

17 December 2021

SILVERDALE SOUTH

STAGE 3 & 4

GEOTECHNICAL INVESTIGATION REPORT

Build Rich

AKL2020-0125AI Rev.0

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EXECUTIVE SUMMARY

This report presents the results of a geotechnical investigation, geohazards assessment and specific geotechnical recommendations to supplement the resource consent application for the proposed subdivision to be undertaken at the Silverdale South, Stage 3 & 4 development.

The site is to be an extension of the previously constructed Silverdale South, Stage 1 & 2 subdivision located directly to the north. It is roughly rectangular in shape with the majority of the land in open pasture or covered in gorse bushes. The landform is characterised by a series of tributary ridges and gullies which traverse the site from the main East Coast Road ridgeline located along the eastern boundary. The site generally slopes to the west and north-west from this ridgeline with the highest elevation at approximately RL 84.0m grading down to RL 31.0m along the western boundary. The site also includes the residential property at 2150 East Coast Road.

Design details for geotechnical aspects of the development are summarised as follows:

- The subsoils encountered as part of this investigation are generally consistent with the published geological records;
- Mapped geomorphological features such as head scarps, gullies, hummocky ground, soil creep and tomos are all present on site and will all be remediated during the earthwork's development by subsoil drainage, site stripping and cut to fill operations;
- Given the geological age of the subsoils and soil fabric/consistency, there is considered to be a low risk of liquefaction at this site;
- Key remediation elements to support the earthworks scheme plan are underfill drains, shear keys or undercutting at the toe of fill along the southern and western boundaries, shear key in cut areas below the MSE wall. The base width of these keys is 5 metres with embedment of the base into rock. Counterfort drainage on sloping lots below the property at 2118 East Coast Road with future palisade wall and shear pile remediation required.
- Bedrock within the locations identified on the Remediation Plan (Drawing 7) is likely to be exposed at finished levels and will require undercutting and capping with engineered clay fill to a minimum depth of 1m. This will require careful planning by the earthworks contractor to set aside sufficient clay fill from the surface of the topography at the commencement of the works programme to ensure appropriate sequencing of the works;
- Based on the findings of our investigation, including the presence of hard deposits at relatively shallow depths, the seismic site subsoil category defined in Section 3.1.3 of NZS 1170.5 is assessed to be C (shallow soil site);
- Specific engineering design of specific remediation elements such as MSE Slopes, retaining walls and palisade walls will be required at detailed design stage;
- The scheme plans illustrate near level lot platforms which will require subdivisional retaining walls to be designed and constructed for each of these terraced sections. The terraced layout of the proposed development is not considered to detrimentally effect the global stability of the site.

Table of Contents

EXECUTIVE SUMMARY.....	ii
1 INTRODUCTION.....	1
1.1 Project Brief.....	1
1.2 Scope of Work.....	1
2 SITE DESCRIPTION.....	2
2.1 Site Location	2
2.2 Landform	2
3 PROPOSED DEVELOPMENT	3
4 INVESTIGATION SCOPE.....	3
4.1 Desktop Study	3
4.2 Previous Investigation	3
4.3 Field Investigation	4
5 GROUND MODEL	5
5.1 Published Geology	5
5.2 Geomorphology.....	6
5.3 Stratigraphic Units.....	6
5.3.1 Topsoil	7
5.3.2 Fill (Engineered and Uncontrolled)	7
5.3.3 Alluvium	7
5.3.4 Colluvium	7
5.3.5 Residual Northland Allochthon	7
5.3.6 Transitional Northland Allochthon	7
5.3.7 Northland Allochthon Rock	7
5.3.8 Summary.....	8
5.4 Groundwater	8
6 GEOHAZARDS ASSESSMENT	9
6.1 Context.....	9
6.2 Seismicity	9
6.3 Liquefaction	9
6.3.1 General	9
6.3.2 Geological Age.....	10
6.3.3 Soil Fabric	10
6.4 Slope Stability	10
6.4.1 Design Criteria	10
6.4.2 Shear Strength Parameters	11
6.4.2.1 Effective Stress Parameters	11
6.4.2.2 Total Stress Parameters	11
6.4.3 Slope Stability Analyses	12
6.4.4 Future Stability Analysis	13
6.5 Erosion	13
6.6 Fill Induced Settlement.....	13
6.7 Expansive Soils.....	13
6.8 Groundwater Impact Assessment.....	14
7 GEOTECHNICAL RECOMMENDATIONS.....	15

7.1	General.....	15
7.2	Seismic Site Subsoil Category.....	15
7.3	Slope Stability Management.....	15
7.3.1	<i>Mechanically Stabilised Earth (MSE) Wall</i>	15
7.3.2	<i>Counterfort Drainage</i>	16
7.3.3	<i>Palisade Wall and Shear Piles</i>	16
7.4	Wetland.....	16
7.5	Earthworks.....	17
7.5.1	<i>General</i>	17
7.5.2	<i>Shear Key</i>	17
7.5.3	<i>Excavatability</i>	18
7.5.4	<i>Stockpiles</i>	18
7.5.5	<i>Underfill Drainage</i>	18
7.5.6	<i>Compaction</i>	18
7.5.7	<i>Capping Layer</i>	18
7.5.8	<i>Temporary Sediment Retention Ponds</i>	19
7.5.9	<i>Temporary Cuts</i>	19
7.5.10	<i>Quality Control</i>	19
7.6	Civil Works	20
7.6.1	<i>Subgrade CBR</i>	20
7.6.2	<i>Service Trenches</i>	20
7.6.3	<i>Retaining Walls</i>	20
7.6.4	<i>Stormwater Soakage</i>	21
8	FOUNDATIONS	21
9	SAFETY IN DESIGN	22
10	FURTHER WORK	22
	USE OF THIS REPORT	23

Drawings

Drawing 01:	Site Investigation Plan
Drawing 02:	Geomorphology Plan
Drawing 03 to 06:	Geological Section A-A to H-H
Drawing 07:	Remediation Plan
Drawing 08:	Shear Key and Drainage Detail
Drawing 09:	Counterfort Drain Detail

Appendices

Appendix A: Aspire Consulting Engineers Development Plans

Appendix B: Hand Auger Borehole, Test Pit and Machine Borehole Logs 2020

Appendix C: Hand Auger Borehole, Test Pit and Machine Borehole Logs 2016

Appendix D: Stability Analysis

Appendix E: Groundwater Assessment

Appendix F: Geotechnical Work Specifications

Appendix G: SiD Risk Assessment

Appendix H: Natural Hazards Risk Assessment

1 INTRODUCTION

1.1 Project Brief

CMW Geosciences (CMW) was engaged by Build Rich Limited to carry out a geotechnical investigation of a site located at 2182 East Coast Road, Silverdale which is being considered for proposed construction of a 318 Lot residential subdivision.

The scope of work and associated terms and conditions of our engagement were detailed in our services proposal letter referenced AKL2020-0125AF Rev.1 dated 22 July 2021.

This report is to support a Resource Consent application to Auckland Council.

1.2 Scope of Work

As detailed in our proposal letter the instructed scope of work to be conducted by CMW was defined as follows:

- A desktop study, including review of related reports, aerial photographs and published geology.
- Site walkover and geomorphology mapping.
- Geotechnical site investigation, comprising the drilling of machine boreholes, hand auger boreholes and excavation test pits.
- Update the existing geological and geotechnical model,
- Identify any geohazards to the proposed development, including instability, groundwater issues, and provide strategies to mitigate;
- Compile all of the above detail into a concise geotechnical investigation report, incorporating relevant plans, field investigation data and recommendations.

2 SITE DESCRIPTION

2.1 Site Location

The site comprises an area of approximately 10.3 hectares and is located at 2182 East Coast Road, legally described as Lot 7 DP 545151 as shown in **Figure 1** below. The site also includes 2150 East Coast Road, legally described as Pt Lot 1 DP 44249 with an approximate area of 3100m².

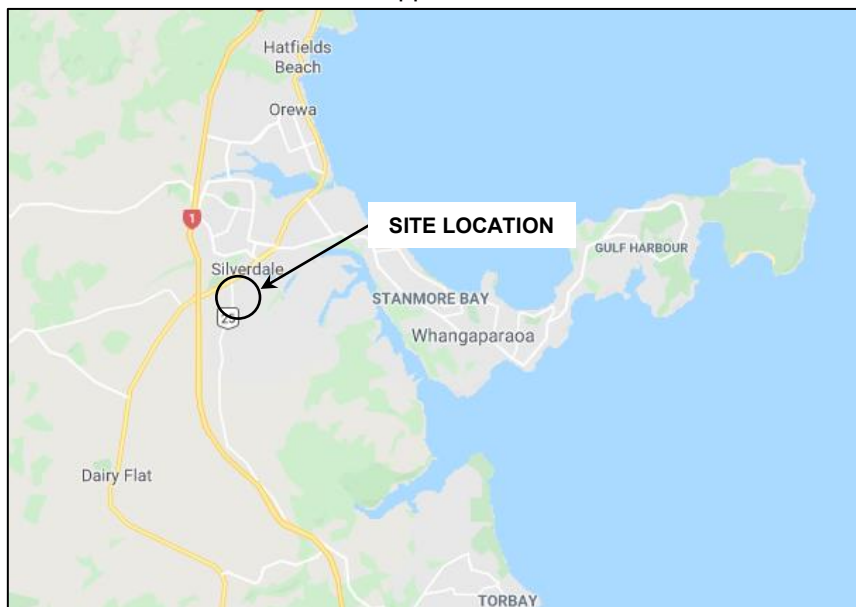


Figure 1: Site Location Plan (Google Maps)

2.2 Landform

The current general landform, together with associated features located within and adjacent to the site is presented on the attached Site Investigation Plan as **Drawing 01**.

The site is roughly rectangular in shape with the majority of the land in open pasture or covered in gorse bushes. The landform is characterised by a series of tributary ridges and gullies which traverse the site from the main East Coast Road ridgeline located along the eastern boundary. The site generally slopes to the west and north-west from this ridgeline with the highest elevation at approximately RL 84.0m grading down to RL 31.0m along the western boundary. The gradients are initially steep off the ridgeline at around 1(V):3(H) from approximately RL 80.0m to RL 65.0m with lessening grade towards the western boundary from approximately RL 65.0m to RL 31.0m and gradients of roughly 1(V):6(H) to 1(V):9(H).

Two of the northern most incised gullies extend down into a wetland and intermittent stream in the north western corner of the site. A number of farm ponds have formed in the gullies and near some of the ridgelines, with several of the ponds now offline since the more recent aerial photos. Several of the gullies have tunnel erosional features such as piping especially below the farm ponds. A number of small stockpiles from felled trees and vegetation are located in the top north-eastern corner of the site, assumed to originate from trees that were located in this area as seen in 2010 to 2011 aerial photographs.

The site is bound to the South by Silverdale Adventure Park, to the west by farmland and an existing dwelling and to the north by the newly formed Stage 1 & 2 East Cost Heights subdivision. Two existing residential properties dominate the majority of the eastern boundary which is situated along the East Coast Road ridgeline. The northern most residential dwelling is included in the proposed wider works as detailed in Section 2.1. It sits at the end of the ridgeline and has East Coast Road running directly along its eastern boundary. The ridgeline controls the slope gradients of the site and it slopes moderately to the west and east at 1(V):3.5(H) and to the north at 1(V):8(H).

Historical aerial photographs¹ show no evidence of significant change in landform across the site and suggest that the property has previously been and is currently open pasture, presumed to be used for agricultural purposes. Minor earthworks have taken place near the northern and southern boundaries due to developments on the neighbouring properties and minor works such as formation of ponds and access tracks.

3 PROPOSED DEVELOPMENT

The current development proposal, as shown on the proposed scheme plans provided by Aspire Consulting Engineers titled 2182 East Coast Road, Silverdale (Stage 3 & 4), 1628 - RC – EW201, EW202 and EW211 to EW219, dated December 2021, is to create approximately 322 residential lots of varying sizes with associated access roads extending from Stages 1 and 2 of the development. Plans illustrate proposed cuts of up to 149,881m³ with the maximum cut depth of 9.0m occurring in the north-eastern corner of the site. Fills of up to 219,703m³ with the maximum fill depths of 11.0m occurring through the centre of the site from east to west in the main gully. Generally the lower lying gully areas are proposed to be filled with the upper ridgelines cut down to ease overall gradients.

The proposed contour plan depicts gentler grades across the site post earthworks. Batter slopes with gradients of approximately 1(V):3(H) are proposed along the eastern and western boundaries, off East Coast Road and the 2118 residential property. A 1(V):0.4(H) MSE wall up to 9.5m high, running north to south divides through the centre of the subdivision. The bulk remainder of the site is proposed to have near level lots due to a terraced layout which will be constructed with numerous subdivisional retaining walls.

4 INVESTIGATION SCOPE

4.1 Desktop Study

A desktop study was carried out before commencing fieldwork. This included online research through Auckland Council Geo Maps, Dial Before You Dig, aerial photographs and review of previous investigation and reporting.

A review of historic and recent aerial photographs between 1973 and 2020 indicated the following activity:

- Existence of only the northern most residential dwelling along the eastern boundary in 1973;
- Formation of the southern residential property along the eastern boundary between 1973 and 1996 which also included some earthworks operations and the pushing out of fill in the west to form the lawn;
- Formation and abandonment of a dirt bike track in the northern portion of the site between 2010 and 2019;
- Filling of the two northern ridgeline ponds between 2017 and 2020;
- Formation of a fill batter along the northern boundary as part of the neighbouring earthworks between 2018 and 2020.

4.2 Previous Investigation

CMW has previously completed preliminary investigation and reporting for the subject site and the wider Silverdale South development as part of a Development Concept Plan (DCP) in 2016. The findings for this are outlined in the report titled Preliminary Geotechnical Investigation Report for Proposed Mixed Use Residential and Commercial Development at Silverdale South referenced AKL2016_0206AA Rev.0 dated 4 August 2016.

The fieldwork was conducted in May 2016 and consisted of 6 machine boreholes, 15 test pits and 11 hand auger boreholes. Of these investigations HA06-16, HA07-16, HA09-16, HA10-16, TP11-16 to TP15-16 and MH01-16 to MH03-16 are relevant to the subject site and have been included in the attached site investigation plan and associated cross sections (investigation logs can be found in **Appendix C**).

¹ Retrolens website, Sourced from <http://retrolens.nz> and licensed by LINZ CC-BY 3.0

The findings of these investigations created a ground profile generally consistent with that of this report. Natural soils consisting of stiff to very stiff residual and colluvial/alluvial materials ranging from 1.4m to 4.0m across the site becoming shallower towards the eastern ridgeline. The majority of the alluvial material was mapped and logged along the western boundary, wetlands and within the gullies.

A highly fractured and permeable transition zone between the natural soils and the bedrock generally ranged from 0.5m to 1.0m thick at depths from 1.4m to 4.0m. The Northland Allochthon rock encountered has been logged as siliceous siltstones and slightly sandy siltstones of the Whangai Formation with strengths ranging from extremely weak to weak. The rock mass was highly fractured and jointed.

CMW have also previously completed the site investigation and reporting for the newly formed Silverdale South, Stage 1 & 2 subdivision located directly to the north of the subject site. Along with the preliminary site investigation completed which details ground conditions similar to those observed within this report, CMW also undertook specific design analyses including slope stability analysis and the design of shear keys. Silverdale South, Stage 1 & 2 has since undergone earthworks which CMW have monitored and subsequently signed off under a Geotechnical Completion Report.

4.3 Field Investigation

The field investigation was carried out between 29 June 2020 and 3 July 2020, and again in August 2021. All fieldwork was carried out under the direction of CMW Geosciences in general accordance with the NZGS specifications² and logged in accordance with NZGS guidance³. The scope of fieldwork completed was as follows:

- Undertook a walkover survey of the site to assess the general landform, site conditions and adjacent structures / infrastructure and observations are detailed in Section 2.2 and Section 5.2;
- Three machine boreholes, MH07-20, MH01-21 and MH02-21 were drilled using rotary techniques to a maximum depth of 15.0m to determine the ground model through and below the proposed earthworks profile. A single standpipe piezometer was installed in MH07-20 from 0.0 to 12.5m to monitor groundwater levels. Engineering logs of the boreholes are provided in **Appendix B**;
- Ten test pits, denoted TP16-20 to TP25-20, were excavated using a 12.5-tonne hydraulic excavator fitted with a 0.6m wide toothed rock bucket to depths of between 3.5m and 5.0m below existing ground levels. All test pits were terminated at target depths which were within Northland Allochthon rock. Engineering logs and photographs of the test pits are presented in **Appendix B**;
- Twelve hand auger boreholes, denoted HA12-20 to HA21-20, HA01-21 and HA02-21, were drilled using a 50mm diameter auger to target depths of up to 5.0m below existing ground levels to visually observe the near surface soil profile and to facilitate in-situ vane shear strength testing. Refusal on hard ground, inferred to be Northland Allochthon rock occurred in hand auger boreholes HA12-20 to HA16-20 and HA18-20 to HA20-20, HA01-21 and HA02-21. HA17-20 and HA21-20 reached the target depth of 5.0m. Engineering logs of the hand auger boreholes, together with peak and remoulded vane shear strengths are presented in **Appendix B**;
- Dynamic cone (Scala) penetrometer (DCP) tests were carried out in the base of hand auger boreholes HA12-20 to HA16-20 and HA18-20 to HA20-20, HA01-21 and HA02-21 to depths ranging from 2.1m to 4.2m to provide soil density profiles and confirm ground conditions. Graphical results of the DCP testing are presented on the borehole logs in **Appendix B**;
- Groundwater monitoring was undertaken on three different occasions during further visits following the initial fieldwork, to monitor the groundwater level in MH07-20. The results of this monitoring is presented in Section 5.4 below.

The approximate locations of the respective investigation sites referred to above are shown on the Site Investigation Plan as **Drawing 01**. Test locations were specifically picked up by survey, with coordinates in

² NZ Geotechnical Society (2017) NZ Ground Investigation Specification, Volume 1 – Master Specification

³ NZ Geotechnical Society (2005), Field Description of Soil and Rock, Guideline for the field classification and description of soil and rock for engineering purposes.

Mount Eden Circuit 2020 and elevations from LINZ, Auckland Vertical Datum 1946 and provided to us by C&R surveyors limited.

5 GROUND MODEL

5.1 Published Geology

Published geological maps⁴⁵ for the area depict the regional geology for the area as comprising Hukerenui Mudstone (Mangakahia Complex) of the Northland Allochthon, previously known as Onerahi Chaos as illustrated in **Figure 2** below.

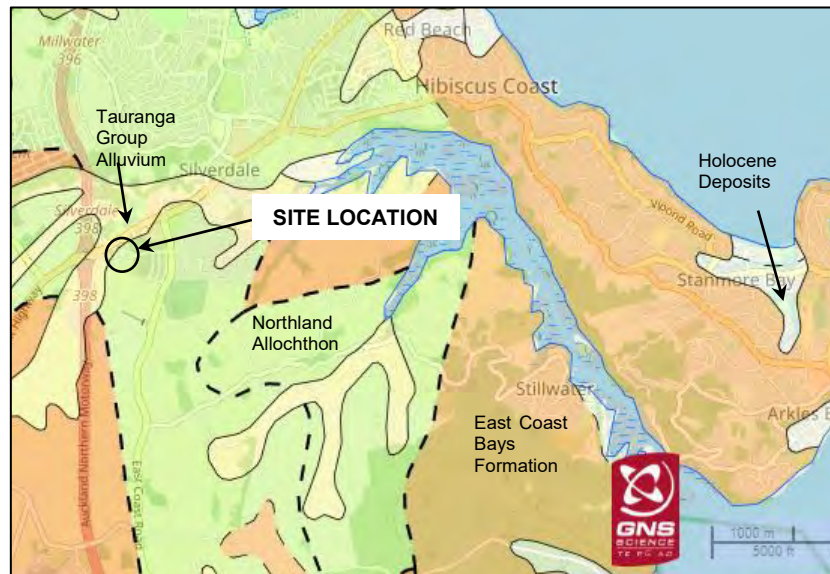


Figure 2: Regional Geology (GNS Science – Geology Web Map 1:250 000)

This strata is part of an allochthonous (meaning removed from its formation location) mass of continental crust that had been peeled from the subduction zone north of New Zealand and emplaced through low angle thrust faulting onto areas of Northland and the Silverdale area.

Due to the nature of the faulting and emplacement, the materials which form the Northland Allochthon are highly fractured, variably weathered and often form a melange of strata including mudstones, siltstones, limestones, ultra-mafic rocks and shales. This geological formation is often unstable even on gentle slopes.

Two lithologies are present within the Northland Allochthon. Whangai Formation is described as cream to grey siliceous and locally calcareous mudstone while Hukerenui Mudstone is described as commonly sheared and deformed mudstone with small serpentine bodies.

Tauranga Group alluvial and colluvial materials generally fill the low-lying areas and gullies. These materials are described as clays and silts.

Groundwater levels are expected to be high during the winter months. The location of historic farm ponds near the head of gullies or on ridgelines with little or no catchment suggests the presence of springs.

Based on the known history of the site and surrounding land levels, some superficial depths of fill could be anticipated as a result of earthwork work operations in neighbouring sites and the filling of historic ponds.

⁴ Edbrooke, S. W. (compiler) 2001: Geology of the Auckland area. Institute of Geological & Nuclear Sciences 1:250 000 geological map 3.1 sheet +74p. Lower Hutt, New Zealand. Institute of Geological & Nuclear Sciences.

⁵ Schofield, J. C. 1989: Sheets Q10 & R10 – Helensville and Whangaparaoa. Geological map of New Zealand 1:50 000. Map (2 sheets) and notes. Wellington, New Zealand. Department of Scientific and Industrial Research.

5.2 Geomorphology

The geomorphology of the site was mapped by examination of aerial photograph stereo pairs^[2] and during a site walkover and is shown in the appended Geomorphology Plan (**Figure 02**).

The geomorphology reflects the underlying geology and associated slope processes. The dominant regional structure is evident in the subject and neighbouring sites in the form of features such as gullies and ridgelines.

This geology is typically known for its deformed, crushed and sheared nature and is notorious for instability even at gentle slopes. The combination of the existing elevation of the East Coast Road ridgeline and the shallow Northland Allochthon rock controls the geomorphology of the site.

Roughly three main gullies trending west to north-west dominate the subject site, the orientation of these is likely to be controlled by groundwater flows creating natural drainage systems for the main ridgeline. The prominent headscarps and significantly steeper slope gradients directly off the ridgeline, both within the subject site and the neighbouring properties suggest historic movement, predominantly within the shallow transition zone which would allow the underlying rock to retain its gradient.

The heads of the gully systems form directly within this steeper slope immediately below the existing residential properties along the eastern boundary. Debris lobes, soil creep and mid slope benches are all present at the head of these gullies with subsequently more shallow slope movement observed in the two northern-most gullies where historic ponds had been formed in mid-slope depressions suggesting the groundwater flow rate is greater here.

The remainder of the site progressing down from the ridgelines and gully heads displays geomorphology characteristic of Northland Allochthon geology. Numerous, presumably shallow (given the shallow residual soil profile and onsite observations), isolated debris lobes are displaced within the gully slopes, most likely occurring along low-angle pre-existing failure planes and shear surfaces in the transition zone, between the residual soils and underlying rock masses. Fissures observed in the test pit investigations throughout the site are interpreted to be the result of swelling and shrinkage creating soil creep movement on the slopes. Of particular note is an area of hummocky, inferred colluvial ground (currently covered in thick gorse) in the southern portion of the site, directly below the last ridgeline. This area of material appears to have been gradually displaced downslope but has been locked in place by the intersecting small gullies that outlet in the south western corner.

Five main ridgelines trending west to north-west begin at a steep gradient directly off the East Coast Road ridgeline and then gradually change to moderately graded, broad, hummocky slopes with terracettes on most slope angles. Localized, shallow debris lobes, mid slope benches and hummocky ground is observed within the slopes of these ridgelines and along the banks of the gullies. All but one of the ridgelines taper off into the gentler slopes of the mapped alluvial plain along the western boundary. The one remaining ridgeline begins in the south eastern corner of the site and grades moderately down to the centre of the western boundary and extends into the neighbouring property. Isolated, shallow, hummocky ground and minor headscarps exist along the slopes of this ridgeline, particularly along the western boundary when the grade increases up to the fence line.

Wet and swampy ground is present within the south and north western corners of the site which is common in this geology where the ground shallows out at the toe of slopes and draining groundwater accumulates. Tunnel-gully erosion can be seen within the two northern gully systems, reiterating the presence of colluvium.

5.3 Stratigraphic Units

The ground conditions encountered and inferred from the investigation were considered to be generally consistent with the published geology for the area and can be generalised according to the following subsurface sequences.

The distribution of the various units encountered is presented in the appended Geological Sections on **Drawing 03 to 06**.

^[2] Sourced from <http://retrolens.nz> and licensed by LINZ CC-BY 3.0

5.3.1 Topsoil

Topsoil was encountered in all the boreholes and test pits and ranged from 0.1m to 0.4m thick below current ground level. The average thickness is approximately 0.3m and material was typically dry to moist.

5.3.2 Fill (Engineered and Uncontrolled)

Uncontrolled fill was encountered in investigation boreholes HA01-21 and HA02-21 which was likely placed during the construction of the dwelling at 2150 East Coast Road. It's also likely given the earthworks batter that was formed during the development of the neighbouring subdivision and extends into the subject site along the northern boundary, the presence of both engineered fill and discarded uncontrolled fill is possible. It should also be noted that filling of two of the natural farm ponds has been undertaken and uncontrolled fill will be present in these areas. More recently, lower portions of the site have also undergone some filling.

A relict dirt bike track formed and then abandoned between 2010 and 2019 may also have included some fill, and the lower portion of the northern most gully was filled with uncontrolled fill in December 2020.

Further uncertified fill of up to 3.0m has been placed in the wetland area in the north-western corner of the site in late 2020.

5.3.3 Alluvium

Alluvial soils were encountered in HA17-20, HA18-20, TP17-20, TP20-20 and TP24-20 generally located at the toe of the gullies and low-lying wet land areas from depths of 0.1m to 0.4m. The alluvial material was generally firm to stiff, brownish grey mottled orange clays, silty clays and clayey silts with black organic staining and organic inclusions. Moisture condition was generally moist to wet. Vane shear strengths ranged from 45kPa to unable to penetrate (UTP) and averaged around 108kPa. 45kPa is observed to be an outlier due to the test pit location being undertaken within the toe of a gully where wet material due to groundwater was encountered.

5.3.4 Colluvium

Colluvial soils were encountered in HA13-20 to HA16-20, HA19-20, TP16-20 to TP19-20, TP21-20 and TP25-20 from depths of 0.4m to 0.8m. They generally consisted of stiff to very stiff, grey, orange, brown mottled orange clays and silty clays. Vane shear strengths ranged from 90kPa to unable to penetrate (UTP) and averaged 157kPa. Colluvial material was typically moist.

5.3.5 Residual Northland Allochthon

Residual soils of the Northland Allochthon Formation were encountered in HA12-20 to HA21-20, TP16-20 to TP23-20 and MH07-20 from depths of 0.15m to 4.3m. These soils generally consisted of stiff to hard, light grey mottled orange, bluish grey, light orange brown, clays silty clays and clayey silts with minor fine to medium sands. Vane shear strengths ranged from 84kPa to UTP and averaged over 160kPa. The residual soils were generally consistent across the site ranging from moist to wet with trace fissures typical of shrink-swell processes.

5.3.6 Transitional Northland Allochthon

A weathered transitional layer was encountered between the residual/colluvium and rock mass in HA15-20, HA20-20, TP16-20 to TP20-20 and TP22-20 to TP25-20 from depths of 1.5m to 4.2m. This layer generally consisted of hard, bluish grey mottled orange, purple red and grey clays, clayey silts with various amounts of gravel sized completely weathered siltstone/mudstone. This zone was observed to be highly fractured with moisture contents ranging from dry to wet.

5.3.7 Northland Allochthon Rock

Completely weathered to highly weathered Northland Allochthon Rock was encountered in all investigation boreholes and test pits from depth of 1.7m to 4.5m below existing ground level. Rock encountered consisted of extremely weak to weak siltstones and mudstones of both the Whangai Formation and Hukerenui Formation origins. Whangai was observed across the majority of the site while Hukerenui appeared to be more isolated to the north western corner of the site in the low-lying area. The rock mass was generally retrieved as completely weathered siltstone/mudstone or highly fractured gravels.

5.3.8 Summary

The distribution of these units is illustrated on the appended Geological Sections A-A to G-G (**Drawing 03 to 06**) and presented below in Table 1.

Table 1: Summary of Strata Encountered				
Unit	Depth to base (m)		Thickness (m)**	
	Min	Max	Min	Max
Topsoil	0.1	0.4	0.1	0.4
*Alluvium	0.6	3.0	0.4	2.8
*Colluvium	0.4	1.8	0.3	1.5
*Residual Northland Allochthon	1.5	4.5	0.2	4.3
*Transitional Northland Allochthon	1.7	4.2	0.2	1.2
Northland Allochthon Rock	-	-	-	-
Notes: *Thickness only recorded where base of strata has been confirmed.				

5.4 Groundwater

During the investigation, which was completed in mid-winter conditions (June/July 2020), groundwater was encountered within boreholes at the depths provided in Table 2, which also presents the results of groundwater monitoring undertaken following the investigation:

Table 2: Groundwater Monitoring Data			
Borehole	Screen Depth (mbgl)	30 June 2020	
		Depth (mbgl)	Elevation (m RL)
HA12-20	-	2.6	67.89
HA16-20	-	0.0	56.50
HA18-20	-	0.5	34.13
HA20-20	-	0.9	62.71

MH07-20			
Date	Screen Depth (mbgl)	Depth (mbgl)	Elevation (m RL)
21 July 2020	12.5	1.2	66.79
22 January 2021	12.5	1.14	66.85
1 April 2021	12.5	2.23	65.76
Note: mbgl = metres below ground level			

However, given the presence of a variable and clayey soil profile, it is possible that perched groundwater may occur during and following periods of rainfall. It should also be noted that while groundwater was not

encountered across all investigation boreholes or test pits, it is typical in this geology for the groundwater to flow through the more permeable transition zone, which in this site is relatively shallow in depth.

6 GEOHAZARDS ASSESSMENT

6.1 Context

Section 106 of the Resource Management Act⁶ (RMA) requires an assessment of the risk from natural hazards to be carried out when considering the granting of a subdivision consent. S106 RMA specifically states that the assessment must consider the combined effect of the natural hazard likelihood and material damage to land or structures (consequence).

The following sections of this report provide an assessment of the geohazards relevant to this site and provide the basis for the Natural Hazards Risk Assessment presented in **Appendix H**.

6.2 Seismicity

A seismic assessment has been carried out in general accordance with NZGS guidance⁷ to calculate the peak horizontal ground acceleration or PGA (a_{max}) as follows:

$$a_{max} = C_{0,1000} \frac{R}{1.3} \times f \times g$$

Where: $C_{0,1000}$ = unweighted PGA coefficient (refer Section 7.2 for subsoil class)

R = return period factor given in NZS1170.5, Table 3.5 (for importance level 2)

f = site response factor subject to subsoil class (refer Section 7.2 for subsoil class)

g = acceleration due to gravity

The ULS PGA was calculated based on a 50-year design life in accordance with the New Zealand Building Code⁸ and importance level (IL) 2 structures. The PGA for the serviceability limit state (SLS) and ultimate limit state (ULS) earthquake scenarios is as follows:

Table 3: Design Peak Ground Acceleration (PGA) for Various Limit States				
Limit State	AEP	R	PGA(g)	Magnitude _{eff}
ACCOP	1/150	0.6	0.09	5.75
ULS	1/500	1.0	0.15	5.75
Note: SLS = serviceability limit state; ULS = ultimate limit state; AEP = annual exceedance probability				

6.3 Liquefaction

6.3.1 General

Soil liquefaction is a process where typically saturated, granular soils develop excess pore water pressures during cyclic (earthquake) loading that exceed the effective stress of the soil. In loose soils, some dilation can occur during this process, which can lead to individual soil grains moving into suspension. Following the onset of liquefaction, the shear strength and stiffness of the liquefied soil is effectively lost causing excessive differential settlement of the ground surface, bearing capacity failure and collapse of structures and low-angle lateral spreading of slopes in liquefiable soils.

⁶ Resource Management Act (1991), as at 29 October 2019

⁷ NZ Geotechnical Society publication "Earthquake geotechnical engineering practice, Module 1: Overview of the standards", (March 2016)

⁸ Ministry of Business, Innovation and Employment (1992) NZ Building Code Handbook, Third Edition, Amendment 13 (effective from 14 February 2014)

In accordance with NZGS guidance⁹ the liquefaction susceptibility of the soils at this site has been considered with respect to geological age, soil fabric and soil consistency / density.

6.3.2 Geological Age

The vast majority, and nearly all, case history data compiled in empirical charts for liquefaction evaluation come from Holocene deposits or man-made fills^{10,11}. Pleistocene aged alluvium (>12,000 years) is also considered to have a very low to low risk of liquefaction¹¹.

The recent alluvium (river and hill slope), units QIS5 + QIS2, found within the low-lying area of the site are of middle to late Pleistocene geological age and therefore, in terms of geological age, are considered to be low risk of liquefaction.

Across the elevated terraces, soils below the water table comprise Northland Allochthon deposits. These soils are defined as having a dated age of 37.0 million to 98.9 million years old. These deposits are therefore significantly older than what case history data would suggest as being susceptible to liquefaction.

6.3.3 Soil Fabric

Soils are also classified with respect to their grain size and plasticity to assess liquefaction susceptibility. Based on more recent case histories, there is general agreement that sands, non-plastic silts, gravels and their mixtures form soils that are susceptible to liquefaction. Clays, although they may significantly soften under cyclic loading, do not exhibit liquefaction features, and therefore are not considered liquefiable. NZGS guidance⁵ sets out the plasticity index (PI) criteria for liquefaction susceptibility as follows:

$PI < 7$: Susceptible to Liquefaction

$7 \leq PI \leq 12$: Potentially Susceptible to Liquefaction

$PI \geq 12$: Not Susceptible to Liquefaction

The fines content of the sands beneath the site also has a significant impact on their liquefaction susceptibility.

Although plasticity index testing has not been undertaken, the soils recorded on site were predominantly moderately to highly plastic silty clays, clays and clayey silts and are therefore considered to be at low risk of liquefaction.

6.3.4 Specific Analyses

Specific liquefaction analysis was not undertaken at the subject site due to the clayey soil fabric, geological age, which all present a very low liquefaction risk. Liquefaction has therefore not been considered further.

6.4 Slope Stability

6.4.1 Design Criteria

The stability of cut batters and fill embankments under a range of design conditions is expressed in terms of a factor of safety, which is defined as the ratio of forces resisting failure to the forces causing failure. The following performance standards are recommended for slope stability assessment:

⁹ Earthquake Geotechnical Engineering Practice, Module 3: Identification, assessment and mitigation of liquefaction hazards", (May 2016)

¹⁰ Seed, H.B. and Idriss, I.M. (1971) *A simplified procedure for evaluating soil liquefaction potential*, Earthquake Engineering Research Centre, Report No. EERC 70-9, University of California

¹¹ Youd, T.L. and Perkins, D.M. (1978) Mapping liquefaction-induced ground failure potential, *Journal of the Geotechnical Engineering Division*, ASCE, Vol. 104, No. GT4, Proc Paper 13659, p. 433-446

Table 4: Slope Stability Factor of Safety Criteria	
Condition	Required Factor of Safety
Static long term conditions (drained soil conditions, normal groundwater)	1.5
Transient short term conditions (elevated groundwater)	1.3
Ultimate Limit State (ULS) seismic condition	1.2*
Note*: Factor of safety < 1.0 acceptable where displacement-based approach is adopted.	

6.4.2 Shear Strength Parameters

6.4.2.1 Effective Stress Parameters

Drained shear strength parameters for the various geological units that underlie the site were inferred from the field investigation and experience in similar ground conditions within the neighbouring sites and across the Northland and Auckland regions. CMW have undertaken extensive work in the area and on adjacent sites and have gained considerable knowledge in the behaviour of these materials and their properties.

Table 5: Summary of Effective Stress Shear Strength Parameters			
Geological Unit	Unit Weight (kN/m ³)	Effective Stress Shear Strength Parameters	
		c' (kPa)	Ø' (deg)
Colluvium	18	4	26
Alluvium	18	3	26
Residual Northland Allochthon	18	5	26
Transitional Northland Allochthon	18	0	20
Completely Weathered to Highly Weathered Northland Allochthon	23	10	40
Engineered Fill	18	5	30
Note: Where c' = effective cohesion, Ø' = effective friction angle			

6.4.2.2 Total Stress Parameters

The soils that will be exposed in the proposed cut batters / underlie the proposed fill embankments comprise predominantly cohesive silts and clays that will behave in an undrained state during short term seismic loading. Undrained soil shear strengths (Su), used for assessing the stability of slopes during seismic loading, were taken from the hand held shear vane results and are summarised as follows:

Table 6: Summary of Undrained Shear Strength Parameters	
Geological Unit	Design Su (kPa)
Colluvium	80
Alluvium	90
Residual Northland Allochthon	100
Transitional Northland Allochthon	200
Engineered Fill	100

6.4.3 Slope Stability Analyses

Slope stability analyses were undertaken using the proprietary software SLIDE 2. Analysis was undertaken using the Morgenstern-Price method of slices under the translational failure mechanism which is the anticipated failure mechanism in this geology. Due to the length of some of the cross sections, initially the Particle Swarm Search with multiple failures was used in order to identify areas with lower factors of safety which could further be targeted for analysis.

Once areas with a low factor of safety (FoS) were identified, these were then targeted using a translational failure path search and results confirmed areas with the highest risk of failure were constant with the mapped colluvial failure lobes, high groundwater and steeper ground within the site.

Stability cases for Sections A-A and B-B were also analysed for a partial remediation case where only the counterfort drainage was assessed. This was completed to determine that the Factors of Safety achieved for the upper lots (directly below the property at 2118 East Coast Rd) were acceptable for a short-term temporary case where the full remediation i.e. palisade wall and/or shear piles weren't constructed until this stage scheme design and building development proposals have been confirmed.

Selected stability printouts are attached in **Appendix D** and summarised as follows:

Table 7: Slope Stability Analyses Results								
Geological Section	Slope Stability Factor of Safety (Existing)		Slope Stability Factor of Safety (Proposed)			Slope Stability Factor of Safety (Remediated)		
	Prevailing	Transient	Prevailing	Transient	Seismic	Prevailing	Transient	Seismic
A-A	1.3	1.0	1.4	0.8	16.6	1.5	1.5	18.3
A-A	Counterfort drainage only – temporary case					1.4	1.1	16.6
B-B	1.4	1.0	1.2	1.2	8.7	1.7	1.4	8.8
B-B	Counterfort drainage only – temporary case					1.4	1.4	8.5
C-C	1.4	1.5*	1.3	1.2*	13.8	1.6*	1.8*	12.8
D-D	1.2*	0.9*	2.1*	0.9*	4.2	2.0*	1.4*	4.2
E-E	1.5	1.3	1.2	1.1	5.1	2.1	2.1	5.1
F-F	1.4	1.1	1.9	2.0	5.5	2.0	2.0	5.0
G-G	1.2	1.2	3.4	2.6	12.4	-	-	-
H-H	1.5	1.1	1.5	1.3	17.9	1.7	1.7	12.9
Note: *This factor of safety was achieved within the site boundaries however the appended slide section illustrates lower factors of safety occurring in the adjacent / neighbouring properties.								

Results within Section B shows the addition of engineered fill within the southern portion of the site should improve the factors of safety for the proposed profile. The high groundwater case still demonstrates a factor of safety of 1.2, however this can be improved during earthworks by the installation of subsoil drainage as outlined in Section 7 below.

The existing profile within Sections C and D demonstrate low factors of safety particularly within the eastern portion of the site, directly adjacent to the 2118 East Coast Road property which is situated off the East Coast Road ridgeline. These factors of safety are consistent with the mapped debris lobes and obvious localised instability that is already evident in this area. The proposed earthworks profile within these two sections is then shown to significantly improve the observed factors of safety, with the filling of the gully creating a buttress for the steep slopes of the East Coast Road ridgeline. Underfill drainage will also aid in reducing pore water pressures created due to the high ground water table recorded. It should be noted as detailed in the appended stability sections that low factors of safety were identified within the steep slopes of the adjacent site (2118 East Coast Road), however they do not extend into the subject site when the proposed earthworks profile is applied.

Geological Sections E to G show generally stable factors of safety within the existing profile during normal groundwater levels, with potential for instability to occur when the groundwater levels are high. The proposed profile with the applied earthworks design scheme demonstrates an improvement in the factors of safety with the installation of a shear key at the base of the filled gully and large cuts in the north-eastern portion of the site to ease the existing gradients. Proposed section E with normal groundwater applied shows a reduced factor of safety due to the extensive cuts proposed within this area, however this can be mitigated by subsoil drainage and the proposed capping layer as outlined in Section 7.5.5 below which is recommended to alleviate erosion within the exposed rock cut.

Results show that the proposed earthworks and new design levels will not worsen the existing slope stability, but generally improve the factors of safety. For areas within the proposed profile where the factors of safety are reduced the implementation of specific remedial earthworks / ground improvement / drainage measures, as described above and outlined in detail in Section 7 below will be required.

6.4.4 Future Stability Analysis

The factors of safety achieved above are deemed acceptable development except for the lots directly below 2118 East Coast Road, which require further stability analysis and detailed design of geotechnical remediation such as palisade walls and/or shear piles to achieve the factors of safety required to meet those set out in the Auckland Council Code of practice for land development and subdivision. This will need to be undertaken in conjunction with scheme design and building design in this area.

6.5 Erosion

There is evidence across the site indicating that the soils are susceptible to erosion where concentrated flows are able to form. This is particularly noted within the incised gullies where tomos have been observed and overland flow paths have created shallow erosion channels.

Along with these geomorphological features, the proposed earthworks cuts are likely to expose erodible rock layers which were once capped and create the potential for consequential piping / tunnelling erosion and slope failure.

Erosion of cut and fill batters during earthworks is considered to be a high-risk natural hazard and easily addressed during construction. Erosion around batters may subsequently contribute to slope instability and falling debris. This hazard can be controlled during the design phase by limiting batters to a maximum of 1(V):3(H) gradients and during earthworks via benches, erosion control blankets, geotextiles and stormwater control. We have also specified that exposed rock areas are undercut and capped with engineered clay fill as detailed further below.

Recommendations for this mitigation and remediation for this is outlined in Section 7.5 below.

6.6 Fill Induced Settlement

Deep fills of the nature proposed on this site may be subject to ongoing settlement for a period following completion of the works. Due to the composition of the underlying soils being very stiff to hard and the relatively shallow overburden soil profile, settlements due to fills are anticipated to be minor in magnitude. Our experience indicates that with appropriate gully preparation and drainage, settlements are typically complete soon after the earthworks are finished.

Where filling is placed over materials suspected to be of a compressible nature or where a significant depth of filling is to be placed, then settlement monitoring points should be installed on the finished surface of the filling and monitored post construction to ensure ongoing settlement rates are within acceptable guidelines for the proposed development.

The number and position of monitoring points and the frequency of post construction settlement monitoring is to be agreed with the Geotechnical Engineer during construction.

6.7 Expansive Soils

Seasonal shrinking and swelling results in vertical surface ground movement which can cause significant cracking of floor slabs and walls. There have been instances of concrete floors and/ or foundations that have been poured on dry, desiccated subgrades in summer months on expansive soils and have undergone heaving and cracking requiring extensive repairs or re-building once the soil moisture contents have

returned to higher levels. This hazard is addressed by a combination of careful foundation design and site preparation.

NZS 3604:2011¹² excludes from the definition of 'good ground', soils with a liquid limit of more than 50% and a linear shrinkage of more than 15% due to their potential to shrink and swell as a result of seasonal fluctuations in water content. For soils exceeding these limits, NZS 3604 has historically referenced AS 2870¹³ for foundation design advice. However the November 2019 update of Acceptable Solution B1/AS1¹⁴ provides amendments to NZS 3604 that define a method for testing and classifying the soils and provides foundation designs for specific, simple house configurations across the range of expansive soil conditions.

Nevertheless, there is evidence in the NZ geotechnical community indicating that the use of the B1/AS1 method of assessment of expansiveness and therefore its design recommendations are likely to be erroneous. Accordingly, our assessments herein have been made in line with our experience and the AS2870 references. Testing has been undertaken during development of the neighbouring sites indicating that the soils are AS2870 Class M or H1.

6.8 Groundwater Impact Assessment

An assessment has been made of the impact of the proposed works on groundwater conditions in accordance with the requirements of Section E7 of the Auckland Unitary Plan (AuP).¹⁵ The assessment has considered the impacts of the proposals for diversion activities and the results are contained in the table presented in **Appendix E** and summarised below.

Following onsite groundwater monitoring, the two main cut areas (along the eastern and western boundaries) were assessed and found to be non-compliant according to the following standards:

- 1) E7.6.1.6(2) *The water take must not be for a period of more than 10 days where it occurs in peat soils, or 30 days in other types of soil or rock;*
- 2) E7.6.1.6(3) *The water take must not occur during construction;*
- 3) E7.6.1.10(1d) *Diversions for no longer than 10 days;*
- 4) E7.6.1.10(3) *The natural groundwater level must not be reduced by more than 2m on the boundary of any adjoining site.*

The proposed excavations required indicate cuts of up to 5.0m within the western boundary and up to 10.0 within the north-eastern portion of the site with approximately 6.0m along the boundary.

Subsoil drains will be installed as part of the earthworks which will follow existing alignments of surface water channels. Any groundwater intercepted by these drains will be returned to streams and/or wetlands in the same locations as present and will not be diverted to other catchments. The proposed excavations are therefore not anticipated to alter the receiving flows at the surrounding catchments. The low permeability of the site surface soils should ensure that the groundwater across the boundary is not lowered by 2.0m or more.

The ground conditions comprise a combination of engineered fill and Northland Allochthon rock. Based on experience and published literature, a permeability value of 10^{-7} m/sec is considered to be a reasonable assumption.

Groundwater measurements indicate that the proposed excavations could induce groundwater drawdown of up to 1.6m along the north-eastern boundary. The magnitude of the groundwater drawdown was therefore assessed for a maximum drawdown of 1.6m in accordance with the CIRIA document¹⁶. Based on this, no influence on the groundwater table is expected at a distance greater than 1.01m away from the excavation. There are no existing structures within this zone of influence so the drawdown effect on neighbouring sites or roads is anticipated to be negligible. Calculations are provided in the appendices.

¹² Standards New Zealand (2011) Timber-framed buildings, NZS 3604:2011, NZ Standard

¹³ Standards Australia Limited (2011) *Residential slabs and footings*, AS 2870-2011, Australian Standard, NSW

¹⁴ Ministry of Business, Innovation and Employment (2019) *Acceptable Solutions and Verification Methods for NZ Building Code Clause B1 Structure*, B1/AS1, Amendment 19

¹⁵ Auckland Unitary Plan Operative in Part (Updated 12 June 2020)

¹⁶ CIRIA Report 113, Control of groundwater for temporary works, 1986

The groundwater monitoring recorded within the western boundary recorded values below that of the proposed cuts and the proposed excavations within this area are therefore not considered a risk to groundwater drawdown.

7 GEOTECHNICAL RECOMMENDATIONS

7.1 General

We consider that the site will be generally suitable for the proposed development provided the recommendations in the following sections are incorporated into the final development design to mitigate the geotechnical hazards.

7.2 Seismic Site Subsoil Category

Based on the findings of our investigation, including the presence of hard deposits at relatively shallow depths, the seismic site subsoil category defined in Section 3.1.3 of NZS 1170.5 is assessed to be C (shallow soil site).

7.3 Slope Stability Management

Results of the slope stability analyses discussed in Section 6.4 above demonstrate that proposed earthworks landform gradients through the proposed development will not worsen the existing site stability. It will in some areas however improve the existing factors of safety provided the remedial works such as subsoil drainage, palisade walls, shear piles, MSE slope and a shear keys excavated in the completely weathered to highly weathered bedrock is undertaken. The careful design of cut batters will be required to ensure surface erosion within the rock cut is mitigated.

The shear key is critical in ensuring the large volumes of fill upslope of the wetland are appropriately buttressed and drained to avoid any downslope instability.

Specific earthworks design requirements to achieve appropriate slope stability factors of safety are presented on **Drawing 08** and outlined in Section 7.5 below.

The proposed earthworks will generally ease gradients and adequate slope stability conditions for the develop are expected to be provided by normal geotechnical remediation techniques during earthworks.

It's understood that earthwork levels across the upper part of the development could possibly change if an agreement is made with the land owner at 2118 East Coast Rd. If the land at 2118 is developed in conjunction with Stage 3 and 4 of the Silverdale south development, then its likely the grades and levels will be reduced which will benefit both properties in terms of global stability. For the purpose of this report and stability management, it is assumed that development will not be done in conjunction with 2118 and therefore remediation such as palisade walls, shear piles and counterfort drainage have been assessed as viable remediation options and provide acceptable slope stability Factors of Safety, both at and beyond the site boundaries. Detailed design of these remediation options will be required at later stage once the final levels have been determined.

7.3.1 Mechanically Stabilised Earth (MSE) Wall

A MSE wall of up to 9.5m high is proposed running north to south more or less through the centre of this stage of the sub-division. Depending on the location onsite, the MSE wall is either founded on natural subsoils (residual soil or unweathered Northland Allochthon rock) or engineered fills placed to infill gullies. As shown on **Drawing 07**, a 5m wide shear key is required at the base of this MSE wall to improve the slope stability and mitigate the risks related to settlement of the MSE wall. The shear key undercut into unweathered Northland Allochthon rock is required where natural subsoils are encountered. The undercut will be backfilled with engineered fill, and the MSE wall is to be founded on the fill material. The anticipated extents of this shear key is indicated on **Drawing 07** but will require onsite verification during construction and may be subject to localised variations.

Detailed design of the MSE wall will need to be undertaken, although the MSE wall has been modelled as part of the of the stability analyses detailed in **Section 6.4.3** above, to confirm that acceptable global stability

Factors of Safety can be achieved and preliminary details of the MSE structure indicate a 1(V):1(H) slope angle with 10m geogrid length. This is preliminary and will require detailed design.

7.3.2 Counterfort Drainage

Completing the stability analysis in the southeastern corner of the development below 2118 East Coast Rd, cross sections A, B and C as shown on **Drawing 01**, demonstrated Factor of Safety below the what is recommended in the ACCoP, particularly for the high ground water cases. As a result, groundwater is to be controlled by counterfort drainage across the steeper slopes below 2118. The Remediation Plan (**Drawing 07**) shows the indicative location of the proposed counterfort drainage and Counterfort Drain Detail (**Drawing 09**) shows the typical construction of the drains. It's expected that the base of all counterfort drains will be excavated down into the underlying Northland Allochthon mudstone to an anticipated depth between 3.0 - 5.0m. Counterfort drainage across these slopes should be installed as soon as the bulk earthworks within this area is completed and are required to control the temporary stability of the slope particularly during the wet winter months. Drains should be outlet either into the public stormwater system or into an appropriate downslope gully or water course.

7.3.3 Palisade Wall and Shear Piles

Inground palisade walls are proposed along the eastern boundary directly below the neighbouring property at 2118 East Coast Road, as well as a section along the upper southern boundary. Shear piles have also been modelled as part of the stability analyses due to lower Factors of Safety within the steeper lots directly below the proposed palisade wall. The requirement for both the palisade and shear piles is required assuming that 2118 is not developed in conjunction with the Silverdale South development. If both properties are developed together and grades across this upper section of the development are reduced and it's likely that most of the future remediation as depicted on **Drawing 07**, will not be required. Further assessment and detailed design (if any) will be required once final earthwork levels have been determined. It is possible that these piles could be integrated in to the building development.

Based on the modelling preliminary details of the palisade walls are as follows.

Table 8: Preliminary Palisade Wall Parameters		
	Preliminary Pile Depth (m)	Preliminary Shear Capacity (kN)
Palisade Wall (Road Vest and RF to RJ – Southern Boundary)	5.0	100
Palisade Wall (Lots 224, 221, 220, 286 to 288)	5.0	100
Palisade Wall (Lots 225 to 242 and Lot 297 Accessway)	6.0 – 6.5	100

However, as mentioned above detailed design will be required.

7.4 Wetland

It is understood that the wetland within the north-western most corner of the site is to filled. A portion of this wetland has already been filled with up to 3.0m of uncertified fill. Removal of this material and any underlying soft and/or organic soils will need to be removed prior to placement of any further fill and underfill drainage.

7.5 Earthworks

7.5.1 General

All earthwork activities must be carried out in general accordance with the requirements of NZS 4431¹⁷ and the requirements of the Auckland Council Code of Practice for Land Development and subdivision under the guidance of a Chartered Professional Geotechnical Engineer.

A Geotechnical Works Specification is provided as **Appendix F** and standard detail drawings are provided as **Drawing 08**. Between them, these documents provide the requirements for site preparation, fill placement, subsoil drainage, compaction requirements, quality assurance testing and as-built requirements.

Those requirements are summarised below.

7.5.2 Shear Key

A shear key as mentioned in Section 7.3 above and detailed in **Drawing 08** has been specified at the toe of the fill batters along the north western and southern boundaries, as well as beneath the toe of the MSE wall where the wall is formed on natural soils. This shear keys should be constructed to be at least 5.0m wide at the base. Excavations to form the shear key are anticipated to be 5.0 to 6.0m deep, extending along the toe of the fills as detailed in the attached drawings. The shear key/s that underlie the MSE wall are expected to be shallower in depth depending on the amount of cut taken off the ridgelines where the MSE wall crosses over. Where cuts along the MSE wall alignment have already encountered unweathered rock, a shear key depth of 1.0m is required, but the depth will increase where residual soils are encountered.

For all shear keys, the base is to be keyed at least 1.0m into the underlying rock with a series of benches and drainage and drainage outlets which are to be maintained throughout the design life of the shear key. A level of redesign is to be expected during the construction of a shear key where ground and or groundwaters conditions vary from what is anticipated.

The construction of shear keys can involve significant risk. The following construction sequencing has been provided for the purpose of reducing the risk of slope instability during construction. This sequencing is considered as good practice in the industry given our understanding of the site topography and underlying geology. If unexpected ground conditions are encountered during shear key construction, the contractor must notify the Geotechnical Engineer as soon as practical so the Engineer can assess stability risk. During shear key construction it is recommended that the following be adhered to by the contractor, although the methodology adapted by the contractor will need to take into account their equipment and other constraints. CMW remains available to assist in developing the construction methodology with the contractor and project team, considering the main construction risk of batter collapse.

- The shear key should be constructed with benches along the cut face. The individual bench height should not exceed 4m, while each bench width should be cut a minimum of two metres back into the soil profile;
- The angle of any battered cut face must not exceed 1H:1V;
- The length of open shear key excavation at any one time should not exceed 40m. Before the contractor is able to excavate a further section, at least $\frac{3}{4}$ of the height of the open shear key must be backfilled with engineered fill and appropriate drainage;
- Shear keys should not be left open for long periods and should not be constructed or left open during periods of wet weather. Works must be planned around fine weather windows with an open section of shear key left for no longer than 48hrs without being backfilled;
- The contractor should expect a steady ingress of groundwater into shear keys during construction and should allow for temporary dewatering.
- Consideration should be given to loads above open shear key excavations by controlling stockpiling and plant movements and by removing excess cut prior to open excavations.

¹⁷ Standards New Zealand (1989) Code of practice for earth fill for residential development, incorporating Amendment No. 1, NZS 4431:1989, NZ Standard

Shear key drainage outlets are to be placed at a maximum spacing of 50m and are to be confirmed by a Geotechnical Engineer onsite before installation.

Any deviations from the methodologies outlined above are at the contractor's risk, unless a prior agreement between the Geotechnical Engineer and/or Project Group has been made.

7.5.3 Excavatability

Given the highly fractured / completely weathered nature of the rock that will be encountered within a large amount of the proposed earthworks cuts, it is expected that excavation of these materials will be readily achieved with normal earthworks plant, such as scrapers and bulldozers with scoops. Where the deep cuts are proposed in to the rock, excavators may be required if more competent material is encountered.

7.5.4 Stockpiles

Careful consideration must be given to the location of temporary topsoil / unsuitables stockpiles to ensure that they are not located immediately above steep or unstable slopes or immediately above proposed stormwater pond excavations.

The location of all temporary stockpiles must be approved by the Geotechnical Engineer prior to placement. Where stockpiles cannot be avoided above sloping ground they should be placed over a wide area with the height restricted under the direction of the Geotechnical Engineer.

7.5.5 Underfill Drainage

Underfill drains will need to be installed beneath new fills within low lying tributaries and gully inverts. Effective drainage is a key factor required for maintaining slope stability and reducing the geotechnical hazards across the site.

We have provided approximate positions of the underfill drainage network required for the subdivision works based on existing contour data. Details are in the Geotechnical Works Specification (**Appendix F**) and in the Underfill Drain Typical Detail (**Drawing 08**).

Subsoil drainage is likely to be required during the construction and is generally specified when and where is required. Some allowance should be made for additional drainage during the earthworks phase of the development.

7.5.6 Compaction

We have considered three likely fill material scenarios in the preparation of our compaction specification contained in **Appendix F**:

Earthfill must be placed, spread and compacted in controlled 250mm to 300mm thick (loose) lifts under the direction of the Geotechnical Engineer. The fill may comprise either granular or cohesive material subject to being free of any organic material and having no particles greater than 150mm diameter.

Most of the proposed cut material, including the natural and existing fill materials should be suitable for reuse as Engineer Certified Fill. Soil textures and moisture contents will however vary widely and careful management, conditioning and compaction control will be required.

All earthfill must be placed to ensure adequate knitting of successive fill lifts by ripping any fill surfaces that have become dry prior to placing the following fill lift.

7.5.7 Capping Layer

The highly fractured rockmass that will be exposed at finished levels across cut depths greater than approximately 3.0m is susceptible to rapid weathering and infiltration of surface water that could compromise downslope stability conditions.

Over-excavation of these deposits to a depth of 1m and capping with engineered filling is a prudent remediation measure. Essentially all of the residual weathered deposits encountered in our investigations across the cut areas would be suitable for use as the engineered capping fill for this purpose. The anticipated extents of the cuts requiring capping have been highlighted on drawing 7.

7.5.8 Temporary Sediment Retention Ponds

Temporary sediment retention ponds may be required to store stormwater for significant periods (several months to years) and therefore their construction should be subject to design and observation input from the geotechnical engineer. As a minimum, the following input is recommended from the project geotechnical engineer:

- Advise on pond locations with respect to land stability and seepage potential;
- Structural design of pond fill embankments including key and compaction specification;
- Observe embankment subgrade conditions and advise on undercut requirements;
- Earthfill QA / QC testing of all embankment materials to ensure compliance with specification.

When decommissioning temporary sediment ponds, all water softened material in the bases and sides of the ponds shall be removed and undercut to the satisfaction of the Geotechnical Engineer. Backfilling of temporary ponds shall be to the compaction standard for general filling unless otherwise specified.

7.5.9 Temporary Cuts

During the development of earthworks temporary cuts may be required. With all over steepened temporary excavations there is a risk of batter collapse. The contractor needs to consider the extent of the excavation that is to be left unsupported for any length of time to mitigate the risk. This will vary with ground conditions and weather. Where cut faces exceed 1.5m, benching and appropriate batter angles are required. Temporary cuts that are susceptible to surface water flows will require diversions or bunds to prevent erosion.

7.5.10 Quality Control

The stripping of existing topsoil, cutting of pre-existing fill materials and undercutting of organic soils, where required from across the site as well as the gully areas must be subject to observation by the project geotechnical engineer to ensure that all unsuitable materials have been removed.

The source and / or type of material used for engineered fill will dictate the type of quality control testing undertaken.

For granular (sand and gravel) fill materials, testing following compaction should be principally in terms of the maximum dry density within the appropriate water content range, which may be calibrated with a dynamic cone (Scala) penetrometer test that is then used as the primary testing measure. Where the source or quality of fill changes, re-calibration will be required.

Where silts and clays are used as filling, alternative test criteria using vane shear strength and air voids should be used. The recommended specification for the proposed development is presented in Table below:

Table 9: Summary of Earthfill Testing Requirements			
Fill Type	Test Method	Frequency*	Compliance Criteria
Granular	Maximum Dry Density Scala Penetrometer	New material type 1 x 1m test / 1000m ³	95% MDD 4 blows per 100mm
Cohesive	Vane Shear Strength	5 tests / 1000m ³	Min. average 140kPa over 10 tests, min. single value 110kPa
	Air voids	1 test / 1000m ³	Max. average 10% over 10 tests, max. single value 12%
Note*: testing frequency may vary at the discretion of the geotechnical engineer, which may include small and / or deep isolated fill areas.			

The source of the fill should be discussed with and approved by the project geotechnical engineer to verify its appropriateness and quality control testing requirements.

7.6 Civil Works

7.6.1 Subgrade CBR

The subdivision roading is shown as being constructed in a combination of both cut and fill areas, although given the requirement to over-excavate exposed rock deposits, the vast majority will be formed in engineered fills. Typical CBR values of between 5% and 6% should be available in fills. In areas of cut natural ground, CBR values as low as 2% or 3% are likely.

As described for the fills, subgrade improvement with lime (if desired) is expected to provide better results than the use of cement due to the clayey nature of the soils.

7.6.2 Service Trenches

All of the materials to be exposed during the excavation of service trenches should be readily removed using an excavator.

Trench collapse is expected to pose problems in areas wherever the weathered transition zone soils are exposed in excavations / excavations extend below the water table in some locations at 1.0m depth and here, trench support is likely to be required. Temporary dewatering, in the form of regularly spaced sump pumps or well point dewatering spears may also be required.

Services trenches excavated along contour in areas of steep ground may need to be backfilled with engineered filling and if in natural ground, may require a drain coil in the base of the trench connected to the stormwater system. Identification of critical service lines must be made once drawings are available.

At the completion of the development, Specific Design Zones for services will be applied in the Geotechnical Completion Report to protect future foundations from settlement from poorly compacted trench backfill and to prevent new loads crushing service pipes. This is a restriction on building foundations within the 45 degree zone of influence from pipe inverts as depicted in Auckland Council's drawing SW22 from their Code of Practice for Land Development and Subdivision.

7.6.3 Retaining Walls

Design parameters for permanent and temporary retaining walls are summarised in Table 10 below.

Table 10: Summary of Geotechnical Design Parameters					
Geological Unit	Unit Weight γ (kN/m ³)	Su (kPa)	c' (kPa)	ϕ' (deg)	E' (MPa)
Engineered Fill	18	100	5	30	30
Residual Soils	18	80	5	26	20
Transitional Northland Allochthon	18	20	0	20	40
Note: γ – soil unit weight; Su – undrained shear strength; c' – cohesion; ϕ' - angle of internal soil friction; E' – long term Young's modulus,					

At the completion of the development, **Specific Design Zones (retaining)** are expected to be applied in the Geotechnical Completion Report to protect retaining walls from future overloading at the crest or undermining at the toe that could lead to instability. These zones typically extend 1.5x distance of the wall height and where they are present above a wall, require deepening of foundations unless the wall has been designed for future foundation loads. Where they are present below a wall, careful consideration needs to be given to location, depth and timing of any future excavations.

Appropriate allowance in the design should be made for any applicable surcharges or slopes above or below the walls, including those in the Auckland Council Practice Note AC2231.

All retaining walls must be backfilled with free draining aggregate, protected from clogging due to fines migration from the soil by a suitable geotextile filter fabric, with perforated subsoil drainage pipe at the toe, out-letting to a suitable point.

With all over steepened temporary batters there is a risk of batter collapse until the wall is fully constructed. The contractor needs to consider the extent of batter left unsupported for any length of time to mitigate this risk. This will vary with ground conditions and weather. Where battering is undertaken more than a few days in advance of wall construction the batter faces must be covered with polythene to prevent them drying out and cracking, especially where expansive clay soils are present. Similarly, during periods of wet weather the batter face should be protected with polythene, and surface water directed away from the crest and toe of the batter.

It is noted that some ground movement will occur behind temporary or permanent retaining walls. By definition, movement of the wall must occur to fully mobilise the active and passive earth pressure coefficients provided in Table * above. The extent of this movement is dependent on the height of retaining, type of wall selected and construction methodology. This must be considered during the design and construction of the retaining walls to ensure adjacent facilities are not adversely affected.

The locations, heights and detailed designs of these will should be reviewed by the Geotechnical Engineer.

7.6.4 Stormwater Soakage

All of the soils at this site are clayey in nature and have very low coefficients of permeability. Accordingly, rain gardens / attenuation ponds are not expected to provide any significant ground soakage function.

Where the less weathered rockmass are exposed in the deeper cuts near design subgrade level, significantly higher permeabilities will be available. However, the addition of concentrated water into these deposits is highly undesirable from a slope stability perspective and is not recommended.

The use of rain gardens for storage capacity and water quality improvement is understood not to be a requirement for this development. If rain gardens are to be used, designs must be reviewed by the geotechnical engineer to ensure that the details are appropriate for each location.

8 FOUNDATIONS

At the completion of the works, a Geotechnical Completion Report (GCR) will be prepared. The GCR will advise on anticipated foundation design parameters and any restrictions that require further engineering investigation and/ or design on individual lots to address any remaining natural hazards as described in Section 71(3) of the Building Act, i.e. erosion, falling debris, subsidence, slippage, and inundation. The certification for residential lots is based on compliance with the "good ground" definition of NZS 3604 at finished ground levels.

Restrictions that are expected to be applied in the GCR to protect the future buildings from natural hazards associated with steep slopes, retaining walls, MSE walls, palisade walls and drainage are outlined in the respective sections in this report.

On this site our provisional expectation is that provided earthworks are completed in accordance with the standards and recommendations described herein, the following will apply:

- A preliminary geotechnical ultimate bearing pressure of 300kPa should be available for shallow strip and pad foundations constructed within both the natural cut ground and engineered fill areas, subject to the short axis of those footings measuring no greater than 2.5m in plan.

There may be areas where localised variations in shear strength within the natural cut ground occur, particularly where the depth of cut varies across the building platforms. Further confirmation of available bearing pressures will be addressed at the time of post earthworks soil testing.

- On this basis of our visual tactile assessment and expansive soil testing from Stages 1 and 2 of the development, we also expect the AS2870 Site Class for Stages 3 and 4 of the development to be either M (moderate) with an anticipated characteristic surface movement up to 40mm or H1 (high) with an anticipated characteristic surface movement up to 60mm. Foundation design may be selected in

accordance with NZS 3604 / appropriate solutions for this Class from AS2870 or may be undertaken by specific engineering design.

- As required by section B1/VM4¹⁸ of the New Zealand Building Code Handbook, a strength reduction factor of 0.5 and 0.8 must be applied to all recommended geotechnical ultimate soil capacities in conjunction with their use in factored design load cases for static and earthquake overload conditions respectively.

9 SAFETY IN DESIGN

The design landform requires site excavations that includes geotechnical works such as undercuts, temporary excavations, steep fill batters, shear key excavations, deep and shallow subsoil drains as specified in this Geotechnical report and on the drawings. Exposure to these works forms a significant safety risk for contractors and inspectors/ testers.

In conducting our scope of work, we have considered and addressed Safety in Design (SiD) aspects relevant to our understanding of the proposed design and construction work. SiD must consider the construction, operation, maintenance, and ultimate demolition phases of the relevant works.

It is noted that CMW are focussed on design aspects, and whilst we have attempted to be comprehensive in our assessment, it is the Contractors responsibility to cover construction related risks in a more comprehensive manner (being the competent party in that respect). The CMW designs/ specifications for undercuts and drainage elements have been made so that no personnel are ever expected to enter unbattered or unprotected excavations to complete the construction. If at any stage a contractor does not consider that a design for excavations can be safely constructed, then CMW must be contacted immediately to discuss alternative design and/ or methods and avoid risk to personnel.

Our SiD risk assessment is presented in Appendix G. This risk assessment must be communicated with all affected parties involved with the project and dealt with through specific on-site risk assessment plans.

10 FURTHER WORK

This report has been undertaken to assess the proposed development plans provided. Should development proposals change, further site investigation, analyses and reporting will be required.

During construction of the proposed earthworks and civil works, appropriate site inspections such as site stripping, earth fill compaction testing, installation of subsoil drainage, shear key excavations, construction of MSE wall, palisade wall, retaining walls and backfilling of service trenches will need to be undertaken by a qualified Geotechnical Engineer who is familiar with the contents of this report.

As detailed within **Section 7.3.1** and **Section 7.3.3** above, detailed design of the MSE wall/s, palisade wall/s, retaining walls and shear piles is required.

¹⁸ Ministry of Business, Innovation and Employment (2019) *Acceptable Solutions and Verification Methods for NZ Building Code Clause B1 Structure*, B1/VM4, Amendment 19

USE OF THIS REPORT

Site subsurface conditions cause more construction problems than any other factor and therefore are generally the largest technical risk to a project. These notes have been prepared to help you understand the limitations of your geotechnical report.

Your geotechnical report is based on project specific criteria

Your geotechnical report has been developed on the basis of our understanding of your project specific requirements and applies only to the site area investigated. Project requirements could include the general nature of the project; its size and configuration; the location of any structures on or around the site; and the presence of underground utilities. If there are any subsequent changes to your project you should seek geotechnical advice as to how such changes affect your report's recommendations. Your geotechnical report should not be applied to a different project given the inherent differences between projects and sites.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface investigation, the conditions may have changed, particularly when large periods of time have elapsed since the investigations were performed.

Interpretation of factual data

Site investigations identify actual subsurface conditions at points where samples are taken. Additional geotechnical information (e.g. literature and external data source review, laboratory testing on samples, etc) are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can exactly predict what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions.

Your report's recommendations require confirmation during construction

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced. For this reason, you should retain geotechnical services throughout the construction stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site. A geotechnical designer, who is fully familiar with the background information, is able to assess whether the report's recommendations are valid and whether changes should be considered as the project develops. An unfamiliar party using this report increases the risk that the report will be misinterpreted.

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical report. Read all geotechnical documents closely and do not hesitate to ask any questions you may have. To help avoid misinterpretations, retain the assistance of geotechnical professionals familiar with the contents of the geotechnical report to work with other project design professionals who need to take account of the contents of the report. Have the report implications explained to design professionals who need to take account of them, and then have the design plans and specifications produced reviewed by a competent Geotechnical Engineer.

Drawings

Drawing 01:	Site Investigation Plan
Drawing 02:	Geomorphology Plan
Drawing 03 to 06:	Geological Section A-A to G-G
Drawing 07:	Remediation Plan
Drawing 08:	Shear Key and Drainage Detail
Drawing 09:	Counterfort Drain Detail

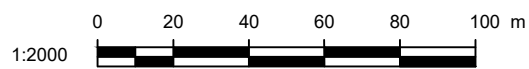


LEGEND:

- HA16-20 HAND AUGER (HA) LOCATION (2020)
- MH07-20 MACHINE BOREHOLE LOCATION (2020)
- TP17-20 TEST PIT (TP) LOCATION (2020)
- HA06-16 HAND AUGER (HA) LOCATION (2016)
- MH02-16 MACHINE BOREHOLE LOCATION (2016)
- TP14-16 TEST PIT (TP) LOCATION (2016)
- HA01-21 HAND AUGER (HA) LOCATION (2021)
- MH01-21 MACHINE BOREHOLE LOCATION (2021)
- SITE BOUNDARY

NOTES:

1. BASE PLAN ADAPTED FROM AUCKLAND COUNCIL GIS.



CLIENT:	BUILD RICH		DRAWN:	HV	PROJECT No:	AKL2020-0125
PROJECT:	STAGE 3 & 4, SILVERDALE SOUTH		CHECKED:	SP	DRAWING:	01
TITLE:	SITE INVESTIGATION PLAN		REVISION:	1	SCALE:	1:2000
			DATE:	29/09/2021	SHEET:	A3



LEGEND:

- R — Ridge Spur
- B — Mid-slope Bench
- Head Scarp / Slope break
- Soil Creep
- Reeds / Swampy ground

- Debris lobe
- Hummocky ground
- Pond
- Historic pond that has been filled

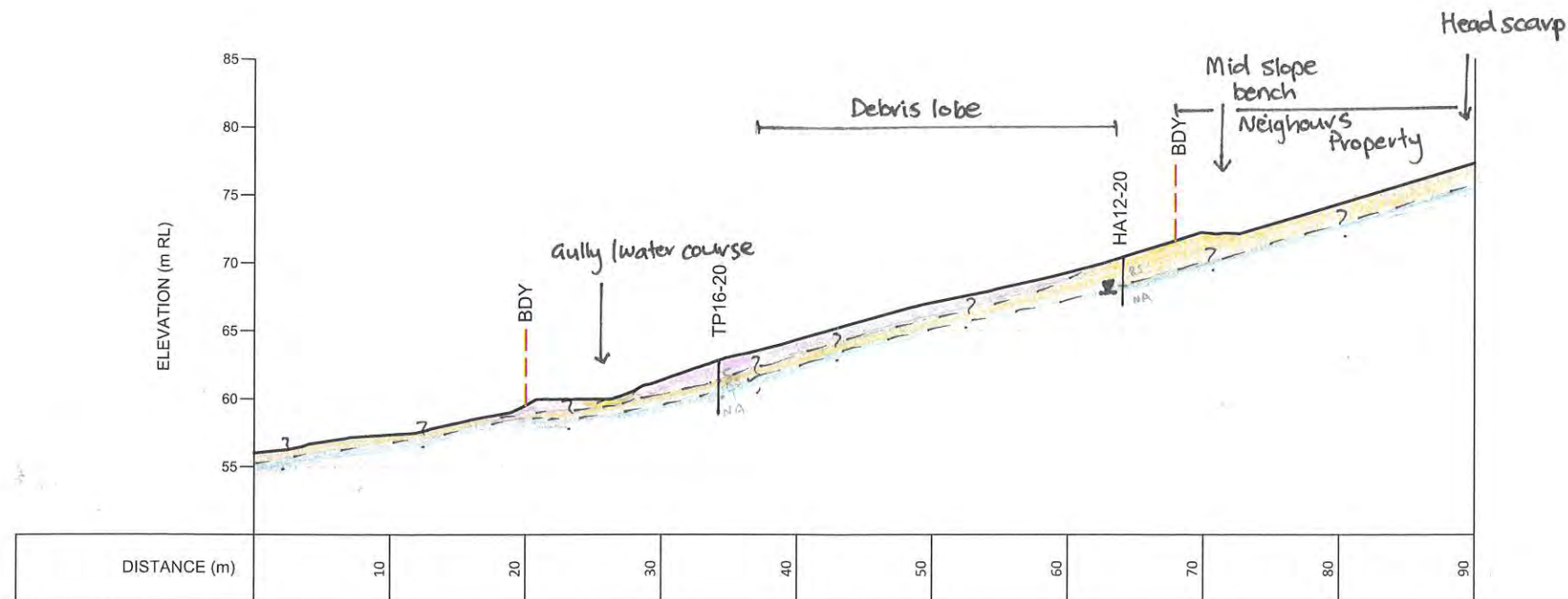
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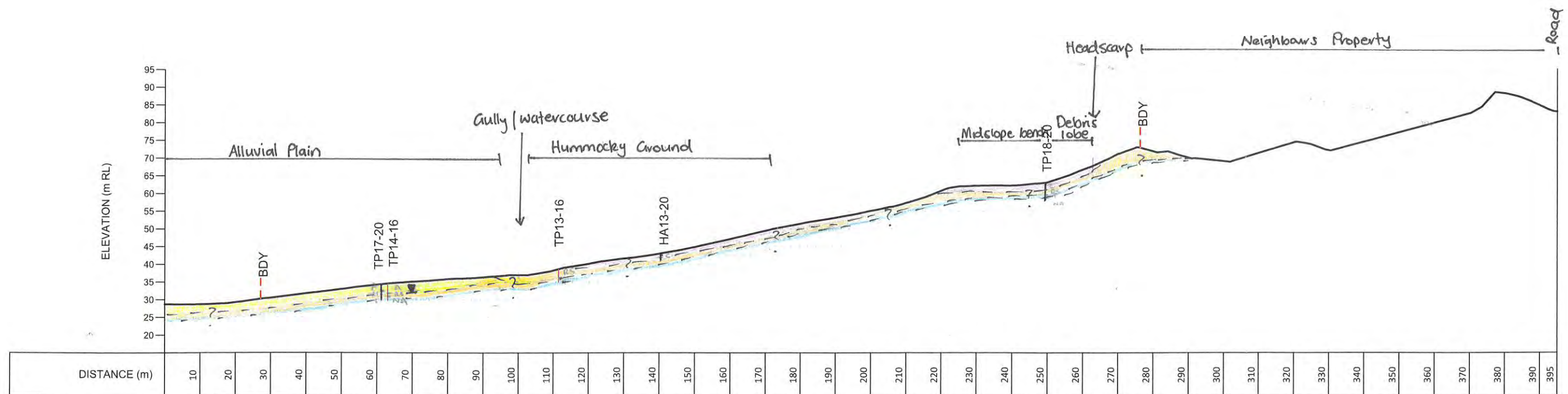
Water course



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TITLE:	GEOMORPHOLOGY PLAN	REVISION:	A	SCALE:	1:2000
		DATE:	07/07/2020	SHEET:	A3



SECTION A
SCALE 1:500



SECTION B
SCALE 1:1250

LEGEND:

EXISTING GROUND PROFILE
COLLUVIUM
ALLUVIUM

RESIDUAL NA
TRANSITIONAL NA
CW to HW NA

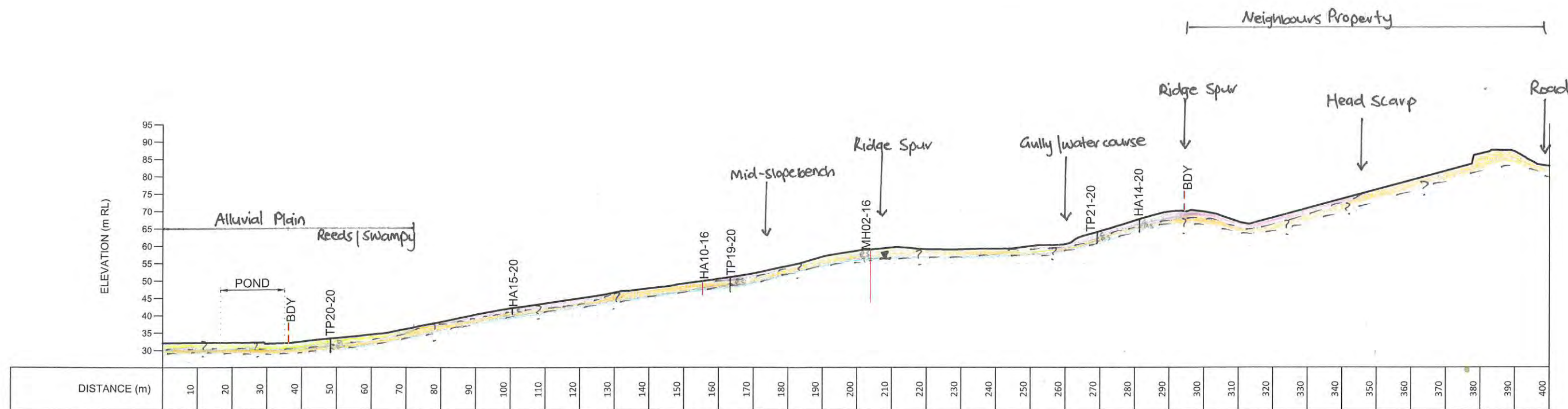
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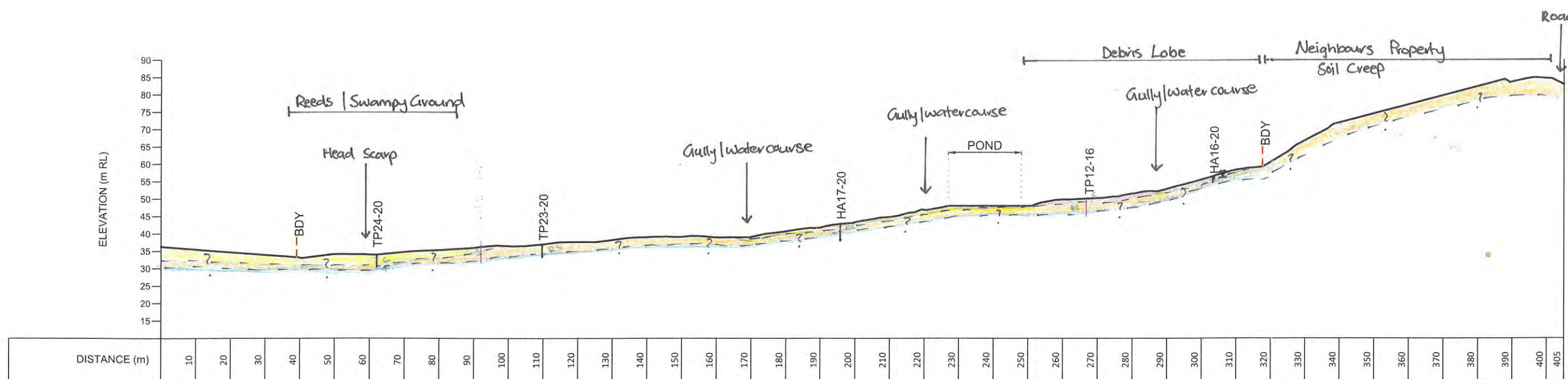
GROUND WATER



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TITLE:	SECTION A & B	REVISION:	A	SCALE:	AS SHOWN
		DATE:	10/07/2020	SHEET:	A3



SECTION C
SCALE 1:1250



SECTION D
SCALE 1:1250

LEGEND:

- EXISTING GROUND PROFILE
- COLLUVIUM
- ALLUVIUM

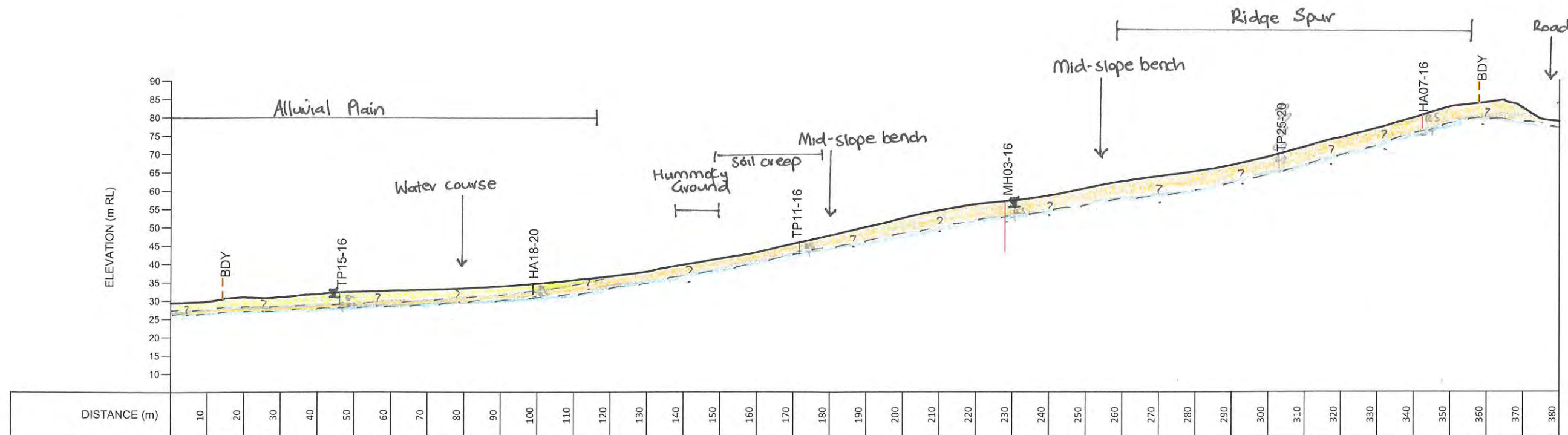
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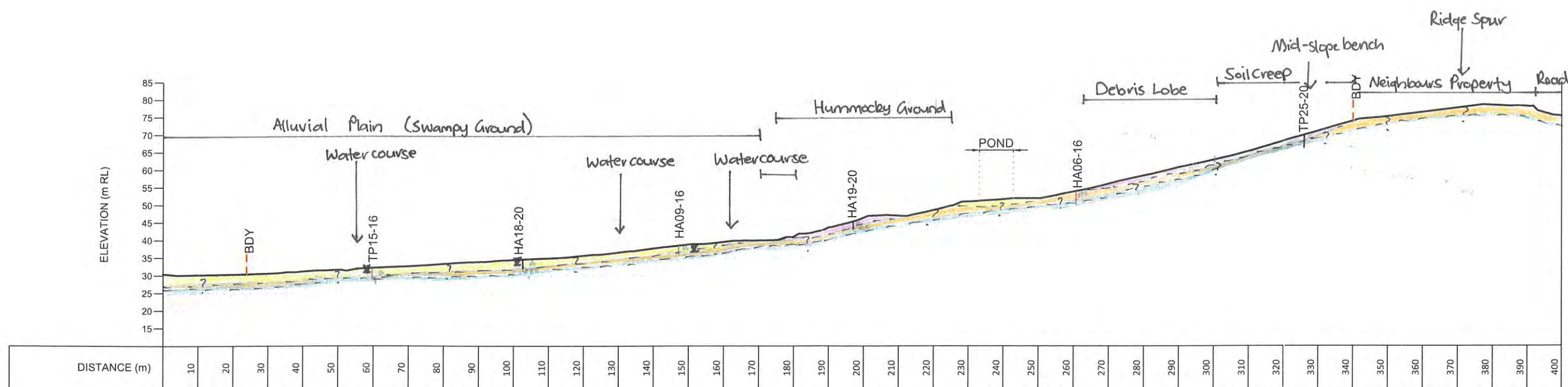
1. BASE PLAN ADAPTED FROM AUCKLAND COUNCIL GIS.
- ▼ GROUND WATER



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PROJECT:	STAGE 3 & 4, SILVERDALE SOUTH	CHECKED:	JW	DRAWING:	04
TITLE:	SECTION C & D	REVISION:	A	SCALE:	1:1250
		DATE:	10/07/2020	SHEET:	A3



SECTION E
SCALE 1:1250



SECTION F
SCALE 1:1250

LEGEND:

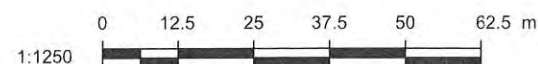
- EXISTING GROUND PROFILE
- COLLUVIUM
- ALLUVIUM

- RESIDUAL NA
- TRANSITIONAL NA
- CW to HW NA

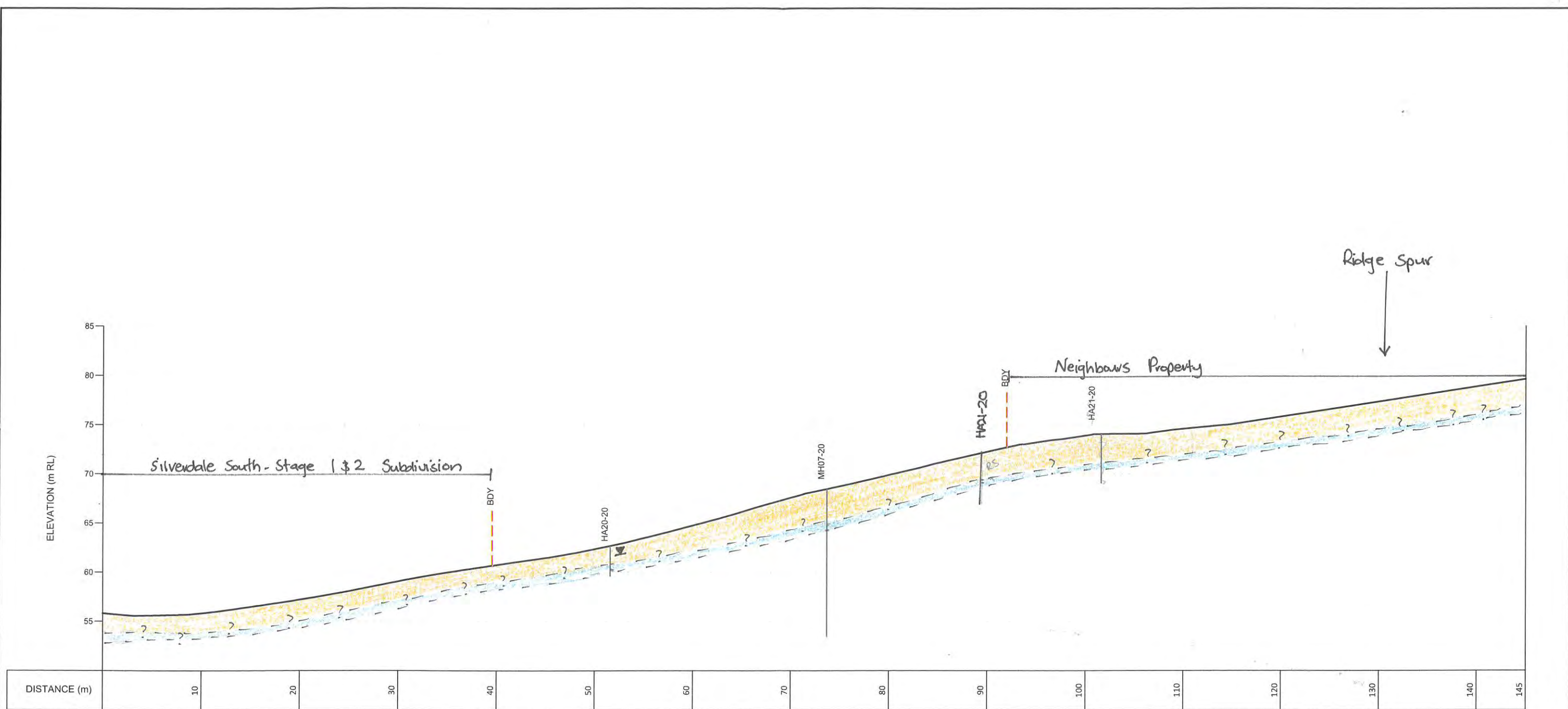
NOTES:

1. BASE PLAN ADAPTED FROM AUCKLAND COUNCIL GIS.

GROUND WATER



CLIENT:	BUILD RICH	DRAWN:	WPJ	PROJECT No:	AKL2020-0125
PROJECT:	STAGE 3 & 4, SILVERDALE SOUTH	CHECKED:	JW	DRAWING:	05
TITLE:	SECTION E & F	REVISION:	A	SCALE:	1:1250
		DATE:	10/07/2020	SHEET:	A3



SECTION G
SCALE 1:400

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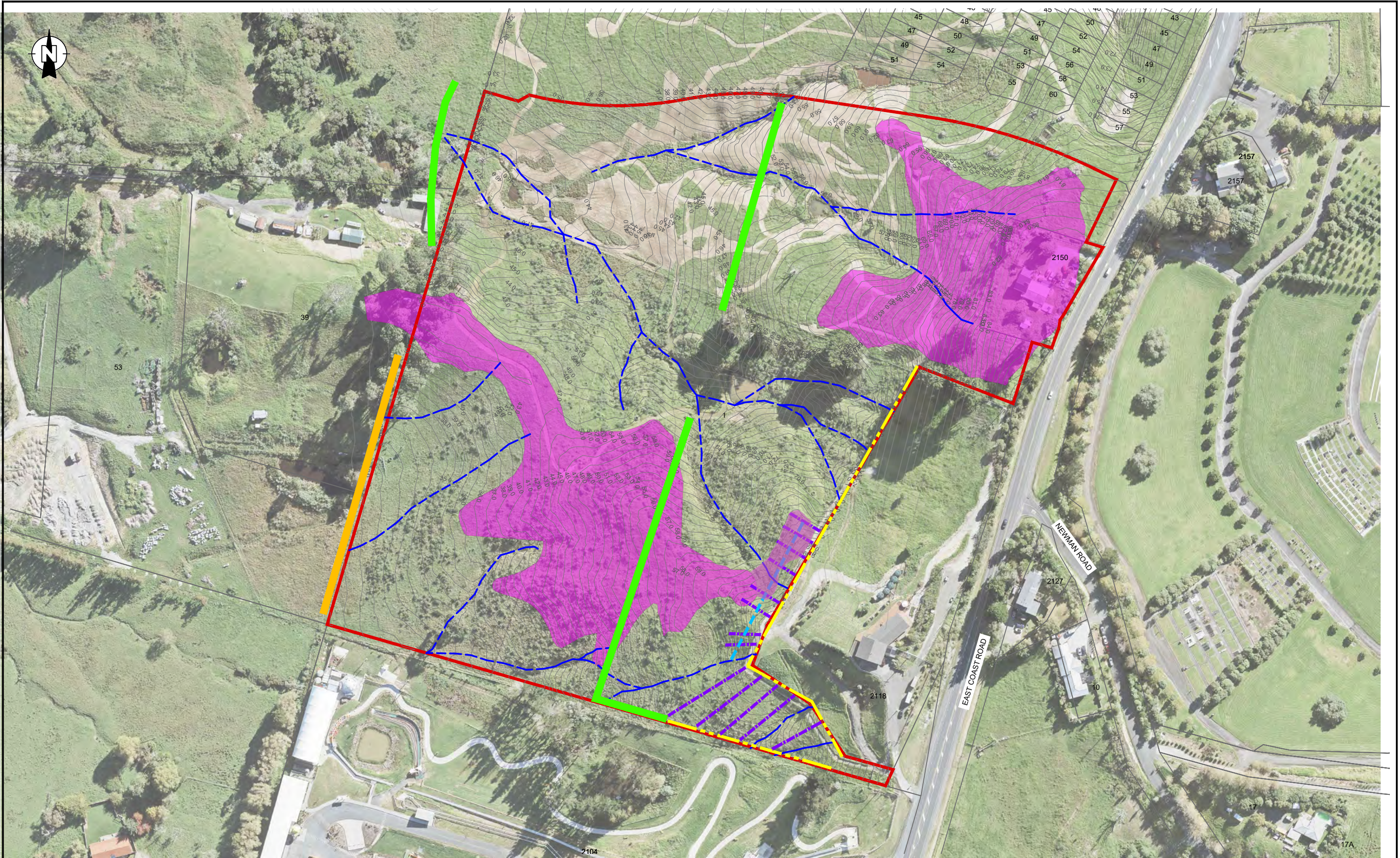
- EXISTING GROUND PROFILE
- RESIDUAL NA
- TRANSITIONAL NA

NOTES:

1. BASE PLAN ADAPTED FROM AUCKLAND COUNCIL GIS.
- CW to HW NA
- GROUND WATER



CLIENT:	BUILD RICH	DRAWN:	WPJ	PROJECT No:	AKL2020-0125
PROJECT:	STAGE 3 & 4, SILVERDALE SOUTH	CHECKED:	JW	DRAWING:	06
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		DATE:	10/07/2020	SHEET:	A3



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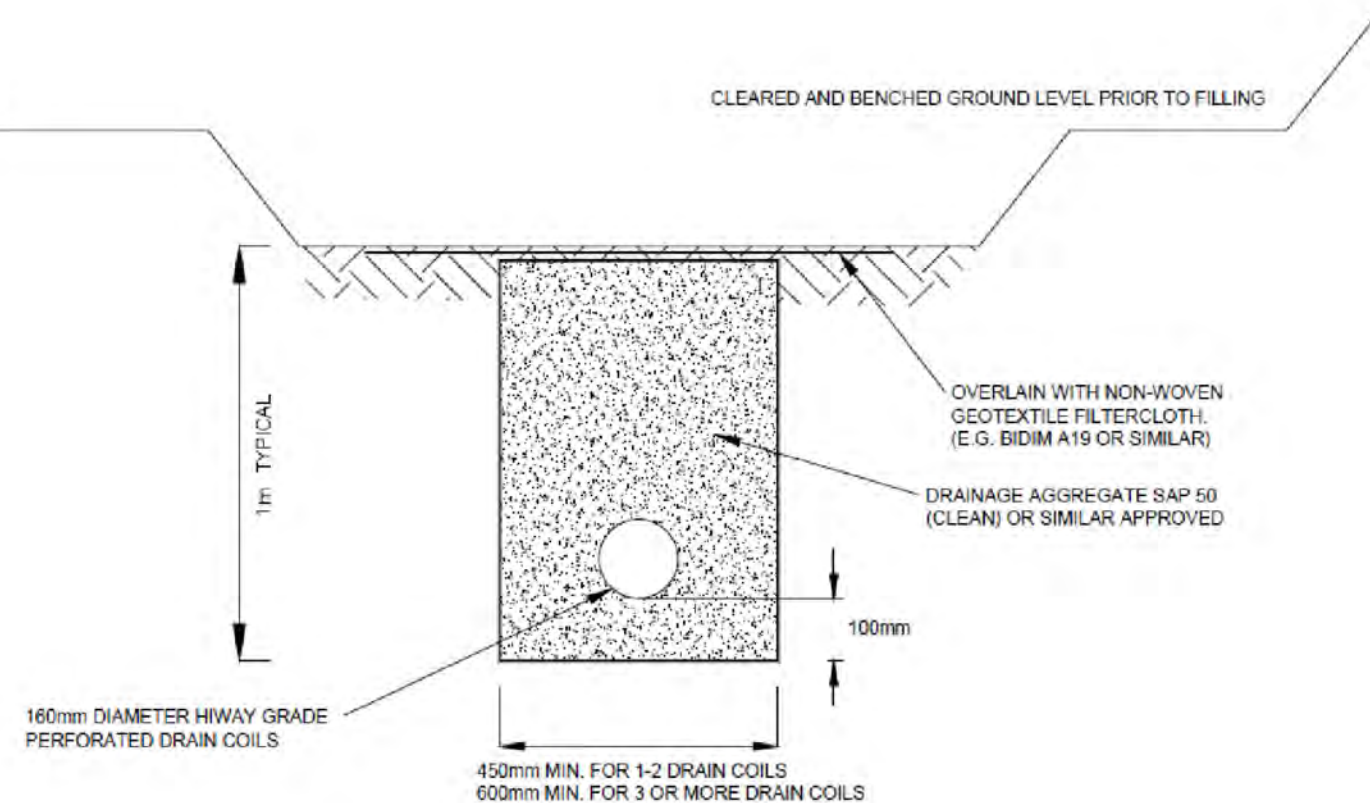
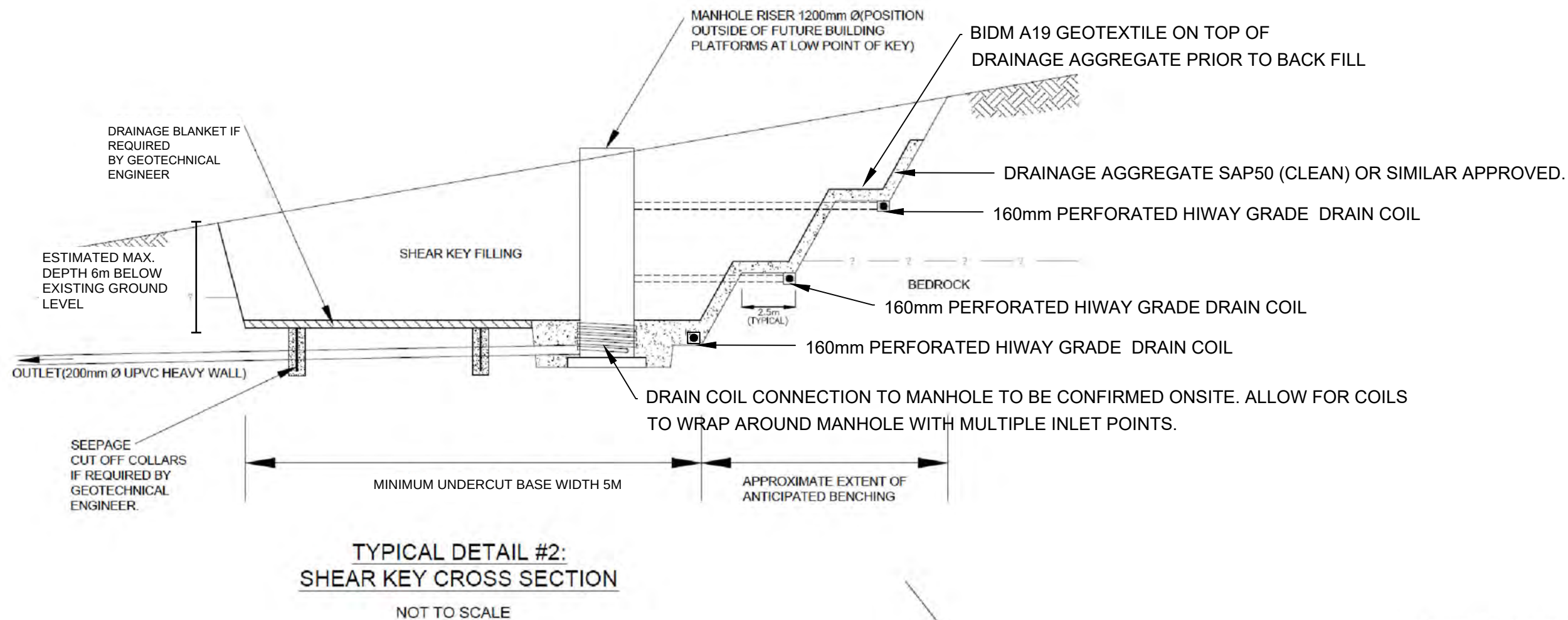
- ANTICIPATED ROCK CUT AREA DRAINAGE
- UNDER FILL DRAINAGE
- SITE BOUNDARY
- UNDERCUT OF LOW STRENGTH SOILS
- SHEAR KEY-MINIMUM WIDTH OF BASE 5m - MAXIMUM DEPTH 6M BELOW EXISTING GROUND LEVEL
- FUTURE REMEDIATION - INGROUND SHEAR PILES
- FUTURE REMEDIATION - PALISADE WALL
- COUNTERFORT DRAINAGE

NOTES:

1. BASE PLAN ADAPTED FROM AUCKLAND COUNCIL GIS.



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PROJECT:	STAGE 3 & 4, SILVERDALE SOUTH		CHECKED:	SP	DRAWING:	07
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			DATE:	29/09/2021	SHEET:	A3

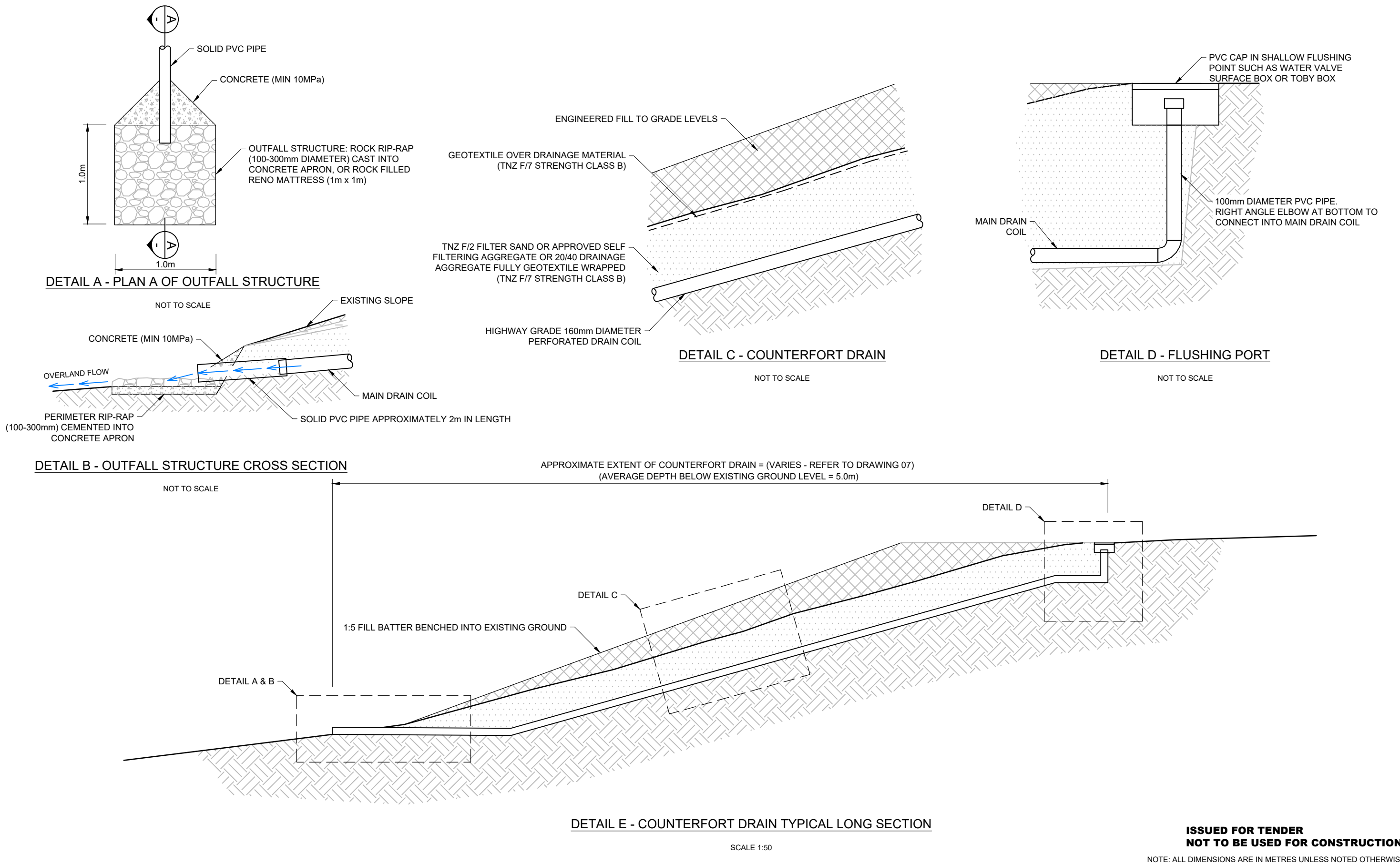


TYPICAL DETAIL #5: UNDERFILL DRAIN

BASE PLAN REFERENCE:



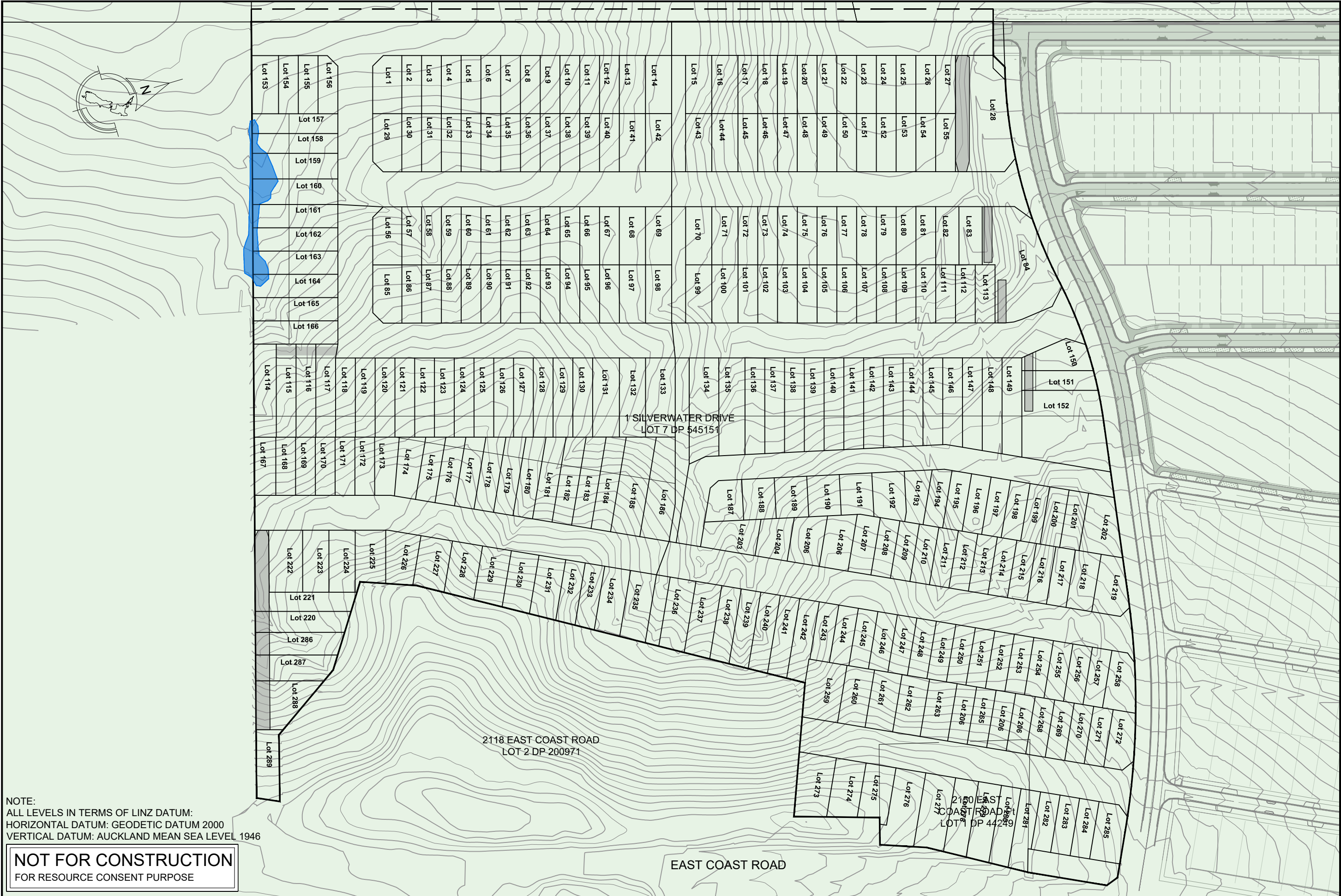
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PROJECT:	SILVERDALE SOUTH - STAGE 3 & 4	CHECKED:	RK	FIGURE:	Drawing: 08
TITLE:	SHEAR KEY AND UNDERFILL DRAINAGE DETAIL	REVISION:	0	SCALE:	NTS
		DATE:	29/04/2021	SHEET:	A3



ISSUED FOR TENDER
NOT TO BE USED FOR CONSTRUCTION
NOTE: ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE

A		ISSUED FOR COMMENT			CLIENT:	BUILD RICH	DRAWN:	PROJECT:
0		ISSUED FOR CONSTRUCTION			PROJECT:	STAGE 3 & 4, SILVERDALE SOUTH	CHECKED: JW	DRAWING: 09
					REVISION: 0	SCALE: NTS		
REV	DATE	DESCRIPTION	BY		TITLE:	COUNTERFORT DRAIN DETAIL	DATE: 10/07/2020	SHEET: A3 L

Appendix A: Aspire Consulting Engineers Development Plans



NOTE:
ALL LEVELS IN TERMS OF LINZ DATUM:
HORIZONTAL DATUM: GEODETIC DATUM 2000
VERTICAL DATUM: AUCKLAND MEAN SEA LEVEL 1946

NOT FOR CONSTRUCTION
FOR RESOURCE CONSENT PURPOSE

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE	1:1500 AT A3	
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					APPROVED	PF	12.21

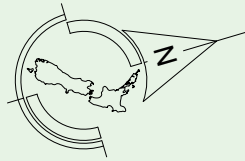
CLIENT
BUILD RICH LIMITED
Conditions of Use: These drawings shall only be used for the purpose for which they were supplied. Do not measure off this drawing. If doubt please contact Engineer.

SITE ADDRESS
2182 EAST COAST ROAD SILVERDALE (STAGE 3 & 4)
DRAWING TITLE
EXISTING SITE PLAN

DRAWING NUMBER	
1628 - RC - PG103	
DATE	REVISION
DEC 2021	-



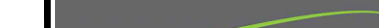
Ph: 09 426 6552
Web: www.aspeng.co.nz



NOTE:
ALL LEVELS IN TERMS OF LINZ DATUM:
HORIZONTAL DATUM: GEODETIC DATUM 2000
VERTICAL DATUM: AUCKLAND MEAN SEA LEVEL 1946

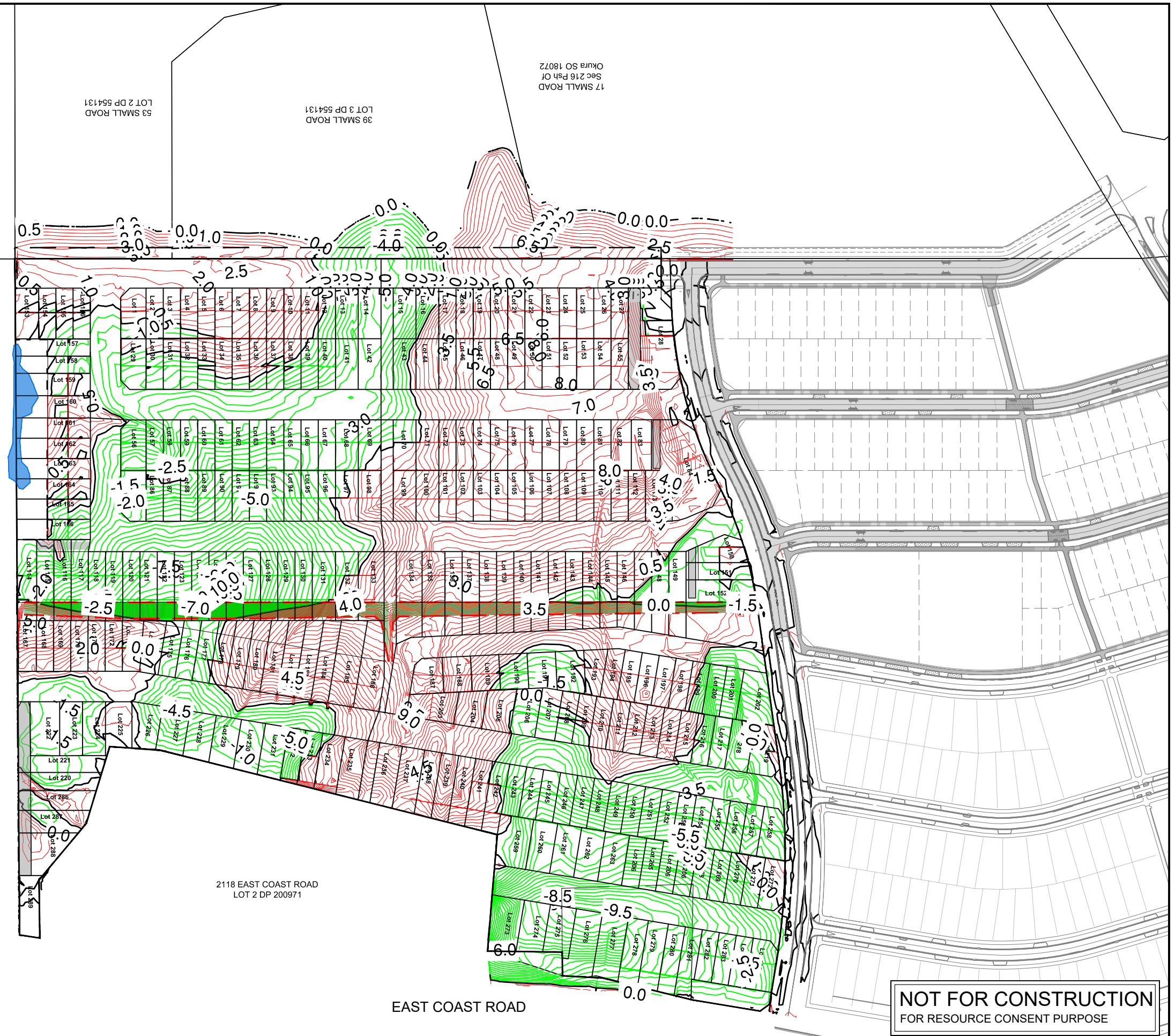
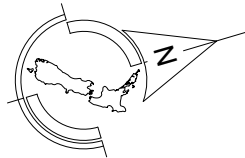
NOT FOR CONSTRUCTION
FOR RESOURCE CONSENT PURPOSE

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				DESIGN	JH	12.21					
				DRAWN	JH	12.21					
				DRAWING CHECK	PF	12.21					
				DESIGN CHECK	PF	12.21	Conditions of Use: <i>These drawings shall only be used for the purpose for which they were supplied. Do not measure off this drawing. If doubt please contact Engineer.</i>				
				APPROVED	PF	12.21					

 Ph: 09 426 6552 Web: www.aspeng.co.nz		
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REV.		DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:1500 AT A3		CLIENT BUILD RICH LIMITED	SITE ADDRESS 2182 EAST COAST ROAD SILVERDALE (STAGE 3 & 4)	DRAWING NUMBER 1628 - RC - EW201		ASPIRE CONSULTING ENGINEERS Ph: 09 426 6552 Web: www.aspeng.co.nz	
						NAME	DATE			DATE			REVISION
					DESIGN	JH	12.21						
					DRAWN	JH	12.21						
					DRAWING CHECK	PF	12.21						
					DESIGN CHECK	PF	12.21						
					APPROVED	PF	12.21	Conditions of Use: These drawings shall only be used for the purpose for which they were supplied. Do not measure off this drawing. If doubt please contact Engineer.		DRAWING TITLE PROPOSED OVERALL CONTOUR PLAN		DEC 2021	-



CUT AND FILL SCHEDULE:			
LOCATION	CUT (m³)	FILL (m³)	AREA (m²)
1 SILVERWATER DRIVE	144,718	208,910	108,097
17 SMALL ROAD	0	4,185	1,393
39 SMALL ROAD	5,169	4,163	3,769
53 SMALL ROAD	0	2,445	1,245
TOTAL	149,881	219,703	114,504

LEGEND

3.0

2.0

CUT AREA:

3.0

2.0

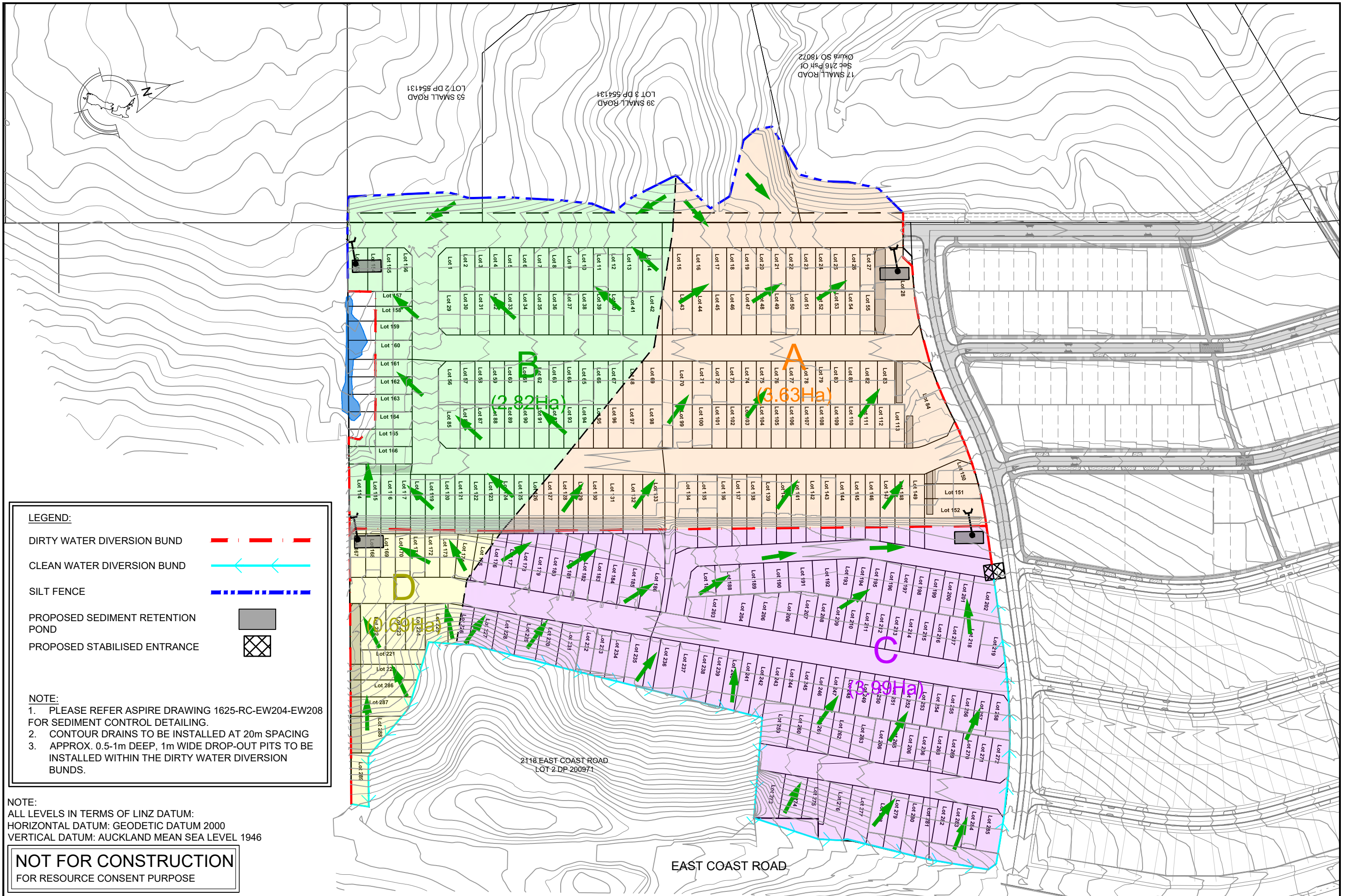
FILL AREA:

NOTE:
ALL LEVELS IN TERMS OF LINZ DATUM:
HORIZONTAL DATUM: GEODETIC DATUM 2000
VERTICAL DATUM: AUCKLAND MEAN SEA LEVEL 1946

NOT FOR CONSTRUCTION
FOR RESOURCE CONSENT PURPOSE

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:2000 AT A3			CLIENT BUILD RICH LIMITED	SITE ADDRESS 2182 EAST COAST ROAD SILVERDALE (STAGE 3 & 4)	DRAWING NUMBER 1628 - RC - EW202	
					NAME	DATE	DATE DEC 2021			REVISION -	
					DESIGN	JH 12.21					
					DRAWN	JH 12.21					
					DRAWING CHECK	PF 12.21					
					DESIGN CHECK	PF 12.21	DRAWING TITLE PROPOSED OVERALL CUT AND FILL CONTOUR PLAN				
					APPROVED	PF 12.21					
								Conditions of Use: <i>These drawings shall only be used for the purpose for which they were supplied. Do not measure off this drawing. If doubt please contact Engineer.</i>			

	
Ph: 09 426 6552 Web: www.aspeng.co.nz	



LEGEND:

- DIRTY WATER DIVERSION BUND
CLEAN WATER DIVERSION BUND
SILT FENCE
PROPOSED SEDIMENT RETENTION POND
PROPOSED STABILISED ENTRANCE

NOTE:

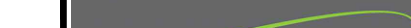
- PLEASE REFER ASPIRE DRAWING 1625-RC-EW204-EW208 FOR SEDIMENT CONTROL DETAILING.
- CONTOUR DRAINS TO BE INSTALLED AT 20m SPACING
- APPROX. 0.5-1m DEEP, 1m WIDE DROP-OUT PITS TO BE INSTALLED WITHIN THE DIRTY WATER DIVERSION BUNDS.

NOTE:

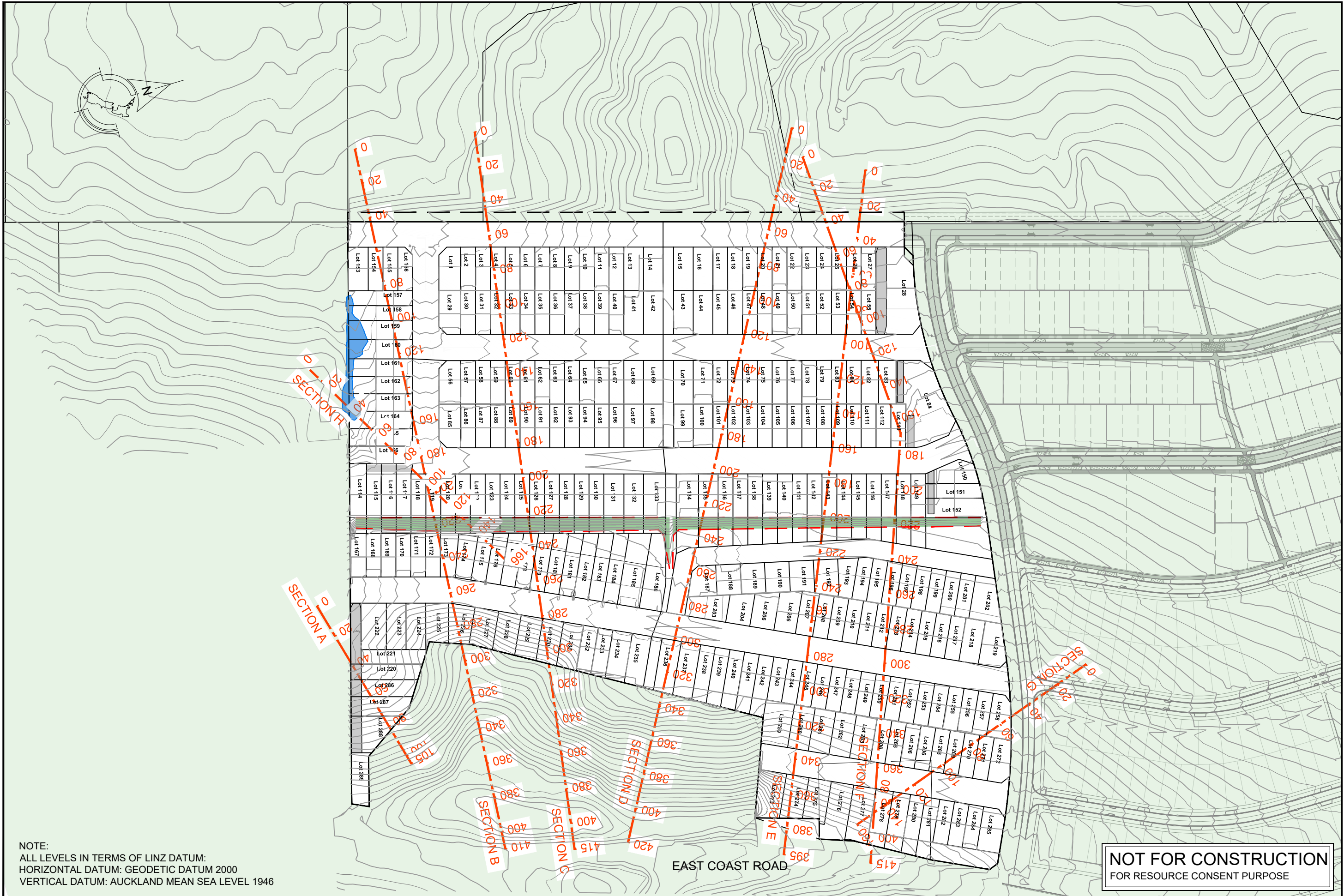
ALL LEVELS IN TERMS OF LINZ DATUM:
HORIZONTAL DATUM: GEODETIC DATUM 2000
VERTICAL DATUM: AUCKLAND MEAN SEA LEVEL 1946

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FOR RESOURCE CONSENT PURPOSE

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:2000 AT A3			CLIENT BUILD RICH LIMITED	SITE ADDRESS 2182 EAST COAST ROAD SILVERDALE (STAGE 3 & 4)	DRAWING NUMBER 1628 - RC - EW203	
					NAME	DATE	DRAWING TITLE PROPOSED EROSION AND SEDIMENT CONTROL PLAN			DATE DEC 2021	REVISION -
					DESIGN	JH 12.21					
					DRAWN	JH 12.21					
					DRAWING CHECK	PF 12.21					
					DESIGN CHECK	PF 12.21	Conditions of Use: <i>These drawings shall only be used for the purpose for which they were supplied. Do not measure off this drawing. If doubt please contact Engineer.</i>				
					APPROVED	PF 12.21					



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REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:2000 AT A3		
					NAME	DATE	
					DESIGN	JH	12.21
					DRAWN	JH	12.21
					DRAWING CHECK	PF	12.21
					DESIGN CHECK	PF	12.21
					APPROVED	PF	12.21

CLIENT
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SITE ADDRESS
2182 EAST COAST ROAD SILVERDALE (STAGE 3 & 4)
DRAWING TITLE
PROPOSED EARTHWORKS SECTIONS PLAN

DRAWING NUMBER	
1628 - RC - EW211	
DATE	REVISION
DEC 2021	-

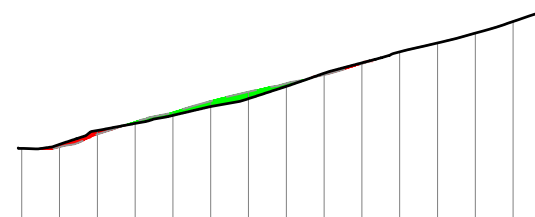


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CUT 

FILL 

VERT EXAG 1:1
Datum 50.000



CHAINAGE	DEPTH	EXISTING LEVELS	DESIGN LEVELS
0			
20			
40	0.35	59.64	59.99
60	-0.73	65.72	64.99
80	0.13	70.65	70.77
100	0.00	76.24	76.24

EARTHWORKS SECTION A

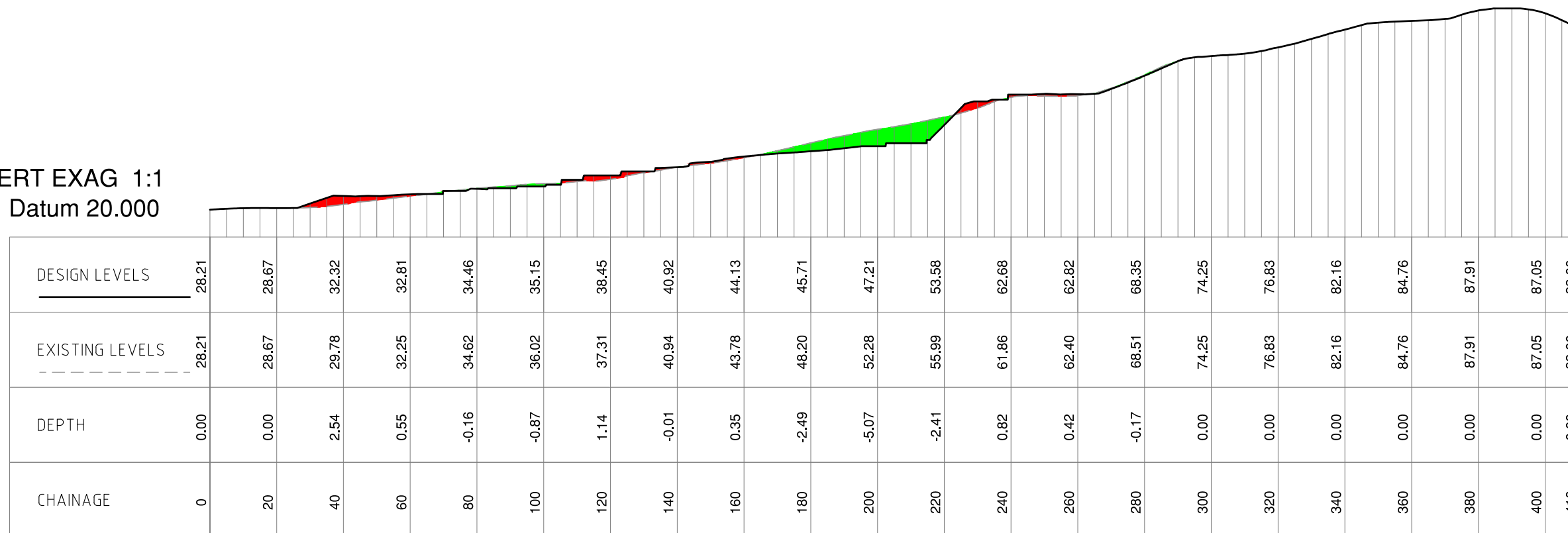
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REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:1000 AT A3			CLIENT BUILD RICH LIMITED	SITE ADDRESS 2182 EAST COAST ROAD SILVERDALE (STAGE 3 & 4)	DRAWING NUMBER 1628 - RC - EW212		 Ph: 09 426 6552 Web: www.aspeng.co.nz	
					NAME	DATE	Conditions of Use: These drawings shall only be used for the purpose for which they were supplied. Do not measure off this drawing. If doubt please contact Engineer.			DRAWING TITLE	DATE		REVISION
					DESIGN	JH 12.21				PROPOSED EARTHWORKS SECTION A	DEC 2021		-
					DRAWN	JH 12.21							
					DRAWING CHECK	PF 12.21							
					DESIGN CHECK	PF 12.21							
					APPROVED	PF 12.21							

CUT 

FILL 

VERT EXAG 1:1
Datum 20.000



EARTHWORKS SECTION B

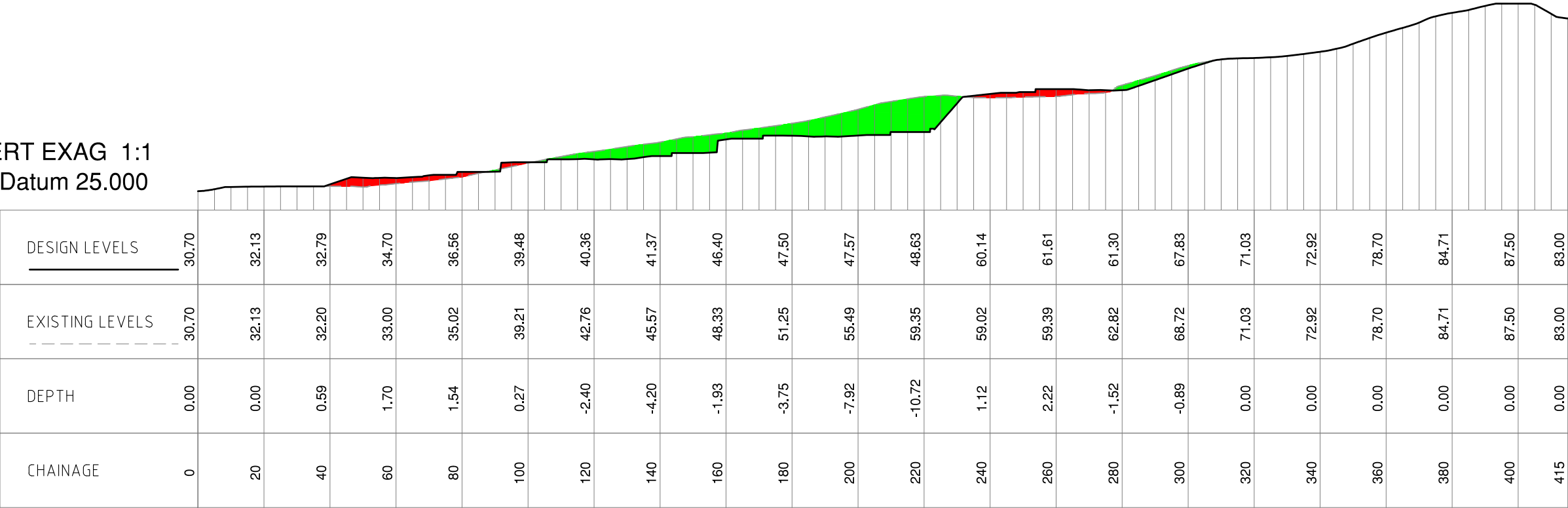
NOT FOR CONSTRUCTION
FOR RESOURCE CONSENT PURPOSE

REV.	DESCRIPTION	CHECK	APPD	DATE	SCALE	1:1500 AT A3		CLIENT BUILD RICH LIMITED	SITE ADDRESS 2182 EAST COAST ROAD SILVERDALE (STAGE 3 & 4)	DRAWING NUMBER 1628 - RC - EW213		 Ph: 09 426 6552 Web: www.aspeng.co.nz	
						NAME	DATE			DRAWING TITLE PROPOSED EARTHWORKS SECTION B	DATE DEC 2021		REVISION -
					DESIGN	JH	12.21						
					DRAWN	JH	12.21						
					DRAWING CHECK	PF	12.21						
					DESIGN CHECK	PF	12.21	Conditions of Use: These drawings shall only be used for the purpose for which they were supplied. Do not measure off this drawing. If doubt please contact Engineer.					
					APPROVED	PF	12.21						

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Datum 25.000



EARTHWORKS SECTION C

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REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:1500 AT A3			CLIENT	SITE ADDRESS	DRAWING NUMBER		
						NAME	DATE	BUILD RICH LIMITED	2182 EAST COAST ROAD SILVERDALE (STAGE 3 & 4)	1628 - RC - EW214		
					DESIGN	JH	12.21			DATE	REVISION	
					DRAWN	JH	12.21					
					DRAWING CHECK	PF	12.21					
					DESIGN CHECK	PF	12.21					
					APPROVED	PF	12.21	Conditions of Use: These drawings shall only be used for the purpose for which they were supplied. Do not measure off this drawing. If doubt please contact Engineer.			DRAWING TITLE PROPOSED EARTHWORKS SECTION C	
									DEC 2021		-	

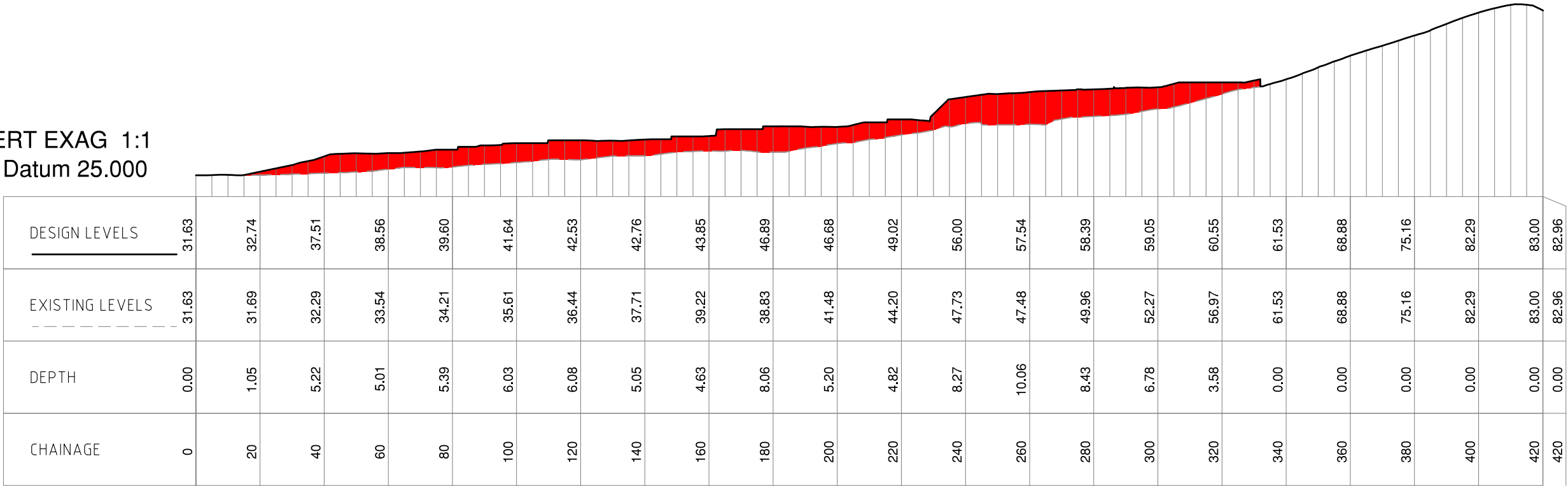


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Web: www.aspeng.co.nz

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Datum 25.000



EARTHWORKS SECTION D

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REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:1500 AT A3			CLIENT BUILD RICH LIMITED	SITE ADDRESS 2182 EAST COAST ROAD SILVERDALE (STAGE 3 & 4)	DRAWING NUMBER 1628 - RC - EW215	
					NAME	DATE	DATE DEC 2021			REVISION -	
					DESIGN	JH 12.21					
					DRAWN	JH 12.21					
					DRAWING CHECK	PF 12.21					
					DESIGN CHECK	PF 12.21	DRAWING TITLE PROPOSED EARTHWORKS SECTION D				
					APPROVED	PF 12.21					
Conditions of Use: <i>These drawings shall only be used for the purpose for which they were supplied. Do not measure off this drawing. If doubt please contact Engineer.</i>											

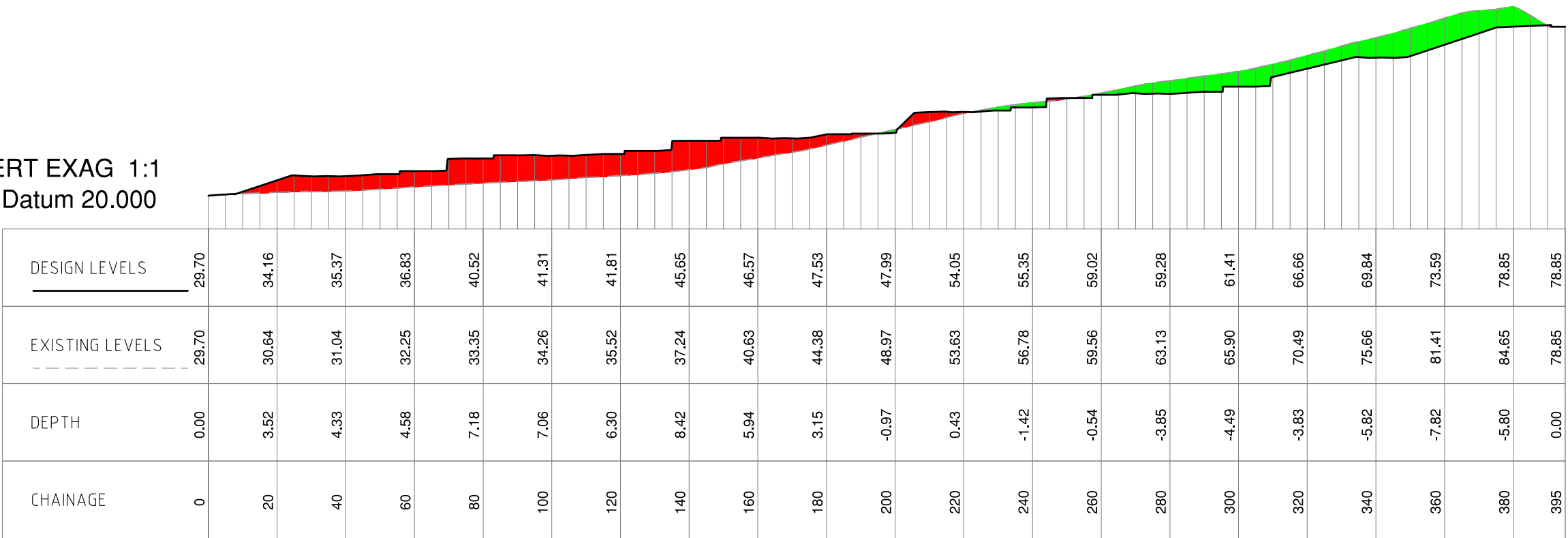


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Web: www.aspeng.co.nz

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Datum 20.000



EARTHWORKS SECTION E

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REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE	1:1500 AT A3
					DESIGN	JH 12.21
					DRAWN	JH 12.21
					DRAWING CHECK	PF 12.21
					DESIGN CHECK	PF 12.21
					APPROVED	PF 12.21

CLIENT
BUILD RICH LIMITED
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SITE ADDRESS
2182 EAST COAST ROAD SILVERDALE (STAGE 3 & 4)
DRAWING TITLE
PROPOSED EARTHWORKS SECTION E

DRAWING NUMBER
1628 - RC - EW216
DATE
DEC 2021
REVISION
-

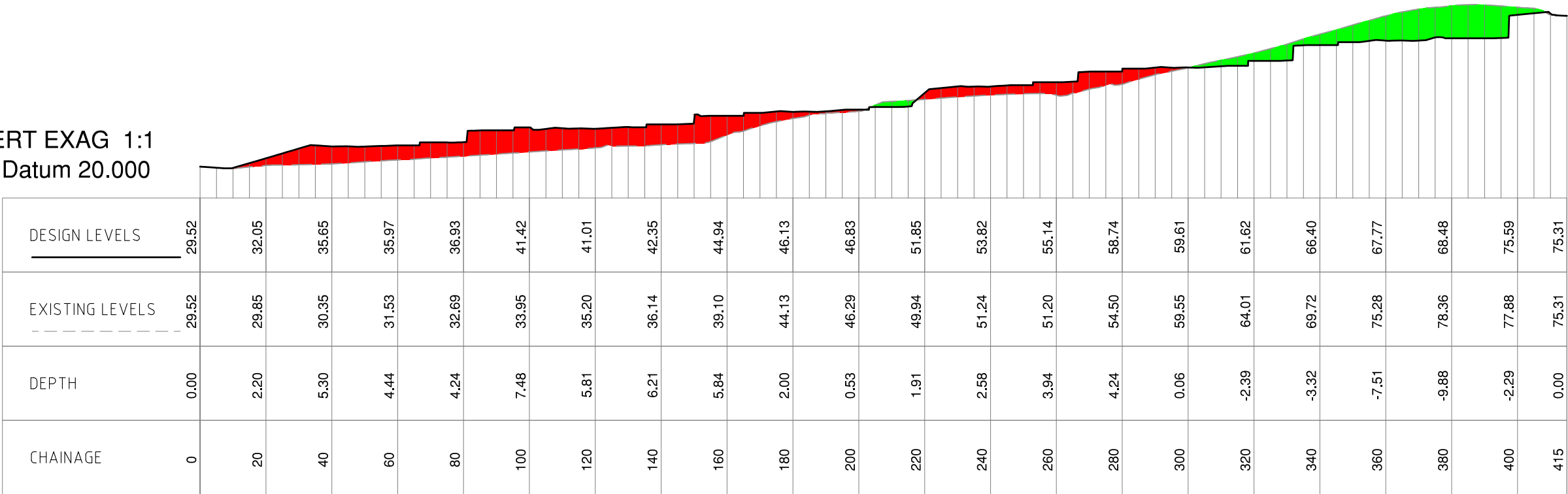
ASPIRE
CONSULTING ENGINEERS

Ph: 09 426 6552
Web: www.aspeng.co.nz

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Datum 20.000



EARTHWORKS SECTION F

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FOR RESOURCE CONSENT PURPOSE

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:1500 AT A3			CLIENT BUILD RICH LIMITED	SITE ADDRESS 2182 EAST COAST ROAD SILVERDALE (STAGE 3 & 4)	DRAWING NUMBER 1628 - RC - EW217	
					NAME	DATE	DRAWING TITLE PROPOSED EARTHWORKS SECTION F			DATE DEC 2021	REVISION -
					DESIGN	JH 12.21					
					DRAWN	JH 12.21					
					DRAWING CHECK	PF 12.21					
					DESIGN CHECK	PF 12.21	Conditions of Use: <i>These drawings shall only be used for the purpose for which they were supplied. Do not measure off this drawing. If doubt please contact Engineer.</i>				
					APPROVED	PF 12.21					

ASPIRE

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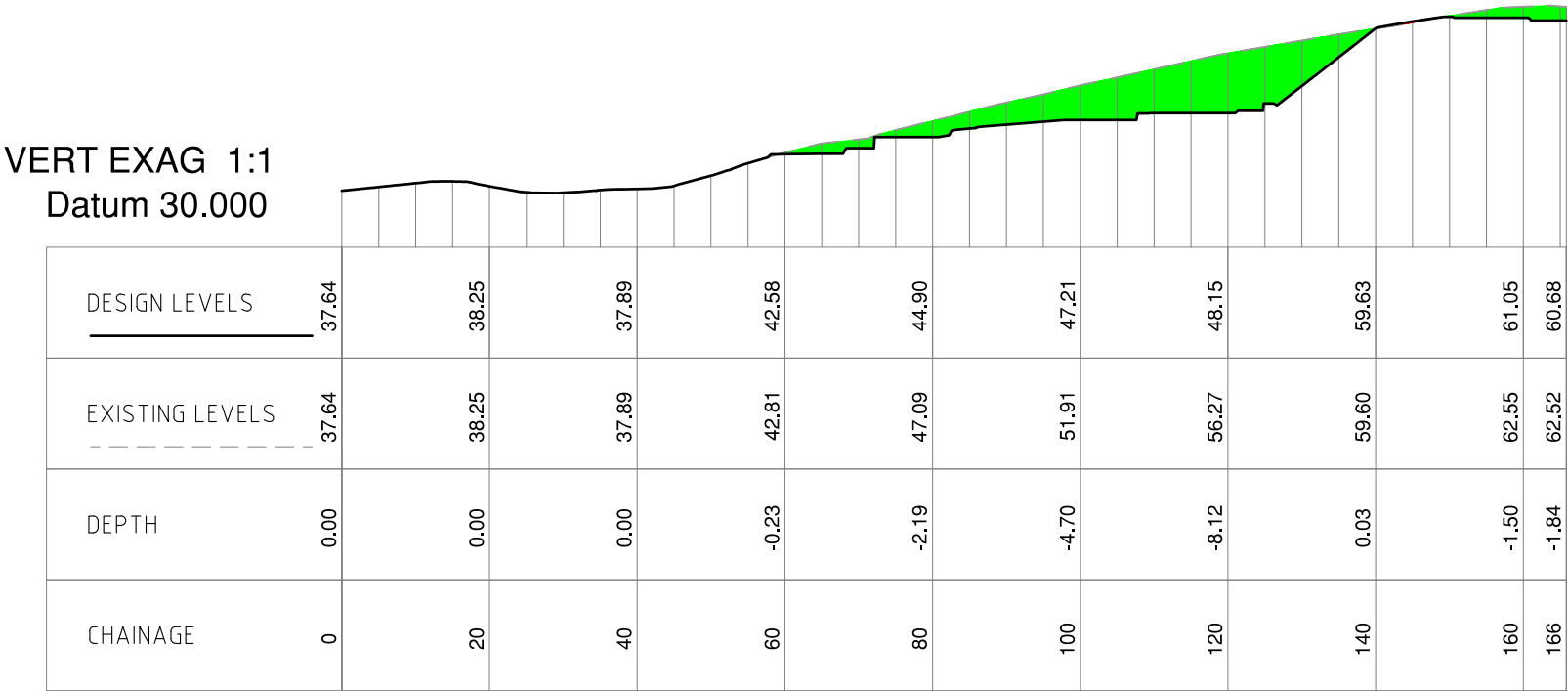
VERT EXAG 1:1
Datum 50.000

EARTHWORKS SECTION G

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:1000 AT A3			CLIENT BUILD RICH LIMITED	SITE ADDRESS 2182 EAST COAST ROAD SILVERDALE (STAGE 3 & 4)	DRAWING NUMBER 1628 - RC - EW218		 Ph: 09 426 6552 Web: www.aspeng.co.nz
					NAME	DATE	DATE					
					DESIGN	JH	12.21					
					DRAWN	JH	12.21					
					DRAWING CHECK	PF	12.21					
					DESIGN CHECK	PF	12.21	DRAWING TITLE PROPOSED EARTHWORKS SECTION G	DATE DEC 2021	REVISION -		
					APPROVED	PF	12.21					
Conditions of Use: These drawings shall only be used for the purpose for which they were supplied. Do not measure off this drawing. If doubt please contact Engineer.												

CUT

FILL



EARTHWORKS SECTION H

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FOR RESOURCE CONSENT PURPOSE

REV.	DESCRIPTION	CHECK	APP'D	DATE	SCALE 1:1000 AT A3			CLIENT BUILD RICH LIMITED	SITE ADDRESS 2182 EAST COAST ROAD SILVERDALE (STAGE 3 & 4)	DRAWING NUMBER 1628 - RC - EW219	
					NAME	DATE	DRAWING TITLE PROPOSED EARTHWORKS SECTION H			DATE DEC 2021	REVISION -
					DESIGN	JH 12.21					
					DRAWN	JH 12.21					
					DRAWING CHECK	PF 12.21					
					DESIGN CHECK	PF 12.21	Conditions of Use: These drawings shall only be used for the purpose for which they were supplied. Do not measure off this drawing. If doubt please contact Engineer.				
					APPROVED	PF 12.21					



Ph: 09 426 6552
Web: www.aspeng.co.nz

Appendix B: Hand Auger Borehole, Test Pit and Machine Borehole Logs 2020 and 2021

HAND AUGER BOREHOLE LOG - HA12-20

Client: Build Rich Limited
 Project: Silverdale South - Stages 3 & 4
 Site Location: Silverdale
 Project No.: AKL2020-0125
 Date: 30/06/2020
 Borehole Location: Refer to Drawing 01



Logged by: TK Checked by: JW Scale: 1:25

Sheet 1 of 1

Position: 391568.9mE; 827626.4mN
 Elevation: 70.49m

Projection: Mount Eden Circuit 2000
 Datum: LINZ, Auckland Vertical 1946

Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Dynamic Cone Penetrometer (Blows/100mm)		
	Depth	Type & Results							5	10	15
30-06-2020 06-06-2020			70.5			TOPSOIL	W				
			70.3			CH: Silty CLAY with trace fine to medium sand: grey mottled orange, high plasticity. (Northland Allochthon)					
	0.4	Peak = 137kPa Residual = 67kPa						VSt			
	0.8	Peak = 123kPa Residual = 59kPa									
	1.2	Peak = 84kPa Residual = 48kPa						St			
	1.6	Peak = 103kPa Residual = 50kPa									
	2.0	Peak = 131kPa Residual = 45kPa				... at 2.00m, ...becoming grey mottled orange.	M to W	VSt			
	2.4	Peak = UTP				Completely weathered, dark grey, MUDSTONE, extremely weak. Weathered to silty CLAY with minor fine to medium sand, low plasticity. (Northland Allochthon)					
	2.8	Peak = UTP						H			
	3.2	Peak = UTP									
	3.6	Peak = UTP				Borehole terminated at 3.6 m					20

Termination Reason: Refusal on Hard Ground

Shear Vane No: 1195 DCP No: 04

Remarks: Groundwater encountered at 2.8m and rose to 2.6m at the end of drilling.

HAND AUGER BOREHOLE LOG - HA13-20

Client: Build Rich Limited
 Project: Silverdale South - Stages 3 & 4
 Site Location: Silverdale
 Project No.: AKL2020-0125
 Date: 30/06/2020
 Borehole Location: Refer to Drawing 01



Logged by: MMC Checked by: JW Scale: 1:25

Sheet 1 of 1

Position: 391419.1mE; 827671.5mN
 Elevation: 43.00m

Projection: Mount Eden Circuit 2000
 Datum: LINZ, Auckland Vertical 1946

Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Dynamic Cone Penetrometer (Blows/100mm)		
	Depth	Type & Results							5	10	15
			43.0			TOPSOIL					
	0.4	Peak = 165kPa Residual = 102kPa		42.8		CL: CLAY minor silt: light grey mottled yellowish orange, low plasticity. (Colluvium)					
	0.8	Peak = 174kPa Residual = 84kPa					D	VSt			
	1.2	Peak = 210kPa+		41.9		CL: CLAY: orange mottled light grey, low plasticity. (Colluvium)					
	1.6	Peak = 210kPa+		41.5		CL: CLAY: bluish grey, low plasticity. (RS Northland Allochthon)					
						Borehole terminated at 1.7 m			6	8	18
										20	
				2							
				3							
				4							
				5							

Termination Reason: Refusal on Hard Ground

Shear Vane No: 1589

DCP No: 02

Remarks: No groundwater encountered.

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 30/06/2020
Borehole Location: Refer to Drawing 01



Sheet 1 of 1

Position: 391538.8mE; 827716.4mN Projection: Mount Eden Circuit 2000
Elevation: 67.72m Datum: LINZ, Auckland Vertical 1946

Survey Source: C & R Surveyors

Termination Reason: Refusal on Hard Ground
Shear Vane No: 1195 DCP No: 04
Remarks: No groundwater encountered.

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 30/06/2020
Borehole Location: Refer to Drawing 01



Sheet 1 of 1

Position: 391375.4mE; 827774.9mN
Elevation: 42.18m

Projection: Mount Eden Circuit 2000
Datum: LINZ Auckland Vertical 1946

Survey Source: C & R Surveyors

Termination Reason: Refusal on Hard Ground
Shear Vane No: 1589 DCP No: 02
Remarks: No groundwater encountered.

HAND AUGER BOREHOLE LOG - HA16-20

Client: Build Rich Limited
 Project: Silverdale South - Stages 3 & 4
 Site Location: Silverdale
 Project No.: AKL2020-0125
 Date: 30/06/2020
 Borehole Location: Refer to Drawing 01



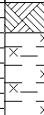
Logged by: TK Checked by: JW Scale: 1:25

Sheet 1 of 1

Position: 391579.4mE; 827791.1mN
 Elevation: 56.50m

Projection: Mount Eden Circuit 2000
 Datum: LINZ, Auckland Vertical 1946

Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)		
	Depth	Type & Results									
									5	10	15
29-06-2020	0.4	Peak = 126kPa Residual = 25kPa	56.5		TOPSOIL	W to S					
			56.4		CH: Silty CLAY with trace fine to medium sand: mottled brown, orange, grey, high plasticity. (Colluvium)						
			56.1		CH: Silty CLAY with trace fine to medium sand: light grey mottled orange, high plasticity. (Northland Allochthon)						
	0.8	Peak = 137kPa Residual = 11kPa				W		VSt			
	1.2	Peak = 168kPa Residual = 20kPa									
	1.6	Peak = > 196kPa									
2.0	Peak = UTP	54.7		Completely weathered, dark grey mottled orange, MUDSTONE, extremely weak. Weathered to silty CLAY with minor fine to medium sand, low plasticity. (Northland Allochthon)	H						
				Borehole terminated at 2.0 m							
										20	

Termination Reason: Refusal on Hard Ground

Shear Vane No: 1195 DCP No: 04

Remarks: Groundwater encountered at the surface.

HAND AUGER BOREHOLE LOG - HA17-20

Client: Build Rich Limited
 Project: Silverdale South - Stages 3 & 4
 Site Location: Silverdale
 Project No.: AKL2020-0125
 Date: 30/06/2020
 Borehole Location: Refer to Drawing 01



Logged by: TK Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 391490.2mE; 827838.1mN Projection: Mount Eden Circuit 2000
 Elevation: 42.82m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Dynamic Cone Penetrometer (Blows/100mm)		
	Depth	Type & Results							5	10	15
			42.8			TOPSOIL					
	0.4	Peak = 95kPa Residual = 53kPa	42.6			CH: Silty CLAY: mottled brown, orange, grey, high plasticity. (Alluvium)		St			
	0.8	Peak = 109kPa Residual = 39kPa	42.2			CH: Silty CLAY with trace fine to medium sand: light grey mottled orange, high plasticity. (Northland Allochthon)					
	1.2	Peak = 151kPa Residual = 81kPa		1			W	VSt			
	1.6	Peak = > 196kPa									
	2.0	Peak = UTP		2		... at 1.80m, ...becoming grey mottled orange.					
	2.4	Peak = UTP	40.5			Completely weathered, dark grey mottled grey, MUDSTONE, extremely weak. Weathered to silty CLAY with minor fine to medium sand, low plasticity. (Northland Allochthon)					
	2.8	Peak = > 196kPa		3							
	3.2	Peak = UTP									
	3.6	Peak = UTP					M	H			
	4.0	Peak = UTP		4							
	4.4	Peak = UTP									
	4.8	Peak = UTP									
	5.0	Peak = UTP		5		Borehole terminated at 5.0 m					

Termination Reason: Target Depth Reached

Shear Vane No: 1195 DCP No:

Remarks: No groundwater encountered.

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 30/06/2020
Borehole Location: Refer to Drawing 01



Sheet 1 of 1

Position: 391438.2mE; 827964.7mN
Elevation: 34.63m

Logged by: MMC Checked by: JW Scale: 1:25

Projection: Mount Eden Circuit 2000
Datum: LINZ, Auckland Vertical 1946

Survey Source: C & R Surveyors

Termination Reason: Unable to Retain Sample			
Shear Vane No:	1589	DCP No:	02
Remarks: Groundwater encountered at 0.8m and rose to 0.5m at the end of drilling.			

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 30/06/2020
Borehole Location: Refer to Drawing 01



Sheet 1 of 1

Position: 391523.7mE; 827962.9mN
Elevation: 45.39m

Projection: Mount Eden Circuit 2000
Datum: LINZ, Auckland Vertical 1946

Survey Source: C & R Surveyors

Termination Reason: Refusal on Hard Ground
Shear Vane No: 1589 DCP No: 04
Remarks: No groundwater encountered.

HAND AUGER BOREHOLE LOG - HA20-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 30/06/2020
Borehole Location: Refer to Drawing 01



Logged by: MMC Checked by: JW Scale: 1:25

Sheet 1 of 1

Position: 391645.4mE; 827957.7mN Projection: Mount Eden Circuit 2000
Elevation: 63.61m Datum: LINZ, Auckland Vertical 1946

Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Dynamic Cone Penetrometer (Blows/100mm)		
	Depth	Type & Results							5	10	15
02-07-2020 30-06-2020			63.6			TOPSOIL					
	0.4	Peak = 105kPa Residual = 57kPa	63.4			CH: CLAY: grey, green mottled orange, high plasticity. (RS Northland Allochthon)	M to W				
	0.8	Peak = 165kPa Residual = 111kPa	62.7			CH: CLAY: bluish grey mottled grey, high plasticity. (RS Northland Allochthon)					
	1.2	Peak = 159kPa Residual = 102kPa		1							
	1.6	Peak = 180kPa Residual = 114kPa				... from 1.70m to 1.90m, ...limonite staining.	D to M				
	2.0	Peak = 156kPa Residual = 99kPa	61.7	2		CL: CLAY: bluish grey mottled greyish yellow, low plasticity. Completely weathered mudstone inclusions (10mm). (Transitional Northland Allochthon)					
	2.4	Peak = 120kPa Residual = 57kPa	61.1			CL: CLAY: bluish grey mottled orange, low plasticity. (Transitional Northland Allochthon)	D				
				3		Borehole terminated at 3.1 m					
									13		
										20	
				4							
				5							

Termination Reason: Refusal on hard ground.

Shear Vane No: 1589

DCP No: 02

Remarks: Initial groundwater @ 1.9m. Groundwater dipped on 2/07/2020 0.9m below ground level.

HAND AUGER BOREHOLE LOG - HA21-20

Client: Build Rich Limited
 Project: Silverdale South - Stages 3 & 4
 Site Location: Silverdale
 Project No.: AKL2020-0125
 Date: 30/06/2020
 Borehole Location: Refer to Drawing 01



Logged by: TK Checked by: JW Scale: 1:25

Sheet 1 of 1

Position: 391721.1mE; 827930.3mN Projection: Mount Eden Circuit 2000
 Elevation: 72.79m Datum: LINZ, Auckland Vertical 1946

Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Dynamic Cone Penetrometer (Blows/100mm)		
	Depth	Type & Results							5	10	15
			72.8			TOPSOIL					
	0.4	Peak = 182kPa Residual = 57kPa	72.6			CH: Silty CLAY with trace fine to medium sand: grey mottled orange and brown, high plasticity. (Northland Allochthon)					
	0.8	Peak = > 196kPa				... at 0.50m, ...becoming light grey mottled orange.		VSt			
	1.2	Peak = > 196kPa		1			W				
	1.6	Peak = > 196kPa				... at 1.80m, ...minor fine to medium sand.		VSt to H			
	2.0	Peak = > 196kPa		2							
	2.4	Peak = UTP				... at 2.70m, ...becoming grey mottled light grey and orange.	D to M				
	2.8	Peak = UTP	69.9			Completely weathered, dark grey, MUDSTONE, extremely weak. Weathered to silty CLAY with minor fine gravel sized mudstone clasts, low plasticity. (Northland Allochthon)	D				
	3.2	Peak = UTP		3							
	3.6	Peak = > 196kPa					H				
	4.0	Peak = UTP		4			M				
	4.4	Peak = UTP									
	4.8	Peak = UTP									
	5.0	Peak = UTP		5		Borehole terminated at 5.0 m					

Termination Reason: Target Depth Reached

Shear Vane No: 1195 DCP No:

Remarks: No groundwater encountered.

Sheet 1 of 1

Survey Source: Hand Held GPS

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA02-21

Client: Build Rich Limited
 Project: Silverdale South - Stages 3 & 4
 Site Location: Silverdale
 Project No.: AKL2020-0125
 Date: 05/08/2021

PRELIMINARY



Borehole Location: Refer to site plan Logged by: CK Checked by: Scale: 1:25 Sheet 1 of 1

Position: 1749406.8mE; 5945039.4mN Projection: NZTM

Elevation: 78.30m

Datum: AUCKHT1946

Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Dynamic Cone Penetrometer (Blows/100mm)		
	Depth	Type & Results							5	10	15
			78.3			OL: TOPSOIL: brown. Low plasticity, with rootlets. (TS)					
			78.2			CH: Silty CLAY with some sand: orange brown streaked light grey. High plasticity, sand is fine grained. (Alluvium)					
	0.4	Peak = UTP				... at 0.50m, ... becoming light grey streaked orange brown		VSt			
	0.8	Peak = >207kPa	77.5			ML: Clayey SILT with some sand: light grey streaked orange brown. Low plasticity, sand is fine grained. (Alluvium)	D				
	1.2	Peak = UTP	77.1			SP: Silty SAND: light grey streaked orange. Sand is fine grained, poorly graded. (Alluvium)		MD	10	14	
			76.7			SP: SAND: light grey. Sand is fine grained, poorly graded. (Alluvium)			10	15	
						Borehole terminated at 1.7 m			8		
										20	
				2							
				3							
				4							
				5							

Termination Reason: Refusal on hard ground. DCP refusal at 1.7m.

Shear Vane No: 2904

DCP No: 05

Remarks: No groundwater encountered.

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 22/09/2021



Position: 1749082.1mE; 5945084.7mN Projection: NZTM
Elevation: 37.30m Datum: AUCKHT1

Survey Source: Hand Held GPS

Termination Reason: Refusal on hard ground. DCP refusal at 2.2m.
 Shear Vane No: 2904 DCP No: 19
 Remarks: No groundwater encountered.

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 22/09/2021



Sheet 1 of 1

Survey Source: Hand Held GPS

Remarks: No groundwater encountered.

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 22/09/2021



Position: 1749068.2mE; 5945054.0mN Projection: NZTM
Elevation: 46.80m Datum: AUCKHT1

Survey Source: Hand Held GPS

Termination Reason: Refusal on hard ground. DCP refusal at 1.4m.
 Shear Vane No: 2904 DCP No: 19
 Remarks: No groundwater encountered.

HAND AUGER BOREHOLE LOG - HA06-21

Client: Build Rich Limited
 Project: Silverdale South - Stages 3 & 4
 Site Location: Silverdale
 Project No.: AKL2020-0125
 Date: 22/09/2021



Borehole Location: Refer to site plan Logged by: CK Checked by: SP Scale: 1:25 Sheet 1 of 1

Position: 1749053.2mE; 5945000.3mN Projection: NZTM
 Elevation: 38.50m Datum: AUCKHT1946 Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Dynamic Cone Penetrometer (Blows/100mm)		
	Depth	Type & Results							5	10	15
			38.5			OL: TOPSOIL: SILT, brown.					
			38.4			ML: Clayey SILT with some sand and fine to coarse gravel sized siltstone fragments: orange brown streaked light grey. Low plasticity. Sand: fine grained. Siltstone: completely weathered, subangular. (Residual Soil)	D	H			
						Borehole terminated at 0.6 m					
										14	
										18	
										20	
				1							
				2							
				3							
				4							
				5							

Termination Reason: Refusal on hard ground. DCP refusal at 0.8m.

Shear Vane No: DCP No: 19

Remarks: No groundwater encountered.

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 22/09/2021



Sheet 1 of 1

Survey Source: Hand Held GPS

Remarks: No groundwater encountered.

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 01/07/2020



Position: 391530.5mE; 827633.8mN	Projection: Mount Eden Circuit 2000	Pit Dimensions: 3.0m by 0.8m
Elevation: 62.87m	Datum: LINZ, Auckland Vertical 1946	Survey Source: C & R Survey

Termination Reason: Target depth reached
Shear Vane No: 1589 DCP No:
Remarks: No groundwater encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

TEST PIT PHOTOGRAPHS: TP16-20

Client: Build Rich Limited
Project: Silverdale South – Stages 3 & 4
Location: Silverdale, Auckland
Project No: AKL2020-0125
Date: 1/7/2020



Logged by: MMC	Position: 391530.493 & 827633.783	Dimensions: 3.0m x 0.8m	Plant: 12.5 Tonne
Checked by:	Elevation: 62.869	Termination Depth: 4.0m	Contractor: Abernethy Projects



TP16 -20 – TEST PIT EXCAVATION

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 01/07/2020



Sheet 1 of 1

Elevation:Elevation: 34.30m

Survey Source: C & R Surveyors

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

TEST PIT PHOTOGRAPHS: TP17-20

Client: Build Rich Limited

Project: Silverdale South – Stages 3 & 4

Location: Silverdale, Auckland

Project No: AKL2020-0125

Date: 1/7/2020



Logged by: MMC

Position: E:391337.865 N:827688.104

Dimensions: 3.0m x 0.8m

Plant: 12.5 Tonne

Checked by:

Elevation: 34.300

Termination Depth: 4.0m

Contractor: Abernethy Projects



TP17-20 – TEST PIT EXCAVATION

TEST PIT LOG - TP18-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 01/07/2020



Test Pit Location: Refer to Drawing 01 Logged by: MMC Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 391508.5mE; 827693.4mN Projection: Mount Eden Circuit 2000 Pit Dimensions: 3.0m by 0.8m
Elevation: 62.98m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Dynamic Cone Penetrometer (Blows/100mm)				Structure & Other Observations Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
	Depth	Type & Results							5	10	15	20	
			63.0			TOPSOIL							
	0.5	Peak = 210+ kPa				CL: Silty CLAY: orange mottled light grey, low plasticity. (Colluvium)	M						
	1.0	Peak = 210+ kPa		1									
	1.5	Peak = UTP											
			61.2			CL: CLAY: yellowish orange, low plasticity. (RS Northland Allochthon)							
	2.0	Peak = 210+ kPa		2			VSt to H						
	2.5	Peak = UTP											
	3.0	Peak = UTP		3									
			59.8			CL: CLAY with minor silt: bluish grey, low plasticity, with completely weathered SILTSTONE inclusions (10mm). (Transitional Northland Allochthon)	D						
	3.5	Peak = UTP											
	4.0	Peak = UTP		4									
			58.8			Completely weathered to highly weathered SILTSTONE, bluish grey. Extremely weak to very weak. Weathered to silty CLAY, low plasticity. (Northland Allochthon)	H						
				5		Test pit terminated at 5.00 m							

Termination Reason: Target depth reached

Shear Vane No: 1589 DCP No:

Remarks: No groundwater encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

TEST PIT PHOTOGRAPHS: TP18-20

Client: Build Rich Limited

Project: Silverdale South – Stages 3 & 4

Location: Silverdale, Auckland

Project No: AKL2020-0125

Date: 1/7/2020



Logged by: MMC

Position: E;391508.483 N:827693.363

Dimensions: 3.0m x 0.8m

Plant: 12.5 Tonne

Checked by:

Elevation: 62.985

Termination Depth: 4.2m

Contractor: Abernethy Projects



TP18-20 – TEST PIT EXCAVATION

TEST PIT LOG - TP19-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 02/07/2020



Test Pit Location: Refer to Drawing 01 Logged by: MMC Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 391431.9mE; 827752.7mN Projection: Mount Eden Circuit 2000 Pit Dimensions: 3.0m by 0.8m
Elevation: 51.00m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
	Depth	Type & Results								
			51.0			TOPSOIL				
			50.8			CH: CLAY minor silt: orange brown, high plasticity. (Colluvium)	M			
	0.5	Peak = 135kPa Residual = 102kPa	50.4			CH: Silty CLAY with trace fine grained sand: bluish grey, high plasticity, with completely weathered SILTSTONE inclusions. (RS Northland Allochthon)	VSt			
	1.0	Peak = 90kPa Residual = 54kPa		1		... from 1.30m to 1.40m, ...limonite streaks.	St			
	1.5	Peak = UTP	49.5			Completely weathered SILTSTONE, bluish grey. Extremely weak. Weathered to silty CLAY, low plasticity. (Transitional Northland Allochthon)				
	2.0	Peak = UTP		2						
	2.5	Peak = UTP	48.4			Completely weathered to highly weathered SILTSTONE, bluish grey. Extremely weak to very weak. (Northland Allochthon)	D	VSt to H		
	3.0	Peak = UTP		3						
	3.5	Peak = UTP								
	4.0	Peak = UTP		4		Test pit terminated at 4.00 m				
				5						

Termination Reason: Target depth reached

Shear Vane No: 1589 DCP No:

Remarks: No groundwater encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

TEST PIT PHOTOGRAPHS: TP19-20

Client: Build Rich Limited

Project: Silverdale South – Stages 3 & 4

Location: Silverdale, Auckland

Project No: AKL2020-0125

Date: 1/7/2020



Logged by: MMC

Position: E:391431.916 N:827752.722

Dimensions: 3.0m x 0.8m

Plant: 12.5 Tonne

Checked by:

Elevation: 50.997

Termination Depth: 4.0m

Contractor: Abernethy Projects



TP19-20 – TEST PIT EXCAVATION

TEST PIT LOG - TP20-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 01/07/2020



Test Pit Location: Refer to Drawing 01 Logged by: MMC Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 391315.6mE; 827770.6mN Projection: Mount Eden Circuit 2000 Pit Dimensions: 3.0m by 0.8m
Elevation: 33.30m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Dynamic Cone Penetrometer (Blows/100mm)				Structure & Other Observations Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
	Depth	Type & Results							5	10	15	20	
			33.3			TOPSOIL							
	0.5	Peak = 114kPa Residual = 63kPa				CH: Silty CLAY: brown grey streaked orange, high plasticity. (Alluvium) ... at 0.30m, ...limonite streaks.	M						
	1.0	Peak = 105kPa Residual = 51kPa		1									
	1.5	Peak = 150kPa Residual = 87kPa											
	2.0	Peak = 210+ kPa		2		CH: Silty CLAY: bluish grey, high plasticity. (RS Northland Allochthon)							
	2.5	Peak = 114kPa Residual = 63kPa					VSt						
	3.0	Peak = 135kPa Residual = 84kPa		3		MH: Clayey SILT with fine to medium sized SILTSTONE clasts (5mm-10mm): bluish grey, high plasticity. (Transitional Northland Allochthon)	M to W						
	3.5	Peak = UTP											
	4.0	Peak = UTP		4		Completely weathered SILTSTONE, bluish grey. Extremely weak to very weak. Weathered to silty CLAY, low plasticity. (Northland Allochthon)	D						
				5		Test pit terminated at 4.90 m							

Termination Reason: Target depth reached

Shear Vane No: 1589

DCP No:

Remarks: Hole beginning to collapse @ 3.0m, benched out to re mediate. Stopped shear vanes due to collapse/instability.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

TEST PIT PHOTOGRAPHS: TP20-20

Client: Build Rich Limited

Project: Silverdale South – Stages 3 & 4

Location: Silverdale, Auckland

Project No: AKL2020-0125

Date: 1/7/2020



Logged by: MMC

Position: E:391315.594 N:827770.572

Dimensions: 3.0m x 0.8m

Plant: 12.5 Tonne

Checked by:

Elevation: 33.296

Termination Depth: 4.9m

Contractor: Abernethy Projects



TP20-20 – TEST PIT EXCAVATION

TEST PIT LOG - TP21-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 02/07/2020



Test Pit Location: Refer to Drawing 01 Logged by: MMC Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 391564.6mE; 827754.8mN Projection: Mount Eden Circuit 2000 Pit Dimensions: 3.0m by 1.0m
Elevation: 63.99m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
	Depth	Type & Results								
			64.0			TOPSOIL				
	0.5	Peak = 90kPa Residual = 84kPa				CL: Silty CLAY: orange brown, low plasticity (slump debris). (Colluvium)	St			
	1.0	Peak = 105kPa Residual = 84kPa		1			M			
	1.5	Peak = UTP	62.5			CL: CLAY minor silt: greyish brown mottled orange, low plasticity. (RS Northland Allochthon)				
	2.0	Peak = UTP		2						
	2.5	Peak = UTP	61.7			Completely weathered to highly weathered SILTSTONE, bluish grey. Extremely weak to very weak. Weathered to silty CLAY, low plasticity. Blocky structure. (Northland Allochthon)	VSt to H			
	3.0	Peak = UTP		3			D			
	3.5	Peak = UTP				Test pit terminated at 3.50 m				
				4						
				5						

Termination Reason: Unable to continue due to instability and collapse.

Shear Vane No: 1589

DCP No:

Remarks: Hole collapsed to 2.0m. Rock encountered @ 2.3m. No groundwater encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

TEST PIT PHOTOGRAPHS: TP21-20

Client: Build Rich Limited

Project: Silverdale South – Stages 3 & 4

Location: Silverdale, Auckland

Project No: AKL2020-0125

Date: 1/7/2020



Logged by: MMC

Position: E:391564.650 N:827754.754

Dimensions: 3.0m x 1.0m

Plant: 12.5 Tonne

Checked by:

Elevation: 63.993

Termination Depth: 3.5m

Contractor: Abernethy Projects



TP21-20– TEST PIT EXCAVATION

TEST PIT LOG - TP22-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 01/07/2020



Test Pit Location: Refer to Drawing 01 Logged by: MMC Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 391366.9mE; 827827.0mN Projection: Mount Eden Circuit 2000 Pit Dimensions: 3.0m by 0.8m
Elevation: 42.91m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
	Depth	Type & Results								
			42.9			TOPSOIL				
	0.5	Peak = 210+ kPa				CL: Silty CLAY: orange mottled yellowish grey, low plasticity. (RS Northland Allochthon)				
	1.0	Peak = UTP		1						
	1.5	Peak = UTP								
	2.0	Peak = UTP		2						
	2.5	Peak = UTP				CL: CLAY: greyish yellow mottled orange, low plasticity. (RS Northland Allochthon) ... at 2.60m, ...limonite staining and limonite nodules.				
	3.0	Peak = UTP		3						
	3.5	Peak = UTP				Completely weathered SILTSTONE, greyish blue. Extremely weak. Weathered to silty CLAY, low plasticity. Blocky structure, crumbling when disturbed. (Transitional Northland Allochthon)				
	4.0	Peak = UTP		4		Completely weathered to highly weathered SILTSTONE, bluish grey. Extremely weak to very weak. (Northland Allochthon)				
						Test pit terminated at 4.20 m				
				5						

Termination Reason: Target depth reached

Shear Vane No: 1589 DCP No:

Remarks: Groundwater not encountered.

TEST PIT PHOTOGRAPHS: TP22-20

Client: Build Rich Limited

Project: Silverdale South – Stages 3 & 4

Location: Silverdale, Auckland

Project No: AKL2020-0125

Date: 1/7/2020



Logged by: MMC

Position: E:391366.925 N:827826.960

Dimensions: 3.0m x 0.8m

Plant: 12.5 Tonne

Checked by:

Elevation: 42.909

Termination Depth: 3.5m

Contractor: Abernethy Projects



TP22-20 – TEST PIT EXCAVATION

TEST PIT LOG - TP23-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 01/07/2020



Test Pit Location: Refer to Drawing 01 Logged by: MMC Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 391431.0mE; 827887.5mN Projection: Mount Eden Circuit 2000 Pit Dimensions: 3.0m by 0.8m
Elevation: 36.96m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Dynamic Cone Penetrometer (Blows/100mm)				Structure & Other Observations Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
	Depth	Type & Results							5	10	15	20	
			37.0			TOPSOIL							
	0.5	Peak = 120kPa Residual = 75kPa				CH: CLAY minor silt: orange brown mottled light grey, high plasticity. (RS Northland Allochthon)							
	1.0	Peak = 165kPa Residual = 84kPa		1									
	1.5	Peak = 180kPa Residual = 93kPa				CH: Silty sandy CLAY: greyish brown with orange streaks, high plasticity. (RS Northland Allochthon)	M						
	2.0	Peak = 162kPa Residual = 87kPa		2			VSt						
	2.5	Peak = UTP											
	3.0	Peak = 210+ kPa				Completely weathered SILTSTONE with trace sand, bluish grey (Powdery, some completely weathered rock inclusions). (Transitional Northland Allochthon)							
	3.5	Peak = 210+ kPa											
	4.0	Peak = UTP				Completely weathered to highly weathered SILTSTONE, dark bluish grey. Extremely weak to very weak, powdery. (Northland Allochthon)	D						
				4		Test pit terminated at 4.00 m							
				5									

Termination Reason: Target depth reached

Shear Vane No: 1589 DCP No:

Remarks: No groundwater encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

TEST PIT PHOTOGRAPHS: TP23-20

Client: Build Rich Limited
Project: Silverdale South – Stages 3 & 4
Location: Silverdale, Auckland
Project No: AKL2020-0125
Date: 1/7/2020



Logged by: MMC

Position: E:391430.952 N:827887.467

Dimensions: 3.0m x 0.8m

Plant: 12.5 Tonne

Checked by:

Elevation: 36.955

Termination Depth: 4.0m

Contractor: Abernethy Projects



TP23-20 – TEST PIT EXCAVATION

TEST PIT LOG - TP24-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 01/07/2020



Test Pit Location: Refer to Drawing 01 Logged by: MMC Checked by: JW Scale: 1:25 Sheet 1 of 1

Position: 391371.2mE; 827915.7mN Projection: Mount Eden Circuit 2000 Pit Dimensions: 3.0m by 0.8m
Elevation: 34.19m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
	Depth	Type & Results								
			34.2			TOPSOIL				
	0.5	Peak = UTP				CL: CLAY minor silt: orange brown mottled brown grey, low plasticity. (Colluvium)				
	1.0	Peak = UTP		1						
	1.5	Peak = UTP				CL: Silty CLAY: brownish grey with orange streaks, low plasticity. (Colluvium)				
	2.0	Peak = UTP		2			D	VSt to H		
	2.5	Peak = UTP								
	3.0	Peak = UTP		3		CL: CLAY: purple red, low plasticity, becoming completely weathered SILTSTONE extremely weak. (Transitional Northland Allochthon)				
	3.5	Peak = UTP				Highly weathered SILTSTONE, bluish grey. Extremely weak to very weak. (Northland Allochthon)				
	4.0	Peak = UTP		4		Test pit terminated at 4.00 m				
				5						

Termination Reason: Target depth reached

Shear Vane No: 1589 DCP No:

Remarks: No groundwater encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

TEST PIT PHOTOGRAPHS: TP24-20

Client: Build Rich Limited

Project: Silverdale South – Stages 3 & 4

Location: Silverdale, Auckland

Project No: AKL2020-0125

Date: 1/7/2020



Logged by: MMC

Position: E:391371.237 N:827915.718

Dimensions: 3.0m x 0.8m

Plant: 12.5 Tonne

Checked by:

Elevation: 34.194

Termination Depth: 3.5m

Contractor: Abernethy Projects



TP24-20 – TEST PIT EXCAVATION

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 01/07/2020



Sheet 1 of 1

Survey Source: C & R Surveyors

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

TEST PIT PHOTOGRAPHS: TP25-20

Client: Build Rich Limited

Project: Silverdale South – Stages 3 & 4

Location: Silverdale, Auckland

Project No: AKL2020-0125

Date: 1/7/2020



Logged by: MMC

Position: E:391645.093 N:827879.000

Dimensions: 3.0m x 0.8m

Plant: 12.5 Tonne

Checked by:

Elevation: 70.085

Termination Depth: 4.0m

Contractor: Abernethy Projects



TP25-20 – TEST PIT EXCAVATION

BOREHOLE LOG - MH07-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 03/07/2020
Borehole Location: Refer to Drawing 01



Logged by: FZ Checked by: JW Scale: 1:50 Sheet 1 of 2

Position: 391667.9mE; 827941.9mN Projection: Mount Eden Circuit 2000 Angle from horizontal: 90°
Elevation: 67.99m Datum: LINZ, Auckland Vertical 1946 Survey Source: C & R Surveyors

Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Recovery	Drilling Method/Support	Dynamic Cone Penetrometer (Blows/100mm)			Structure & Other Observations Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
		Depth	Type & Results									5	10	15	
				68.0			TOPSOIL								
				67.8			CH: Silty CLAY: light orange brown, high plasticity. (Northland Allochthon)								
							... at 0.80m, ...becoming light orange brown streaked orange and light grey.								
							... from 1.10m to 1.40m, ...with some fine sand.								
		1.5	Peak = 120kPa Residual = 30kPa SPT = (1,3,6) N* = 9		1					100	TT / HQ3				
		1.5			2					67	SPT				
							... at 2.20m, ...trace limonite staining.			100	TT / HQ3				
		3.0	Peak = 48kPa Residual = 7kPa SPT = (4,4,6) N* = 10		3		CH: Silty CLAY with medium to coarse gravel sized completely weathered mudstone clasts: light bluish grey, high plasticity. (Northland Allochthon)			33	SPT				
		3.0			4					100	TT / HQ3				
		4.5	SPT = (14,22,18) N* = 40 Peak = UTP		5		MUDSTONE: light bluish grey with light brownish grey mottles. Completely weathered to silty CLAY with medium to coarse gravel sized mudstone inclusions. Highly fractured. (Northland Allochthon)			44	SPT				4.5-6.4m:7,B,ST,R,OP,IF,(CL),
		4.5			6					48	TT / HQ3				
		6.0	SPT = (12,13,15) N* = 28		7		... at 6.50m, ...poor recovery due to highly fractured rock.			44	SPT				6.4-9.0m:8,B,ST,R,OP,IF,(CL),
										38	TT / HQ3				
		7.5	SPT = (5,5,10) N* = 15		8					56	SPT				
										43	TT / HQ3				
		9.0	SPT = (5,9,13) N* = 22		9					78	SPT				9.4-10.5m:3,B,ST,R,IF,(CL),
										35	TT / HQ3				
					10										

Termination Reason: Target Depth Reached

Shear Vane No: DCP No:

Remarks: Single piezometer installed from 0.0m to 12.0m. Hole collapse from 12.0m to 15.0m prior to piezo installation.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

BOREHOLE LOG - MH07-20

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 03/07/2020
Borehole Location: Refer to Drawing 01



Logged by: FZ Checked by: JW Scale: 1:50 Sheet 2 of 2

Position: 391667.9mE; 827941.9mN
Elevation: 67.99m

Projection: Mount Eden Circuit 2000
Datum: LINZ, Auckland Vertical 1946

Angle from horizontal: 90°
Survey Source: C & R Surveyors

Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Recovery	Drilling Method/Support	Dynamic Cone Penetrometer (Blows/100mm)			Structure & Other Observations Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
		Depth	Type & Results									5	10	15	
		10.5	SPT = (5,8,14) N* = 22				... from 10.40m to 10.50m, ...becoming angular medium gravel sized mudstone clasts.								10.5-12.0m:8.B,ST,R,OP,IF, (CL),
					11					78	SPT				
										52	TT / HQ3				
		12.0	SPT = (15,29,25/22mm (Run over)) N* = 50 +	56.0	12		MUDSTONE: light bluish grey. Mudstone weathered to silty CLAY with medium to coarse gravel sized clasts. Highly fractured. (Northland Allochthon)			78	SPT				12.4-13.5m:5.B,ST,R,OP,IF, (CL),
					13					43	TT / HQ3				
		13.5	SPT = (12,34,16/20mm) N* = 50+							63	SPT				
					14		MUDSTONE: light bluish grey. Highly fractured with highly weathered angular medium gravel sized mudstone clasts. (Northland Allochthon)			51	TT / HQ3				14.0-15.0m:4.B,ST,R,OP,IF, (CL),
		15.0	SPT = (20,30/60mm) N* = 50+		15		Borehole terminated at 15.0 m			97	SPT				
					16										
					17										
					18										
					19										
					20										

Termination Reason: Target Depth Reached

Shear Vane No: DCP No:

Remarks: Single piezometer installed from 0.0m to 12.0m. Hole collapse from 12.0m to 15.0m prior to piezo installation.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

BOREHOLE CORE PHOTOGRAPHS: MH07-20

Client: Build Rich Limited

Project: Silverdale South Stage 3 & 4

Location: Refer to Drawing 01

Project No: AKL2020-0125

Date: 03/07/2020

Logged by: FYZ

Position: E.1749410.0m N.5945111.0m

Hole Diameter: 95mm

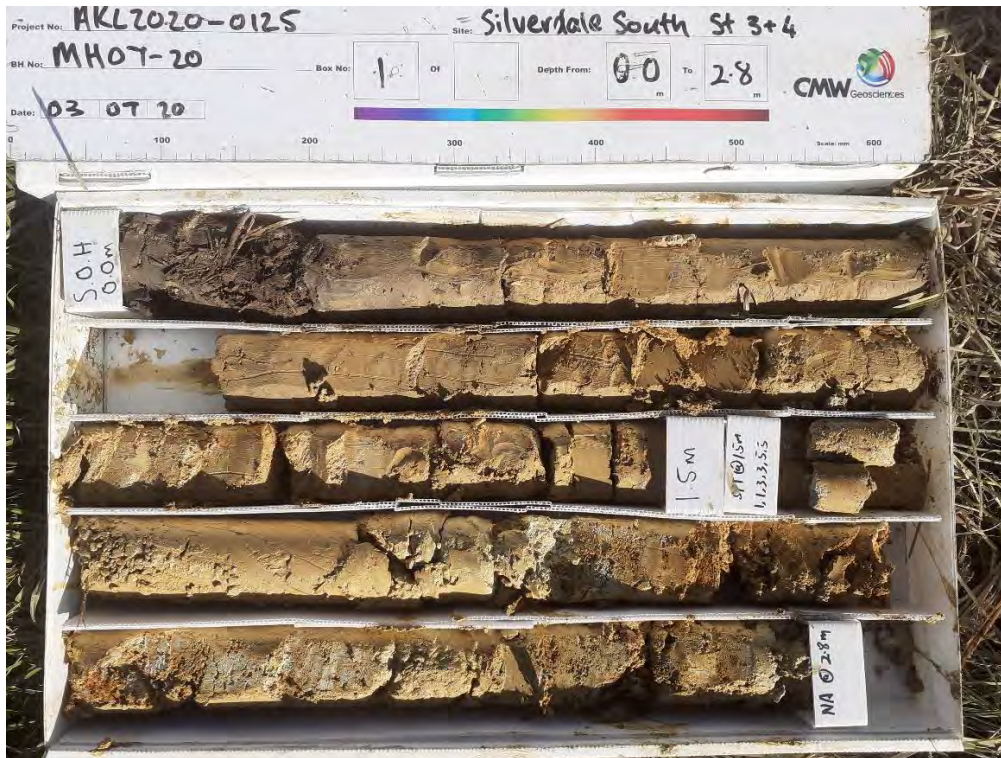
Plant: Excavator Rig

Checked by:

Elevation: RL 67.70m

Angle from Horizontal: 90°

Contractor: McMillan Drilling



MH07-20: 0.00m to 2.80m



MH07-20: 2.80m to 9.00m

This report of boreholes must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination.

BOREHOLE CORE PHOTOGRAPHS: MH07-20

Client: Build Rich Limited

Project: Silverdale South Stage 3 & 4

Location: Refer to Drawing 01

Project No: AKL2020-0125

Date: 03/07/2020

Logged by: FYZ

Position: E.1749410.0m N.5945111.0m

Hole Diameter: 95mm

Plant: Excavator Rig

Checked by:

Elevation: RL 67.70m

Angle from Horizontal: 90°

Contractor: McMillan Drilling



MH07-20: 9.00m to 15.00m

BOREHOLE LOG - MH01-21

Client: Build Rich Limited

Project: Silverdale South - Stages 3 & 4

Site Location: Silverdale

Project No.: AKL2020-0125

Date: 06/08/2021

Borehole Location: Refer to site plan

PRELIMINARY



Logged by: LSW

Checked by:

Scale: 1:50

Sheet 1 of 1

Position: 1749109.0mE; 5945143.0mN Projection: NZTM

Elevation: 30.80m

Datum: AUCKHT1946

Survey Source: Hand Held GPS

Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Weathering							Recovery	RQD	Estimated Strength					Defect Spacing (mm)					Drilling Method/Support	Structure & Other Observations Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks			
		Depth	Type & Results							RS	CW	HW	MW	SW	UW	EW			VW	W	MS	S	VS	ES	<20	20-60	60-200	200-600			600-2000	>2000	
				30.8			OL: TOPSOIL: Brown.																										
				30.7			CH: Silty CLAY: Brown. High plasticity. (Alluvium) ... from 0.50m to 0.80m, becoming light brown mottled grey and brown. ... from 0.80m to 1.30m, becoming brown.		F to St								97																
		1.5	Peak = 87kPa Residual = 39kPa SPT = (0,5,6) N* = 11		1																												
		1.5																															
		2.0	Peak = 122kPa Residual = 29kPa		2		CH: Silty CLAY: Light greyish brown mottled brown. High plasticity. (Alluvium)	W									76																
		3.0	SPT = (3,3,4) N* = 7		3				St																								
				26.9	4		ML: Sandy SILT with some clay: Light bluish grey. Low plasticity. Sand is fine to medium grained. (Alluvium)										64																
				26.3			Completely weathered, bluish grey SANDSTONE. Extremely weak: Weathered to sandy SILT. Low plasticity. Sand is fine to medium grained. (Northland Allochthon)																										
		5.0	SPT = (8,15,10) N* = 25		5																												
				25.3			Completely weathered to highly weathered, greenish grey SILTSTONE. Extremely weak: (Northland Allochthon)																										
				24.8	6		Highly weathered, grey mottled light grey SANDSTONE. Extremely weak to very weak: Sand is fine to medium grained. (Northland Allochthon)										95	100															
		6.5	SPT = (14,17,19) N* = 36																														
					7																												
		8.0	SPT = (12,14,11) N* = 25		8												100	100															
				22.4			Moderately weathered, bluish grey mottled dark grey and reddish brown SILTSTONE. Extremely weak to very weak: (Northland Allochthon)										100	91															
					9																												
		9.5	SPT = (8,12,16) N* = 28																														
							Borehole terminated at 9.50 m																										
					10																												

Termination Reason: Target Depth Reached

Shear Vane No: 1824

DCP No:

Remarks:

BOREHOLE LOG - MH02-21

Client: Build Rich Limited
Project: Silverdale South - Stages 3 & 4
Site Location: Silverdale
Project No.: AKL2020-0125
Date: 05/08/2021

PRELIMINARY



Borehole Location: Refer to site plan

Logged by: LSW

Checked by:

Scale: 1:50

Sheet 1 of 1

Position: 1749102.0mE; 5945118.0mN Projection: NZTM

Elevation: 30.40m

Datum: AUCKHT1946

Survey Source: Hand Held GPS

Well	Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/Relative Density	Weathering							Recovery	RQD	Estimated Strength					Defect Spacing (mm)					Drilling Method/Support	Structure & Other Observations Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
		Depth	Type & Results							RS	CW	HW	MW	SW	UW	EW			VW	W	MS	S	VS	ES	<20	20-60	60-200	200-600			600-2000	>2000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
				30.4			OL: TOPSOIL: Brown.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													

Termination Reason: Target Depth Reached

Shear Vane No:

DCP No:

Remarks:

BOREHOLE CORE PHOTOGRAPHS: MH01-21

Client: Build Rich Limited

Project: Silverdale South Stage 3+4

Location: Silverdale

Project No: AKL2020-0125

Date: 6 August 2021



Sheet No. 1 of 2

Logged by: LSW

Position: 1749109mE, 5945143mN

Hole Diameter: 63mm

Plant: Tractor-Mounted Drill Rig

Checked by:

Elevation: 30.8m

Angle from Horizontal: 90°

Contractor: ProDrill



MH01-21: 0.00m to 3.45m



MH01-21: 3.45m to 7.75m

This report of boreholes must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination.

BOREHOLE CORE PHOTOGRAPHS: MH01-21

Client: Build Rich Limited

Project: Silverdale South Stage 3+4

Location: Silverdale

Project No: AKL2020-0125

Date: 6 August 2021



Sheet No. 2 of 2

Logged by: LSW

Position: 1749109mE, 5945143mN

Hole Diameter: 63mm

Plant: Tractor-Mounted Drill Rig

Checked by:

Elevation: 30.8m

Angle from Horizontal: 90°

Contractor: ProDrill



MH01-21: 7.75m to 9.50m

This report of boreholes must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination.

BOREHOLE CORE PHOTOGRAPHS: MH02-21

Client: Build Rich Limited

Project: Silverdale South Stage 3+4

Location: Silverdale

Project No: AKL2020-0125

Date: 5 August 2021



Sheet No. 1 of 2

Logged by: LSW

Position: 1749102mE, 5945118mN

Hole Diameter: 63mm

Plant: Tractor-Mounted Drill Rig

Checked by:

Elevation: 30.3m

Angle from Horizontal: 90°

Contractor: ProDrill



MH02-21: 0.00m to 4.40m



MH02-21: 4.40m to 8.00m

This report of boreholes must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination.