGS Geotechnical Publication – Acid Sulphate Soils

A summary of our understanding of sighted third-party information is presented below. We note that the below summary of information is limited to that considered relevant to the geotechnical assessment of the site, is intended to present facts and opinions as outlined in the third-party sources, and does not constitute interpretation or endorsement by KGA.

4.2 Published Regional Geology

The geology of the site and surrounding area is detailed on the GNS Science New Zealand Geology Web Map (Scale 1:250,000). This shows the site and immediately surrounding areas to be underlain by the following:

- Late to Middle Pleistoicene River and Hillslope Deposits of the Tauranga Group
- Early Miocene East Coast Bays Formation (Warkworth Subgroup) of the Waitemata Group
- Middle Eocene to Early Miocene Mahurangi Limestone (Motatau Complex) in the Northland Allochthon.
- Late Cretaceous to Middle Eocene Hukerenui Mudstone (Managakahia Complex) in the Northland Allochthon

We point out that the geological map is regional in scale and therefore only useful as an approximate guide to the types of materials that may underlie the site. It is possible that other materials not indicated on the map are present beneath the subject site, and also that some of the indicated materials are absent. Regardless, the presence or absence of any material can only be confirmed onsite by site specific investigation methods.

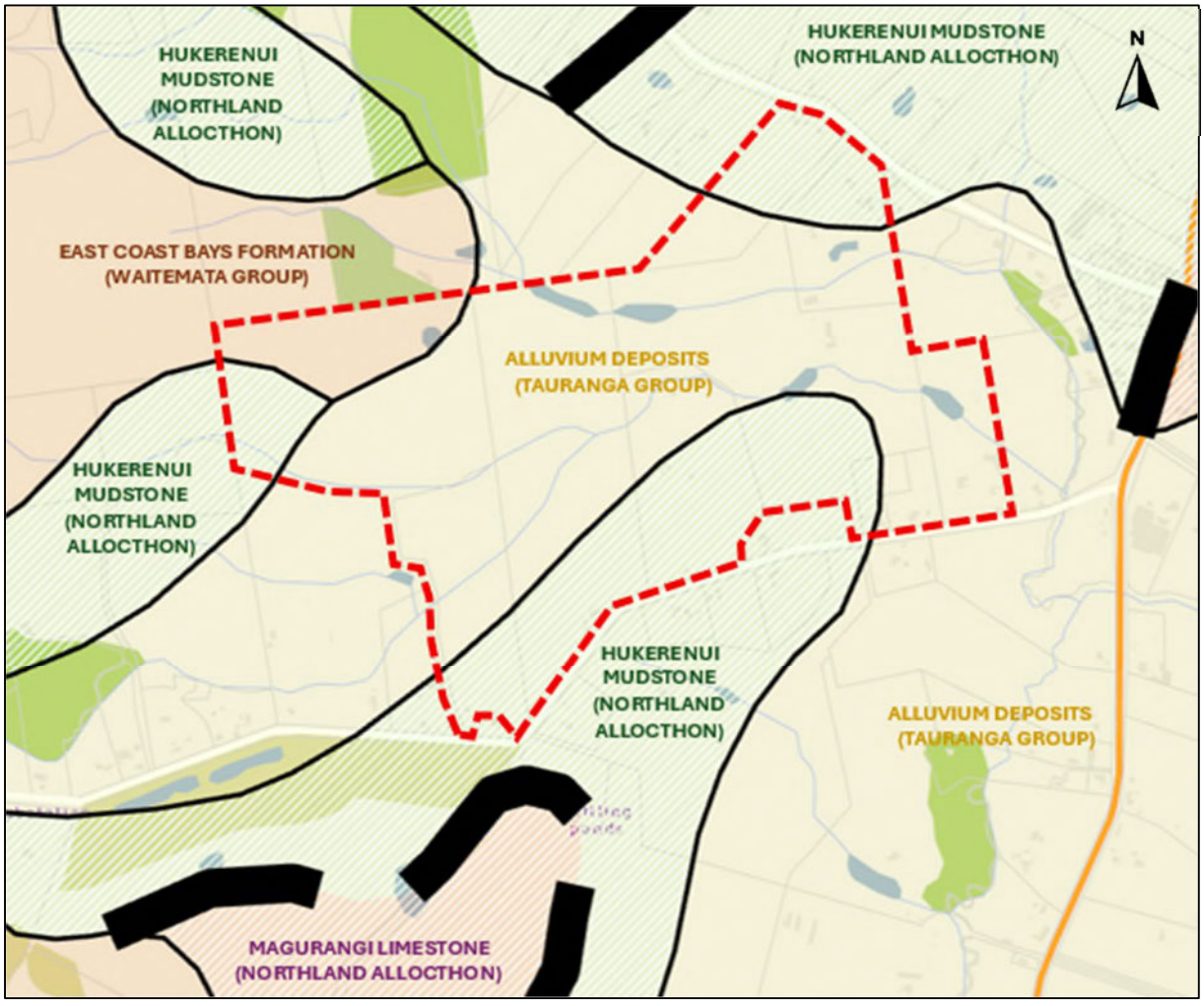


Figure 3: Excerpt from the GNS New Zealand Geology Web Map (not to scale). The subject site boundaries (dashed red line) relative to the mapped geological units and features are indicative and approximately only.

4.2.1. Tauranga Group River and Hills Slope Deposits

Tauranga Group deposits are mapped through the central portion of the site (generally west to east) within the lowland area located between the regional ridgelines that bound the northern and southern extents of the site.

The Tauranga Group is generally described as consisting of light grey to orange-brown pumiceous sand, silt and mud, with occasional inclusions of black muddy peat and lignite. These materials were deposited in predominantly fluvial and lacustrine environments and are therefore expected to be highly variable in composition and engineering properties.

4.2.2. East Coast Bays Formation of the Waitemata Group

An outcrop of East Coast Bays Formation is mapped beneath the northwest corner of the site at the termination of the northern ridgeline. This formation typically comprises mudstone and graded sandstone, forming alternating beds of siltstone and sandstone in the unweathered state, generally encountered at depths greater than approximately 5 m to 8 m. Weathering of the formation results in the development of stiff clays and silts in the completely decomposed state.

At intermediate weathering grades, the material commonly comprises moderately to highly weathered silty fine sand and fine sandy silt, which may retain the original bedding structure and exhibit slight cementation.

4.3 Mahurangi Limestone of the Northland Allochthon

A limestone quarry is located to the south of the site. Geological mapping indicates the presence of Mahurangi Limestone, which comprises a sequence of pale grey to white laminated muddy limestones, commonly interbedded with graded sandstone beds.

The strength of this formation can vary; however, the limestone is generally moderately to well cemented and hard in its intact state. The rock mass may be folded and structurally disrupted, with conditions ranging from highly fractured or shattered zones to relatively intact rock.

A key geotechnical characteristic of Mahurangi Limestone is the presence of clay-rich seams and infillings within the rock mass. When exposed to atmospheric conditions and moisture, these clays can absorb water and degrade rapidly, leading to a reduction in strength. As a result, exposed or

disturbed material may become soft and unstable, particularly where weathering or excavation exposes clay-bearing zones.

4.3.1. Hukerenui Mudstone of the Northland Allochthon

The northwest and northeast corners, together with portions of the southern area of the site, are mapped as being underlain by undifferentiated Hukerenui Mudstone of the Mangakahia Complex, part of the Northland Allochthon. This unit typically comprises sheared bentonitic mudstone, ranging from soft to moderately hard and exhibiting variable colours including red, brown, green and grey, with locally variable calcareous content.

Due to the highly sheared nature of the formation, these materials are well known to exhibit reduced shear strength and poor slope stability characteristics, and may be prone to instability even on relatively gentle slopes.

4.4 Auckland Council GeoMaps Website

A review of the information available on the Auckland Council GIS Web application “GeoMaps” has been conducted, and is discussed in the following subsections.

4.4.1. Service and Waterways

The maps show no public services run through the property. A number of overland flow paths and flood plains are shown to run through the site, generally trending in a west to east direction towards Rangitopuni Stream, as shown in Figure 4.

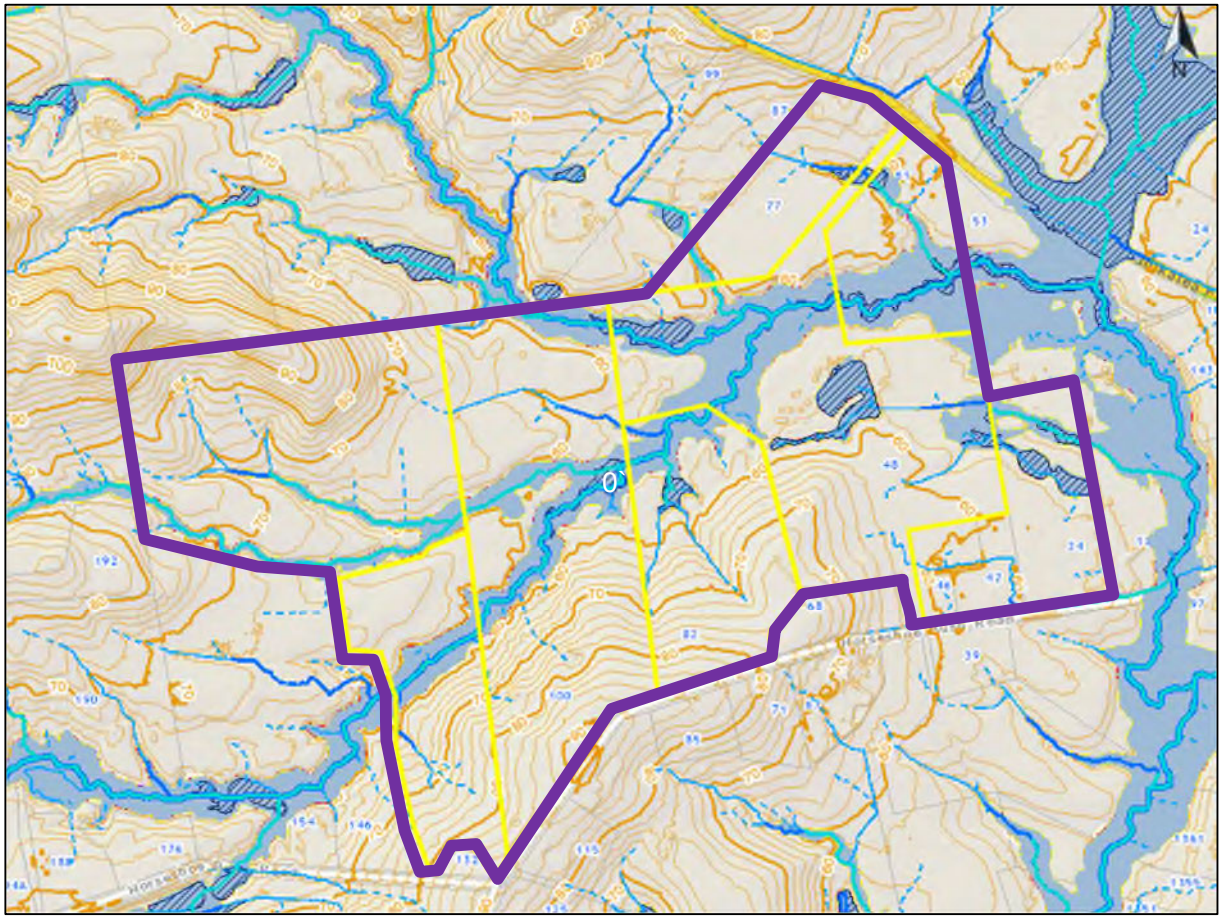


Figure 4: Approximate site extent overlying overland flow paths and flood plains/prone areas, sourced from Auckland Council GeoMaps web application (not to scale).

4.4.2. Liquefaction Vulnerable Areas

As indicated in Figure 5, the *"Level B – Calibrated Desktop Assessment"* liquefaction vulnerability layer within GeoMaps indicates that the lowland areas of the site, which are mapped as being underlain by Tauranga Group alluvial deposits, are classified as "Liquefaction Damage is Unlikely." The sloping ground across the northwest and northeast corners, and the southern portion of the site, which are mapped as being underlain by either Waitemata Group or Northland Allochthon materials, is classified as "Very Low Liquefaction Vulnerability."

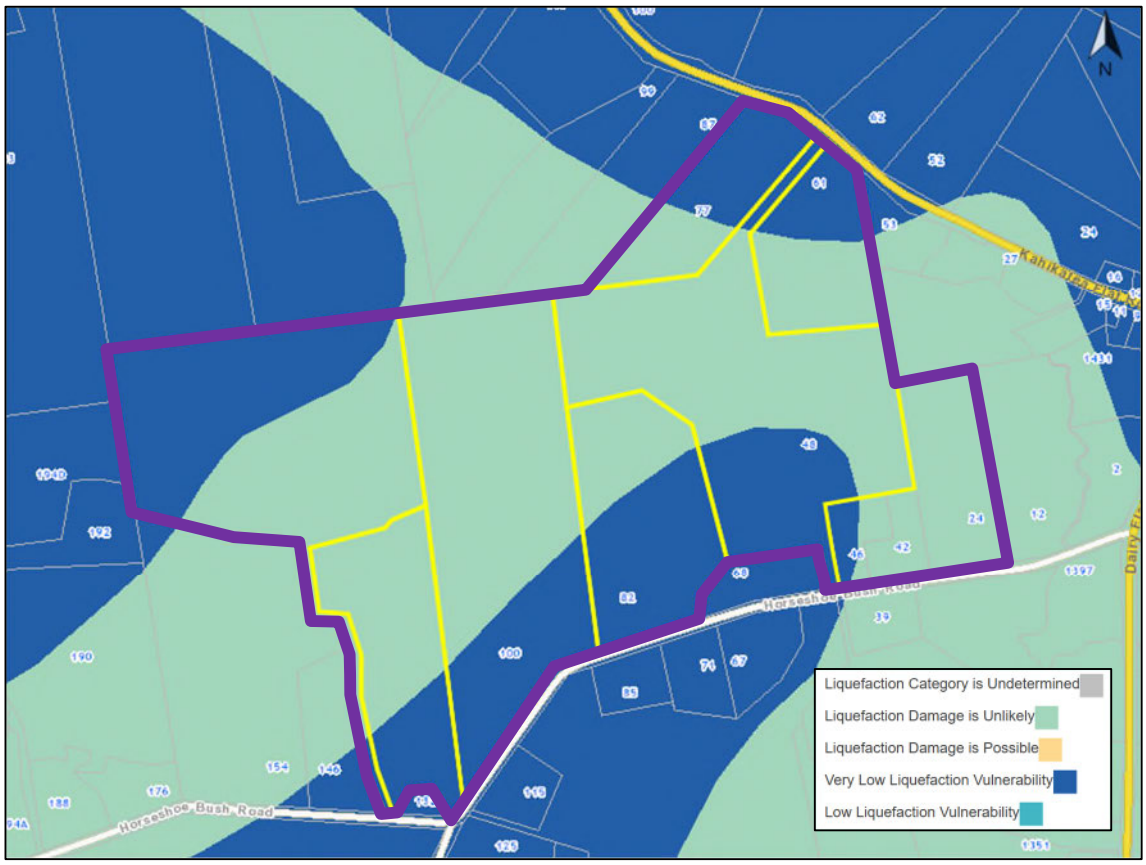


Figure 5: Approximate site location overlying the Liquefaction Vulnerability Areas, sourced from Auckland Council GeoMaps (not to scale).

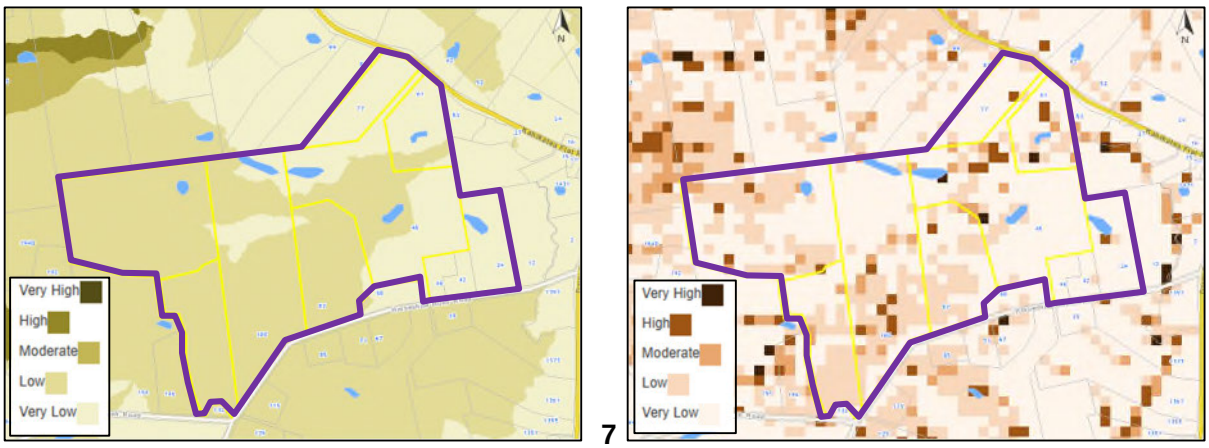
The “Liquefaction Damage is Unlikely” classification indicates that there is a probability of greater than 85% that liquefaction-induced ground damage will be “None to Minor” during a ULS (1:500 year) seismic shaking event. The “Very Low Liquefaction Vulnerability” classification indicates that there is a probability of greater than 99% that liquefaction-induced ground damage will be “None to Minor” for the same ULS seismic event.

This dataset has been generated using a high-level calibrated desktop assessment based on regional geological and geomorphological mapping, together with qualitative interpretation of a limited number of subsurface investigations. Due to the regional scale of the mapping and the limited subsurface data available, there remains a degree of uncertainty associated with these classifications. Accordingly, site-specific geotechnical investigations and detailed assessment will be required to confirm the liquefaction vulnerability across the site as part of future stages of design and consenting.

4.4.3. Landslide Susceptibility

Landslide susceptibility mapping for both large landslides and small-scale shallow landslides has recently been incorporated into the GeoMaps application as part of PC120. These maps are based on the Auckland Council Technical Report entitled *"Auckland Region Landslide Susceptibility Assessment"*, reference TR2025/7, dated May 2025.

The mapping indicates that land within the site is classified as "Very Low" to "Low" susceptibility for large-scale landslides, and "Very Low" to "Very High" susceptibility for shallow landslides (refer to Figures 6 and 7). Cells classified as "High" to "Very High" susceptibility to shallow landslides are also mapped within approximately 150 m upslope of the Site to the west and north of portions of the site.



6 7

Figures 6 and 7: Large scale (Figure 6) and small-scale shallow (Figure 7) Landslide Susceptibility Maps, sourced from Auckland Council GeoMaps (Not to scale).

Based on the outcomes of this assessment, the site has been assigned an overall "Medium" risk classification, corresponding to a "Tolerable" risk level. We have made reference to relevant activity type in Tables E36.4.1B and E36.4.1C of Unitary Plan E36 as detailed below. The assessment carried out within this letter complies with E36.6.A1 Standard (risk assessment carried out by a geotechnical professional). It is also important to note that the following Activity Status is for the assumed 'post-development' of the site.

- **A122 – Controlled Activity –** New structures and buildings and external additions and alterations to existing structures and buildings (as existing at 03/11/25) with a gross floor area more than 20m^2 associated with activities potential sensitive to natural hazards in medium (tolerable) and high (significant) landslide hazard risk areas that comply with Standard E36.6.A1.

- **A124 – Restricted Discretionary –** New structures and buildings and external additions and alterations to existing structures and buildings (as existing at 03/11/25) with a gross floor area more than 20m2 associated with activities sensitive to natural hazards in landslide hazard risk areas that comply with Standard E36.6.A1.
- **A133 – Restricted Discretionary -** All other infrastructure in landslide susceptibility assessment areas not otherwise provided for.

A detailed PC120 Landslide Hazard Risk Assessment has been undertaken by KGA and is presented in Attachment F.

4.5 Historic Imagery

To better understand the site's historic land use and geomorphic development, a review of historic aerial photographs sourced from Auckland Council GeoMaps has been undertaken. Figures 8 to 13 illustrate the evolution of the site from the 1940s to the present, with key observations summarised below:

1940s Photograph: The earliest available aerial photograph indicates the site was predominantly used for farmland. The properties comprising Lot 1 DP 130668 and Lot 3 DP 130668 (Horseshoe Bush Road) appear to be covered in shrubs and bush vegetation. Vegetation also appears largely uncontrolled along the main drainage flow paths traversing the site. Small dwellings are present along the road frontage of 100 Horseshoe Bush Road and 61 Kahikatea Flat Road, with several minor farm sheds and structures scattered across the properties.

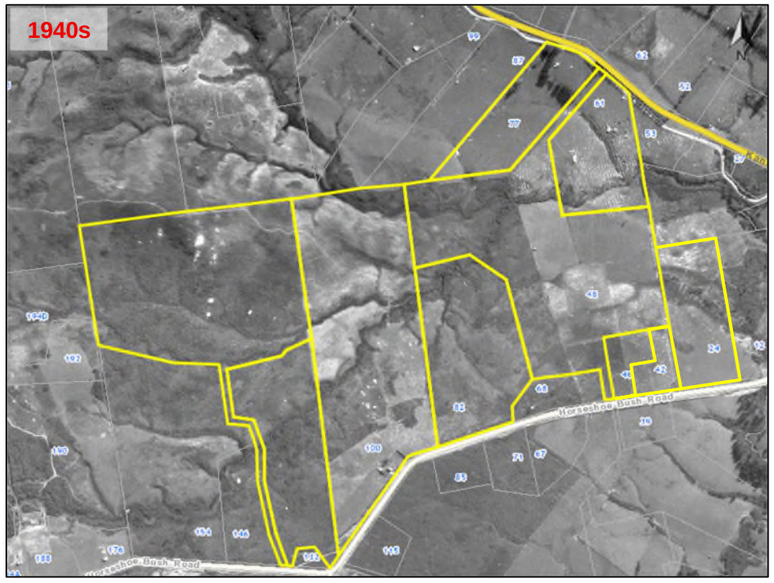
1960s Photograph: By the 1960s, much of the site had been cleared of bush and shrub vegetation, with remaining vegetation largely confined to the main drainage channels. Well-established farm paddocks and farm tracks are visible across the properties. Lines of large trees appear to have been planted as windbreaks at several locations across the site. Several farm ponds are also evident, including the existing larger ponds located at the base of slopes in the western portion of the Site and within the northern portion of the central valley. Additional structures are also present on 61 and 77 Kahikatea Flat Road.

1990s Photograph: The site appears to remain largely unchanged through to the 1990s, although neighbouring properties appear to have undergone further development during this period. Windbreak tree lines and vegetation along the main flow paths appear more established. The existing structure located near the centre of 82 Horseshoe Bush Road, and the road fronts of 24 and 42 Horseshoe Bush Road appear to have been constructed during this period. A farm pond has also been constructed in the northern portion of 24 Horseshoe Bush Road.

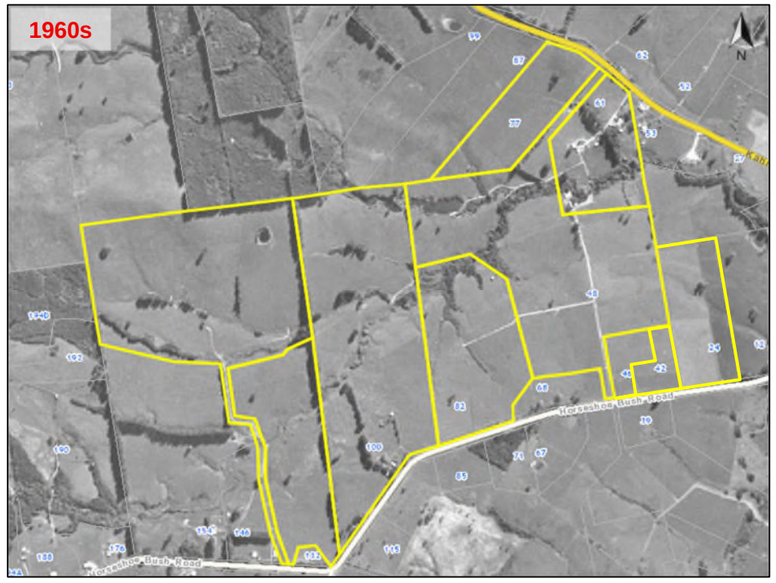
2000 to 2005 Photograph: The first available colour aerial imagery, captured between approximately 2000 and 2005, shows the Site remaining generally unchanged. The structure located along the road frontage of 77 Kahikatea Flat Road appears newly constructed.

2017 Photograph: This photograph shows the formation of a low-lying wetland area within 48 Horseshoe Bush Road, along with the construction of the existing large shed structure adjacent to this area. A large industrial complex is also evident immediately to the east of the site.

2024–2025 Photograph: The most recent aerial photograph shows the site largely in the condition observed during the site walkover inspection. Areas of apparent recent ground disturbance are visible adjacent to the pond located in the central portion of the site.



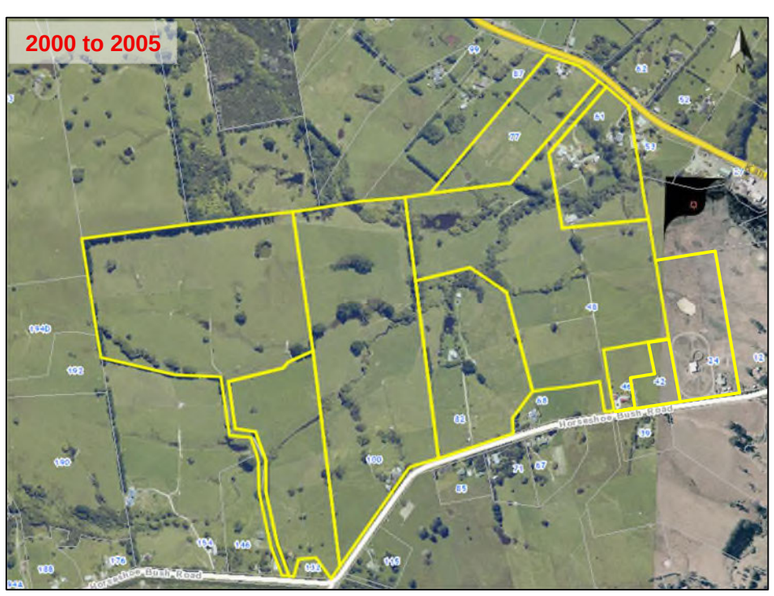
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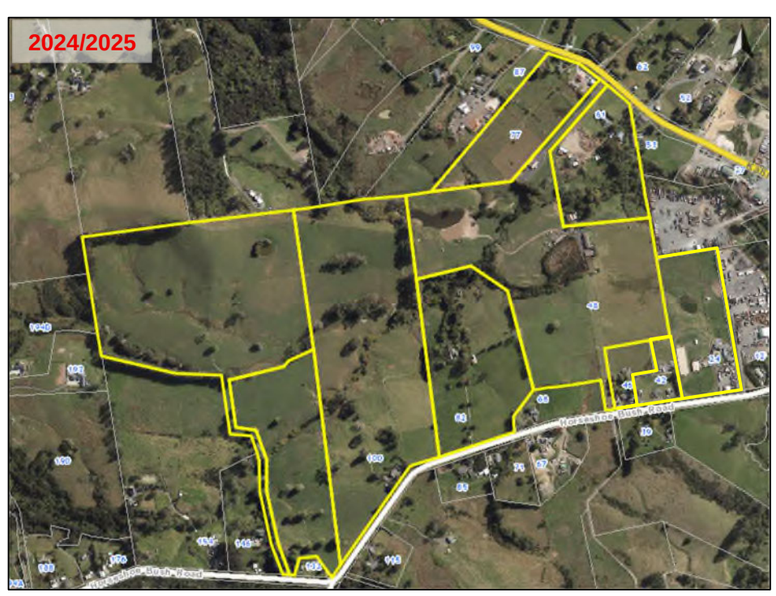
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Figures 8 to 13: Historical aerial photography, sourced from Auckland Council GeoMaps application (Not to scale).

4.6 LINZ Geospatial Information

We have reviewed publicly available geospatial information from Land Information New Zealand (**LINZ**) relating to the site and the immediately surrounding area. This data assisted in confirming the current site topography and geomorphology, and in identifying potential historic landslide or mass movement features, including those that may be obscured by vegetation or not readily apparent during site inspection.

The information obtained was used to generate a three-dimensional model of the site using the 2024 LINZ LiDAR-derived Digital Elevation Model (**DEM**), as presented in Figures 14 and 15. In addition, a slope angle analysis was applied to the DEM to visually represent ground gradients across the site in plan view, as shown in Figure 16.

Interpretation of the 3D terrain model and slope gradient mapping generally confirms the observations made during our reconnaissance walkover (refer Section 5) and the review of background information. In particular, the models assisted in identifying large relic landslide scarp features along the northwest and southwest portions of the site, together with numerous smaller scarp features located along the gully margins of the drainage channels that traverse the site. Areas of hummocky ground are also more readily identifiable in the LiDAR model and are observed downslope of the larger scarp features, which may indicate areas of previous or ongoing land movement. The interpreted landforms are presented on the Geomorphology Plan (Drawing KGA 4) included in Appendix A.

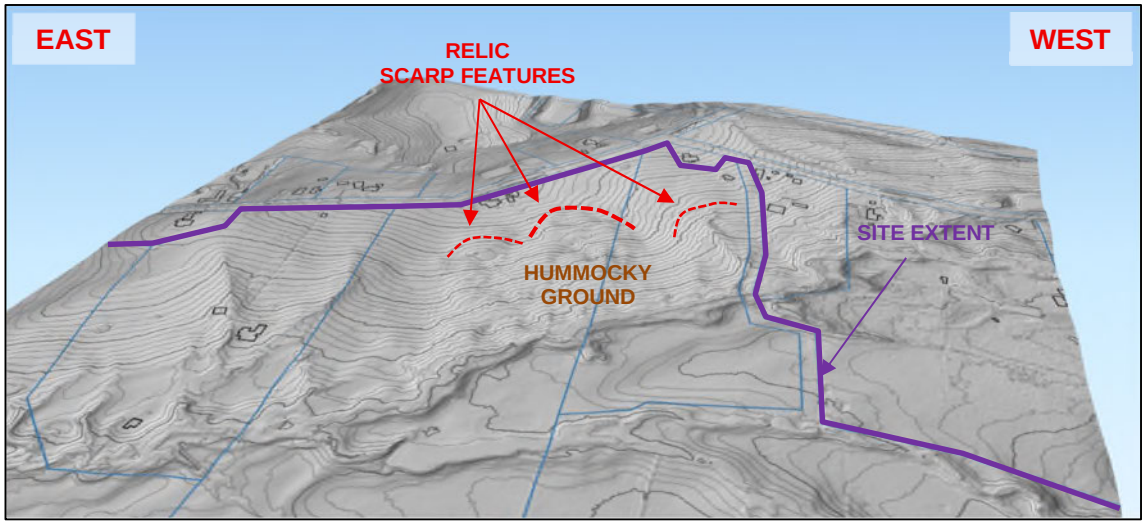


Figure 14: Three-dimensional perspective of the site elevation (data sourced form LINZ) of the southern Northland Allochthon slopes (looking south).

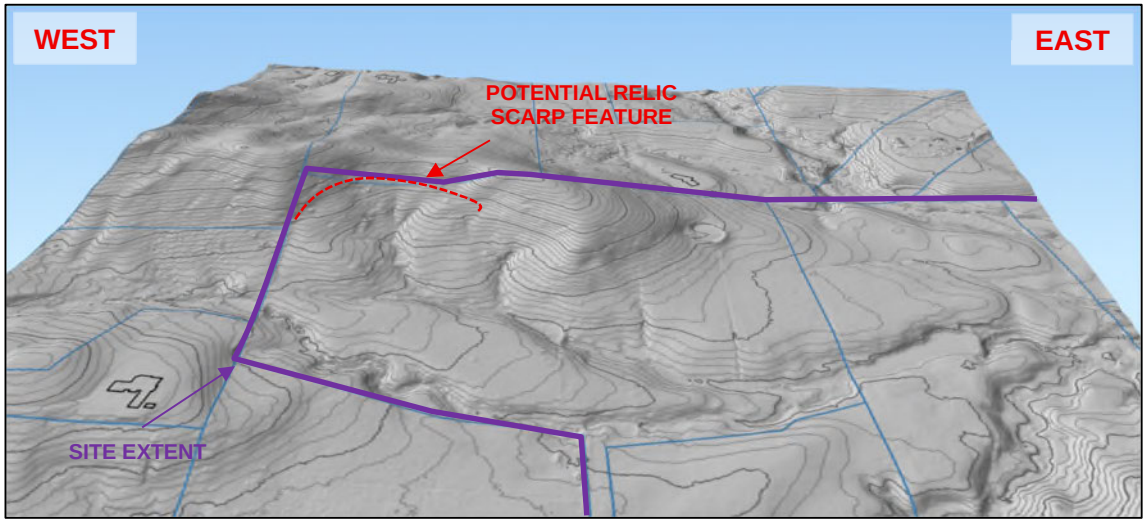


Figure 15: Three-dimensional perspective of the site elevation (data sourced from LINZ) of the northwest corner of the site which comprises a Waitemata Group Ridge (looking north).

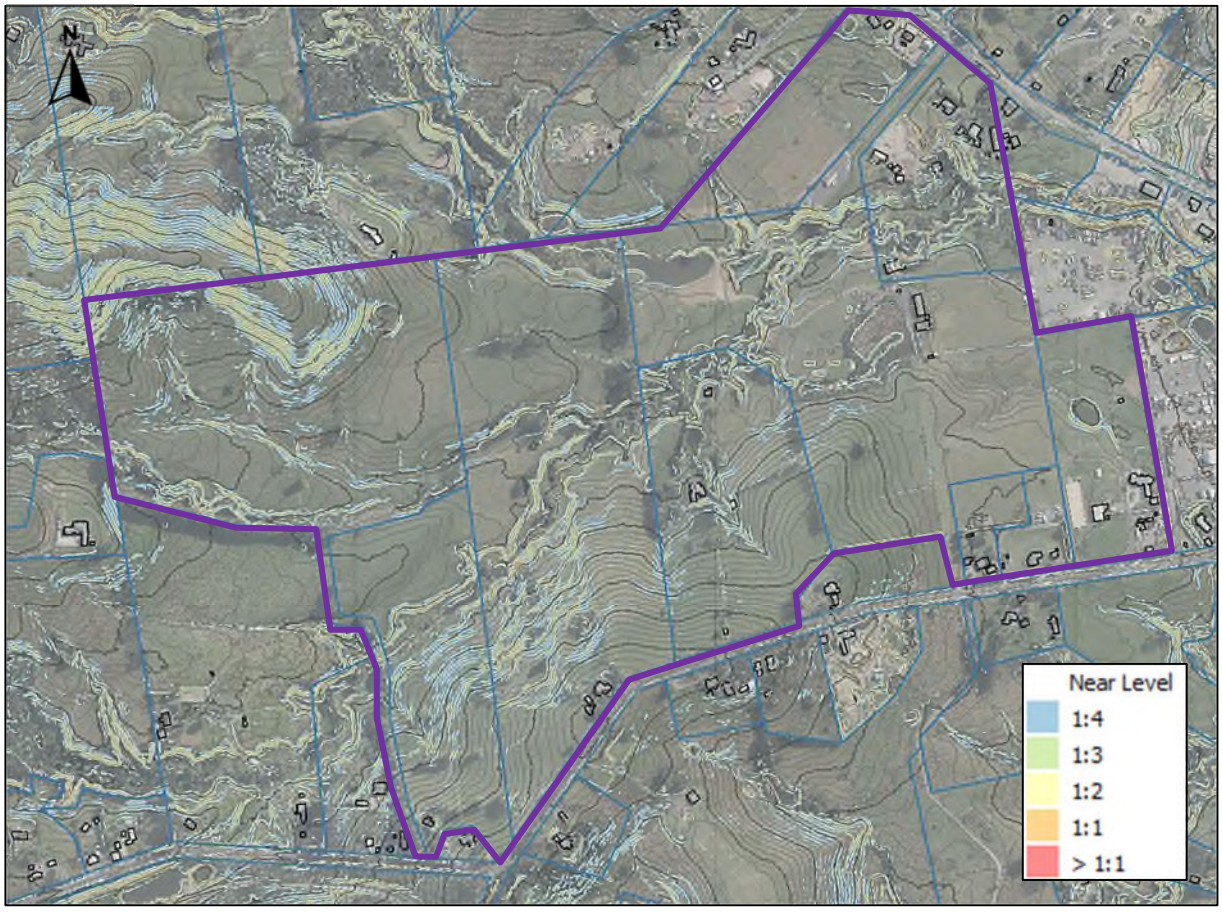


Figure 16: Slope gradients (calculated from 2024 LINZ LiDAR data).

4.7 New Zealand Geotechnical Database (NZGD)

A review of the NZGD identified several publicly available geotechnical investigations in the immediate vicinity of the Site. The available information includes the following:

- North of the Site – 63 Turley Road
  - 1 × hand-auger borehole logged by Engineering Design Consultants Limited (EDC)
- East of the Site – 17 Kahikatea Flat Road
  - 9 × hand-auger boreholes logged by Engineered Geology Limited (EGL)
  - 4 × machine boreholes logged by URS Limited (URS)
- South of the Site – Limestone quarry / landfill area
  - 2 × machine boreholes logged by Tonkin + Taylor (T+T)
  - 7 × standpipe boreholes logged by ProDrill Limited

The subsurface investigation logs are summarised in Table 1 below. Copies of the referenced borehole logs are included in Appendix C.

The subsurface conditions identified within the NZGD records are generally consistent with the expected geological conditions inferred from the published geological mapping (refer Section 4.2).

The EDC borehole, drilled within the lowland north of the ridgeline feature in the northwestern corner of the site, together with the boreholes logged by EGL and URS to the east of the site, encountered alluvial deposits comprising variable silts, clays and sands, with occasional inclusions of organic material and fine to coarse gravels. Recorded shear strengths within these materials ranged from approximately 40 kPa to greater than 180 kPa.

The T+T and ProDrill boreholes, located south of the site between Horseshoe Bush Road and the limestone quarry, encountered both Mahurangi Limestone and Hukerenui Mudstone of the Northland Allochthon Complex. The logged materials varied considerably, however, both formations were commonly noted to be highly fractured and sheared, consistent with the structural characteristics typically associated with these units.

Table 1: Summary of Relevant NZGD subsurface Investigation Information.

Location	Date of Investigation	Company	Investigation Type	NZGD ID	Original ID	Stratum						Scala Penetrometer Range	Measured Groundwater
						Topsoil	Fill	Alluvium Deposits (TG)	Mahurangi Limestone (NA)	Hukerenui Mudstone Residual Soils (NA)	Hukerenui Mudstone (NA)		
North of Site 63 Turley Road	26/05/2016	EDC	Hand-Auger	HA_87978	HA4	--	--	0.0 - 4.9*	--	--	--	4.9 - 6.55 No Refusal	1.9
East of Site 17 Kahikatea Flat Road	18/11/2003	EGL	Hand-Auger	HA_120541	BH1	0.0 - 0.2	--	0.2 - 2.7*	--	--	--	N/A	0.9
					BH2	0.0 - 0.3	--	0.3 - 2.7*	--	--	--	N/A	0.8
					BH3	0.0 - 0.2	--	0.2 - 3.0*	--	--	--	N/A	1.9
					BH4	0.0 - 0.2	0.2 - 2.0	2.0 - 3.0*	--	--	--	N/A	2.9
					BH5	0.0 - 0.2	0.2 - 0.7	0.7 - 4.2*	--	--	--	N/A	--
					BH6	0.0 - 0.1	0.1 - 2.3	2.3 - 3.0*	--	--	--	N/A	3.0
					BH7	0.0 - 0.1	--	0.1 - 4.1*	--	--	--	N/A	2.3
					BH8	0.0 - 0.2	--	0.2 - 2.1*	--	--	--	N/A	2
					BH9	0.0 - 0.3	--	0.3 - 2.1*	--	--	--	N/A	--
	24/06/2004	URS	Well Machine Borehole	RC_80610	MW5	--	0.0 - 1.6	1.6 - 3.25*	--	--	--	N/A	N/A
					MW6	--	0.0 - 1.6	1.6 - 3.25*	--	--	--	N/A	N/A
					SB1	--	0.0 - 1.1	1.1 - 4.0*	--	--	--	N/A	N/A
					SB2	--	0.0 - 1.2	1.2 - 4.0*	--	--	--	N/A	N/A
South of Site Limestone Quarry/Landfill	28/03/1991	T+T	Machine Borehole	RC_124551	Shaft 2	--	--	--	--	0.0 - 2.1	2.1 - 10.8*	N/A	--
	1/08/1995			RC_71047	W21	Wash Drilled to 3.0m					3.0 - 41.5*	N/A	--
	18/12/1995	ProDrill	Standpipe Borehole	RC_68907	W7	0.0 - 2.0	--	--	2.0 - 9.0*	--	--	N/A	--
				RC_68908	W8	0.0 - 0.7	--	--	0.7 - 11.0*	--	--	N/A	8.25
				RC_68909	W9	0.0 - 1.2	--	--	1.2 - 8.0*	--	--	N/A	7.25
				RC_68910	W10	0.0 - 0.3	--	--	0.3 - 7.5*	--	--	N/A	--
				RC_68911	W11	0.0 - 0.7	--	--	0.7 - 13.5*	--	--	N/A	10.6
				RC_68912	W12	0.0 - 1.5	--	--	1.5 - 8.8	--	8.8 - 10.5*	N/A	10.25
				RC_68913	W13	0.0 - 0.7	--	--	0.7 - 5.5	--	5.5 - 9.08	N/A	8.46

Note: All measurements are in metres -- = material/groundwater not encountered * = End of Borehole N/A = not applicable.

4.7.1. NZGS Geotechnical Publication – Acid Sulphate Soils

The presence of organic soils resulting from fluvial/lacustrine depositional environments, and the proximity of the property to documented flood plains (approximately 9m distance), indicates that acid sulphate soils could be possible at the site. Review of "Preliminary assessment of the acid sulphate soils hazard in the Auckland region" (Roberts & McConchie, 2017) shows that the site is in the vicinity of low, medium, and high probability areas (see Figure 17 below).

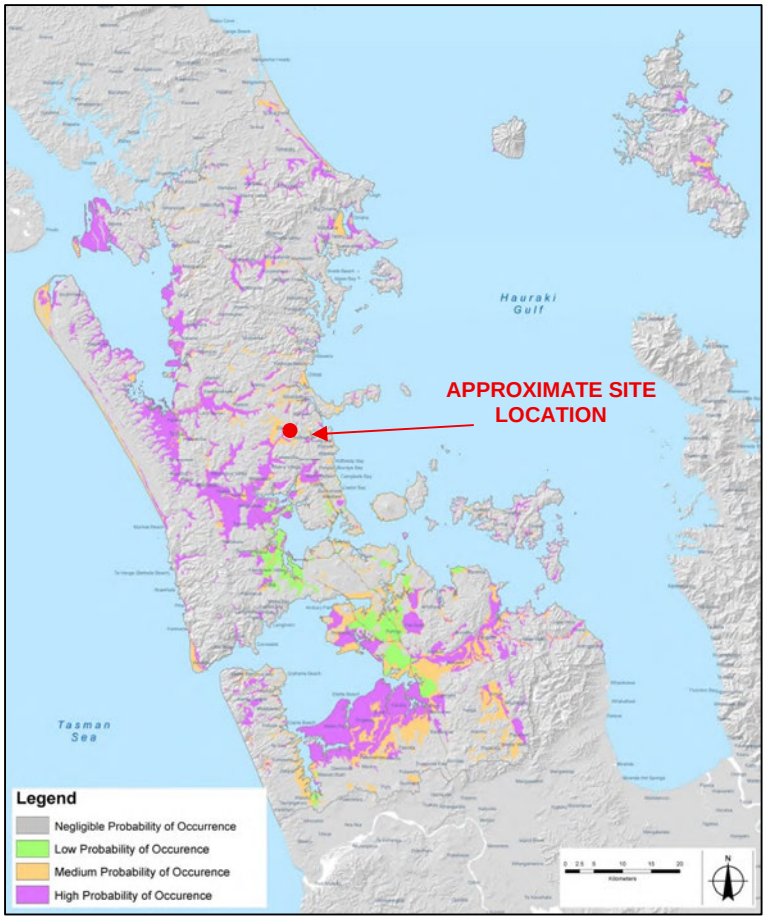


Figure 17: Preliminary map of the potential for acid sulphate soils in the Auckland Region (sourced from Roberts & McConchie, 2017)

Based on the low-lying alluvial setting, mapped Tauranga Group deposits, proximity to drainage channels and floodplain areas, and the potential presence of organic-rich soils, acid sulphate soils may be encountered from near-surface level within the low-lying portions of the site. The presence, extent, depth, and severity of acid sulphate soils have not been confirmed as part of this appraisal and should be assessed during future site-specific investigation.

The sulphuric acid produced within acid sulphate soils can cause corrosive damage to concrete and steel reinforcing over time if they are exposed to the acidic soils. Where acid sulphate soils are confirmed, earthworks and construction may require specific management measures, including:

- targeted laboratory testing;
- segregation of affected materials;
- treatment/neutralisation;
- controlled reuse or off-site disposal;
- groundwater management; and
- durability design for buried concrete, steel, reinforcing, and services.

These matters are considered manageable through future investigation, detailed design, and appropriate construction methodology.

5. SITE WALKOVER AND KGA ZONING

KGA carried out a detailed site walkover of the subdivision extent on 23 February 2026. This walkover was carried out by a Senior Engineering Geologist to confirm the interpretation of our desktop study (Section 4 above) and identify any additional features to note.

To facilitate reference and discussion for the following subsections of this report, we have divided the site into distinct Zones, classified based on geological, topographical and geomorphological characteristics (which are discussed in detail in the following sections). The Zone extents are presented in Figure 18 and within our Zoning Plan (Drawing KGA 2) presented in Appendix A. The Zones include the following:

- Zone 1 – Waitemata Group Block – Located in the northwest corner of the site.
- Zone 2 – Northland Allochthon Northwest Block (southerly aspect) – Located in the northwest corner of the site.
- Zone 3 – Northland Allochthon Southern Block – Located on the southern portion of the site.
    - Zone 3a – Western extent of southern Block (northwest aspect)
    - Zone 3b – Central extent of southern Block (north aspect)
    - Zone 3c – Eastern extent of southern Block (northeast aspect)

- Zone 4 – Northland Allochthon Northeast Block (south aspect) – Located in Northeast corner of the site.
- Zone 5 – Alluvium Lowland – Located through the centre of the site (west to east).
  - Zone 5a – Western extent including west most secondary tributaries.
  - Zone 5b – Central extent including main overland flow path/channel.
  - Zone 5c – Northeast extent.
  - Zone 5d – Eastern extent.

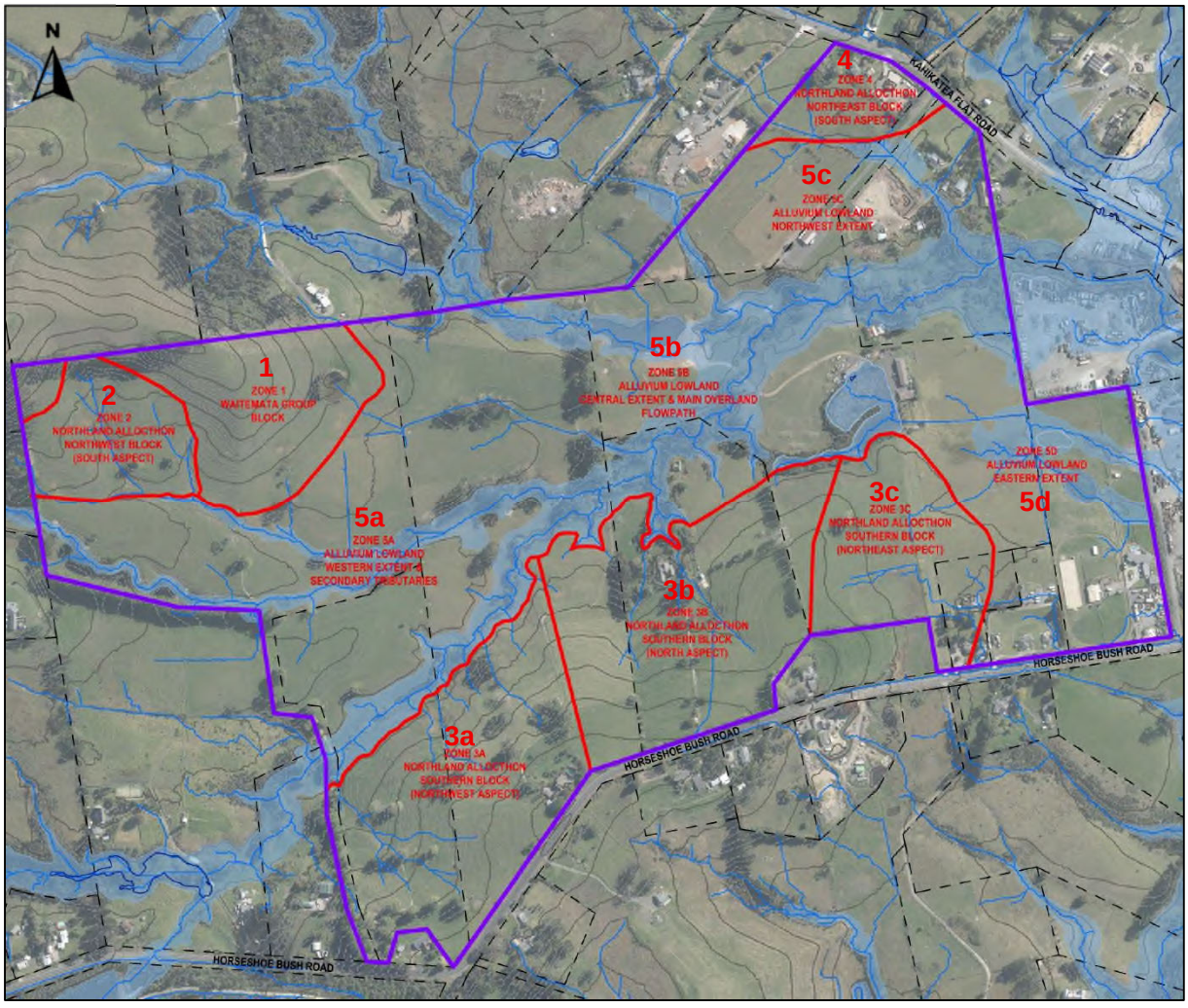


Figure 18: Site plan showing KGA Zoning (not to scale).

5.1 Zone 1 - Waitemata Group Block

This area is located in the northwest corner of the site, entirely within Lot 1 DP 130668 Horseshoe Road. The zone impasses the eastern end of a regional ridgeline assumed to be underlain by the more competent Waitemata Group materials. This zone comprises moderately to steeping sloping ground with an east to south aspect. It is covered exclusively by farmland, with a large, circular farm pond located on the eastern portion of the zone, near the base of the slopes. A large scarp like feature is present on the southern facing slopes and assumed to be a relic feature of historical landslip feature, as shown in Figure 19.



Figure 19: Photograph of Zone 1 sloping ground. Taken from the centre of the site looking northeast.

5.2 Zone 2 – Northland Allochthon Northwest Block

This area is location in the northwest corner of the site, entirely within Lot 1 DP 130668 Horseshoe Road. The zone is located immediately southwest of the steep slopes of the relic scarp feature located within Zone 1. The zone comprises moderately sloping ground with a southerly aspect. A series of overland flow paths have incised small gully like features, flowing north to south through the zone. These are inferred to originate from a combination of surface runoff and springs located in the upper northern portions of the slope. Hummocky ground was observed adjacent to the flow paths.

5.3 Zone 3 – Northland Allochthon Southern Block

This zone comprises the northern slopes of the regional ridgeline that forms the southern boundary of the site. The area is mapped as being underlain by the variable materials of the Northland Allochthon Complex. For the purposes of this assessment, the zone has been divided into three distinct sections based on slope aspect, which is inferred to be a governing factor influencing the variation in observed near-surface ground conditions. These sections comprise slopes facing northwest, north, and northeast.



Figure 20: Photograph of Zone 3 sloping ground. Taken from the centre of the site looking south.

5.3.1. Zone 3a – Western Extent of Southern Block (northwest aspect)

Zone 3a comprises the western third of the block, including the southern portion of Lot 3 DP 130668 and the southwest portion of 100 Horseshoe Bush Road. The slopes within this zone are moderately to steeply inclined, generally facing northwest, and terminate at the incised gully associated with the primary overland flow path that traverses the site from west to east. A number of secondary overland flow paths were also observed draining through this area toward the main channel.

Two larger scarp features were observed near the crest of the ridgeline along the southern extent of this zone. The ground downslope of these scarps, which comprises the majority of the zone, exhibits evidence of slow ground movement or creep, including hummocky ground surface, leaning trees, and displaced power poles, as illustrated in Figure 21.



Figure 21: Photograph of Zone 3a sloping ground with hummocky ground and leaning trees and power pole. Taken from half way up the slopes looking west.

5.3.2. Zone 3b – Central Extent of Southern Block (north aspect)

Zone 3b comprises the central third of the block and includes the southeast corner of 100 Horseshoe Bush Road and the southern portion of 82 Horseshoe Bush Road. The slopes within this area are generally gently to moderately inclined. No clear evidence of deep-seated ground movement was observed within this zone during the site inspection. However, two minor incised gully features are present and appear to originate approximately mid-slope, potentially associated with natural spring or seepage features. These gullies extend downslope toward the central drainage corridor of the site.

5.3.3. Zone 3c – Eastern Extent of Southern Block (northeast aspect)

Zone 3c comprises the easternmost third of the block, encompassing the southern portion of 48 Horseshoe Bush Road. The slopes within this area generally fall toward the northeast. No evidence of ongoing ground movement or significant overland flow paths was observed within this zone during our walkover inspection.

5.4 Zone 4 – Northland Allochthon Northeast Block

This area is located in the northeast corner of the site, entirely within 77 Kahikatea Flat Road. The zone comprises gently sloping ground facing generally south to southwest and is mapped as being underlain by the variable materials of the Northland Allochthon Complex. No evidence of ongoing ground movement or significant overland flow paths was observed within this zone during our walkover inspection.



Figure 22: Photograph of Zone 4 sloping ground. Taken from northeast most corner of the site looking southwest towards Zone 5c.

5.5 Zone 5 - Alluvium Lowland

Zone 5 comprises the low-lying alluvial valley floor that extends through the central portion of the site and generally follows the primary drainage corridor that traverses the site from west to east. The area is mapped as being underlain by Tauranga Group alluvial deposits and is characterised by flat to gently undulating ground, with several drainage channels, overland flow paths, and localised wet or ponded areas observed during the site walkover. Due to the large extent of this lowland area and the variation in drainage features present, the zone has been divided into four sub-zones for the purposes of describing site observations.

5.5.1. Zone 5a – Western Extent Including West-Most Secondary Tributaries

Zone 5a comprises the western portion of the alluvial lowland, including the westernmost secondary tributaries. This area encompasses the south portion of Lot 1 DP 130668 Horseshoe Bush Road and the northern portions of Lot 3 DP 130668 and 100 Horseshoe Bush Road. The ground in this area is generally near level to gently sloping toward the east. The secondary tributaries within this zone are locally steeply incised, with numerous shallow failures observed along the gully banks, particularly along the south-facing slopes.

5.5.2. Zone 5b – Central Extent Including Main Overland Flow Path/Channel.

Zone 5b comprises the central portion of the alluvial lowland, where multiple overland flow paths converge into the main drainage channel that traverses the site. This area encompasses northern portions of 48 and 82 Horseshoe Bush Road. The ground within this area is generally gently sloping to near level. The main overland flow paths within this zone are fenced and heavily vegetated, as shown in Figure 23. A large farm pond is also present within the northern portion of this zone, shown in Figure 24.

An earthworks crossing is present across the main drainage path. This feature was observed to be under construction in the 2014 aerial photograph (refer Section 4.5). The crossing has since failed, resulting in the formation of a large scarp feature, as shown in Photo 25. The failure has occurred on near-level ground and is interpreted to likely be associated with excess water pressures developing within the fill forming the dam or crossing structure.

23 

24 

Figures 23 and 24: Photographs of Zone 5b. Figure 23 shows the incised gullies converging, with the main tributary fenced and vegetated. Figure 24 shows the large farm pond located within the northern portion of the zone. Both photographs were taken looking southwest.

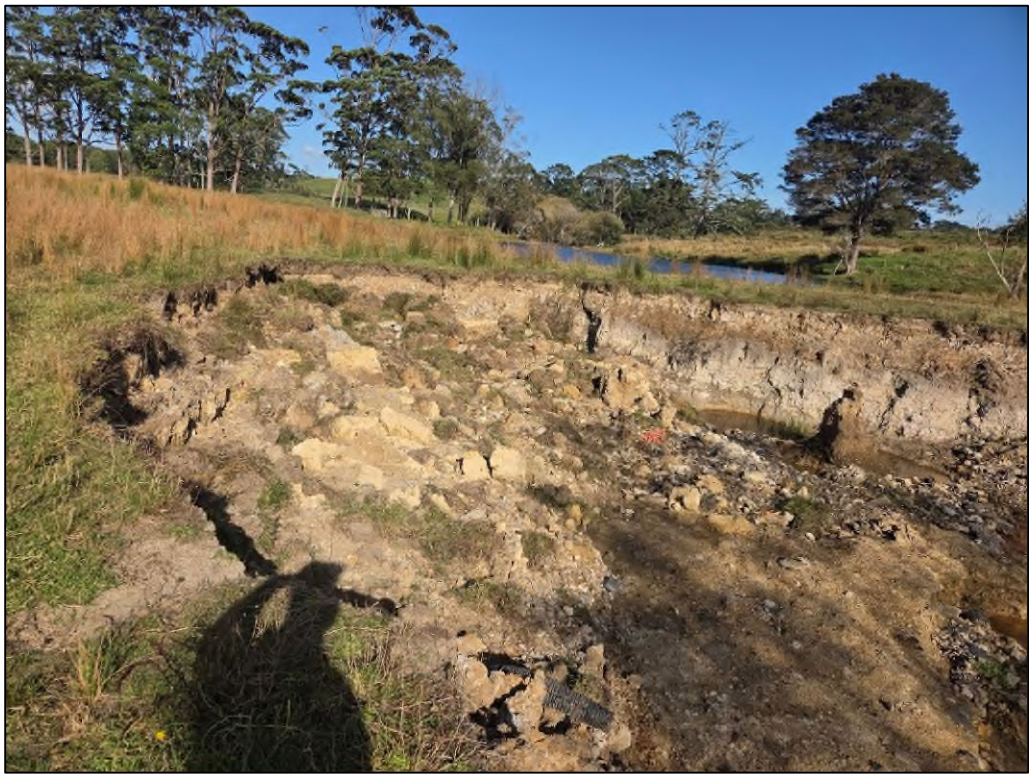


Figure 25: Photograph showing the failure of the earthwork pond dam within Zone 5b, exposing variable fill materials, with the base saturated.

5.5.3. Zone 5c – Northeast Extent.

Zone 5c comprises the northeastern portion of the alluvial lowland and is situated at a slightly higher elevation than Zone 5b. This area encompasses the southern extent of 77 Kahikatea Flat Road, and the northern extent of 61 Kahikatea Flat Road. The ground surface across this zone is generally near level, with moderately sloping banks along the southern extent, where the area is incised by the main tributary channel. Several larger scarp features were observed along these banks, indicating localised slope instability associated with erosion and incision of the drainage channel.



Figure 26: Photograph of southern slopes of Zone 5c, with observed scarp feature and hummocky ground. Taken looking northwest.

5.5.4. Zone 5d – Eastern Extent.

Zone 5d comprises the eastern extent of the alluvial lowland and is characterised by generally near-level ground. A well-established wetland area was observed adjacent to the dwelling located near the centre of 48 Horseshoe Bush Road. The wetland appears to be associated with the low-lying drainage environment and shallow groundwater conditions within this portion of the site. A farm pond is also present in the northern portion of 24 Horseshoe Bush Road.



Figure 27: Photograph of near level alluvial lowland of Zone 5d, Taken from Horseshoe Bush Road looking north.

6. GEOHAZARD IDENTIFICATION

Section 106 of the Resource Management Act (**RMA**) states that a Consent Authority may refuse to grant a Resource Consent, or may grant a conditional consent, if it considers that:

- There is significant risk from natural hazards.
- Sufficient provision has not been made for legal and physical access to each allotment to be created by the subdivision.

As part of our geotechnical assessment, we have undertaken a review of the potential geotechnical hazards (geohazards) that could affect each the site. These are issues or constraints to development relating to the ground. Having identified the potential geohazards, it is then possible to assign risk levels to each. Our assessment uses the risk classification methods provided in Section 2.4.3 of the "The Auckland Council Code of Practice for Land Development and Subdivision – Chapter 2: Earthworks and Geotechnical", Version 2., dated May 2023 (**COP**). The risk table presented in the COP is reproduced in Table 2 below.

Table 2: Risk Classification Table

Likelihood	Consequence				
	Insignificant C1	**Minor C2**	**Moderate C3**	**Major C4**	**Catastrophic C5**
Almost Certain L5	Medium 5	High 10	Very High 15	Extreme 20	Extreme 25
Likely L4	Low 4	Medium 8	High 12	Very High 16	Extreme 20
Moderate L3	Low 3	Medium 6	Medium 9	High 12	Very High 15
Unlikely L2	Very Low 2	Low 4	Medium 6	Medium 8	High 10
Rare L1	Very Low 1	Very Low 2	Low 3	Low 4	Medium 5

By defining the potential geohazards, the table enables prioritisation and problem definition that can be addressed by appropriate geotechnical design. Geotechnical design recommendations to allow mitigation of relevant geohazards identified are given in the subsequent sections below. In some cases, it may not be possible to fully mitigate the risk, and some 'Residual Risk' may still be applicable to the site. The potential existing and future (post-development) geohazards risk are listed in Table 3 below.

References to residual risk in this report relate to the geotechnical risk remaining after investigation, design, and construction of appropriate mitigation measures. The identification of Moderate or High preliminary geotechnical risk areas does not, in itself, mean those areas are undevelopable. Rather, those areas require targeted investigation and specific geotechnical design to confirm whether building platforms, roads, services, and open space areas can be formed safely and stably.

We point out that our geohazard identification and associated risk assessment relates to geotechnical risks only. Other geohazards (such as contamination) may apply to the project and these must be managed by other appropriate parties.

Only those geohazards that are determined to present a risk to the site and / or proposed development have been discussed further. As part of our assessment, we have considered the impact of remaining geohazards but, either due to the situation of the site and / or the nature of the proposed development, those geohazards which are not discussed further within this report are deemed to have only no to minor effects, and hence are not a consideration for the site.

Table 3: Potential Geohazards Affecting the Proposed Development Safety in Design Risk Register

Geohazard	Existing Site Risk (Pre-Development)			Initial Comments	Future Site Risk (Post-Development)			Geotechnical Mitigation /Engineering Control Summary	Report Section(s) (If applicable)
	Likelihood	Consequence	Risk Rating		Likelihood	Consequence	Risk Rating		
Expansive Soils	Likely L4	Moderate C3	**High 12**	*Preliminary Soil Classification of Highly to Extreme Reactive Soils (Class H to E) as per MBIE A19.*	Likely L4	Insignificant C1	**Low 4**	*Laboratory Shrink/Swell testing should be conducted as part of Geotechnical Completion Documentation following completions of site formation earthworks. Final Lot development will need to consider classification in foundation design.*	**7.1**
Seismic Setting (Seismic Site Classification / Liquefaction Potential)	Likely L4	Major C4	**Very High 16**	• *Preliminary seismic soil classification of Shallow soil site (Class C) for the ground underlain by Waitemata Group or Northland Allochthon materials and Deep soil site (Class D) for ground underlain by Alluvium deposits.* • *Silts and sands encountered below groundwater level.*	Likely L4	Insignificant C1	**Low 4**	*Potential liquefaction risk at site. Following appropriate testing (CPTs/DMTs) the seismic soil class can be confirmed for detailed structural design.*	**7.2**
Problematic Soils (Compressible / Collapsible / Sensitive)	Likely L4	Moderate C3	**High 12**	• *Problematic soils comprising peat/organic material are expected to be encountered within the lowland alluvium.* • *Northland Allochthon know to be sensitive to groundwater fluctuations.*	Likely L4	Minor C2	**Medium 8**	*Problematic soils to be removed beneath building footprint and/or accounted for in specific design.*	**7.3**
Uncontrolled Fill & Other Unsuitable Materials	Likely L4	Moderate C3	**High 12**	*Uncontrolled fill and unsuitable material expected to be encountered (farmland).*	Rare L1	Moderate C3	**Low 3**	*Unsuitable/non-engineered fill material to be removed as part of the site formation works*	**7.3**
Site Instability (Slope Instability / Soil Creep / Erosion / Significant Slopes)	Likely L4	Major C4	**Very High 16**	• *Deep-Seated Instability – Evidence of deep-seated instability across the site (particularly within the Northland Allochthon slopes.* • *Shallow Instability – Shallow stability observed across the site, with the gully features and sloping ground.*	Unlikely L2	Major C4	**Medium 8**	• *Deep ground investigation comprising machine borehole and cone penetration tests are to be carried out on site to confirm deep-seated movement.* • *Site specific slope stability both global and local will be carried out with future Specific Design to account for potential slope instability.*	**7.4**
Boundary Effects (Groundwater Drawdown / Boundary Excavations)	Rare L1	Minor C2	**Very Low 2**	*Proposed excavations near boundary are no deeper than neighbouring sites ground level RL.*	Rare L1	Minor C2	**Very Low 2**	*Geohazard deemed not applicable to site.*	N/A
Coastal Assessment (ASCIE) / Tsunami Risk	N/A	N/A	N/A	*Site not located within the Auckland Council ASCIE regression.*	N/A	N/A	N/A		N/A
Geothermal	N/A	N/A	N/A	*Site not located in a known geothermally active setting.*	N/A	N/A	N/A		N/A
Rockfall	N/A	N/A	N/A	*No cliff/rock outcrops located above or below site.*	N/A	N/A	N/A		N/A
Acid Sulphate Soils	Unlikely L2	Major C4	**Medium 8**	*Acid sulphate soils may be present within the lowland alluvium deposits.*	Unlikely L2	Minor C2	**Low 4**	*Site-specific lab testing for acid sulphates to be carried out. Can be accounted for in specific design.*	**7.3**
Cave / Lava Tubes	N/A	N/A	N/A	*Site not located within known lava flows.*	N/A	N/A	N/A	*Geohazard deemed not applicable to site.*	N/A
Trees	Likely L4	Moderate C3	**High 12**	*Larger vegetation to be removed as part of site formation earthworks.*	Unlikely L2	Minor C2	**Low 4**	*Where removed, root bulbs and surround unsuitable materials will need to be undercut and replaced during site formation works..*	N/A
Stormwater & Wastewater Considerations									
Stormwater (uncontrolled surface runoff / flooding / onsite disposal)	Moderate L3	Moderate C3	**Medium 9**	*Stormwater controls required.*	Rare L1	Moderate L3	**Low 3**	*Stormwater to be diverted away from building platforms into existing public services.*	**N/A**
Wastewater (onsite disposal)	N/A	N/A	N/A	*Onsite wastewater disposal has not considered. Wastewater to be connect to existing public service.*	N/A	N/A	N/A	*Geohazard deemed not applicable to site.*	N/A

Note: Geohazard with existing site risk ratings less than 4 (Low) have not been considered further in this report unless specifically stated..

7. GEOHAZARD ASSESSMENT AND FURTHER GEOTECHNICAL INPUT

Our geohazard risk identification assessment, detailed in Section 6 identified several potential geotechnical hazards across the site that may influence the proposed development. These include expansive soils, unsuitable or problematic materials, elevated groundwater conditions, and site instability.

Based on the findings of this assessment, a preliminary geohazard risk classification has been assigned to each Zone outlined in Section 5. The classification considers the potential presence of expansive soils, unsuitable or problematic materials, and both shallow and deep-seated slope instability. The resulting risk classifications are summarised in Table 4 below.

Table 4: Preliminary Geohazard Risk Classifications of Proposed Zones

Zone		preliminary risk classification	Comment Notes
Zone 1		Medium	Relic scarp features and moderate to steep slopes are present. Further investigation and slope stability assessment will be required to confirm development suitability.
Zone 2		High	Hummocky ground, incised drainage features, and inferred Northland Allochthon materials indicate an elevated instability risk. Targeted investigation and stability assessment will be required.
Zone 3	Zone 3a	Very High	Relic scarps, hummocky ground, leaning trees, and displaced services indicate potential slope movement. Detailed investigation, modelling, and mitigation design will be required
	Zone 3b	Medium to Very High	Localised gullies and seepage features are present. Further investigation is required to confirm slope stability and groundwater conditions.
	Zone 3c	Medium to High	No evident instability was observed during the walkover; however, inferred Northland Allochthon materials require confirmation by investigation.
Zone 4		Medium	No evident instability was observed during the walkover; however, inferred Northland Allochthon materials may present variable ground conditions requiring confirmation.
Zone 5 (a to d)		Medium, localised Vey High (main fluvial channels)	Low-lying alluvial ground may include soft, compressible, organic-rich, saturated, and potentially acid sulphate soils from near-surface level. Detailed investigation and ground treatment may be required.

Note: Classifications are preliminary only and subject to change following detail subsurface investigation.

Areas classified as Moderate Risk comprise parts of the site that may be suitable for future development, provided that development-specific geotechnical investigation, analysis, and design are undertaken to confirm the feasibility of building platforms and access in these areas.

Areas classified as High Risk comprise portions of the site that are not currently considered suitable for development without significant geotechnical intervention. These areas generally include steeper slopes and locations where evidence of instability was observed during the site assessment. While development may still be possible in some cases, it will require detailed investigation and design, and will likely involve significant stabilisation or remediation measures to ensure the long-term stability of any future development. An indication of the preliminary risk classification extents on site (using the colour code from Tables 2 to 4) is presented in Figure 28.

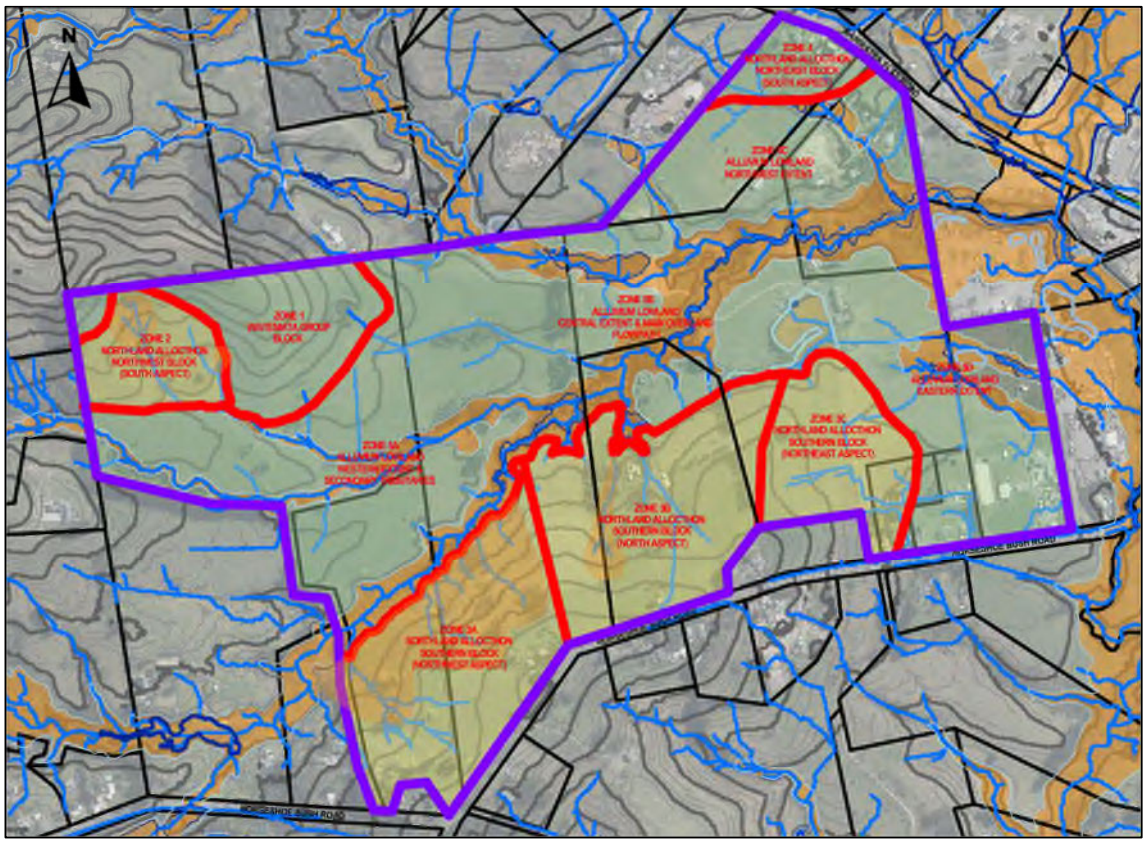


Figure 28: Preliminary Geohazard Risk Classifications of Proposed Zones on KGA Site Plan (not to scale).

It is noted that the above risk classifications are based primarily on geomorphic observations made during the site walkover and interpretation of remote sensing datasets (including LiDAR-derived terrain models). The classifications do not account for other planning or development controls that may apply to the site.

It is also possible that areas currently classified as High Risk could be reclassified following detailed geotechnical investigation and analysis, while areas currently assessed as Moderate Risk could also be revised should additional hazards or constraints be identified.

The key geohazard mitigation strategies and further geotechnical investigations required to support the proposed development are discussed in detail in the following sections.

7.1 Preliminary Expansive Soil Classification

The underlying soils on the site comprise Alluvium materials. Experience with similar soils elsewhere suggests that the site soils are likely to be susceptible to seasonal shrink/swell movements as the ground dries out and then wets up in a cyclic manner from summer to winter.

The New Zealand Ministry of Business, Innovation & Employment (**MBIE**) released an amendment to the New Zealand Building Code Clause B1 Structure in November 2018 (**MBIE A19**). The MBIE A19 amendment has revised the various classes that were otherwise given within AS2870 for shrink-swell severity (principally A, S, M, H, and E), with the revision being due to an increase in the ULS design criteria from 1/300-year drought period to a 1/500-year drought period.

Based on our assessment, for the purposes of preliminary design, the site may be designated as **Highly to Extremely Reactive (Class H to E)**. Soils within this Expansive Soil Class may be assumed to have an SLS 500-year return design characteristic surface movement (y_s) of greater than 78mm. It is important to note this classification is preliminary only, and based on our experience with recent developments in the immediate area.

Shrink/swell laboratory testing should be conducted prior to site formation works to confirm the expansive nature of the soils within the building platforms. Shrink/Swell effects may be reduced via subgrade replacement (with granular material), which could improve future development foundation requirements.

7.2 Preliminary Seismic Hazard Assessment

7.2.1. Seismic Subsoil Classification

Based on our interpretation of the available field and geological information, the site has been preliminarily classified as Subsoil Class C (Shallow Soil Site) for areas underlain by Waitemata Group and Northland Allochthon materials, and Subsoil Class D (Deep Soil Site) for areas underlain by alluvial deposits, in accordance with NZS 1170.5:2004 Section 3.1.3.4 (seismic design).

This classification is preliminary only, and a site-specific subsoil classification will be required prior to subdivision works in accordance with the requirements of NZS 1170.5:2022. Confirmation of the final classification will require site-specific geotechnical investigation, including a series of Cone Penetration Tests (CPTs) undertaken across the site to a minimum depth of 30m, or to effective refusal, whichever is encountered first.

7.2.2. Qualitative Liquefaction Potential Assessment

Soil liquefaction occurs when cyclic loading, such as that generated during earthquakes, causes a loss of soil strength and stiffness due to the build-up of excess pore water pressures. Soils most susceptible to liquefaction typically comprise loose, saturated, uniformly graded sands and fine sands.

Based on the mapped geology and available information, the alluvial deposits of the Tauranga Group present within the lowland areas of the site may be susceptible to liquefaction, depending on the density, composition, and groundwater conditions of the materials. In contrast, the Waitemata Group and Northland Allochthon materials underlying the surrounding slopes are generally considered to have low liquefaction susceptibility.

Prior to subdivision works, it is recommended that a site-specific liquefaction assessment be undertaken to verify the liquefaction potential across the Site. This assessment will require deep subsurface investigations, comprising a combination of machine boreholes, cone penetration tests, and dilatometer tests undertaken across the proposed subdivision area. These investigations will provide the necessary data to undertake a quantitative liquefaction assessment in accordance with current geotechnical practice and relevant New Zealand design standards.

7.3 Problematic Soils & Other Unsuitable Materials

Based on the review of available geological information, site observations, and nearby subsurface investigation records, a number of potentially problematic soils and unsuitable materials may be encountered across the site.

Within the alluvial lowland areas, soils associated with the Tauranga Group deposits are anticipated to comprise variable silts, clays and sands, with occasional organic materials and peat. These materials can exhibit low shear strength, high compressibility, and variable groundwater conditions, high acid sulphate content and may therefore be unsuitable for direct support of engineered fill or building foundations without treatment or removal.

Across the sloping areas underlain by Northland Allochthon materials, the Hukerenui Mudstone is known to be highly sheared and clay-rich, which can result in reduced shear strength and poor stability characteristics, particularly where exposed or disturbed by earthworks.

In addition, areas of colluvial soils, slope debris, and previously disturbed ground may be present on the slopes, particularly below identified scarp features and within gully systems. Such materials may be loose, heterogeneous, and moisture sensitive, and may therefore be unsuitable for founding or fill support without specific treatment.

Accordingly, a comprehensive subsurface investigation should be undertaken across the site to assess the nature, extent, thickness, and engineering properties of these materials. This investigation should include an appropriate combination of machine boreholes, test pits, cone penetration testing, and targeted laboratory testing to enable detailed assessment of problematic soils, groundwater conditions, earthworks constraints, and suitable foundation and ground improvement options for the proposed development.

7.4 Qualitative Site Instability Assessment

Based on the site walkover observations, review of available topographic and LiDAR information, and interpretation of geomorphological features identified across the site, several areas of potential slope instability have been identified. These include locations where relict landslide scarps, hummocky ground, and incised gully systems are present, particularly within the sloping areas underlain by Northland Allochthon materials.

Evidence of creep-related ground deformation, including leaning trees and minor scarp features, was observed in some areas, indicating that portions of the site are subject to ongoing or historic slow ground movement. In addition, localised shallow failures were observed along steeply incised gully banks within the lowland areas where drainage channels have eroded into the surrounding soils.

Given the scale of the proposed subdivision and the presence of these geomorphological features, a site-specific slope stability assessment will be required as part of future geotechnical investigations and detailed design. This assessment should include targeted subsurface investigations and slope stability modelling to better define the stability of the slopes and the suitability of proposed building platform locations.

This assessment will provide a better understanding of whether additional slope stabilisation or retaining measures are required to ensure the formation of safe and stable building platforms. Where required, mitigation measures may comprise one or a combination of the following:

- Bulk undercut and replacement with competent engineered fill material.
- Shear keys.
- In-ground retaining walls.
- Subsoil drainage to reduce groundwater pressures.

8. DEVELOPMENT FEASIBILITY

Based on the appraisal completed to date, the proposed subdivision is considered feasible from a geotechnical perspective, provided the geotechnical constraints identified in this report are appropriately addressed during future stages of investigation, design, and construction.

The main constraints requiring further assessment include slope instability, variable alluvial ground conditions, shallow groundwater/seepage, potential acid sulphate soils, uncontrolled or disturbed fill, expansive soils, and potential liquefaction-related effects.

Appropriate mitigation measures are expected to be available for these constraints and may include targeted earthworks treatment, removal or replacement of unsuitable soils, engineered fill construction, groundwater and surface water drainage control, acid sulphate soil management, slope stabilisation, retaining, erosion protection, specific foundation design, setbacks, and localised layout refinement where required.

In our professional opinion, and based on our experience with large-scale land development projects involving similar geotechnical constraints, appropriate mitigation measures should be able to be implemented to provide safe and stable building platforms within the currently proposed development layout, subject to confirmation by future site-specific geotechnical investigation and detailed design.

9. LIMITATIONS

This report was prepared in the context defined in Section 1 above and must not be relied upon by any other party other than our Client, for whom it was prepared, and the relevant Territorial Authority. It has been compiled with respect to the brief given to us, and must not be relied upon in any other context, recreated for any other purpose, or used by any person who is not our Client without first obtaining our written permission.

This report has been prepared exclusively for the development outlined in the accompanying drawings. The conclusions are based on publicly available information and interpretations of third-party investigational data. Should any modifications be made to the development proposal, we must be afforded the opportunity to review the updated plans to confirm the continued validity of this report's conclusions and recommendations.

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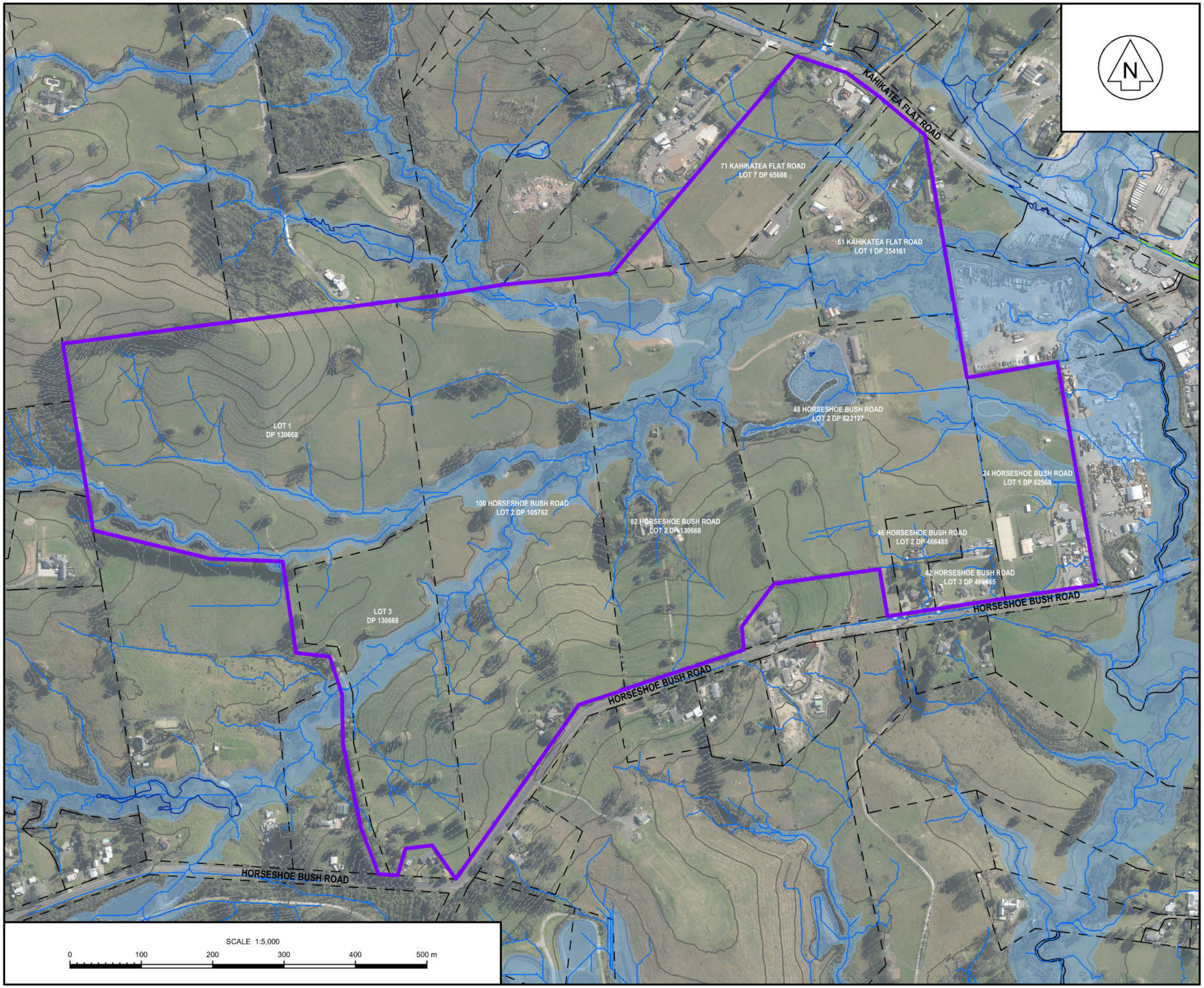
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ATTACHMENTS

Attachment A:	KGA Drawings
Attachment B:	Proposed Development Plan
Attachment C:	NZGD Information
Attachment D:	Site Walkover Photographs
Attachment F:	PC120 Landslide Hazard Risk Assessment

ATTACHMENT A

KGA Drawings



LEGEND

- FLOOD PLAINS
- SITE BOUNDARY
- NEIGHBOURING BOUNDARIES
- EXISTING TOPOGRAPHIC CONTOURS, MAJOR INTERVAL = 5.0M
- OVERLAND FLOWPATH

NOTES

1. LOCATIONS OF FEATURES AND GROUND INVESTIGATION POINTS ARE APPROXIMATE ONLY.
2. AERIAL IMAGE SOURCED FROM AUCKLAND COUNCIL GEOMAPS WEBSITE.
3. CONTOURS SOURCED FROM LAND INFORMATION NEW ZEALAND AUCKLAND 2024 LIDAR DATA.
4. PROPOSED LAYOUT SOURCED FROM PRELIMINARY DEVELOPMENT PLAN BY ISTHMUS LIMITED, REFERENCE 5202, DATED 20 MAY 2026.

REV	DATE	REVISION DESCRIPTION	BY	CHK	APP
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A	23-03-2026	GAR ISSUE	TR	ET	YC

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TAUKIRI PROPERTY LIMITED

PROJECT TITLE
PROPOSED RESIDENTIAL SUBDIVISION
KAHIKATEA FLAT ROAD
PINE VALLEY

DRAWING TITLE
SITE PLAN

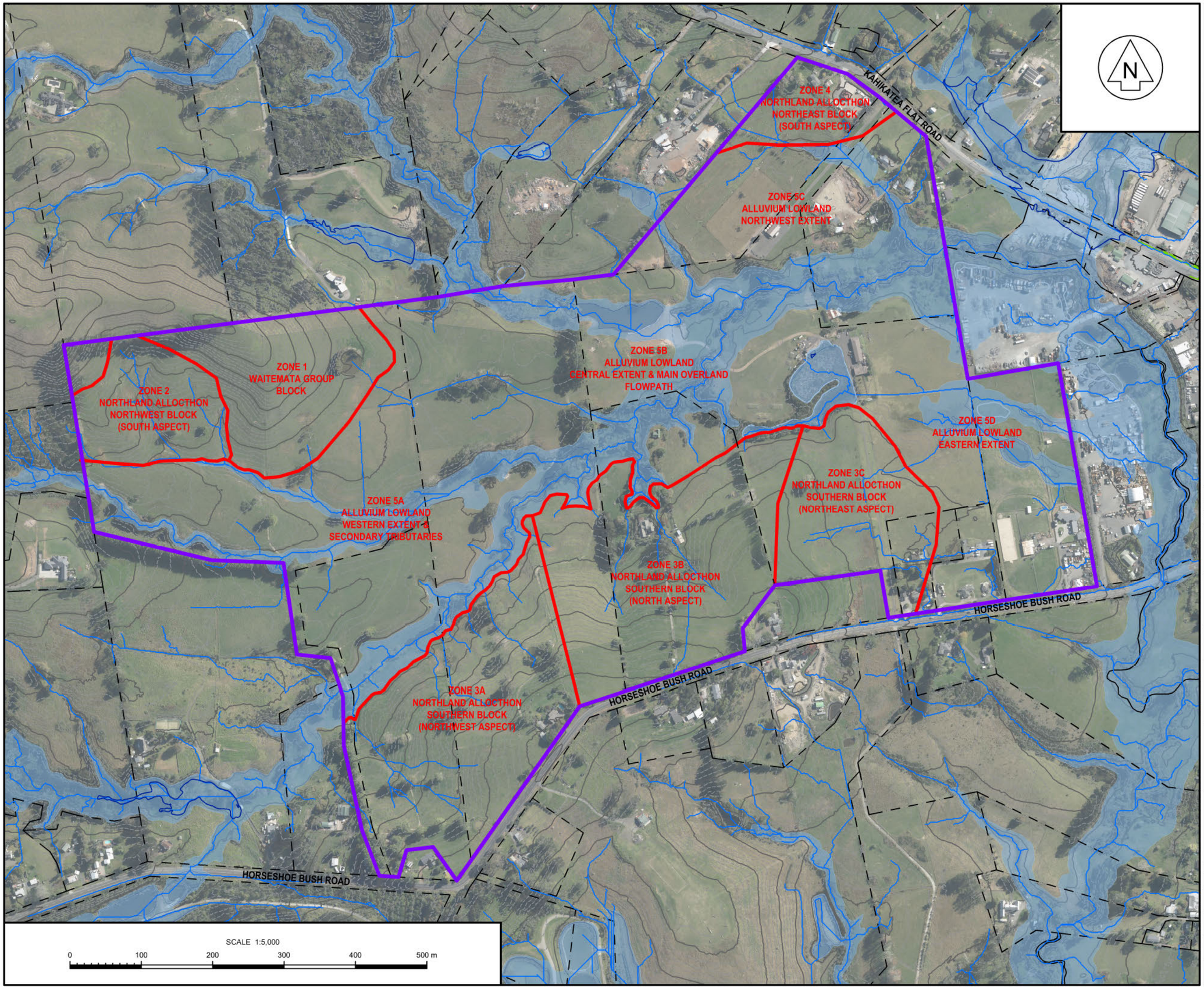
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DRAWN	TR	DATE	23-03-2025	APPROVED	YC	DATE	23-03-2025

STATUS
'FAST TRACK' CONSENT

SCALE	SIZE
1:5,000	A3

COORDINATE SYSTEM	HEIGHT DATUM
NZTM	AKL 1946

PROJECT NUMBER	DRAWING NUMBER	REVISION
K260094-1	KGA 1	B



LEGEND

- FLOOD PLAINS
- SITE BOUNDARY
- KGA ZONING LINE
- NEIGHBOURING BOUNDARIES
- EXISTING TOPOGRAPHIC CONTOURS, MAJOR INTERVAL = 5.0M
- OVERLAND FLOWPATH

NOTES

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DRAWING TITLE

KGA ZONING PLAN

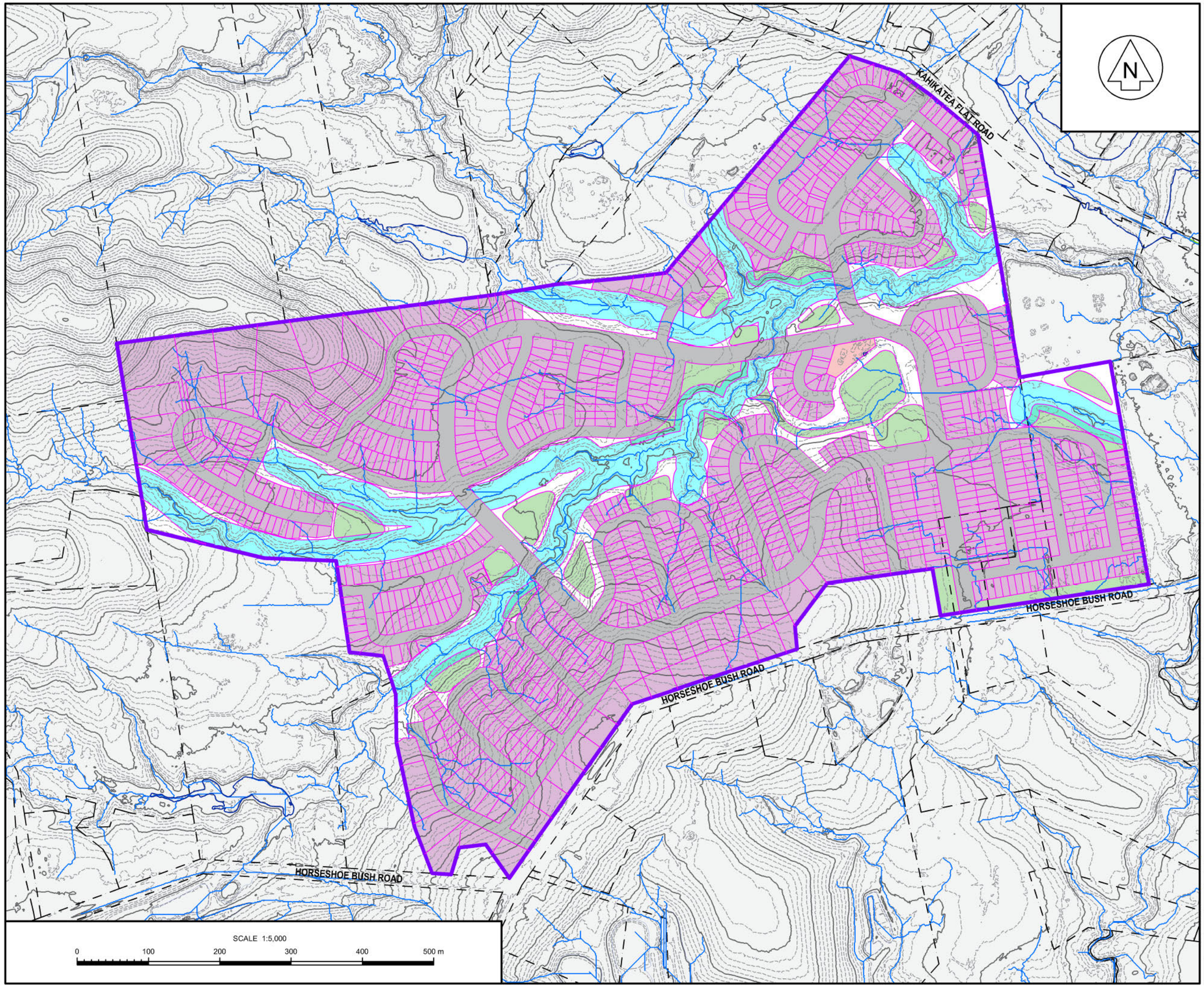
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1:5,000	A3

COORDINATE SYSTEM	HEIGHT DATUM
NZTM	AKL 1946

PROJECT NUMBER	DRAWING NUMBER	REVISION
K260094-1	KGA 2	B



LEGEND

- PROPOSED LOT BLOCKS
- PROPOSED ACCESSWAYS/JOALS
- PROPOSED ROADWAYS
- PROPOSED RIPARIAN AREAS
- WETLAND AREAS
- SITE BOUNDARY
- NEIGHBOURING BOUNDARIES
- EXISTING TOPOGRAPHIC CONTOURS, MAJOR INTERVAL = 5.0M
- OVERLAND FLOWPATH

NOTES

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DRAWING TITLE
SUBDIVISION LAYOUT PLAN

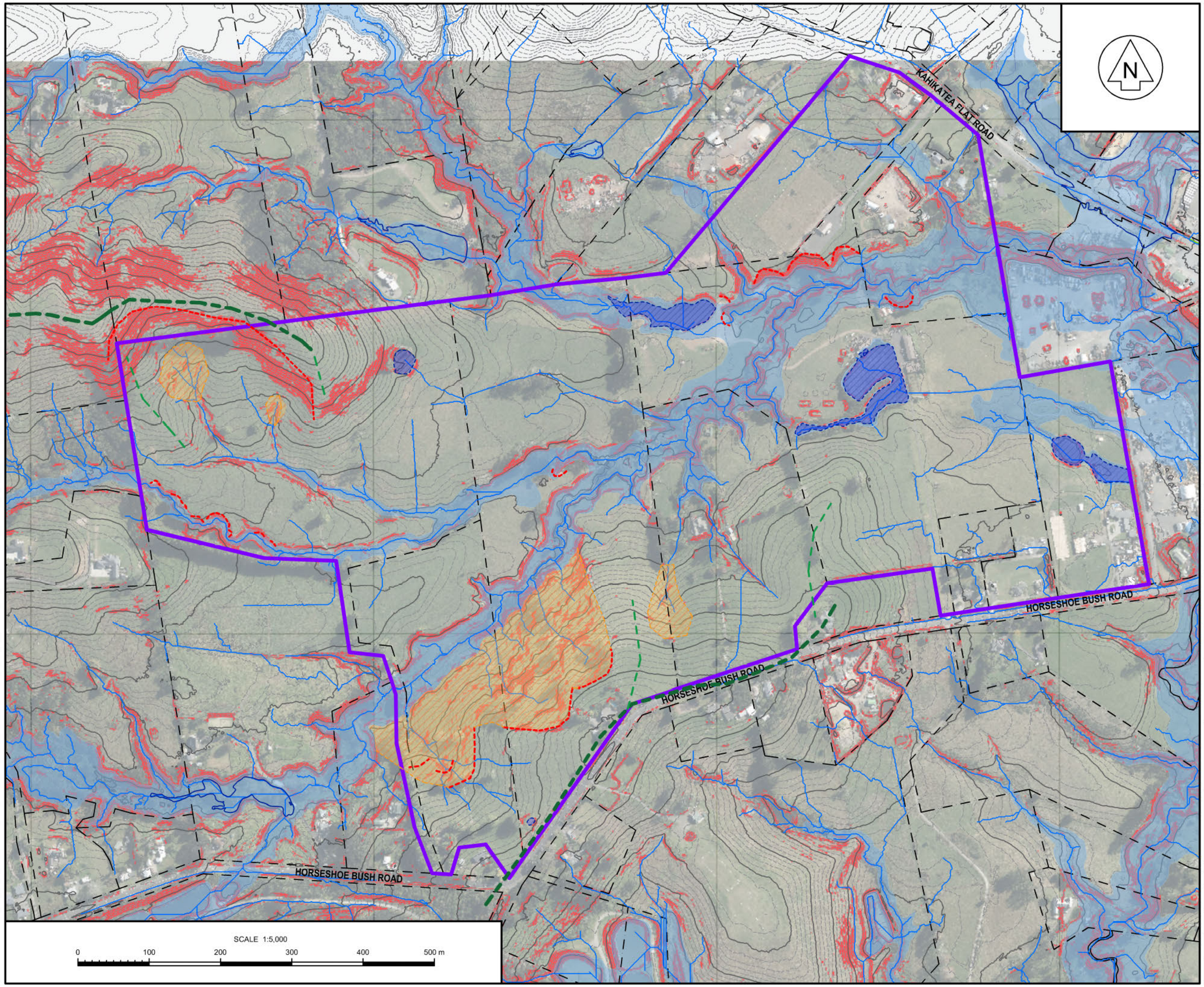
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SCALE	SIZE
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COORDINATE SYSTEM	HEIGHT DATUM
NZTM	AKL 1946

PROJECT NUMBER	DRAWING NUMBER	REVISION
K260094-1	KGA 3	B



LEGEND

- SLOPES GREATER THAN 1:4
- HUMMOCKY GROUND
- EXISTING PONDS
- FLOOD PLAINS
- SITE BOUNDARY
- MAIN RIDGE LINES
- SECONDARY RIDGE LINES
- MAPPED/INFERRED SCARP FEATURES
- NEIGHBOURING BOUNDARIES
- EXISTING TOPOGRAPHIC CONTOURS, MAJOR INTERVAL = 5.0M
- OVERLAND FLOWPATH

NOTES

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PINE VALLEY

DRAWING TITLE
GEOMORPHOLOGICAL PLAN

DESIGNED	TR	DATE	23-03-2025	CHECKED	ET	DATE	23-03-2025
DRAWN	TR	DATE	23-03-2025	APPROVED	YC	DATE	23-03-2025

STATUS
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1:5,000	A3

COORDINATE SYSTEM	HEIGHT DATUM
NZTM	AKL 1946

PROJECT NUMBER	DRAWING NUMBER	REVISION
K260094-1	KGA 4	B

ATTACHMENT B

Proposed Development Plan

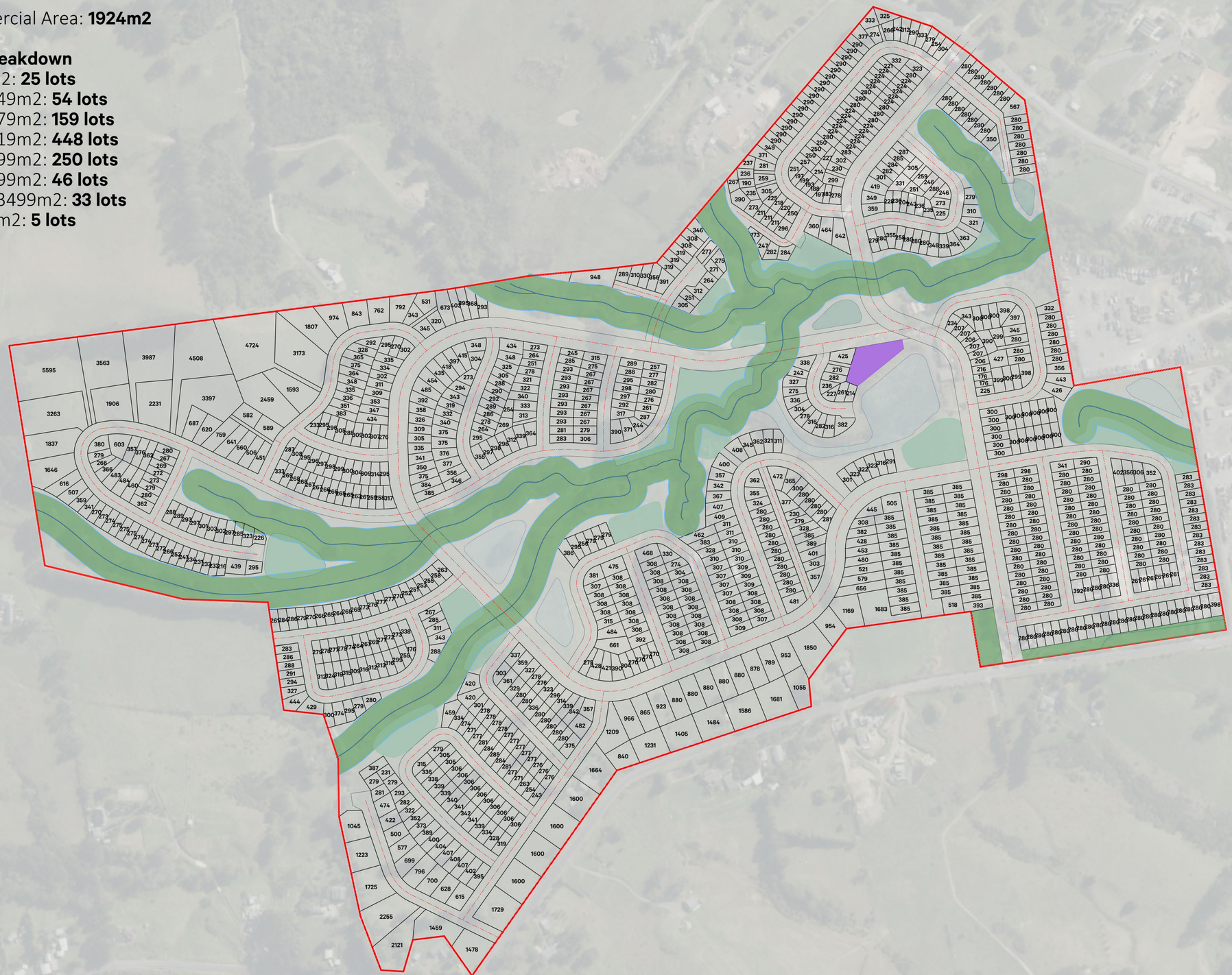
DRAFT

LEGEND

Total Yield: **1020 Lots**

Commercial Area: **1924m2**

Size Breakdown
< 219m2: **25 lots**
220 - 249m2: **54 lots**
250 - 279m2: **159 lots**
280 - 319m2: **448 lots**
320 - 499m2: **250 lots**
500 - 999m2: **46 lots**
1000 - 3499m2: **33 lots**
> 3500m2: **5 lots**



No.	Description	Drn	Chk	Date
C	Layout Update	ET	BW	20.05.26
B	Boundary Update	ET	BW	05.05.26
A	Illustrative Masterplan	ET	BW	14.04.26

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Client
Tuakiri Property

Job Name
Horseshoe Bush Road

Scale
1:2500 @ A1
1:5000 @ A3

Drawing Title
Illustrative Masterplan

Job No. 5202

Drawing Number IGL_5202_L-01

Revision B

Issued For
Consultation

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ATTACHMENT C

NZGD Information

NZGD ID: 87976

ENGINEERING DESIGN CONSULTANTS

DRILLED: 26/05/2016 **FILE:** 46201

HAND AUGER NO.: HA2

SHEET 1 OF 1

PROJECT: Proposed Subdivision **CLIENT:** Chris Shields

ADDRESS: 63 Turley Road, Dairy Flat

LOGGED	PROCESSED	CHECKED
DM	DM	CMcP

BH LOCATION: COORDS: 1744672mE, 5943204mN RL GROUND: 108m

SHEAR VANE ID#: 266

DEPTH (m) GL	SOIL DESCRIPTION (Strength/density, colour, structure, minor, MAJOR, plasticity, moisture content, other comments)	LEGEND	GROUND WATER	SHEAR STRENGTH (kPa) ○Residual ●Peak	SOIL SENSITIVITY	SCALA BLOWS (PER 50 mm)
	TOPSOIL	TS				
	Very stiff, brownish orange, SILT, trace sand, slightly moist, slightly friable (OTAMATEA CLAYSTONE)				4.0	
	moist, low plasticity					
1	streaks of pale creamy brown				2.9	
	streaks and pockets of red fine to medium gravel and sand, moist to very moist					
	friable, occasional streaks of white, white streaks contain minor pumice, occasional trace fine gravels				5.2	
	Very stiff, pale whitish grey, SILT, minor clay, minor to trace pumice, wet, low plasticity (OTAMATEA CLAYSTONE)					
2	streaks of fine sand and gravel, some clay, moderately plastic		IN		4.5	
	slightly friable					
	stiff, pale creamy orange brown				4.0	
3					2.6	
	very stiff					
					3.7	
	streaked pale creamy grey					
	Very stiff, darkish bluish grey, SILT, minor clay, trace pumice, moist, low to moderate plasticity (OTAMATEA CLAYSTONE)			Peak Exceeded	-	
4	no pumice, trace sand			Peak Exceeded	-	
5	End of Hand Auger (Target depth achieved)			Unable To Penetrate	-	

EOH @ 5.40 m

NOTES:

Groundwater was encountered at 1.9m bgl during drilling

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NZGD ID: 87976

Printed: 15/12/2016 10:25:50 a.m.

NZGD ID: 87978

ENGINEERING DESIGN CONSULTANTS

DRILLED: 26/05/2016 **FILE:** 46201

HAND AUGER NO.: HA4

SHEET 1 OF 1

PROJECT: Proposed Subdivision **CLIENT:** Chris Shields

LOGGED	PROCESSED	CHECKED
DM	DM	CMcP

ADDRESS: 63 Turley Road, Dairy Flat

BH LOCATION: COORDS: 1745063mE, 5943103mN RL GROUND: 75m

SHEAR VANE ID#: 266

DEPTH (m) GL	SOIL DESCRIPTION (Strength/density, colour, structure, minor, MAJOR, plasticity, moisture content, other comments)	LEGEND	GROUND WATER	SHEAR STRENGTH (kPa) ○ Residual ● Peak	SOIL SENSITIVITY	SCALA BLOWS (PER 50 mm)
0	Firm to stiff, dark brown, trace white streaks, SILT, minor pumice, minor sand, minor clay, wet, low plasticity (ALLUVIUM)					
	wet, highly plastic			Peak Exceeded	-	
	Very stiff, pale creamy brown, mottled orange, SILT, some sand, dry, friable (ALLUVIUM)					
1	moist, dark purple grey brown, mottled orange, streaked white, low plasticity, no sand, minor clay				2.3	
	Very stiff, dark purple grey brown, mottled orange, clayey SILT, wet, moderately plastic (ALLUVIUM)					
	pale creamy grey, streaked orange, minor to trace pumice				2.2	
	saturated		IN			
2					1.5	
	streaks of black					
	pale grey					
	firm to stiff on auger (very stiff in situ)				2.2	
	very stiff, trace rootlet (1-2mm diameter)					
3					2.1	
	Very stiff, dark brownish grey, streaked black, streaked white, clayey SILT/silty CLAY, saturated, highly to moderately plastic (ALLUVIUM)					
	Very stiff, dark bluish greenish grey, sandy SILT, very moist, slightly friable (difficult to auger) (ALLUVIUM)			Peak Exceeded	-	
4					3.0	
	Stiff, bluish grey, SILT, some clay, trace to minor sand, wet, moderately plastic (ALLUVIUM)					
	decaying wood (2 - 5mm diameter)				2.8	
	End of Hand Auger (hole collapsing)					
5						
6						

EOH @ 6.55 m

NOTES:
Groundwater was encountered at 1.9m bgl during drilling

ENGINEERING DESIGN CONSULTANTS LTD

CIVIL, STRUCTURAL, ENVIRONMENTAL, GEOTECHNICAL AND FIRE ENGINEERS

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Produced With GEROC Core-GS

NZGD ID: 87978

Printed: 15/12/2016 10:29:51 a.m.

NZGD ID: 120541

Engineering Geology Ltd

BOREHOLE No. 1

SITE: 17 Kahikitea Flat Road, DAIRY FLAT

REF: 5238

Sheet 1 of 1

REDUCED LEVEL / STRATA INTERPRET.	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%)	WATER LEVEL
Alluvium	TOPSOIL; sand, silty, moist, loose, dark brown					
	SILT; tr. clay, moist, sl. friable, v. stiff, dark grey brown					
	clayey, sl. plastic, light grey, orange brown specks					
	v. moist, orange brown streaks					
	CLAY; silty, v. moist, plastic, v. stiff, light grey, orange brown		1			900mm 18/11/2003
	tr. organics					
	SILT; clayey, sl. organics, wet, plastic, stiff, light grey, orange brown					
	CLAY; silty, tr. organics, wet, v. plastic, stiff, light grey		2			
	sl. silt					
	no silt, v. wet, groundwater encountered at 2.1m					
	SILT; sandy, tr. organics, saturated, v. plastic, hard, white grey					
	SAND; (v.f.), silty, saturated, dense, grey white					
	E.O.B. @ 2.7m (too hard to auger)		3			
			4			
			5			

CORRECTED VANE SHEAR STRENGTH (kPa)

● Field vane (BS 1377)

○ Remoulded Field vane

50 100 150

113

132

133

104

89

62

92

>207 UTP

>207 UTP

NOTES

LOGGED BY: DM

DATE DRILLED: 18-Nov-03

DRILL METHOD: 50 mm Hand Auger

NZGD ID: 120541

NZGD ID: 120541

Engineering Geology Ltd

BOREHOLE No. 2

Sheet 1 of 1

SITE: 17 Kahikitea Flat Road, DAIRY FLAT

REF: 5238

REDUCED LEVEL / STRATA INTERPRET.	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%)	WATER LEVEL
Alluvium	TOPSOIL; silt, woodchips, moist, sl. friable, dark brown v. stiff					
	SILT; clayey, moist, sl. plastic, v. stiff, brown grey, orange brown specks					
	v. moist, plastic, grey, orange brown		1			
	tr. organics					
	CLAY; silty, wet, plastic, stiff, brown grey, orange brown					
	tr. silt					
	tr. organics, v. wet, v. plastic, v. stiff, groundwater encountered 2.1m		2			18/11/2003 800mm
	SILT; clayey, sl.sand (f.), saturated, v.plastic, stiff					
	sandy (v.f.), no clay, yellow brown					
	hard		3			
	E.O.B. @ 2.7m (too hard to auger)					
			4			
			5			

CORRECTED VANE SHEAR STRENGTH (kPa)

● Field vane (BS 1377)

○ Remoulded Field vane

50 100 150

148 169 153 148 139 77 121 52 >207 UTP

NOTES

LOGGED BY: DM

DATE DRILLED: 18-Nov-03

DRILL METHOD: 50 mm Hand Auger

NZGD ID: 120541

NZGD ID: 120541

Engineering Geology Ltd

BOREHOLE No. 3

Sheet 1 of 1

SITE: 17 Kahikitea Flat Road, DAIRY FLAT

REF: 5238

REDUCED LEVEL / STRATA INTERPRET.	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%)	WATER LEVEL
Alluvium	TOPSOIL; silt, tr. sand, moist, sl. friable, dark brown					
	SILT; sl.topsoil, tr.organics, moist, sl.friable, v.stiff, sl. clay, sl. plastic, grey brown, orange brown					
	clayey					
	v. moist, stiff					
	CLAY; silty, v. moist, plastic, grey brown, orange brown		1			
	v. stiff					
	SILT; clayey, wet, plastic, v.stiff, grey brown					
	tr. sand, v. moist, sl. friable					
	sandy					
	wet					
	dark grey, orange brown					
	SAND; (v.f.) silty, wet, dense, yellow brown		2			1.9m 18/11/2003
	saturated, mod. dense, groundwater encountered at 2.1m					
	gravelly (med)					
	CLAY; silty, mod. organics, v. wet, v. plastic, v. stiff, dark grey					
	stiff					
	tr. organics, grey		3			
	E.O.B. @ 3.0m					
			4			
			5			

CORRECTED VANE SHEAR STRENGTH (kPa)

● Field vane (BS 1377)

○ Remoulded Field vane

50 100 150

130 92 124 141 148 >207 104 118 92 74

NOTES

LOGGED BY: DM

DATE DRILLED: 18-Nov-03

DRILL METHOD: 50 mm Hand Auger

NZGD ID: 120541

NZGD ID: 120541

Engineering Geology Ltd

BOREHOLE No. 4

Sheet 1 of 1

SITE: 17 Kahikitea Flat Road, DAIRY FLAT

REF: 5238

REDUCED LEVEL / STRATA INTERPRET.	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%)	WATER LEVEL
FILL	Topsoil, silt, wood fragments, moist, sl. friable, dark brown					
	SILT; mod. topsoil, tr. gravel (f.-c.), moist, slightly friable stiff, dark brown, yellow brown					
	dark brown, orange brown and grey nodules		1			
	gravelly (f.-c.), v. stiff, dark/orange brown, grey					
	tr. clay, dark brown, grey					
	sl. clay, v. moist					
	clayey, sl. plastic, dark/yellow brown, grey					
	tr. clay					
	sl. clay, tr. gravel (f.)					
	tr. clay, dark brown, grey, orange brown		2			
Alluvium	SILT; clayey, v. moist, sl. plastic, v. stiff, grey brown, grey, orange brown					
	sl. clay, wet, plastic					2.9m 18/11/2003
	clayey, green grey, orange brown					
	CLAY; silty, wet, plastic, v. stiff, green grey		3			
	E.O.B. @ 3.0m					
			4			
			5			

CORRECTED VANE SHEAR STRENGTH (kPa)

● Field vane (BS 1377)

○ Remoulded Field vane

50 100 150

59

74

118

110

156

108

156

108

118

NOTES

LOGGED BY: DM

DATE DRILLED: 18-Nov-03

DRILL METHOD: 50 mm Hand Auger

NZGD ID: 120541

NZGD ID: 120541

Engineering Geology Ltd

BOREHOLE No. 5

Sheet 1 of 1

SITE: 17 Kahikitea Flat Road, DAIRY FLAT

REF: 5238

REDUCED LEVEL / STRATA INTERPRET.	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%)	WATER LEVEL
FILL	TOPSOIL; silt, moist, sl. plastic, dark brown					
	SILT; tr. gravel (med), v. moist, sl. plastic, v. stiff, tr. clay, dark brown, sl. friable					
	sl. plastic, stiff					
Alluvium	SILT; clayey, v. moist, sl. plastic, v. stiff, grey brown, orange brown		1			
	light grey, orange brown					
	sl. clay					
	clayey					
	hard white clay nodules					
	CLAY; silty, wet, plastic, v. stiff, light grey, orange brown		2			
	SILT; clayey, tr. organics, wet, plastic, v. stiff, hard white clay nodules, orange brown, light grey					
	CLAY; silty, wet, plastic, v. stiff, hard white clay nodules, grey, orange brown		3			
	SILT; clayey, wet, v. plastic, v. stiff, hard white clay nodules, grey					Dry
	tr. gravel (f.)		4			
	E.O.B. @ 4.2m					
			5			

CORRECTED VANE SHEAR STRENGTH (kPa)

● Field vane (BS 1377)

○ Remoulded Field vane

50 100 150

104
80
151
101
133
118
124
154
156
124
124
133
116
110

NOTES Hole collapse below 2m

LOGGED BY: DM

DATE DRILLED: 18-Nov-03

DRILL METHOD: 50 mm Hand Auger

NZGD ID: 120541

NZGD ID: 120541

Engineering Geology Ltd

BOREHOLE No. 6

Sheet 1 of 1

SITE: 17 Kahikitea Flat Road, DAIRY FLAT

REF: 5238

REDUCED LEVEL / STRATA INTERPRET.	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%)	WATER LEVEL
FILL	SILT; topsoil, gravelly (f.-c.), v. moist, dark brown					
	dark brown, orange brown nodules					
	firm to stiff					
	stiff					
	tr. clay, gravelly (v.c.)					
	tr. sand (med.)		1			
	sl. gravel (f.-med.), v. stiff					
	sl. clay, sl. plastic, dark brown, yellow brown					
	clayey, yellow brown, dark brown					
	gravelly (v.c.), wet, plastic, green grey, grey, dark brown		2			
	gravelly (f.-c.)					
	v. wet, seepage at 2.2m					
Alluvium	Old TOPSOIL; silt, tr. gravel, v. moist, plastic, v. stiff, dark brown					
	SILT; clayey, v. moist, plastic, v. stiff, grey, orange brown					
	wet					
	v. wet, groundwater encountered at 3.0m		3			3.0m 18/11/2003
	E.O.B. @ 3.0m					
			4			
			5			

CORRECTED VANE SHEAR STRENGTH (kPa)

● Field vane (BS 1377)

○ Remoulded Field vane

50 100 150

50 95 >207 158 157 >207 108 154 156 163

UTP UTP

NOTES

LOGGED BY: DM

DATE DRILLED: 18-Nov-03

DRILL METHOD: 50 mm Hand Auger

NZGD ID: 120541

NZGD ID: 120541

Engineering Geology Ltd

BOREHOLE No. 7

SITE: 17 Kahikitea Flat Road, DAIRY FLAT

REF: 5238

Sheet 1 of 1

REDUCED LEVEL / STRATA INTERPRET.	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%)	WATER LEVEL
Alluvium	TOPSOIL; silt, wet, sl. plastic, dark brown		0			
	SILT; wet, plastic, grey, orange brown v. stiff tr. sand (v.f.), v. moist tr. organics, sl. plastic		1			
	no sand clayey					
	CLAY; silty, tr. sand (c.), wet, plastic, v. stiff, grey v. plastic, stiff		2			2.3m 18/11/2003
	SILT; clayey, tr.sand (c.), wet, v.plastic, stiff, grey v. stiff tr. organics					
	CLAY; silty, tr. sand (c.) v. wet, v. plastic, stiff, grey brown, grey, groundwater at 2.6m saturated		3			
	SILT; clayey, saturated, v. plastic, v. stiff, grey tr. sand stiff sl. clay, v. stiff clayey, hard, white clay nodules					
	CLAY; wet, hard, grey		4			
	E.O.B. @ 4.1m (too hard to auger)		5			

CORRECTED VANE SHEAR STRENGTH (kPa)

● Field vane (BS 1377)

○ Remoulded Field vane

50 100 150

160 158 110 170 111 108 95 139 96 102 92 113 207 >207

UTP

NOTES

LOGGED BY: DM

DATE DRILLED: 18-Nov-03

DRILL METHOD: 50 mm Hand Auger

NZGD ID: 120541

NZGD ID: 120541

Engineering Geology Ltd

BOREHOLE No. 8

Sheet 1 of 1

SITE: 17 Kahikitea Flat Road, DAIRY FLAT

REF: 5238

REDUCED LEVEL / STRATA INTERPRET.	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%)	WATER LEVEL
Alluvium	TOPSOIL; silt, v. moist, sl. plastic, dark grey brown					
	SILT; tr. sand, moist, sl. friable, v. stiff, light grey, orange brown					
	v. moist, grey, orange brown streaks					
	tr. clay, no sand		1			
	sl. clay, grey					
	tr. clay, sl. plastic, occ. black streaks					
	no clay, wet, plastic					
	clayey					
	CLAY; silty, wet, plastic, v. stiff, grey					
	SILT; clayey, v. wet, v. plastic, v. stiff, grey					
	groundwater encountered at 2.0m		2			2.0m 25/11/2003
	E.O.B. @ 2.1m					
			3			
			4			
			5			

CORRECTED VANE SHEAR STRENGTH (kPa)

● Field vane (BS 1377)

○ Remoulded Field vane

50 100 150

108

182

198

178

102

141

>207

UTP

NOTES

LOGGED BY: DM

DATE DRILLED: 25-Nov-03

DRILL METHOD: 50 mm Hand Auger

NZGD ID: 120541

NZGD ID: 120541

Engineering Geology Ltd

BOREHOLE No. 9

Sheet 1 of 1

SITE: 17 Kahikitea Flat Road, DAIRY FLAT

REF: 5238

REDUCED LEVEL / STRATA INTERPRET.	DESCRIPTION OF SOIL	SOIL SYMBOL	DEPTH (m)	SAMPLE TYPE	WATER CONTENT (%)	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ● Field vane (BS 1377) ○ Remoulded Field vane 50 100 150
Alluvium	TOPSOIL; silt, v. moist, sl. plastic, dark brown						
	sl. friable						
	stiff, dark brown, brown						93
	SILT; sl. topsoil, v. moist, sl. friable, stiff, brown, dark brown streaks						
	orange brown nodules						78
	wet, plastic, firm to stiff, orange brown, brown		1				50
	v. stiff						133
	10% soil recovery						
	tr. sand, v. moist, hard, grey, orange brown						>207
	sl. sand						
	sandy, v. stiff, grey						182
			2				
	E.O.B. @ 2.1m						126
			3				
			4				
			5				

NOTES

LOGGED BY: DM

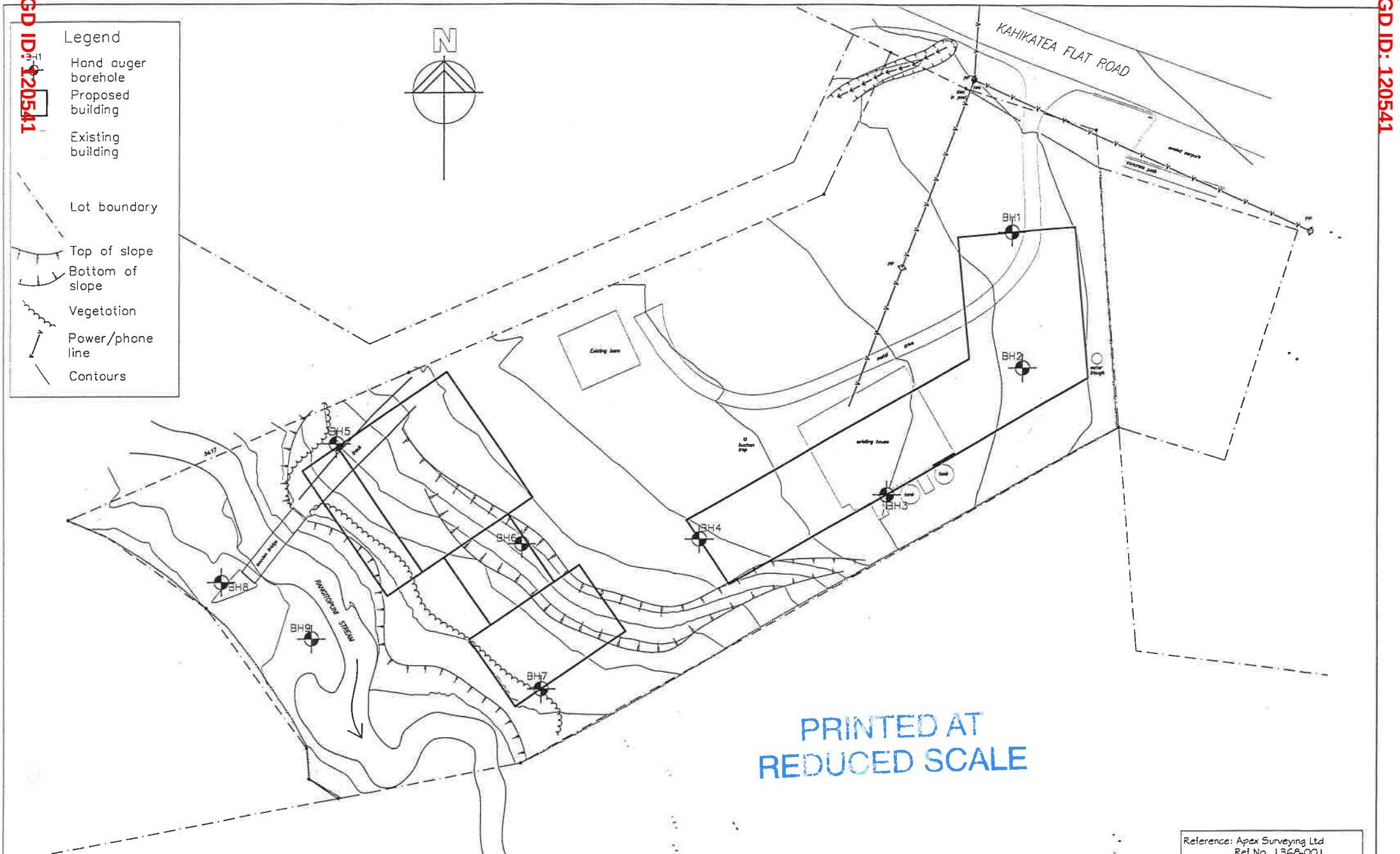
DATE DRILLED: 25-Nov-03

DRILL METHOD: 50 mm Hand Auger

NZGD ID: 120541

NZGD ID: 120541

NZGD ID: 120541



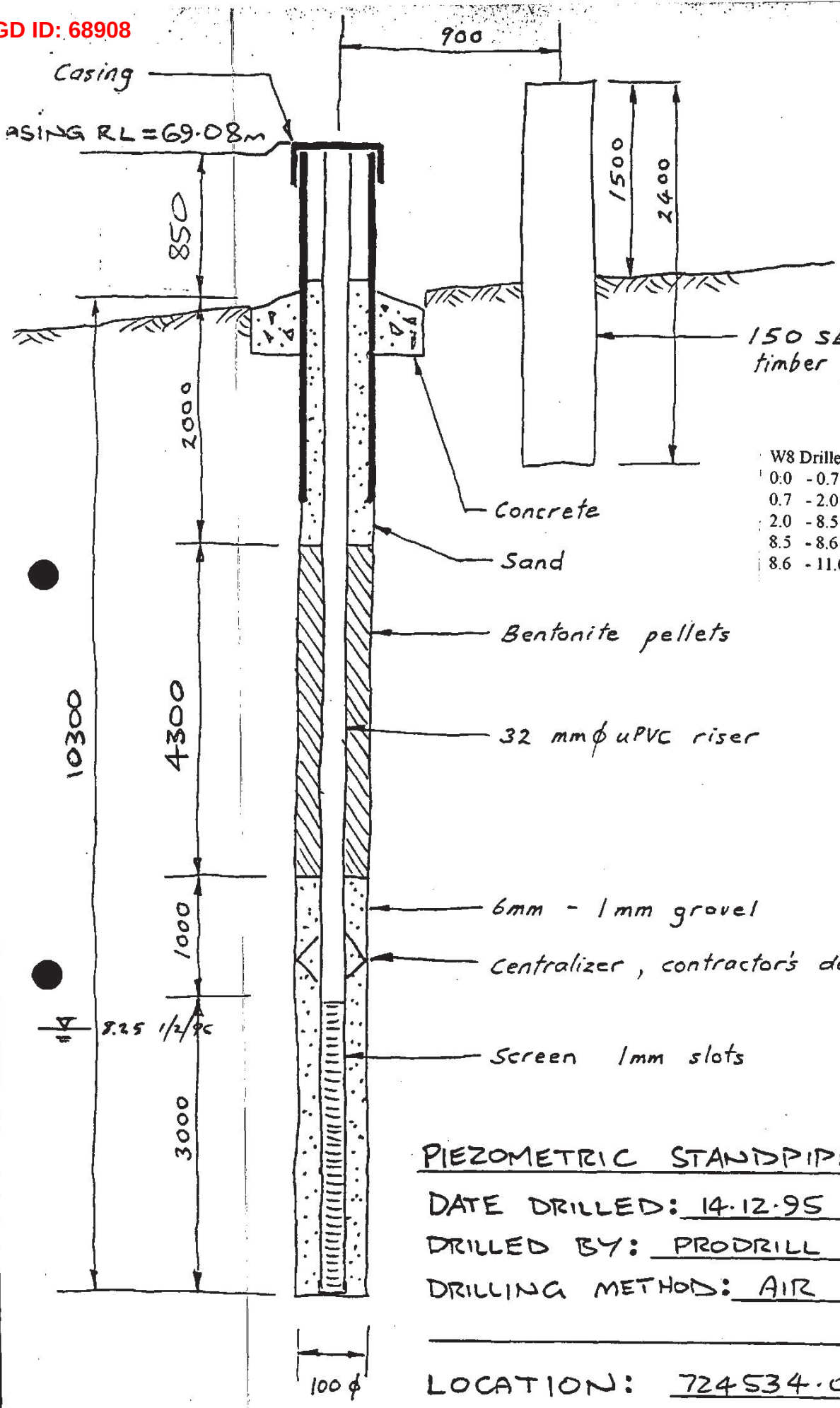
Reference: Apex Surveying Ltd
Ref No. 1368-001

ENGINEERING GEOLOGY LTD
Unit 7C, 331 Rosedale Rd, PO Box 301054, Albany
Ph (09)486-2546, Fax (09)486-2556

17 Kahikatea Flat Rd, DAIRY FLAT
Borehole location plan

Drawing No.	5238-1
Date:	Dec 2003
Drawn:	DM
Scale:	1:500
Filename:	5238-1

NZGD ID: 68908



W8 Drillers log

0.0	- 0.7 m	topsoil
0.7	- 2.0 m	clay, brown
2.0	- 8.5 m	limestone
8.5	- 8.6 m	scoria
8.6	- 11.0 m	limestone

PIEZOMETRIC STANDPIPE W8

DATE DRILLED: 14.12.95

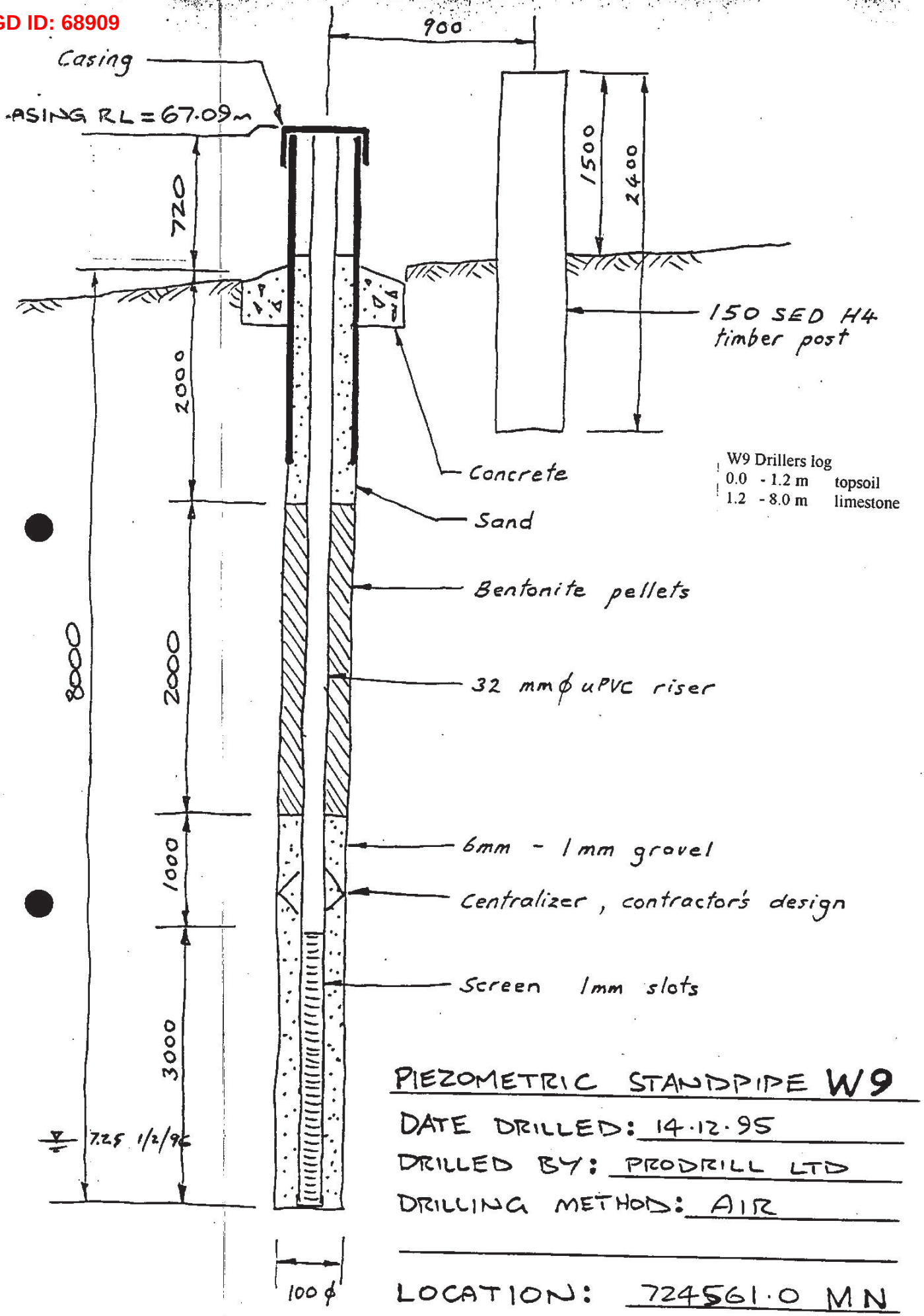
DRILLED BY: PRODRILL LTD

DRILLING METHOD: AIR

LOCATION: 724534.0 MN
287438.0 ME

NZGD ID: 68908

NZGD ID: 68909



PIEZOMETRIC STANDPIPE **W9**

DATE DRILLED: 14·12·95

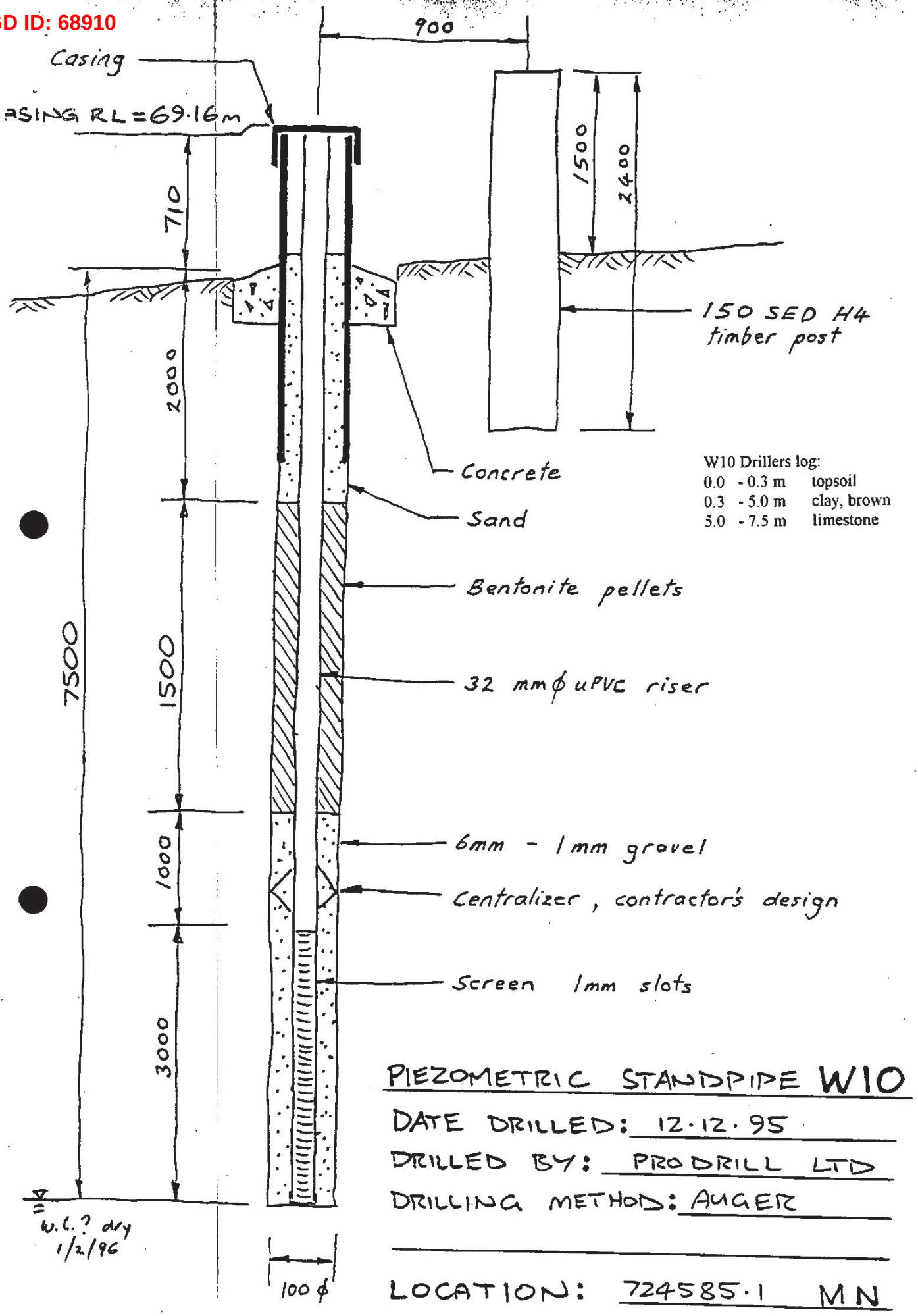
DRILLED BY: PRODRILL LTD

DRILLING METHOD: AIR

LOCATION: 724561·0 MN
287505·0 ME

NZGD ID: 68909

NZGD ID: 68910



PIEZOMETRIC STANDPIPE W10

DATE DRILLED: 12·12·95

DRILLED BY: PRODRILL LTD

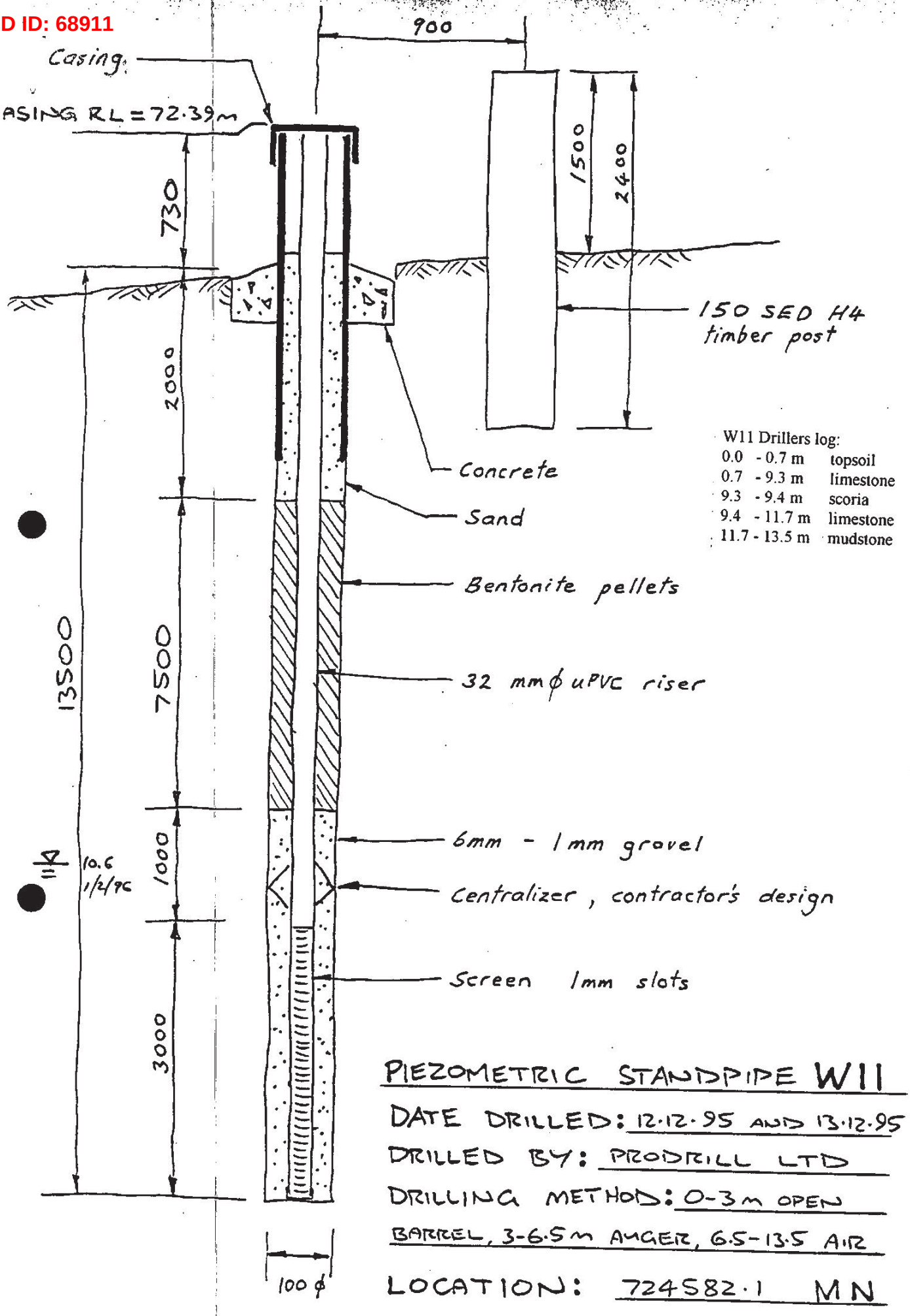
DRILLING METHOD: AUGER

LOCATION: 724585·1 MN

287578·1 ME

NZGD ID: 68910

NZGD ID: 68911



W11 Drillers log:

0.0	- 0.7 m	topsoil
0.7	- 9.3 m	limestone
9.3	- 9.4 m	scoria
9.4	- 11.7 m	limestone
11.7	- 13.5 m	mudstone

PIEZOMETRIC STANDPIPE W11

DATE DRILLED: 12.12.95 AND 13.12.95

DRILLED BY: PRODRILL LTD

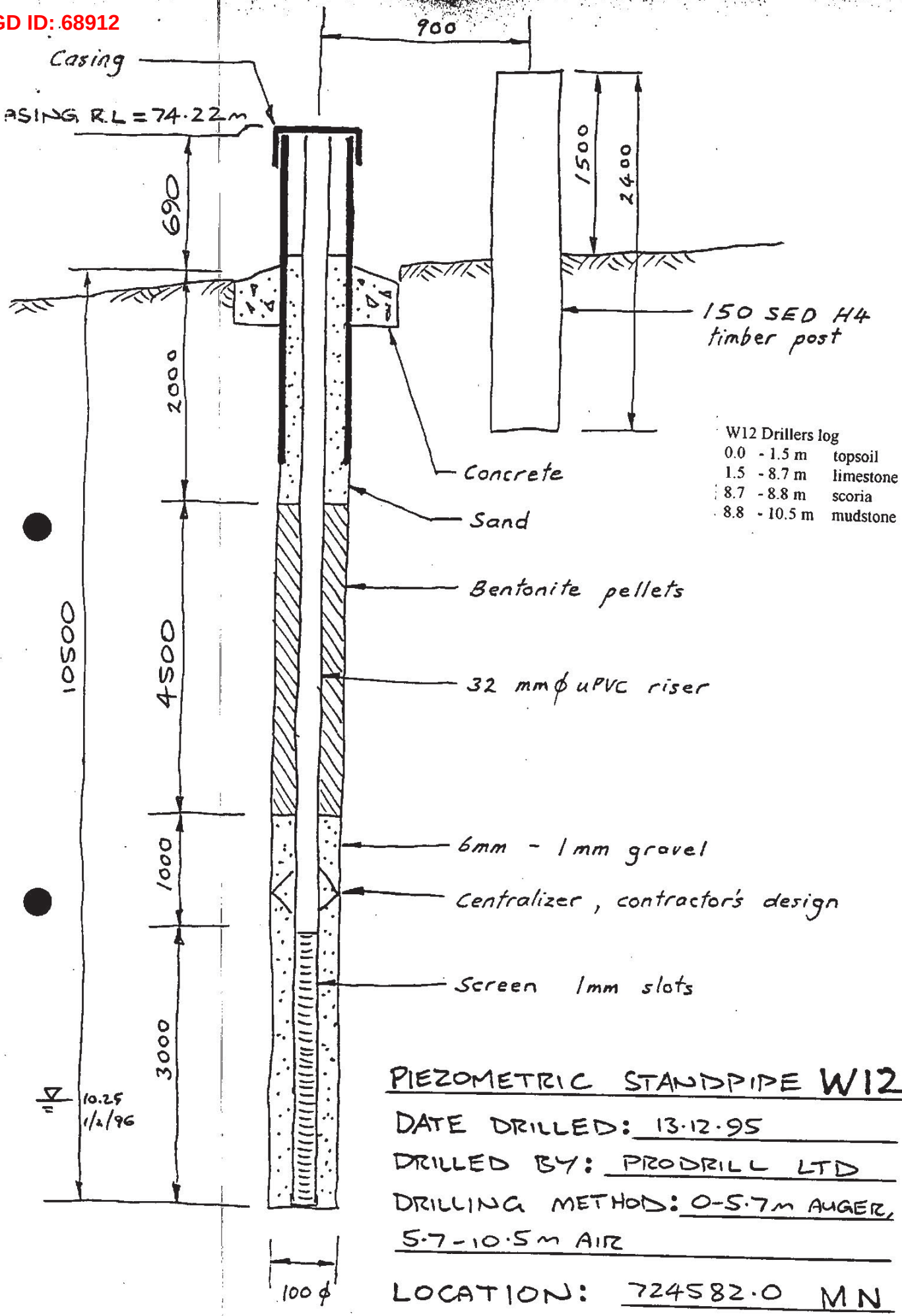
DRILLING METHOD: 0-3m OPEN BARREL, 3-6.5m AUGER, 6.5-13.5 AIR

LOCATION: 724582.1 MN

287638.0 ME

NZGD ID: 68911

NZGD ID: 68912



W12 Drillers log

0.0	- 1.5 m	topsoil
1.5	- 8.7 m	limestone
8.7	- 8.8 m	scoria
8.8	- 10.5 m	mudstone

PIEZOMETRIC STANDPIPE W12

DATE DRILLED: 13·12·95

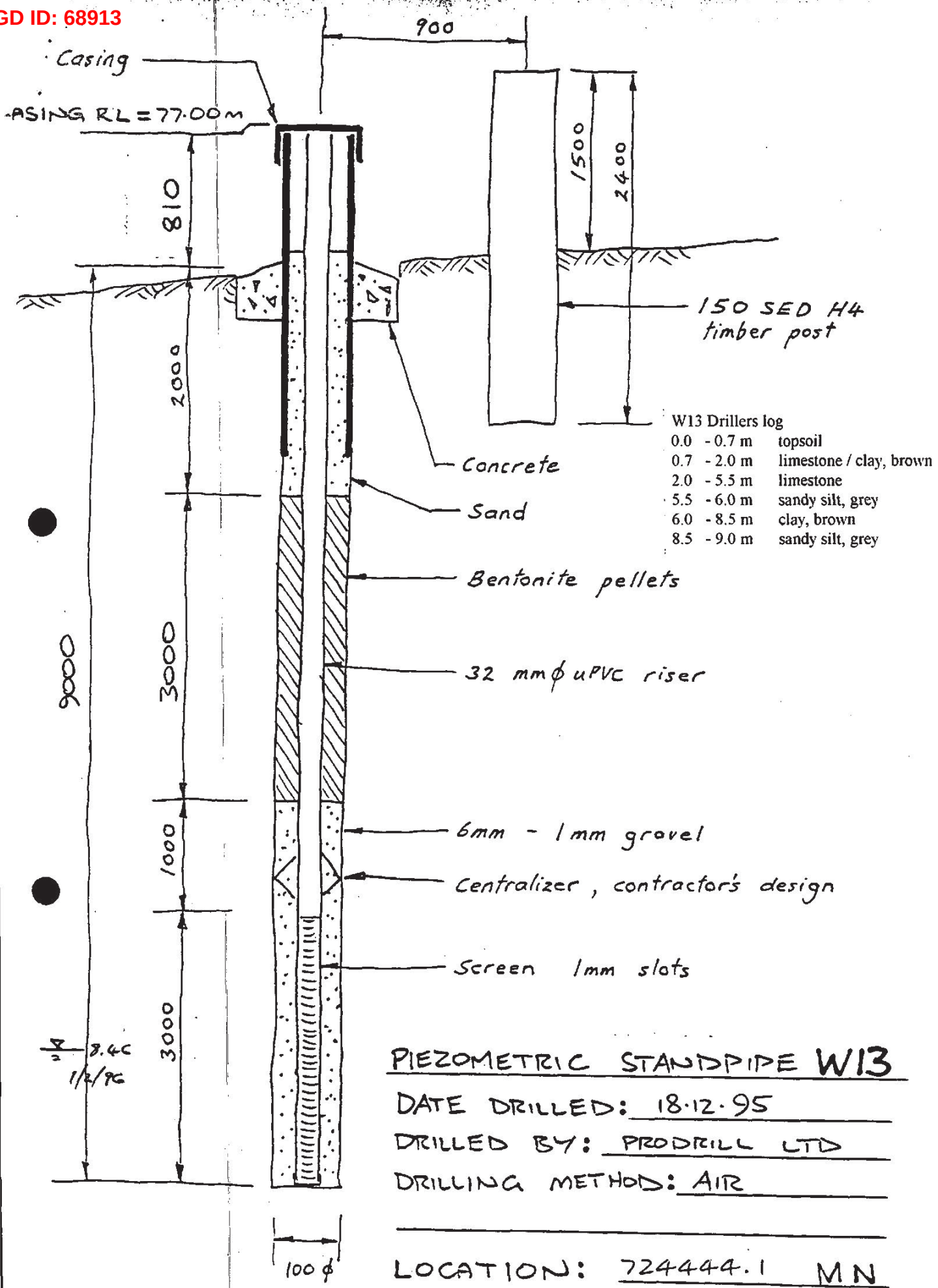
DRILLED BY: PRODRILL LTD

DRILLING METHOD: 0-5·7m AUGER, 5·7-10·5m AIR

LOCATION: 724582·0 MN
287693·0 ME

NZGD ID: 68912

NZGD ID: 68913



W13 Drillers log

0.0	- 0.7 m	topsoil
0.7	- 2.0 m	limestone / clay, brown
2.0	- 5.5 m	limestone
5.5	- 6.0 m	sandy silt, grey
6.0	- 8.5 m	clay, brown
8.5	- 9.0 m	sandy silt, grey

PIEZOMETRIC STANDPIPE W13

DATE DRILLED: 18.12.95

DRILLED BY: PRODRILL LTD

DRILLING METHOD: AIR

LOCATION: 724444.1 MN

287177.0 ME

NZGD ID: 68913

Bore ID 4799

TONKIN & TAYLOR LTD.

DRILL HOLE LOG

DRILL HOLE No: W21
Hole Location:

SHEET 1 OF 3

PROJECT: REDVALE LANDFILL	LOCATION: DAIRY FLAT		JOB No: 13770
CO-ORDINATES mN / mE	DRILL TYPE:	HOLE STARTED:	00/08/95
	DATUM:	HOLE FINISHED:	00/08/95
DIRECTION: ------	R.L. GROUND: m	DRILLED BY:	
ANGLE FROM HORIZ.: -90.00 °	R.L. COLLAR: m	LOGGED BY: BDH	CHECKED:

DESCRIPTION OF CORE

WEATHERING, HARDNESS, STRENGTH, COLOUR, ROCK OR SOIL TYPE, DEFECT SPACING, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...); STRATIGRAPHIC NAME

ROCK DEFECTS

PROMINENT JOINTS, BEDDING, SEAMS, VEINS, SHATTER, SHEAR & CRUSH ZONES, FOLIATION, SCHISTOSITY, ATTITUDE, WIDTH, SPACING, SMOOTHNESS

ROCK WEATHERING · ROCK HARDNESS · PT LOAD / UCS TEST (MPa) · CORE LOSS / LIFT (%) · METHOD, CORE & CASING · TEST SYMBOL · DEPTH (m) · GRAPHIC LOG · DEFECT LOG · FRACTURE LOG (spacing of natural fractures (cm)) · DATE / DEPTH · ROD (%) · WATER · DRILL WATER LOSS (%) · WATER PRESSURE TESTS Lugeons or Permeability (10^{-7}m/s) · CORE BOX RL (m)

Wash drilled to 3.0m depth.

brownish grey, slightly sandy, clayey SILTSTONE, very soft, very weak.

So(?) 40°-50°

partings 40°-50°

Geology ID 4799

greenish grey SILTSTONE indent with nail. qu=1MPa

0.0 – 3.0m wash drilled

3.0 – 44.5m interbedded siltstone + mudstone Overall Chaos breccia

grades greenish grey silty MUDSTONE, sheared, slickensided/polished surfaces

lanar, smooth

oken and shattered by

greenish grey silty mudstone to muddy SILTSTONE.

J50°

fabric dip 70°

shattered

grades to silty MUDSTONE hard to break core by hand

J60° J60°

fabric dip 60°

RL 13770 19/10/95

NZGD ID: 71047
NZGD ID: 71047

TONKIN & TAYLOR LTD.

DRILL HOLE LOG

DRILL HOLE No: W21
Hole Location:

SHEET 2 OF 3

PROJECT: REDVALE LANDFILL | LOCATION: DAIRY FLAT | JOB No: 13770

CO-ORDINATES mN / mE | DRILL TYPE: | HOLE STARTED: 00/08/95

DIRECTION: ------ | DATUM: | HOLE FINISHED: 00/08/95

ANGLE FROM HORIZ.: -90.00 ° | R.L. GROUND: m | DRILLED BY:

R.L. COLLAR: m | LOGGED BY: BDH | CHECKED:

DESCRIPTION OF CORE | ROCK DEFECTS

WEATHERING, HARDNESS, STRENGTH, COLOUR, ROCK OR SOIL TYPE, DEFECT SPACING, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...); STRATIGRAPHIC NAME	DEFECT LOG	PROMINENT JOINTS, BEDDING, SEAMS, VEINS, SHATTER, SHEAR & CRUSH ZONES, FOLIATION, SCHISTOSITY, ATTITUDE, WIDTH, SPACING, SMOOTHNESS
grey SILTSTONE, soft, weak, mudstone interbeds.		shear zone, plastic gouge, slickensided.
		J60°
		J60° smooth, planar fabric dip 40°
grey mudstone pervasively sheared/polished.		very soft, very weak
		completely shattered/crushed
		J60° J10° J20°:
grades sandy SILTSTONE.		slickensided, polished, planar
very soft, very weak		
grey SILTSTONE, soft, weak indent with thumbnail with difficulty.		J60°
		J40° irregular
		J20°
rehealed fractures througout.		J10°
		J60° irregular
		J10°
		J20°
grey fine sandy SILTSTONE, massive appearance.		
grades to grey silty MUDSTONE from muddy sandy SILTSTONE massive but		
internally brecciated (rehealed) fabric		
thumbnail hard.		

DATE / DEPTH | RQD (%) | WATER | DRILL WATER LOSS (%) | WATER PRESSURE TESTS Lugeons or Permeability (10^{-7} m/s) | CORE BOX RL (m)

RQD: 41, 25, 67, 90, 100

RL 13770 17/10/95

NZGD ID: 71047
NZGD ID: 71047

TONKIN & TAYLOR LTD.

DRILL HOLE LOG

DRILL HOLE No: W21
Hole Location:

SHEET 3 OF 3

PROJECT: REDVALE LANDFILL		LOCATION: DAIRY FLAT	JOB No: 13770
CO-ORDINATES mN / mE		DRILL TYPE:	HOLE STARTED: 00/08/95
		DATUM:	HOLE FINISHED: 00/08/95
DIRECTION: -----		R.L. GROUND: m	DRILLED BY:
ANGLE FROM HORIZ.: -90.00 °		R.L. COLLAR: m	LOGGED BY: BDH CHECKED:

DESCRIPTION OF CORE

WEATHERING, HARDNESS, STRENGTH, COLOUR, ROCK OR SOIL TYPE, DEFECT SPACING, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...); STRATIGRAPHIC NAME

ROCK DEFECTS

PROMINENT JOINTS, BEDDING, SEAMS, VEINS, SHATTER, SHEAR & CRUSH ZONES, FOLIATION, SCHISTOSITY, ATTITUDE, WIDTH, SPACING, SMOOTHNESS

ROCK WEATHERING | ROCK HARDNESS | PT LOAD / UCS TEST (MPa) | CORE LOSS / LIFT (%) | METHOD, CORE & CASING | TEST SYMBOL | DEPTH (m) | GRAPHIC LOG | DEFECT LOG | FRACTURE LOG spacing of natural fractures (mm) | DATE / DEPTH | RQD (%) | WATER | DRILL WATER LOSS (%) | WATER PRESSURE TESTS Lugeons or Permeability (10^{-7} m/s) | CORE BOX RL (m)

Description	Defects
grey silty MUDSTONE	J70°
	J60° slickensided
	J40°
massive break core by hand with difficulty	
rehealed fabric	
grey soft, weak, sandy (fine) SILTSTONE/MUDSTONE.	J40°(?) J60° slickensided, planar
	J50°
clay content increasing	J60°, sheared
	J60°, sheared
sheared throughout, rehealed, soft, weak.	
grey silty MUDSTONE, soft, weak.	
sheared throughout, polished breakages.	crushed
END OF DRILLHOLE AT 41.5m.	

RQD: 100, 95, 95, 68

RL 13770 17/10/95

NZGD ID: 71047
NZGD ID: 71047

NZGD ID: 80610

22128 : 29295

Sheet 1 of 1

URS New Zealand — DRILL HOLE LOG MW5

URS New Zealand Limited, 13-15 College Hill, Ponsonby, Auckland	Phone 09 3551200 Fax 09 3551333	Project No.: 46213-235	Project Reference: Caltex REP-Daily Flat
Drilling Contractor: Perry Drilling			
Drill Type: Tractor Mounted	Logged By: P Abbott; Checked By:; Date Started: 24-6-04; Date Finished: 24-6-04	Relative Level: mRL; Coordinates: mN, mE; Permit No: 29290	Client: Caltex Oil New Zealand

SAMPLE TYPE	SAMPLING AND TESTING	WELL CONSTRUCTION DETAILS	DEPTH (m)	LEGEND	DESCRIPTION OF STRATA	GEOLOGICAL DESCRIPTION
Hard Auger	SST287 (0.7-0.9m)	Flush lockable wellhead; PVC end cap; Concrete; 32mm blank PVC; 32mm Machine Slotted PVC; 32mm PVC joiner (no screen); 7/14 Waikato Park Gravel Pack	0		Concrete	FILL
					Basecourse	
			1		Dark brown CLAY, wet, firm.	
					Grey gravelly SILT with minor clay, soft, wet to saturated.	
HOLLOW STEM AUGER	SST288 (1.5-1.7m)		2		Grey CLAY, very firm, wet. Grades to light grey brown CLAY, firm, saturated.	TAURANGA GRP
	SST289 (2.8-3.1m)		3			
			4		EOH at 3.25m bgl	

REMARKS: SST287 - Soil Sampling Interval

WEL_DARYFLAT.GPJ WDCAZ.GDT 5/4/04

NZGD ID: 80610

NZGD ID: 80610

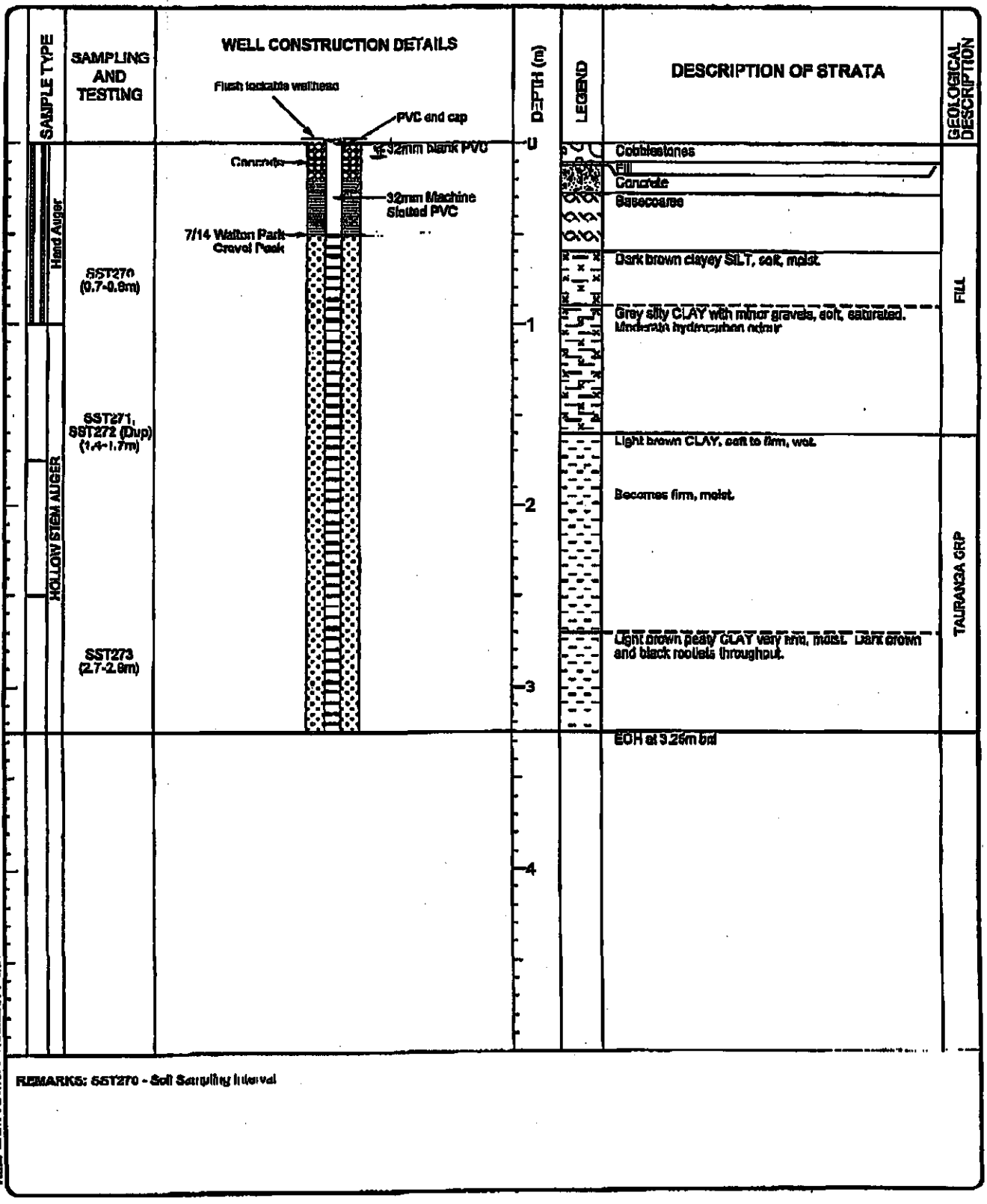
Sheet 1 of 1

URS New Zealand

DRILL HOLE LOG MW6

URS New Zealand Limited
13-15 College Hill, Ponsonby, Auckland
Phone 09 3551200
Fax 09 3551333

Drilling Contractor: Perry Drilling		Project No.: 48213-235	Project Reference: Caltex REP Dairy Flat
Drill Type: Tractor Mounted	Logged By: P Abbott Checked By: Date Started: 24-8-04 Date Finished: 24-8-04	Relative Level: mRL Coordinates: mN mE Permit No: 29295	Client: Caltex Oil New Zealand



REMARKS: SST270 - Soil Sampling Interval

WELL DAIRY FLAT.SPJ WOOKZ.GDT 5/5/04

NZGD ID: 80610

NZGD ID: 80610

Sheet 1 of 1

URS New Zealand

DRILL HOLE LOG SB1

URS New Zealand Limited
13-15 College Hill, Ponsonby, Auckland
Phone 09 3551300
Fax 09 3551333

Project No.: 49213-235

Project Reference: Caltex REP-Dairy Flat

Drilling Contractor: Perry Drilling

Drill Type: Tractor Mounted

Logged By: P Abbott
Checked By:
Date Started: 24-5-04
Date Finished: 24-5-04

Relative Level: mRL
Coordinates: mN
mE
Permit No:

Client: Caltex Oil New Zealand

SAMPLE TYPE	DRILL RUN (m)	FIELD SHEAR STRENGTH (kPa)	PENETROMETER BLOWS (N)	SAMPLING AND OTHER TESTING	GROUND WATER DATA AND COMMENTS	PIEZOMETER CONSTRUCTION	DEPTH (m)	LEGEND	DESCRIPTION OF STRATA	GEOLOGICAL DESCRIPTION
Hand Auger	0.00			SST281 (0.2-0.8m)			0		Concrete Basecoarse. GAP40, finer gravels and sand. Saturated.	FILL
	1.00						1		Grey sandy CLAY with minor gravels to 8mm. Moist. Dark brown silty CLAY with slight peat/hydrocarbon odour. Moist to dry. Basecoat saturated.	
SOLID STEM AUGER				SST282 (1.6-1.9m)						
	2.00						2		Grades to light brown CLAY Purplish brown CLAY very firm, cohesive. Some black staining and peaty CLAY horizons with rootlets to 5mm diameter.	TAURANGA GRP
				SST283 (2.6-2.9m)						
	3.00						3		Distinct increase of rootlets at 3m Grey and dark brown CLAY very firm, wet, cohesive.	
							4		EOH at 4.0m bgl	

REMARKS: SST281 - Soil Sampling Interval

AUGER DAIRYFLAT.GPJ WCONZ.GDT 5/6/04

NZGD ID: 80610

NZGD ID: 80610

RECEIVED 20-04-2007 02:02PM FROM-0864935513333 TO-AUCKLAND REGIONAL CO PAGE 014

Sheet 1 of 1

URS New Zealand

DRILL HOLE LOG SB2

URS New Zealand Limited 13-15 Cottage Hill, Ponsonby, Auckland	Phone 09 5551820 Fax 09 3331333	Project No.: 46213-235	Project Reference: Caltex REP-Dairy Plot
Drilling Contractor: Perry Drilling			
Drill Type: Tractor Mounted	Logged By: P Abbott Checked By: Date Started: 24-5-04 Date Finished: 24-5-04	Relative Level: mRL Coordinates: mN mE Permit No.	Client: Caltex Oil New Zealand

SAMPLE TYPE	DRILL RUN (m)	FIELD SHEAR STRENGTH (kPa)	PENETROMETER BLOWS (N)	SAMPLING AND OTHER TESTING	GROUND WATER DATA AND COMMENTS	PIEZOMETER CONSTRUCTION	DEPTH (m)	LEGEND	DESCRIPTION OF STRATA	GEOLOGICAL DESCRIPTION
Hand Auger	0.00			SST284 (0.5-0.9m)			0		Concrete Basecoarse Light grey sandy CLAY with minor fine gravels, dry to moist, very firm.	FILL
	1.00			SST285 (1.5-1.8m)			1		Brown to dark brown silty CLAY, moist, firm Becomes saturated at 1.0m bgl Becomes saturated.	
SOLID STEM AUGER	2.00			SST286 (3.0-3.3m)			2		Dark brown peaty CLAY, very firm, moist to wet. Light brown CLAY, very firm, moist.	TAURANGA.GRP
	3.00						3			
							4		EOH at 4.0m bgl	

REMARKS: SST284 - Soil Sampling Interval

AUGER DIARY (LAT.32) WOQNZ.GDT 6/8/04

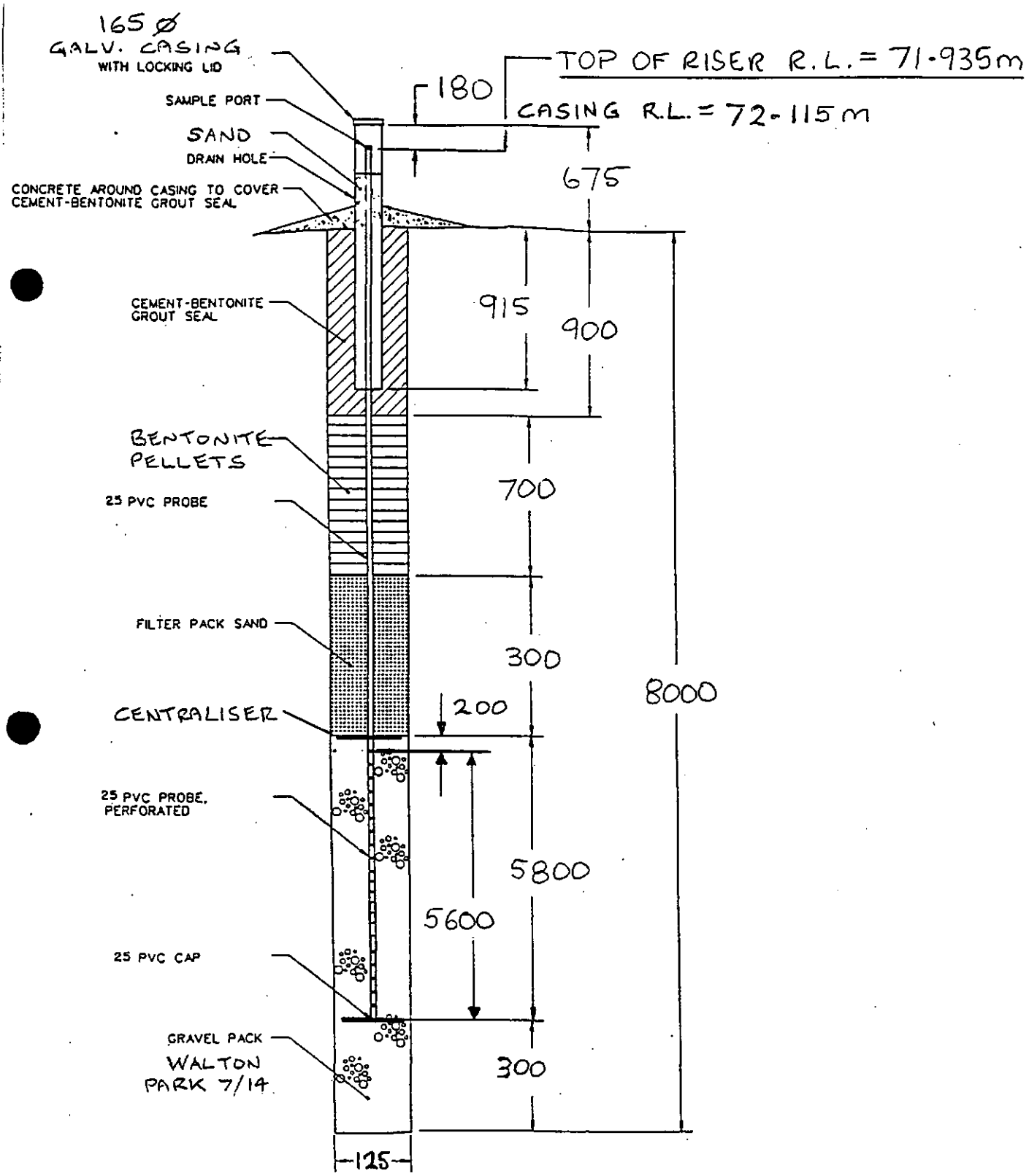
NZGD ID: 80610

20/04/2007 15:14 0864935513333 URS NZ LIMITED PAGE 14/14

NZGD ID: 81046

LANDFILL GAS MONITORING PROBE: P9A 23252

Date Drilled:	1 FEBRUARY 2000	Location:	PHASE 9 BOUNDARY
Drilling Method:	AIR DRILLING	Northing:	724465·80 m
Drilled by:	DRILLWELL EXPLORATION	Easting:	288064·18 m
As-Built by:	SIMON COURT	Ground RL:	71·440 m



NOTE

ALL DIMENSIONS IN MM EXCEPT WHERE INDICATED

NOT TO SCALE

TOP OF RISER + CASING RL'S MEASURED WITH CAPS OFF

NZGD ID: 81046

NZGD ID: 81046

P9A

Drillwell Exploration NZ LTD | Standard Document SD501.0 | Version: 17 March 1999

Drillwell Exploration NZ LTD

ISO9001 Registered

9 Rawson Way, Takanini, Auckland — Daily Log Sheet (General)

Log No. 30435

1° client WM N.Z — Project No. Comp DC | Year 99 | Div GE | # 316 — Day Tue

2° client — Permit No. 23252 — Date day 1 | mth 1 | yr 20

Location REDVALE LANDFILL (street address or locality) — Bore Hole No. P9A — Bore Size 5"

or Grid ref Map | easting | northing — Rig No. 62 — Tender No. 56/25 — Compressor No.

Purpose of Bore GROUND MON — Consultant First Surname

Work Details 11.00 – 12.00 Travel
TO SITE : SITE INDUCTIO
E SITE INSEPECTION
PICK UP TRANSPORTER, UTE
COMPRESSOR ETC UNLOAD
SET UP ON P9A.
AIR DRILL TO 8-2m
PLACE IN 25m PVC
AS REQUIRED MOVE
RIG TO WLGOA
PULL RODS OUT OFF HOLE
FOR NIGHT:
UNLOAD WATER TANKER
TAKE TO WASH BAY
TO FIN LEAVE SITE 5.15
MOTEL 5.30

Bore Log P9A

0 – 3.7 TOP SOIL
BROWN CLAYS
3.7 – 8.2 MUDSTONE
TRACE LIMESTONE

LX 900
B/S 1:6
MP 1:9
SCREEN TO 2-1
PIZZO 7.7
FALL BACK 8m
HOLE 8.2

Materials Used — eg Casing, Bits, PVC, Screens, Other items, etc

Cement		W/PACK	4		
Handicrete		LX PELLETS	1		
QuickMud		25m PVC	8.5		
Bentonite		25m END CAPS	2		
Pac-R		25m CENTRALIZER	1		
Core Boxes					

Signed

Client representative B HORNE

Drill crew GARY H

Other MP MOB

Kilometers Drill Rig

Support tender	
6x6 Crane tender	
Light tender	
Equip. transporter	50k
Utility service	70k
Other	

Time

	Work hrs	Total hrs
Rig Working	5¼	
Start		11.00
Stand-by		
Finish		5.30
Compressor		
Total		
DH Hammer		# men
Accom/Meals		2
Contract Rate		
Travel	1¼	

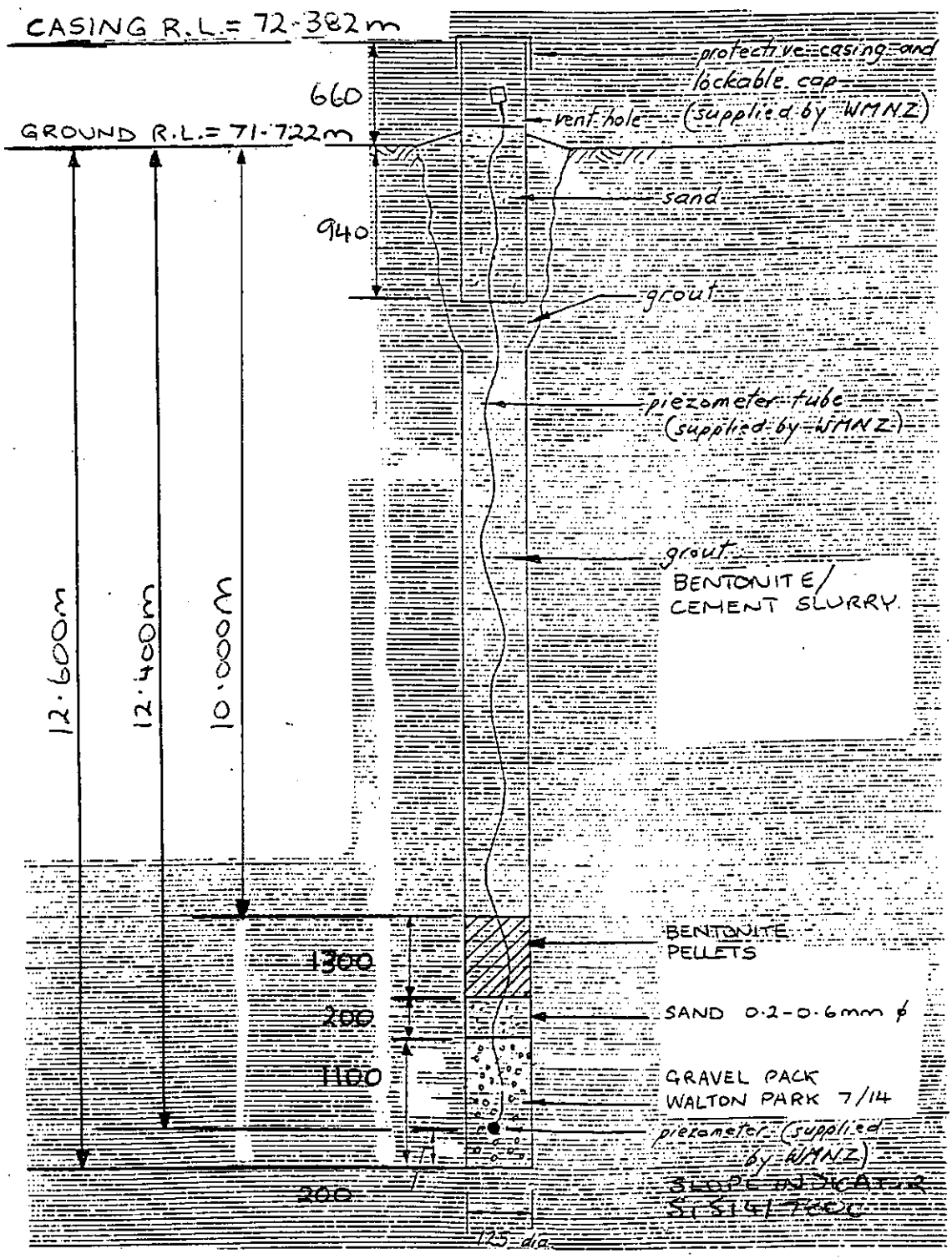
Other - Specify

NZGD ID: 81046

NZGD ID: 81046

Pneumatic Piezometer: WL6 SA

Date Drilled:	2 FEBRUARY 2000	Location:	PHASE 9 BOUNDARY
Drilling Method:	AIR DRILLING	Northing:	724462.00 m
Drilled by:	DRILLWELL EXPLORATION	Easting:	288063.66 m
As-Built by:	SIMON COURT	Ground RL:	71.722 m



NOTE:
CASING RL MEASURED WITH CAP OFF
ALL DIMENSIONS IN MM EXCEPT WHERE INDICATED
NOT TO SCALE

NZGD ID: 81046

NZGD ID: 81046

WL6SA

Drillwell Exploration NZ LTD | Standard Document SD501.0 | Version: 17 March 1999

Drillwell Exploration NZ LTD

9 Rawson Way, Takanini, Auckland

Daily Log Sheet (General)

Log No. 30436

1°client W.M.NZ | Project No. DC 99 6C 316 (Comp Year Div #) | Day WED

2° client | Permit No. 23252 WL6DA | Date 2 2 00 (day mth yr)

Location REDVALE LANDFILL (street address or locality) | Bore Hole No. WL6SA | Bore Size 5"

or Grid ref (Map, easting, northing) | Rig No. 62 | Tender No. 25 | Compressor No.

Purpose of Bore Ground Mon | Consultant (First, Surname)

Work Details Moved 7.00 - 7.15:
Load Tanker With Water
Take To Site
Continue To Air Drill
To 29.5 ; Pull Rods
10.30 - 12.00 Waiting
For Pneumatic Piezo
Run In Probe only
To 27m ; Run In
Rods Clean Hole
Pull Rods Run Probe
To 27.5 ;
Move To WL6SA ;
Air Drill To 13.5m
Pull Rods Seat In
Probe Run In Tremmy
Mix up Grout . Pump
Down Clean Pump etc
Load Rods Tools etc
Take To Wash Bay leave Site 5.00 - Motel 5.15

Bore Log WL6DA.
Hole Depth 27.5
Probe To 27.2.
W/P from 27.5 - 26m
B/S To 25.8 L/x To 24.8
Grout To 1.5m

WL 6SA
Hole Depth 12.6
Probe To 12.4
W/P from 12.6 To 11.5
B/S To 11.3 L/x To 10m
Grout To 1.5m

Compressor Hours 90 cfm
4430.3
4424.4
5.9 Hours

Materials Used eg Casing, Bits, PVC, Screens, Other items, etc

Cement	12	Blasting Stand	1				
Handicrete		W/Park	2				
QuickMud		L/x Pellets	1				
Bentonite	1 1/2						
Pac-R							
Core Boxes							

Signed

Client representative B Horne

Drill crew GARY A

Driller

Kilometers	
Drill Rig	
Support tender	
6x6 Crane tender	
Light tender	
Equip. transporter	
Utility service	29k
Other	

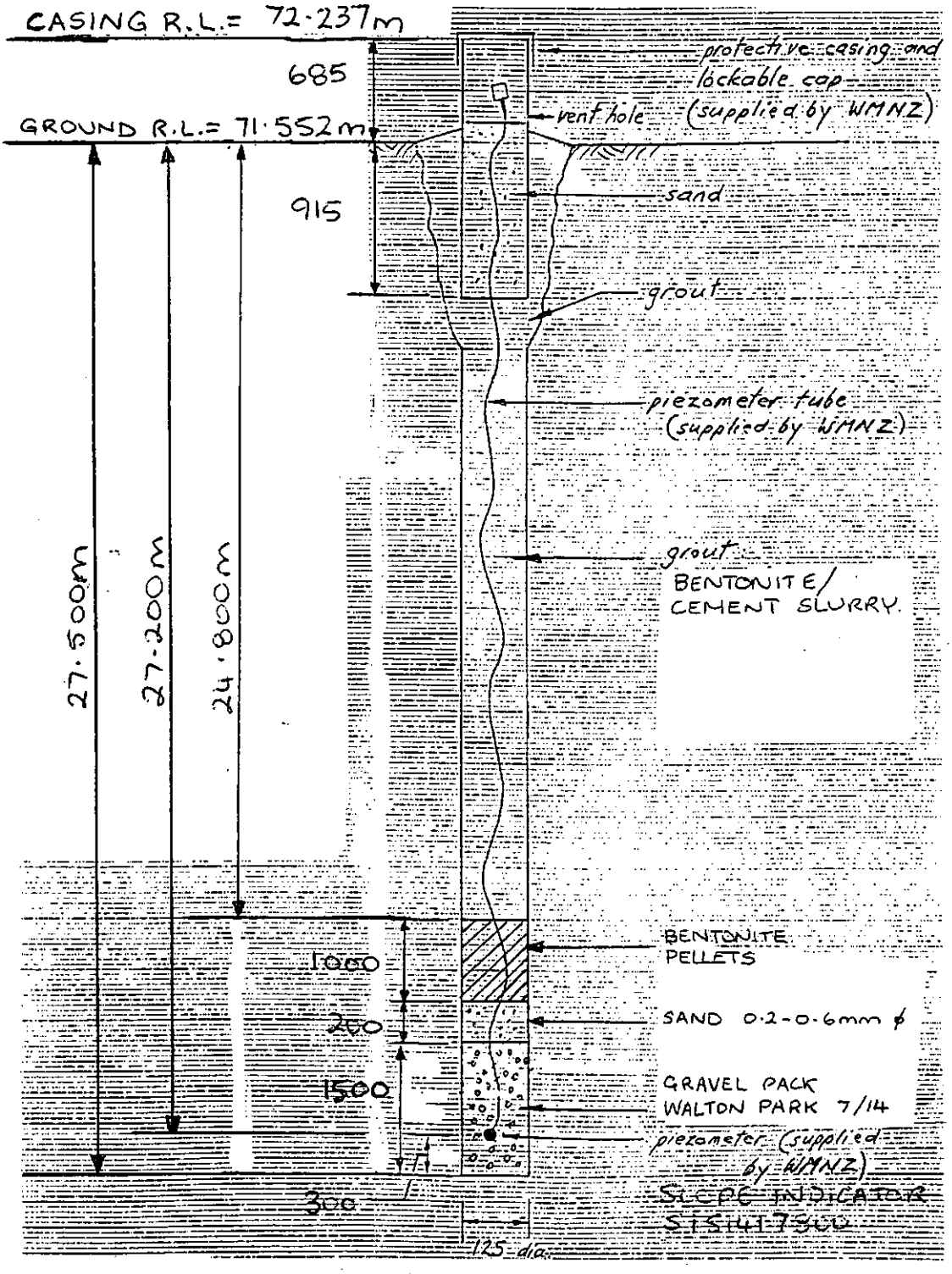
Time	Work hrs	Total hrs
Rig Working	8 1/4	Start 7.00
Stand-by	1 1/2	Finish 5.15
Compressor	5.9	Total 10 1/4
DH Hammer		# men Accom/Meals 2
Contract Rate		Other - Specify
Travel	1/2	Other - Specify

NZGD ID: 81046

NZGD ID: 81046

Pneumatic Piezometer: WL6 D A

Date Drilled: 2 FEBRUARY 2000	Location: PHASE 9 BOUNDARY
Drilling Method: AIR DRILLING	Northing: 724463·72 m
Drilled by: DRILLWELL EXPLORATION	Easting: 288063·71 m
As-Built by: SIMON COURT	Ground RL: 71·552 m



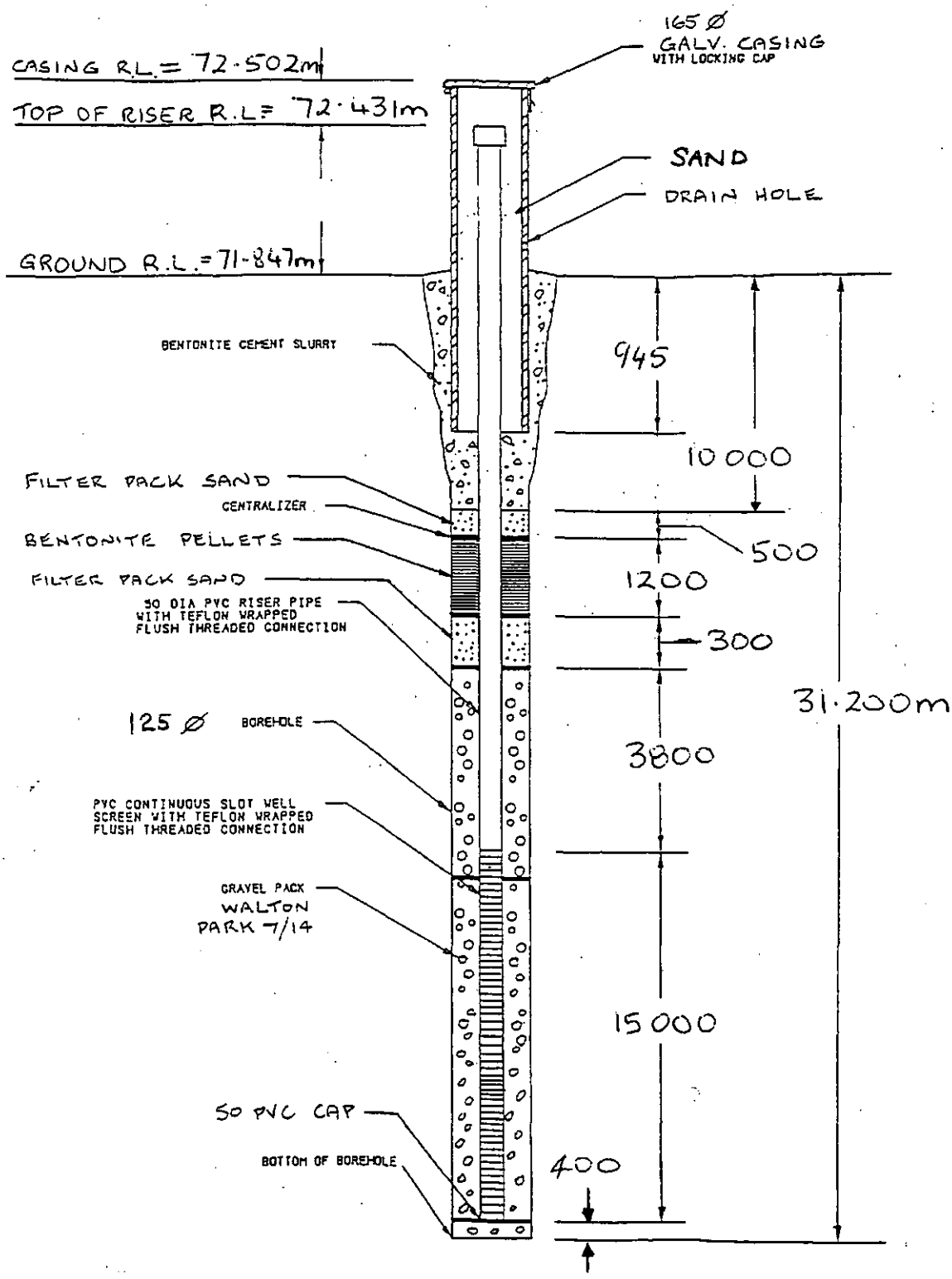
NOTE:
CASING RL MEASURED WITH CAP OFF
ALL DIMENSIONS IN MM EXCEPT WHERE INDICATED
NOT TO SCALE

NZGD ID: 81046

NZGD ID: 81046

GROUNDWATER MONITORING WELL: M2B

Date Drilled:	3 FEBRUARY 2000	Location:	PHASE 9 BOUNDARY
Drilling Method:	AIR DRILLING	Northing:	7244 60.10 m
Drilled by:	DRILLWELL EXPLORATION	Easting:	288063.75 m
As-Built by:	SIMON COURT	Ground RL:	71.847 m



NOTE:
TOP OF RISER & CASING RL ARE MEASURED WITH CAPS OFF
ALL DIMENSIONS IN MM EXCEPT WHERE INDICATED
NOT TO SCALE

NZGD ID: 81046

NZGD ID: 81046

M2B

Drillwell Exploration NZ LTD | Standard Document SD501.0 | Version: 17 March 1999

Drillwell Exploration NZ LTD

9 Rawson Way, Takanini, Auckland

Daily Log Sheet (General)

Log No. 30437

1°client W.M.N.Z | Project No. 06 99 6e 316 (Comp Year Div #) | Day Thur

2° client | Permit No. 23252. | Date 3 2 20 (day mth yr)

Location Redvale Land Fill (street address or locality) | Bore Hole No. M2B | Bore Size 5"

or Grid ref (Map, easting, northing) | Rig No. 62 | Tender No. 25 | Compressor No.

Purpose of Bore Groundwater | Consultant (First, Surname)

Work Details	Bore Log M2B.
Moved 2.00 - Site 7.15	
Wash Rods, Tools Etc	0 - 3.9 Brown clay
Take up To Site	sticky:
Pick up 175 cfm	3.9 : 13.7 Mud Stone.
Compressor Take up To	13.7 Hard Limestone
Drill site Move On	13.7 : 31.2 Lime rock:
Set up Air Drill	Hard Bands:
TD 31.2 — Pull Rods	
Run In 50m PVC	
Back fill As Required:	Installation
Clean up Gear.	Hole Depth 31.2.
Cement In 4 Lockable	W/P from 31.2 To 12m
Covers Pack Gear	P:2210 Set 30.8m Top of
Leave site 5.00 - 5.15	Screen 15.8
	B/S 11.7 2x 10.5
	B/S 10m Slurry To
Compressor Hours 175 cfm	1.5
[redacted] 6874.8	
[redacted] 6871.6	
[redacted] 3.2	

Materials Used eg Casing, Bits, PVC, Screens, Other items, etc

Cement	4	50m Screw Cap	1	2x Pellets	1
Handicrete	8	3x3m Slotted Screen	3	25m PVC	2m
QuickMud		50m Plain Tredco	23m		
Bentonite	1/2	50m Centralizers	4		
Pac-R		W/Park	13		
Core Boxes		B/Sawn	1		

Signed

Client representative B Wilcox

Drill crew G. Maxwell

Driller [redacted]

Kilometers	Drill Rig	
	Support tender	
	6x6 Crane tender	
	Light tender	
	Equip. transporter	
	Utility service	33/4
	Other	

Time	Work hrs	Total hrs
Rig Working	9 3/4	Start 7.00
Stand-by		Finish 5.15
Compressor	3.2	Total 10 1/4
DH Hammer		# men Accom/Meals 2
Contract Rate		Other - Specify
Travel	1/2	Other - Specify

NZGD ID: 81046

NZGD ID: 81046

M2B

Drillwell Exploration NZ LTD | Standard Document SD501.0 | Version: 17 March 1999

Drillwell Exploration NZ LTD

ISO9001 Registered

Log No. 30438

9 Rawson Way, Takanini, Auckland

Daily Log Sheet (General)

1°client N M . N . 2 | Project No. 0 | 99 | Ce | 316 (Comp | Year | Div | #) | Day Fri 5

2° client | Permit No. | Date 4 (day) 2 (mth) 20 (yr)

Location Requale Lawofill (street address or locality) | Bore Hole No. | Bore Size

or Grid ref (Map | easting | northing) | Rig No. 62 | Tender No. 06/25 | Compressor No.

Purpose of Bore Groumo mon | Consultant (First | Surname)

Work Details	Bore Log
Mobd 7.00 - Site 7.15	
Break Down all Roo's	
& 1000 Trailers	
1000 water TAnker:	
TAke Down Compessor	
After cleaning	
1000 Rig After Getting	
Stuck IN Tree BRAnches	
Tie Down WASh Room	
TRANSporter:	
leave Site 9.15 - 10.30	

Materials Used eg Casing, Bits, PVC, Screens, Other items, etc

Cement							
Handicrete							
QuickMud							
Bentonite							
Pac-R							
Core Boxes							

Signed

Client representative

Drill crew C. Brannan

Driller

Kilometers Drill Rig

Support tender	
6x6 Crane tender	
Light tender	
Equip. transporter	60k
Utility service	74k
Other	

Time

	Work hrs	Total hrs
Rig Working	2	Start 7.00
Stand-by		Finish 10.30
Compressor		Total 3½ (# men)
DH Hammer		Accom/Meals
Contract Rate		Other - Specify
Travel	1½	Other - Specify

NZGD ID: 81046

NZGD ID: 81816

DRILLWELL EXPLORATION N.Z. LTD.

20213

DRILLING CONTRACTORS

DAILY LOG SHEET

1191-12289

P.O. BOX 360 MANUREWA

Client: W. R. Hogan

P O Box 13576, Onehunga

Date: 9-2-94

Day: Wednesday

Engineers:

Rig No.: 15

Location: Clenbrook Road, Patumahoe

Tender Truck No.: 29

Permit No 14/17/1146

Size and Purpose of Bore: 100 mm water bore Ref R12695458

WATER BOARD COPY

Work Details and Bore Hole No.: 1.

Cut slush pit set and levelled up rig, unloaded gear, cored water. Drilled to 6.5 metres, unloaded cement, cleaned well.

GROUNDWATER A.R.W.B.
W.B. No
NAME Hogan
TECHNICAL FILES
14 17 1146
ACTION
BORE LOG
PUMP TEST
COMPUTER
WATER QUAL

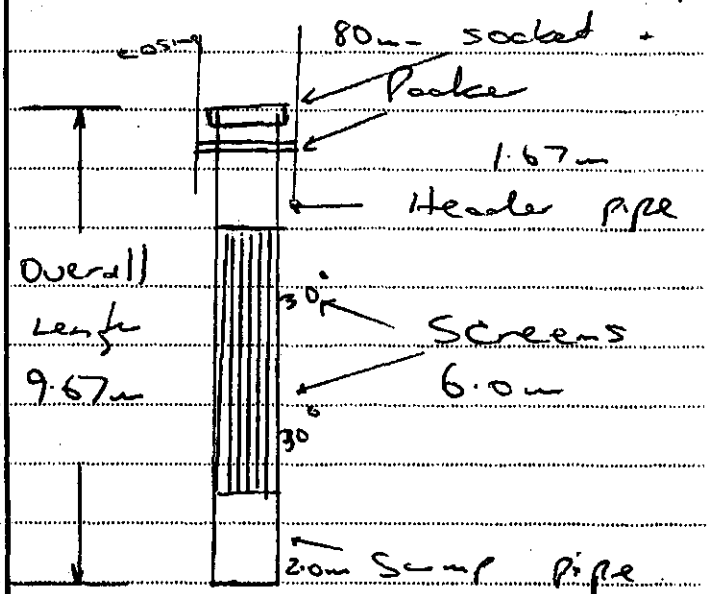
Note cored, need clip to site, as we were unable to get it to site in one trip with utility.

Bore Log :

On - 2 Brass clamps

2 - 6.5 Brass centralisers

PVC Screen Assembly



C. L TO TOP of screen Assembly = 42.75m

NZGD ID: 81816

NZGD ID: 81816

DRILLWELL EXPLORATION N.Z. LTD.

20214

DRILLING CONTRACTORS

DAILY LOG SHEET

P.O. BOX 360 MANUREWA

Client: W. R Hosen

Date: 10-2-94

Day: Thursday

Engineers:

Rig No.: 15

Location: Clevedon Road

Tender Truck No.: 29

Size and Purpose of Bore: 100mm Water Bore

WATER BOARD COPY

Work Details and Bore Hole No.: 1

Bore Log :

Casted water.
Drilled 100 mm probe Hole to 56.60 meter.
Pulled out.
backfilled production zone with metal chip.
Sealed Hole.
mixed up mud + bran in sump pit.
Reamed Hole to 44.20m
Flushed Hole
Pulled out rock rollers.
Installed 100 mm casing. 44.45m
mixed up cement and pumped behind casing.
cleaned up clear.
casted water.
Ceased work.

0.5 - 12 Brown sands s.H
12 - 13.5 Kaawa sandstone crumb
13.5 - 28.5 Kaawa sandstone
28.5 - 30.5 Shellrock
30.5 - 32.3 K Sandstone Shell
32.3 - 36 Shellbed
36 - 37.3 K Sandstone Shell
37.3 - 40.7 Shell rock
40.7 - 42.3 K Sandstone Shell
42.3 - 50.51 Shellbed, some shellrock
50.51 - 56.60 Blue clay silty clays.

NZGD ID: 81816

NZGD ID: 81816

DRILLWELL EXPLORATION N.Z. LTD.

20215

DRILLING CONTRACTORS

DAILY LOG SHEET

P.O. BOX 360 MANUREWA

Client: W. R. Hogan

Date: 11-2-94

Day: Friday

Engineers:

Rig No.: 15

Location: Glenbrook Road

Tender Truck No.: 29

Size and Purpose of Bore: 100mm water bore

WATER BOARD COPY

Work Details and Bore Hole No.: 1.

Lowered collars rods

Drilled and flushed to

52.50m Pulled out rods.

Installed screen Assembly.

Lowered rods, checked

screen in position.

Pulled out.

Installed Airline.

Tested bore.

Moved work.

Bore Log :

Flow tests		Approx
12.15	7 lengths	9,000 g
12.45	8 lengths	9,500 "
1.45	"	9,500 "
3.00	"	9,500 "
4.00	4 lengths	6,800 "
4.15	2 lengths	1680 "

75% of airline = 776 cmpd

Start press 80 PSI

Run press 60 PSI

SWL 5.30m

Suggested 100mm Submersible pump setting to be 4 Lengths of pipe

NZGD ID: 81816

NZGD ID: 81816

DRILLWELL EXPLORATION N.Z. LTD.

20216

DRILLING CONTRACTORS

DAILY LOG SHEET

P.O. BOX 360 MANUREWA

Client: W. R. Hosen

Date: 14-2-94

Day: Monday

Engineers:

Rig No.: 15

Location: Glenbrook Road

Tender Truck No.: 29

Size and Purpose of Bore: 100 mm water bore

WATER BOARD COPY

Work Details and Bore Hole No.: 1

Bore Log

Withdrew Airline

loaded gear.

Pumped out Slush pit.

Folded up rig.

cemented around top of bore.

completed with

ceased work.

NZGD ID: 81816

TONKIN & TAYLOR LTD.

NZGD ID: 124551

EXCAVATION NO: SHAFT 2

SHEET 1 OF 2

EXCAVATION LOG

PROJECT: REDVALE LANDFILL | LOCATION: WEST PROPERTY | JOB NO: 10944

CO-ORDINATES: 724465 mN, 287568 mE | EXPOSURE TYPE: SHAFT | HOLE STARTED: 27.3.91

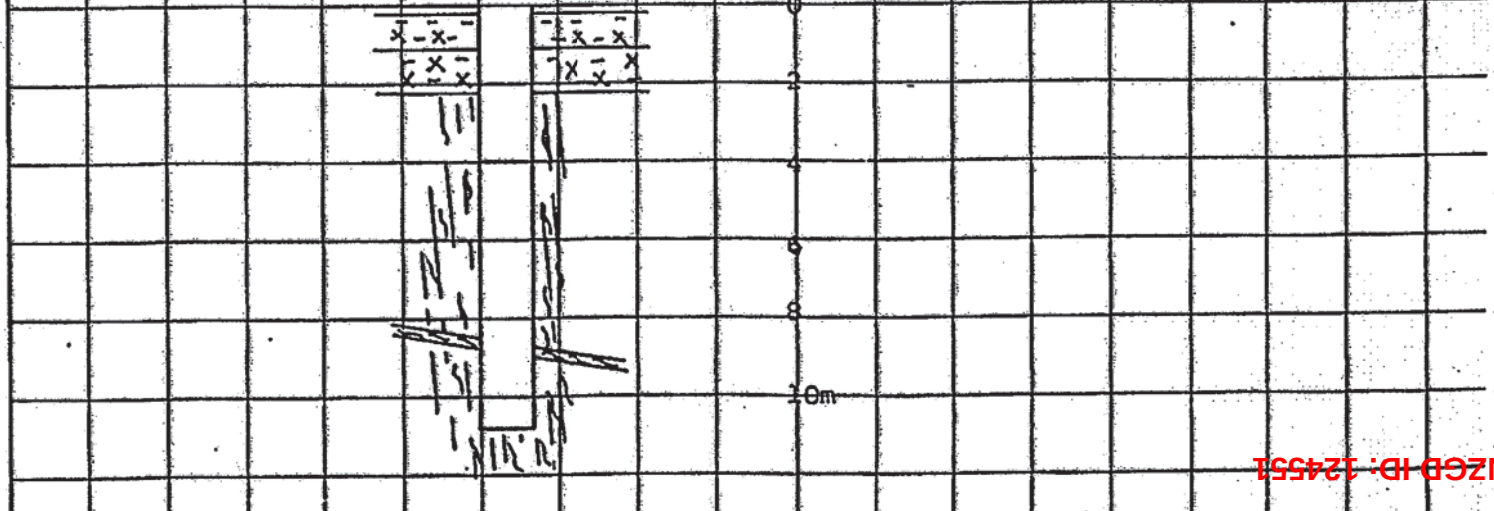
RL: 26.5 m | EQUIPMENT: SOILMEC R9E | HOLE FINISHED: 28.3.91

DATUM: A.M.S.L. | OPERATOR: PERRY | LOGGED BY: BDH

EXCAVATION DIMENSIONS: 1.45 m diameter | CHECKED BY: RS

EXCAVATION AND TESTS				ENGINEERING DESCRIPTION						GEOLOGICAL	
PENETRATION 1 2 3	SUPPORT	WATER	SAMPLES, TESTS	RL (m) / DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION	SHEAR STRENGTH OR RELATIVE DENSITY	ESTIMATED SHEAR STRENGTH, kPa	ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
	NONE	DRY		1			Yellow brown silty CLAY firm moist plastic				Residual Soil	
				2			Yellow brown SILT-CLAY firm to stiff, moist, plastic					
				3			Rockmass breakage surfaces polished, smooth slickensided. Rock mass pervasively sheared and bracciated				Completely sheared and brecciated MUDSTONE All breakage surfaces highly polished and slickensided	
				4								
				5			Sheared 70° - 040° moist to wet					
				6								

SKETCH



NZGD ID: 124551

TONKIN & TAYLOR LTD.

NZGD ID: 12455I

EXCAVATION LOG

EXCAVATION NO: SHAFT 2

SHEET 2 OF 2

PROJECT: REDVALE LANDFILL
LOCATION: WEST PROPERTY
JOB NO: 10944

CO-ORDINATES: 724465 mN
287568 mE
RL: 76.5 m
DATUM: A.M.S.L.

EXPOSURE TYPE: SHAFT
EQUIPMENT: SOILMEC R9E
OPERATOR: PERRY
EXCAVATION DIMENSIONS: 1.45 m diameter

HOLE STARTED: 27.3.91
HOLE FINISHED: 27.3.91
LOGGED BY: BDH
CHECKED BY: RS

EXCAVATION AND TESTS					ENGINEERING DESCRIPTION						GEOLOGICAL	
PENETRATION 1 2 3	SUPPORT	WATER	SAMPLES, TESTS	RL (m) DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION	SHEAR STRENGTH OR RELATIVE DENSITY	ESTIMATED SHEAR STRENGTH, kPa	ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
	NONE	DRY	Bulk Sample	7 8 9 10			Sheared 70° - 220° Green-grey very stiff clayey SILT Shear zone 15° - 290°				Completely sheared and brecciated MUDSTONE All breakage surfaces highly polished and slickensided	
							E.O.S. 10.8 m					

SKETCH

NZGD ID: 12455I

NZGD ID: 124552

EXCAVATION LOG

EXCAVATION NO: TP 58
SHEET 1 OF 1

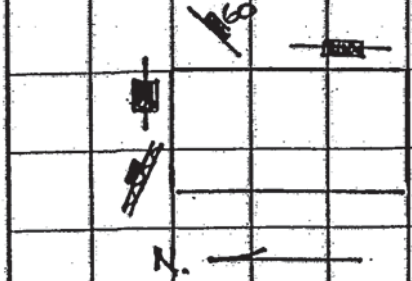
PROJECT: REDVALE LANDFILL
LOCATION: PHASE 10 BUND STAGE 2
JOB NO: 12290

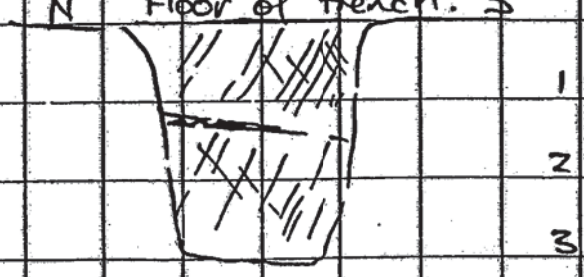
CO-ORDINATES: 287500mE; 7245 67mN.
RL:
DATUM:
EXPOSURE TYPE: PIT
EQUIPMENT: MITSUBISHI
OPERATOR:
EXCAVATION DIMENSIONS:
HOLE STARTED: 3-3-94
HOLE FINISHED: 3-3-94
LOGGED BY: BDH
CHECKED BY:

EXCAVATION AND TESTS					ENGINEERING DESCRIPTION						GEOLOGICAL	
PENETRATION 1 2 3	SUPPORT	WATER	SAMPLES, TESTS	RL (m) / DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION	SHEAR STRENGTH OR RELATIVE DENSITY	ESTIMATED SHEAR STRENGTH, kPa 50 100 200	ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
				1			SW Green soft weak MUDSTONE. Blocky all breakage surfaces highly polished. Rock mass crushed in areas. No continuous shear zones.				MUDSTONE	
				2								
				3			EOP 3.2m.					

SKETCH

PLAN.





NZGD ID: 124552

ATTACHMENT D

Site Walkover Photos (23-02-2026)


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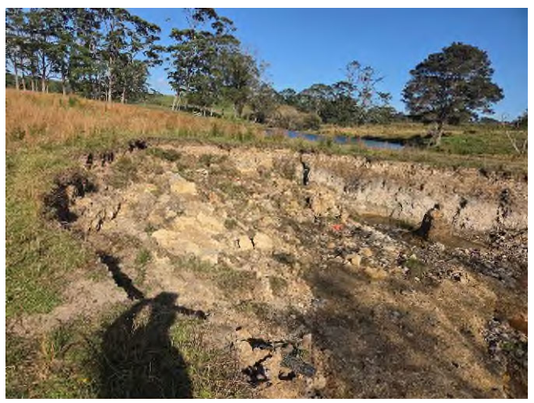
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ATTACHMENT F

PC120 Landslide Hazard Risk Assessment

31 May 2026

K260094-2b

Tuakiri Property Limited
PO Box 331000
Takapuna
Auckland

GEOTECHNICAL ASSESSMENT LETTER
LANDSLIDE HAZARD RISK ASSESSMENT - PLAN CHANGE PC120 - KAHIKATEA FLAT ROAD & HORSESHOE BUSH ROAD, PINE VALLEY

1. INTRODUCTION

At the request of Tuakiri Property Limited, KGA Geotechnical Group Limited (KGA) has undertaken a preliminary landslide hazard assessment for the proposed residential subdivision of the existing properties located along Kahikatea Flat Road and Horseshoe Bush Road, Pine Valley. This assessment has been carried out in accordance with Appendix 24 of Chapter E36 of the Auckland Unitary Plan – Plan Change 120 (PC120) and complies with the requirements of E36.6.A1 and E36.9 (i.e. be prepared by a suitably qualified geotechnical professional).

This assessment is preliminary and has been undertaken prior to detailed site-specific investigation and earthworks design. It relies primarily on desktop review of available information, including geological mapping, LiDAR-derived terrain models, historic aerial imagery, and reconnaissance site observations by a senior engineering geologist. The assessment considers the post-development condition of the site, assuming that appropriate earthworks, mitigation measures, and remediation works will be implemented during construction where required.

This assessment has been prepared solely for use in support of the Auckland Council “Fast-Track” consenting process. It should be noted that the risk levels identified within this report may be subject to change following detailed subsurface investigation, geotechnical analysis, and slope stability assessment. KGA should therefore be provided the opportunity to review and update this assessment once detailed development layouts, earthworks designs, and geotechnical investigation data become available.

2. BACKGROUND INFORMATION

This letter should be read in conjunction with our Geotechnical Appraisal Report (GAR), Reference No. K260094-1b, dated 29 May 2026. We recommend that the reader be familiar with the contents of this report, as the information contained therein is pertinent to the assumptions, presented in this letter.

3. SITE DESCRIPTION

The proposed subdivision development comprises the entirety of 10 existing properties located within the Pine Valley area, legally described as follows:

• 61 Kahikatea Flat Road	Lot 1 DP 354161	4.65Ha
• 77 Kahikatea Flat Road	Lot 7 DP 65688	4.24Ha
• 24 Horseshoe Bush Road	Lot 1 DP 62568	4.06Ha
• 42 Horseshoe Bush Road	Lot 3 DP 466485	1.00Ha
• 46 Horseshoe Bush Road	Lot 2 DP 466485	1.00Ha
• 48 Horseshoe Bush Road	Lot 2 DP 623127	16.48Ha
• 82 Horseshoe Bush Road	Lot 2 DP 130668	7.54Ha
• 100 Horseshoe Bush Road	Lot 2 DP 105762	16.25Ha
• (unnumbered) Horseshoe Bush Road	Lot 1 DP 130668	15.91Ha
• (Unnumbered) Horseshoe Bush Road	Lot 3 DP 130668	6.75Ha

Together, these parcels comprise a total plan area of approximately 77.88Ha and are collectively referred to herein as “the site.”

Overall, the site is irregular in plan shape and is bounded to the north, west, and east by existing rural properties, comprising a mixture of lifestyle blocks and farmland. The site is bounded by Kahikatea Flat Road to the northeast and Horseshoe Bush Road to the south. At present, each of the existing Lots that comprise the Site is accessed via its legally established road frontage. In addition, the property at 48 Horseshoe Bush Road also benefits from a panhandle accessway connecting to Kahikatea Flat Road at the northeast corner of the site.

The regional topography of the site is controlled by two prominent ridgeline features, one terminating in the northwest corner of the site and the other forming the southern boundary of the site, both trending generally west to east. Ground levels generally fall from these elevated features toward the central portion of the site, which comprises low lying, near-level to gently sloping terrain associated with ancient flood terrace deposits, gently falling toward the east to northeast. A series of incised gully features traverse the lowland areas, generally draining from the southwest and west toward the northeast and east.

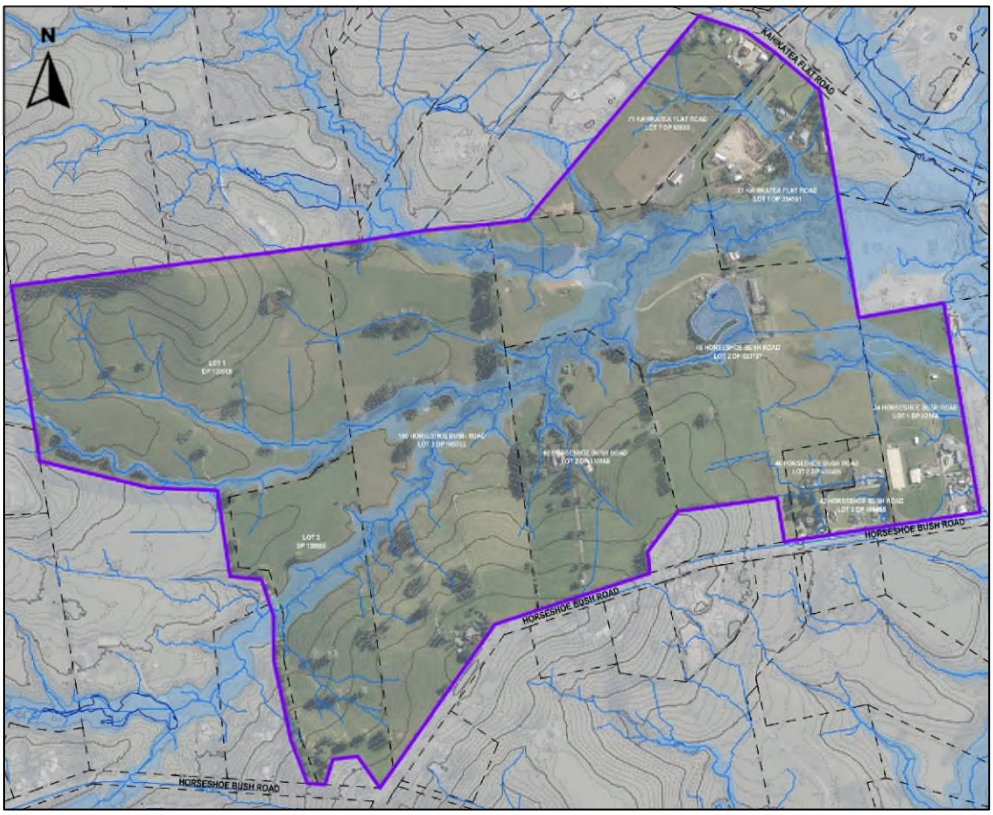


Figure 1: Snippet from KGA Site Plan showing proposed subdivision development extent, existing property boundaries and site cover (not to scale).

4. RISK ASSESSMENT

The risk assessment for this site has been carried out in general accordance with Appendix 24 of the PC120 documentation, “Landslide Hazard Risk Assessment Methodology”, dated 3 November 2025. This process includes a four-stage approach to quantify the risk and to determine Activity Status in accordance with Table E36.4.1B of the Auckland Unitary Plan (AUP); PC120 modifications. The four-stage approach includes the following:

- Stage 1: Desktop study including a review of landslide susceptibility maps and mapped landslides.
- Stage 2: Determination of risk assessment methodology and development of engineering geological models.
- Stage 3: Determination of risk class for selected landslides by semi quantitative and qualitative methods.
- Stage 4: Use of the risk assessment to determine activity status.

The quantitative assessment addresses the potential annual risk to loss of life. Its basis is to determine an annual risk of low of life.

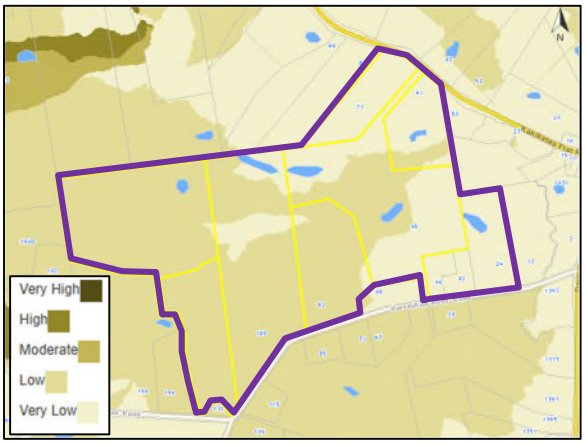
4.1 Stage 1 – Desktop Stuy - Landslide Susceptibility Maps

The Auckland Council GeoMaps (AC GeoMaps) database includes landslide susceptibility maps for both “small-scale shallow landslide” and “large scale landslides”. This mapping is based on Technical Report TR2025/7 entitled “Auckland Region Landslide Susceptibility Assessment”, dated May 2025. The basis of this document is a regional study carried out by WSP entitled “Auckland Landslide Susceptibility Study Technical Reprot 2025”, dated February 2025.

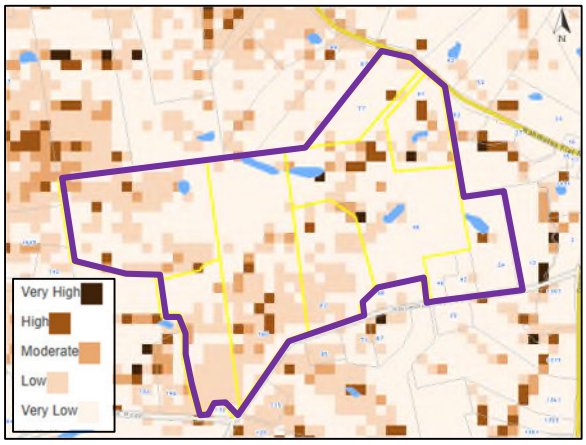
The technical document states the following regarding the susceptibility and the use for detailed analysis:

- *“This is a susceptibility dataset and does not describe hazard or risk”.*
- *“This is a regional-level assessment and is not intended to site-specific use without further, more detailed assessment”.*

We have assessed the AC GeoMaps portal to check for mapped susceptibility for both shallow and deep-seated landslides. The mapping indicates that land within the Site is classified as “Very Low” to “Low” susceptibility for large-scale landslides, and “Very Low” to “Very High” susceptibility for shallow landslides (refer to Figures 2 and 3). Cells classified as “High” to “Very High” susceptibility to shallow landslides are also mapped within approximately 150 m upslope of the Site to the west and north of portions of the Site.



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Figures 2 and 3: Large scale (Figure 2) and small-scale shallow (Figure 3) Landslide Susceptibility Maps, sourced from Auckland Council GeoMaps (Not to scale).

4.2 Stage 2 – Ground Model, Landslide Type and Landuse Activity

4.2.1. Ground Model

As discussed in Section 2, KGA has undertaken a preliminary geotechnical assessment comprising a detailed desktop review and reconnaissance site walkover. Based on interpretation of the observed site topography and geomorphology, together with available subsurface information from nearby sites, and drawing on our experience in the area, we consider that the regional geological mapping (Figure 4) provides a reasonable preliminary representation of the underlying ground conditions across the Site.

We have utilised this information as part of our landslide risk assessment. However, it is noted that this preliminary ground model will be refined following site-specific subsurface investigations and detailed geotechnical assessment.

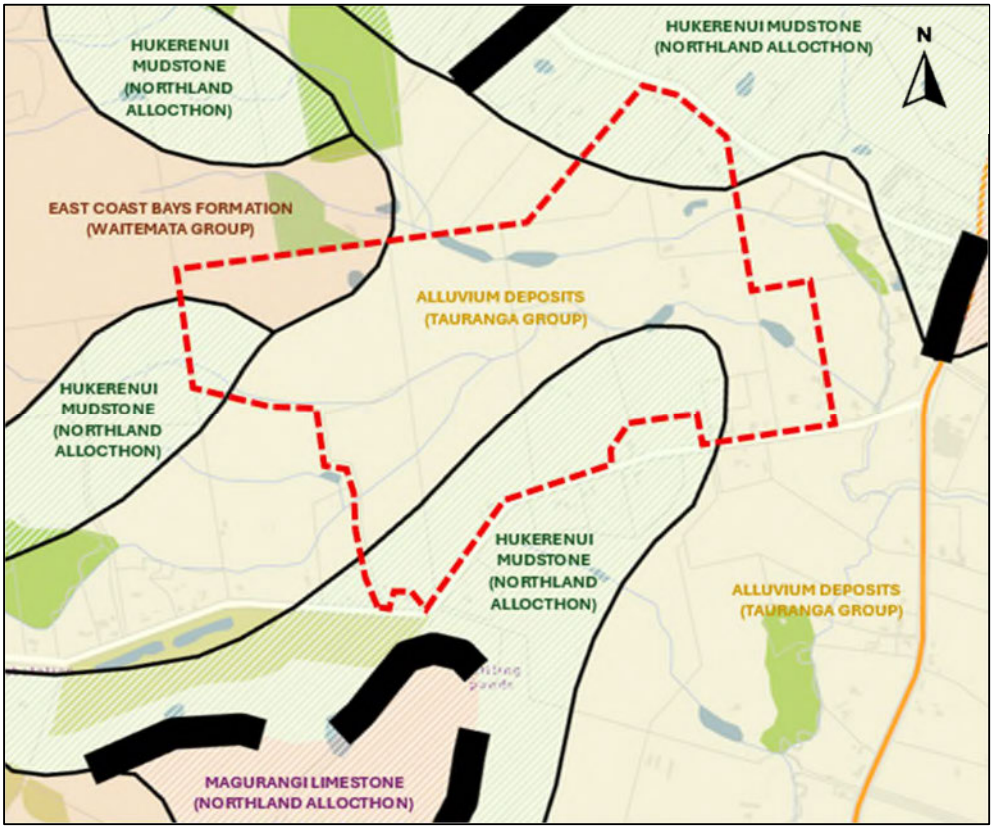


Figure 4: Excerpt from the GNS New Zealand Geology Web Map (not to scale).

4.2.2. Landslide Types

Appendix 24 requires consideration of three landslide event types, representing ‘High Likelihood’, ‘Medium Likelihood’, and ‘Maximum Credible’ scenarios. Our assessment of landslide mechanisms generally follows the guidance presented in Cruden & Varnes (1996). Based on the site observations and available background information, the following landslide mechanisms have been considered as part of this risk-based assessment.

- **Medium Likelihood – Shallow Translational Land Movement** *(rapid, wet earth slide):*
  Shallow translational failures were observed on-site, particularly within gentle to moderately sloping areas underlain by Northland Allochthon materials and along the incised gully slopes within the lowland alluvial deposits. These failures are typically shallow and associated with saturated near-surface soils and erosion of gully banks. Following development, shallow failures may still occur locally along the remaining gully features that are intended to remain within permanent riparian corridors.
- **High Likelihood – Shallow Creep** *(very slow, moist soil slide):*
  Evidence of soil creep was observed across parts of the Site, particularly downslope of larger relic landslip scarps and on moderately sloping terrain. Indicators included hummocky ground surfaces, leaning vegetation, and displaced infrastructure. Following development, slow creep movement may still occur due to the inherent slope geometry of the Site and the presence of subsoil materials susceptible to shrink–swell behaviour.
- **Maximum Credible – Deep-Seated Movement** *(slow, moist earth slide):*
  Two areas of larger scarp features were observed within the northwest (Waitemata Group) and southwest (Northland Allochthon) portions of the Site. These features indicate that larger-scale historical slope failures have occurred within these areas. As part of the proposed development, it is assumed that these areas will be subject to detailed geotechnical investigation and assessment, and that appropriate mitigation and stabilisation measures will be incorporated into the site formation and earthworks design where required.

4.2.3. Landuse Activity & Stage 3 Method Requirements

To determine the appropriate method for the quantitative landslide risk assessment, reference has been made to Table 1 of PC120 Appendix 24. This table specifies the required assessment methodology based on the land use activity and the applicable landslide susceptibility class. For the proposed land use activity of “Subdivision”, the required assessment methodology is Method 2, reflecting the presence of areas classified as Very High Susceptibility to shallow landslides.

In accordance with PC120 Appendix 24, a Method 2 assessment is required to include the following:

- *A semi-quantitative risk assessment covering a broad range of potential impacts. This approach is equivalent to Method 1. Where a Method 1 assessment has already been completed, the results of that assessment may be adopted without revision.*

- *A quantitative risk assessment addressing individual risk to life.*

Accordingly, this assessment includes both a semi-quantitative risk assessment (Method 1), addressing a range of potential impacts including human safety, societal consequences, and building damage, and a quantitative risk assessment (Method 2) to determine the Annual Individual Fatality Risk (AIFR).

It is noted that this assessment is preliminary only and remains subject to revision following site-specific subsurface investigation, geotechnical assessment, and slope stability analysis.

4.3 Semi-Quantitative Risk Assessment (Method 1)

The semi-quantitative risk assessment has been carried out in accordance with PC120 Appendix 24, Tables 3 to 6, to evaluate the likelihood and consequence of the three relevant landslide mechanisms identified for the site (refer to Section 4.2.1).

The Method 1 assessment is intended to provide an initial classification of risk before proceeding to the quantitative (Method 2) evaluation required under the PC120 framework.

4.3.1. Likelihood Assessment

The likelihood ratings have been inferred from our interpretation of desktop information, site walkover observations, and professional experience, consistent with the likelihood definitions provided in Table 3 of Appendix 24. Based on the site-specific evidence available, the following likelihood classifications have been adopted:

- **Shallow Translational Land Movement – Likely***:*
  Shallow translational movements are considered Likely (approximately 1 in 100 years). Shallow failures were observed during our site walkover, particularly along incised gully slopes. Following development, shallow failures may still occur within the riparian corridors associated with the retained drainage features. Provided appropriate slope stability and erosion control measures are implemented during site formation works, this type of failure is unlikely to occur within the developed areas of the site, including roads and finished residential lots.

- **Shallow Creep – Likely:**
  Shallow soil creep is assessed as Likely (approximately 1 in 100 years). Evidence of creep was observed across portions of the Site during the walkover, including hummocky ground and leaning vegetation. Creep is expected to continue at a slow rate due to the existing slope gradients and the presence of underlying materials that may be sensitive to seasonal shrink–swell behaviour.
- **Deep-Seated Movement – Unlikely:**
  Deep-seated movement is assessed as Unlikely (approximately 1 in 10,000 years). Although relict deep-seated landslide features were identified on the site, reactivation of these mapped features is not anticipated within the design life of the proposed development, assuming that appropriate stability measures are incorporated into the site formation and earthworks design.

4.3.2. Consequence Assessment

Consequences have been assessed in accordance with Table 4 of Appendix 24, considering both Human Safety and Buildings Accommodating Sensitive Activities. For conservatism, the higher of the two consequence categories has been adopted for each landslide mechanism.

- **Shallow Translational Land Movement – Minor:**
  Any potential movement is expected to be small-scale, affecting slope margins rather than Roadways and Lots, with limited damage requiring reinstatement.
- **Shallow soil creep — Insignificant to Minor:**
  Post-earthworks, creep is not expected to impact structures. Any deformation, if it were to occur, would be minor and readily repairable.
- **Deep-seated instability — Major (structural), Minor to Medium (human safety):**
  Although deep-seated instability is assessed as “Unlikely,” the worst-case structural consequence is conservatively assigned as “Major” due to the hypothetical extent of deformation if such an event were to occur. Human safety consequences remain lower, reflecting the unlikely nature of rapid or catastrophic failure in this geological setting.

4.3.3. Risk Classification

Based on the above assessed likelihood and consequence, we have utilised Table 6 from PC120, to assess the risk. Translational movement is circled red, creep movement circled blue and deep-seated movement circled purple for visual purposes.

Risk classification table:

Likelihood category	Consequence category: Insignificant	Minor	Medium	Major	Catastrophic
Almost certain	Medium (tolerable)	High (significant)	High (significant)	High (significant)	High (significant)
Likely	Low (acceptable)	Medium (tolerable)	High (significant)	High (significant)	High (significant)
Possible	Low (acceptable)	Low (acceptable)	Medium (tolerable)	High (significant)	High (significant)
Unlikely	Low (acceptable)	Low (acceptable)	Low (acceptable)	Medium (tolerable)	High (significant)
Rare	Low (acceptable)	Low (acceptable)	Low (acceptable)	Low (acceptable)	Medium (tolerable)
Barely credible	Low (acceptable)	Low (acceptable)	Low (acceptable)	Low (acceptable)	Low (acceptable)

Figure 5: Annotated Risk Classification Table taken from PC120; Appendix 24

Based on Figure 5, the development site should be considered “tolerable”, with respect to building. We point out that if the consequence for the “deep-seated” landslide assumes “Human Safety” (Medium to Minor) instead of the required “Building” impact, the risk would be classified as acceptable.

4.4 Quantitative Risk Assessment (Method 2)

4.4.1. General

Method 2 requires calculation of the Annual Individual Fatality Risk (AIFR) for each relevant landslide mechanism. The assessment follows the PC120 Appendix 24 risk equation and uses probability components informed by site-specific modelling, investigation data, and representative values from AGS (2007c) for vulnerability and occupancy. The Method 2 analysis focuses on actual risk to future development.

Accordingly, the probabilities used in Method 2 reflect the likelihood of a landslide hazard resulting in death, not the natural slope below.

The AIFR is calculated using:

$$R_{LoL} = P(H) \times P(S:H) \times P(T:S) \times V(D:T)$$

Where:

- P(H) = annual probability of the landslide occurring
- P(S:H) = conditional probability of the slide impacting the dwelling
- P(T:S) = probability of a person being present (Consistent with residential use), **0.7** has been adopted
- V(D:T) = vulnerability of an exposed person given the impact.

4.4.2. AIFR Calculations

Table 1: Shallow Translational Movement AIFR Calculations

Parameter	Value	Justification
P(H)	0.01	Shallow slips may occur on steep natural slopes during adverse conditions (consistent with "Likely").
P(S:H)	0.02	Geometry and setbacks mean only ~2% chance of affecting a building platform. Although "Likely" in natural unmitigated slopes, such failures are not expected to reach building platforms, which are positioned upslope on stable ground or behind retaining structures.
P(T:S)	0.7	Residential occupancy.
V(D:T)	0.01	Slip expected to cause local ground deformation, not structural collapse.
Total		$\boldsymbol{R_{LoL} = 0.01 \times 0.02 \times 0.7 \times 0.01 = 1.4 \times 10^{-6}}$

Table 2: Shallow Soil Creep AIFR Calculations

Parameter	Value	Justification
P(H)	0.01	Low annual probability consistent with "Likely", based on the fact that earthworks and retaining will address creep.
P(S:H)	0.02	Creep is "Possible" in natural slopes but unlikely to affect future dwellings, especially where platforms are level or designed to account for shallow surface movement (lateral creep)
P(T:S)	0.7	Residential occupancy.
V(D:T)	0.001	Creep causes distortion, not collapse; occupants can exit safely.
Total		$\boldsymbol{R_{LoL} = 0.01 \times 0.02 \times 0.7 \times 0.01 = 1.4 \times 10^{-7}}$

Table 3: Deep-Seated Instability AIFR Calculations

Parameter	Value	Justification
P(H)	0.0001	"Deep-seated failure is assessed as Unlikely.
P(S:H)	0.25	Deep movement, if it occurred, would be broad and slow, with very low likelihood of impacting ridge-crest lots, given proposed setbacks.
P(T:S)	0.7	Residential occupancy.
V(D:T)	0.2	If a deep failure occurred, structural damage possible, but rapid catastrophic collapse unlikely in this geology.
Total		$\boldsymbol{R_{LoL} = 0.0001 \times 0.25 \times 0.7 \times 0.2 = 3.5 \times 10^{-6}}$

4.4.3. Total Annual Individual Fatality Risk (AIFR)

$$R_{Total} = 1.4 \times 10^{-6} + 1.4 \times 10^{-7} + 3.5 \times 10^{-6}$$
$$\boldsymbol{R_{Total} \approx 5.04 \times 10^{-6}}$$

Using Figure 5, contained in PC120; Appendix 24, this results in an overall "Medium" risk and a resultant "Tolerable" classification (development land yet to be urbanised).

5. ACTIVITY STATUS

We consider that the quantitative (Method 2) analysis is the most appropriate for use in determining the activity status for the development. This is compliant with PC120; Appendix 24 “Stage 4”, which states, *“Where multiple risk assessment methods are applied, results from Method 2 shall take precedence over those from Method 1”.*

We have made reference to relevant activity type in Tables E36.4.1B and E36.4.1C of Unitary Plan E36 as detailed below. The assessment carried out within this letter complies with E36.6.A1 Standard (risk assessment carried out by a geotechnical professional).

It is also important to note that the following Activity Status is for the assumed ‘post-development’ of the site.

Table 4: Relevant Activities from Tables E36.4.1B and E36.4.1C of Unitary Plan E36

E36.4.1B Activity Table		Activity Status*
A122	New structures and buildings and external additions and alterations to existing structures and buildings (as existing at 03/11/25) with a gross floor area more than 20m^2 associated with activities potential sensitive to natural hazards in medium (tolerable) and high (significant) landslide hazard risk areas that comply with Standard E36.6.A1.	Controlled
A124	New structures and buildings and external additions and alterations to existing structures and buildings (as existing at 03/11/25) with a gross floor area more than 20m2 associated with activities sensitive to natural hazards in landslide hazard risk areas that comply with Standard E36.6.A1.	Restricted Discretionary
A133	All other infrastructure in landslide susceptibility assessment areas not otherwise provided for.	Restricted Discretionary

* = The landslide risk assessment in respect to AFIR is considered to be ‘Tolerable’

6. LIMITATIONS

This letter was prepared in the context defined in Section 1 must not be relied upon by any other party other than that for whom it was prepared and the relevant Territorial Authority. It has been compiled with respect to the brief given to us and must not be relied upon in any other context or recreated for any other purpose. Conclusions and risk assessments contained in this letter report are based on our knowledge of the local geology and our experience in landslide failure types and should not be construed as a guarantee. The result of this assessment is for use in planning only.

Yours faithfully,

p.p. KGA Geotechnical Group Limited

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