RILEY CONSULTANTS

GEOTECHNICAL INVESTIGATION REPORT MURIWAI DOWNS RESERVOIR MURIWAI VALLEY

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GEOTECHNICAL INVESTIGATION REPORT
MURIWAI DOWNS RESERVOIR, MURIWAI VALLEY

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Report reference: 210339-A

Date: 18 November 2021

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Issue:	Details:	Date:
1.0	Final Report	18 November 2021

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1.0 Introduction

Riley Consultants Ltd (RILEY) has been engaged by The Bears Home Project Management Limited (BHPM) to undertake a geotechnical investigation and assessment of a proposed water storage reservoir in Muriwai Valley, Auckland.

Preliminary design drawings by McKenzie & Co indicate the reservoir will be excavated several meters into the existing slope, with a small ring embankment up to 3m high on the northern, eastern, and western sides. The southern slope will be cut into the hillside and excess fill materials placed in a nominated disposal area upslope to the south.

The primary objectives of the investigation were to:

- Specify the geological context of the reservoir site, and how this could influence structural safety, water retention, and reservoir slope integrity.
- Determine if any prohibitive geological or geotechnical conditions exist that could prohibit safe and cost-effective construction and operation.
- Support a package of work for a resource consent application to Auckland Council (Council).

We expect this report will accompany others being prepared by WWLA and Mckenzie & Co.

2.0 Site Description

The proposed reservoir site is located on a very gentle (<5°) north facing slope approximately 9km south-west of Kumeu, Auckland. It is bordered by Muriwai Road to the north, an ephemeral stream to the west and perennial stream to the east. Access to the site from the north is via the neighbouring sand quarry at 555 Muriwai Road. Additionally, a private farm track extends from the north-eastern corner of the site through the middle of the site.

The site is currently in pasture with livestock grazing. The steep slopes down to the stream and gully are also in pasture with the immediate stream banks well vegetated with occasional large shrubs and trees.

A quarry 2.5ha in plan area and up to 25m deep is located approximately 300m west of the proposed reservoir (Muriwai Sandstone Quarry).

3.0 Desktop Review

A desktop review of available geotechnical information on regional and local geology, geomorphology, seismicity, and historic geotechnical investigation data was undertaken prior to undertaking site investigations. The review enabled development of a preliminary geological model for the site, which was then used to develop the site investigation programme. Results of the desktop review are presented below.

3.1 Geological Setting

The GNS Science 1:250,000-scale QMAP and accompanying bulletin for the area (Map 3 'Auckland', 2001) indicates the site is underlain by Late Pliocene-age Awhitu Group Dunes (Pad) comprising unconsolidated bedded dune sands with intercalated paleosols, lignite and carbonaceous mudstone and some extremely weak, sub-horizontally bedded sandstone 1.8 to 3.6 million years old – Figure 1. Due to the predominant westerly winds the dune sands create gentle westerly (windward) facing slopes and steeper easterly (leeward) slopes.

The site is located adjacent to a perennial stream along the south-eastern boundary. The stream approximately defines the geological boundary between recent alluvial/colluvial deposits of the Tauranga Group (Qa1) and the older Nihotupu Formation (Mtn) submarine volcaniclastic sandstones and siltstones of the Manukau Group. The Nihotupu Formation likely underlies the Awhitu Group dunes at depth beneath the site.

An inferred basalt sill of the Waiatarua Formation (Mtw) is mapped to the north of the site. Its possible extent beneath the site is uncertain, however, it was not encountered in any subsurface investigations at the site.

Figure 1: Geology Map (from GNS Science). Site circled in red

3.2 Review of Aerial Imagery

Ground elevation contours generated from 1m LiDAR flown in 2016 indicates the reservoir footprint generally sits within the existing contours on a terrace feature at the base of gentle (< 5°) northerly facing slopes. At the south-eastern extents of the reservoir and fill area, the slopes down to the stream increase steeply to between 15° and 30°. Slopes down to the western gully are gentle to moderate (~12°).

The aerial imagery indicates the site has been used for pasture since the 1980s. A dairy effluent disposal field was installed on the site within the reservoir footprint in early 2019.

4.0 Geotechnical Site Investigations

A geotechnical investigation was undertaken at the reservoir site and fill disposal area, involving:

1. Desktop review of available geotechnical information.
2. Walkover inspection and field mapping of the site and surrounds.

3. Inspection of the existing quarry (Muriwai Sandstone Quarry) to the immediate west of the site.
4. Subsurface investigations comprising:
    a. 12 no. machine excavated test pits.
    b. Retrieval of bulk soil samples from test pits for laboratory testing.
    c. 3 no. machine boreholes with standard penetration tests (SPTs).
    d. Installation of standpipe piezometers in each machine borehole.
    e. 12 no. cone penetrometer tests (CPTs).
    f. 4 no. Seismic Dilatometer tests (sDMTs).

Test locations and depths were selected based on the preliminary design provided by McKenzie and Co. with the aim of achieving suitable coverage across the site, and characterising soils for conceptual borrow/cut areas and embankment locations and heights.

Site investigations were undertaken between 4 August 2021 and 12 August 2021. Some of the proposed test locations were moved due to practical constraints. Final test locations are shown on the appended Site Plan, RILEY Dwg: 210339-1 (Appendix H).

Materials were logged by a RILEY engineer/geologist in accordance with the New Zealand Geotechnical Society, Field Description of Soil and Rock Guidelines (2005).

4.1 Geomorphological Site Assessment

A walkover was undertaken by a senior engineering geologist from RILEY to undertake preliminary geological mapping.

The following comments can be made:

- The general site geomorphology comprises dunes with generally gentler western slopes and steeper eastern slopes, likely representative of the prevailing wind directions during formation of the sand deposits.
- Exposures at the nearby quarry indicate the complexity of dune deposits with younger dunes overlying older dunes and filling of previous channels/depressions with further sand deposits and fine-grained soils (Photos 1 and 2).
- Cementation of the sand deposits with limonite (iron oxide) and clay minerals varies vertically and laterally across the site (i.e., does not appear consistent). A hardpan (typically a 0.2m to 1.0m thick limonite cemented sand layer running approximately coincident with ground surface) has been encountered within 3m of ground surface across portions of the site. It would appear from exposures, geomorphic expression and subsurface investigations, that this layer is not present across the entire site.
- The dune deposits have been subsequently incised by two north draining streams near the investigated site, with the eastern stream bordered by degraded alluvial terraces.

- Erosion associated with incision of these streams has exposed an apparent more resistant and stronger cemented sand horizon around the perimeter of the ridge upon which the reservoir is proposed (Photo 3). This layer, which appears to be dipping gently to the west, often presents on-site as outcrops and steeper slopes. It also appears to be associated with water springs. The cementation of this horizon does appear to vary across the site. Near the eastern corner of the proposed reservoir the strength of this layer appears to be significantly less than other locations as evidenced by lack of steeper slope definition and greater gully headward erosion (Figure 2). This is also supported by subsurface investigation at the location.
- The springs are noted to be associated with gully headward erosion near the proposed development, likely as a result of saturation of the soil deposits and possible degradation of cementation (Figure 3). The springs appear to emerge beneath the weakly cemented sand layer and with preferential erosion undermining the cemented sand layer.
- No obvious sinkhole or 'tomo' features were observed in the walkover or encountered in the subsurface investigation.
- On the eastern steeper slopes, shallow type ground movement (known as 'sheep tracks' or terracetting) was noted on slopes of 27º (1V:2H) or steeper. Natural slopes of any significant size did not seem to exceed an angle of about 34º.

Photo 1: Natural filling of depression with later dune deposits in Awhitu Group exposed at the Muriwai Sandstone Quarry. Boundaries of the depression are arrowed. Within the depression fill is cross bedding and an unconformity.

Photo 2: Weakly cemented sand material overlying clayey silt exposed in the quarry. The clayey silt has been subject to preferential erosion compared to the sand above most likely due to frittering on stress relief joints. This fine-grained material, including some organics, filled a small depression under the weakly cemented sand. This preferential erosion of layers is also seen near the subject site.

- On the eastern (leeward) side of the ridge are mid-slope terraces. These are inferred to be primarily a combination of elevated degraded terraces and debris from headward gully erosion. This is illustrated in Figure 2.

Figure 2: Annotated image of key geomorphic features on the eastern (leeward) side of the ridge. Extent of the proposed works shown in white.

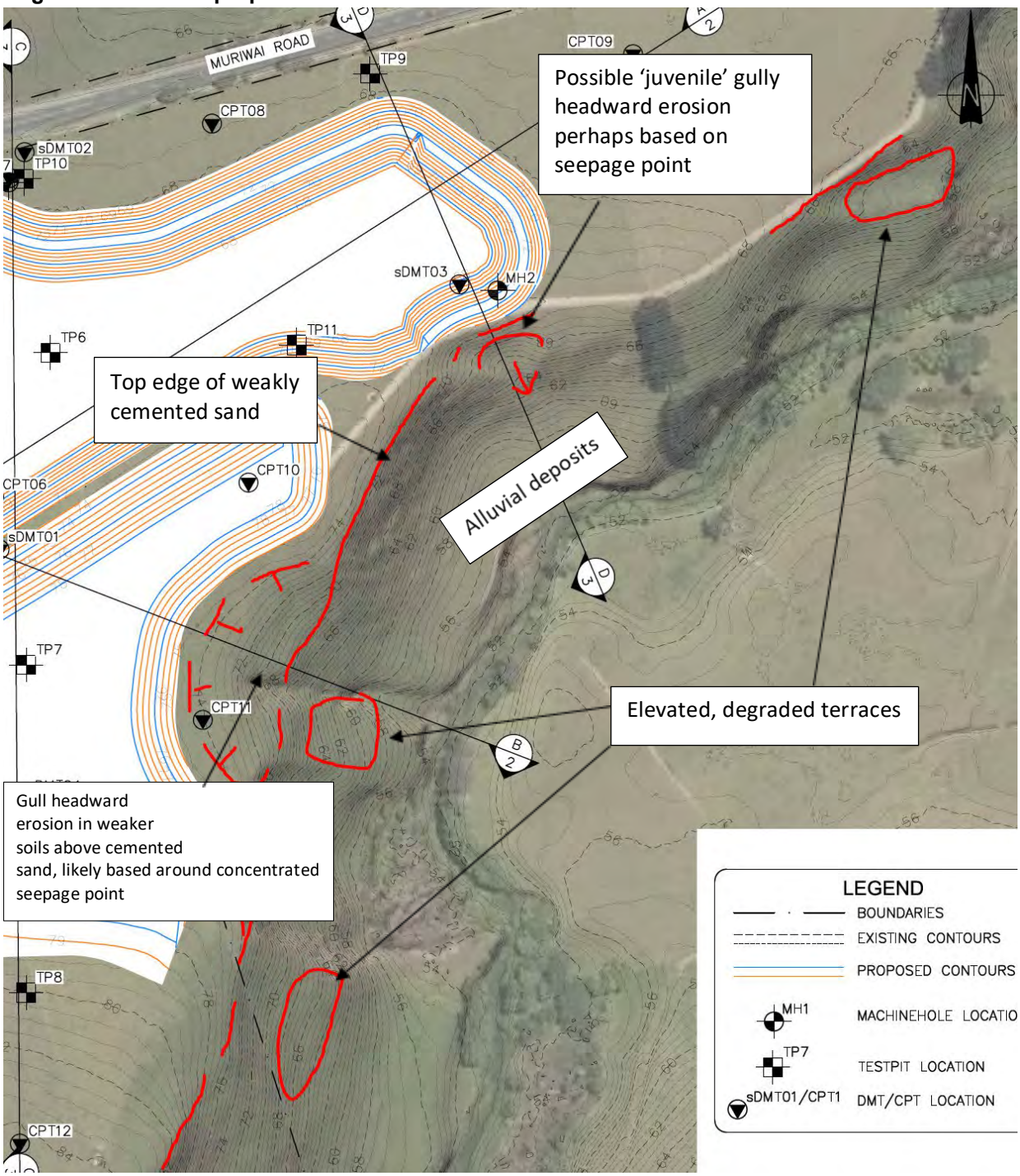


Photo 3: Weakly cemented sand horizon underlain by interlayered silts and sands. The weakly cemented sand is relatively resistant to erosion whereas the weaker interlayered beds beneath have been preferentially weathered. Although the strength of the weakly cemented sand horizon does vary across the site, this stratification is believed to underlie much of the ridge the proposed works are to be undertaken.

Figure 3: Image from Google Earth (date July 2015). Solid red lines illustrate inferred extent of weakly cemented resistant sand layer as exposed at the surface. Dashed lines signify where the sand layer is possibly less cemented and subject to headward gully erosion. Evident is the water springs which appear to align with the cemented sand horizon.

4.2 Test Pits

A total of 12 test pits were excavated with a 13-tonne excavator operated by Burnetts Transport and Earthmoving between 4 August 2021 and 5 August 2021, to depths between 4.4m and 4.8m (target depth extent of excavator reach).

Four were undertaken within the reservoir footprint as part of the reservoir basin and borrow area investigation (TP2, TP4, TP6, and TP11); four as part of the dam embankment foundation assessment (TP3, TP5, TP9, and TP10); and four at the margins of the fill disposal area (TP1, TP7, TP8, and TP12).

Following logging and sampling, pits were backfilled with the arisings and tracked over to match the previous ground surface.

Test pit logs are presented in Appendix A.

4.2.1 Laboratory Tests

Bulk soil samples were collected from selected locations within the test pits for laboratory testing by WSP Ltd (WSP), an IANZ accredited soil laboratory.

A suite of tests was performed including particle size, plasticity, compaction, and material behaviour tests as summarised in Table 1. This information will be used to inform detailed design of the reservoir including material suitability for dam embankment construction, strength parameters, and construction processes.

Table 1: Bulk Samples Collected for Soil Testing and Tests Undertaken

Test Pit ID	Sample Depth (mbgl)	Sample Description	Moisture Content	Atterberg Limits	Particle Size			Standard Compact. Test	Solid Density	Emerson Crumb
					Wet Sieve	Hydro	Fines content (75 µm split)			
TP2	1.8	Silty CLAY	1	1		1		1	1	1
TP2	2.0	Silty sandy CLAY			1					
TP2	3.4	Cemented SAND			1					
TP4	2.4	Silty SAND			1					
TP6	2.1	Sandy SILT	1	1		1		1		1
TP6	2.9	SAND			1					
TP8	1.7	Silty SAND					1			
TP10	1.8	Silty CLAY		1		1	1			1
TP11	1.7	Sandy SILT				1				
TP11	2.0	Silty SAND			1					
		Total	2	3	5	4	2	2	1	3

Note: 1. Meters below ground level (mbgl).

4.3 Machine Boreholes

Machine boreholes were drilled by Drill Force Ltd between 9 August 2021 and 11 August 2021 using a Hydra Power Trekker TK060 track-mounted rotary drill rig, to depths ranging 11m to 14m.

Sample recovery was generally good with greater than 75% recovery in all boreholes except for MH02, which experienced 100% core loss between 5.5m to 6.0m. This is attributed to the presence of saturated, loose to medium dense sand that appears to have liquefied by the drilling process.

Standard Penetration Tests (SPT) tests were undertaken at 1.5m intervals using a split spoon driven by a safety auto trip hammer. Due to COVID-19 Level 4 restrictions it is unknown which hammer is on the rig used. The measured energy transfer ratio (efficiency) across all 12 hammers owned by Drill Force ranges from 72% to 82%, with an average of 77%. We have conservatively adopted a value of 80% for the purposes of our assessment.

Core samples were retrieved and placed in boxes and photographed on-site. Borehole logs, core photographs, and the SPT hammer efficiency certificate can be found in Appendices B, C, and D, respectively.

4.3.1 Piezometer Installations

Standpipe piezometers were installed in each of the machine boreholes upon completion of drilling. These comprised machine-slotted internally threaded 32mm PVC pipe with screens of various lengths (see Table 2). Approximately 0.5m high upstands were protected by lockable steel 'toby boxes' and cemented in place. Backfill materials comprised a blinding sand and filter sand around the slotted sections, and hydrated bentonite pellets for seals. Boreholes were flushed with clean water prior to installation.

Table 2: Borehole Piezometer Screen Installation

Machine Hole ID	Screen Interval (m bgl)	Screen Length (m)	Geology
MH1	10.5m to 13.5m	3.0	Slightly cemented SAND
MH2	4.5 to 6m 7.5 to 9m	1.5 1.5	Slightly cemented SAND
MH3	3.5 to 6m	2.5	Loose SAND

4.4 Cone Penetrometer Tests

Cone Penetrometer Testing (CPT) was undertaken by Drill Force Ltd on 10 August 2021 using an 18T Geomil Panther capable of pushing 170kN and up to 40m depth. CPTs were advanced to a target depth of 15m or earlier refusal.

4.5 Seismic Dilatometer Testing

Drill Force Ltd also conducted down-hole seismic dilatometer testing across four locations on 12 August 2021 using the same 18T Geomil Panther rig. Testing was carried out between 2m and 11.5m below ground level (bgl) and was conducted in accordance with ASTM and Eurocode standards. The sDMT is a flat dilatometer, which measures the shear wave velocity between two receivers located at 0.5 m apart. When a shear wave is generated at surface, involving striking a timber beam with a sledgehammer, to produce a shear-wave signal, it reaches first the upper receiver, then, after a delay, the lower receiver. The sDMT test results are presented in Appendix E.

5.0 Investigation Findings

5.1 Stratigraphy/Geological Model

Test pitting allowed visual observation of material characteristics to 4.8m depth, while CPT/sDMT and Machine boreholes provided information on soil types and properties (e.g., strength and groundwater depth) to 14m depth. Inspection of the adjacent quarry enabled visual appraisal of the quarry faces up to c.25m depth.

Within the quarry faces, the Awhitu Group deposits were observed as moderately weathered, very weak to extremely weak sand with some thick bedding and cross bedding and occasional discontinuous cemented hardpan layers.

In general accordance with the GNS Science QMAP map for the area, the materials encountered in the RILEY site investigations comprised Awhitu Group Dune deposits which were observed in all investigation locations and were generally described as medium dense, fine-grained sand and silty fine-grained sand becoming dense with depth and with slightly cemented layers. Awhitu Group sands vary in density with depth (as is common with sand dune deposits). The level of cementation of the dune sand is also variable, which is reflected in the machine borehole logs and CPT results.

5.2 Lab Results

Eight samples of Awhitu Group materials were tested for a range of parameters. These are summarised in Table 3 and Figures 3 and 4. A full set of results is attached in Appendix H.

Table 3: Laboratory Test Result Summary for Awhitu Group

Test	Unit	No. of Tests	Minimum	Maximum
Natural Moisture Content	%	5	59.2	67.2
Liquid Limit	%	3	105	136
Plastic Limit	%	3	46	64
Plasticity Index		3	41	87
Solid Density	t/m^3	1	2.86	-
Maximum Dry Density	t/m^3	2	1.05	1.06
Optimum Moisture Content	%	2	54	56
Emerson Crumb	Grading	3	Grade 1 – Non-dispersive	

Figure 3: Typical Particle Size Distribution of Awhitu Group Clay (TP2 1.8m) and Silty Clay (TP6 2.1m)

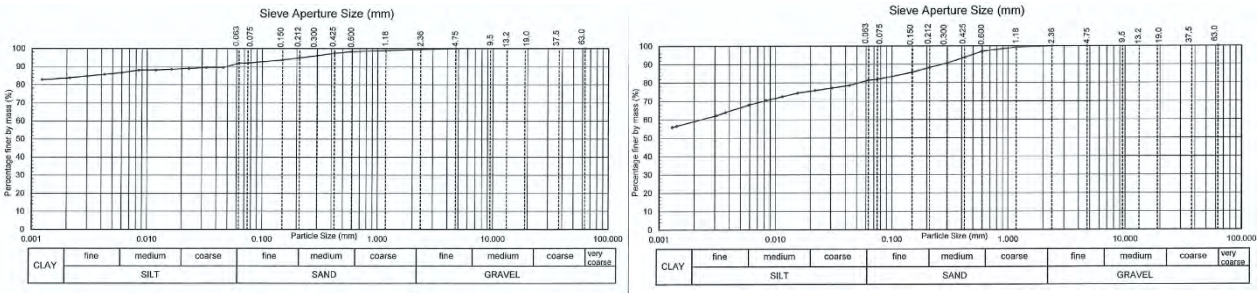
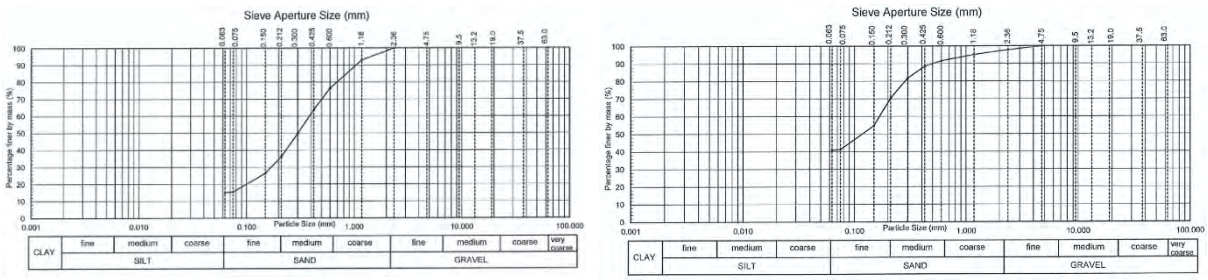


Figure 4: Typical Particle Size Distribution of Awhitu Group Sand (TP2 3.4m) and Silty Sand (TP4 2.4m)



Based on the grading and plasticity of the surficial clay a low to very low permeability could be expected if well compacted with low air voids.

5.3 Groundwater

The static groundwater table was not encountered by any of the test pits.

Rapid inflows were encountered in TP2 at 1m and 1.8m bgl, and slow seeps were encountered in TP4, TP6, and TP10 between depths of 1.2m and 2m. These inflows are interpreted to be perched groundwater seeping along discontinuous hardpans or other permeability contrasts within the stratigraphy.

Depth to the regional groundwater table is not discernible during drilling due to the method introducing fluid into the surrounding ground. Soils were logged by RILEY as wet to saturated from 2.4m bgl and 2.7m bgl in MH01 and MH03, respectively. Initial piezometer readings, taken the day after drilling was completed, show groundwater at 11.9m, 8.6m, and 4.8m bgl in MH01, MH02, and MH03, respectively (refer Table 3). Ongoing monitoring of piezometers is recommended to measure the static groundwater table and understand episodic and seasonal fluctuation thereof.

Based on investigation and monitoring results to-date, groundwater appears to comprise a two layered groundwater system:

1. An upper water surface, which may be perched either on a discontinuous hardpan (therefore creating a discontinuous perched water table), or on the finer grained interlayered soils beneath the weakly cemented sand. This perched water is likely transient and only partially saturates the upper soils.
2. Lower regional groundwater table some 9m to 12m bgl. This is possibly extensive and controlled by the streams on either side.

Table 4: Groundwater Monitoring Levels

Borehole	Collar RL	Screen Depth (m)	Water Depth (bgl)		
			10/08/2021	11/08/2021	12/08/2021
MH01	73.2	10.5 - 13.5	-	11.8	12.4
MH02	70.7	4.5 - 6.0	5.1	-	9.1
		7.5 - 9.0			
MH03	68.3	3.5 - 6.0	-	3.23	5.3

6.0 Natural Hazards

6.1 Seismicity and Site Classification

The seismic hazard at the site is considered low in the New Zealand context, with no recorded large earthquakes since records began (c. 1840). There are no active faults mapped nearby (the nearest is approximately 48km away in the Hunua Ranges). An inactive fault is mapped approximately 2.8km to the south-east associated with the Nihotupu Formation and is noted to transverse through the Waitakere Ranges area. This fault is not currently considered to present a seismic risk to the site.

The seismic loading induced on the dam embankment will depend on, amongst other factors, the natural period of the structure and stiffness of the underlying soil/rock which affect the ground motion input to the structure. Sites with low strength, deep soils can amplify ground accelerations, requiring the structures built on them to resist a higher seismic coefficient. The New Zealand Structural Design code, NZS 1170.5:2004: Earthquake Actions, contains response spectra for structural design. Sites are categorised into five classes (Class A to E) ranging from rock sites, Class A and B to very soft or deep soil sites, Class D and E. Class C is transitional between B and D for shallow soil sites, which results in the largest peak ground acceleration.

The sDMT data indicates an average shear wave velocity of 540m/s over the tested depth of around 10m. This suggests a natural period of around T=0.17s for the upper 30m assuming Vs_{30}=540m/s. Despite being underlain by a considerable thickness of sediment, the site is reasonable stiff in a seismic response sense i.e., Vs_{30} is greater than the minimum Vs_{30}=360m/s for Site Class B (Rock) in NZS 1170.5:2004.

Calculations indicate the depth to bedrock would need to be at least 80m deep for the site to be classed as subsoil Class D (T>0.6s) assuming shear wave velocities do not increase. Based on present understanding of the local geology, this is considered unlikely.

On balance, the site has been classified as **Site Class C (shallow soil sites)** which results in the most conservative input ground motions.

In accordance with the New Zealand Society on Large Dams (NZSOLD) Dam Safety Guidelines (2015), two levels of ground shaking have been considered, with ground motions derived using MBIE guidance (2016), MBIE Module 1: Method 1/NZTA Bridge Manual Addendum 6A/:

- Operating Basis Earthquake (OBE) based on 150-year return period shaking:
  - PGA=0.09g, M_{eff}=5.9
- Safety Evaluation Earthquake (SEE) based on 1,000-year return period shaking:
  - PGA=0.2g, M_{eff}=5.9

6.2 Design Seismicity

The reservoir has been assigned a 'Low' Potential Impact Classification (RILEY Ref: 210339-B) in accordance with the NZSOLD Guidelines (2015). Due to the long recurrence intervals, seismic parameters for design are normally established by a site-specific seismic hazard assessment by a technical specialist, using both probabilistic and deterministic methods.

This involves evaluation of the following scenarios:

- Operating Basis Earthquake (OBE) – The earthquake for which a dam, appurtenant structure, and gate/valve system that fulfils a dam safety function is designed to remain operational, with any damage being minor and readily repairable following the event. It is considered that an annual exceedance probability (AEP) of 1 in 150 is appropriate for the OBE.
- Safety Evaluation Earthquake (SEE) – The earthquake that would result in the most severe ground motion, which a dam structure must be able to endure without uncontrolled release of the reservoir. Ground motion parameters should be estimated for the 50th percentile Controlling Maximum Earthquake (CME) or 1 in 1,000 AEP developed by a probabilistic approach.

6.3 Liquefaction Potential

Liquefaction can occur in saturated, loose to medium dense, cohesionless deposits (sands and non-plastic silts) under moderate to severe ground shaking. Geologically recent materials or very weak manmade fills are typically the most susceptible soils. Effects on dam structures can include settlement/differential settlement resulting in cracking and loss of freeboard or internal erosion through cracks, lateral spreading of the abutments into the dam, and/or foundation bearing failure.

We have undertaken an initial liquefaction susceptibility assessment using both qualitative and quantitative methods:

- A qualitative visual assessment was carried out to identify materials potentially susceptible to liquefaction based on soil description in test pit and drillhole logs.
- A quantitative analytical assessment was carried out on sDMT, CPT, and SPT data using the following methods (in order considered most to least reliable in cemented dune sands):
    - Seismic dilatometer sDMT test results against threshold values of Vs for liquefaction occurrence, i.e., using Cliq v. 3.3.2.9 by GeoLogismiki.
    - CPT-based triggering assessment using the Boulanger & Idriss (2014) method in Cliq v. 3.3.2.9 by GeoLogismiki.
    - SPT-based triggering method from Idriss and Boullanger (2014).
- The methods are based on the latest methodology from the NZGS and Ministry of Business, Innovation and Employment (MBIE) Guidelines, developed after the Canterbury earthquake sequence, with the most up to date guidance published in 2016.
- For the purposes of the liquefaction analyses presented in this report, a depth to groundwater of 1.0m bgl has been used which is likely very conservative (Section 5.3).

6.3.1 Results

A quantitative assessment of each individual investigation point has been made in terms of liquefaction susceptibility. Potentially liquefiable materials were identified within the upper 10.0m of the soil profile, comprising interbedded layers of cohesionless, loose to medium dense sands and silty sands of the Awhitu Group.

Soils become more resistant to liquefaction as they become older due to densification and various weathering and chemical cementation processes. The Awhitu Group dune sand deposits are assigned to the Late Pliocene-age (1.8M to 3.6M-years old).

There is evidence of cementation of sand grains and “hardpan” features in weathered outcrops around the site, which have a strength consistent with “extremely weak rock” in terms of the NZGS field description guidelines (Photo 4).

Photo 4: Outcrop of weathered Awhitu Group dune sands exhibiting weak cementation in the upper portion and assessed not susceptible to liquefaction.

Published guidance from Youd & Perkins (1978) indicates that dune sands of this age are "very unlikely" to be susceptible to liquefaction. This conclusion is reinforced by the observation that almost all liquefaction case history data are from Holocene-age deposits or constructed fills (Idris & Boulanger 2008). However, soil aging effects are difficult to quantify and are not typically included in design procedures.

Assessment of the sDMT data indicates:

- Shear-wave velocities ranging from 130m/s at 2m depth increasing to 500 to 600m/s at 10m depth. The case history data shows no liquefaction above an overburden stress-corrected Vs_1>210m/s, i.e., limiting upper value in sandy soils.
- No liquefaction is predicted for either the OBE nor SEE events while assessing the sDMT data using the Kayen et. al (2013) method. Note that the sDMT assessment was carried out in Cliq developed by GeoLogismiki, which also plots CRR for a nearby CPT as a comparison but is not associated with the sDMT data or assessment.

Assessment of the CPT data indicates:

- OBE: Very low LSNs consistent with little to no expression of liquefaction and negligible settlements were predicted.
- SEE: Liquefaction Severity Numbers (LSN) up to 17, which is consistent with little to minor expression of liquefaction and free-field settlements between 5mm to 80mm predicted.
- Overall, the thickness of liquefied soils for the OBE event is negligible, and several metres typically between 3m and 8m bgl for the SEE event. CPT analysis shows this material could be susceptible to liquefaction if it were in a saturated state during strong seismic shaking.

It should be acknowledged that advancing the CPT cone in weakly cemented material can disturb or break down the cementitious bonds resulting in underprediction of the soils resistance to liquefaction. For this reason, and the less soil disturbance caused by advancing the dilatometer blade, the sDMT data is considered more reliable in these soil types.

Assessment of the SPT data indicates:

- OBE: No liquefaction is predicted for the OBE event.
- SEE: No liquefaction is predicted at MH01, and very low LSNs consistent with little to no expression of liquefaction and free-field settlements less than 10mm and 25mm in MH02 and MH03.

Results from the liquefaction assessment are attached in Appendix F.

Location A in the central portion of the site between the proposed cut batter for the reservoir and fill areas comprises a cluster of investigation locations, MH01, CPT6, and sDMT1. Location B in the northern portion of the site downslope of the proposed reservoir comprises a cluster of investigation locations, MH03, CPT7, and sDMT2. A comparison of these test locations and liquefaction susceptibility methods are presented in Table 5 under a SEE event.

Table 5: Comparison of Testing Methods for SEE Ground Motions

Investigation Type	Location A	Location B
sDMT Kayen et. al (2013)	No Liquefaction.	No Liquefaction.
CPT Idriss and Boullanger (2014)	Liquefaction between 3.2m to 5.5m with 77mm free-field settlement.	Liquefaction between 3.8m to 5.8m, 13mm free-field settlement.
SPT Idriss and Boullanger (2014)	No Liquefaction.	Liquefaction between 1m to 6m, SPT N=5 to 11, 22mm free-field settlement.

Overall, the age of the depositions, soil compositions, and sDMT data indicate the soil is not susceptible to liquefaction. Conversely, CPT and SPT based method predict little to minor expression of liquefaction, but this may be conservative in view of the methods disturbing or breaking down the cementitious bonds formed in the sand over time.

Further, the groundwater table has generally been measured below potentially susceptible units meaning they may only be partially saturated. Modification to the drainage characteristics of the site is expected to significantly reduce the potential for soils to be saturated. Additional factors that could lead to a reduction in soil moisture beneath the reservoir includes the provision of a geomembrane liner, which will largely prevent infiltration of surface-water. Drainage of soils will also be aided by inclusion of under-liner drains if seepage horizons are noted within the excavation.

There is the potential that hardpan layers within the sand could impede vertical drainage. If this is observed to have a significant influence on seepage patterns within the reservoir excavation during construction, mechanical puncturing of hardpan layers may be appropriate.

As part of the construction of the dam, three piezometers have been installed to allow ongoing monitoring of groundwater levels in the vicinity of the reservoir. A design verification hold-point is envisaged to confirm the assumed groundwater model.

On this basis, and the results of our assessment, liquefaction is not considered to present a significant risk to the reservoir.

6.4 Slope Stability

Slope stability analyses were carried out for Cross Sections A through to D, to assess the available Factor of Safety (FoS) against instability for the existing ground profiles modified for the proposed development. Section A assesses the existing western slope with the proposed dam and the cut slope (3H:1V) of the reservoir. Section B assesses the existing south-eastern slope with the proposed fill batter (5H:1V) and the cut slope (3H:1V) of the reservoir. Section C assesses the proposed fill batter (5H:1V) with the cut slope (3H:1V) of the reservoir. Section D assesses the existing south facing slope at the eastern extent of the proposed reservoir with the proposed dam and the cut slope (3H:1V) of the reservoir. The proposed embankment slopes (3H:1V) are acceptably stable on a firm foundation subject to final design checks as part of the preliminary design. Our modelling utilised the effective stress parameters outlined in Table 5, using the Morgenstern-Price method of limit equilibrium analysis, and non-circular optimised Cuckoo failure modes.

Geotechnical parameters were developed from the subsurface testing information and terrain analysis/back-analysis of existing slopes. Back analysis of the steeper eastern slopes of approximately 27º that displayed evidence of shallow instability (i.e., marginal stability) was carried out to assess the typical soil shear strength parameters. The adopted effective stress parameters are considered reasonable based on our back analysis, as well as our experience and understanding of the behaviour of soils in the area. The selected effective stress parameters are presented in Table 5.

Existing groundwater conditions were modelled at approximately 3m to 9m depth depending on location on-site and elevated groundwater conditions were modelled between 2m and 2.9m depth, based on RILEY site observations and investigation locations. Sensitivity analyses for surface saturation were also undertaken, to model a short-term high intensity storm event.

Table 6: RILEY Adopted Effective Stress Strength Soil Parameters

Description	ɣ (kN/m^3)	c' (kPa)	ϕ' (degrees)
Clayey SILT/Sandy Silt	18	5	30
Hardpan	20	15	35
Medium Dense to Dense SAND	18	4	35
Interbedded Dense/V.Stiff Material	18	3	32
Colluvium	18	3	28
FILL	18	5	32

A FoS of 1.0 indicates the forces driving and resisting instability are in equilibrium, and a FoS of less than 1.0 indicates theoretical failure. In accordance with NZSOLD Dam Safety Guidelines (2015), we have adopted a target a FoS of 1.5 or greater for normal groundwater conditions, and 1.3 or greater for worst-case, short-term/transient groundwater conditions.

Under OBE seismic conditions, a FoS greater than 1.0 is required for pseudo-static methods; under SEE seismic conditions, deformations are acceptable provided they do not lead to an uncontrolled release of the impounded contents. Ground motion input parameters for these events are outlined in Section 6.1.

Stability analysis shows that the minimum FoS targets are met for all scenarios with the exception of Section C under SEE ground motions. Additionally, initial stability analysis were carried on the reservoir (southern) cut slope to determine the maximum gradient available before instability is predicted. A 3H:1V, the cut meets minimum FoS requirements whether a hardpan layer is present or not. Table 6 shows the target and achieved FoS. Selected slope stability outputs are presented in Appendix G.

For the SEE case, displacements were estimated using sliding-block analysis methods (Jibson, 2007). Because the yield acceleration of the slope is very similar to the input ground motions, only minor displacements (<10mm) are predicted. These are considered unlikely to result in uncontrolled release of the reservoir contents and are therefore acceptable. It should be noted adopting the PGA as the input seismic coefficient and pseudo-static analyses are conservative due to the varying response of the slope and reversing nature of seismic ground motions. When assessing the full slope under pseudo-static conditions, a reduction factor of 0.65 to the PGA is commonly applied (per NZTA Report 613 Seismic Design of High Cut Slopes, 2018) but has been conservatively ignored in our assessment.

In all cases, the reservoir excavation, dam embankments, and fill disposal areas have been offset a minimum distance of ½ the slope height away from the crest of the slope, as a precaution against slope instability.

Table 6: Slope Stability Results

Cross Section	Case	Target FoS	Minimum FoS		Comments
			Existing Slope	Cut Embankment	
Section A	Normal Groundwater Levels	1.5	2.5	2.6	OK
	High Groundwater Levels	1.3	2.1	-	OK
	Saturated Sensitivity	1.3	1.7	1.5	OK
	SEE earthquake	-	1.1	1.3	OK
Section B	Normal Groundwater Levels	1.5	1.5	2.0	OK
	High Groundwater Levels	1.3	1.4	1.6	OK
	Saturated Sensitivity	1.3	0.9*	1.5	*>1.3 for proposed Fill disposal area
	SEE earthquake	-	0.9*	1.1	*>1.0 for proposed Fill disposal area
Section C	Normal Groundwater Levels	1.5	-	1.7	OK
	High Groundwater Levels	1.3	-	2.3	OK
	Saturated Sensitivity	1.3	-	1.4	OK
	SEE earthquake	-	-	~1.0	Displacements <5mm
Section D	Normal Groundwater Levels	1.5	1.8	2.9	OK
	High Groundwater Levels	1.3	1.7	2.0	OK
	Saturated Sensitivity	1.3	1.4	1.5	OK
	SEE earthquake	-	~1.0	1.7	OK. Seismic slip surface well clear of proposed pond

7.0 Design Implications

7.1 Introduction

The present design concept is for a geomembrane-lined, homogeneous embankment dam in keeping with other large water storage reservoirs in similar ground conditions.

Based on the investigations undertaken to-date, the critical geotechnical considerations are the potential for slope instability, foundation seepage and surficial or internal erosion.

7.2 Construction Materials and Zoning

Construction will largely be conducted using site derived materials. Key materials to be transported to site include filter compatible drainage aggregate, geomembrane, and geosynthetics.

Bulk fill for dam construction is likely to comprise a mixture of fine to medium sands and stiff to very stiff silts identified within the borrow area/reservoir footprint. Sand dominated earth fills tend to require the addition of significant moisture to achieve an acceptable degree of compaction. This will necessitate access to a locally derived water source. We anticipate the contractor will require less than 200m^3/day on average, and no more than 500m^3/day based on experience.

The compacted sand fill is likely to be relatively free draining but may be subject to internal erosion (piping) under seepage flows or external erosion due to water flow for example from rainfall on dam batters during construction.

Based on the anticipated moderate permeability of the sand, the primary water retaining element will be a liner. The investigations have identified a potential low permeability cohesive material typically at least 1m thick that could be contemplated as a liner. This could be used as part of a composite lining system (i.e., beneath the HDPE for improved performance), or alternatively as an upstream zone within the dam embankment. There are some challenges with the use of such a material however, such as being prone to shrinkage. As a conservative approach synthetic lining, say with HDPE or a geosynthetic clay liner (GCL) is therefore envisaged. The persistent depth of sands within the reservoir floor means that lining of the reservoir is also likely to be required. As recommended in Section 6.3.1 under-liner drainage will be considered in the detail design phase , noting the potential for seepage loss from the drains themselves if the subgrade is very permeable (requiring deign mitigation such as lining to the drains themselves). This philosophy is in keeping with other dams of a similar geological setting.

Preliminary analyses were undertaken to assess possible leakage rates of water through the geomembrane liner using the method outlined by Giroud and Bonaparte (1989). Observations of in-service reservoirs suggest that leaks most commonly occur as either seam defects or larger holes from accidental puncture. A summary of typical installation defect frequencies is available in Design Standard-13 Embankment Dams, Chapter 20: Geomembranes (USBR, 2018). These range from less than one defect per acre for excellent installation quality up to 10 to 20 defects per acre for poor installation quality. Defect sizes typically range from a small hole with a surface area of about 3.1mm^2 (representing seam defects), up to large holes with a surface area of about 1cm^2 representing accidental punctures.

Combined leakage rate estimates across the entire floor are estimated to be 0.2L/s assuming excellent installation quality and seam defects, up to 0.4L/s for fair installation quality and small holes. We recommend these estimates be compared with observations of in-service performance of similar reservoirs. Extreme leakage rates would be considered unacceptable and would require drawdown of the reservoir for inspection and repairs to affected areas.

Based on the preliminary analysis it is reasonable to conclude that water table mounding under the pond, caused by leakage from the reservoir to the underlying subgrade, will be localised and unlikely to result in any significant effects. Leakage would either seep vertically, or along bedding horizons in the sand and outlet to the slopes to the west and east. Further assessment on leakage rates and requirements for piezometers and basal drainage will be undertaken during detailed design.

The disposal fill area is necessary to accommodate the excess cut material. It is proposed to be up to 5m deep and slopes at approximately 5H:1V. This material is likely to be compacted in lifts however, it is not necessary to achieve equivalent compaction as the fill dam embankment, assuming that no future building is proposed within the fill disposal area.

A greater quantity of cut earthworks, compared to embankment fill, will likely be required to account for material compaction and unsuitable materials. Estimates of loss factors will vary across the pond footprint both in plan and with depth, and this will need be considered alongside material bulking factors etc. during earthworks balancing. Once lab test results are available, following COVID-19 Level 4 lockdown, these would assist in determining actual loss factors and would also be helpful in evaluating different material handling and placement methods.

7.3 Foundation and Reservoir Floor Treatment

Awhitu Group deposits observed in borrow areas, depending on the results of the awaiting lab testing, are expected to be generally suitable for reuse in dam construction in combination with a synthetic liner, subject to further assessment. Layers containing higher proportions of silt and clay could be suitable as low permeability fill, whilst sandy silt and silty sand layers could be utilised as general fill. The selection of either an internally zoned or homogeneous dam embankment will be made during detailed design but due to the modest fill heights a homogeneous section is preferable.

The generally dense sandy soils underlying the site are considered sufficiently strong to support the embankments proposed notwithstanding further detailed assessment. While it is not envisaged that any considerable depth of undercut will be required as part of the foundation preparation or liquefaction mitigation, the variable and permeable nature of the foundation warrants further assessment as part of detailed design. Settlement effects, and the implications for the lining system, will also need to be evaluated in detail.

The requirement for, an extent of, any underdrainage system within the reservoir floor to avoid uplift of the liner will depend on long-term groundwater trends and the final reservoir floor elevation, to be confirmed during detailed design. The current proposed dam floor consists of a flat base at RL 67.5m, which is above the maximum recorded groundwater table to date and as such, sustained groundwater is not considered a significant risk for construction.

Prevention of wind uplift of the liner during low reservoir levels will also need to be considered.

7.4 Liquefaction

sDMT, CPT, and SPT data have been evaluated using the methods outlined in Section 6.3. No liquefaction is predicted at OBE ground motions and only minor at SEE. No specific mitigation options are considered warranted based on present information.

7.5 Reservoir Slope Stability

The dunes generally have gently rounded to flat ridge crests, flanked by moderate to steep slopes. The steeper slopes (24° to 34°) typically show signs of colluvium accumulation at their base and may be subject to soil creep. Exposed sand soils have limited resistance to erosion, and incised gully features are present where overland flow paths concentrate near the valley floor.

Generally, slope instability on the reservoir margins is expected to be minor in nature and unlikely to represent a hazard for the dam, pond slopes and stockpile. Initial stability analysis of the cut reservoir embankments indicate that cuts no steeper than 3H:1V meet the minimum FoS requirements. Maintenance of grass and vegetative cover in the slopes above reservoir level is recommended to further minimise the potential for shallow slumping or erosion. Perched groundwater in the upper soil horizons, e.g., above the hardpan where present, may lead to localised surficial saturation. Although not considered to pose an obvious risk to instability at a recommended batter of 3H:1V, the incorporation of regularly spaced counterfort drains extending 5m back from the face to a depth of 3m is considered prudent and will minimise the risk of this occurring and consequential effects on the lining system.

7.6 Spillway Cut

Hydraulic Design of the spillway is covered in RILEY report (Ref: 210339-B). Geotechnical considerations relevant to the spillway relate largely to protection of the underlying Awhitu Group sands from erosion. If disturbed, the fine sand making up the invert and side slopes of the channel are likely to be erodible under surface flows. In addition, careful detailing for seepage control is required where hardpan materials are used such as concrete linings or nib walls, as water tracking beneath such interfaces could cause internal erosion.

We understand that the proposed spillway is located at the western end of the reservoir close to a scarp feature observed during geological mapping. Should this spillway location be progressed to detailed design, further detailed investigations of this area will be required to get a better understanding of the behaviour of materials and the implications on the design.

In cases where specific erosion protection such as concrete or riprap is not warranted, the surfaces should be re-topsoiled and grassed.

7.7 Construction Considerations

The dam is likely to be constructed using conventional earthmoving equipment. The supplied 14 tonne excavator was found to be satisfactory for excavating to depths up to ~4.5m, i.e., similar to the likely maximum borrow area/reservoir cut.

The contractor should consider suitable excavation, placement, and compaction methodologies to ensure that design requirements are met.

As outlined earlier, the prevailing sandy soils are narrowly graded and would be potentially susceptible to piping failure in a concentrated leak scenario (i.e., complete rupture of the liner). Accordingly, sound commissioning and long-term monitoring procedures are recommended.

Construction dewatering is unlikely to be required, albeit minor perched water tables and seepages are possible locally and should be planned for in construction activities. Regularly spaced subsurface drains through the cut face of the pond will control this in the longer term.

Surface water management during construction will need to be considered and an appropriate methodology developed when planning the works. Standard erosion and sediment control works that are designed and implemented in accordance with Auckland Council Guidelines, are likely to be sufficient during construction.

8.0 Conclusions and Recommendations

RILEY has carried out detailed geological mapping of the site along with an intrusive geotechnical investigation comprising test pits, machine boreholes, CPTs, and sDMTs. The site is underlain by Awhitu Group dune sand deposits of the Late Pliocene-age (1.8M to 3.6M-years old) and there is evidence of cementation of sand grains and 'hardpan' features in weathered outcrops around the site, which have a strength consistent with 'extremely weak' rock.

Liquefaction and slope stability analyses have been carried out using the data acquired from the geotechnical investigations and has assisted the design implications and recommendations for this project. Key points are listed below:

- No liquefaction triggering is indicated for the OBE ground motions.
- For the SEE design case, no liquefaction is indicated for the sDMT data and little to minor liquefaction is indicated for the CPT and SPT data. It is noted that CPT and SPT based methods may overpredict the susceptibility of these soils due to breaking of the cementitious bonds during testing. On balance, based on the soils age, sDMT results, and groundwater monitoring to-date, liquefaction is not considered to present a credible risk to the reservoir.
- Slope stability analyses were carried out for several cross sections under various groundwater scenarios as well as under a seismic event. All results except for one location during the SEE achieve the minimum FoS requirements. Deformation is predicted to be small (<5mm), which is considered acceptably low.
- The construction of the reservoir is likely to comprise material from the borrow area as well as a synthetic liner.
- Counterfort drains are recommended along the rear cut of the reservoir to minimise the risk of surficial saturation.
- The current spillway location will require further investigation and analysis due to the presence of geological features in this location.

9.0 Limitation

This report has been prepared solely for the benefit of The Bears Home Project Management Limited as our client with respect to the brief and Auckland Council in processing the consent(s). The reliance by other parties on the information or opinions contained in the report shall, without our prior review and agreement in writing, be at such parties' sole risk.

Recommendations and opinions in this report are based on data from limited test positions. The nature and continuity of subsoil conditions away from the test positions are inferred, and it must be appreciated that actual conditions could vary considerably from the assumed model.

During excavation and construction, the site should be examined by an engineer or engineering geologist competent to judge whether the exposed subsoils are compatible with the inferred conditions on which the report has been based. It is possible that the nature of the exposed subsoils may require further investigation and the modification of the design based upon this report.

Riley Consultants Ltd would be pleased to provide this service to The Bears Home Project Management Limited and believes the project would benefit from such continuity. In any event, it is essential Riley Consultants Ltd is contacted if there is any variation in subsoil conditions from those described in the report as it may affect the design parameters recommended in the report.

APPENDIX A

Test Pit Logs (TP1 to TP12)

Riley Consultants ltd
4 Fred Thomas Drive, Takapuna
Auckland, 0622
Tel: +649-489-7872

TEST PIT LOG

Project:	Location:	Hole position:	No.:
710 Muriwai Road	Muriwai Downs	Refer to RILEY dwg: 210339-1	**TP01**

Job No.:	Start Date: 05-08-21 Finish Date: 05-08-21	Ground Level (m):	Co-Ordinates (NZTM):
210339		76	E 1,730,493 N 5,925,600

Client:	Hole Depth:	Sheet:
The Bears Home Project Management Limited	4.50 m	1 of 1

Elevation (m)	Depth (m)	Geological Unit	Geological Description (refer to separate Geotechnical and Geological Information sheet for further information)	Legend	Unified Symbol	Soil Shear Strength (kPa) 50 100 150 200	Scala Penetrometer (blows / 50 mm) 3 6 9 12 15	Groundwater	Soil Moisture	Samples	Tests
+75.50											
+75.25	0.25	Topsoil	TOPSOIL.						M		
+74.60	0.90		Silty CLAY with minor sand; orange with brown mottles. Stiff; moist; moderately plastic; sand, fine [AWHITU GROUP].								V= 85 R= 28
	1	Awhitu Group	Sandy SILT with some clay, trace gravel; light grey brown with orange mottles. Very stiff to hard; moist; sand, fine, micaceous; gravel; fine to coarse.						M		V= 140+
			1.60 m Grades to some extremely weak gravel; grey, light orange and dark orange mixed.								V= 134 R= 42
	2										V= 199+
+72.60	2.90										
	3		Sandy SILT with some clay; some gravel; light grey and light orange mixed with light red mottles. Hard; moist; slightly plastic; sand, fine, micaceous; gravel, fine to coarse.								
+72.10	3.40										
+71.90	3.60		Fine to medium SAND; light grey and light pink mixed. Medium dense to dense; moist; slightly cemented; sand, micaceous.						M		
	4		Fine to medium SAND; dark orange brown with black limonite inclusions. Medium dense to dense; moist; slightly cemented; more resistant to excavation than above.								
+71.00	4.50										
	5		EOH @ 4.50 m								

Explanations:

Rock Mass Weathering - unweathered, slightly weathered, moderately weathered, highly weathered, completely weathered, residually weathered

Relative soil Strength - very soft/very loose, soft/loose, firm/medium dense, stiff/dense, very stiff/very dense

- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Scala Penetrometer - blows/50mm
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Water Strike (1st, 2nd ...)
- Water Rise (1st, 2nd ...) and Rise Time (minutes)

GROUNDWATER

- [X] None
- [ ] Slow Seep (depth)
- [ ] Rapid Inflow (depth)

HOLE TERMINATED DUE TO: Target Depth

Remarks

1. Bulk sample taken at 3.0m bgl to 3.2m bgl.

All dimensions in metres Scale 1:34	Rig Type: Machine Excavator (13 tonne)	Shear Vane No. 2945	Logged by: GB	Checked by: SLP

RILEYAKL.GLB Log RILEY TP (AKL) 210339-TP LOGS.GPJ <<DrawingFile>> 17/09/2021 13:39 Produced by gINT Professional

Riley Consultants ltd
4 Fred Thomas Drive, Takapuna
Auckland, 0622
Tel: +649-489-7872

TEST PIT LOG

Project:	Location:	Hole position:	No.:
710 Muriwai Road	Muriwai Downs	Refer to RILEY dwg: 210339-1	**TP02**

Job No.:	Start Date: 04-08-21 Finish Date: 04-08-21	Ground Level (m):	Co-Ordinates (NZTM):
210339		70	E 1,730,496 N 5,925,768

Client:	Hole Depth:	Sheet:
The Bears Home Project Management Limited	4.60 m	1 of 1

Elevation (m)	Depth (m)	Geological Unit	Geological Description (refer to separate Geotechnical and Geological Information sheet for further information)
+69.75			
+69.45	0.30	Topsoil	TOPSOIL.
		Awhitu Group	Silty CLAY with trace sand; light orange brown. Stiff to very stiff; moderately to highly plastic; sand, fine [AWHITU GROUP].
	1		
			1.80 m - 2.00 m Grades to trace light grey mottles.
+67.65	2.10		
+67.45	2.30		Silty SAND with some gravel; orange and dark orange with black limonite inclusions. Medium dense; sand, fine, micaceous; gravel, fine to coarse.
			Fine to medium SAND with minor silt; ligh orange brown with minor black limonite inclusions. Loose; slightly cemented
	3		
+66.45	3.30		
			Fine to medium SAND with minor silt; dark brown. Medium dense to dense; moist to wet; slightly cemented; more resistant to excavation than above; sand, micaceous.
+66.05	3.70		
			Fine to medium SAND; light orange with minor black limonite inclusions. Medium dense to dense; slightly cemented,sand, micaceous.
	4		
+65.15	4.60		
			EOH @ 4.60 m
	5		

Legend | Unified Symbol | Soil Shear Strength (kPa): 50 100 150 200 | Scala Penetrometer (blows / 50 mm): 3 6 9 12 15 | Groundwater | Soil Moisture | Samples | Tests

Soil Moisture: M | M | M

Samples: ES | ES

Tests:
- No. 1: 1, 0, 1, 1, 1, 1, 2, 1, 1, 2, 1, 1, 1, 2, 1, 1, 1
- V= 74 R= 23
- V= 80 R= 26
- V= 88 R= 23
- V= 117 R= 45

Groundwater: 0.9m; 4/08/2021; 4/08/2021

Explanations:

Rock Mass Weathering - unweathered, slightly weathered, moderately weathered, highly weathered, completely weathered, residually weathered

Relative soil Strength - very soft/very loose, soft/loose, firm/medium dense, stiff/dense, very stiff/very dense

- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Scala Penetrometer - blows/50mm
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Water Strike (1st, 2nd ...)
- Water Rise (1st, 2nd ...) and Rise Time (minutes)

GROUNDWATER

- [ ] None
- [ ] Slow Seep (depth)
- [X] Rapid Inflow (depth 1.0, 1.8 m)

HOLE TERMINATED DUE TO: Target Depth

Remarks

1. Bulk samples taken at 1.8m bgl to 2.0m bgl, 2.0m bgl to 2.2m bgl and 3.4m bgl to 3.6m bgl.

All dimensions in metres Scale 1:34	Rig Type: Machine Excavator (13 tonne)	Shear Vane No. 2945	Logged by: GB	Checked by: SLP

Riley Consultants ltd
4 Fred Thomas Drive, Takapuna
Auckland, 0622
Tel: +649-489-7872

TEST PIT LOG

Project:	Location:	Hole position:	No.:
710 Muriwai Road	Muriwai Downs	Refer to RILEY dwg: 210339-1	**TP03**

Job No.:	Start Date: 04-08-21 Finish Date: 04-08-21	Ground Level (m):	Co-Ordinates (NZTM):
210339		67	E 1,730,451 N 5,925,853

Client:	Hole Depth:	Sheet:
The Bears Home Project Management Limited	4.50 m	1 of 1

Elevation (m)	Depth (m)	Geological Unit	Geological Description (refer to separate Geotechnical and Geological Information sheet for further information)	Legend	Unified Symbol	Soil Shear Strength (kPa) 50 100 150 200	Scala Penetrometer (blows / 50 mm) 3 6 9 12 15	Groundwater	Soil Moisture	Samples	Tests
+67.00											
+66.75	0.25	Topsoil	TOPSOIL.						M		No. 1 1, 1, 1, 2, 1, 2, 2, 2, 2, 2, 3, 2, 4, 4, 4, 4, 4, 4
+66.10	0.90		Clayey SILT with minor sand; orange with brown mottles. Very stiff; moist; slightly plastic; sand, fine [AWHITU GROUP].						M		
+65.50	1.50		Silty fine SAND with gravel; light orange brown. Loose to medium dense; moist; sand, micaceous. 1.20 m Grades to 100mm of dark orange limonite layer.				0.9m				UTP
+65.00	2.00		Fine to medium SAND with minor silt; orange with black limonite inclusions. Medium dense to dense; moist; slightly cemented; micaceous.								
		Awhitu Group	Fine to medium SAND with minor silt; orange brown with some black limonite inclusions. Medium dense to dense; dry to moist; cemented; more resistant to excavations than above.						DM		
+62.50	4.50										
			EOH @ 4.50 m								

Explanations:

Rock Mass Weathering - unweathered, slightly weathered, moderately weathered, highly weathered, completely weathered, residually weathered

Relative soil Strength - very soft/very loose, soft/loose, firm/medium dense, stiff/dense, very stiff/very dense

- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Scala Penetrometer - blows/50mm
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Water Strike (1st, 2nd ...)
- Water Rise (1st, 2nd ...) and Rise Time (minutes)

GROUNDWATER

- [X] None
- [ ] Slow Seep (depth)
- [ ] Rapid Inflow (depth)

HOLE TERMINATED DUE TO: Target Depth

Remarks

All dimensions in metres Scale 1:34	Rig Type: Machine Excavator (13 tonne)	Shear Vane No. 2945	Logged by: GB	Checked by: SLP

RILEYAKL.GLB Log RILEY TP (AKL) 210339-TP LOGS.GPJ <<DrawingFile>> 17/09/2021 13:39 Produced by gINT Professional

RILEY CONSULTANTS Engineers and Geologists
Riley Consultants ltd
4 Fred Thomas Drive, Takapuna
Auckland, 0622
Tel: +649-489-7872

TEST PIT LOG

Project:	Location:	Hole position:	No.:
710 Muriwai Road	Muriwai Downs	Refer to RILEY dwg: 210339-1	**TP04**

Job No.:	Start Date: 05-08-21 Finish Date: 05-08-21	Ground Level (m):	Co-Ordinates (NZTM):	Sheet:
210339		72	E 1,730,448 N 5,925,690	1 of 1

Client: The Bears Home Project Management Limited

Hole Depth: 4.50 m

Elevation (m)	Depth (m)	Geological Unit	Geological Description (refer to separate Geotechnical and Geological Information sheet for further information)	Legend	Unified Symbol	Soil Shear Strength (kPa)	Scala Penetrometer (blows / 50 mm)	Groundwater	Soil Moisture	Samples	Tests
+71.75						50 100 150 200	3 6 9 12 15				
+71.50	0.25	Topsoil	TOPSOIL.						M		
			Silty CLAY with trace sand; light orange brown. very stiff; moist to wet; moderately plastic; sand, fine [AWHITU GROUP].						MW		V= 125 R= 45
+70.85	0.90										V= 122 R= 43
	1		Clayey SILT with some sand, trace gravel; orange with trace light grey and dark orange mottles. Very stiff; slightly to moderately plastic; sand, fine; gravel, fine.								V= 199+
								5/08/2021			V= 128 R= 43
	2										V= 198 R= 51
+69.45	2.30	Awhitu Group	2.20 m Grades to minor light grey mottles.						MW		V= 199+
+69.15	2.60		Silty fine to medium SAND with minor silt; light grey with trace orange mottles. Loose; moist to wet; sand, micaceous.						M		
			Fine to medium SAND with minor silt; orange with dark orange mottles. Loose; moist.								
	3		3.00 m Grades to minor black limonite inclusions.								
+68.25	3.50										
			Fine to medium SAND with trace silt; dark orange with minor dark limonite inclusions. Medium dense to dense; moist; slightly cemented; sand, micaceous; more resistant to excavation than above.								
+67.85	3.90								M		
	4		Fine to medium SAND with trace gravel; dark orange brown with light grey mottles and black limonite inclusions. Tightly packed; moist; slightly cemented; sand, micaceous; more resistant to excavation than above.								
+67.25	4.50		4.10 m - 4.50 m Grades to light grey with black limonite inclusions.								
			EOH @ 4.50 m								
	5										

Explanations:

Rock Mass Weathering - unweathered, slightly weathered, moderately weathered, highly weathered, completely weathered, residually weathered

Relative soil Strength - very soft/very loose, soft/loose, firm/medium dense, stiff/dense, very stiff/very dense

- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Scala Penetrometer - blows/50mm
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Water Strike (1st, 2nd ...)
- Water Rise (1st, 2nd ...) and Rise Time (minutes)

GROUNDWATER

- [ ] None
- [X] Slow Seep (depth 2.0 m)
- [ ] Rapid Inflow (depth)

HOLE TERMINATED DUE TO: Target Depth

Remarks

1. Bulk sample taken at 2.4m bgl to 2.6m bgl.

All dimensions in metres Scale 1:34	Rig Type: Machine Excavator (13 tonne)	Shear Vane No. 2945	Logged by: GB	Checked by: SLP

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Tel: +649-489-7872

TEST PIT LOG

Project:	Location:	Hole position:	No.:
710 Muriwai Road	Muriwai Downs	Refer to RILEY dwg: 210339-1	**TP05**

Job No.:	Start Date: 05-08-21 Finish Date: 05-08-21	Ground Level (m):	Co-Ordinates (NZTM):	Sheet:
210339		67	E 1,730,395 N 5,925,743	1 of 1

Client: The Bears Home Project Management Limited

Hole Depth: 4.40 m

Elevation (m)	Depth (m)	Geological Unit	Geological Description (refer to separate Geotechnical and Geological Information sheet for further information)	Legend	Unified Symbol	Soil Shear Strength (kPa) 50 100 150 200	Scala Penetrometer (blows / 50 mm) 3 6 9 12 15	Groundwater	Soil Moisture	Samples	Tests
+66.75											
+66.50	0.25	Topsoil	TOPSOIL.						M		
+65.95	0.80		Silty CLAY with some sand; orange brown with trace dark orange mottles. Very stiff; moist; moderately plastic; sand, fine [AWHITU GROUP].			△ ×					V= 179 R= 30
+65.65	1.10		Sandy SILT with some clay, minor gravel; orange brown with dark orange mottles. Very stiff; moist; sand, fine; gravel, fine to coarse.			△ ×					V= 122 R= 48
+65.45	1.30		Fine to medium SAND with minor silt; light orange brown with minor black limonite inclusions. Medium dense; moist; slightly cemented; sand, micaceous.						M DM		
	2	Awhitu Group	Fine to coarse SAND with minor silt; brown with some black limonite inclusions, trace light orange and light grey mottles. Medium dense to dense; dry to moist; slightly cemented; sand, micaceous; more resistant to excavation than above.								
	3		2.60 m Grades to light orange with minor dark brown limonite inclusions; slightly cemented.								
	4										
+62.35	4.40		Difficult to excavate with 13 tonne machine. EOH @ 4.40 m								
	5										

Explanations:

Rock Mass Weathering - unweathered, slightly weathered, moderately weathered, highly weathered, completely weathered, residually weathered

Relative soil Strength - very soft/very loose, soft/loose, firm/medium dense, stiff/dense, very stiff/very dense

- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Scala Penetrometer - blows/50mm
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Water Strike (1st, 2nd ...)
- Water Rise (1st, 2nd ...) and Rise Time (minutes)

GROUNDWATER

- [X] None
- [ ] Slow Seep (depth)
- [ ] Rapid Inflow (depth)

HOLE TERMINATED DUE TO: Target Depth

Remarks

All dimensions in metres Scale 1:34	Rig Type: Machine Excavator (13 tonne)	Shear Vane No. 2945	Logged by: GB	Checked by: SLP

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TEST PIT LOG

Project:	Location:	Hole position:	No.:
710 Muriwai Road	Muriwai Downs	Refer to RILEY dwg: 210339-1	**TP06**

Job No.:	Start Date: 04-08-21 Finish Date: 04-08-21	Ground Level (m):	Co-Ordinates (NZTM):
210339		70	E 1,730,609 N 5,925,829

Client:	Hole Depth:	Sheet:
The Bears Home Project Management Limited	4.50 m	1 of 1

Elevation (m)	Depth (m)	Geological Unit	Geological Description (refer to separate Geotechnical and Geological Information sheet for further information)	Legend	Unified Symbol	Soil Shear Strength (kPa)	Scala Penetrometer (blows / 50 mm)	Groundwater	Soil Moisture	Samples	Tests
+69.50						50 100 150 200	3 6 9 12 15				
+69.25	0.25	Topsoil	TOPSOIL.						M		No. 1 0, 1, 1, 2, 2, 2, 1, 2, 1, 2, 2, 1, 2, 2, 1, 2 V= 85 R= 31
+68.20	1.30		Silty CLAY with trace sand; brown orange. Stiff; moist to wet; moderately to highly plastic; sand, fine [AWHITU GROUP].				0.9m	4/09/2021			V= 94 R= 40; V= 80 R= 31
+67.50	2.00		Clayey SILT with minor sand; brown orange with grey and dark orange mottles. Stiff; slightly to moderately plastic; sand, fine, micaceous.						W		UTP; V= 134 R= 51
+66.60	2.90	Awhitu Group	Sandy SILT with minor clay, minor gravel; orange with trace light grey and dark orange mottles. Hard to very stiff; dry to moist; sand, fine.						DM		
+65.90	3.60		Silty fine to medium SAND with minor gravel; orange with white specks. Loose; dry to moist; sand, micaceous; gravel, fine to medium.								
+65.00	4.50		Fine to medium SAND with some silt; light orange with black and white specks. Medium dense to dense; dry to moist; slightly cemented; sand, micaceous; more resistant to excavation than above. 4.10 m Grades to minor to some black limonite inclusions. 4.20 m - 4.50 m Grades to dark brown with light orange mottles; large amount of micaceous sand.						DM		
	5		EOH @ 4.50 m								

Explanations:

Rock Mass Weathering - unweathered, slightly weathered, moderately weathered, highly weathered, completely weathered, residually weathered

Relative soil Strength - very soft/very loose, soft/loose, firm/medium dense, stiff/dense, very stiff/very dense

- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Scala Penetrometer - blows/50mm
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Water Strike (1st, 2nd ...)
- Water Rise (1st, 2nd ...) and Rise Time (minutes)

GROUNDWATER

- [ ] None
- [X] Slow Seep (depth 1.2 m)
- [ ] Rapid Inflow (depth)

HOLE TERMINATED DUE TO: Target Depth

Remarks

1. Bulk samples taken at 2.1m bgl to 2.3m bgl and 2.9m bgl to 3.1m bgl.

All dimensions in metres Scale 1:34	Rig Type: Machine Excavator (13 tonne)	Shear Vane No. 2945	Logged by: GB	Checked by: SLP

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TEST PIT LOG

Project:	Location:	Hole position:	No.:
710 Muriwai Road	Muriwai Downs	Refer to RILEY dwg: 210339-1	**TP07**

Job No.:	Start Date: 05-08-21 Finish Date: 05-08-21	Ground Level (m):	Co-Ordinates (NZTM):
210339		76	E 1,730,595 N 5,925,693

Client:	Hole Depth:	Sheet:
The Bears Home Project Management Limited	4.60 m	1 of 1

Elevation (m)	Depth (m)	Geological Unit	Geological Description (refer to separate Geotechnical and Geological Information sheet for further information)	Legend	Unified Symbol	Soil Shear Strength (kPa) 50 100 150 200	Scala Penetrometer (blows / 50 mm) 3 6 9 12 15	Groundwater	Soil Moisture	Samples	Tests
+75.50											
+75.30	0.20	Topsoil	TOPSOIL.						M		
			Clayey SILT with some sand; orange brown. Very stiff; moist; slightly to moderately plastic; sand, fine [AWHITU GROUP].			△ ×					V= 151 R= 34
+74.80	0.70		0.70 m Changed to toothed bucket.						DM		
+74.50	1.00		Silty fine to medium SAND; light orange brown with minor black limonite inclusions. Loose; dry to moist;								
		Awhitu Group	Fine to medium SAND with minor silt; light orange with some dark brown limonite inclusions. medium dense; dry to moist; slightly cemented; sand, micaceous; more resistant to excavation than above.								
+72.80	2.70		Fine to medium SAND with trace silt; medium brown with trace white specks. Medium dense to dense; dry to moist; slightly cemented; sand, micaceous; more resistant to excavation than above.						DM		
+70.90	4.60		EOH @ 4.60 m								

Explanations:

Rock Mass Weathering - unweathered, slightly weathered, moderately weathered, highly weathered, completely weathered, residually weathered

Relative soil Strength - very soft/very loose, soft/loose, firm/medium dense, stiff/dense, very stiff/very dense

- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample

- Scala Penetrometer - blows/50mm
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Water Strike (1st, 2nd ...)
- Water Rise (1st, 2nd ...) and Rise Time (minutes)

GROUNDWATER

- [X] None
- [ ] Slow Seep (depth)
- [ ] Rapid Inflow (depth)

HOLE TERMINATED DUE TO: Target Depth

Remarks

All dimensions in metres Scale 1:34	Rig Type: Machine Excavator (13 tonne)	Shear Vane No. 2945	Logged by: GB	Checked by: SLP

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RILEY CONSULTANTS Engineers and Geologists
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TEST PIT LOG

Project:	Location:	Hole position:	No.:
710 Muriwai Road	Muriwai Downs	Refer to RILEY dwg: 210339-1	**TP08**

Job No.:	Start Date: 05-08-21 Finish Date: 05-08-21	Ground Level (m):	Co-Ordinates (NZTM):
210339		80	E 1,730,594 N 5,925,554

Client:	Hole Depth:	Sheet:
The Bears Home Project Management Limited	4.70 m	1 of 1

Elevation (m)	Depth (m)	Geological Unit	Geological Description (refer to separate Geotechnical and Geological Information sheet for further information)	Legend	Unified Symbol	Soil Shear Strength (kPa) 50 100 150 200	Scala Penetrometer (blows / 50 mm) 3 6 9 12 15	Groundwater	Soil Moisture	Samples	Tests
+80.00											
+79.70	0.30	Topsoil	TOPSOIL.						M		
			Silty CLAY with minor sand; orange brown. Stiff; moderately plastic; sand, fine [AWHITU GROUP].								V= 97 R= 23
+78.80	1.20		1.00 m - 1.20 m Grades to trace fine to coarse gravel; orange.								V= 99 R= 45
											V= 199+
+78.30	1.70		Silty fine to medium SAND with minor gravel, minor clay; orange with trace light grey mottles. Medium dense; moist to wet; sand, micaceous; gravel, fine to coarse, extremely weak.						MW		UTP
+77.80	2.20		Fine to medium SAND with some silt; light orange brown. Medium dense; moist; sand, micaceous.						M		
+77.40	2.60	Awhitu Group	Fine to medium SAND with minor silt; light orange brown with minor black limonite inclusions. medium dense to dense; moist; slightly cemented; sand, micaceous.								
			2.60 m - 2.80 m Grades to brown with black slightly cemented SAND.						W		
+76.40	3.60		Fine to medium SAND with minor silt, trace clay; light orange light grey with some dark brown limonite inclusions. Medium dense; wet; slightly cemented; more resistant to excavation than above.								
+76.10	3.90		Sandy SILT with some clay, minor gravel; light grey and light red mixed; very stiff; slightly plastic; sand, fine.								V= 185 R= 43
+75.30	4.70		Fine to medium SAND with minor silt, trace clay; light orange brown with minor black limonite inclusions. Medium dense to dense; wet; slightly cemented; sand, micaceous.						W		
			EOH @ 4.70 m								

Explanations:

Rock Mass Weathering - unweathered, slightly weathered, moderately weathered, highly weathered, completely weathered, residually weathered

Relative soil Strength - very soft/very loose, soft/loose, firm/medium dense, stiff/dense, very stiff/very dense

- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Scala Penetrometer - blows/50mm
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Water Strike (1st, 2nd ...)
- Water Rise (1st, 2nd ...) and Rise Time (minutes)

GROUNDWATER

- [X] None
- [ ] Slow Seep (depth)
- [ ] Rapid Inflow (depth)

HOLE TERMINATED DUE TO: Target Depth

Remarks

1. Bulk sample taken at 1.7m bgl to 1.9m bgl.

All dimensions in metres Scale 1:34	Rig Type: Machine Excavator (13 tonne)	Shear Vane No. 2945	Logged by: GB	Checked by: SLP

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TEST PIT LOG

Project:	Location:	Hole position:	No.:
710 Muriwai Road	Muriwai Downs	Refer to RILEY dwg: 210339-1	**TP09**

Job No.:	Start Date: 04-08-21 Finish Date: 04-08-21	Ground Level (m):	Co-Ordinates (NZTM):
210339		68	E 1,730,741 N 5,925,943

Client:	Hole Depth:	Sheet:
The Bears Home Project Management Limited	4.50 m	1 of 1

Elevation (m)	Depth (m)	Geological Unit	Geological Description (refer to separate Geotechnical and Geological Information sheet for further information)
+67.50			
+67.30	0.20	Topsoil	TOPSOIL.
			Silty CLAY with minor sand; orange. Stiff to very stiff; moist; moderately plastic; sand, fine [AWHITU GROUP].
+66.80	0.70		
	1		Sandy SILT with minor sandstone gravel; light orange. Hard; moist; sand, fine; gravel, fine to coarse.
+65.90	1.60		
	2	Awhitu Group	Fine to medium SAND with trace silt; light grey with trace light orange mottles. Medium dense to dense; dry to moist; sand, micaceous; more resistant to excavation than above.
	3		2.60 m - 4.20 m Grades to light orange with minor black limonite inclusions and trace white specks.
	4		
+63.30	4.20		
			Fine to medium SAND with trace silt; light grey with trace light orange mottles. Dense; dry to moist; sand, micaceous; more resistant to excavation than above.
+63.00	4.50		4.40 m Grades to dark orange and grey SAND
			EOH @ 4.50 m
	5		

Legend

Unified Symbol

Soil Shear Strength (kPa): 50 100 150 200

Scala Penetrometer (blows / 50 mm): 3 6 9 12 15; 1.0m

Groundwater

Soil Moisture: M; MW; M; DM; DM

Samples

Tests: No. 1 — 0, 1, 0, 1, 2, 1, 2, 2, 2, 2, 1, 2, 1, 1, 1, 1, 2, 2, 6; V= 102 R= 37; UTP

Explanations:

Rock Mass Weathering - unweathered, slightly weathered, moderately weathered, highly weathered, completely weathered, residually weathered

Relative soil Strength - very soft/very loose, soft/loose, firm/medium dense, stiff/dense, very stiff/very dense

- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Scala Penetrometer - blows/50mm
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Water Strike (1st, 2nd ...)
- Water Rise (1st, 2nd ...) and Rise Time (minutes)

GROUNDWATER

- [X] None
- [ ] Slow Seep (depth)
- [ ] Rapid Inflow (depth)

HOLE TERMINATED DUE TO: Target Depth

Remarks

All dimensions in metres Scale 1:34	Rig Type: Machine Excavator (13 tonne)	Shear Vane No. 2945	Logged by: GB	Checked by: SLP

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TEST PIT LOG

Project:	Location:	Hole position:	No.:
710 Muriwai Road	Muriwai Downs	Refer to RILEY dwg: 210339-1	**TP10**

Job No.:	Start Date: 04-08-21 Finish Date: 04-08-21	Ground Level (m):	Co-Ordinates (NZTM):
210339		68	E 1,730,594 N 5,925,899

Client:	Hole Depth:	Sheet:
The Bears Home Project Management Limited	4.50 m	1 of 1

Elevation (m)	Depth (m)	Geological Unit	Geological Description (refer to separate Geotechnical and Geological Information sheet for further information)
+67.75			
+67.50	0.25	Topsoil	TOPSOIL.
		Awhitu Group	Silty CLAY; light brown orange with light grey mottles. Stiff to very stiff; moist to wet; moderately to highly plastic; trace micaceous [AWHITU GROUP].
+65.75	2.00		Sandy SILT with minor clay; light orange with light grey mottles. Very stiff; wet; non to slightly plastic; sand, fine.
+65.25	2.50		Silty SAND with minor clay; light grey with light grey mottles. Loose; sand, fine; micaceous.
+64.75	3.00		Fine to medium SAND with some silt, trace clay; light orange with dark orange and light grey mottles. Medium dense to dense; moist to wet; sand. micaceous slightly cemented. 3.80 m - 4.20 m Grades to trace white specks. 3.90 m - 4.50 m Grades to some dark orange and trace light orange mottles.
+63.25	4.50		EOH @ 4.50 m

Legend; Unified Symbol

Soil Shear Strength (kPa): 50 100 150 200

Scala Penetrometer (blows / 50 mm): 3 6 9 12 15; 0.9m

Groundwater: 4/08/2021

Soil Moisture: M, MW, W, MW

Samples

Tests:
No. 1 0, 1, 1, 2, 1, 2, 1, 2, 1, 2, 1, 2, 1, 1, 2
V= 65 R= 20
V= 60 R= 23
V= 80 R= 31
V= 125 R= 40
V= 188 R= 31

Explanations:

Rock Mass Weathering - unweathered, slightly weathered, moderately weathered, highly weathered, completely weathered, residually weathered

Relative soil Strength - very soft/very loose, soft/loose, firm/medium dense, stiff/dense, very stiff/very dense

- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Scala Penetrometer - blows/50mm
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Water Strike (1st, 2nd ...)
- Water Rise (1st, 2nd ...) and Rise Time (minutes)

GROUNDWATER

- [ ] None
- [X] Slow Seep (depth 1.4 m)
- [ ] Rapid Inflow (depth)

HOLE TERMINATED DUE TO: Target Depth

Remarks

1. Bulk sample taken at 1.8m bgl to 2.0m bgl.

All dimensions in metres Scale 1:34	Rig Type: Machine Excavator (13 tonne)	Shear Vane No. 2945	Logged by: GB	Checked by: SLP

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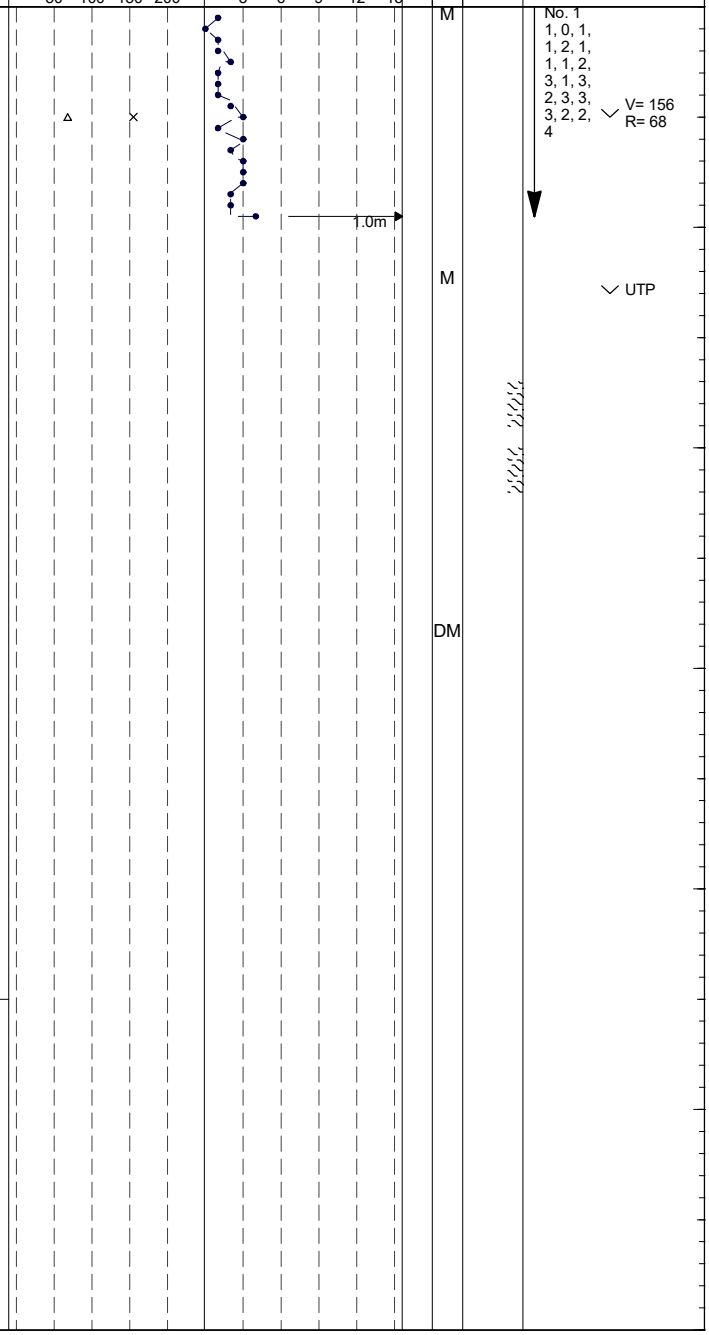
TEST PIT LOG

Project:	Location:	Hole position:	No.:
710 Muriwai Road	Muriwai Downs	Refer to RILEY dwg: 210339-1	**TP11**

Job No.:	Start Date: 04-08-21 Finish Date: 04-08-21	Ground Level (m):	Co-Ordinates (NZTM):
210339		74	E 1,730,709 N 5,925,828

Client:	Hole Depth:	Sheet:
The Bears Home Project Management Limited	4.50 m	1 of 1

Elevation (m)	Depth (m)	Geological Unit	Geological Description (refer to separate Geotechnical and Geological Information sheet for further information)	Legend	Unified Symbol
+73.50					
+73.25	0.25	Topsoil	TOPSOIL.		
			Silty CLAY with trace sand; orange. Very stiff; moist; moderately plastic; sand, fine, micaceous [AWHITU GROUP].		
+72.30	1.20				
			Sandy SILT; orange brown. Hard; moist; non plastic; sand, fine, micaceous.		
+71.50	2.00				
		Awhitu Group	Silty fine to medium SAND; yellow light orange with trace dark orange mottles. Loose; moist; sand, micaceous.		
+70.70	2.80				
			Fine to medium SAND with minor silt; light orange brown with minor black limonite inclusions. Medium dense to dense; dry to moist; sand, micaceous; slightly cemented. 2.90 m Grades to minor black limonite inclusions.		
+69.00	4.50				
			EOH @ 4.50 m		



Explanations:

Rock Mass Weathering - unweathered, slightly weathered, moderately weathered, highly weathered, completely weathered, residually weathered

Relative soil Strength - very soft/very loose, soft/loose, firm/medium dense, stiff/dense, very stiff/very dense

- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Scala Penetrometer - blows/50mm
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Water Strike (1st, 2nd ...)
- Water Rise (1st, 2nd ...) and Rise Time (minutes)

GROUNDWATER

- [X] None
- [ ] Slow Seep (depth)
- [ ] Rapid Inflow (depth)

HOLE TERMINATED DUE TO:
Target Depth

Remarks

1. Bulk samples taken at 1.7m bgl to 1.9m bgl and 2.0m bgl to 2.2m bgl.

All dimensions in metres Scale 1:34	Rig Type: Machine Excavator (13 tonne)	Shear Vane No. 2945	Logged by: GB	Checked by: SLP

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TEST PIT LOG

Project:	Location:	Hole position:	No.:
710 Muriwai Road	Muriwai Downs	Refer to RILEY dwg: 210339-1	**TP12**

Job No.:	Start Date: 05-08-21 Finish Date: 05-08-21	Ground Level (m):	Co-Ordinates (NZTM):	Sheet:
210339		77	E 1,730,664 N 5,925,606	1 of 1

Client: The Bears Home Project Management Limited

Hole Depth: 4.80 m

Elevation (m)	Depth (m)	Geological Unit	Geological Description (refer to separate Geotechnical and Geological Information sheet for further information)	Legend	Unified Symbol	Soil Shear Strength (kPa)	Scala Penetrometer (blows / 50 mm)	Groundwater	Soil Moisture	Samples	Tests
+76.50						50 100 150 200	3 6 9 12 15				
+76.25	0.25	Topsoil	TOPSOIL.						M		
			Clayey SILT with some sand; orange. Very stiff to hard; moist; slightly to moderately plastic; sand, fine [AWHITU GROUP].						M		V= 134 R= 40
+75.40	1.10										UTP
			Fine to medium SAND with minor silt; light orange brown with black limonite inclusions. Medium dense to dense; dry to moist; sand, micaceous; slightly cemented.						DM		
+74.20	2.30										V= 97 R= 17
		Awhitu Group	Sandy SILT with some clay, some gravel; light red with light grey mottles. Stiff; wet; slightly plastic; sand, fine, micaceous ; gravel, fine to medium.						W		
+73.70	2.80										
			Silty fine to medium SAND with trace clay; light orange with minor black and trace light red mottles. Medium dense to dense; moist to wet; sand, micaceous; slightly cemented.						MW		
			3.60 m Grades to some black limonite inclusions.								
+72.60	3.90										
			Silty fine to medium SAND with minor clay; light orange brown with trace black limonite inclusions. Medium dense to dense; wet; slightly cemented.						W		
+72.00	4.50										
			Sandy SILT with minor clay; brown with light orange and light grey mottles. Hard; wet; sand, fine to medium.								
+71.70	4.80		4.60 m - 4.80 m Grades to light orange brown with trace light grey mottles and trace black limonite inclusions.								
			EOH @ 4.80 m								

Explanations:

Rock Mass Weathering - unweathered, slightly weathered, moderately weathered, highly weathered, completely weathered, residually weathered

Relative soil Strength - very soft/very loose, soft/loose, firm/medium dense, stiff/dense, very stiff/very dense

- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Scala Penetrometer - blows/50mm
- Permeability Test
- Schmidt Hammer
- Insitu Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Water Strike (1st, 2nd ...)
- Water Rise (1st, 2nd ...) and Rise Time (minutes)

GROUNDWATER

- [X] None
- [ ] Slow Seep (depth)
- [ ] Rapid Inflow (depth)

HOLE TERMINATED DUE TO: Target Depth

Remarks

All dimensions in metres Scale 1:34	Rig Type: Machine Excavator (13 tonne)	Shear Vane No. 2945	Logged by: GB	Checked by: SLP

APPENDIX B

Machine Logs (MH1 to MH3)

Riley Consultants ltd
4 Fred Thomas Drive, Takapuna
Auckland, 0622
Tel: +649-489-7872

MACHINE HOLE LOG

Project:	Location:	Hole position:	No.:
710 Muriwai Road	Muriwai Downs	Refer to RILEY dwg: 210339-1	**MH01**

Job No.:	Start Date: 09-08-21 Finish Date: 09-08-21	Ground Level (m):	Co-Ordinates (NZTM):
210339		73	E 1,730,573 N 5,925,738

Client:	Hole Depth:	Sheet:
The Bears Home Project Management Limited	13.95 m	1 of 2

Elevation (m)	Depth (m)	Geological Unit	Geological Description	Legend	Weathering (RS CW HW MW SW UW)	Rock Field Strength (H/EW VW W MS S VS ES E)	Drilling Method	RQD (%)	Core Loss (%) 25 50 75	Field Testing	Defect Description (type, orientation, spacing, roughness, persistence aperture, infilling etc)	Piezometer
+72.50	0	Topsoil	TOPSOIL				HQ3					
			Silty CLAY, minor sand; brownish orange. Very stiff; moist; moderatley plastic; sand, fine [AWHITU GROUP].									
+71.30	1		SILT, some clay, some sand; light orange with orange mottles. Hard; moderately plastic. Sand, fine.				SPT			SPT 1.50 m 2, 3, 3, 4, 6, 6; Nc=19		
	2		1.95 m Grades to very stiff (PP = 3.0 kg/cm^2)				HQ3					
			2.40 m SILT, some sand, some clay; light orange. Stiff; wet; non plastic. Sand, fine.									
+69.45	3		Silty clayey SAND with some silt; orange. Medium dense; slightly cemented.				SPT			SPT 3.00 m 1, 1, 2, 3, 3, 3; Nc=11		
			3.70 m Grades to some Silt.				HQ3					
+68.75	4	Awhitu Group	4.00 m Grades to SAND, some silt, some clay limonite; medium dense; dark orange brown mottles, dark yellow. Core broken up; slightly cemented.				SPT			SPT 4.50 m 3, 3, 4, 3, 3, 4; Nc=14		
			SAND, some silt, some clay limonite; medium dense; dark orange brown mottles, dark yellow. Core broken up; slightly cemented.				HQ3					
	5						SPT					
							HQ3					
	6						SPT			SPT 6.00 m 2, 2, 3, 2, 3, 3; Nc=11		
							HQ3					
	7		7.20 m Grades to speckled black; medium dense.				SPT			SPT 7.50 m 2, 2, 3, 3, 3, 3; Nc=12		

Explanations:

TCR - Total Core Recovery
SCR - Solid Core Recovery
RQD - Rock Quality Designation
N - SPT Spoon
Nc - SPT Solid Cone
Attitude of discontinuities displayed as Dip/Dip Direction and Trend/Plunge

- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Lugeon Test - Flow Type/Adopted Value
- Water Strike (1st, 2nd ...)
- Water Rise (1st, 2nd ...) and
- Rise Time (minutes)

Test Methods

Geological description:
"Field Descriptions of Soil and Rock", NZ Geotechnical Society (2005)

Shear Vane:
"Guideline for Hand Held Shear Vane Test", NZ Geotechnical Society (2001)

Remarks

1. Piezometer details:
   - 32mm diameter low pressure PVC
   - Cap riser from 0.0m bgl to 0.2m bgl.
   - Bentonite backfill from 0.2m bgl to 10m bgl.
   - Blinding sand from 10.0m bgl to 10.5m bgl.
   - Screened pipe with filter sand from 10.5m bgl to 13.5m bgl.
   - Blinding sand from 13.5m bgl to 13.7m bgl.
   - Bentonite backfill from 13.7m bgl to 13.85m bgl.
   - Filter sand from 13.85 m bgl to 13.95m bgl.
2. PP = Pocket Penetrometer

All dimensions in metres Scale 1:50	Driller: DRILL FORCE	Rig Type: Wireline	Drilling Fluid:	Shear Vane No.:	Logged by: AWT	Checked by: SLP

Riley Consultants ltd
4 Fred Thomas Drive, Takapuna
Auckland, 0622
Tel: +649-489-7872

MACHINE HOLE LOG

Project:	Location:	Hole position:	No.:
710 Muriwai Road	Muriwai Downs	Refer to RILEY dwg: 210339-1	**MH01**

Job No.:	Start Date: / Finish Date:	Ground Level (m):	Co-Ordinates (NZTM):
210339	09-08-21 / 09-08-21	73	E 1,730,573 N 5,925,738

Client:	Hole Depth:	Sheet:
The Bears Home Project Management Limited	13.95 m	2 of 2

Elevation (m)	Depth (m)	Geological Unit	Geological Description	Legend	Weathering (RS CW HW MW SW UW)	Rock Field Strength (H/EW W MS S VS ES)	Drilling Method	RQD (%)	Core Loss (%) 25 50 75	Field Testing	Defect Description (type, orientation, spacing, roughness, persistence aperture, infilling etc)	Piezometer
	9	Awhitu Group	7.95 m Core intact. (PP > 4.5 kg/cm^2); more cemented than above. SAND, some silt, some clay limonite; medium dense; dark orange brown mottles, dark yellow. Core broken up; slightly cemented. *(continued)* 8.26 m Core can be broken with thumb pressure, slightly cemented; No apparant bedding.			HQ3			SPT 9.00 m 3, 3, 2, 4, 4, 4; Nc=14		
	10					SPT						
						HQ3						
	11					SPT				SPT 10.50 m 1, 2, 4, 3, 5, 5; Nc=17		
						HQ3						
	12					SPT				SPT 12.00 m 2, 3, 3, 5, 6, 7; Nc=21		
	13					HQ3						
+58.80						SPT				SPT 13.50 m 2, 1, 3, 3, 4, 5; Nc=15		
	14		EOH @ 13.95 m									
	15											

Explanations:

TCR - Total Core Recovery
SCR - Solid Core Recovery
RQD - Rock Quality Designation
N - SPT Spoon
Nc - SPT Solid Cone
Attitude of discontinuities displayed as Dip/Dip Direction and Trend/Plunge

- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Lugeon Test - Flow Type/Adopted Value
- Water Strike (1st, 2nd ...)
- Water Rise (1st, 2nd ...) and
- Rise Time (minutes)

Test Methods

Geological description:
"Field Descriptions of Soil and Rock", NZ Geotechnical Society (2005)

Shear Vane:
"Guideline for Hand Held Shear Vane Test", NZ Geotechnical Society (2001)

Remarks

1. Piezometer details:
   - 32mm diameter low pressure PVC
   - Cap riser from 0.0m bgl to 0.2m bgl.
   - Bentonite backfill from 0.2m bgl to 10m bgl.
   - Blinding sand from 10.0m bgl to 10.5m bgl.
   - Screened pipe with filter sand from 10.5m bgl to 13.5m bgl.
   - Blinding sand from 13.5m bgl to 13.7m bgl.
   - Bentonite backfill from 13.7m bgl to 13.85m bgl.
   - Filter sand from 13.85 m bgl to 13.95m bgl.
2. PP = Pocket Penetrometer

All dimensions in metres Scale 1:50	Driller: DRILL FORCE	Rig Type: Wireline	Drilling Fluid:	Shear Vane No.:	Logged by: AWT	Checked by: SLP

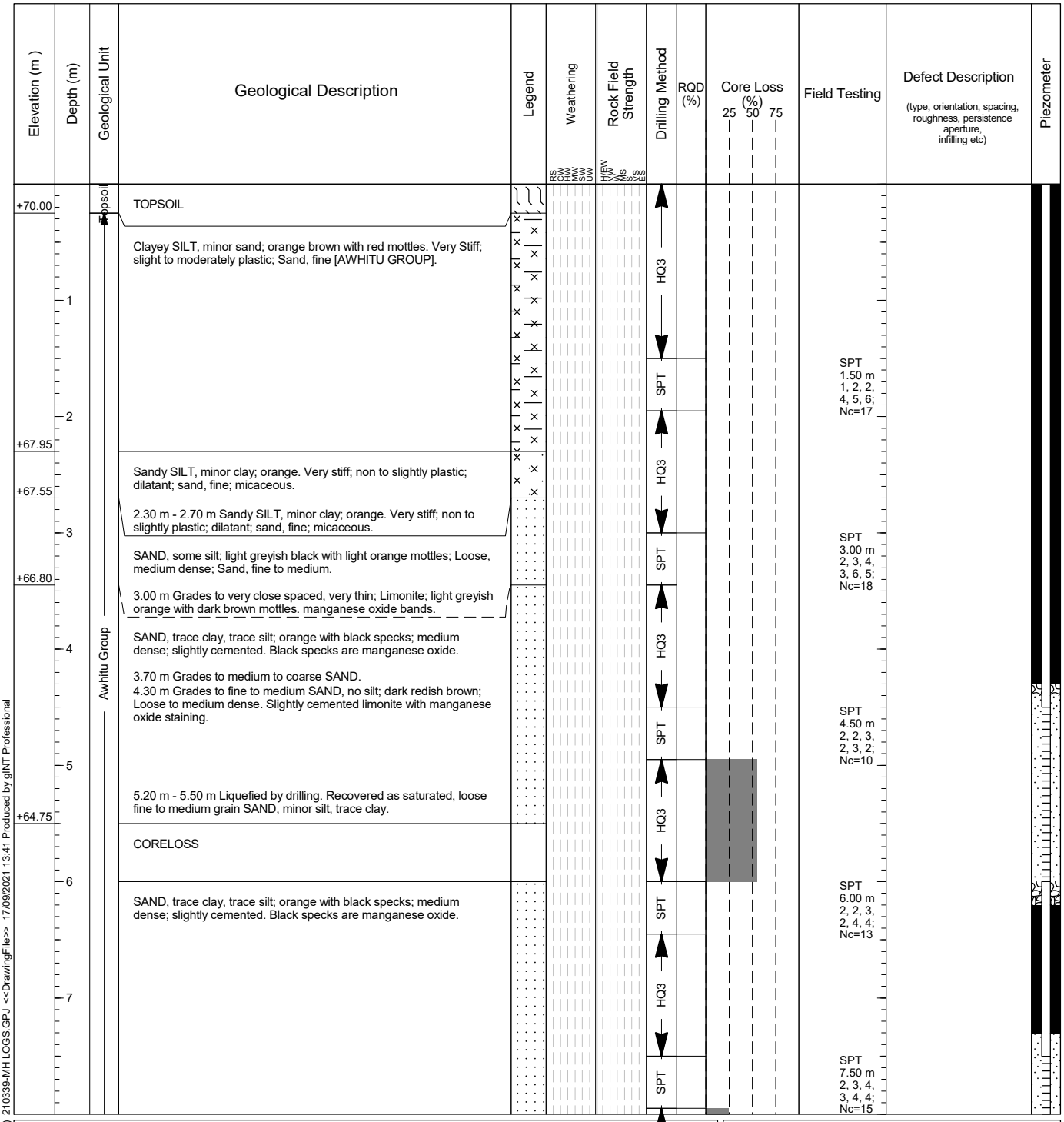
Riley Consultants ltd
4 Fred Thomas Drive, Takapuna
Auckland, 0622
Tel: +649-489-7872

MACHINE HOLE LOG

Project:	Location:	Hole position:	No.:
710 Muriwai Road	Muriwai Downs	Refer to RILEY dwg: 210339-1	**MH02**

Job No.:	Start Date: 09-08-21 Finish Date: 09-08-21	Ground Level (m):	Co-Ordinates (NZTM):
210339		70	E 1,730,795 N 5,925,852

Client:	Hole Depth:	Sheet:
The Bears Home Project Management Limited	10.95 m	1 of 2



Explanations:

TCR - Total Core Recovery
SCR - Solid Core Recovery
RQD - Rock Quality Designation
N - SPT Spoon
Nc - SPT Solid Cone
Attitude of discontinuities displayed as Dip/Dip Direction and Trend/Plunge

- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Lugeon Test - Flow Type/Adopted Value
- Water Strike (1st, 2nd ...)
- Water Rise (1st, 2nd ...) and
- Rise Time (minutes)

Test Methods

Geological description:
"Field Descriptions of Soil and Rock", NZ Geotechnical Society (2005)

Shear Vane:
"Guideline for Hand Held Shear Vane Test", NZ Geotechnical Society (2001)

Remarks

1. Piezometer details:
   - 32mm diameter low pressure PVC
   - Bentonite backfill from 0.0m bgl to 4.3m bgl.
   - Filter sand from 4.4m bgl to 4.5m bgl.
   - Screened pipe with filter sand from 4.5m bgl to 6.0m bgl.
   - Blinding sand from 6.0m bgl to 6.2m bgl.
   - Bentonite backfill from 6.2m bgl to 7.3m bgl.
   - Blinding sand from 7.3m bgl to 7.5m bgl.
   - Screened pipe with filter sand from 7.5m bgl to 9.0m bgl.
   - Blinding sand from 9.0m bgl to 9.2m bgl.
   - Bentonite backfill from 9.2m bgl to 9.5m bgl.
2. PP = Pocket Penetrometer

All dimensions in metres Scale 1:50	Driller: DRILL FORCE	Rig Type: Wireline	Drilling Fluid:	Shear Vane No.:	Logged by: AWT	Checked by: SLP

Riley Consultants ltd
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Auckland, 0622
Tel: +649-489-7872

MACHINE HOLE LOG

Project:	Location:	Hole position:	No.:
710 Muriwai Road	Muriwai Downs	Refer to RILEY dwg: 210339-1	**MH02**

Job No.:	Start Date: 09-08-21 Finish Date: 09-08-21	Ground Level (m):	Co-Ordinates (NZTM):
210339		70	E 1,730,795 N 5,925,852

Client:	Hole Depth:	Sheet:
The Bears Home Project Management Limited	10.95 m	2 of 2

Elevation (m)	Depth (m)	Geological Unit	Geological Description	Legend	Weathering (RS CW HW MW SW UW)	Rock Field Strength (H/EW W MW MS SW SS E)	Drilling Method	RQD (%)	Core Loss (%) 25 50 75	Field Testing	Defect Description (type, orientation, spacing, roughness, persistence aperture, infilling etc)	Piezometer
	9	Awhitu Group	SAND, trace clay, trace silt; orange with black specks; medium dense; slightly cemented. Black specks are manganese oxide. *(continued)*				HQ3					
							SPT			SPT 9.00 m 4, 4, 5, 5, 5, 6; Nc=21		
	10						HQ3					
			10.50 m Bedding Joint; 30deg dip; planar, rough, <2mm aperture, tight.				SPT			SPT 10.50 m 2, 2, 3, 3, 3, 4; Nc=13		
+59.30	11		EOH @ 10.95 m									
	12											
	13											
	14											
	15											

Explanations:

TCR - Total Core Recovery
SCR - Solid Core Recovery
RQD - Rock Quality Designation
N - SPT Spoon
Nc - SPT Solid Cone
Attitude of discontinuities displayed as Dip/Dip Direction and Trend/Plunge

- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Lugeon Test - Flow Type/Adopted Value
- Water Strike (1st, 2nd ...)
- Water Rise (1st, 2nd ...) and
- Rise Time (minutes)

Test Methods

Geological description:
"Field Descriptions of Soil and Rock", NZ Geotechnical Society (2005)

Shear Vane:
"Guideline for Hand Held Shear Vane Test", NZ Geotechnical Society (2001)

Remarks

1. Piezometer details:
   - 32mm diameter low pressure PVC
   - Bentonite backfill from 0.0m bgl to 4.3m bgl.
   - Filter sand from 4.4m bgl to 4.5m bgl.
   - Screened pipe with filter sand from 4.5m bgl to 6.0m bgl.
   - Blinding sand from 6.0m bgl to 6.2m bgl.
   - Bentonite backfill from 6.2m bgl to 7.3m bgl.
   - Blinding sand from 7.3m bgl to 7.5m bgl.
   - Screened pipe with filter sand from 7.5m bgl to 9.0m bgl.
   - Blinding sand from 9.0m bgl to 9.2m bgl.
   - Bentonite backfill from 9.2m bgl to 9.5m bgl.
2. PP = Pocket Penetrometer

All dimensions in metres Scale 1:50	Driller: DRILL FORCE	Rig Type: Wireline	Drilling Fluid:	Shear Vane No.:	Logged by: AWT	Checked by: SLP

Riley Consultants ltd
4 Fred Thomas Drive, Takapuna
Auckland, 0622
Tel: +649-489-7872

MACHINE HOLE LOG

Project:	Location:	Hole position:	No.:
710 Muriwai Road	Muriwai Downs	Refer to RILEY dwg: 210339-1	**MH03**

Job No.:	Start Date: 11-08-21 Finish Date: 11-08-21	Ground Level (m):	Co-Ordinates (NZTM):
210339		68	E 1,730,587 N 5,925,898

Client:	Hole Depth:	Sheet:
The Bears Home Project Management Limited	10.95 m	1 of 2

Elevation (m)	Depth (m)	Geological Unit	Geological Description	Legend	Weathering (RS CW HW MW SW UW)	Rock Field Strength (H/EW W MS S VS ES)	Drilling Method	RQD (%)	Core Loss (%) 25 50 75	Field Testing	Defect Description (type, orientation, spacing, roughness, persistence aperture, infilling etc)	Piezometer
+67.90	0	Topsoil	TOPSOIL				HQ3					
			Silty CLAY, trace sand; dark yellow. Very stiff, highly plastic. Sand, fine [AWHITU GROUP].									
	1		0.35 m Grades to orange, trace fine grained limonite inclusions.									
			1.70 m Grades to light grey with light orange mottles; minor fine to medium grained sand.				SPT			SPT 1.50 m 1, 0, 1, 1, 2, 1; Nc=5		
+66.00	2		Fine to medium SAND; light brownish yellow with light orange mottles. Loose; slightly cemented.				HQ3					
			2.70 m - 3.00 m SAND is non cemented or disturbed by drilling. Saturated.									
	3						SPT			SPT 3.00 m 1, 1, 2, 2, 3, 3; Nc=10		
+64.65			3.40 m Very thin Limonite pan, orange.									
	4	Awhitu Group	Loose SAND, minor clay, trace fine grained inclusions of light grey sand; light yellowish brown with orange mottles. Very close spaced laminar limonite bands.				HQ3					
			4.15 m Grades to medium to coarse SAND, trace clay.									
			4.30 m Grades to minor clay.									
+63.40			4.70 m Fine to medium pumiceous SAND, minor clay, some silt.				SPT			SPT 4.50 m 2, 1, 1, 2, 1, 1; Nc=5		
	5		Fine to medium pumiceous SAND, some silt, minor clay; light yellowish brown and orange mottles. Loose.				HQ3					
+62.70			5.35 m Grey mottles, light red (pink), orange. Loose; trace mica.									
			Fine to medium SAND, trace silt, trace clay; light yellow with light orange mottles, speckled black. Loose.									
	6		5.70 m Grades to minor Silt, slightly cemented; orange to light brownish red.				SPT			SPT 6.00 m 2, 2, 2, 3, 3, 3; Nc=11		
			6.30 m Grades to light brownish red, trace mica, trace limonite with manganese oxide staining; Medium dense.				HQ3					
	7		6.80 m Grades to moderately cemented.									
+60.80			Gravelly SAND, some silt, trace gravel; brownish orange. Loose; slightly cemented; gravels, fine; disturbed by drilling.				SPT			SPT 7.50 m 1, 2, 3, 3, 4, 4; Nc=14		

Explanations:

TCR - Total Core Recovery
SCR - Solid Core Recovery
RQD - Rock Quality Designation
N - SPT Spoon
Nc - SPT Solid Cone
Attitude of discontinuities displayed as Dip/Dip Direction and Trend/Plunge

- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Lugeon Test - Flow Type/Adopted Value
- Water Strike (1st, 2nd ...)
- Water Rise (1st, 2nd ...) and
- Rise Time (minutes)

Test Methods

Geological description:
"Field Descriptions of Soil and Rock", NZ Geotechnical Society (2005)

Shear Vane:
"Guideline for Hand Held Shear Vane Test", NZ Geotechnical Society (2001)

Remarks

1. Piezometer details:
   - 32mm diameter low pressure PVC.
   - Cap riser from 0.0m bgl to 0.2m bgl.
   - Bentonite backfill from 0.2m bgl to 2.5m bgl.
   - Blinding sand from 2.5m bgl to 3.0m bgl.
   - Screened pipe with filter sand from 3.0m bgl to 6.0m bgl.
   - Blinding sand from 6.0m bgl to 6.5m bgl.
   - Bentonite backfill from 6.5m bgl to 7.0m bgl
   - Filter sand from 7.0m bgl to 10.95m bgl.
2. NOTE: Where pocket penetrometer (PP) value >4.5 kg/cm^2 - water pushed to surface of core at 10.95m

All dimensions in metres Scale 1:50	Driller: DRILL FORCE	Rig Type: Wireline	Drilling Fluid:	Shear Vane No.:	Logged by: AWT	Checked by: SLP

Riley Consultants ltd
4 Fred Thomas Drive, Takapuna
Auckland, 0622
Tel: +649-489-7872

MACHINE HOLE LOG

Project:	Location:	Hole position:	No.:
710 Muriwai Road	Muriwai Downs	Refer to RILEY dwg: 210339-1	**MH03**

Job No.:	Start Date: 11-08-21 Finish Date: 11-08-21	Ground Level (m):	Co-Ordinates (NZTM):
210339		68	E 1,730,587 N 5,925,898

Client:	Hole Depth:	Sheet:
The Bears Home Project Management Limited	10.95 m	2 of 2

Elevation (m)	Depth (m)	Geological Unit	Geological Description	Legend	Weathering (RS CW HW MW SW UW)	Rock Field Strength (H/EW W MS S VS ES)	Drilling Method	RQD (%)	Core Loss (%) 25 50 75	Field Testing	Defect Description (type, orientation, spacing, roughness, persistence aperture, infilling etc)	Piezometer
	9	Awhitu Group	Gravelly SAND, some silt, trace gravel; brownish orange. Loose; slightly cemented; gravels, fine; disturbed by drilling. *(continued)* 8.00 m Grades to fine to medium, trace silt; light orange with black mottles, yellowish brown, brownish orange. Medium dense; moderately cemented; blackish orange colouration = Limonite; ~ 45deg very thick, faint bedding.				HQ3			SPT 9.00 m 2, 2, 3, 4, 5, 5; Nc=17		
	10					SPT						
						HQ3						
+57.15			10.45 m "Joint", 45deg dip; planar rough; 2mm-3mm aperture; manganese oxide coating - same as bedding; inferred bedding joint.				SPT			SPT 10.50 m 1, 2, 2, 3, 5, 5; Nc=15		
	11		EOH @ 10.95 m									
	12											
	13											
	14											
	15											

Explanations:

TCR - Total Core Recovery
SCR - Solid Core Recovery
RQD - Rock Quality Designation
N - SPT Spoon
Nc - SPT Solid Cone
Attitude of discontinuities displayed as Dip/Dip Direction and Trend/Plunge

- Small Disturbed Sample
- Large Disturbed Sample
- U100 Undisturbed Sample
- Lugeon Test - Flow Type/Adopted Value
- Water Strike (1st, 2nd ...)
- Water Rise (1st, 2nd ...) and
- Rise Time (minutes)

Test Methods

Geological description: "Field Descriptions of Soil and Rock", NZ Geotechnical Society (2005)

Shear Vane: "Guideline for Hand Held Shear Vane Test", NZ Geotechnical Society (2001)

Remarks

1. Piezometer details:
   - 32mm diameter low pressure PVC.
   - Cap riser from 0.0m bgl to 0.2m bgl.
   - Bentonite backfill from 0.2m bgl to 2.5m bgl.
   - Blinding sand from 2.5m bgl to 3.0m bgl.
   - Screened pipe with filter sand from 3.0m bgl to 6.0m bgl.
   - Blinding sand from 6.0m bgl to to 6.5m bgl.
   - Bentonite backfill from 6.5m bgl to 7.0m bgl
   - Filter sand from 7.0m bgl to 10.95m bgl.
2. NOTE: Where pocket penetrometer (PP) value >4.5 kg/cm^2 - water pushed to surface of core at 10.95m

All dimensions in metres Scale 1:50	Driller: DRILL FORCE	Rig Type: Wireline	Drilling Fluid:	Shear Vane No.:	Logged by: AWT	Checked by: SLP

APPENDIX C

Borehole Core Photographs

Machine Borehole 2 Photographs

Photo 1: MH2 from surface to 3m bgl

Photo 2: MH2 from 3m to 6m bgl

Photo 3: MH2 from 6m to 9.45m bgl

Photo 4: MH2 from 9.45m to 10.95m bgl

APPENDIX D

SPT Hammer Efficiency Certificate

Table 1. Summary of SPT Hammer Energy Transfer Measurements

The maximum, minimum, and standard deviation in energy transfer for each SPT sample over the SPT N value increment are included in Appendix B.

Hammer No.	Calibrated with Drill Rig No.	Number of Valid Test Samples	Average Transferred Energy	**Average Energy Transfer Ratio**	Range in Transferred Energy	Range in Energy Transfer Ratio
DFSH001	79	3	0.369kNm	**77.7%**	0.361kNm to 0.383kNm	76.0% to 80.5%
DFSH002	79	3	0.366kNm	**77.1%**	0.358kNm to 0.373kNm	75.3% to 78.5%
DFSH003	86	3	0.364kNm	**76.5%**	0.358kNm to 0.373kNm	75.3% to 78.5%
DFSH004	89	3	0.369kNm	**77.6%**	0.364kNm to 0.376kNm	76.7% to 79.1%
DFSH005	81	3	0.343kNm	**72.3%**	0.322kNm to 0.354kNm	67.8% to 74.6%
DFSH006	79	3	0.381kNm	**80.2%**	0.338kNm to 0.409kNm	71.2% to 86.1%
DFSH007	81	3	0.371kNm	**78.1%**	0.359kNm to 0.390kNm	75.6% to 82.1%
DFSH008	81	3	0.352kNm	**74.2%**	0.341kNm to 0.361kNm	71.9% to 76.0%
DFSH009	86	3	0.344kNm	**72.4%**	0.336kNm to 0.353kNm	70.8% to 74.4%
DFSH010	79	3	0.370kNm	**77.8%**	0.365kNm to 0.372kNm	76.8% to 78.4%
DFSH011	86	3	0.374kNm	**78.8%**	0.363kNm to 0.390kNm	76.5% to 82.1%
DFSH012	79	3	0.387kNm	**81.5%**	0.372kNm to 0.400kNm	78.4% to 84.2%

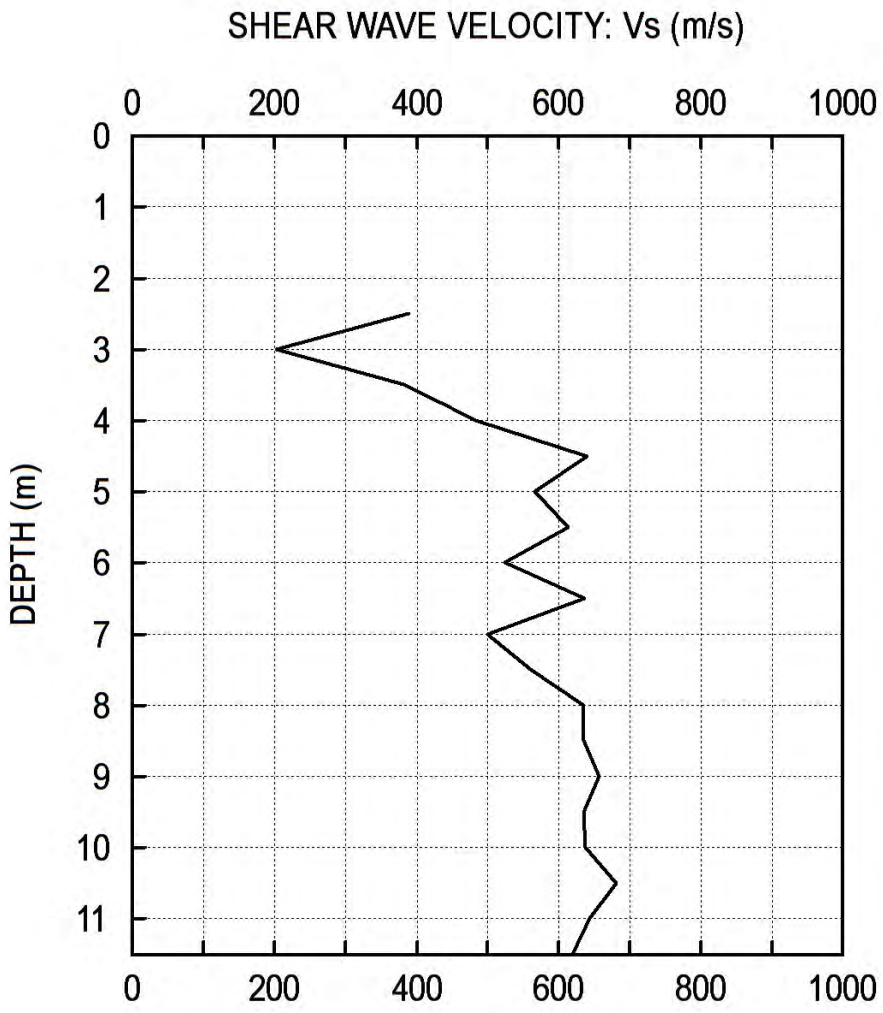
Average Blow Rate (blows
14
14
14
16
12
10
19
16
12
16
9
13

APPENDIX E

Seismic Dilatometer Test Results

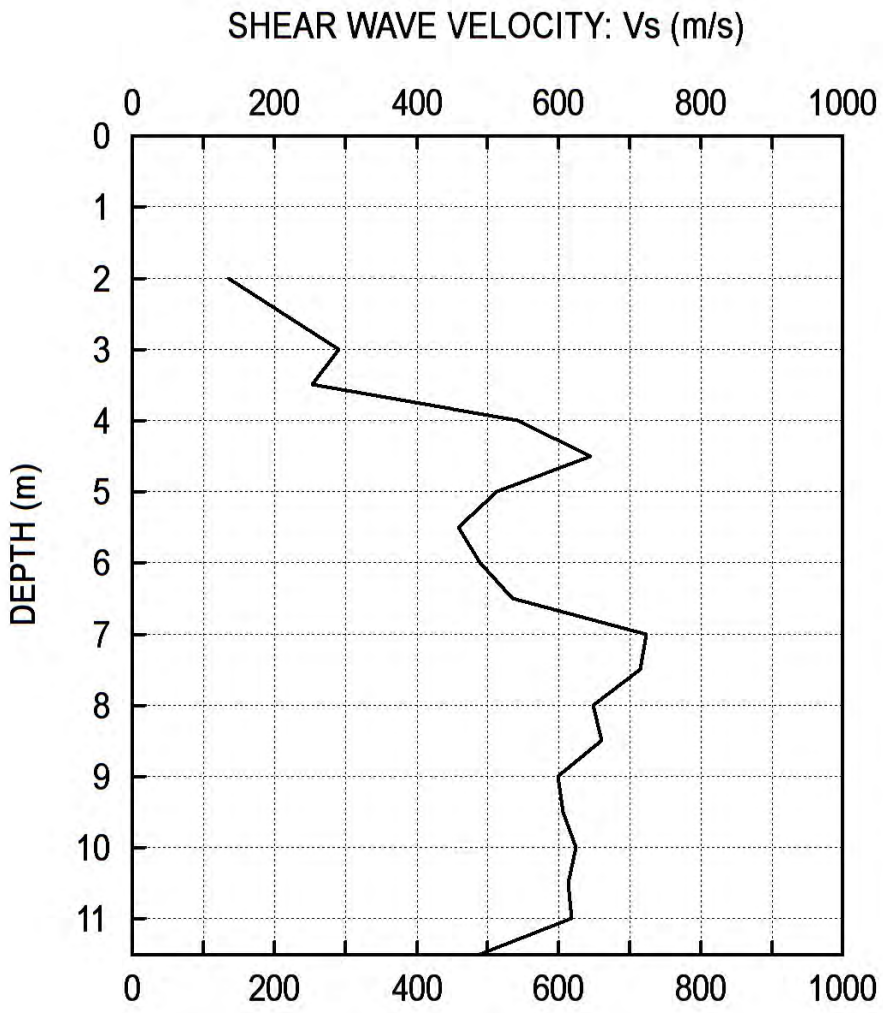
SEISMIC DILATOMETER TEST (S D M T)

Drill Force NZ	Riley Consultants	TEST
DF21GE177	614 Muriwai Rd, Auckland	**sDMT01**
		12 AUG 2021



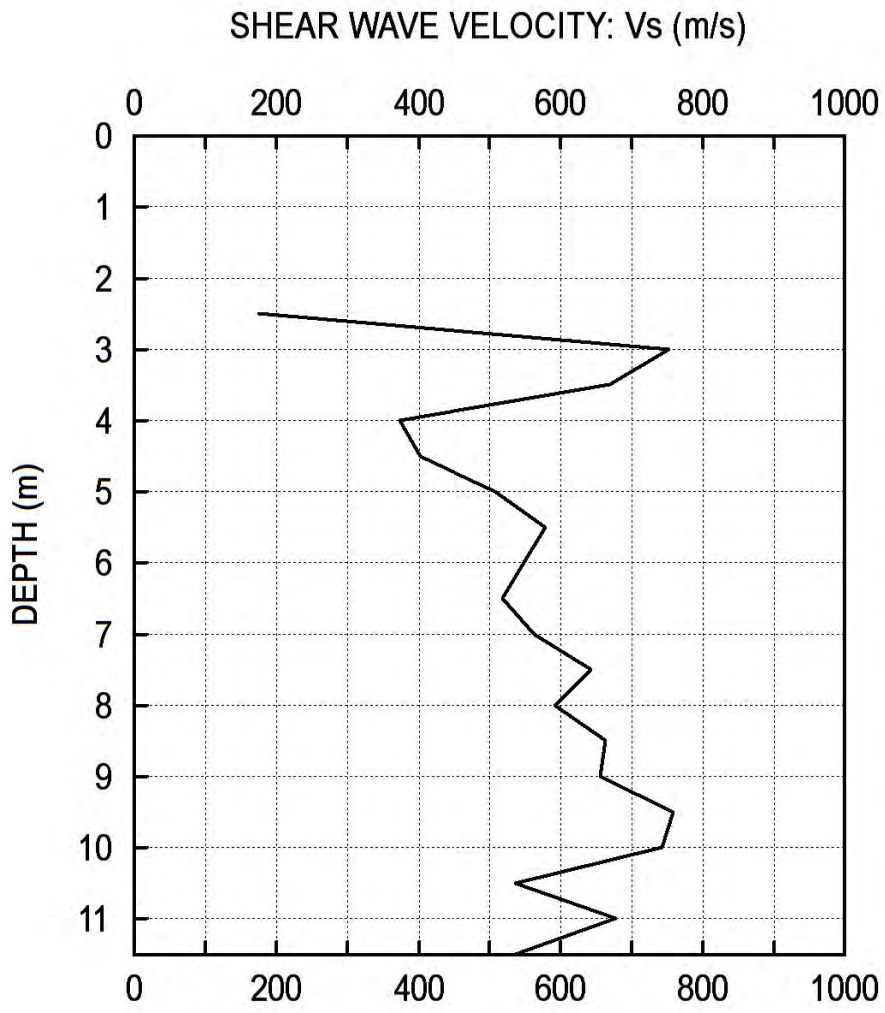
SEISMIC DILATOMETER TEST (S D M T)

Drill Force NZ	Riley Consultants	TEST
DF21GE177	614 Muriwai Rd, Auckland	**sDMT02**
		11 AUG 2021



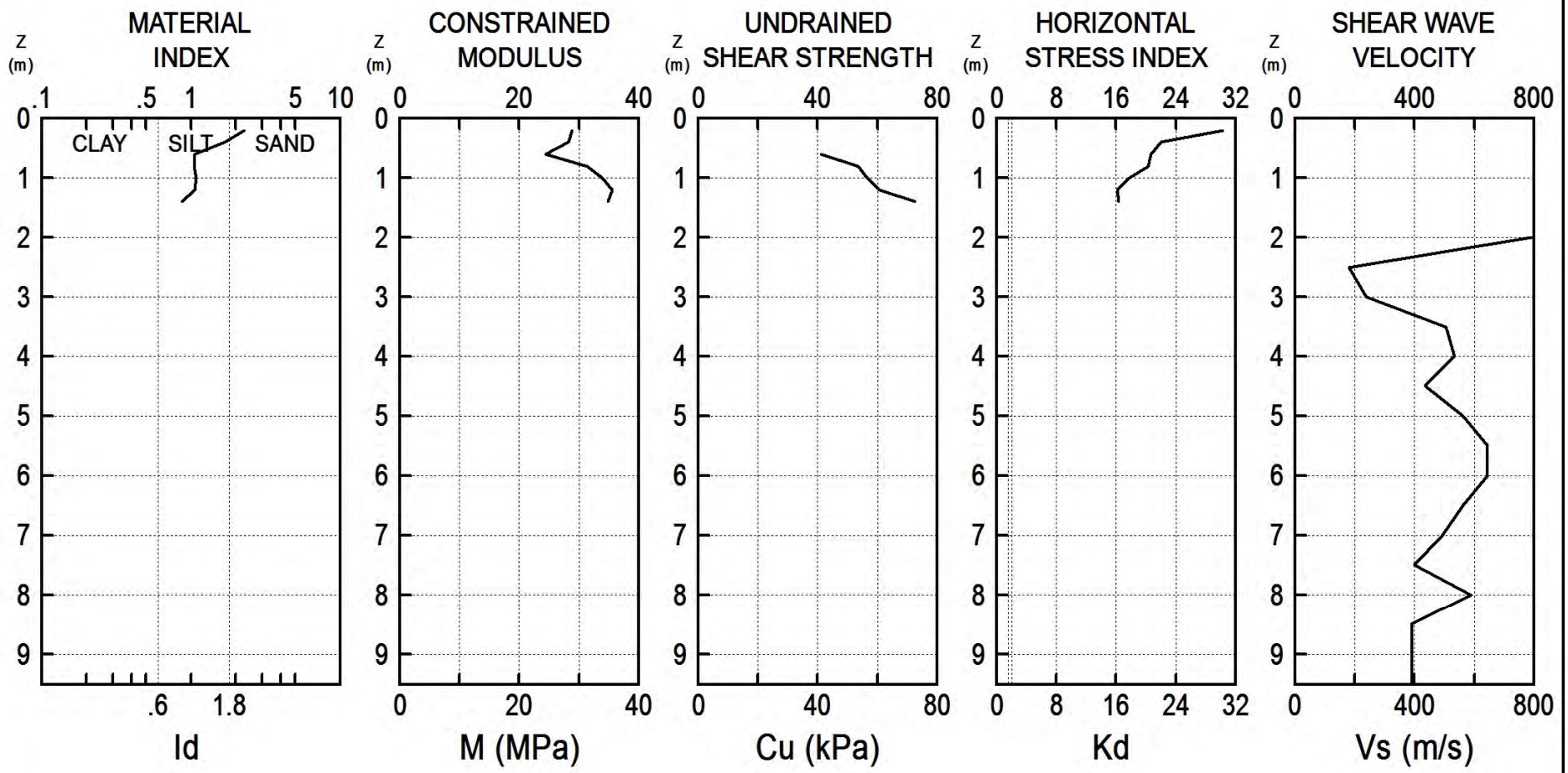
SEISMIC DILATOMETER TEST (S D M T)

Drill Force NZ	Riley Consultants	TEST
DF21GE177	614 Muriwai Rd, Auckland	**sDMT03**
		11 AUG 2021



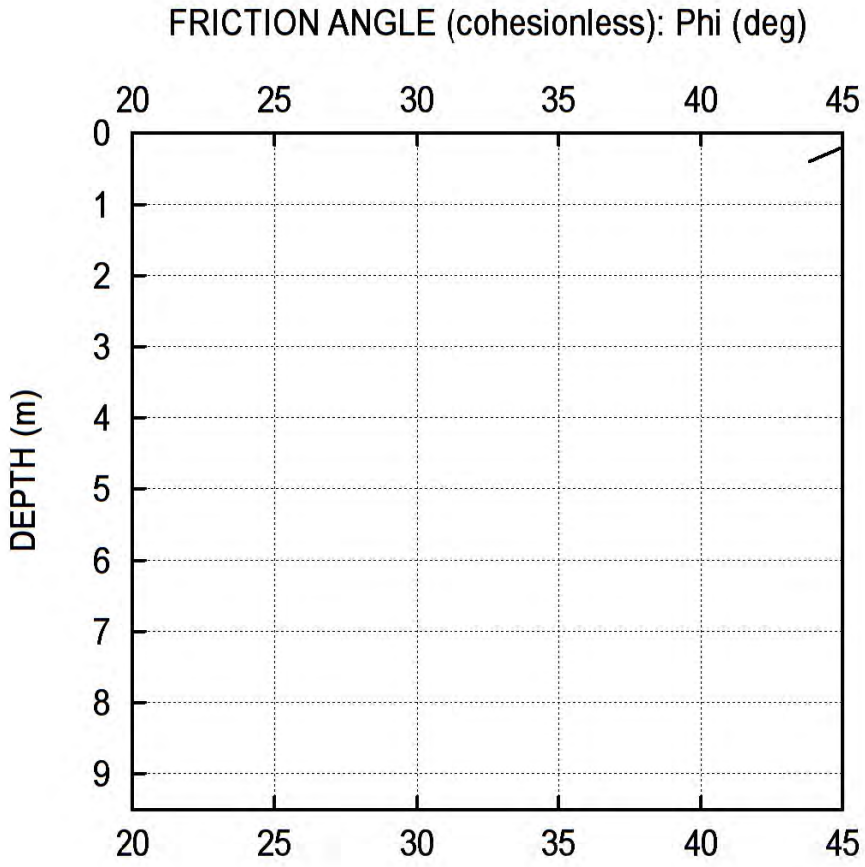
SEISMIC DILATOMETER TEST (S D M T)

Drill Force NZ DF21GE177	Riley Consultants 614 Muriwai Rd, Auckland	TEST **sDMT04** 11 AUG 2021



DILATOMETER TEST (D M T)

Drill Force NZ	Riley Consultants	TEST
DF21GE177	614 Muriwai Rd, Auckland	**sDMT04**
INTERPRETED GEOTECHNICAL PARAMETERS		11 AUG 2021

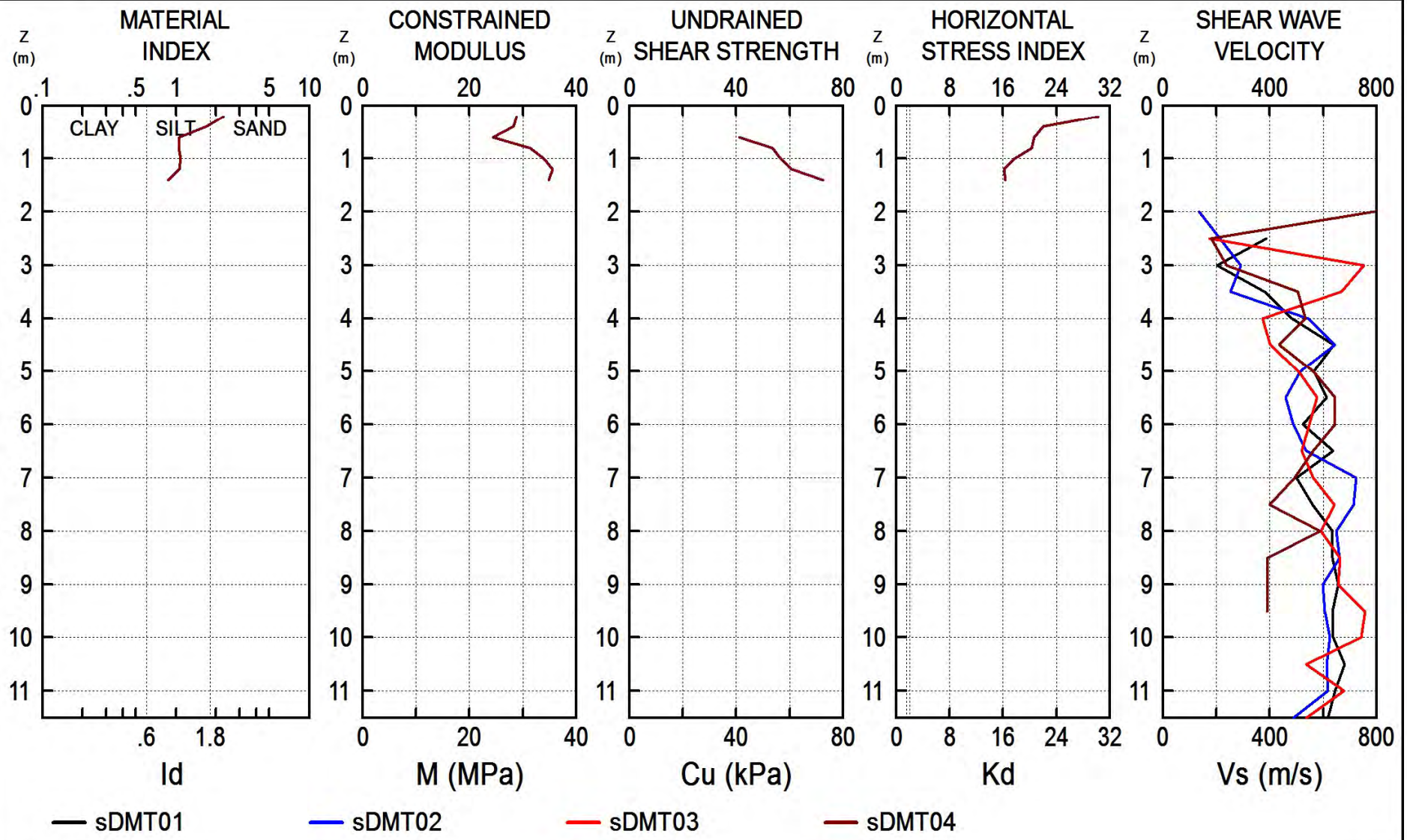


Drill Force NZ

DF21GE177

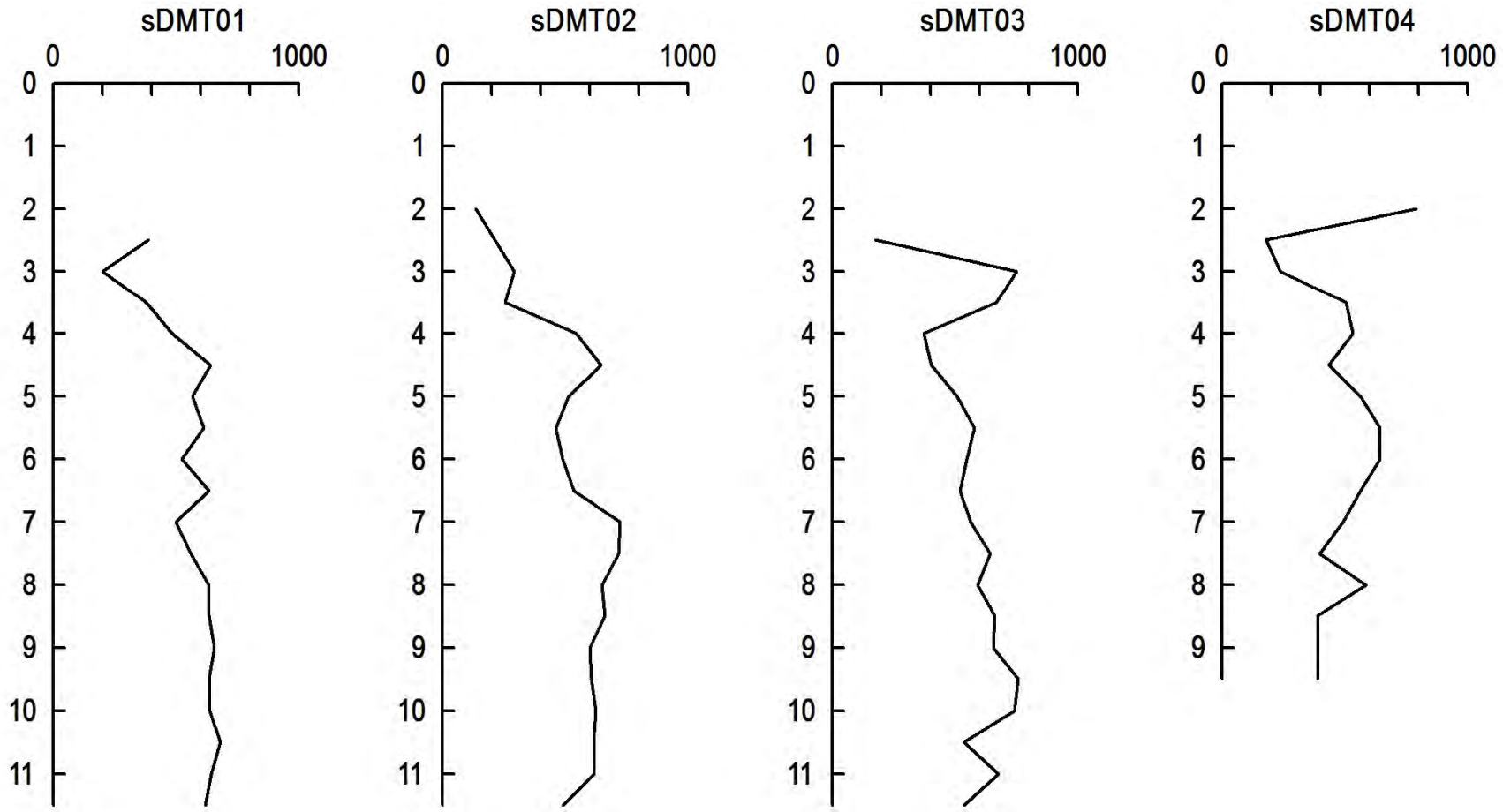
Riley Consultants

614 Muriwai Rd, Auckland



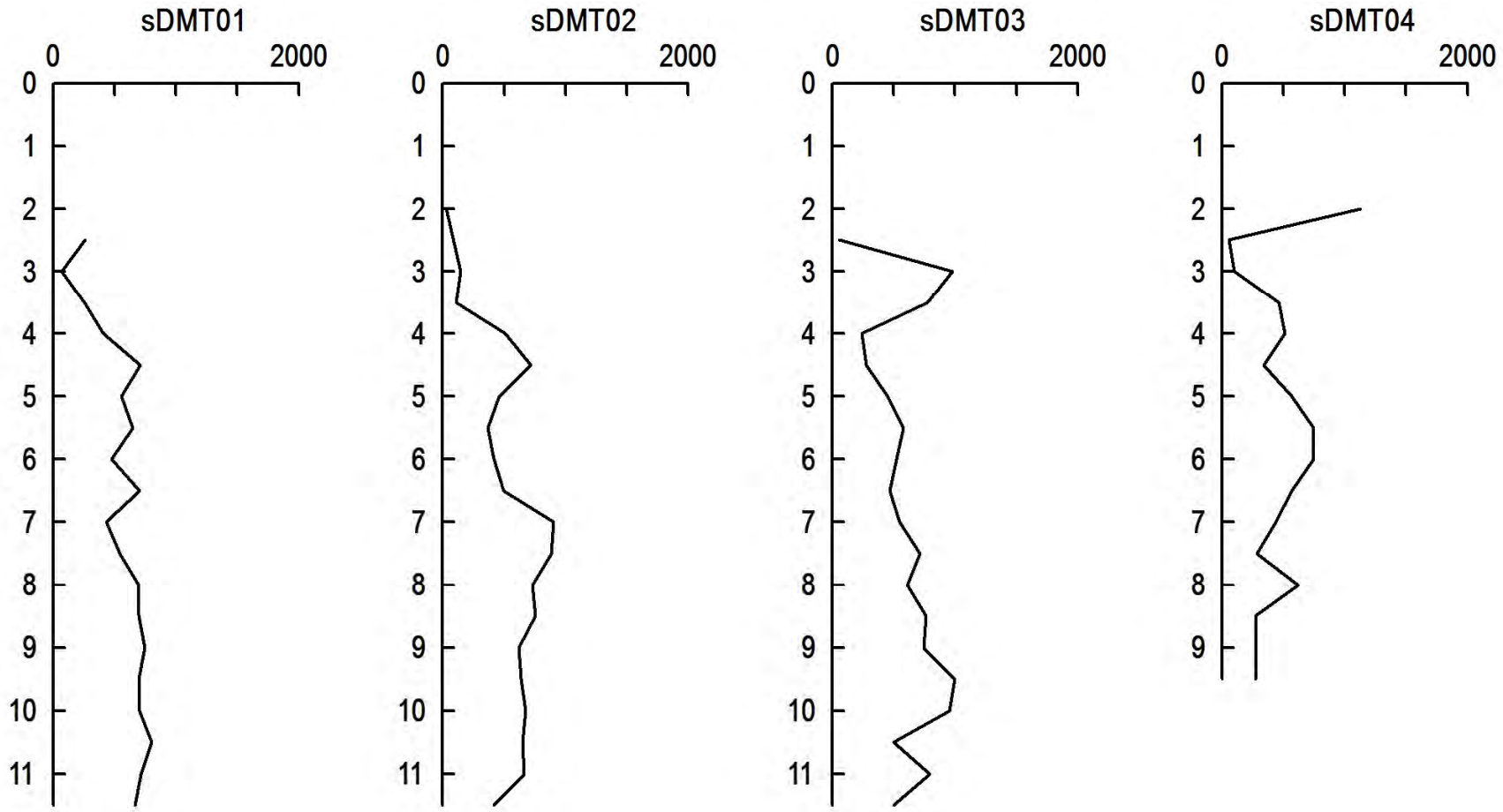
Drill Force NZ	Riley Consultants
DF21GE177	614 Muriwai Rd, Auckland

CROSS SECTION OF SHEAR WAVE VELOCITY Vs (m/s)

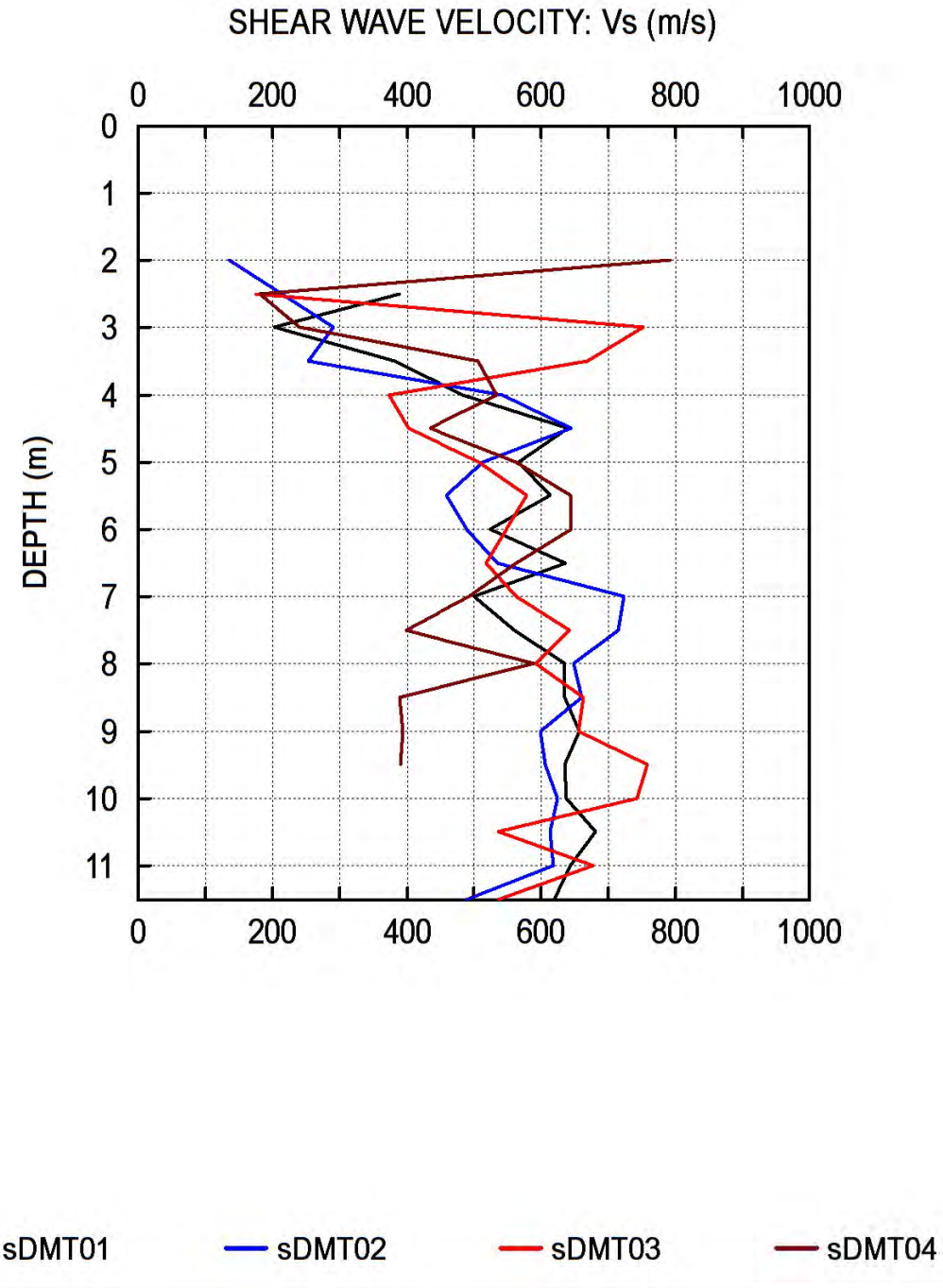


Drill Force NZ	Riley Consultants
DF21GE177	614 Muriwai Rd, Auckland

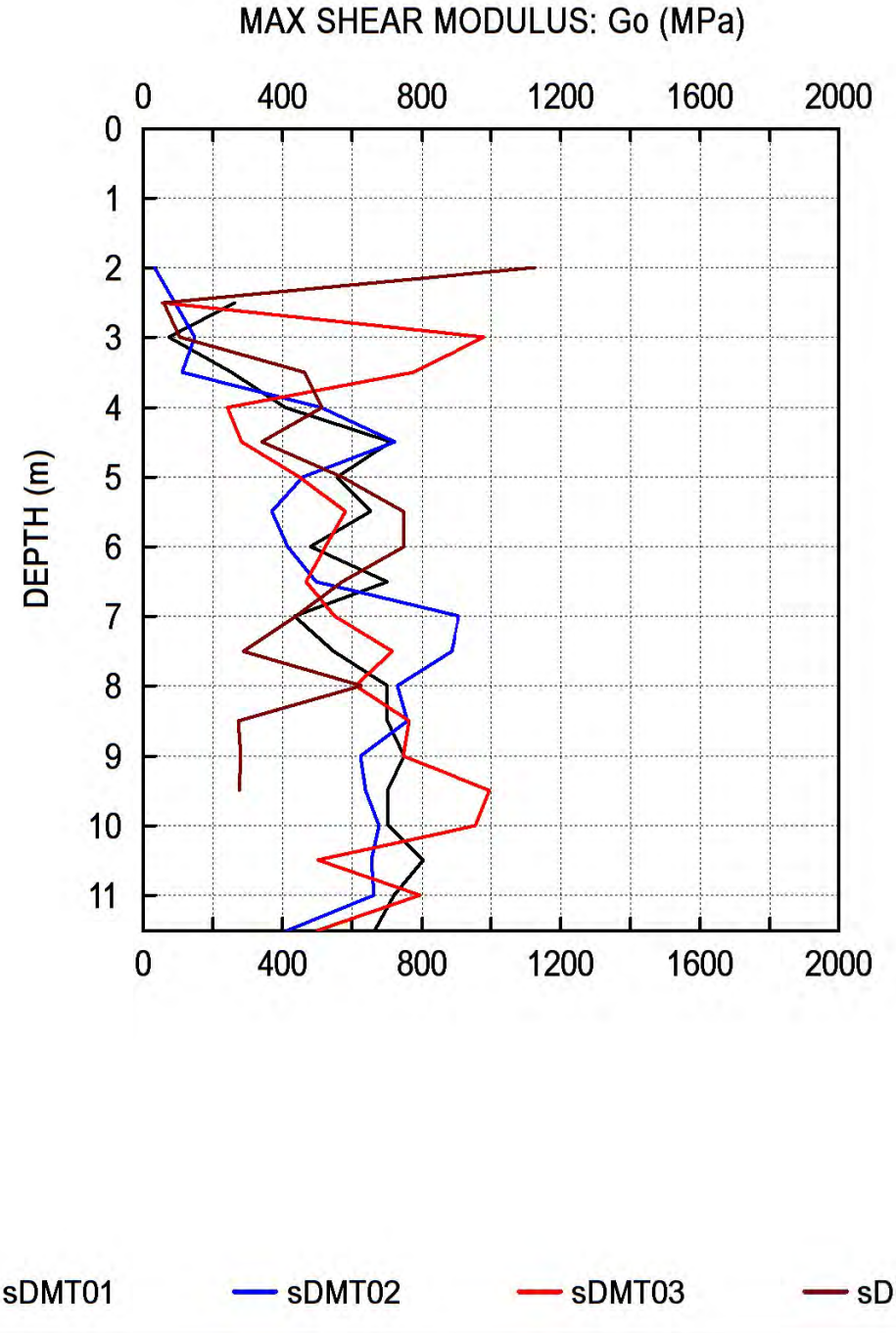
CROSS SECTION OF MAX SHEAR MODULUS Go (MPa)



Drill Force NZ	Riley Consultants	
DF21GE177	614 Muriwai Rd, Auckland	
SUPERIMPOSED TEST RESULTS		



Drill Force NZ	Riley Consultants	
DF21GE177	614 Muriwai Rd, Auckland	
SUPERIMPOSED TEST RESULTS		



APPENDIX F

Liquefaction Results

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Vs BASED LIQUEFACTION ANALYSIS REPORT (Kayen et al. 2013)

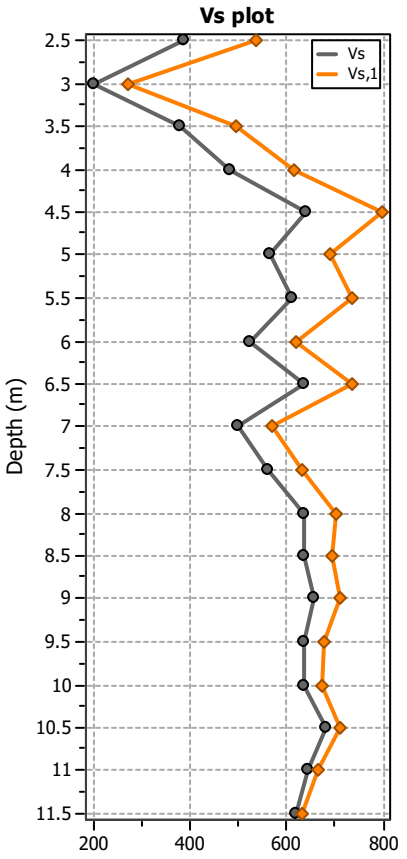
Project title : 210339 - Muriwai Downs

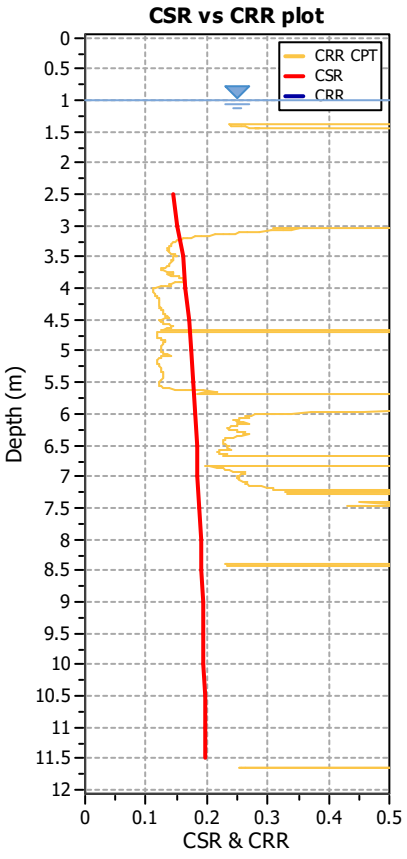
Location : 710 Muriwai Road

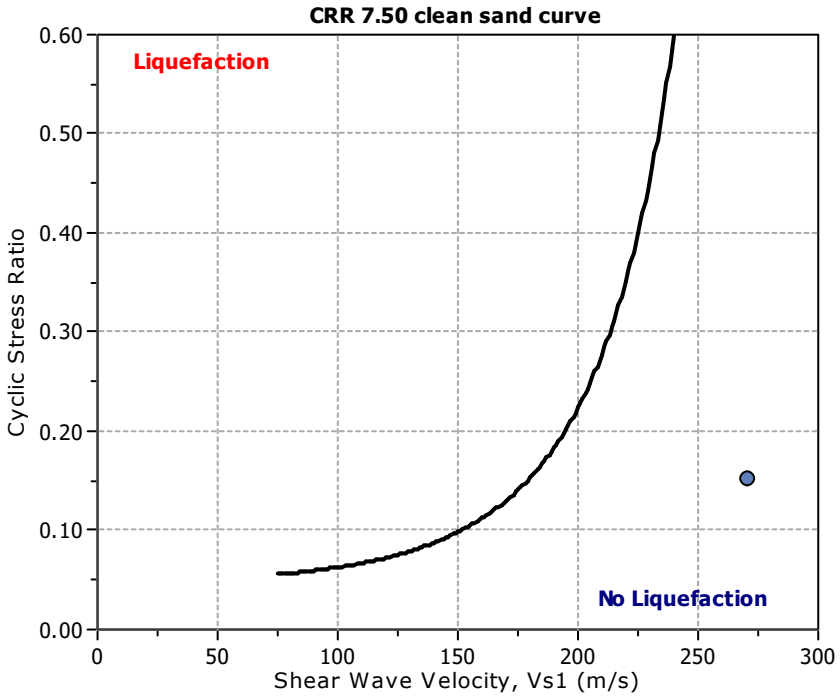
CPT file : CPT-06

:: Input parameters and analysis properties ::

Calculation method:	Kayen et. al (2013)
G.W.T. (in-situ):	1.00 m
G.W.T. (earthq.):	1.00 m
Earthquake magnitude M_w:	5.90
Peak ground acceleration:	0.20g







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Vs BASED LIQUEFACTION ANALYSIS REPORT (Kayen et al. 2013)

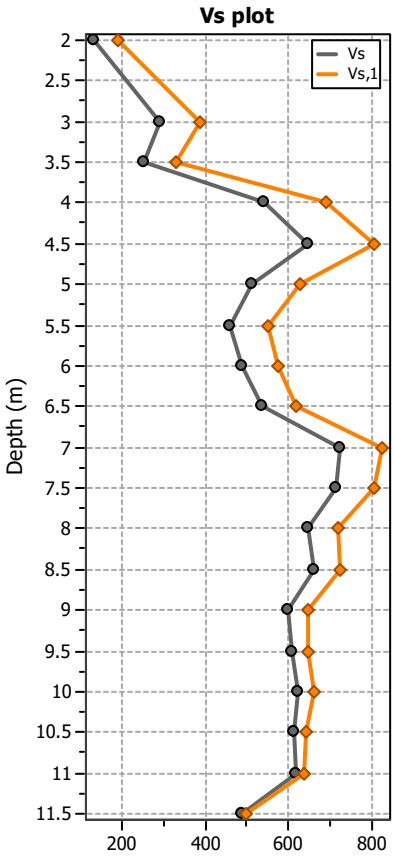
Project title : 210339 - Muriwai Downs

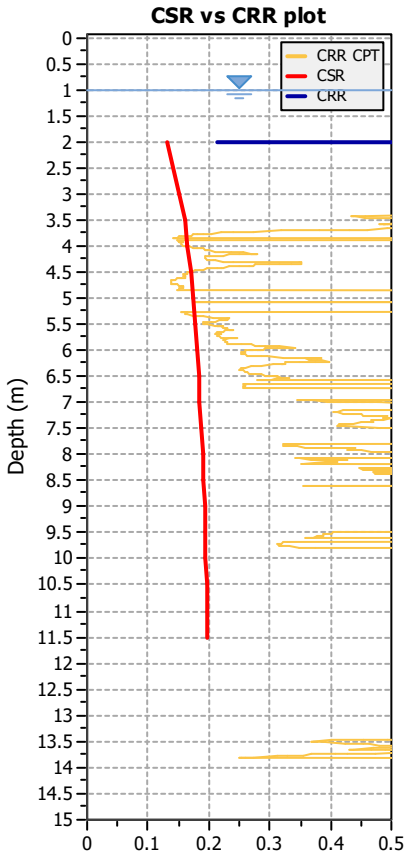
Location : 710 Muriwai Road

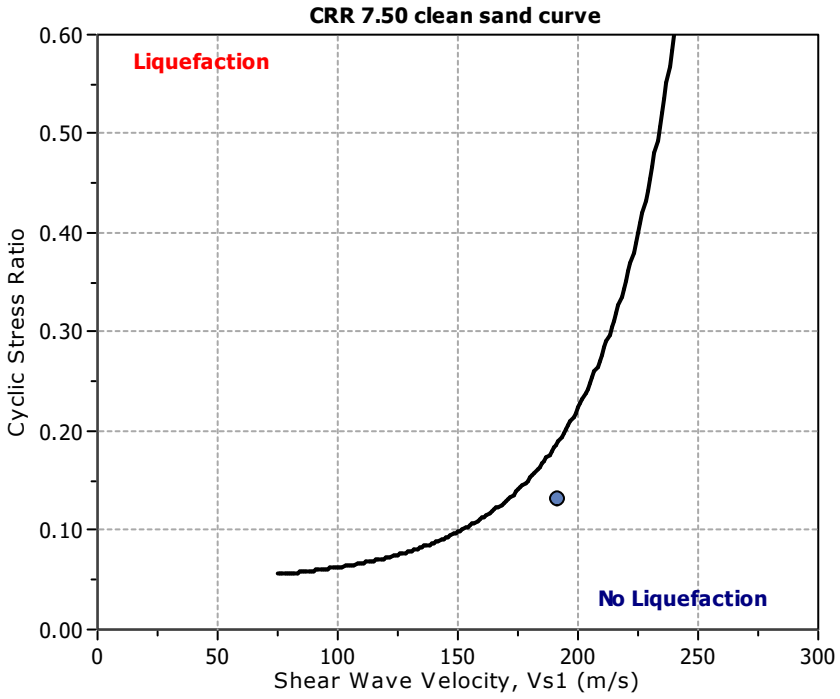
CPT file : CPT-07

:: Input parameters and analysis properties ::

Calculation method:	Kayen et. al (2013)
G.W.T. (in-situ):	1.00 m
G.W.T. (earthq.):	1.00 m
Earthquake magnitude M_w:	5.90
Peak ground acceleration:	0.20g







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Vs BASED LIQUEFACTION ANALYSIS REPORT (Kayen et al. 2013)

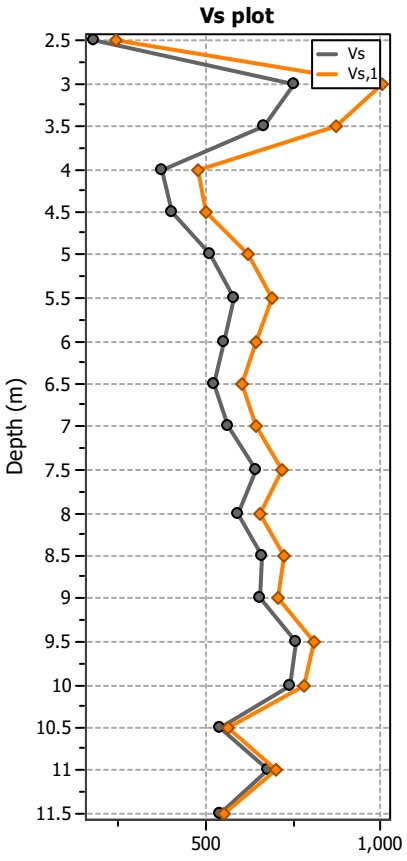
Project title : 210339 - Muriwai Downs

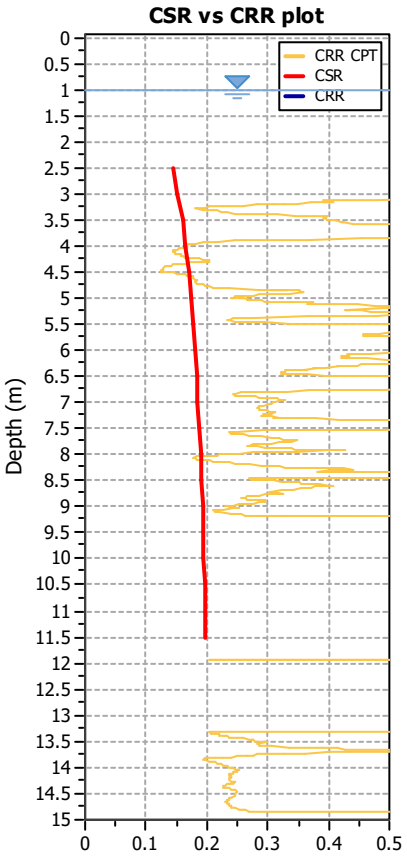
Location : 710 Muriwai Road

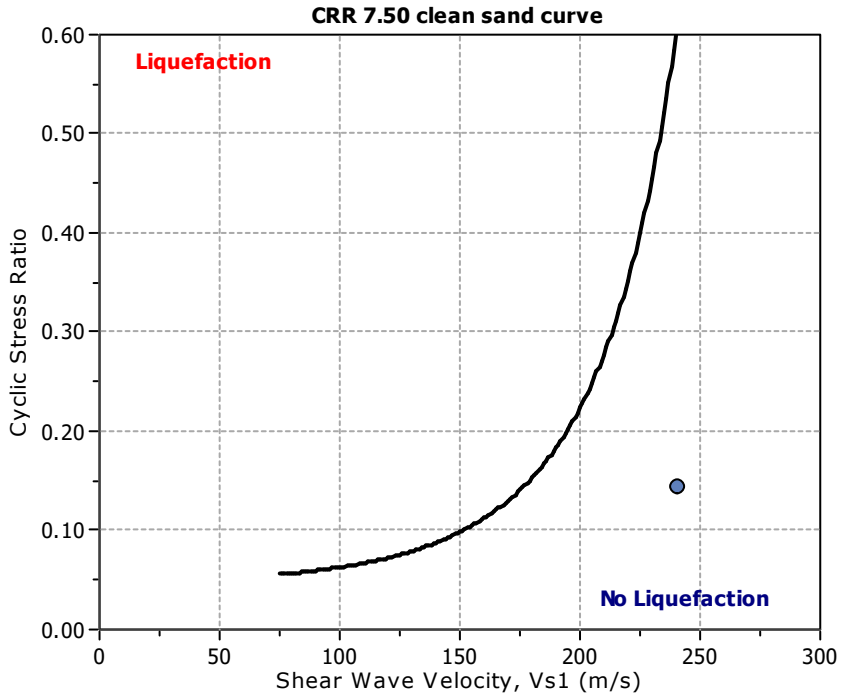
CPT file : CPT-09

:: Input parameters and analysis properties ::

Calculation method:	Kayen et. al (2013)
G.W.T. (in-situ):	1.00 m
G.W.T. (earthq.):	1.00 m
Earthquake magnitude M_w:	5.90
Peak ground acceleration:	0.20g







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Vs BASED LIQUEFACTION ANALYSIS REPORT (Kayen et al. 2013)

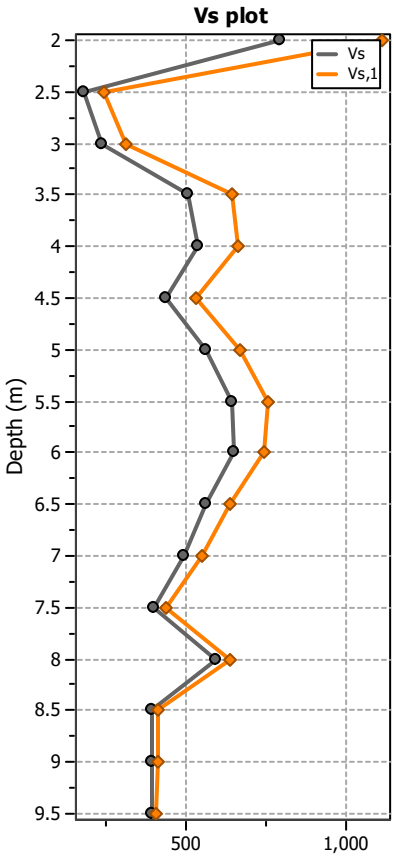
Project title : 210339 - Muriwai Downs

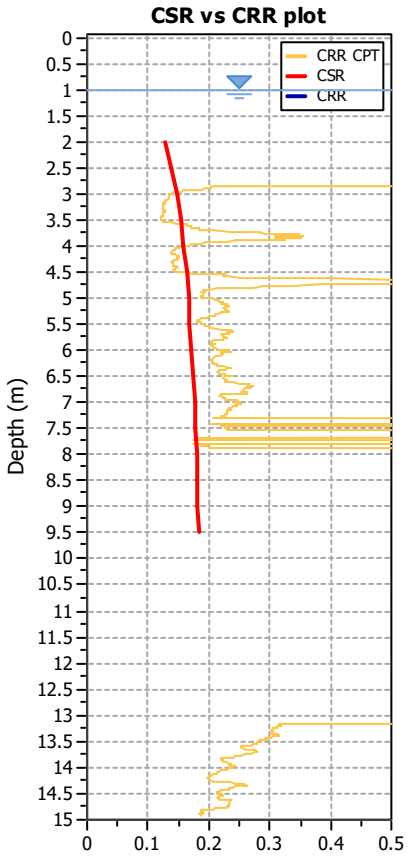
Location : 710 Muriwai Road

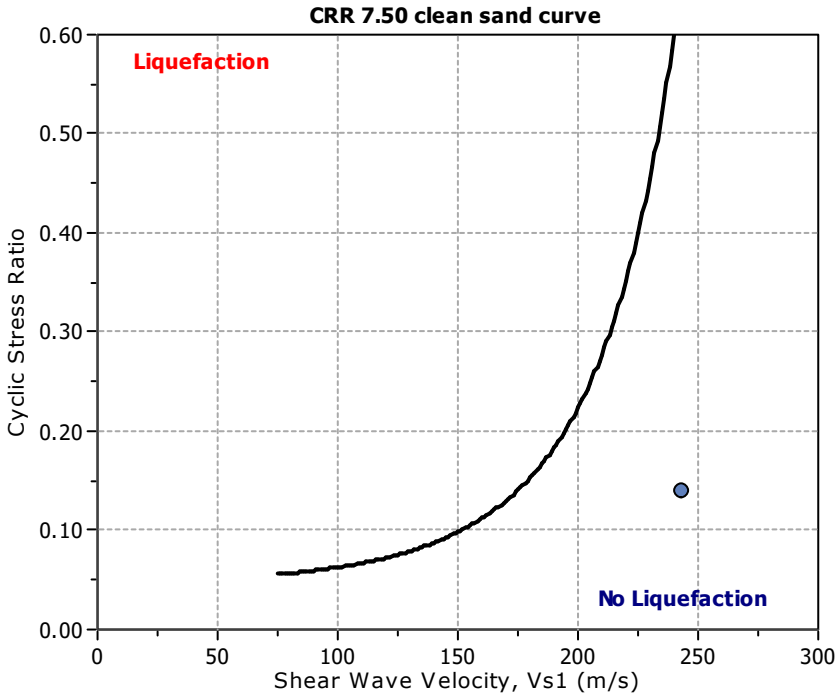
CPT file : CPT-02

:: Input parameters and analysis properties ::

Calculation method:	Kayen et. al (2013)
G.W.T. (in-situ):	1.00 m
G.W.T. (earthq.):	1.00 m
Earthquake magnitude M_w:	5.90
Peak ground acceleration:	0.20g







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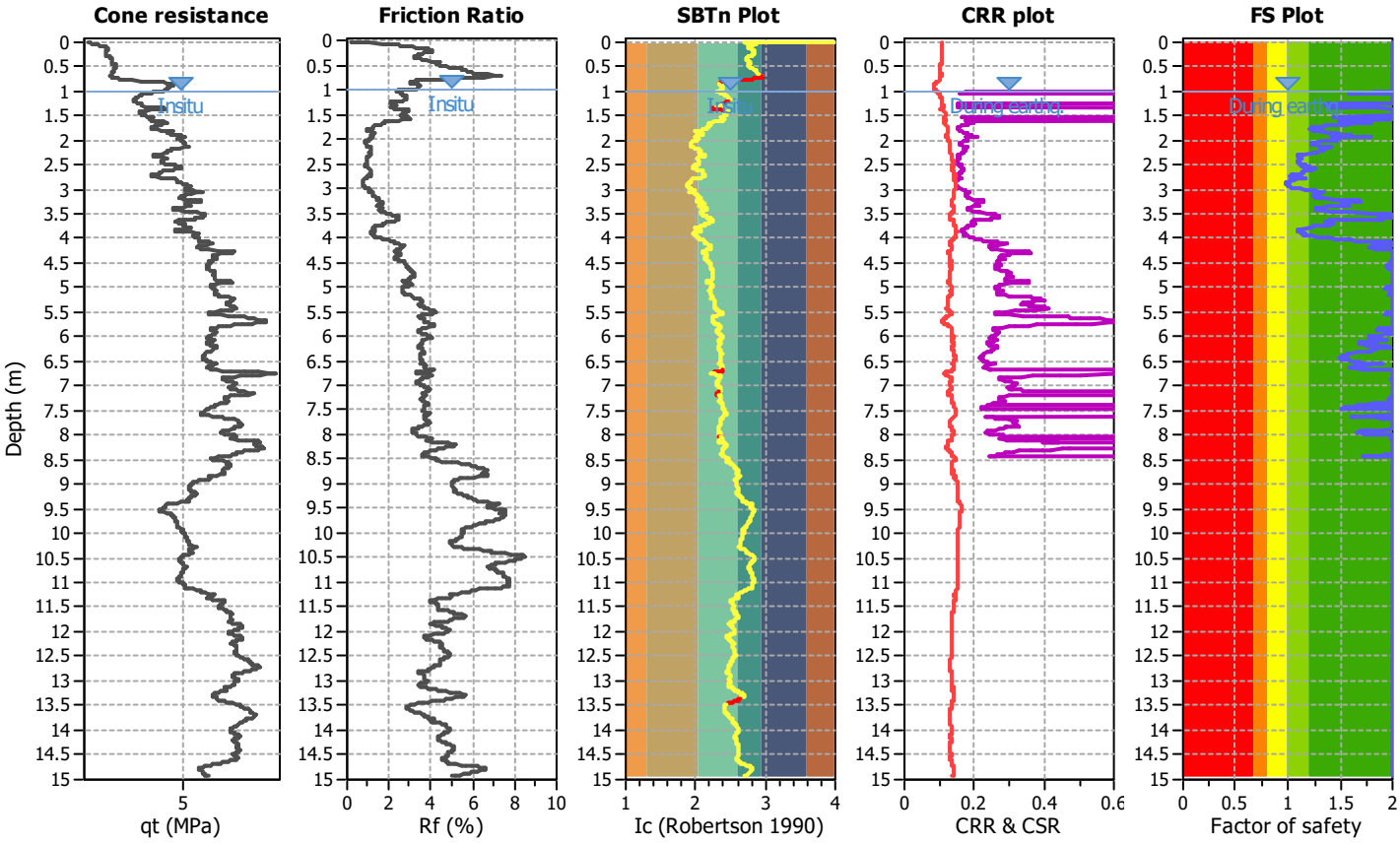
LIQUEFACTION ANALYSIS REPORT

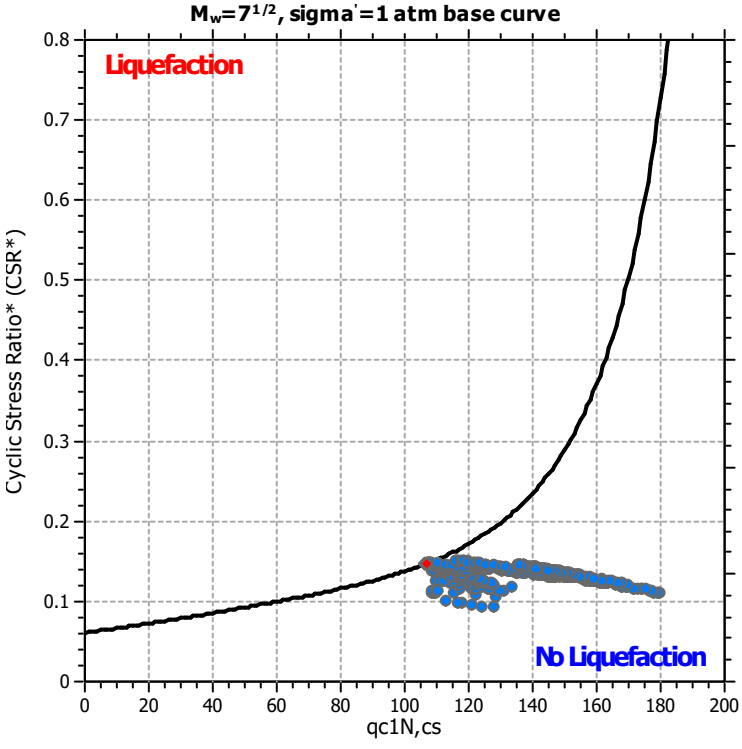
Project title : 210339 - Muriwai Downs **Location : 710 Muriwai Road**

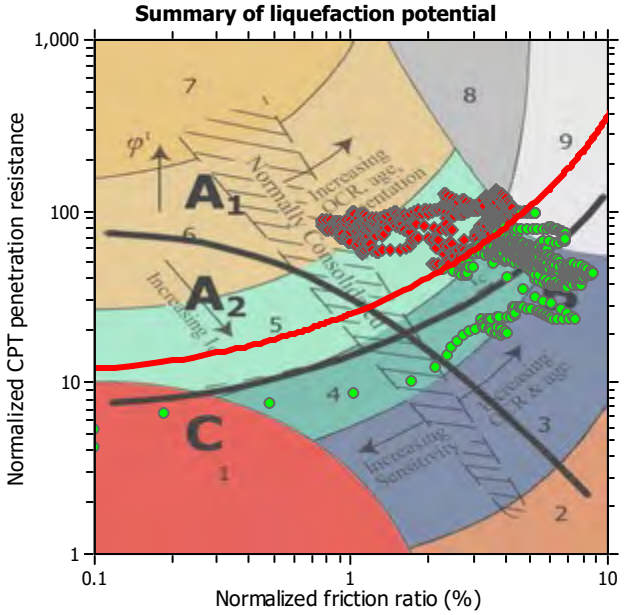
CPT file : CPT-01

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

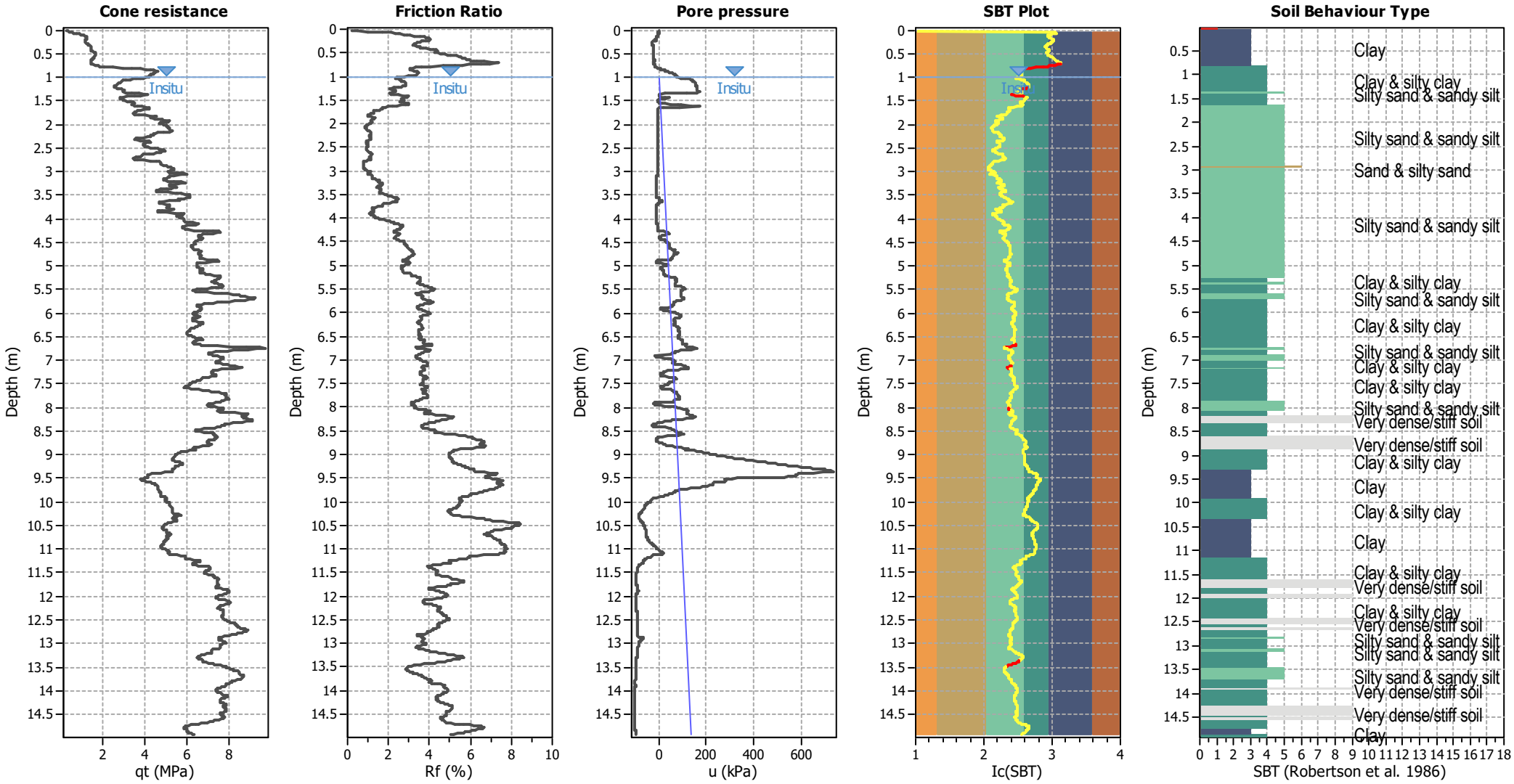






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



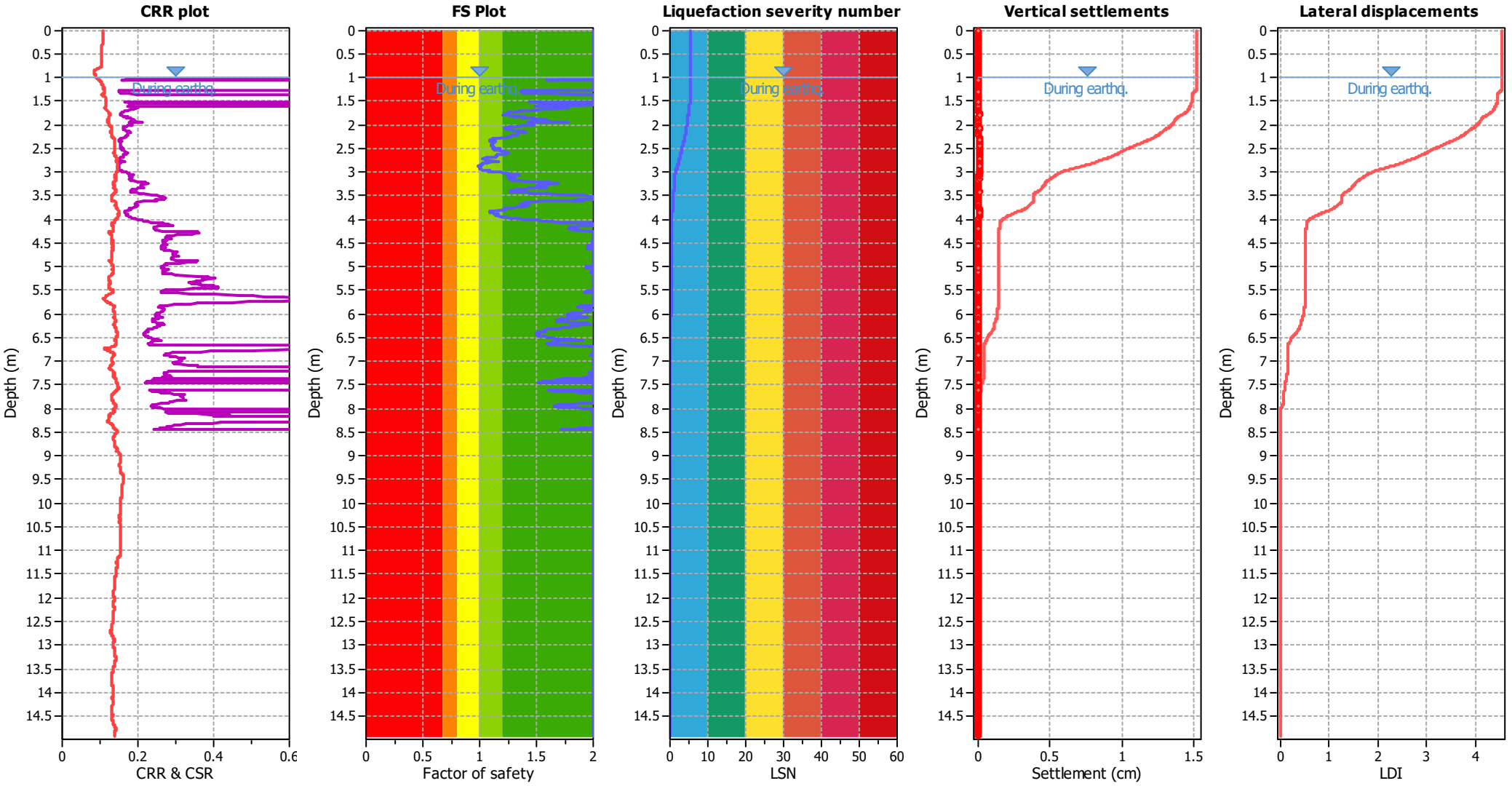
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.40	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.40	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

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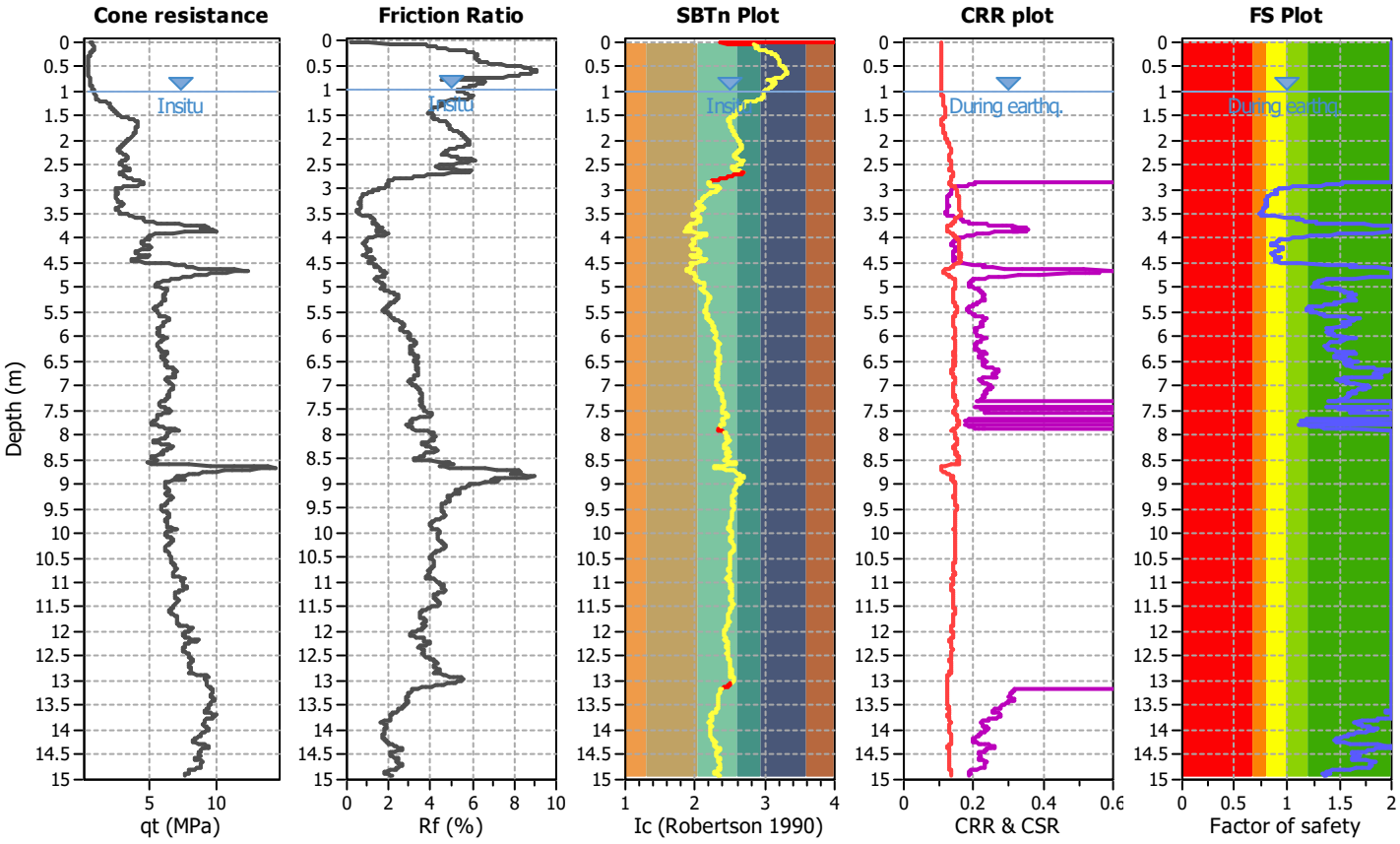
LIQUEFACTION ANALYSIS REPORT

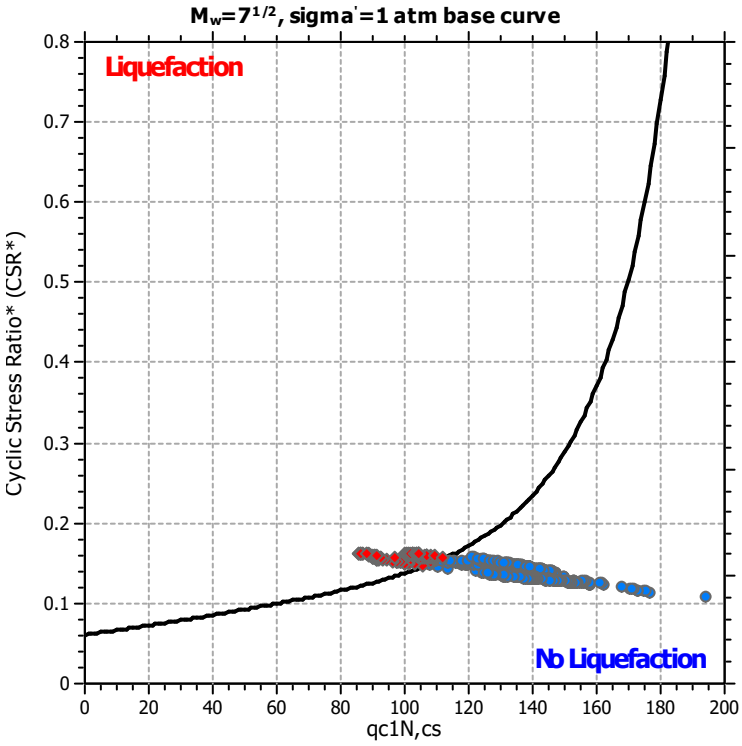
Project title : 210339 - Muriwai Downs **Location : 710 Muriwai Road**

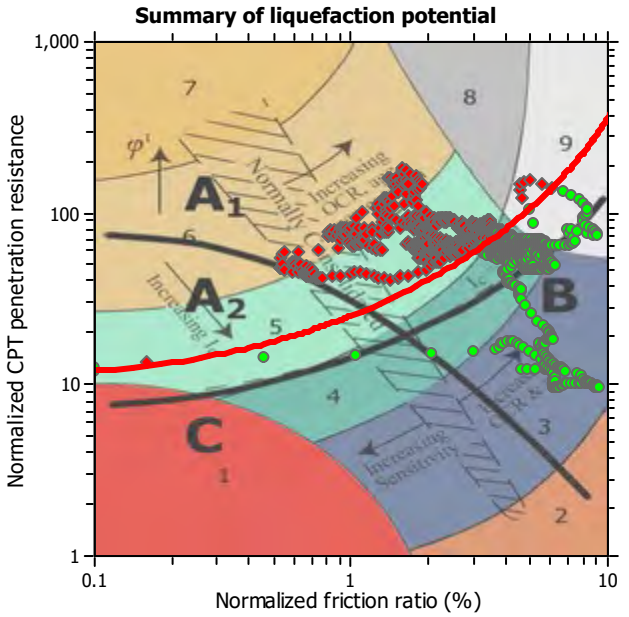
CPT file : CPT-02

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

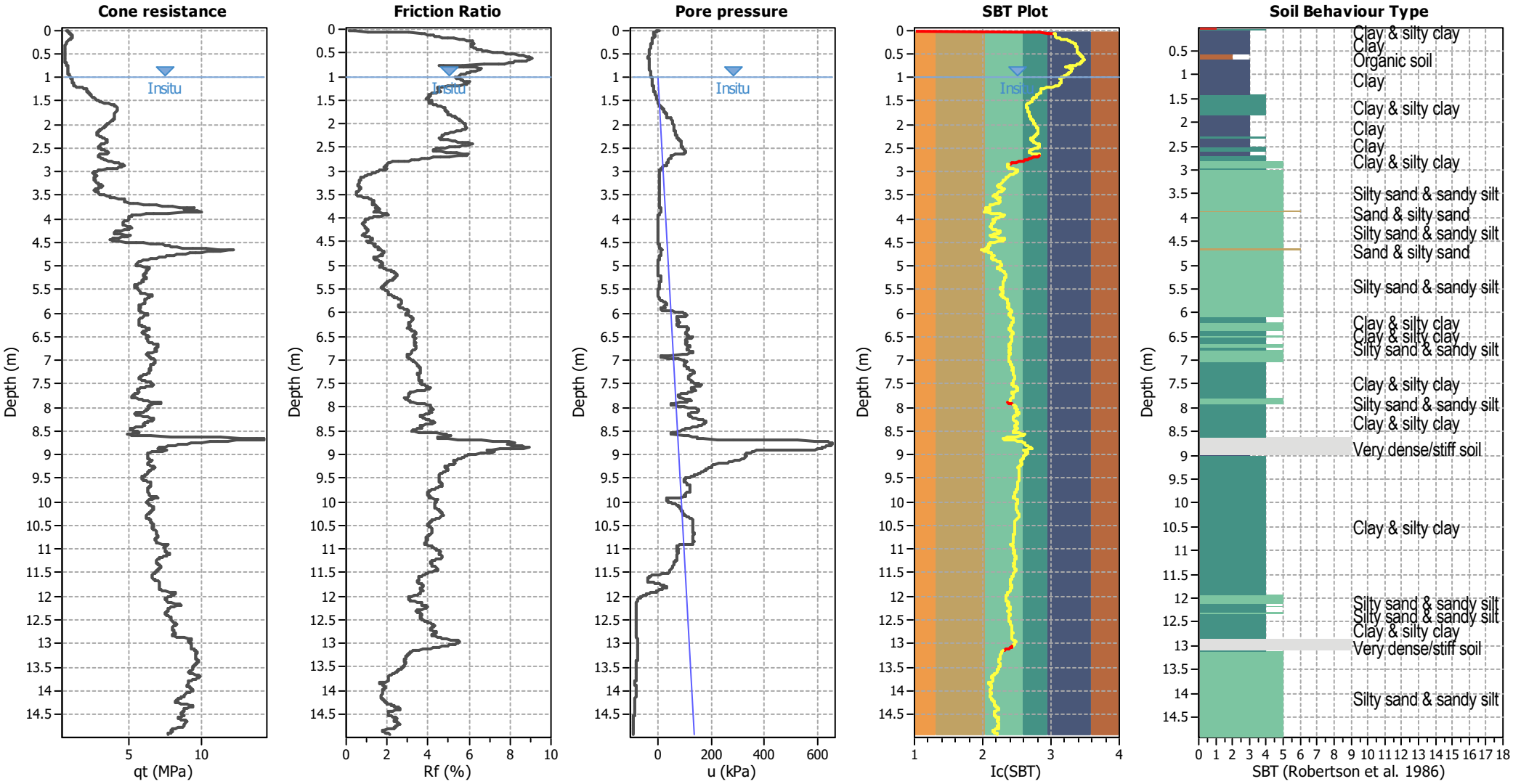






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



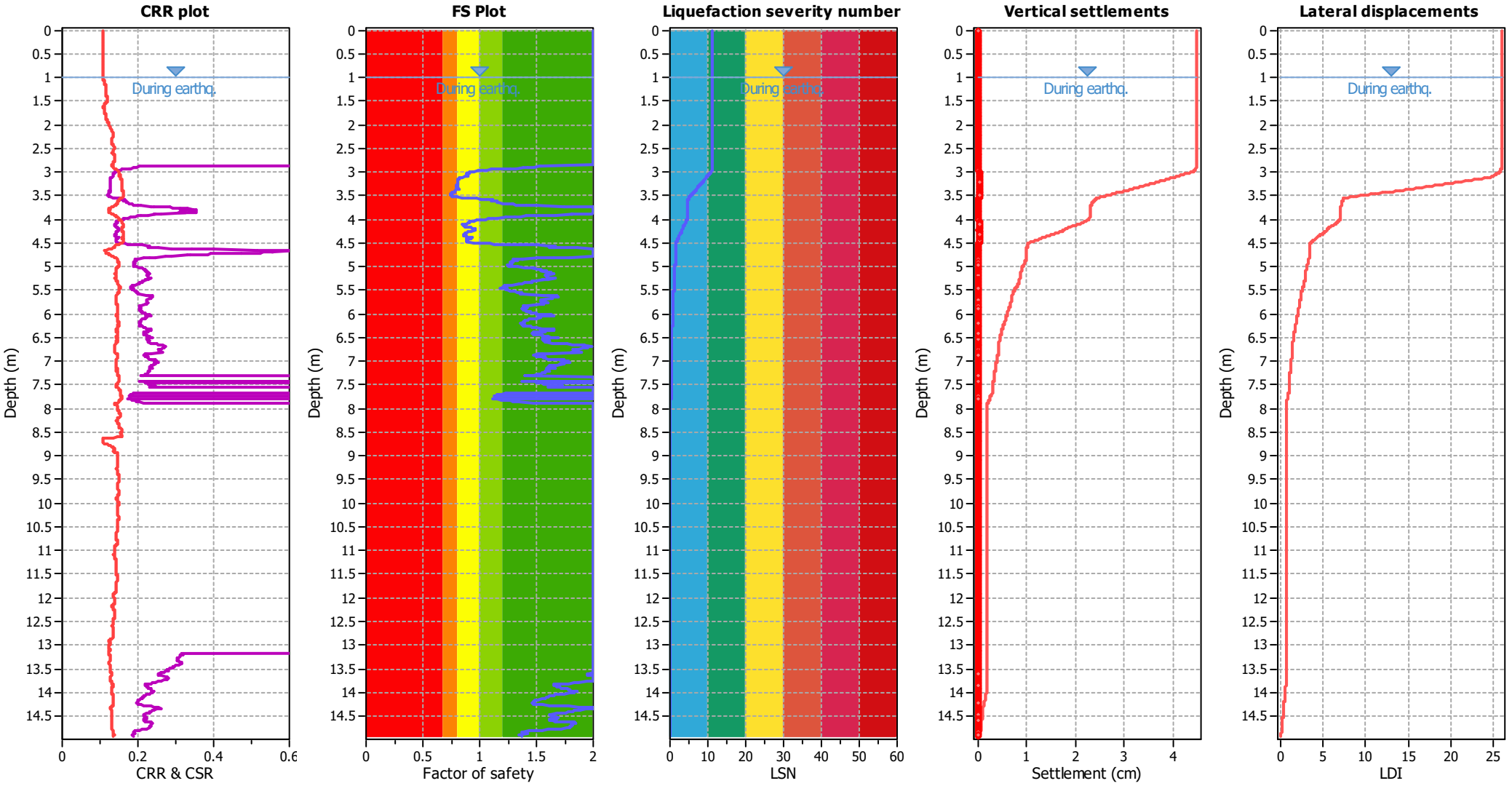
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.40	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.40	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

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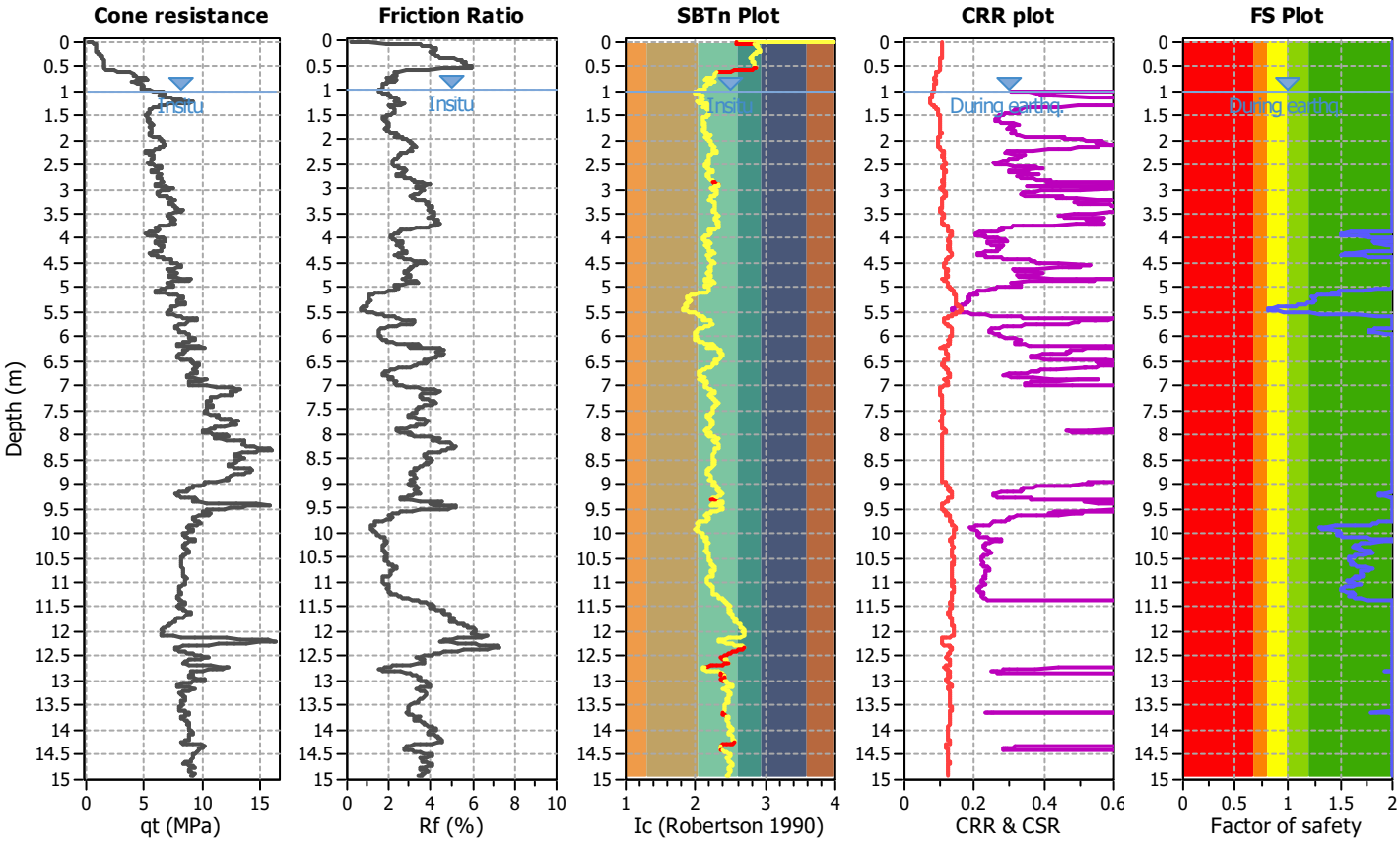
LIQUEFACTION ANALYSIS REPORT

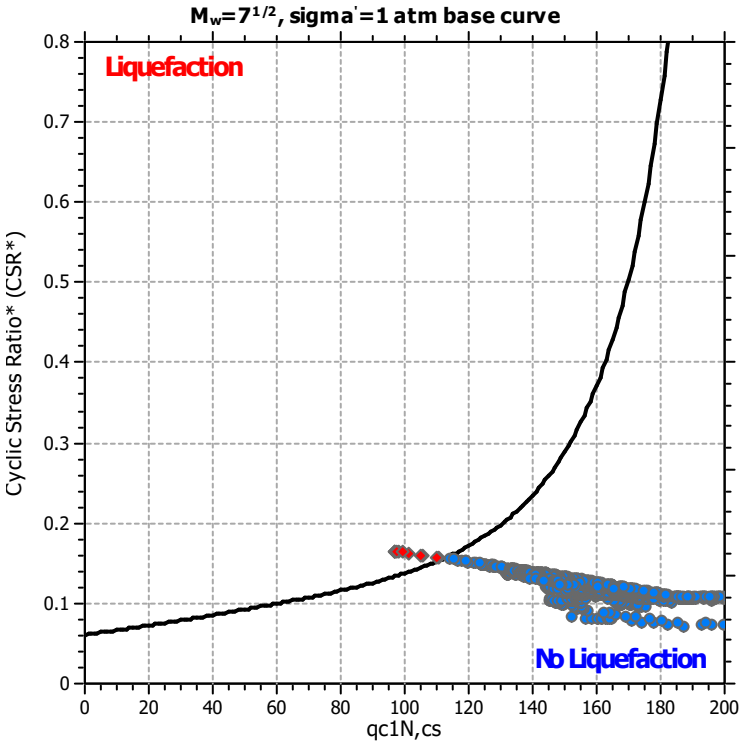
Project title : 210339 - Muriwai Downs **Location : 710 Muriwai Road**

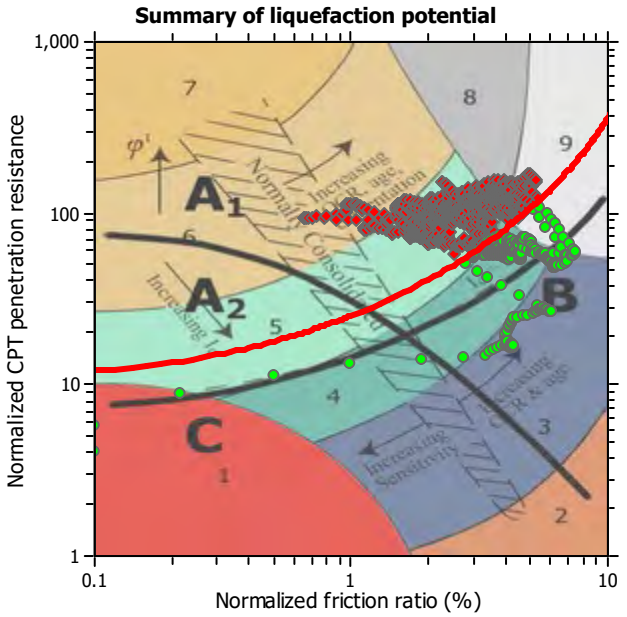
CPT file : CPT-03

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

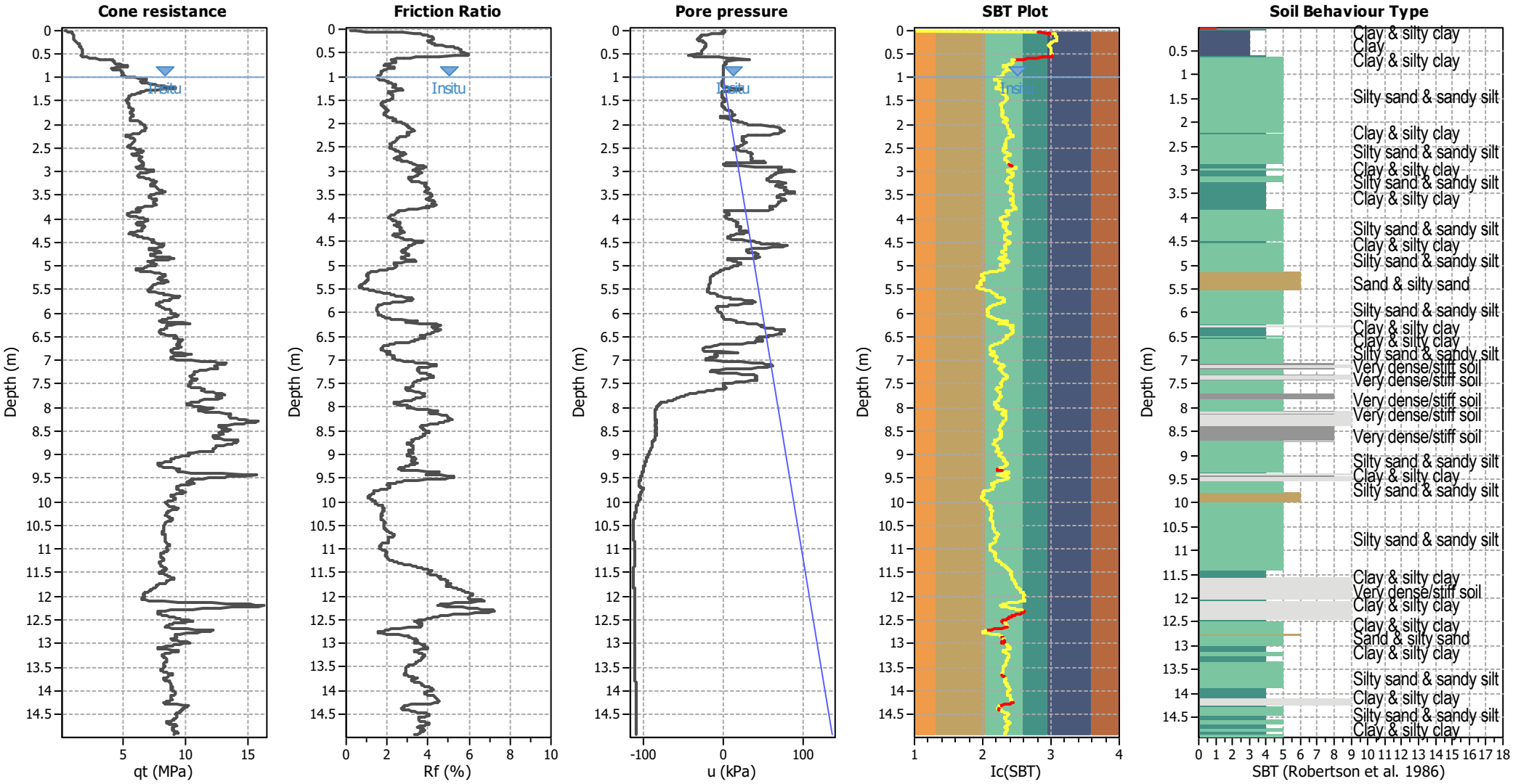






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



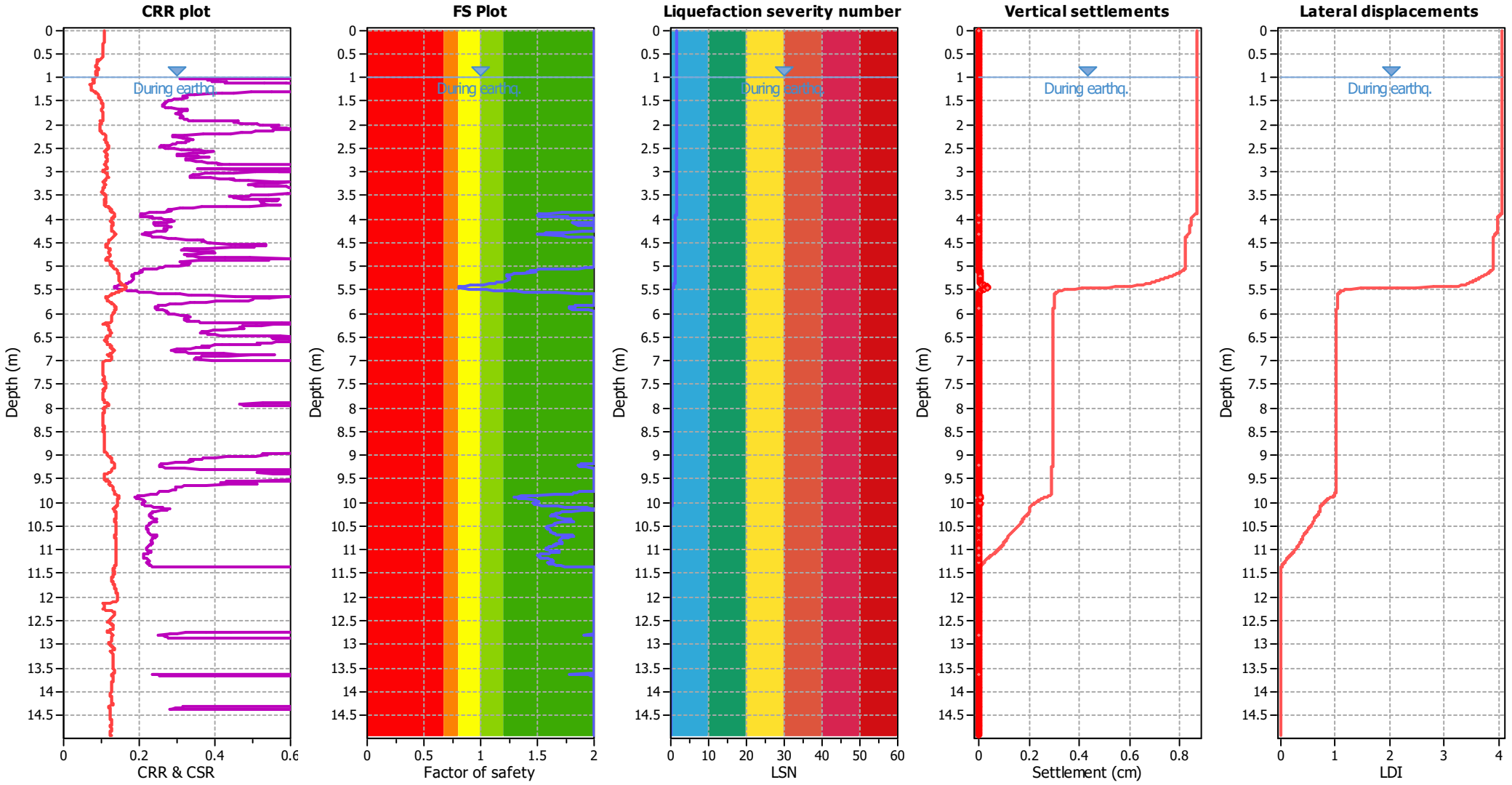
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.40	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.40	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

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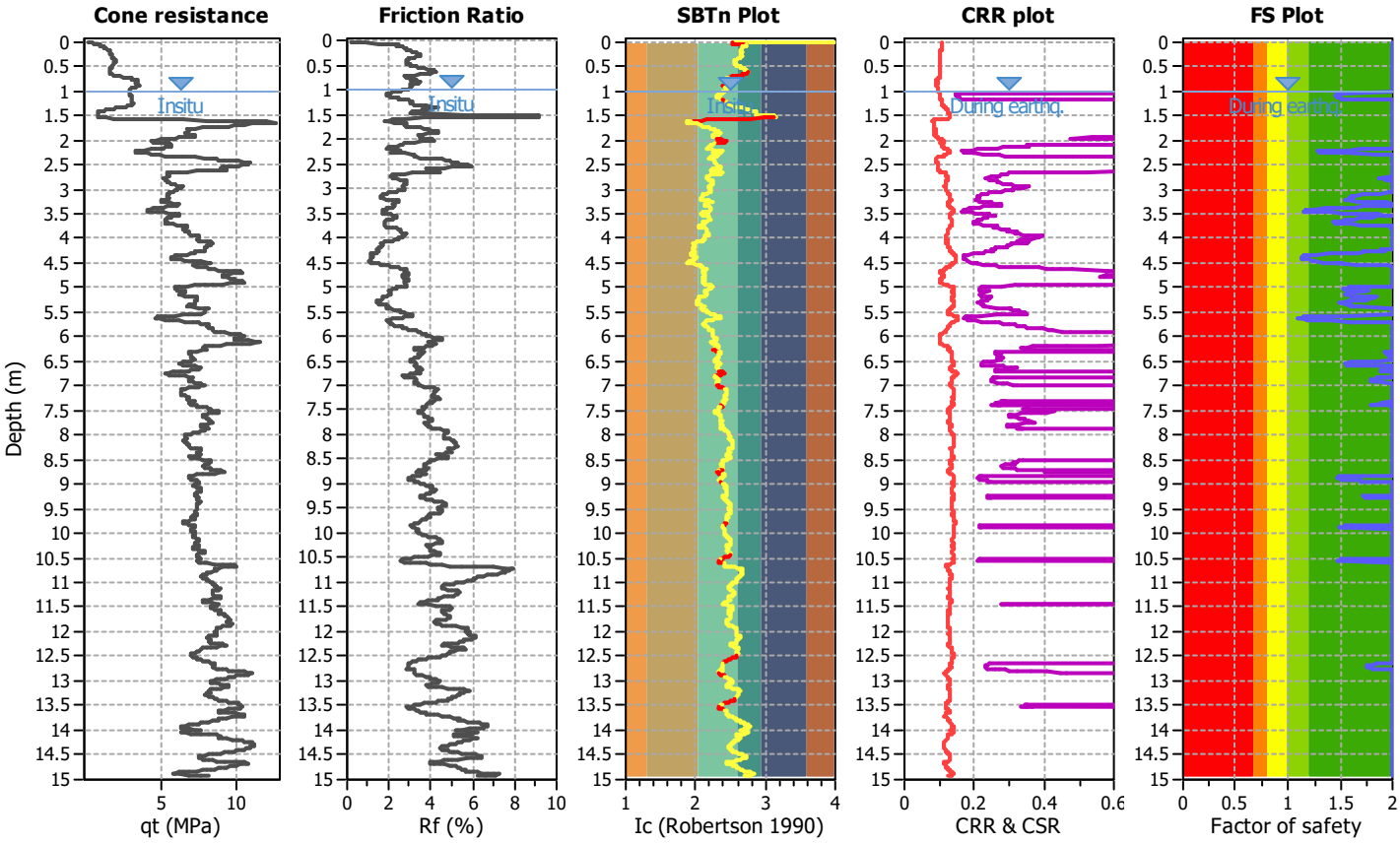
LIQUEFACTION ANALYSIS REPORT

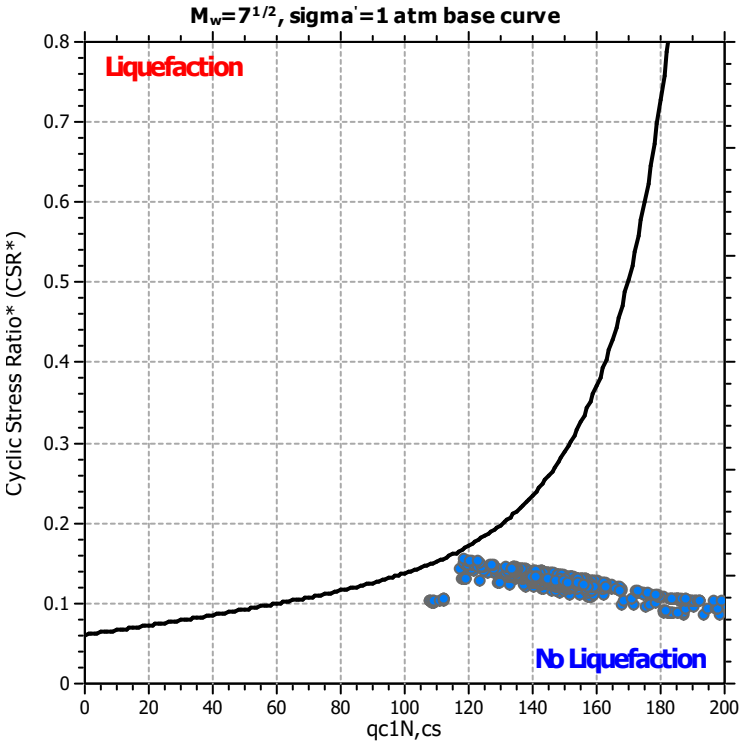
Project title : 210339 - Muriwai Downs **Location : 710 Muriwai Road**

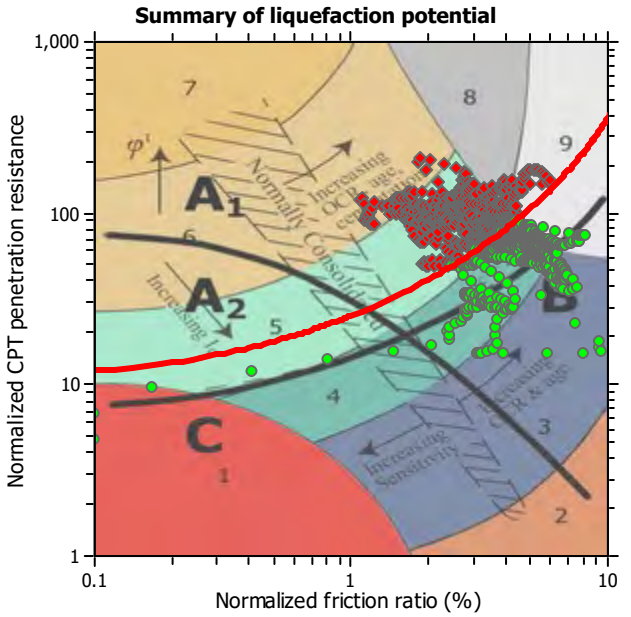
CPT file : CPT-04

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

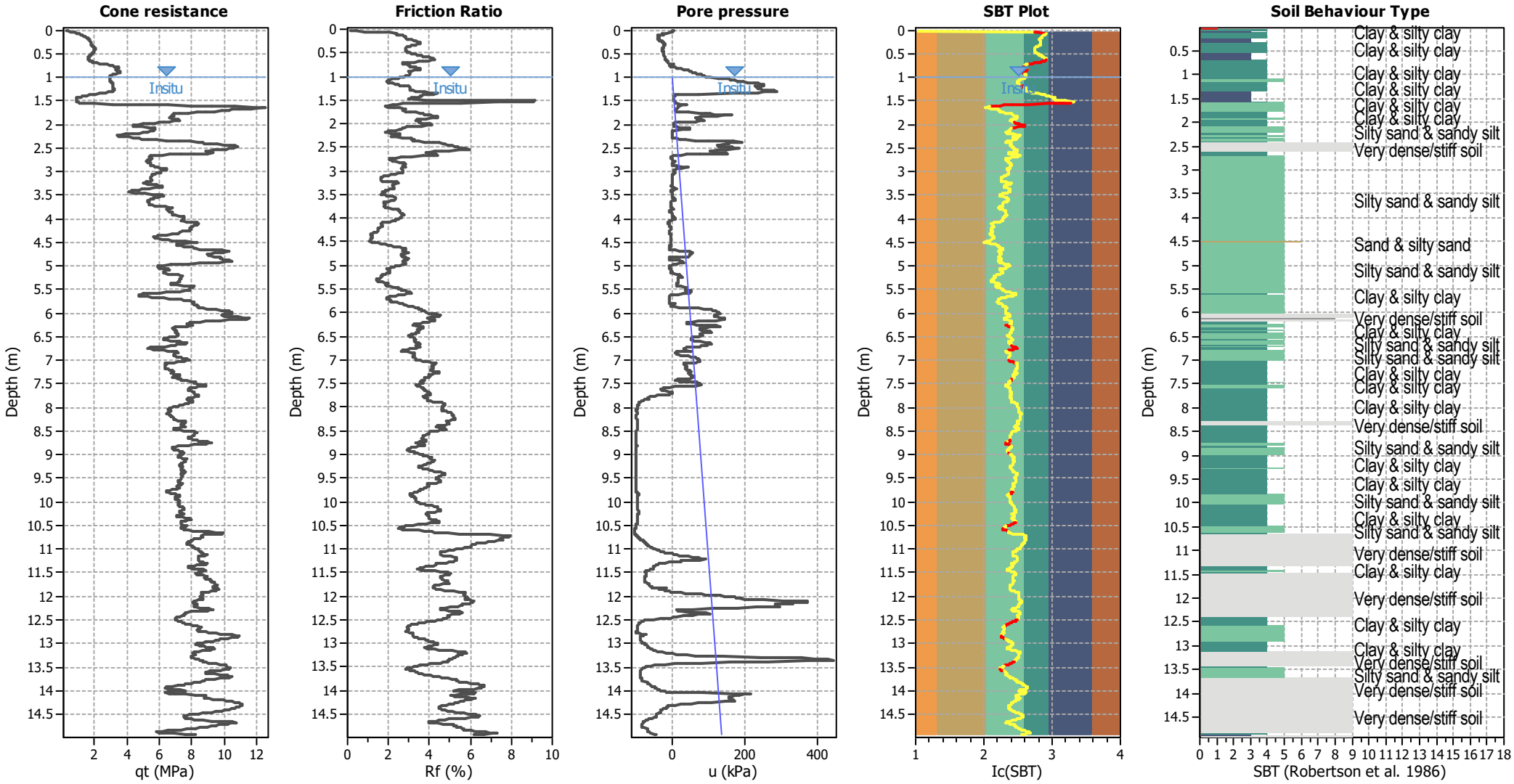






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



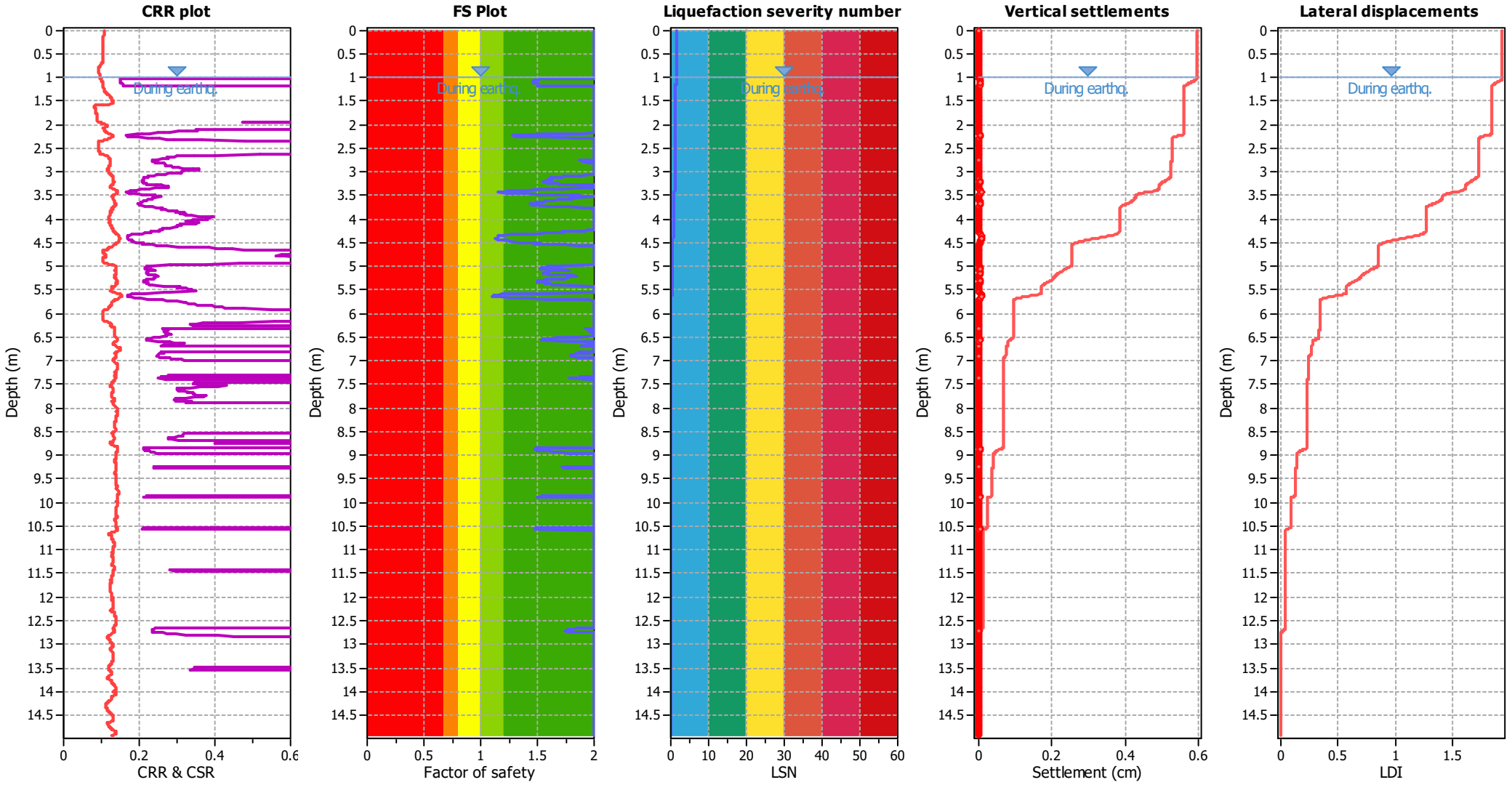
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.40	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.40	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

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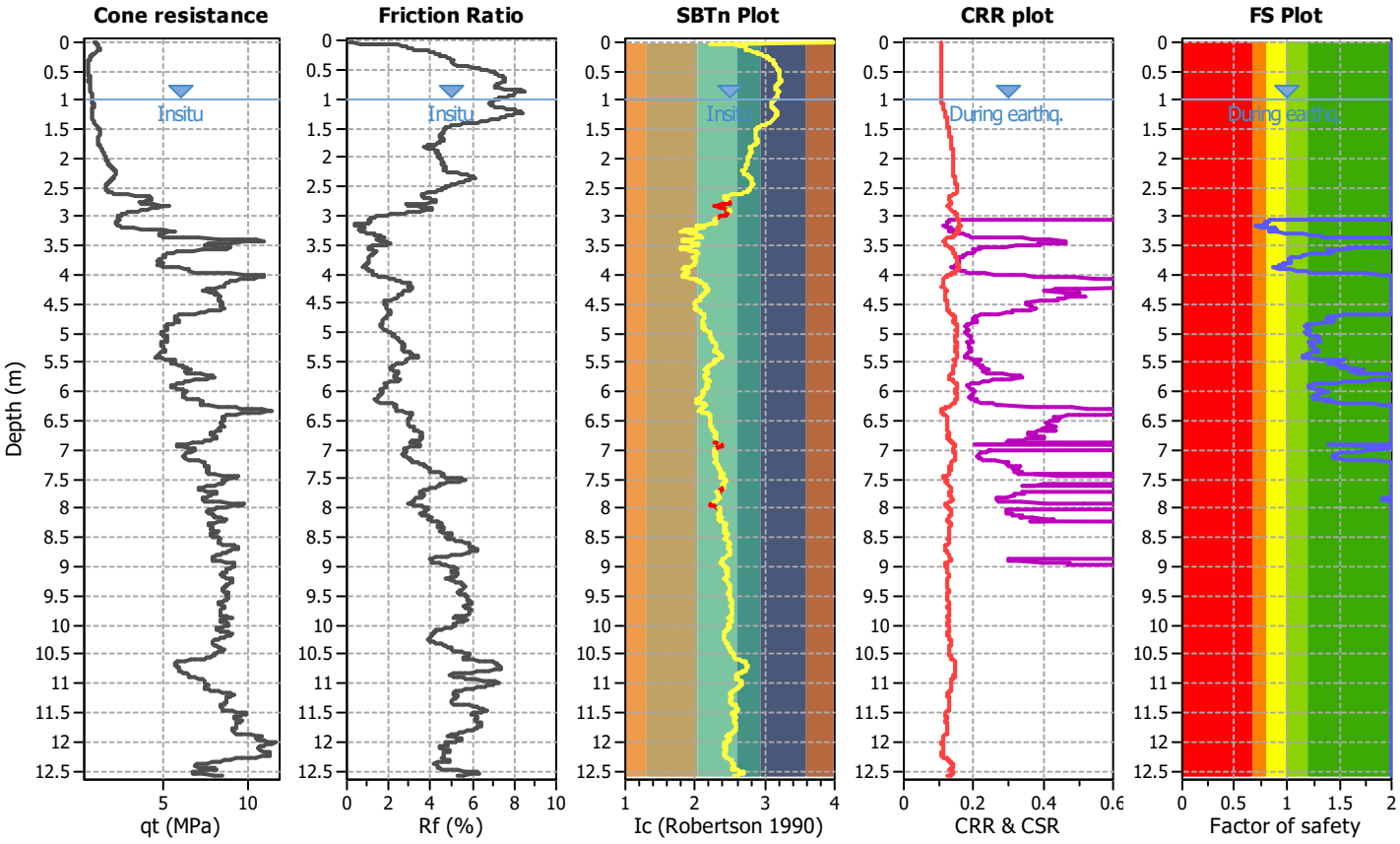
LIQUEFACTION ANALYSIS REPORT

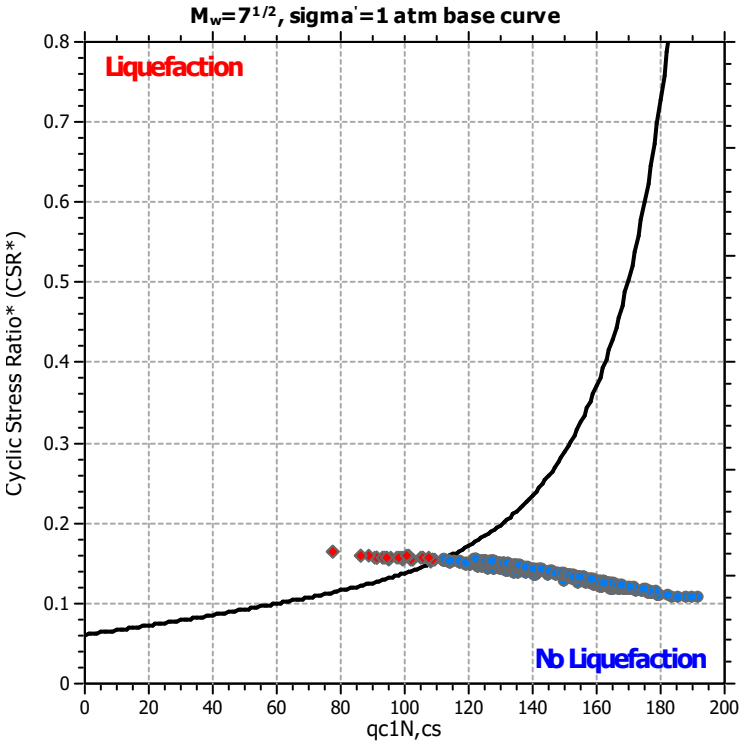
Project title : 210339 - Muriwai Downs **Location : 710 Muriwai Road**

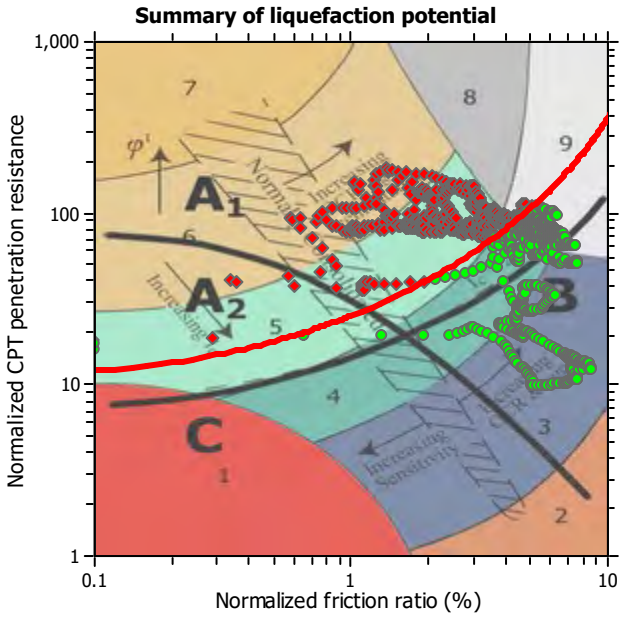
CPT file : CPT-05

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

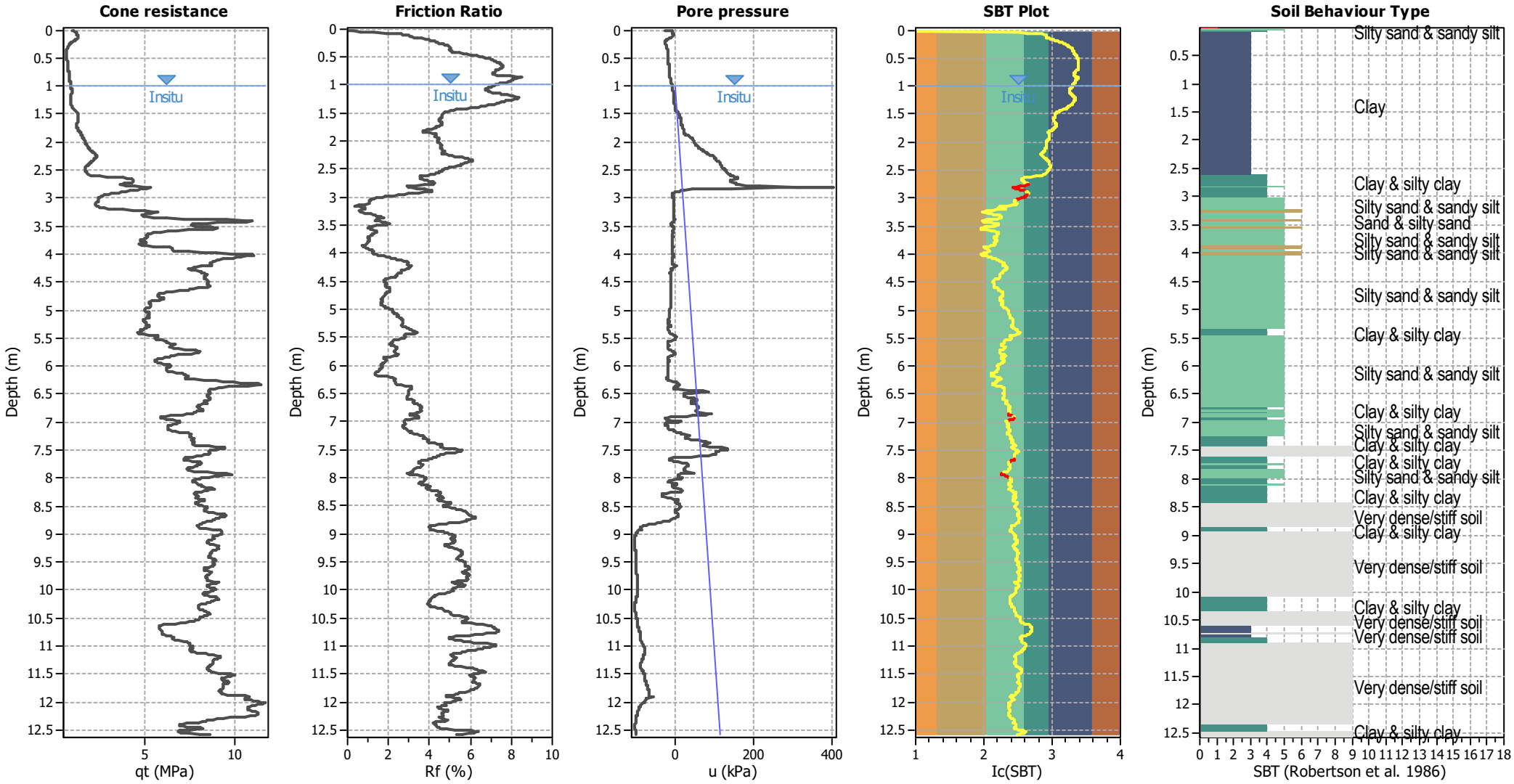






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



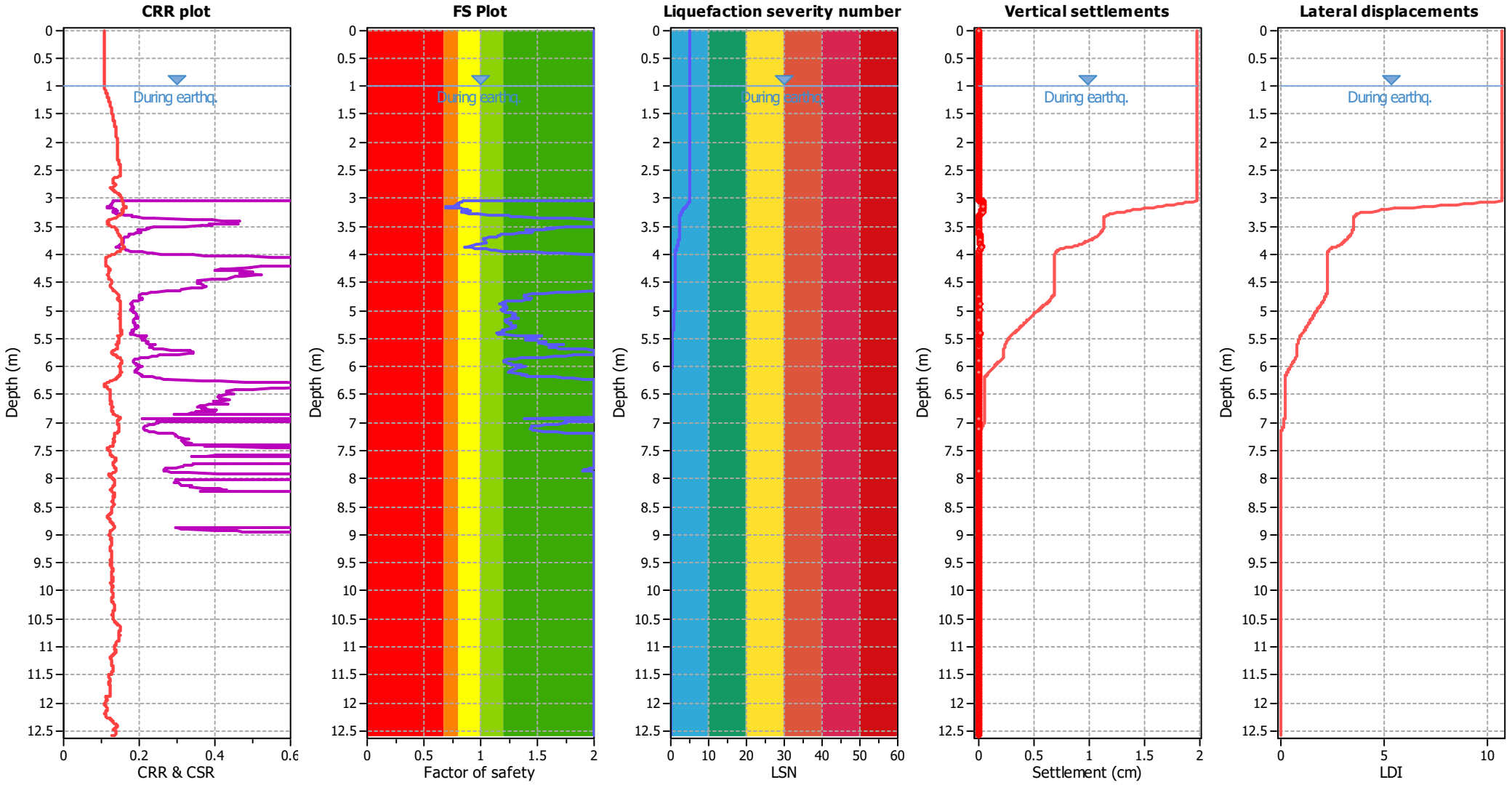
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.40	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.40	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

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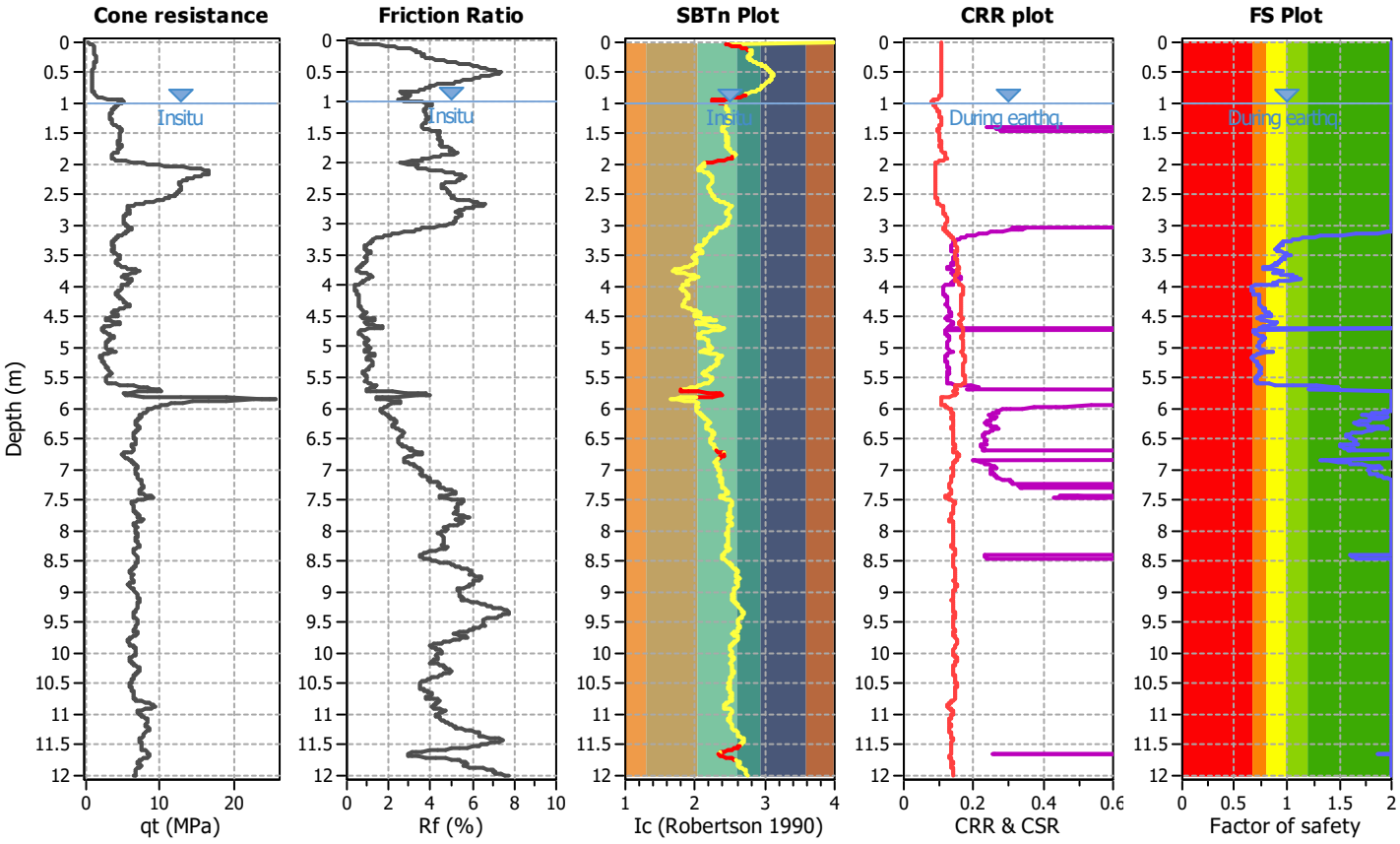
LIQUEFACTION ANALYSIS REPORT

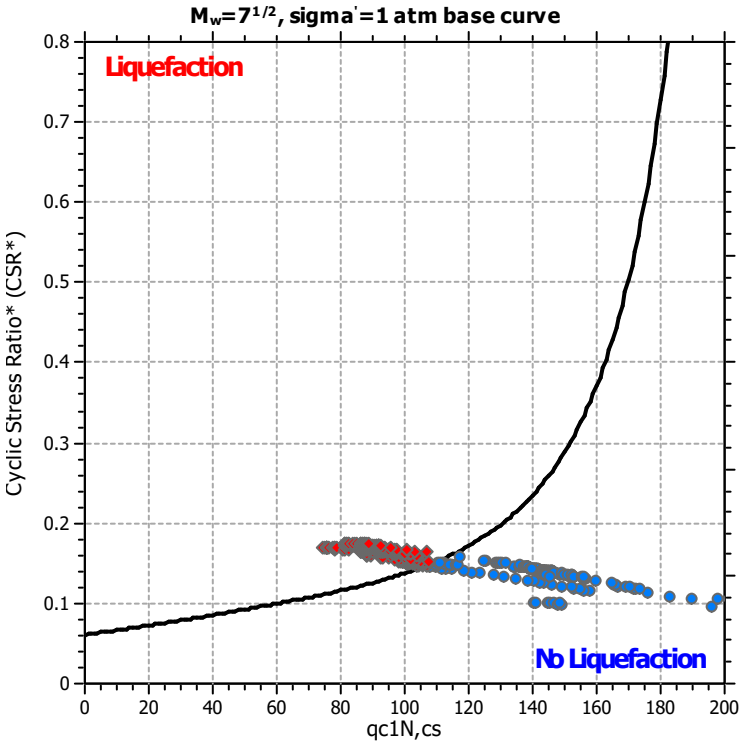
Project title : 210339 - Muriwai Downs **Location : 710 Muriwai Road**

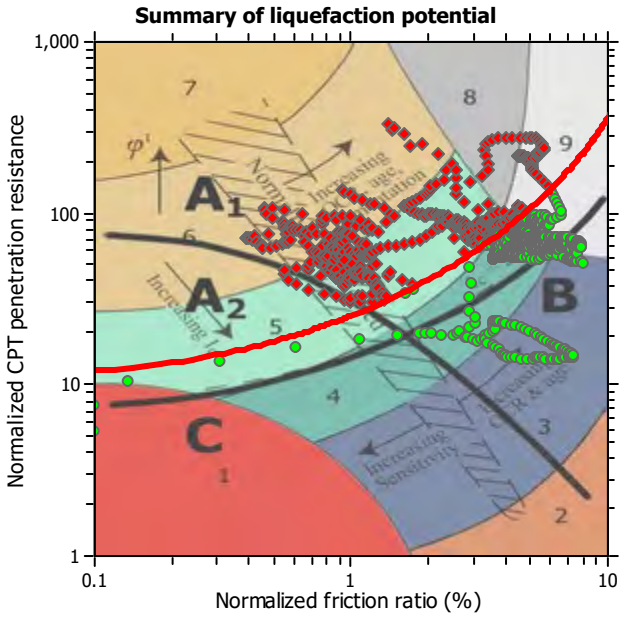
CPT file : CPT-06

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

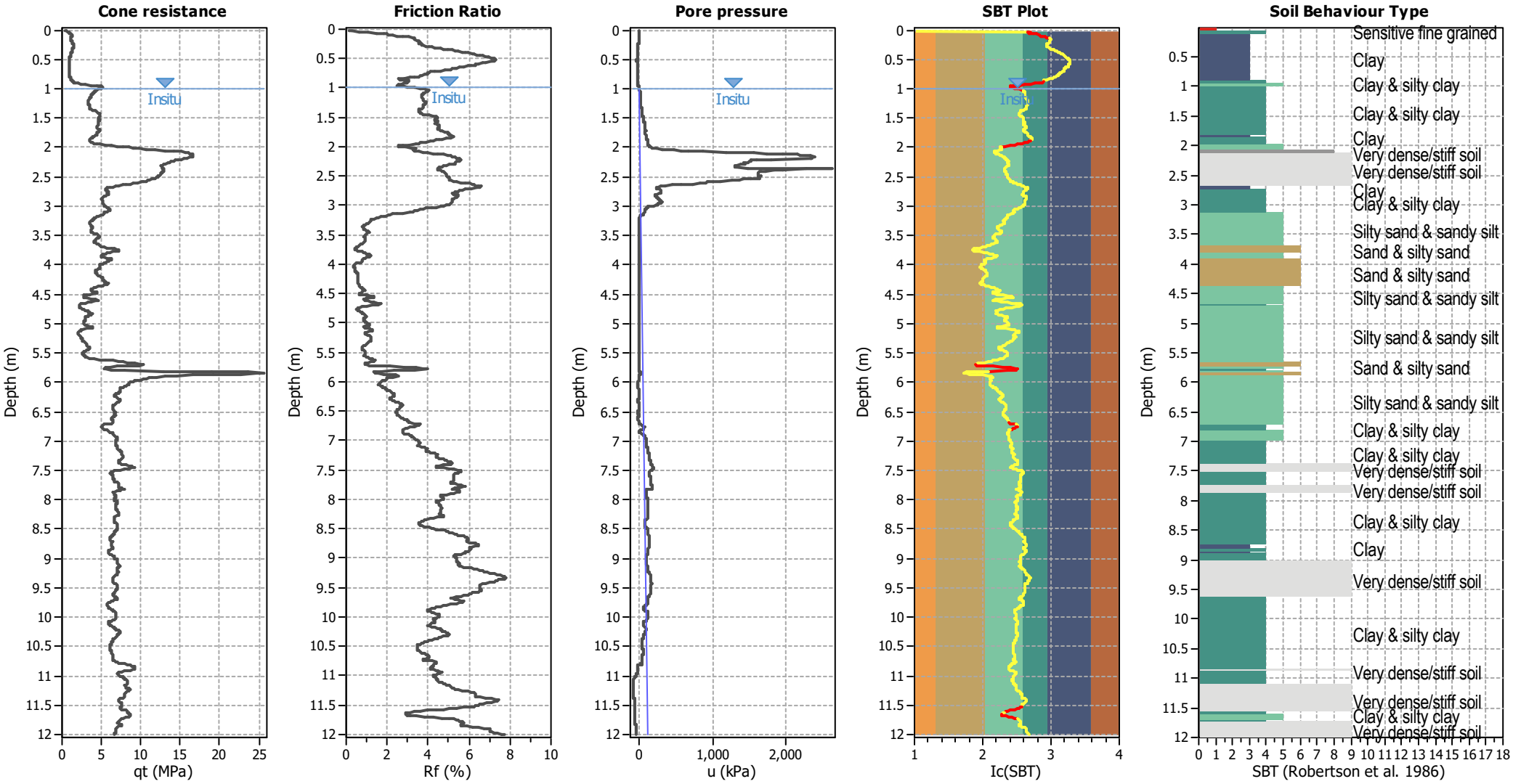






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



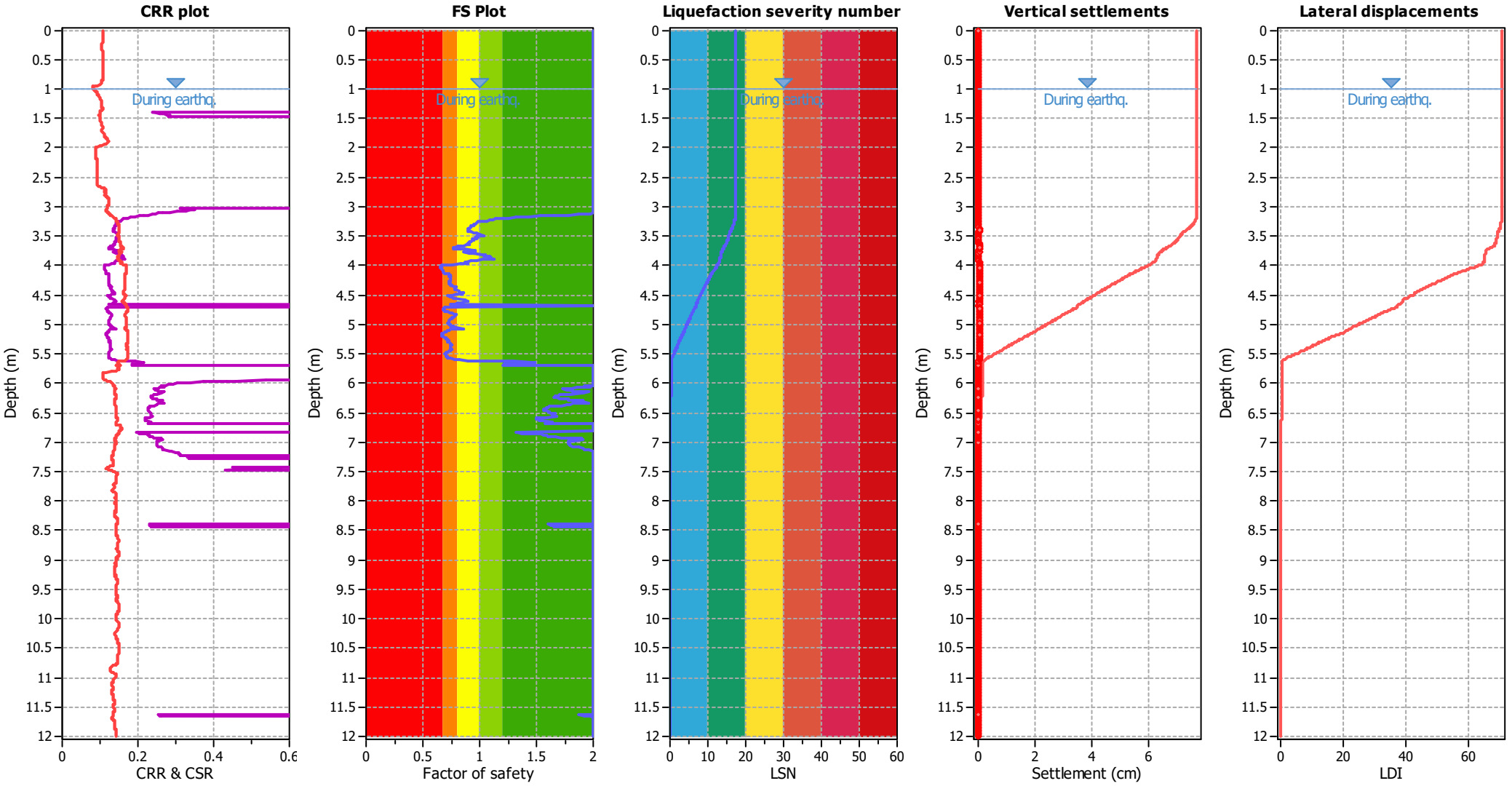
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.40	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.40	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

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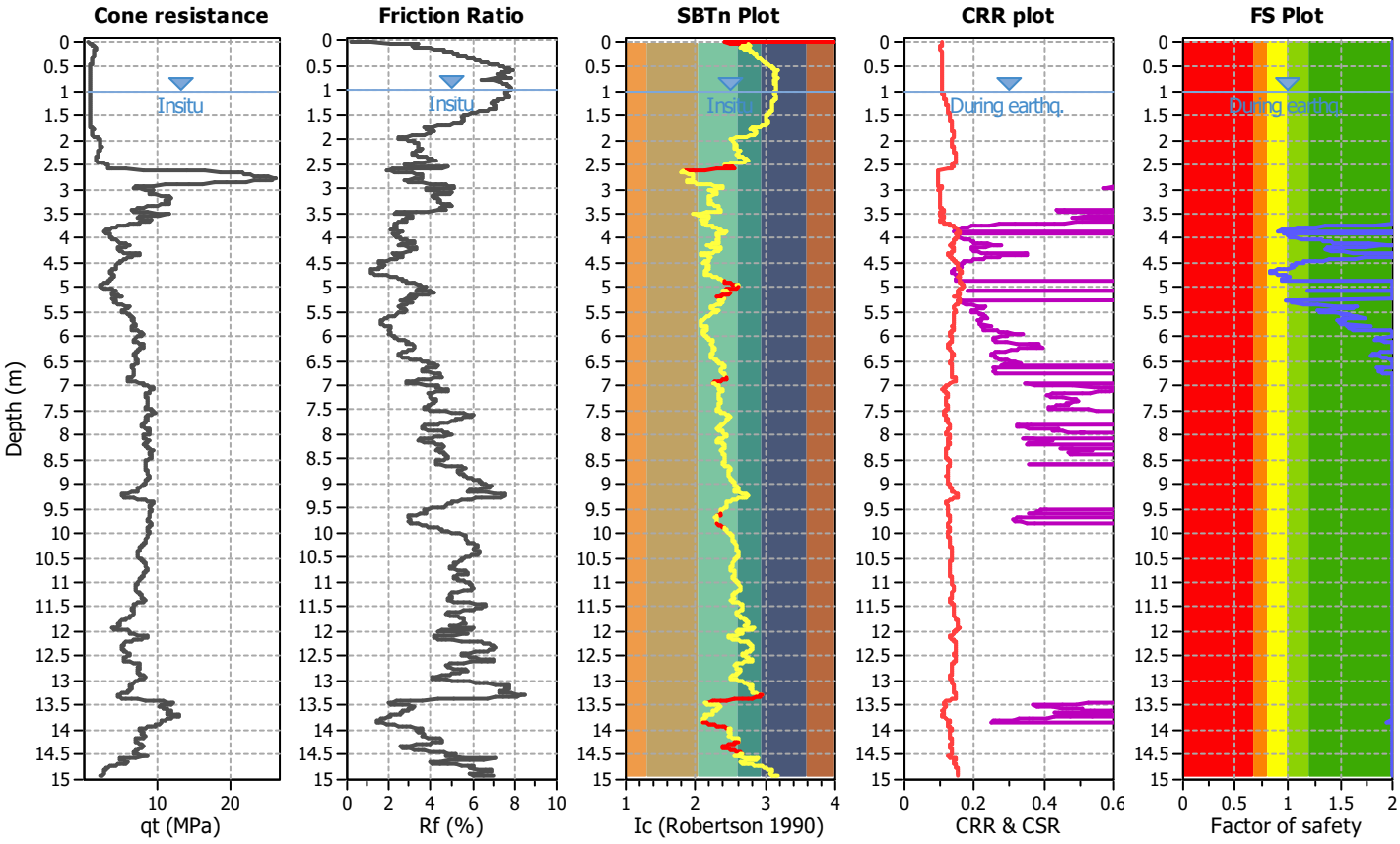
LIQUEFACTION ANALYSIS REPORT

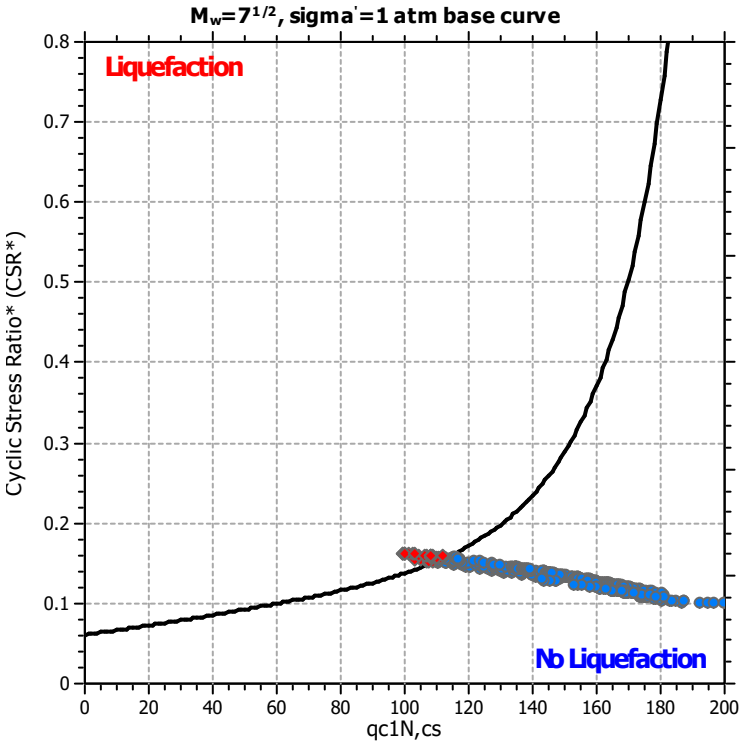
Project title : 210339 - Muriwai Downs **Location : 710 Muriwai Road**

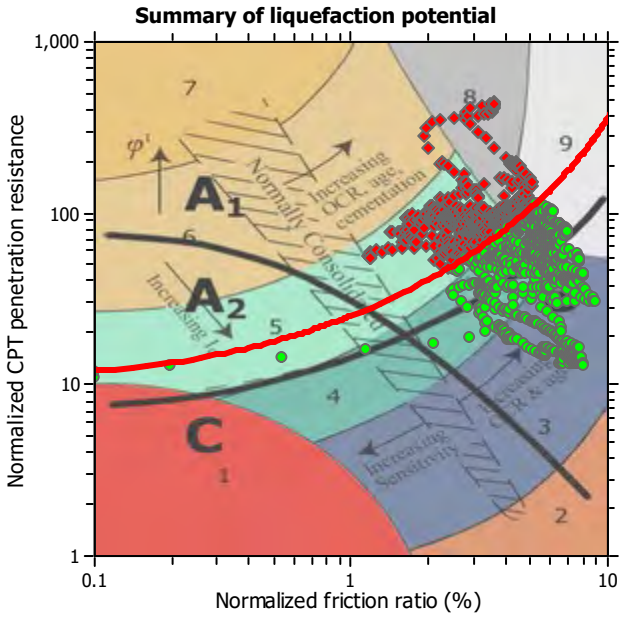
CPT file : CPT-07

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

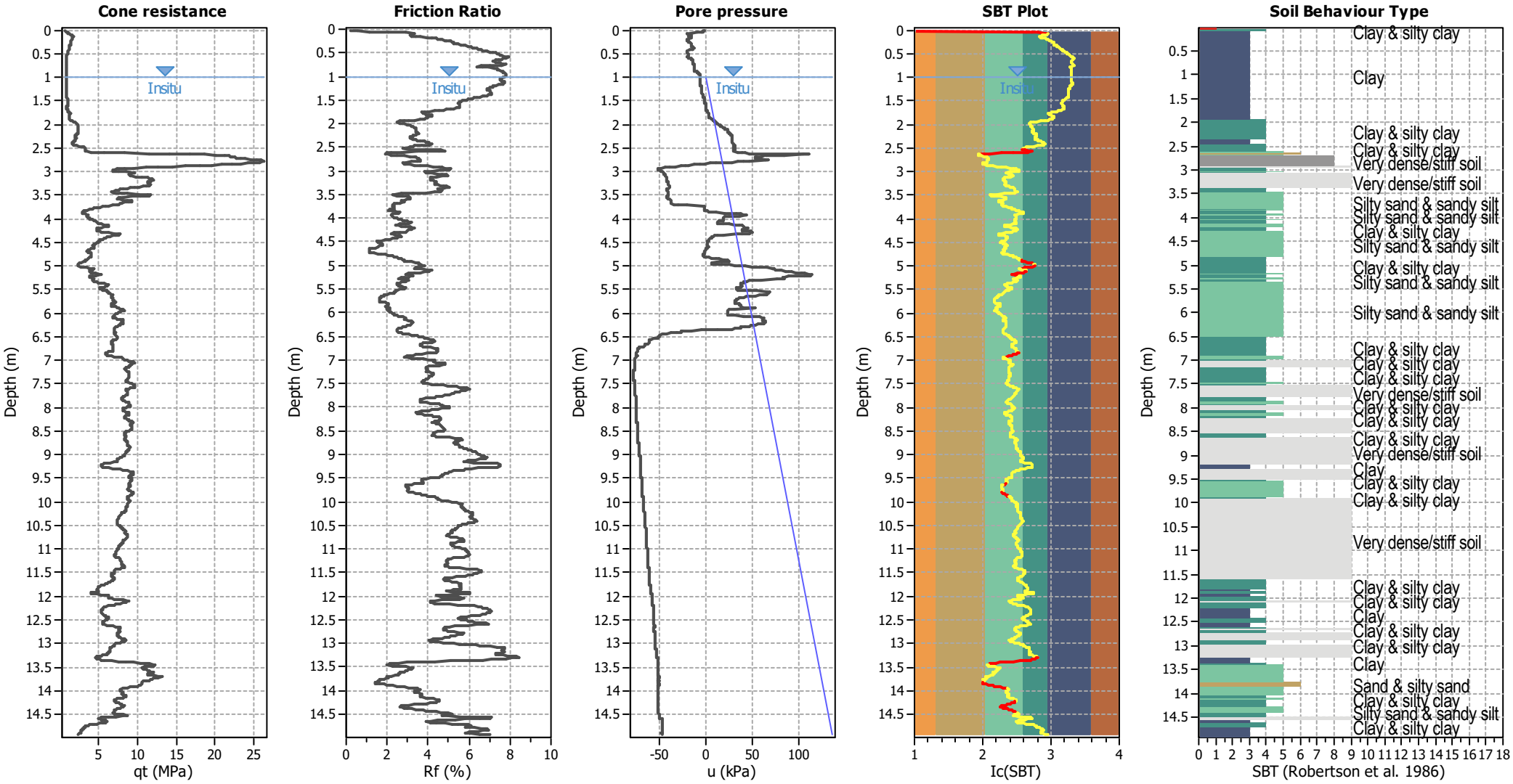






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



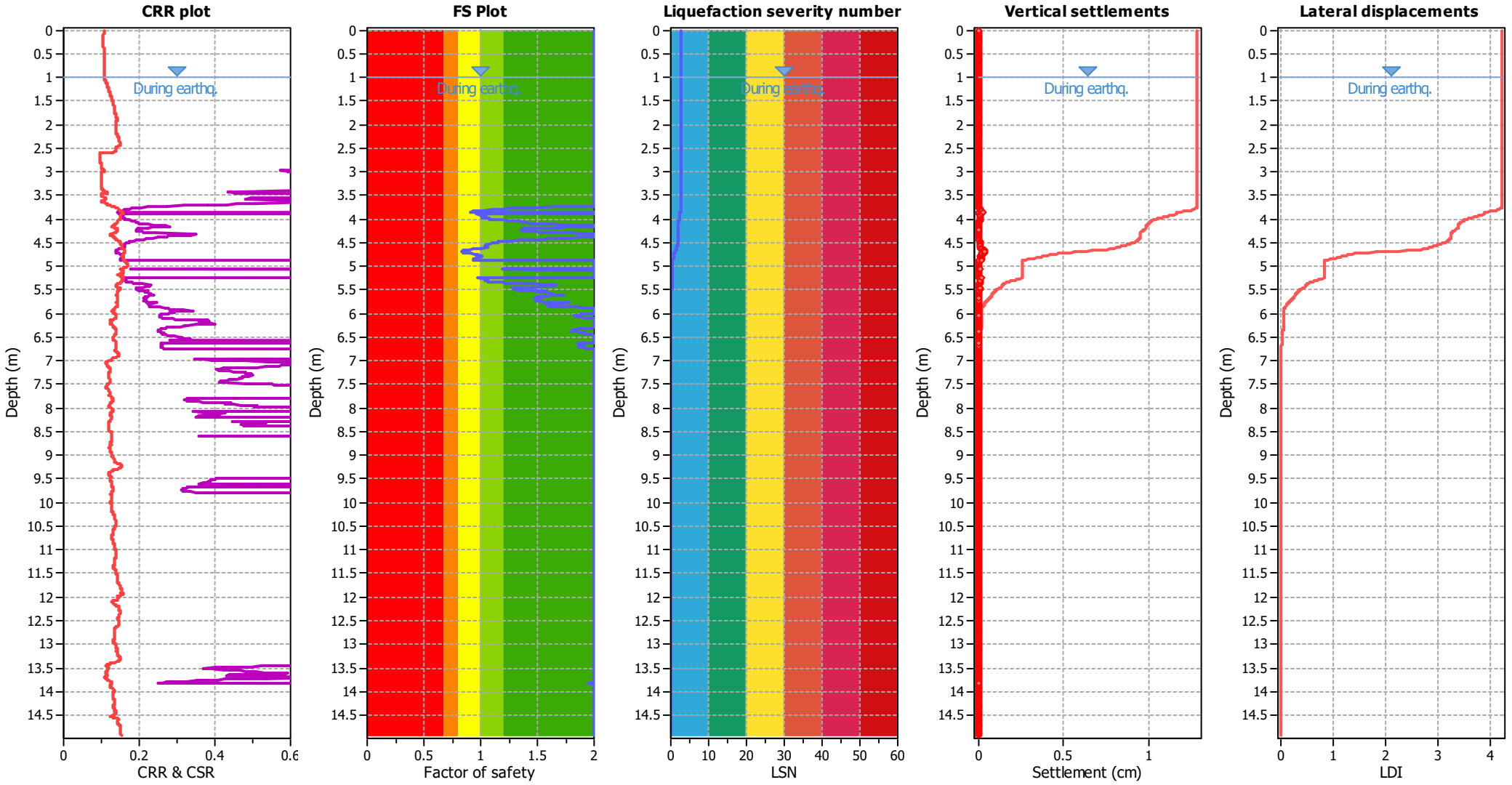
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.40	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.40	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

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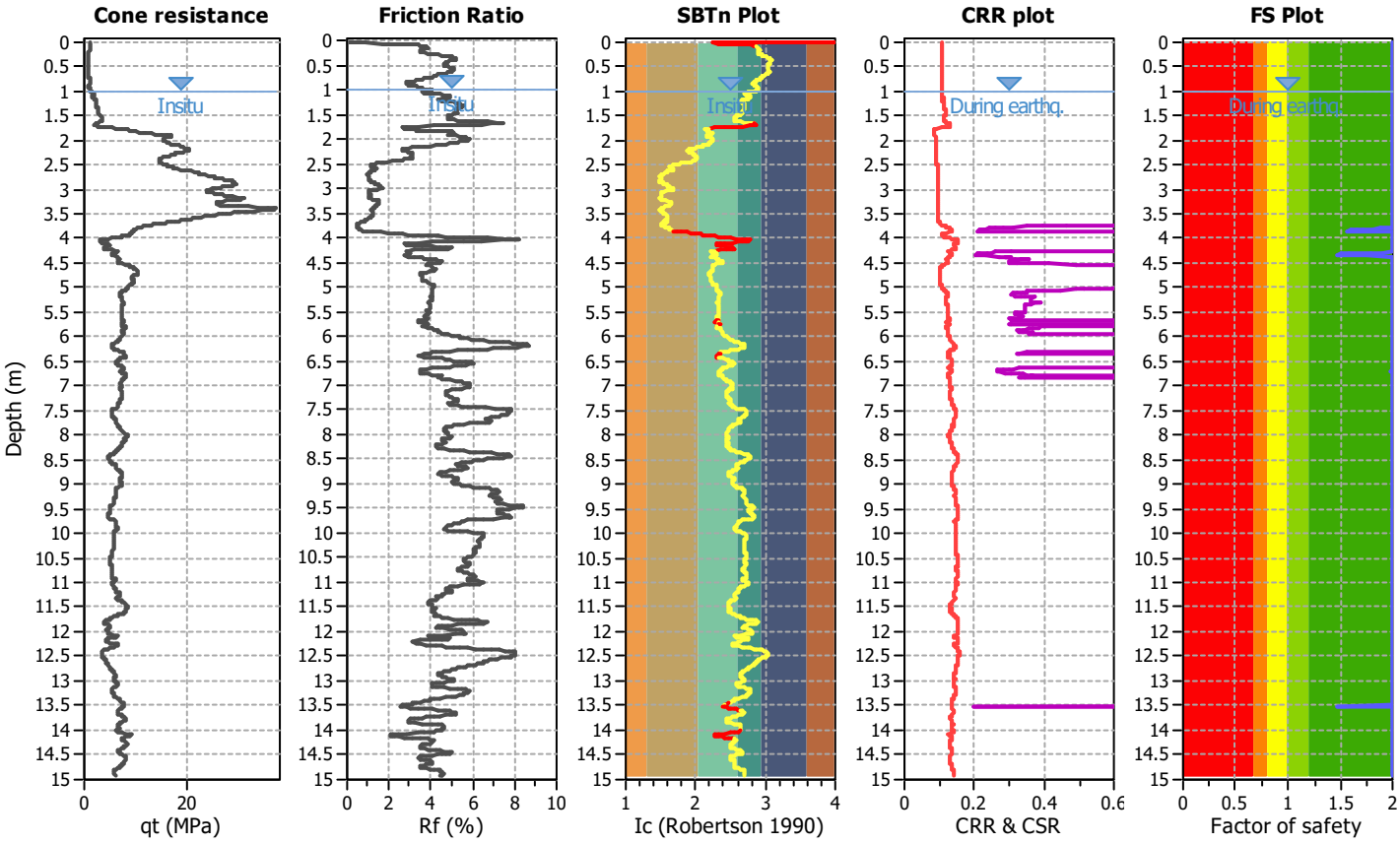
LIQUEFACTION ANALYSIS REPORT

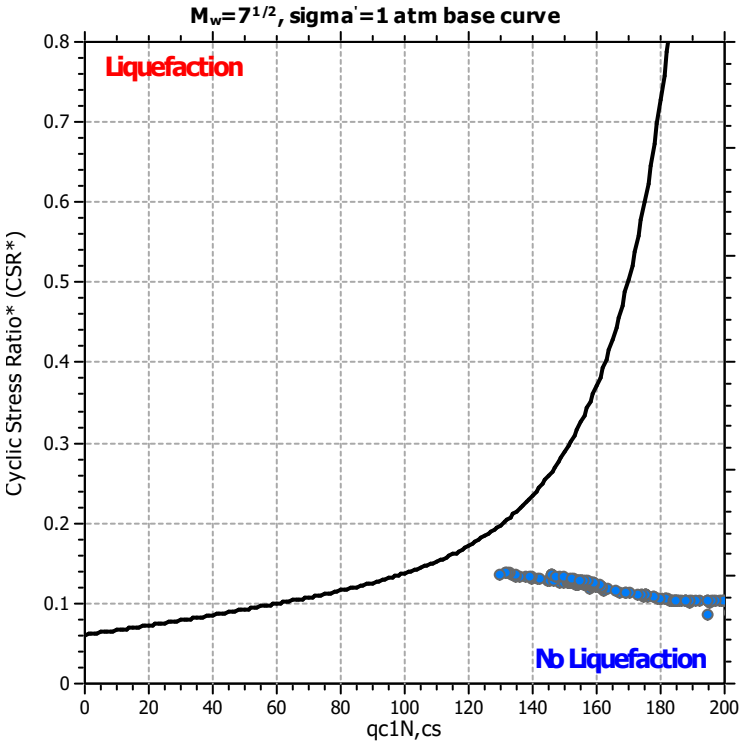
Project title : 210339 - Muriwai Downs **Location : 710 Muriwai Road**

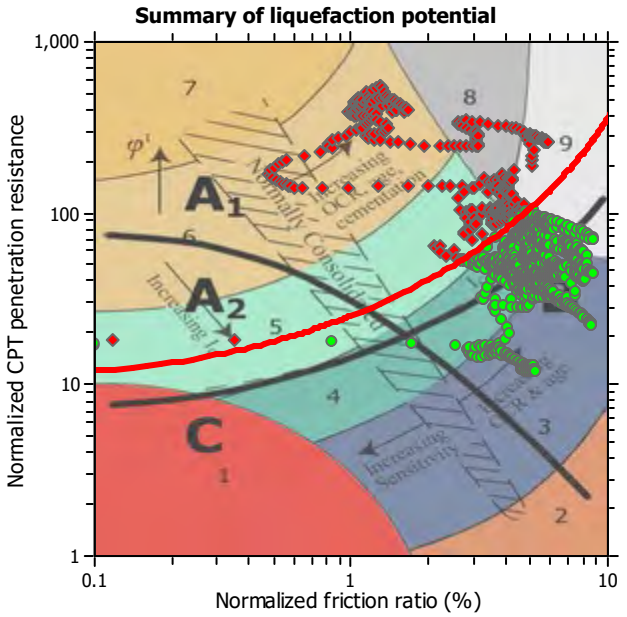
CPT file : CPT-08

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

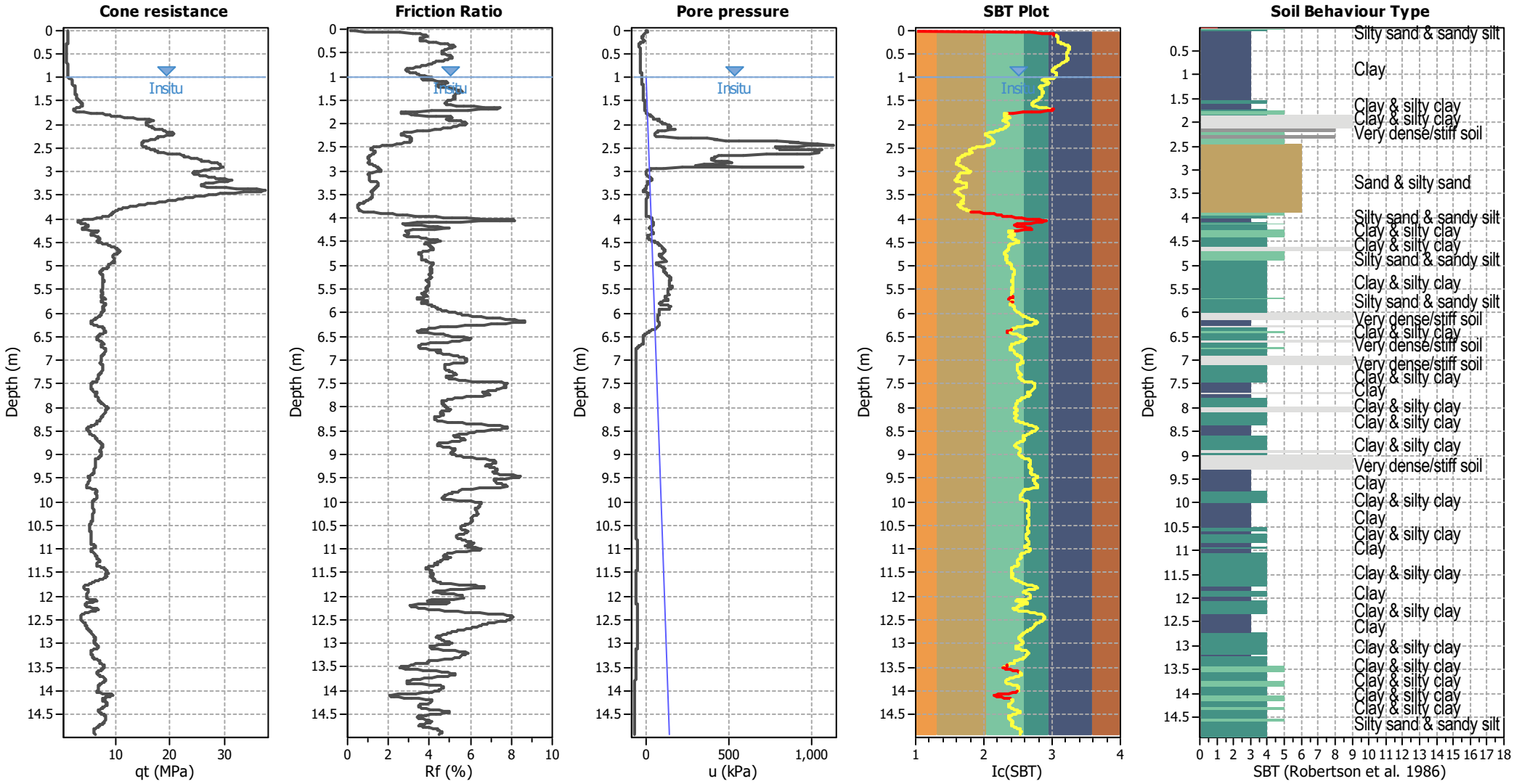






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



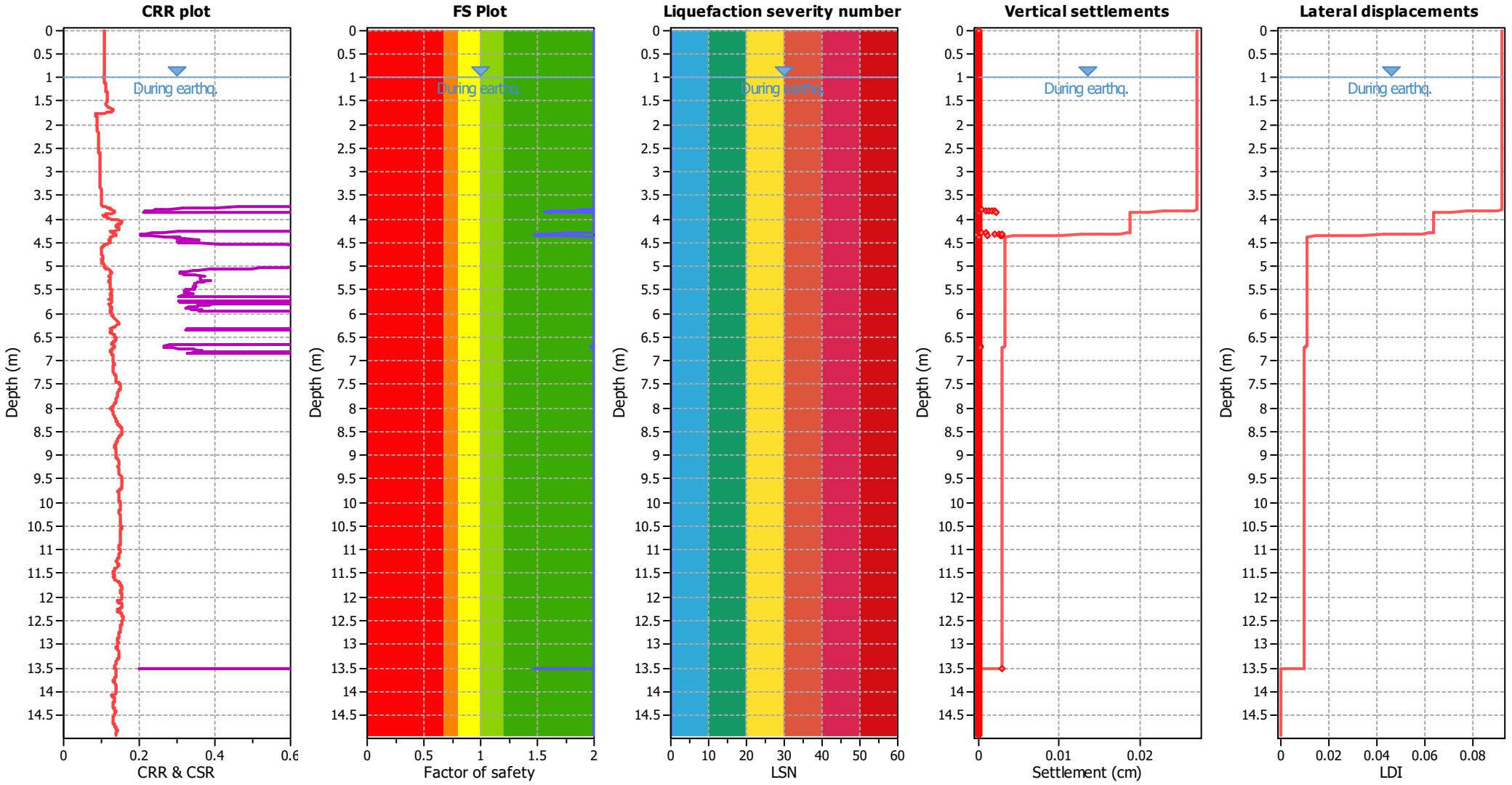
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.40	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.40	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

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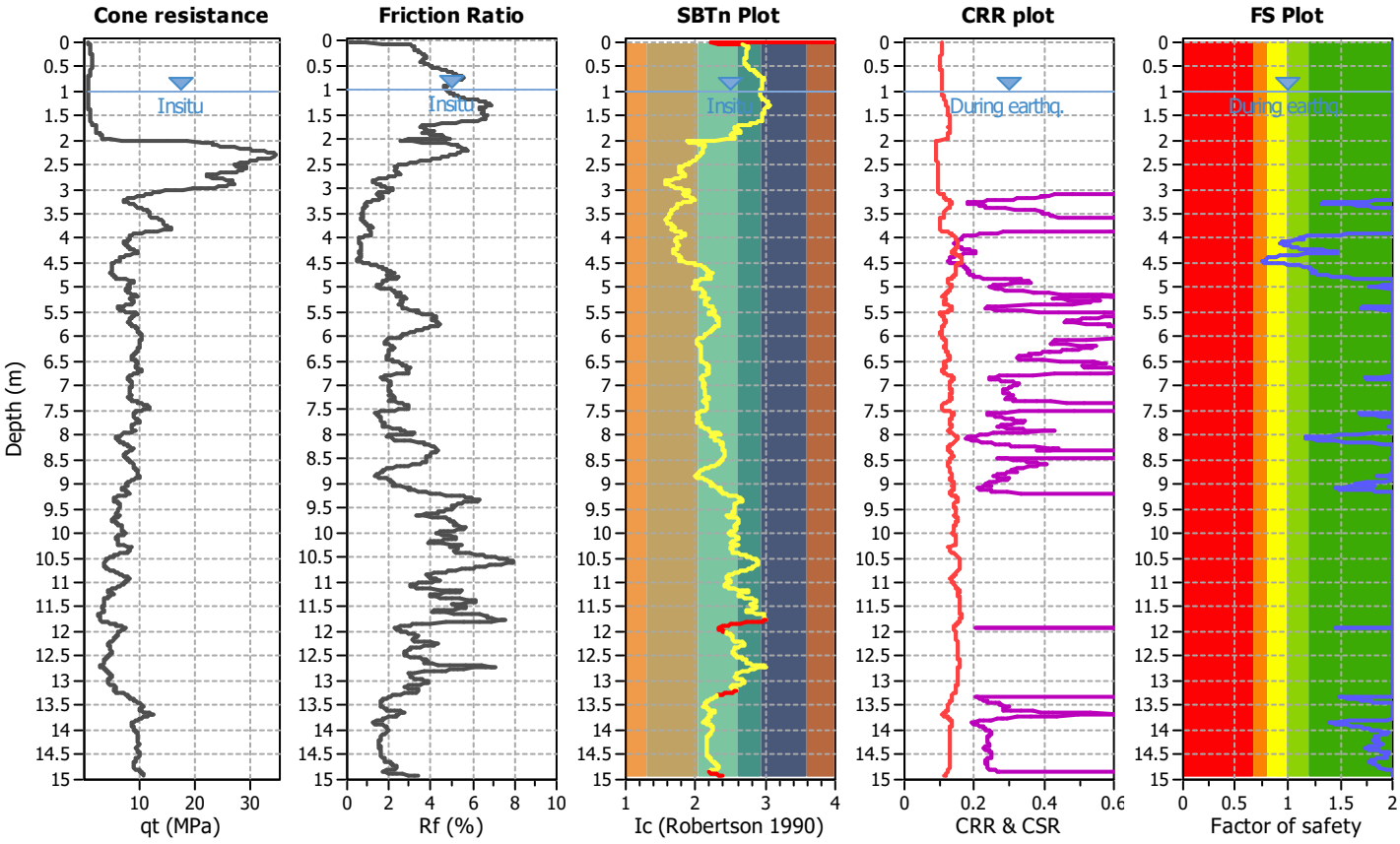
LIQUEFACTION ANALYSIS REPORT

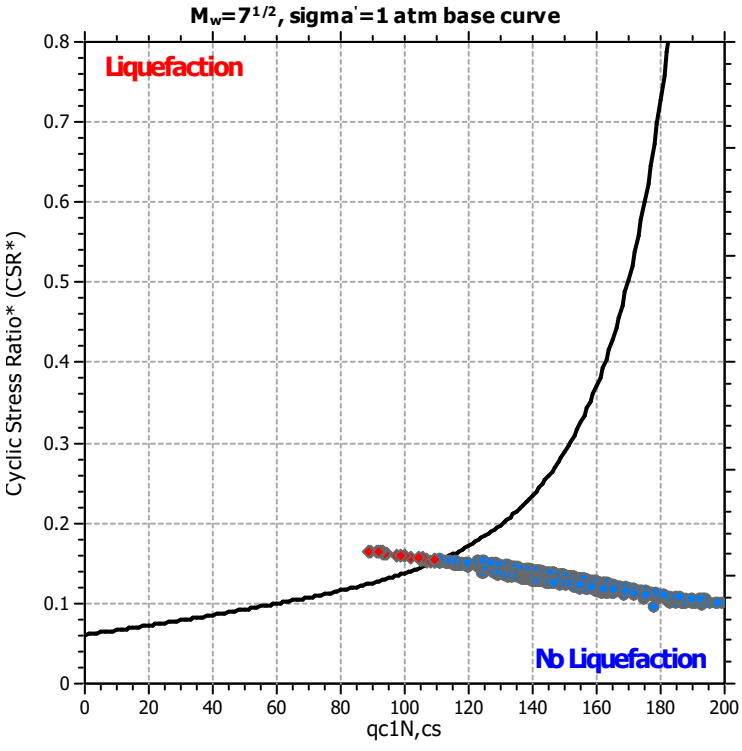
Project title : 210339 - Muriwai Downs **Location : 710 Muriwai Road**

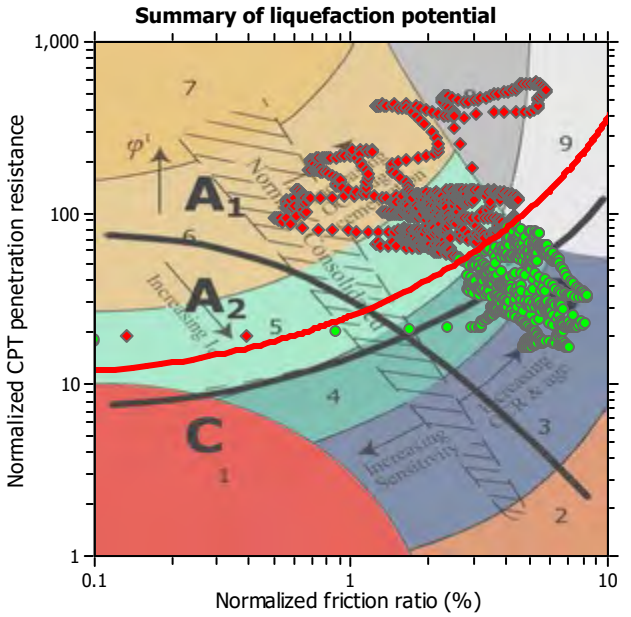
CPT file : CPT-09

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

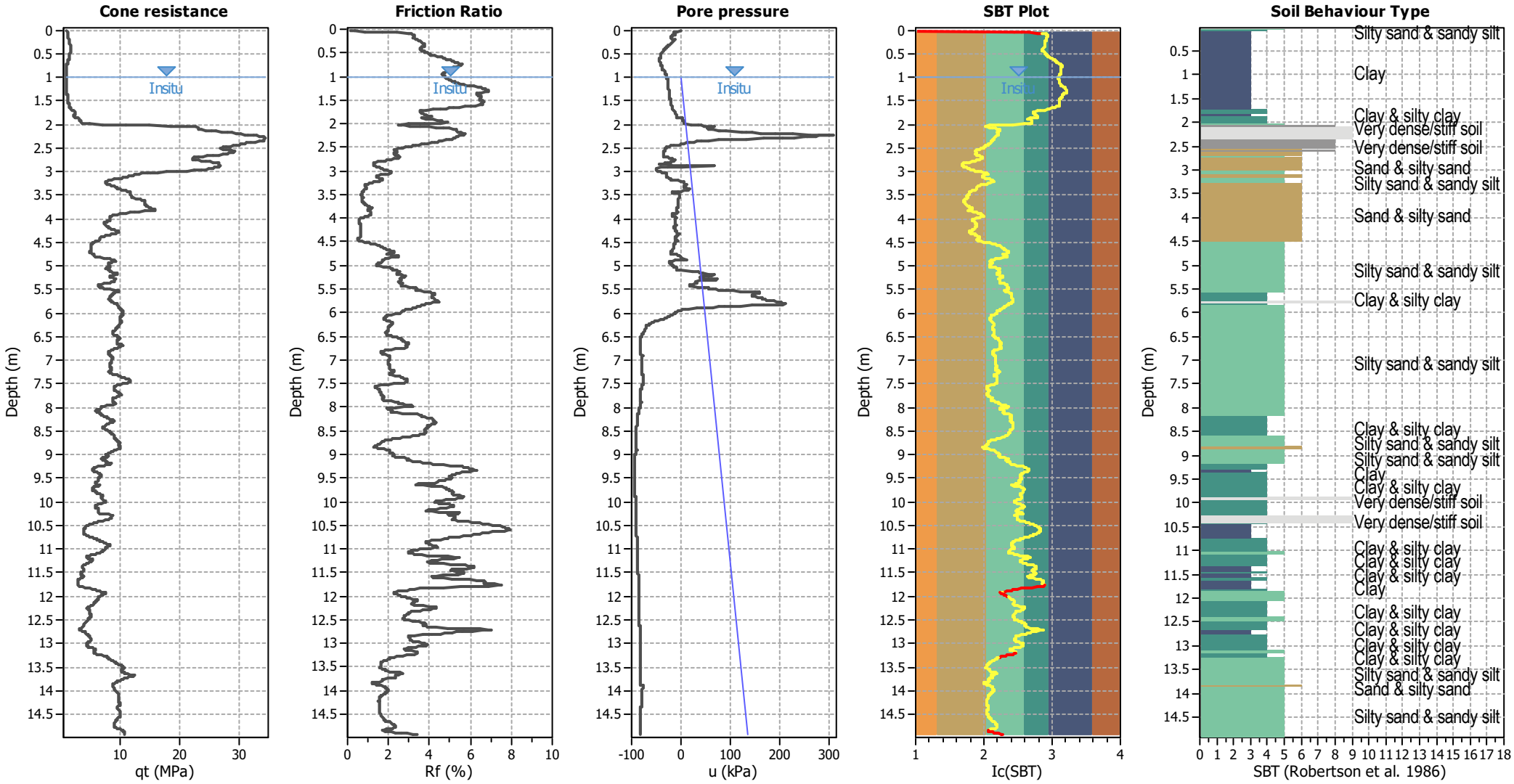






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



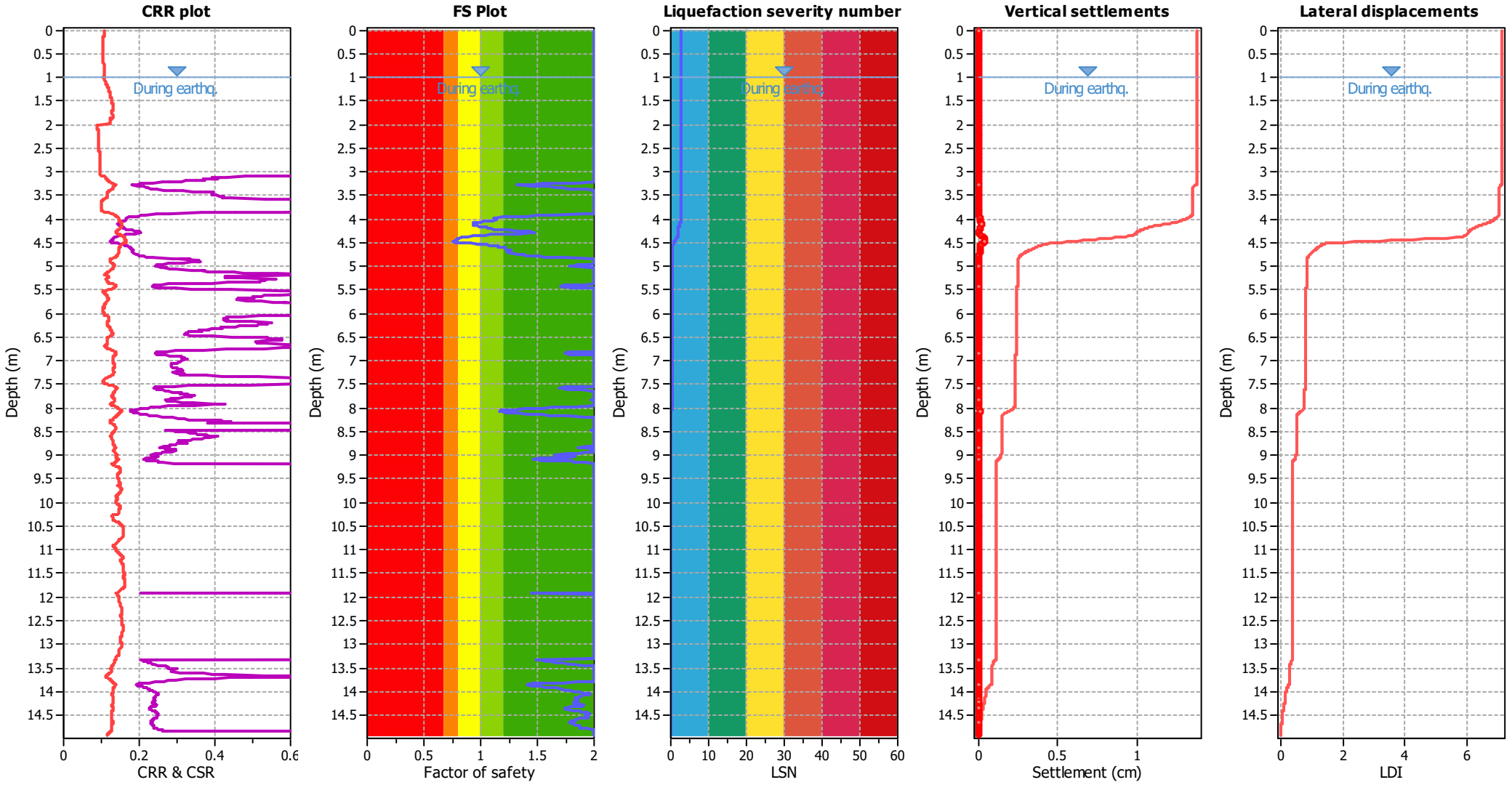
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.40	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.40	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

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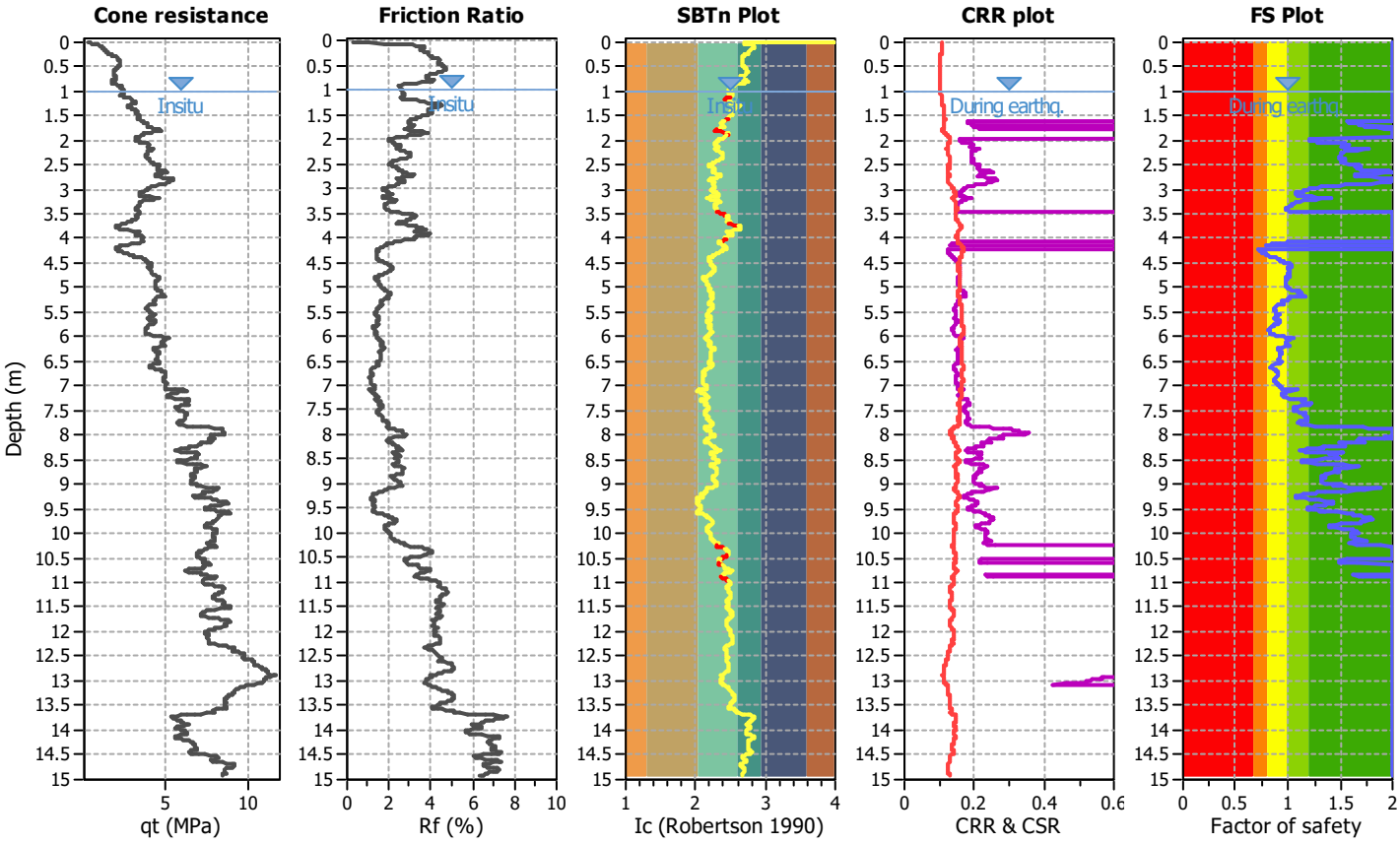
LIQUEFACTION ANALYSIS REPORT

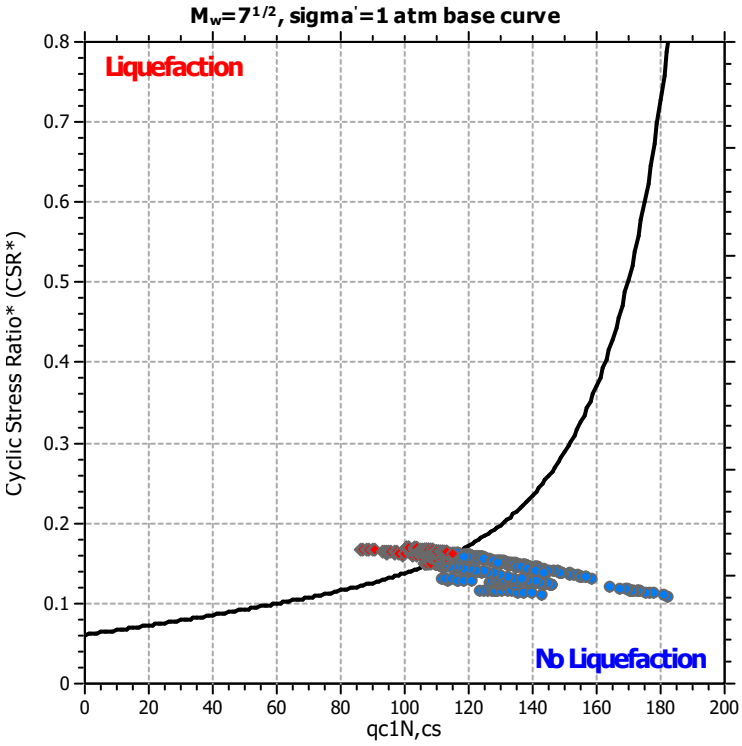
Project title : 210339 - Muriwai Downs **Location : 710 Muriwai Road**

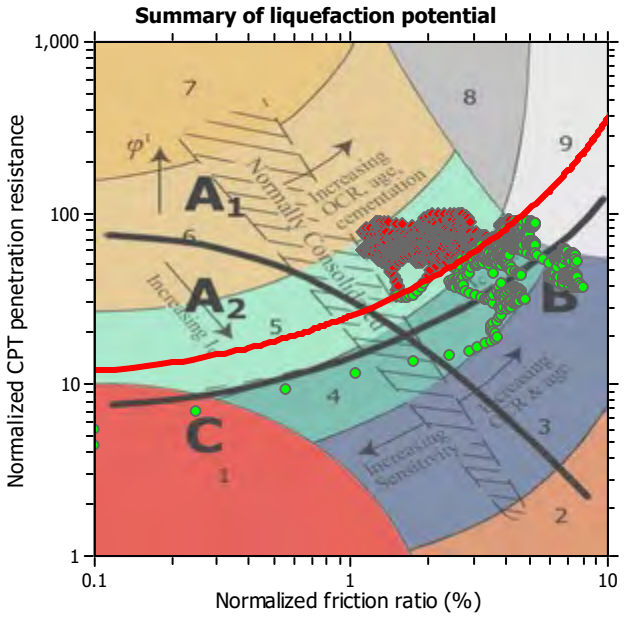
CPT file : CPT-10

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

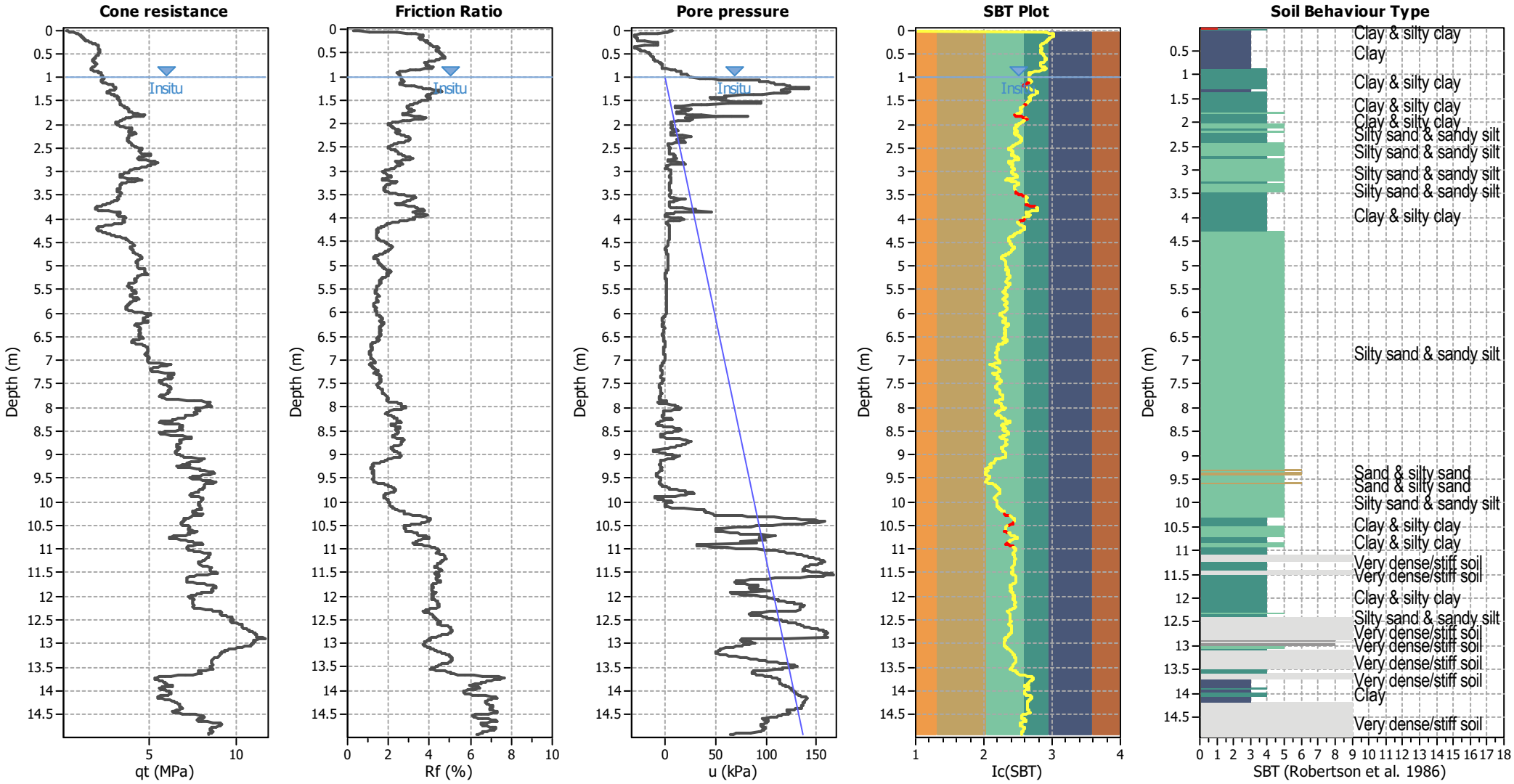






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



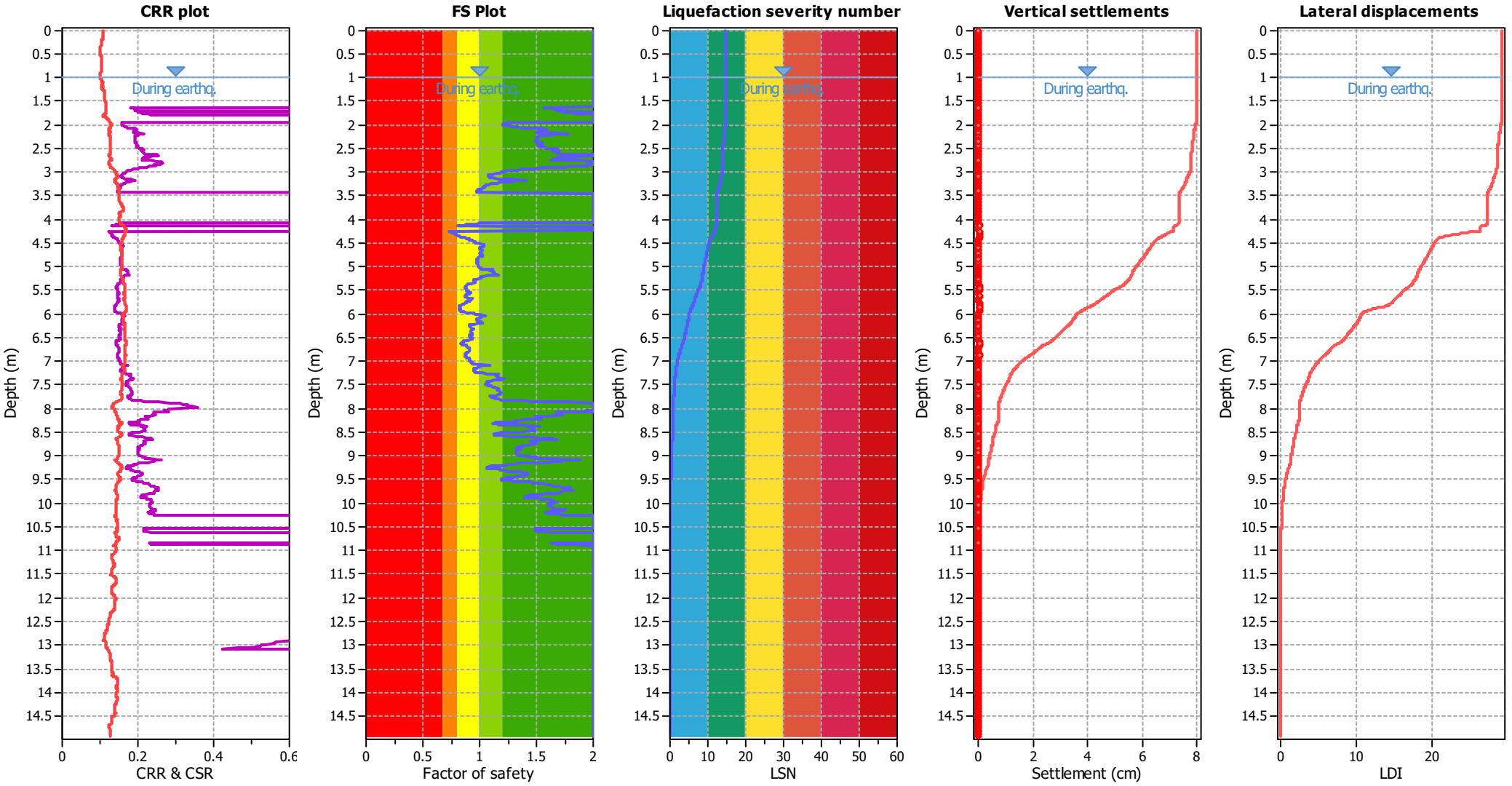
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.40	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.40	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

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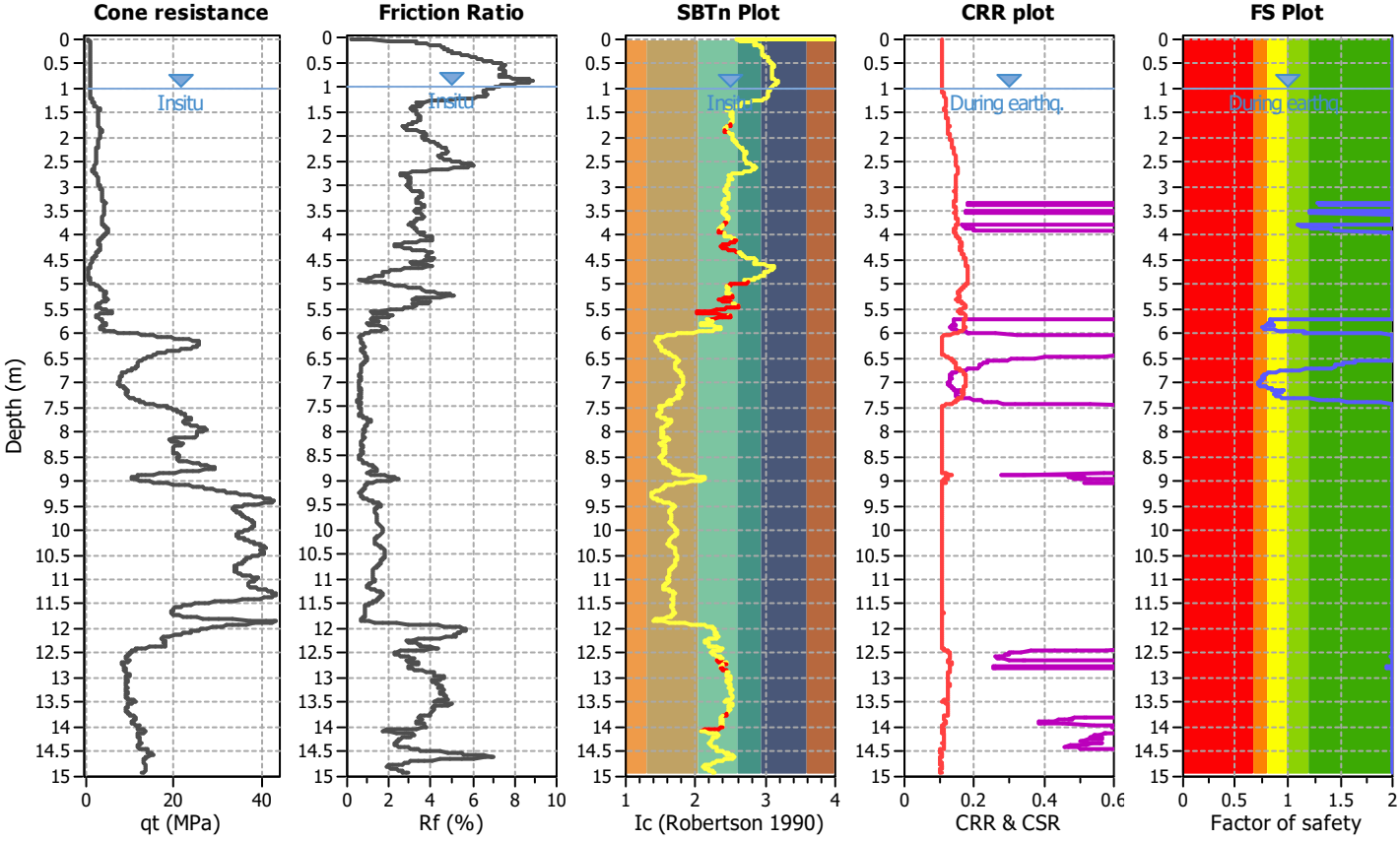
LIQUEFACTION ANALYSIS REPORT

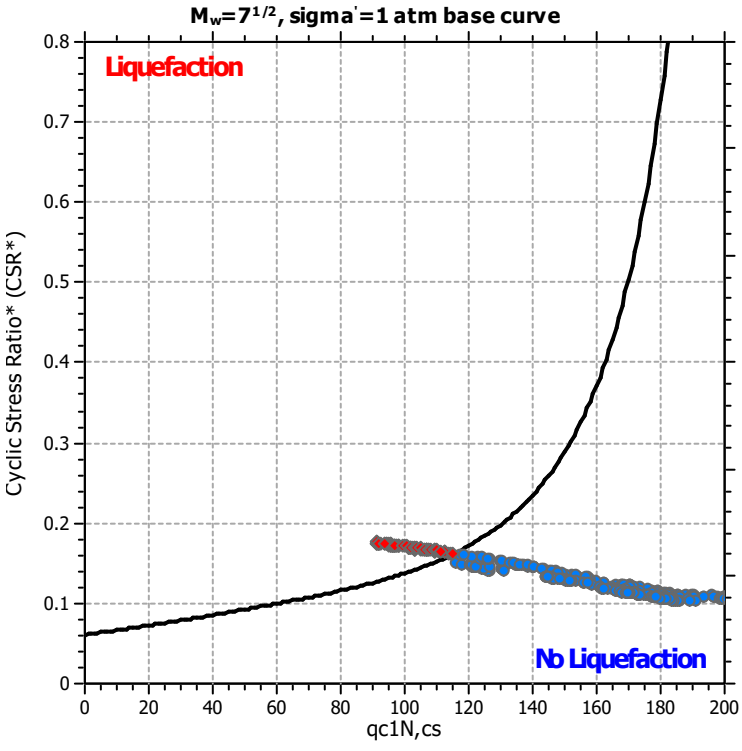
Project title : 210339 - Muriwai Downs **Location : 710 Muriwai Road**

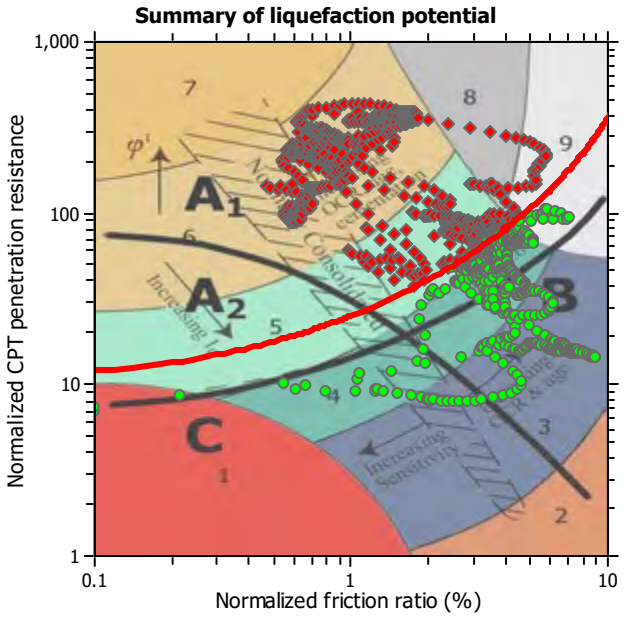
CPT file : CPT-11

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

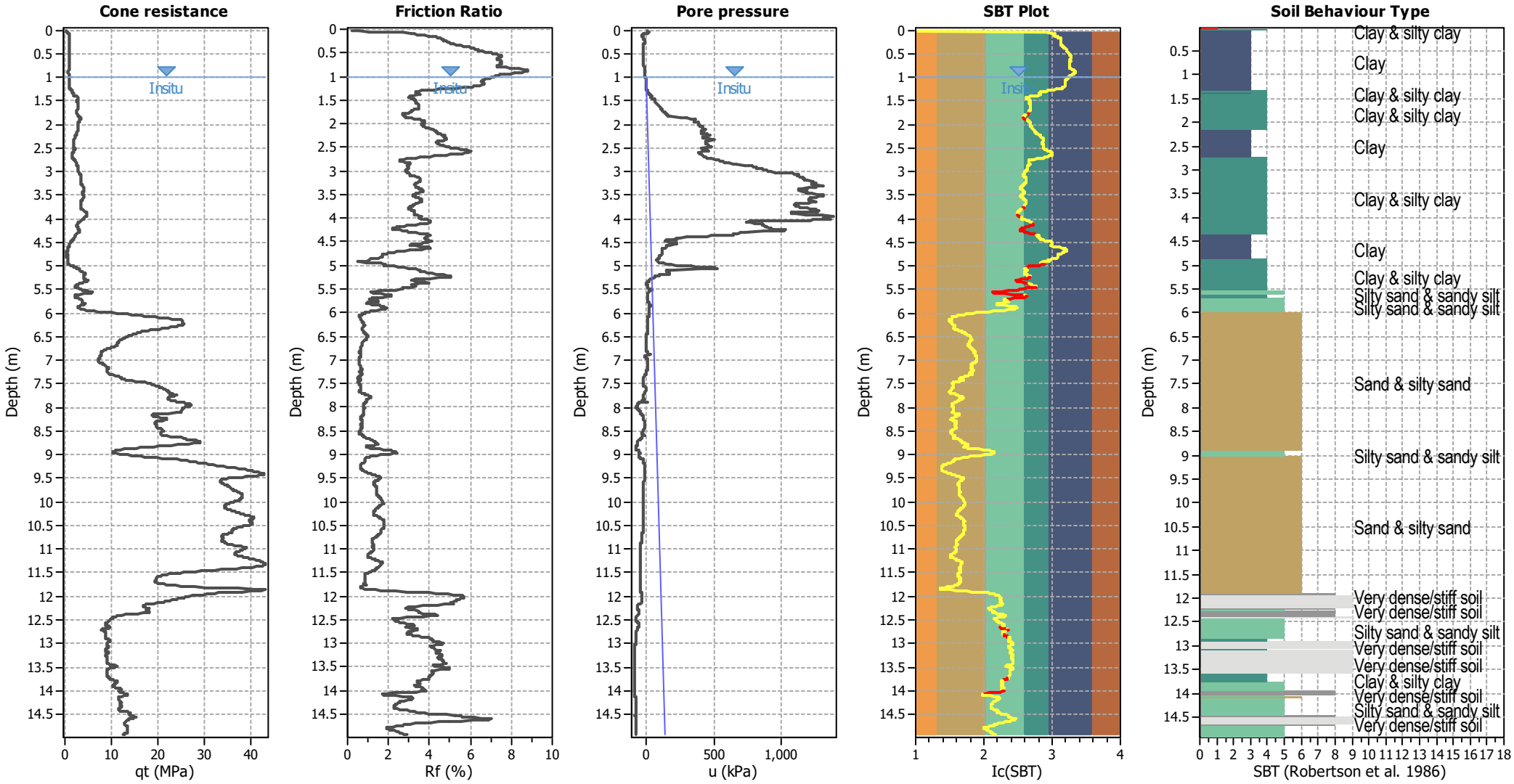






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



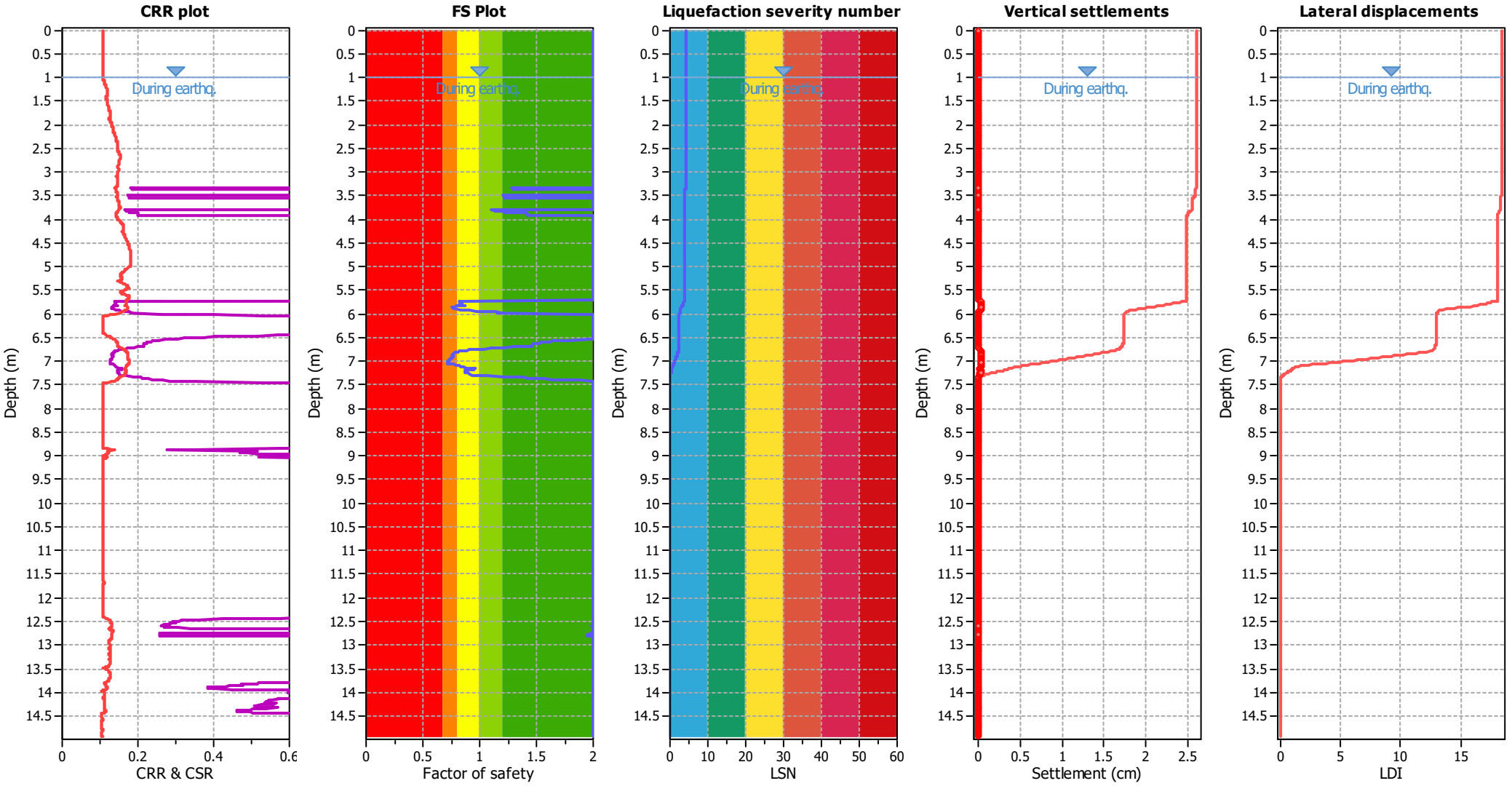
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.40	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.40	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

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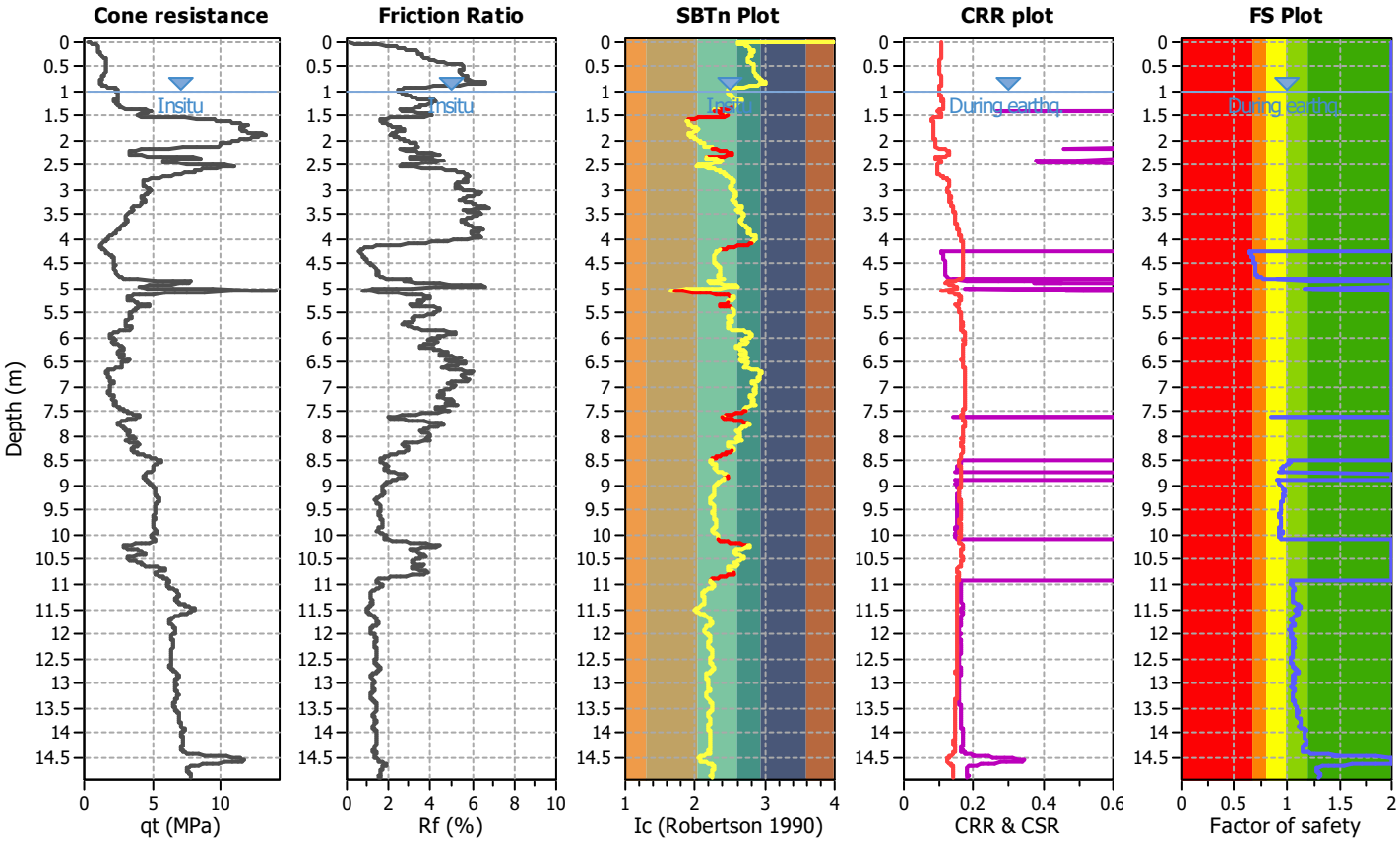
LIQUEFACTION ANALYSIS REPORT

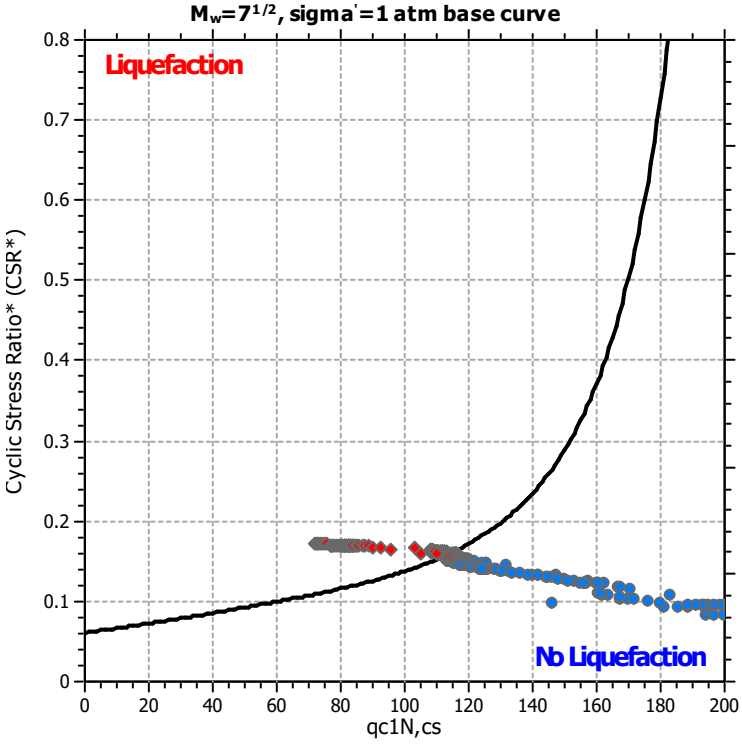
Project title : 210339 - Muriwai Downs **Location : 710 Muriwai Road**

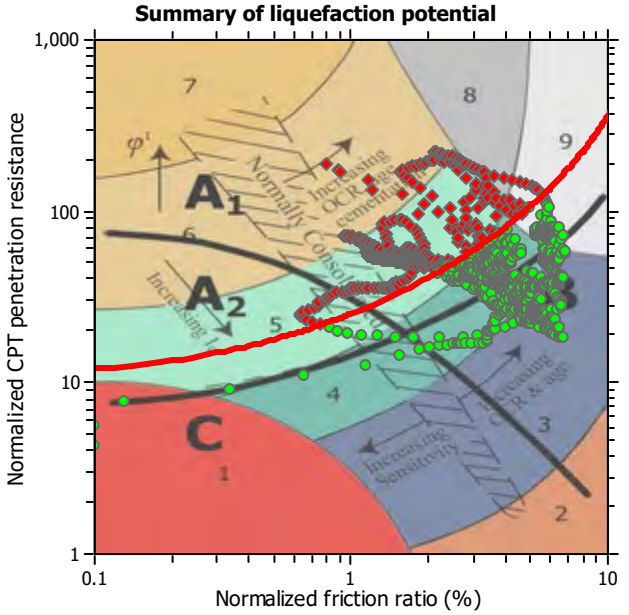
CPT file : CPT-12

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	5.90	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.20	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

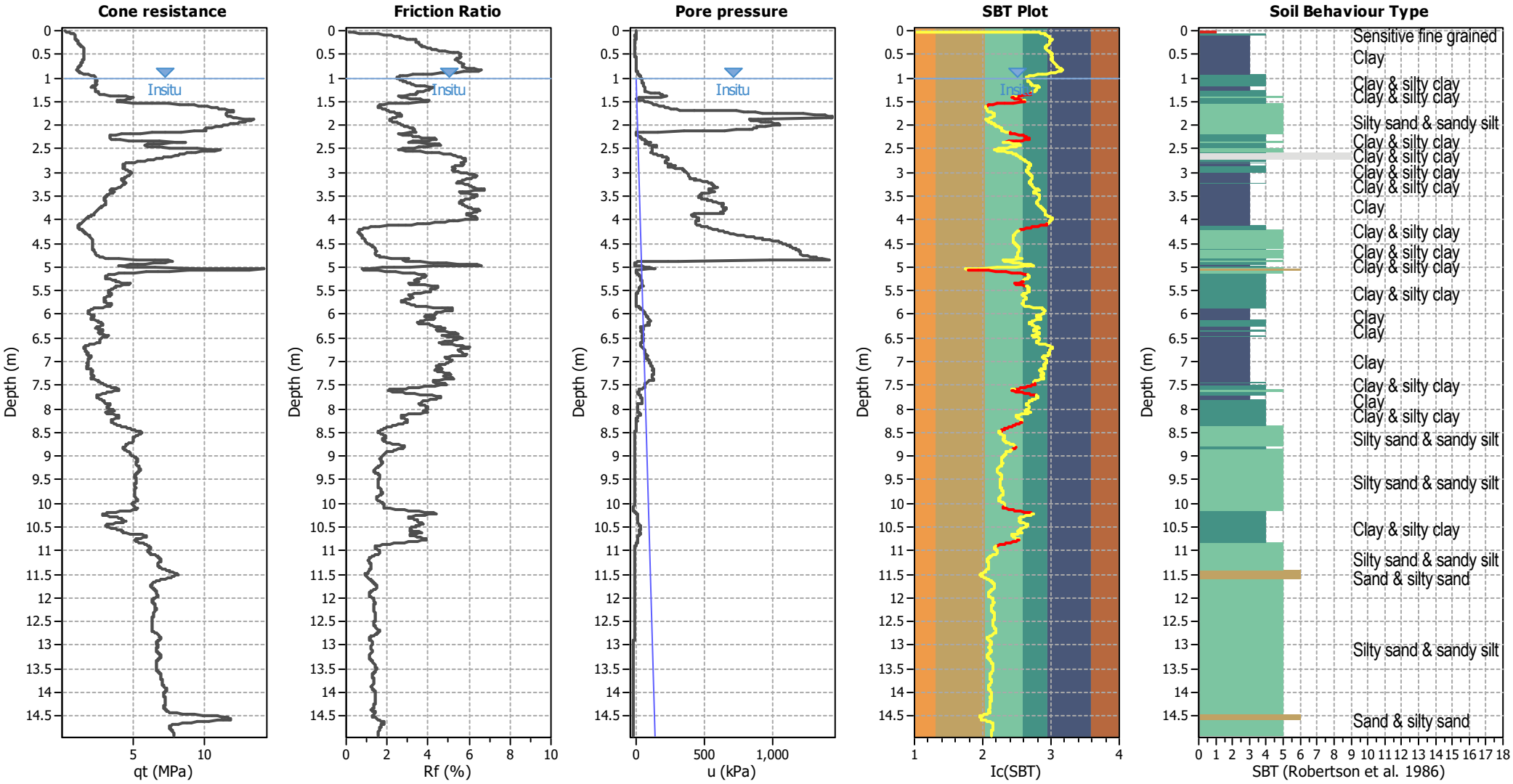






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



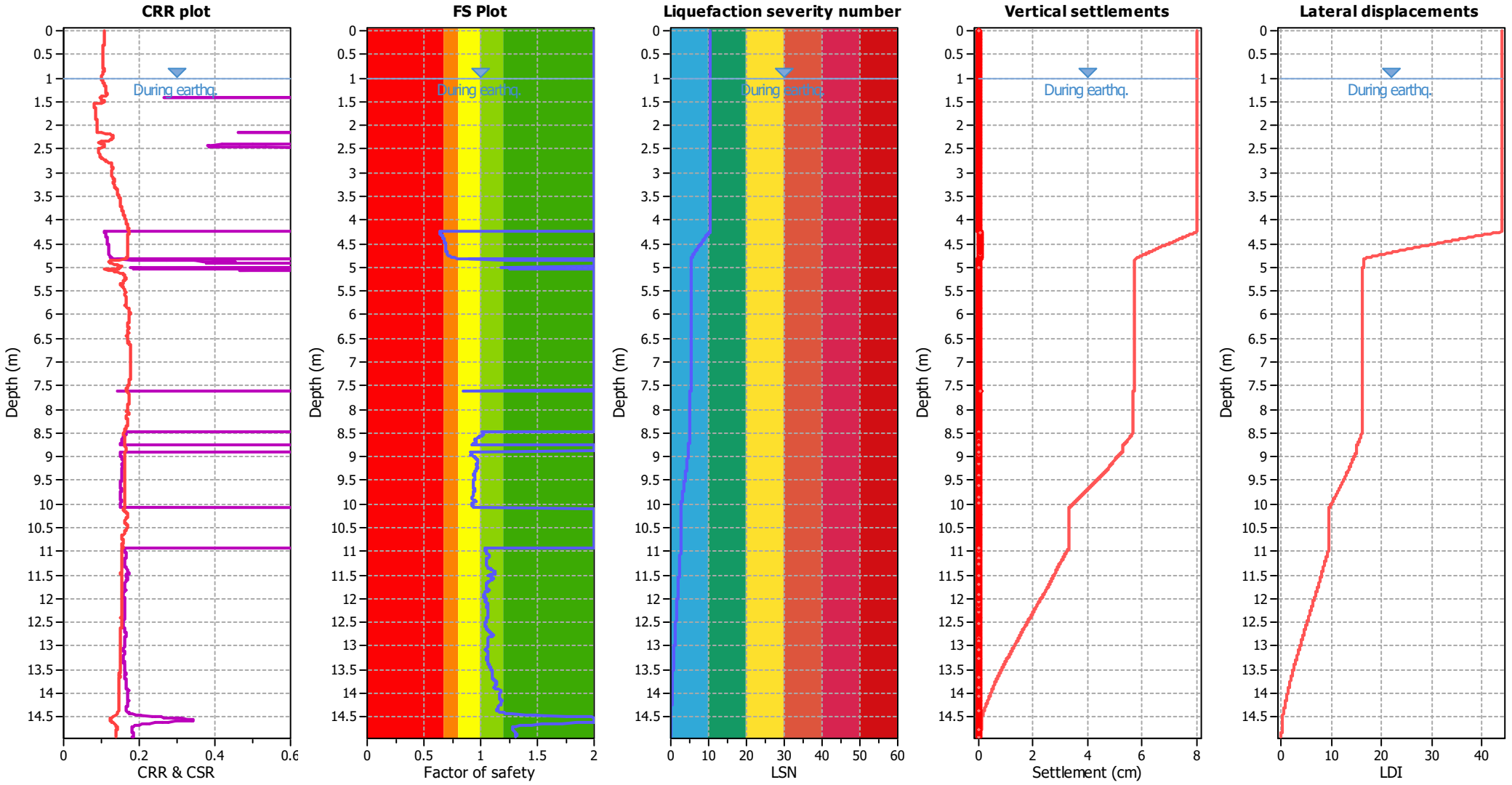
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.40	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.40	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.20	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

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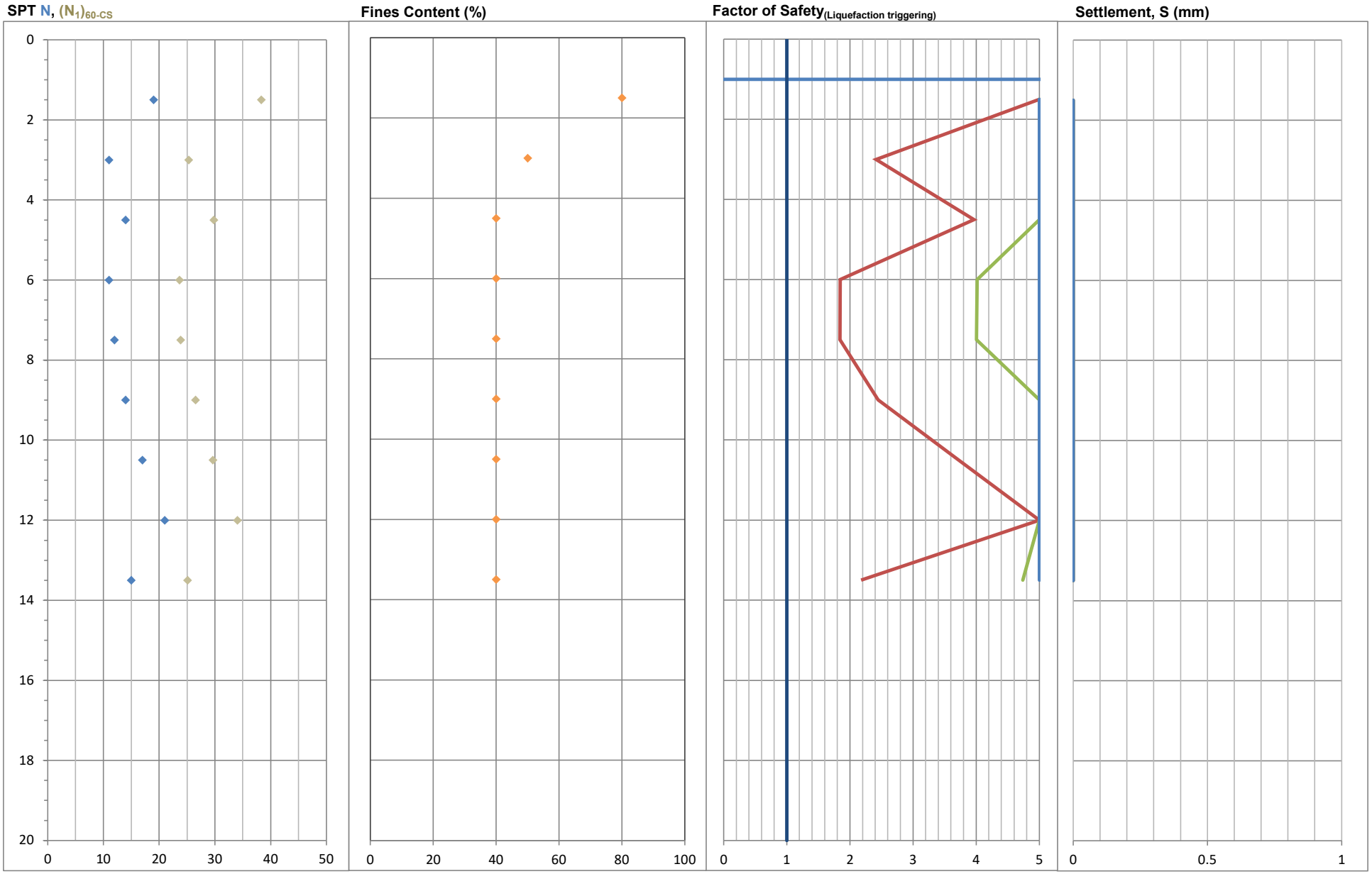
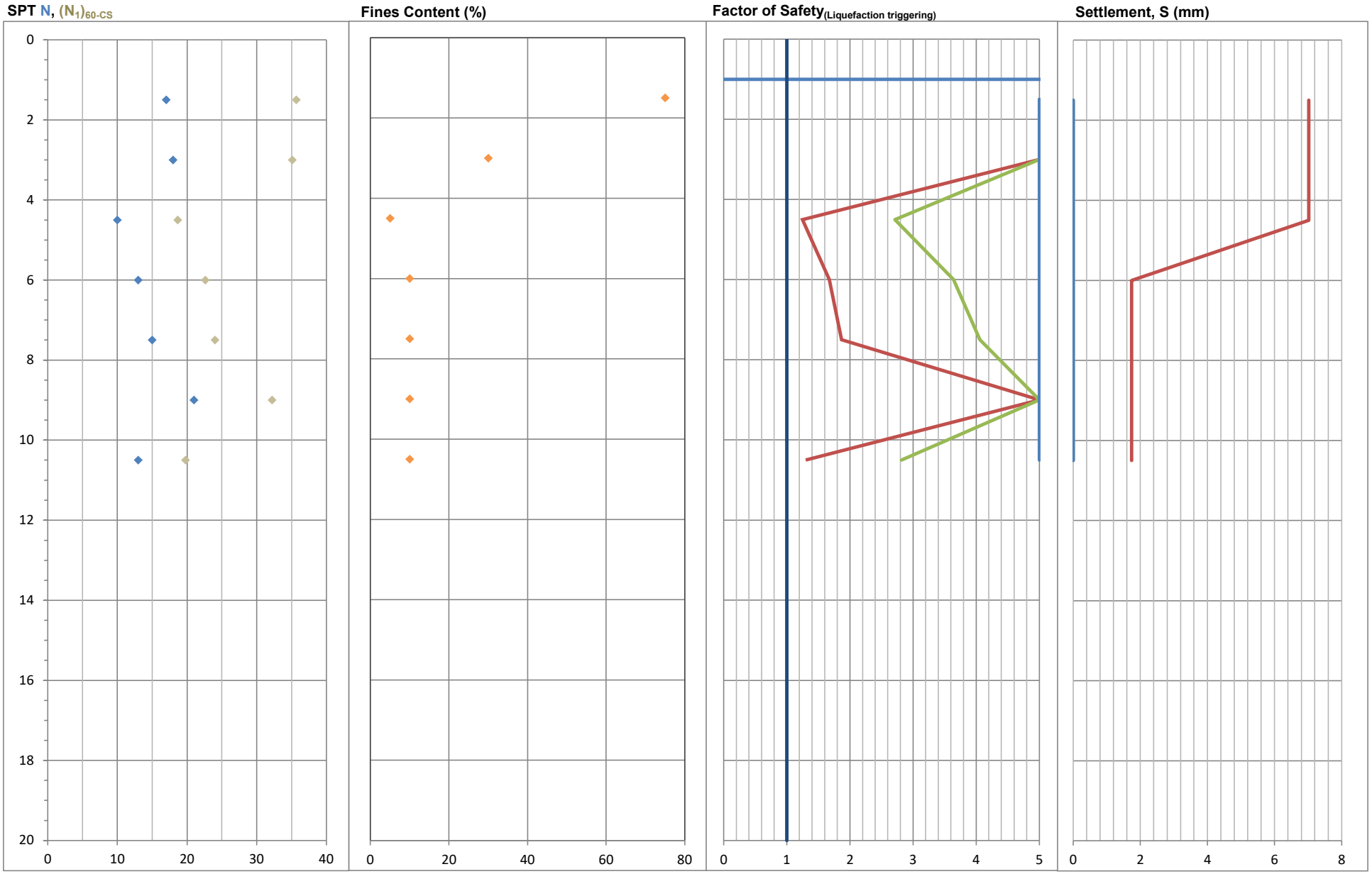
Test:	***MH01***	File:	210339	***SLS1***	Mw	5.9	PGA	0.09	g	S	0	mm	S_{Index}	0	mm	LSN	0
Project:	Muriwai Downs			***SLS2***	Mw	5.9	PGA	0.01	g	S	0	mm	S_{Index}	0	mm	LSN	0
Water table depth:	1	m		***ULS***	Mw	5.9	PGA	0.2	g	S	0	mm	S_{Index}	0	mm	LSN	0



RILEY CONSULTANTS

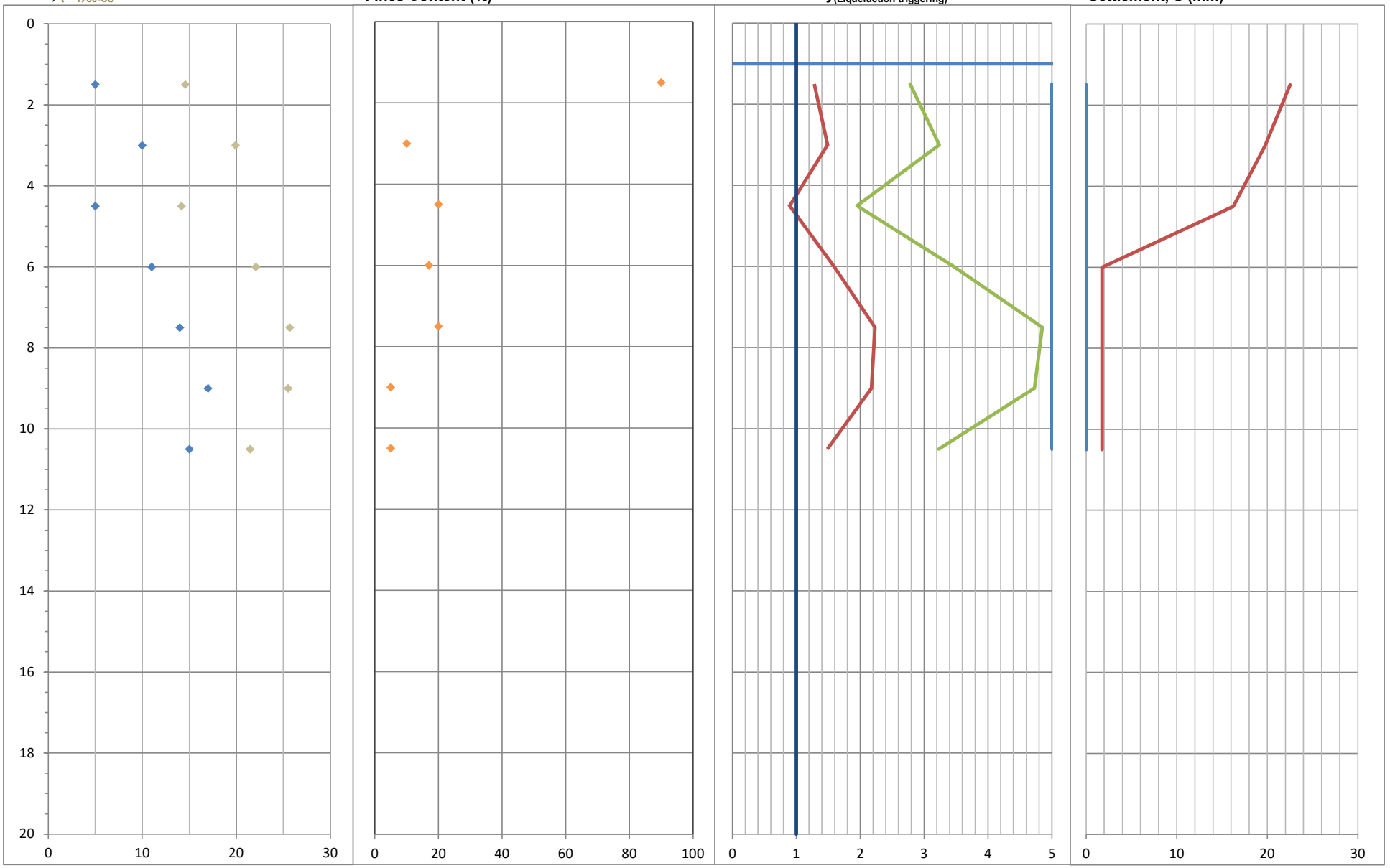
Test:	***MH02***	File:	210339	***SLS1***	Mw	5.9	PGA	0.09	g	S	0	mm	S_{Index}	0 mm	LSN	0
Project:	Muriwai Downs			***SLS2***	Mw	5.9	PGA	0.01	g	S	0	mm	S_{Index}	0 mm	LSN	0
Water table depth:	1	m		***ULS***	Mw	5.9	PGA	0.2	g	S	7	mm	S_{Index}	5 mm	LSN	1



RILEY CONSULTANTS

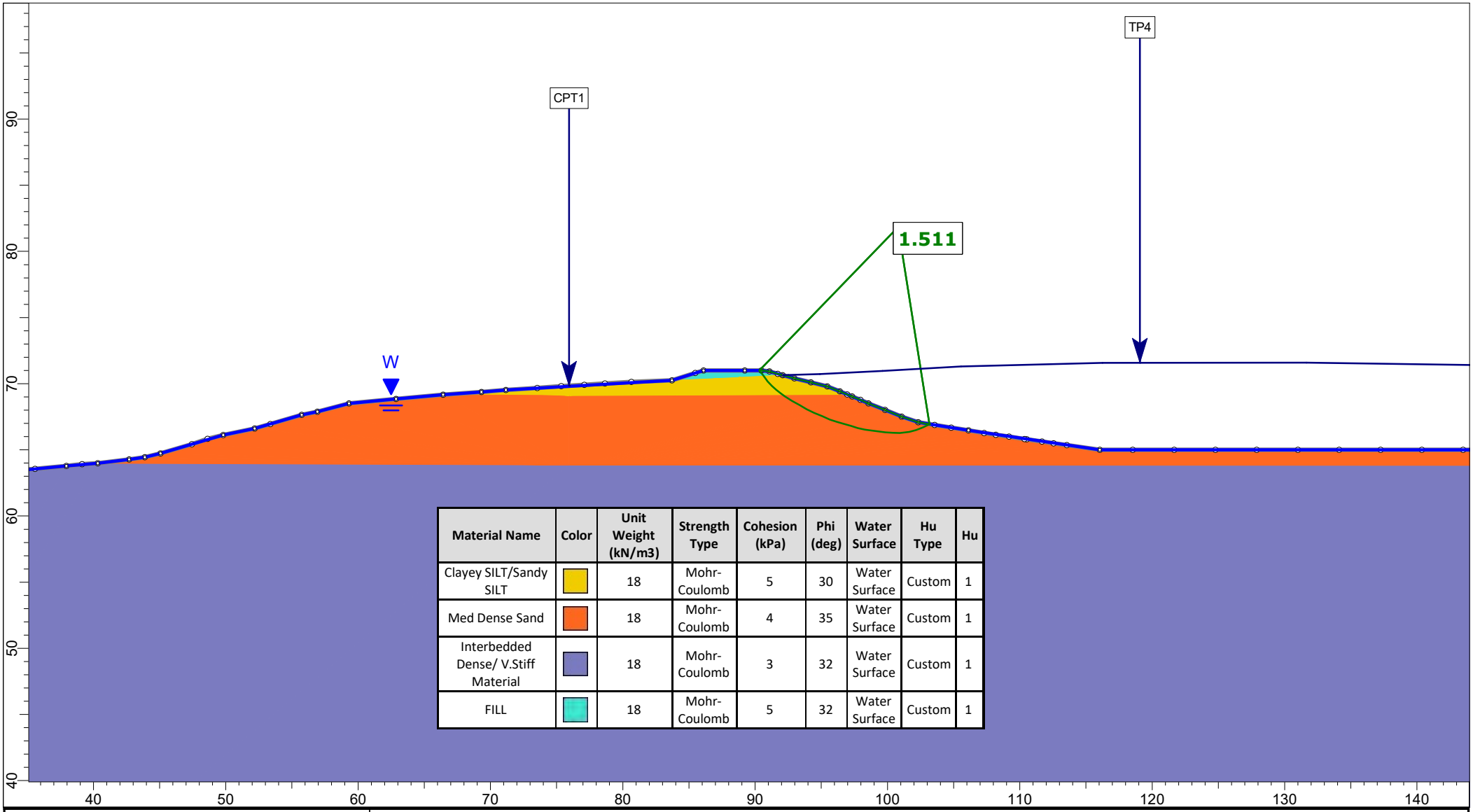
Test:	***MH03***	File:	210339	***SLS1***	Mw	5.9	PGA	0.09	g	S	0	mm	S_{Index} 0 mm	LSN	0
Project:	Muriwai Downs			***SLS2***	Mw	5.9	PGA	0.01	g	S	0	mm	S_{Index} 0 mm	LSN	0
Water table depth:	1	m		***ULS***	Mw	5.9	PGA	0.2	g	S	23	mm	S_{Index} 21 mm	LSN	6

SPT N, $(N_1)_{60\text{-}CS}$ | **Fines Content (%)** | **Factor of Safety$_{(Liquefaction\ triggering)}$** | **Settlement, S (mm)**



APPENDIX G

Slope Stability Outputs



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Clayey SILT/Sandy SILT		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Med Dense Sand		18	Mohr-Coulomb	4	35	Water Surface	Custom	1
Interbedded Dense/ V.Stiff Material		18	Mohr-Coulomb	3	32	Water Surface	Custom	1
FILL		18	Mohr-Coulomb	5	32	Water Surface	Custom	1

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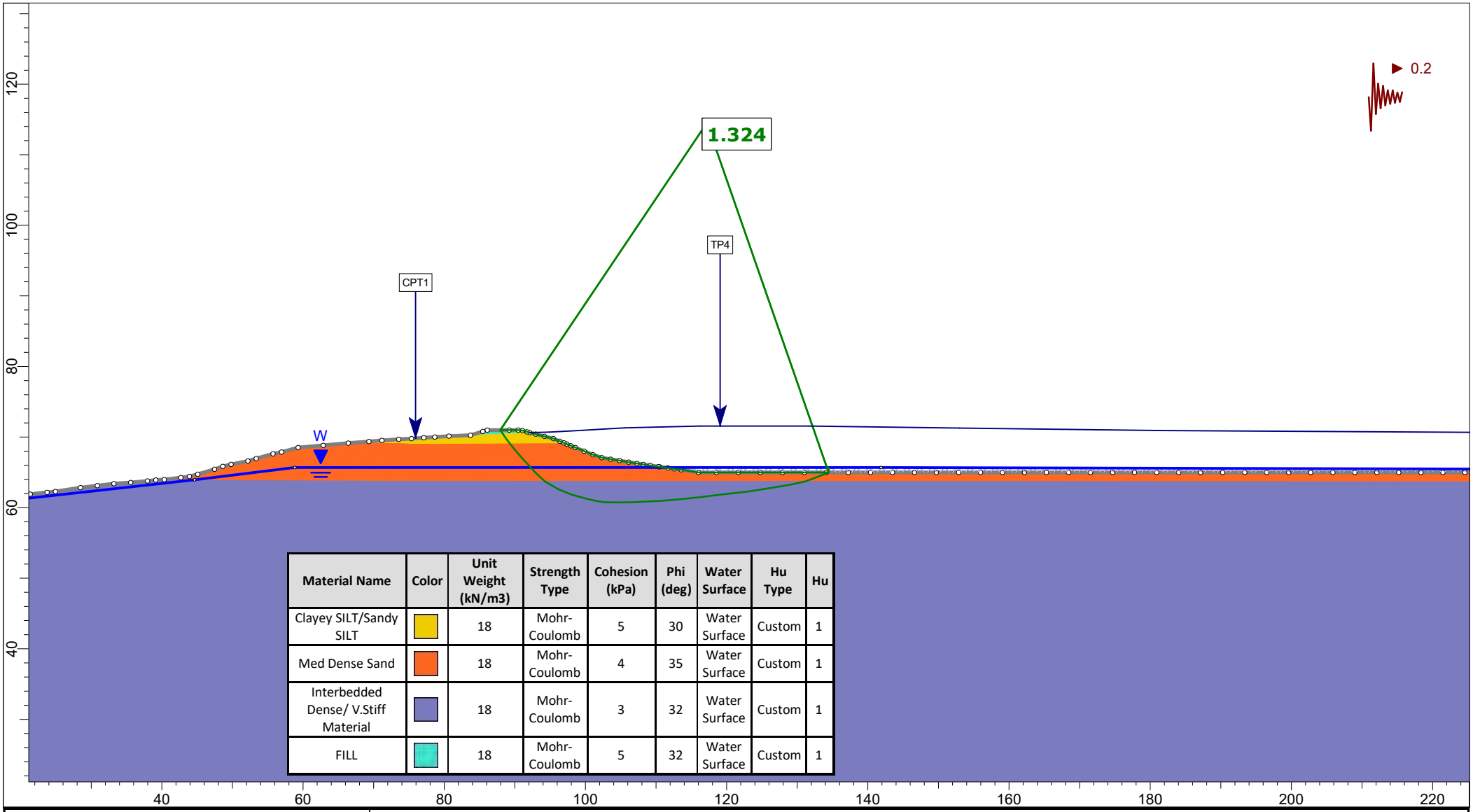
SLIDEINTERPRET 9.017

Project	Muriwai Downs		
Group	Section A	*Scenario*	Static, Full Saturation
Drawn By	LES	*Company*	The Bears Home Project Management
Date	4/09/2021	*File Name*	Section A.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Clayey SILT/Sandy SILT		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Med Dense Sand		18	Mohr-Coulomb	4	35	Water Surface	Custom	1
Interbedded Dense/ V.Stiff Material		18	Mohr-Coulomb	3	32	Water Surface	Custom	1
FILL		18	Mohr-Coulomb	5	32	Water Surface	Custom	1

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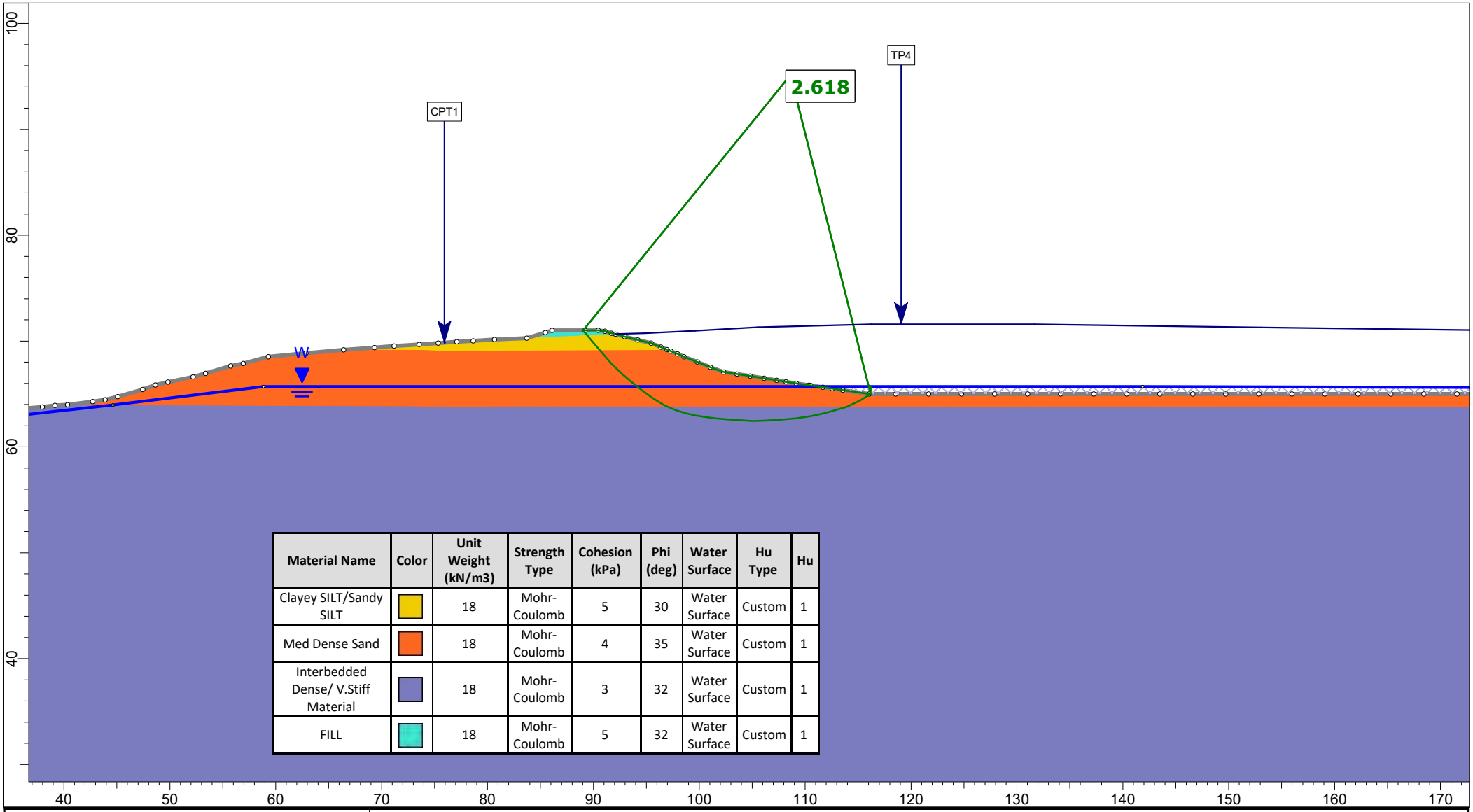
SLIDEINTERPRET 9.017

Project	Muriwai Downs		
Group	Group 1	*Scenario*	Seismic, Existing
Drawn By	LES	*Company*	The Bear Home Project Management
Date	4/09/2021	*File Name*	Section A.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Clayey SILT/Sandy SILT		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Med Dense Sand		18	Mohr-Coulomb	4	35	Water Surface	Custom	1
Interbedded Dense/ V.Stiff Material		18	Mohr-Coulomb	3	32	Water Surface	Custom	1
FILL		18	Mohr-Coulomb	5	32	Water Surface	Custom	1

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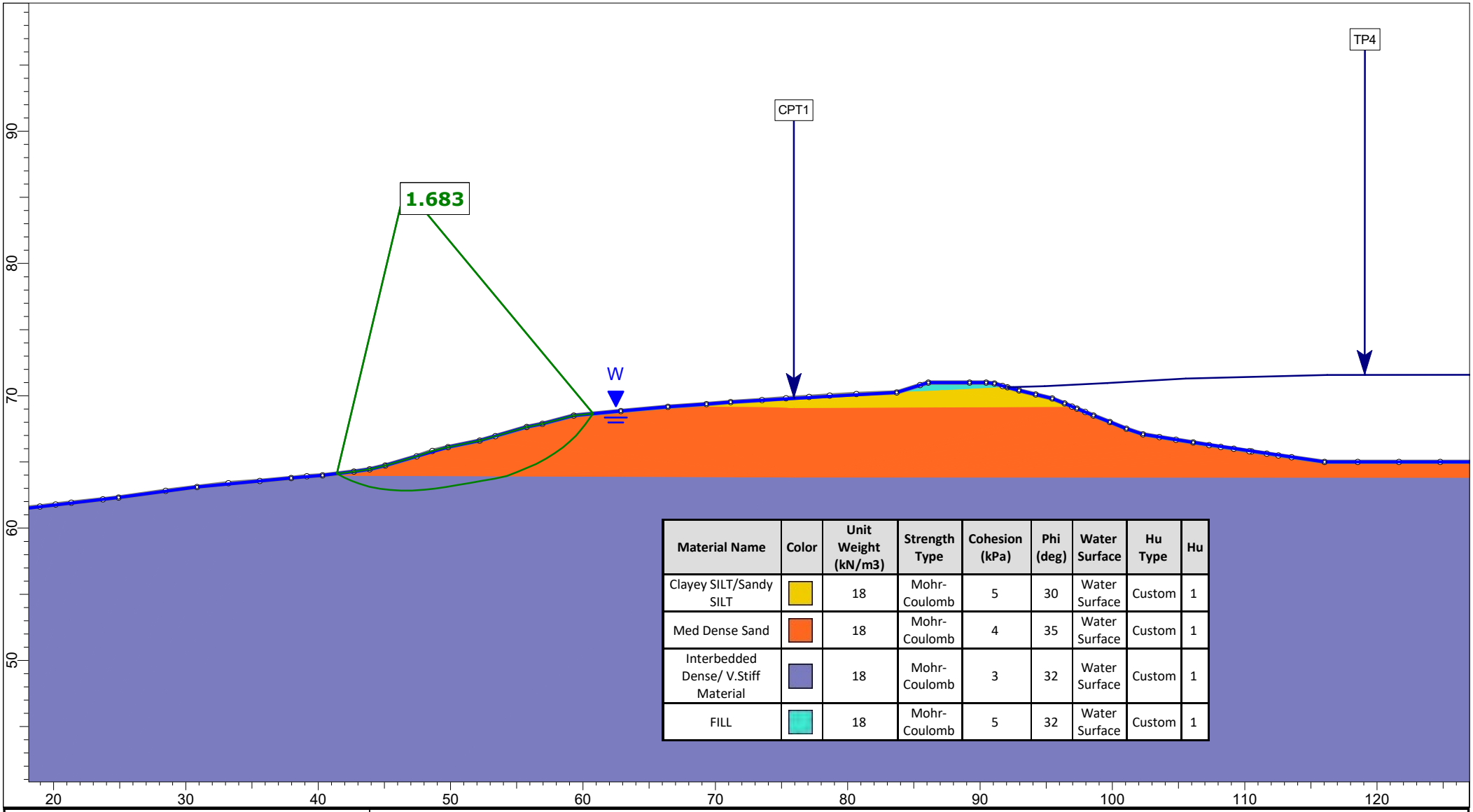
SLIDEINTERPRET 9.017

Project	Muriwai Downs		
Group	Group 1	*Scenario*	Static, Existing, Normal GW
Drawn By	LES	*Company*	The Bear Home Project Management
Date	4/09/2021	*File Name*	Section A.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Clayey SILT/Sandy SILT		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Med Dense Sand		18	Mohr-Coulomb	4	35	Water Surface	Custom	1
Interbedded Dense/ V.Stiff Material		18	Mohr-Coulomb	3	32	Water Surface	Custom	1
FILL		18	Mohr-Coulomb	5	32	Water Surface	Custom	1

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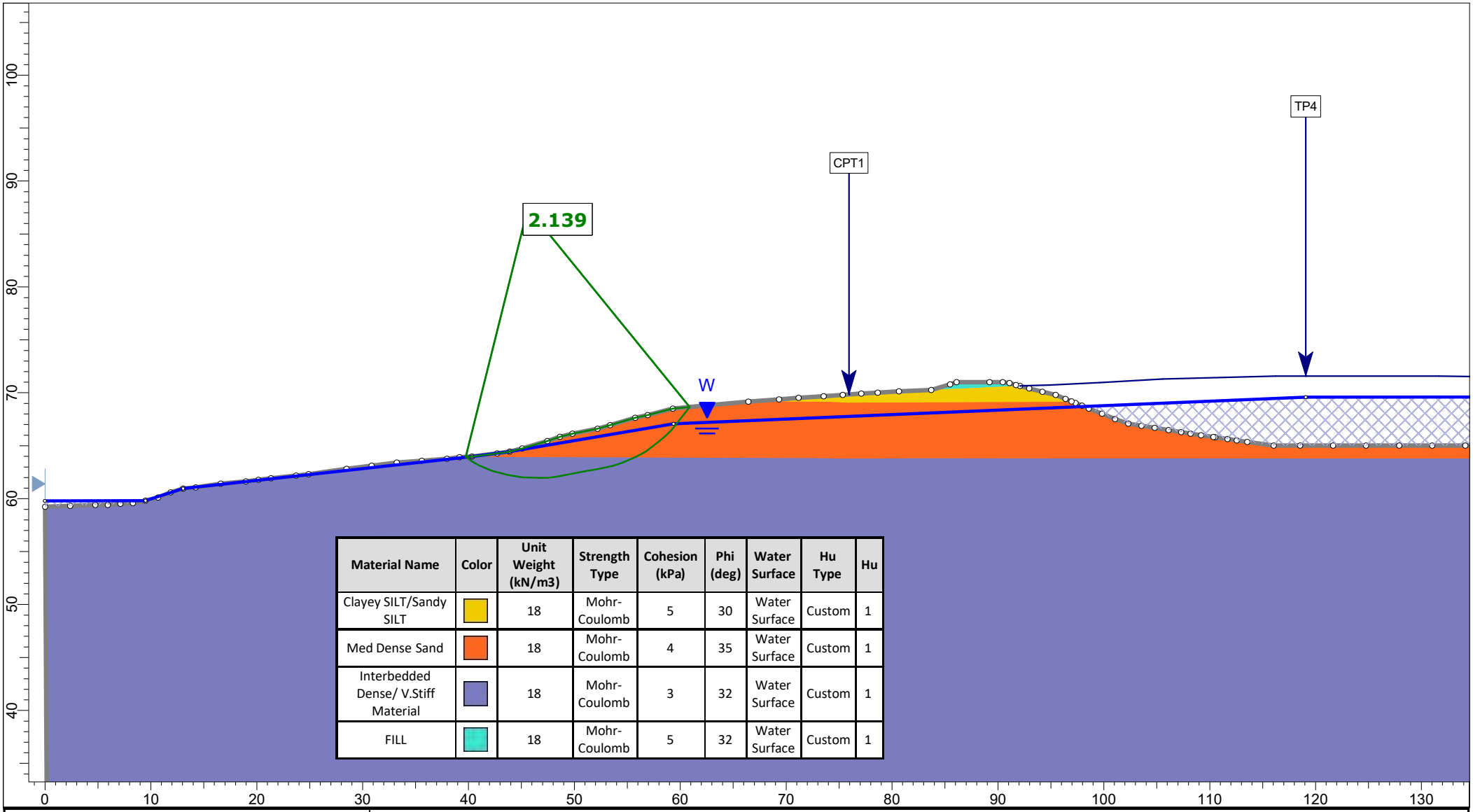
Project	Muriwai Downs		
Group	Section A	*Scenario*	Static, Full Saturation
Drawn By	LES	*Company*	The Bear Home Project Management
Date	4/09/2021	*File Name*	Section A.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Clayey SILT/Sandy SILT		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Med Dense Sand		18	Mohr-Coulomb	4	35	Water Surface	Custom	1
Interbedded Dense/ V.Stiff Material		18	Mohr-Coulomb	3	32	Water Surface	Custom	1
FILL		18	Mohr-Coulomb	5	32	Water Surface	Custom	1

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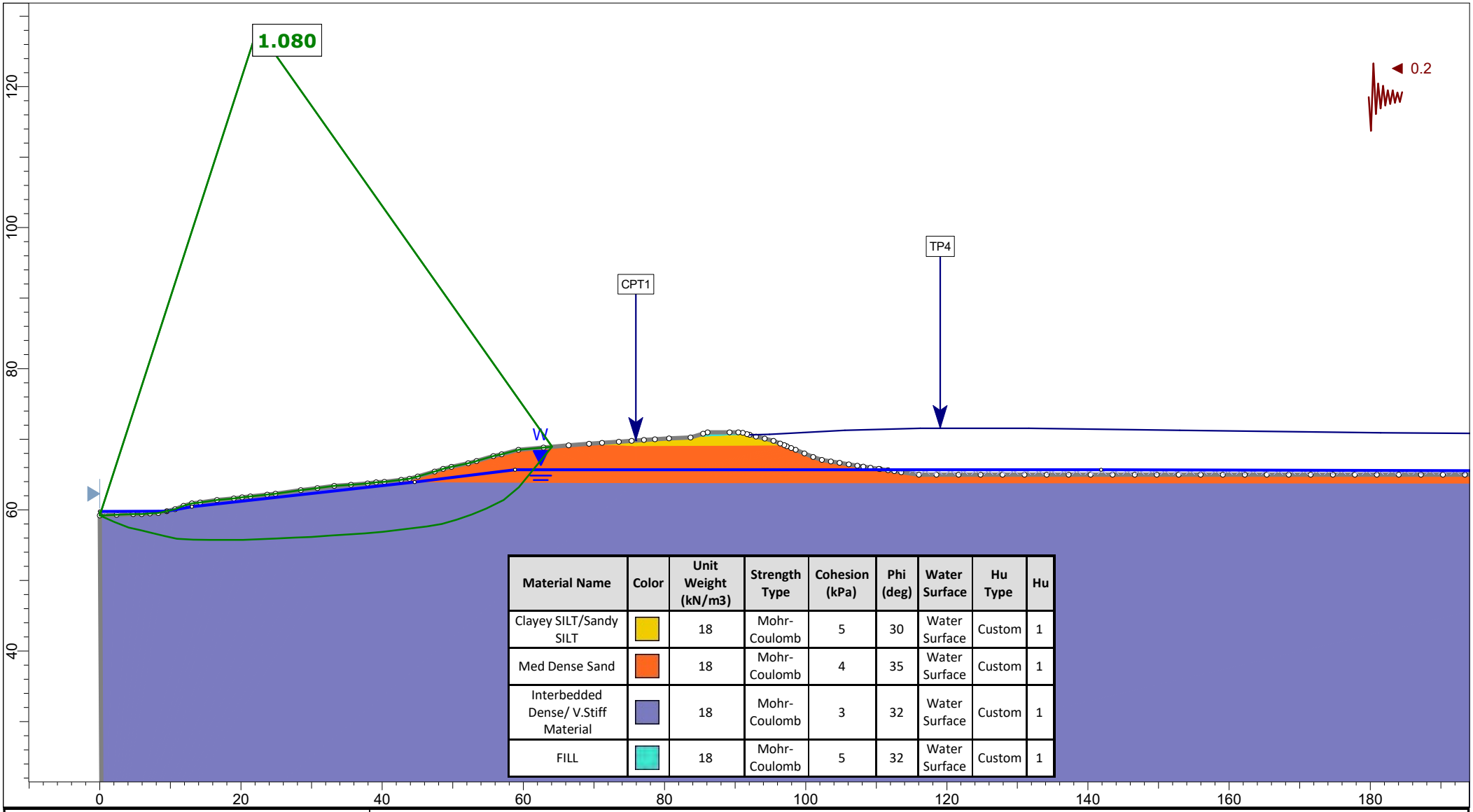
SLIDEINTERPRET 9.017

Project	Muriwai Downs		
Group	Group 1	*Scenario*	Static, Existing, High GW
Drawn By	LES	*Company*	The Bear Home Project Management
Date	4/09/2021	*File Name*	Section A.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Clayey SILT/Sandy SILT		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Med Dense Sand		18	Mohr-Coulomb	4	35	Water Surface	Custom	1
Interbedded Dense/ V.Stiff Material		18	Mohr-Coulomb	3	32	Water Surface	Custom	1
FILL		18	Mohr-Coulomb	5	32	Water Surface	Custom	1

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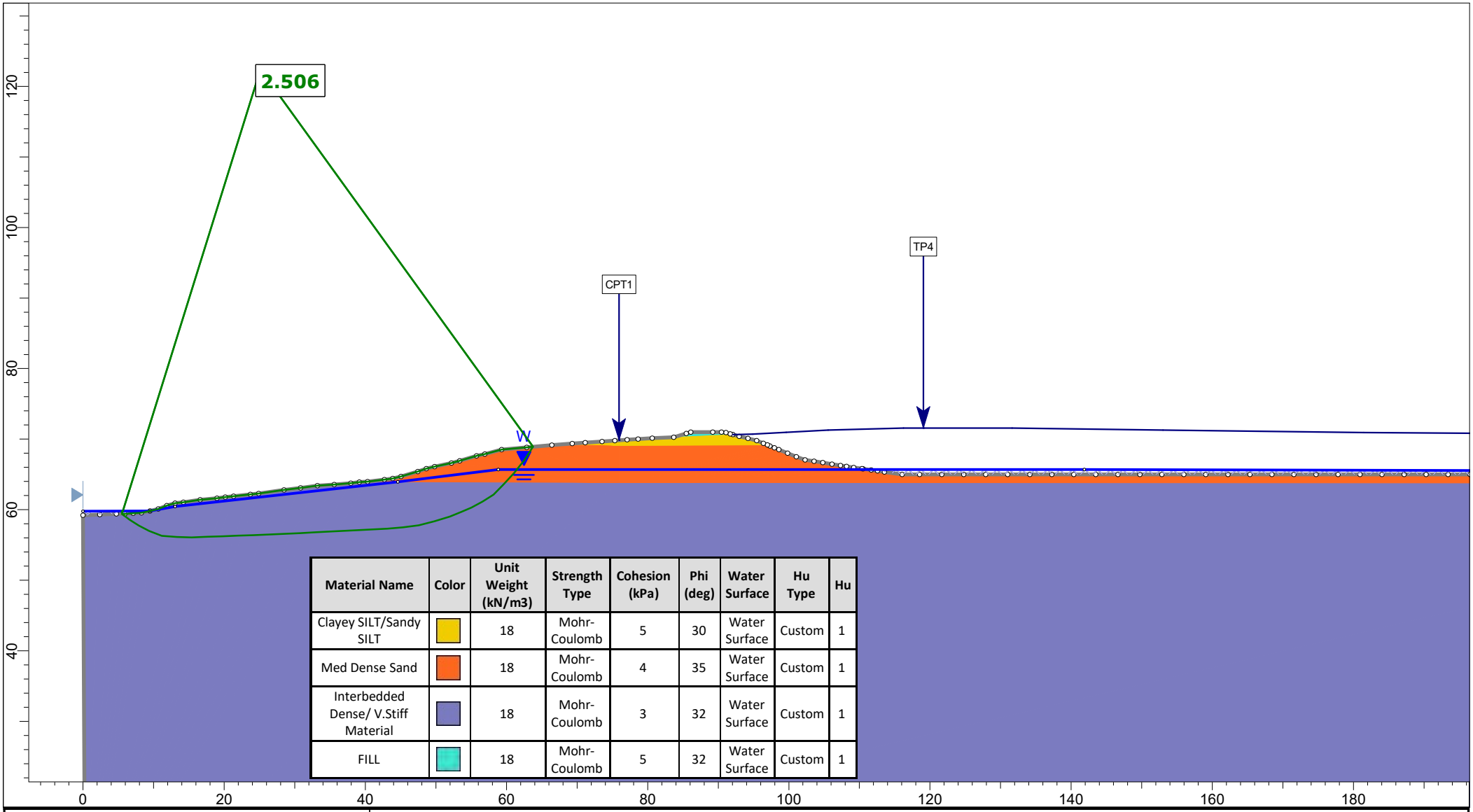
SLIDEINTERPRET 9.017

Project	Muriwai Downs		
Group	Group 1	*Scenario*	Seismic, Existing
Drawn By	LES	*Company*	The Bear Home Project Management
Date	4/09/2021	*File Name*	Section A.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Clayey SILT/Sandy SILT		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Med Dense Sand		18	Mohr-Coulomb	4	35	Water Surface	Custom	1
Interbedded Dense/ V.Stiff Material		18	Mohr-Coulomb	3	32	Water Surface	Custom	1
FILL		18	Mohr-Coulomb	5	32	Water Surface	Custom	1

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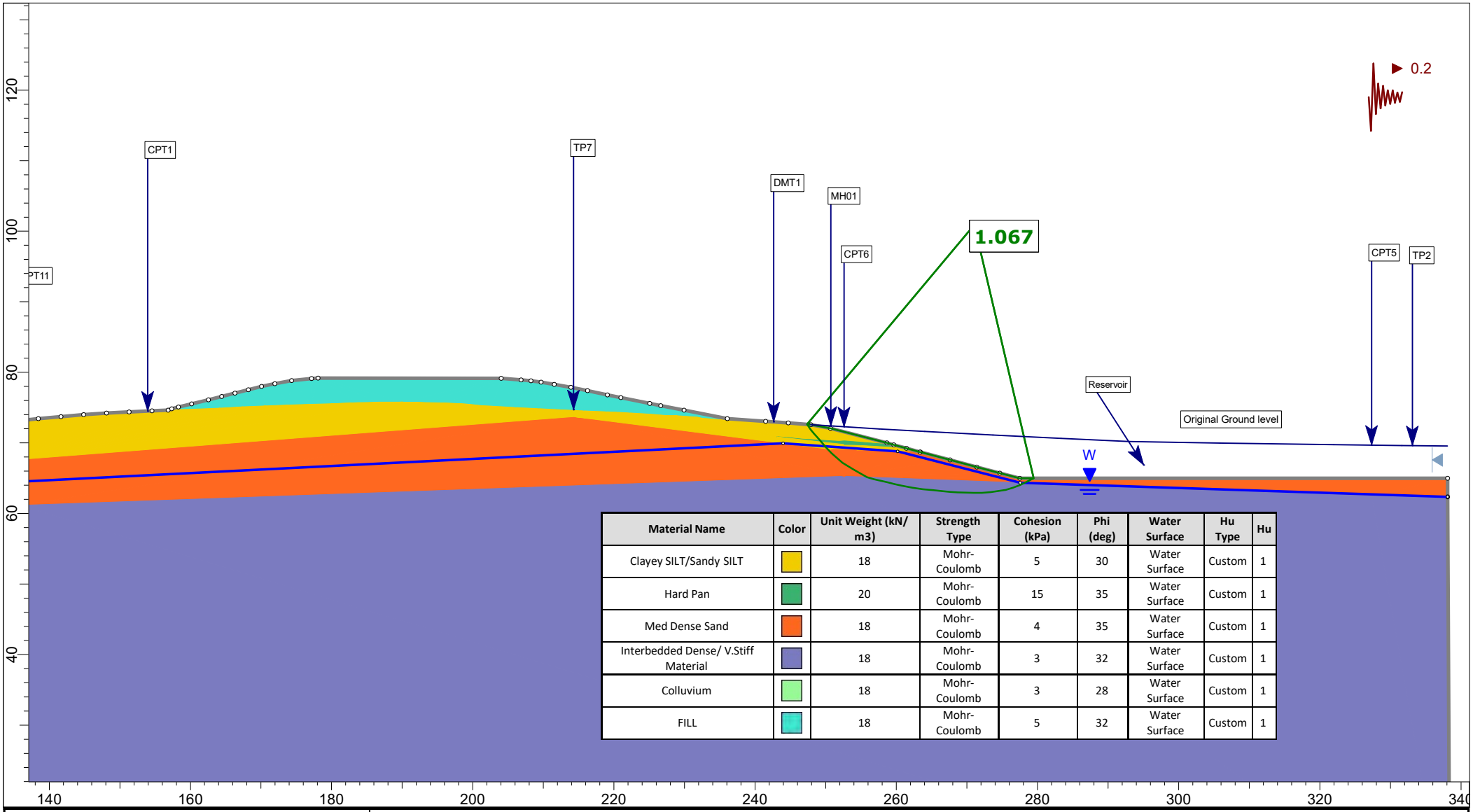
SLIDEINTERPRET 9.017

Project	Muriwai Downs		
Group	Group 1	*Scenario*	Static, Existing, Normal GW
Drawn By	LES	*Company*	The Bear Home Project Management
Date	4/09/2021	*File Name*	Section A.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Clayey SILT/Sandy SILT		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Hard Pan		20	Mohr-Coulomb	15	35	Water Surface	Custom	1
Med Dense Sand		18	Mohr-Coulomb	4	35	Water Surface	Custom	1
Interbedded Dense/ V.Stiff Material		18	Mohr-Coulomb	3	32	Water Surface	Custom	1
Colluvium		18	Mohr-Coulomb	3	28	Water Surface	Custom	1
FILL		18	Mohr-Coulomb	5	32	Water Surface	Custom	1

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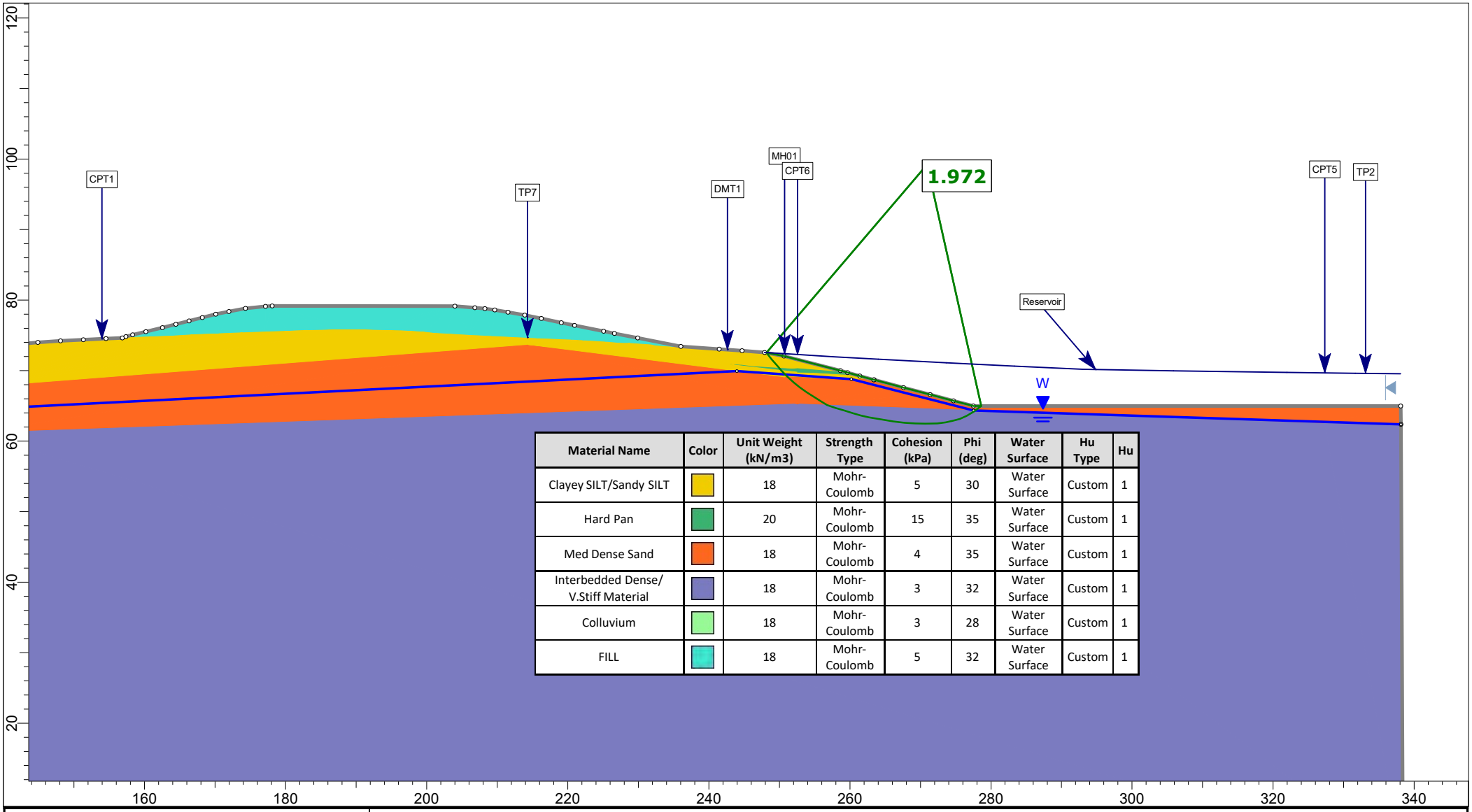
SLIDEINTERPRET 9.017

Project	Muriwai Downs		
Group	Section B	*Scenario*	Seismic, Design GW
Drawn By	LES	*Company*	The Bears Home Project Management
Date	1/09/2021	*File Name*	Section B V3.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Clayey SILT/Sandy SILT		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Hard Pan		20	Mohr-Coulomb	15	35	Water Surface	Custom	1
Med Dense Sand		18	Mohr-Coulomb	4	35	Water Surface	Custom	1
Interbedded Dense/ V.Stiff Material		18	Mohr-Coulomb	3	32	Water Surface	Custom	1
Colluvium		18	Mohr-Coulomb	3	28	Water Surface	Custom	1
FILL		18	Mohr-Coulomb	5	32	Water Surface	Custom	1

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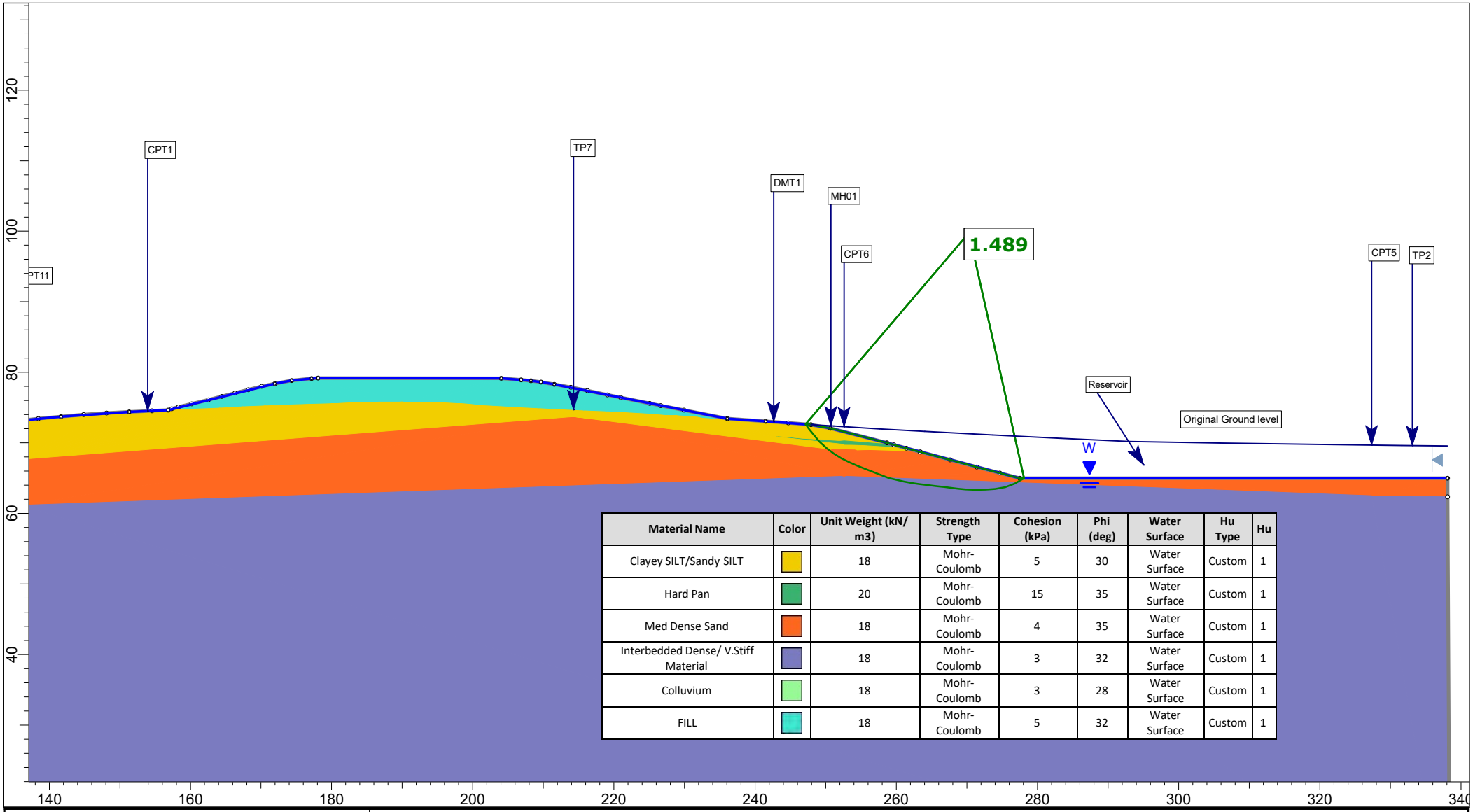
SLIDEINTERPRET 9.017

Project	Muriwai Downs		
Group	Section B	*Scenario*	Static, Design GW
Drawn By	LES	*Company*	The Bears Home Project Management
Date	1/09/2021	*File Name*	Section B V3.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Clayey SILT/Sandy SILT		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Hard Pan		20	Mohr-Coulomb	15	35	Water Surface	Custom	1
Med Dense Sand		18	Mohr-Coulomb	4	35	Water Surface	Custom	1
Interbedded Dense/ V.Stiff Material		18	Mohr-Coulomb	3	32	Water Surface	Custom	1
Colluvium		18	Mohr-Coulomb	3	28	Water Surface	Custom	1
FILL		18	Mohr-Coulomb	5	32	Water Surface	Custom	1

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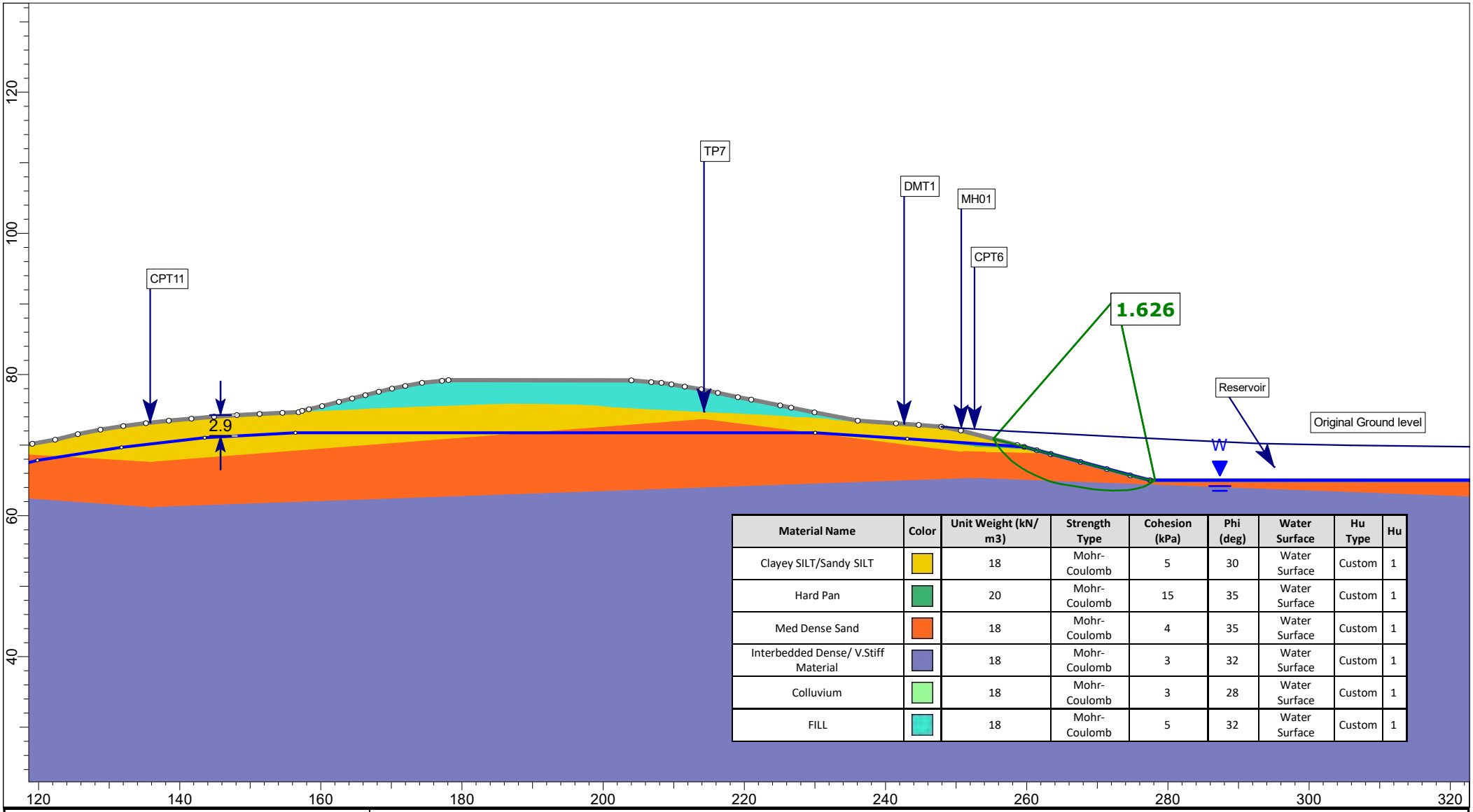
Project	Muriwai Downs		
Group	Section B	*Scenario*	Static, Full Sat
Drawn By	LES	*Company*	The Bears Home Project Management
Date	1/09/2021	*File Name*	Section B V3.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Clayey SILT/Sandy SILT		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Hard Pan		20	Mohr-Coulomb	15	35	Water Surface	Custom	1
Med Dense Sand		18	Mohr-Coulomb	4	35	Water Surface	Custom	1
Interbedded Dense/ V.Stiff Material		18	Mohr-Coulomb	3	32	Water Surface	Custom	1
Colluvium		18	Mohr-Coulomb	3	28	Water Surface	Custom	1
FILL		18	Mohr-Coulomb	5	32	Water Surface	Custom	1

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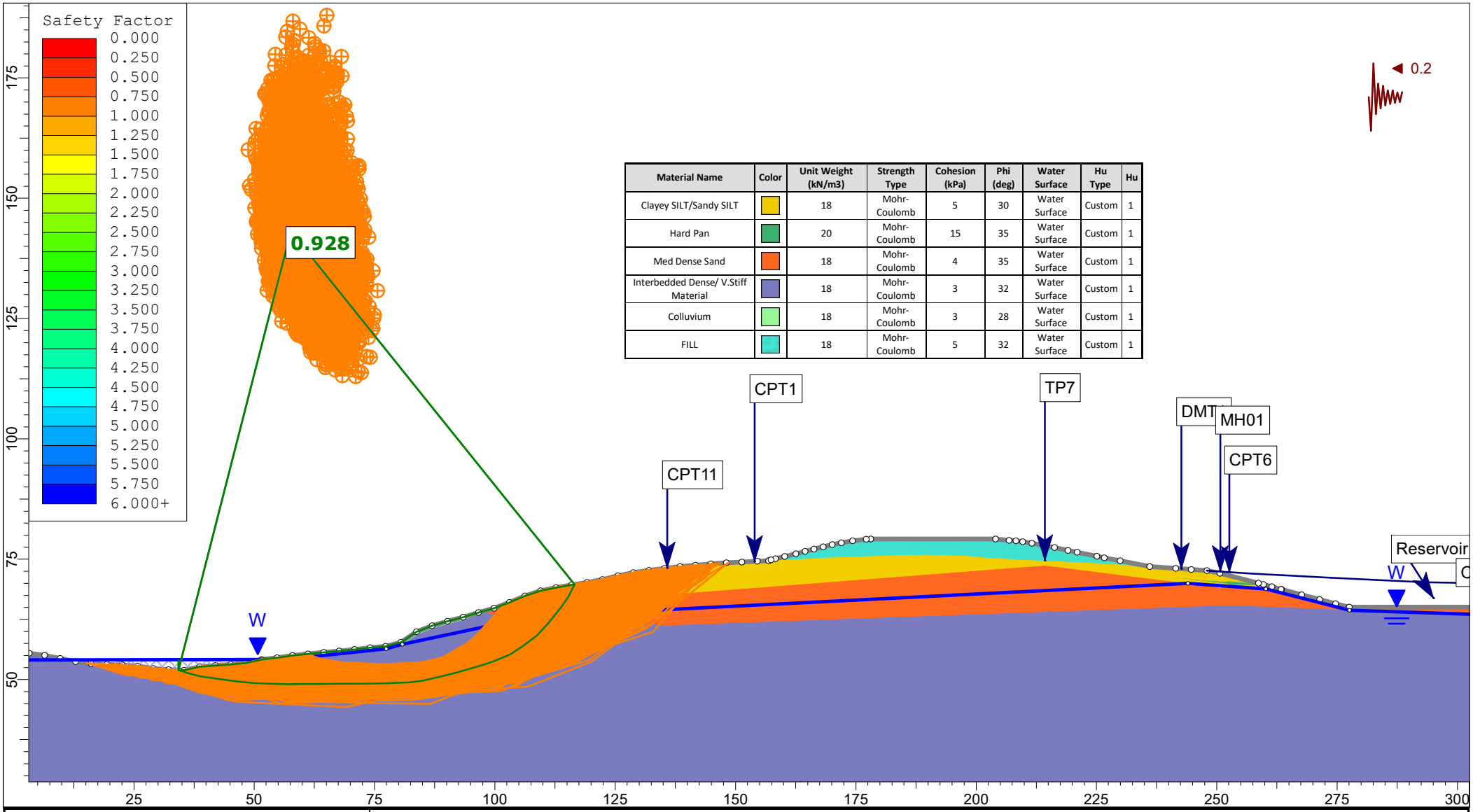
Project	Muriwai Downs		
Group	Section B	*Scenario*	Static, High GW
Drawn By	LES	*Company*	The Bears Home Project Management
Date	1/09/2021	*File Name*	Section B V3.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Clayey SILT/Sandy SILT		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Hard Pan		20	Mohr-Coulomb	15	35	Water Surface	Custom	1
Med Dense Sand		18	Mohr-Coulomb	4	35	Water Surface	Custom	1
Interbedded Dense/ V.Stiff Material		18	Mohr-Coulomb	3	32	Water Surface	Custom	1
Colluvium		18	Mohr-Coulomb	3	28	Water Surface	Custom	1
FILL		18	Mohr-Coulomb	5	32	Water Surface	Custom	1

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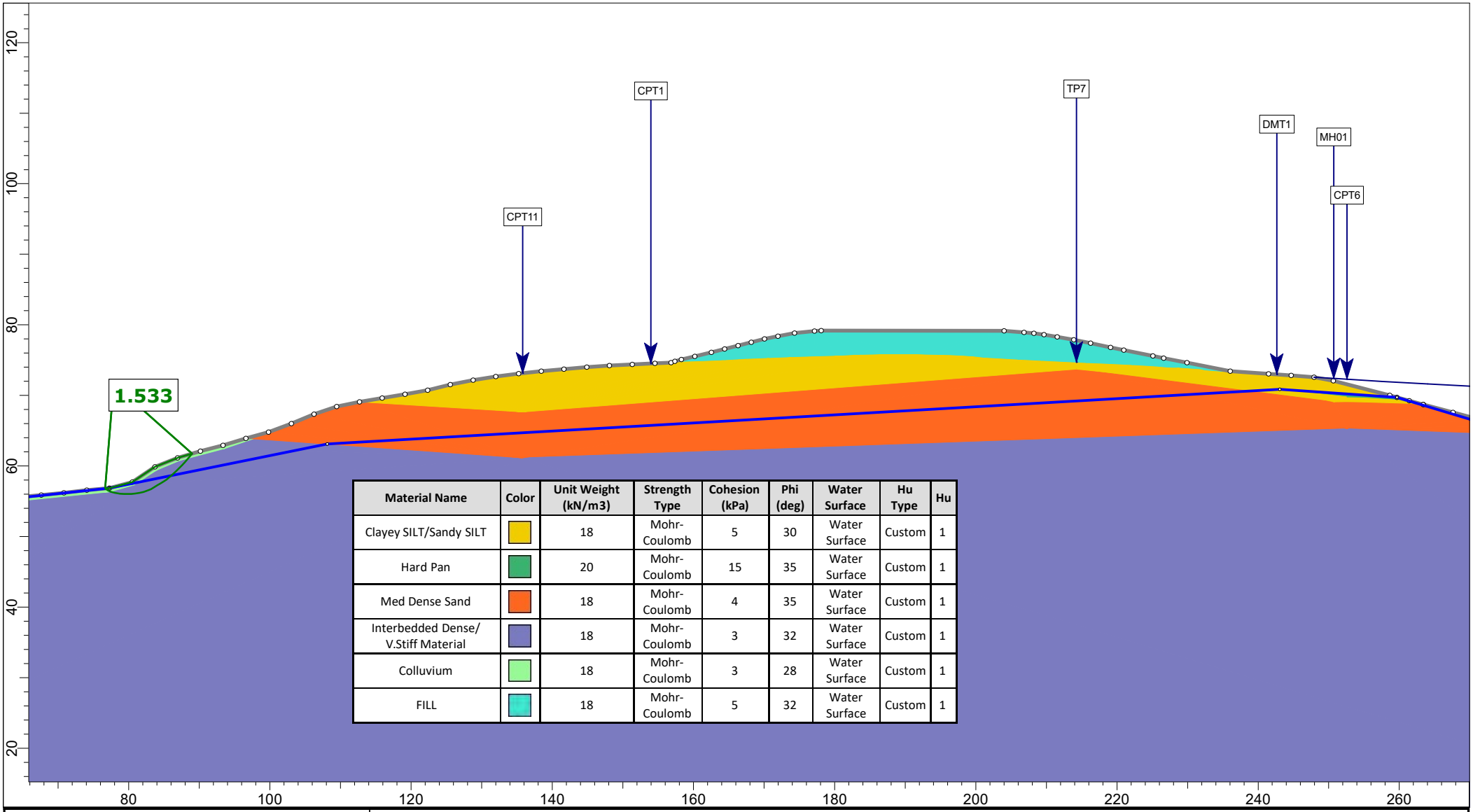
SLIDEINTERPRET 9.017

Project	Muriwai Downs		
Group	Section B	*Scenario*	Seismic, Design GW
Drawn By	LES	*Company*	The Bears Home Project Management
Date	1/09/2021	*File Name*	Section B V3.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Clayey SILT/Sandy SILT		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Hard Pan		20	Mohr-Coulomb	15	35	Water Surface	Custom	1
Med Dense Sand		18	Mohr-Coulomb	4	35	Water Surface	Custom	1
Interbedded Dense/ V.Stiff Material		18	Mohr-Coulomb	3	32	Water Surface	Custom	1
Colluvium		18	Mohr-Coulomb	3	28	Water Surface	Custom	1
FILL		18	Mohr-Coulomb	5	32	Water Surface	Custom	1

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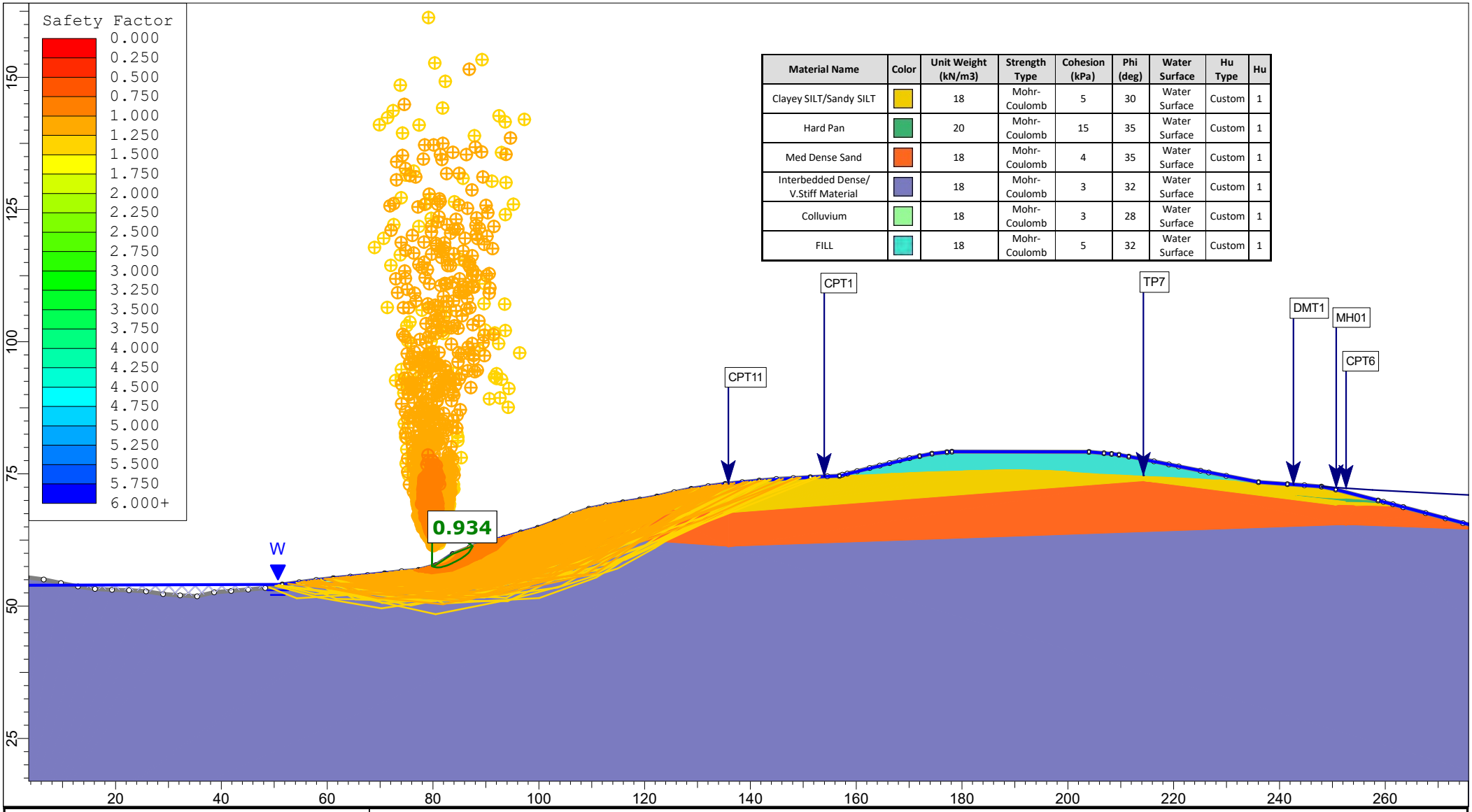
SLIDEINTERPRET 9.017

Project	Muriwai Downs		
Group	Section B	*Scenario*	Static, Filled, Design GW, SE Slope
Drawn By	LES	*Company*	The Bears Home Project Management
Date	1/09/2021	*File Name*	Section B V3.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Clayey SILT/Sandy SILT		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Hard Pan		20	Mohr-Coulomb	15	35	Water Surface	Custom	1
Med Dense Sand		18	Mohr-Coulomb	4	35	Water Surface	Custom	1
Interbedded Dense/ V.Stiff Material		18	Mohr-Coulomb	3	32	Water Surface	Custom	1
Colluvium		18	Mohr-Coulomb	3	28	Water Surface	Custom	1
FILL		18	Mohr-Coulomb	5	32	Water Surface	Custom	1

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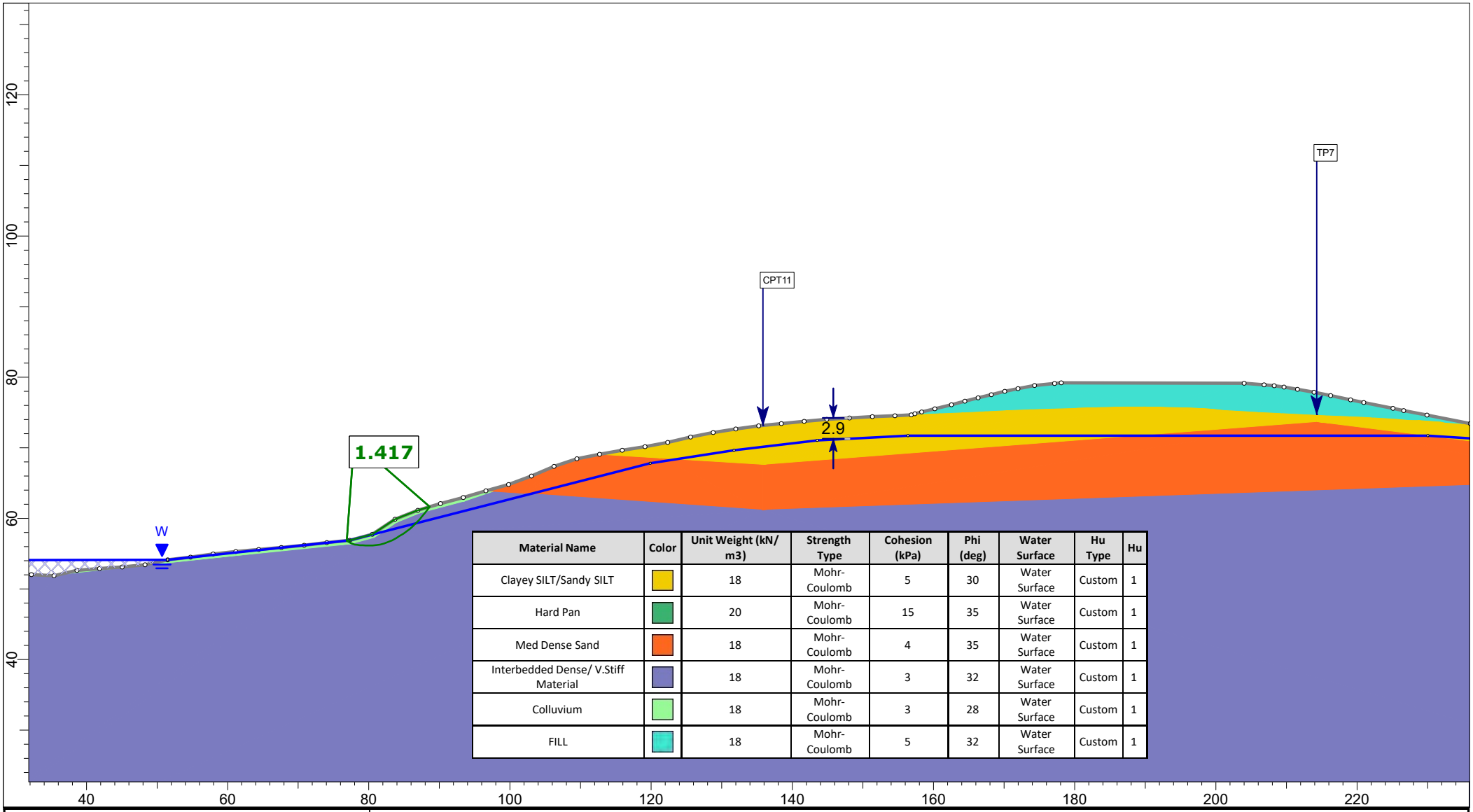
SLIDEINTERPRET 9.017

Project	Muriwai Downs		
Group	Section B	*Scenario*	Static, Full Sat
Drawn By	LES	*Company*	The Bears Home Project Management
Date	1/09/2021	*File Name*	Section B V3.slmd



Material Name	Color	Unit Weight (kN/ m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Clayey SILT/Sandy SILT		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Hard Pan		20	Mohr-Coulomb	15	35	Water Surface	Custom	1
Med Dense Sand		18	Mohr-Coulomb	4	35	Water Surface	Custom	1
Interbedded Dense/ V.Stiff Material		18	Mohr-Coulomb	3	32	Water Surface	Custom	1
Colluvium		18	Mohr-Coulomb	3	28	Water Surface	Custom	1
FILL		18	Mohr-Coulomb	5	32	Water Surface	Custom	1

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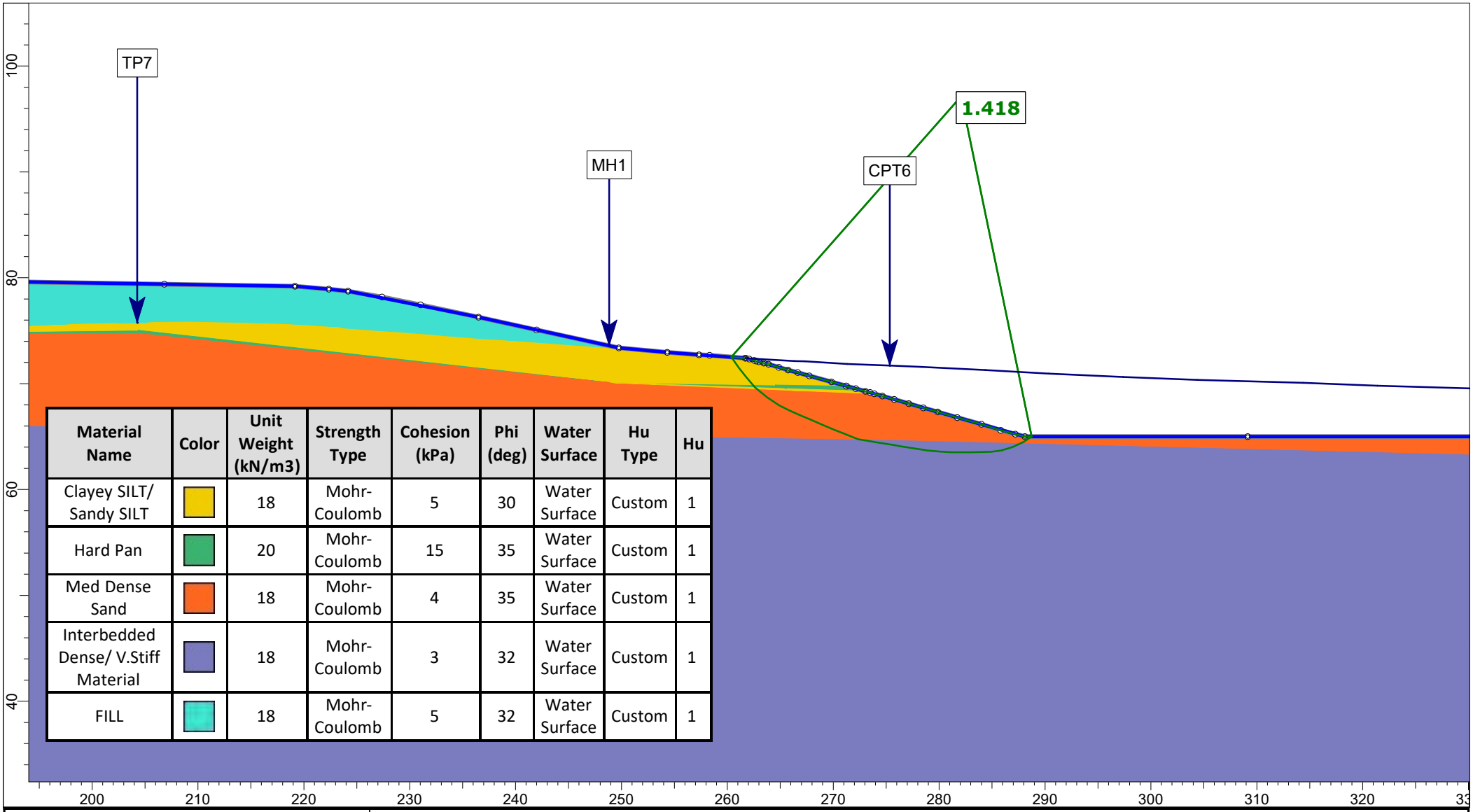
SLIDEINTERPRET 9.017

Project	Muriwai Downs		
Group	Section B	*Scenario*	Static, Filled, High GW, SE Slope
Drawn By	LES	*Company*	The Bears Home Project Management
Date	1/09/2021	*File Name*	Section B V3.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Clayey SILT/ Sandy SILT		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Hard Pan		20	Mohr-Coulomb	15	35	Water Surface	Custom	1
Med Dense Sand		18	Mohr-Coulomb	4	35	Water Surface	Custom	1
Interbedded Dense/ V.Stiff Material		18	Mohr-Coulomb	3	32	Water Surface	Custom	1
FILL		18	Mohr-Coulomb	5	32	Water Surface	Custom	1

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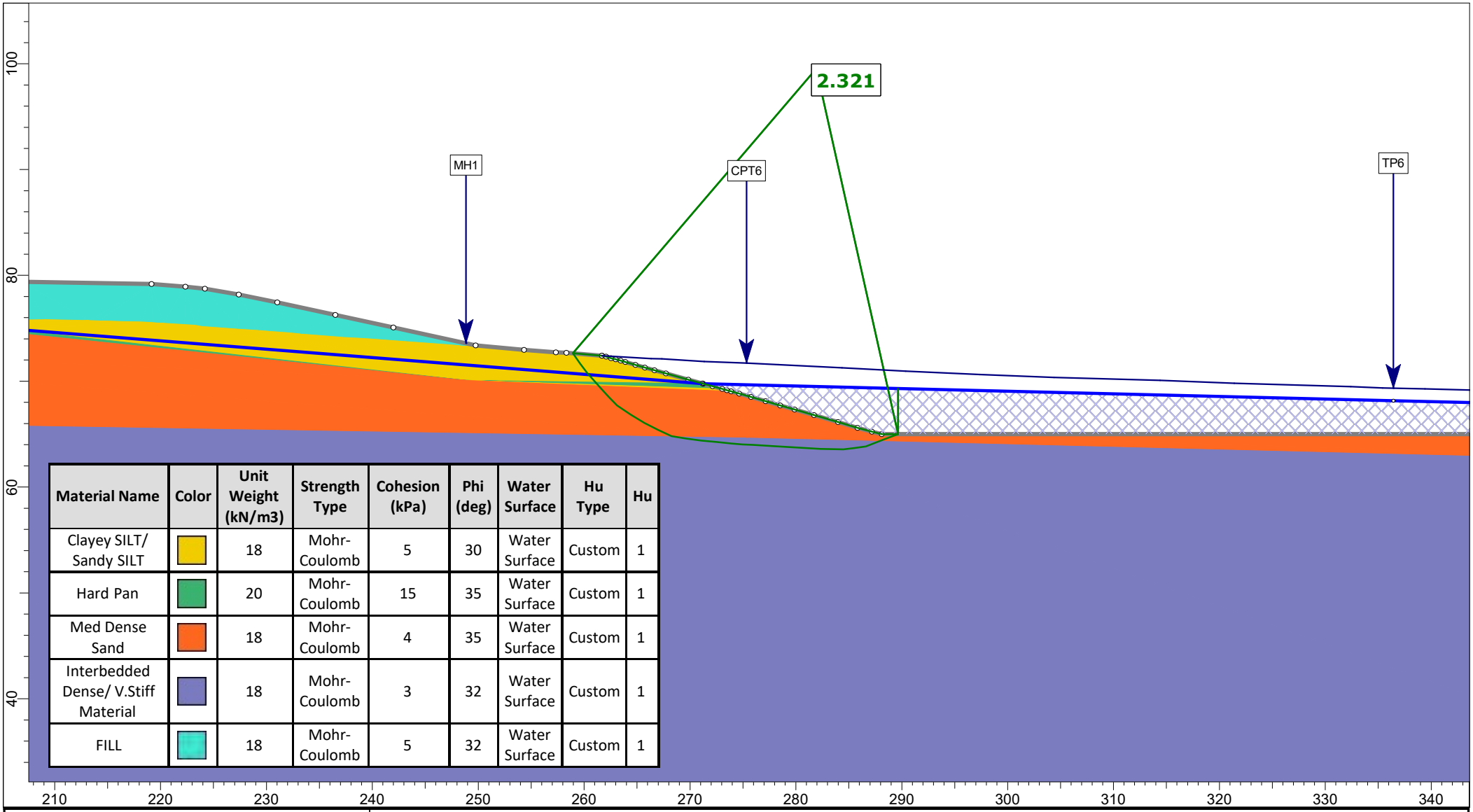
Project	Muriwai Downs		
Group	Section C	Scenario	Static, Proposed reservoir, Sat
Drawn By	LES	Company	The Bears Home Project Management
Date	6/09/2021	File Name	Section C.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Clayey SILT/ Sandy SILT		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Hard Pan		20	Mohr-Coulomb	15	35	Water Surface	Custom	1
Med Dense Sand		18	Mohr-Coulomb	4	35	Water Surface	Custom	1
Interbedded Dense/ V.Stiff Material		18	Mohr-Coulomb	3	32	Water Surface	Custom	1
FILL		18	Mohr-Coulomb	5	32	Water Surface	Custom	1

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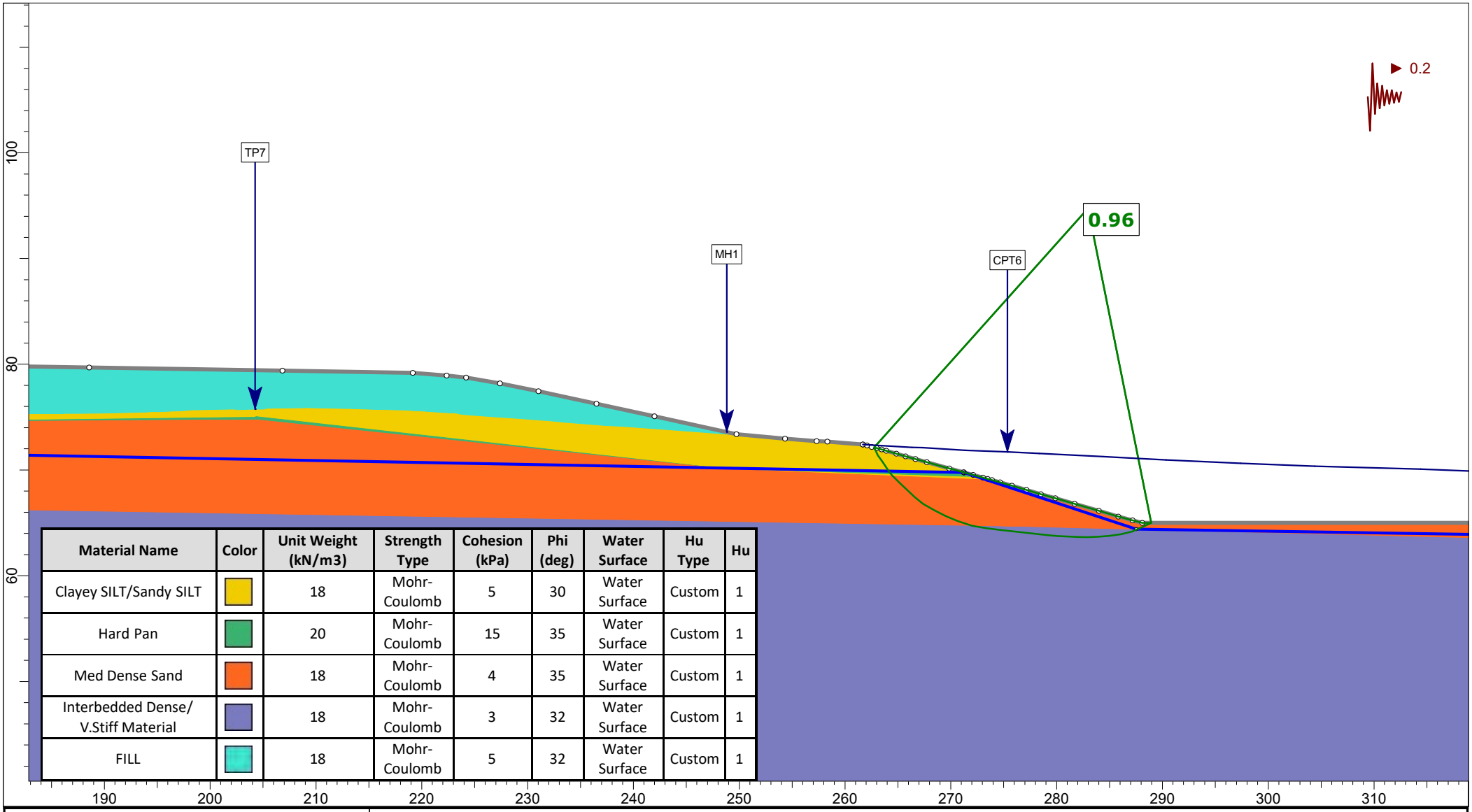
Project	Muriwai Downs		
Group	Section C	*Scenario*	Static, Proposed reservoir, High GW
Drawn By	LES	*Company*	The Bears Home Project Management
Date	6/09/2021	*File Name*	Section C.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Clayey SILT/Sandy SILT		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Hard Pan		20	Mohr-Coulomb	15	35	Water Surface	Custom	1
Med Dense Sand		18	Mohr-Coulomb	4	35	Water Surface	Custom	1
Interbedded Dense/ V.Stiff Material		18	Mohr-Coulomb	3	32	Water Surface	Custom	1
FILL		18	Mohr-Coulomb	5	32	Water Surface	Custom	1

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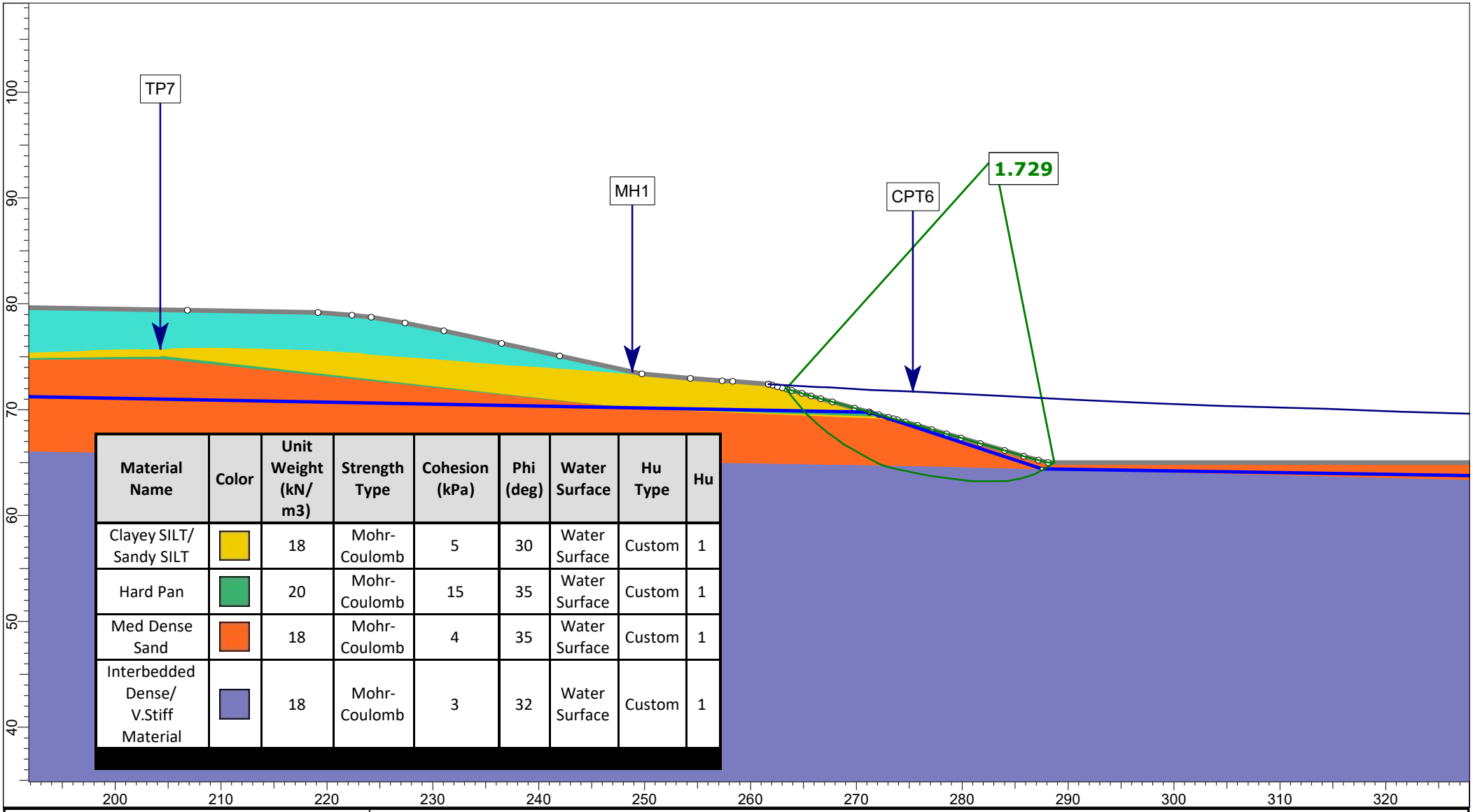
Project	Muriwai Downs		
Group	Section C	*Scenario*	Seismic, Proposed reservoir, Normal GW
Drawn By	LES	*Company*	The Bears Home Project Management
Date	6/09/2021	*File Name*	Section C.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Clayey SILT/ Sandy SILT		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Hard Pan		20	Mohr-Coulomb	15	35	Water Surface	Custom	1
Med Dense Sand		18	Mohr-Coulomb	4	35	Water Surface	Custom	1
Interbedded Dense/ V.Stiff Material		18	Mohr-Coulomb	3	32	Water Surface	Custom	1

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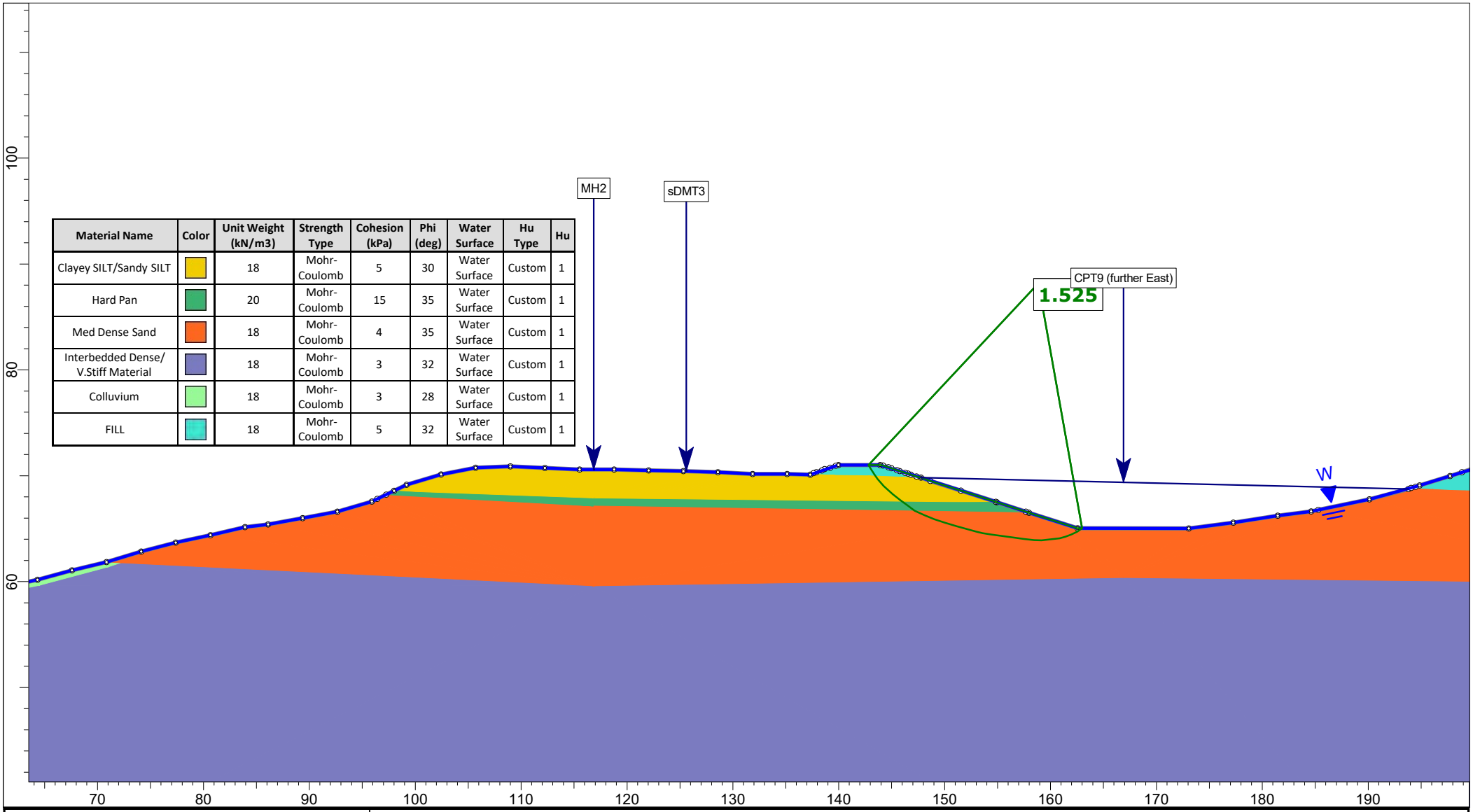
Project	Muriwai Downs		
Group	Section C	*Scenario*	Static, Proposed reservoir, Normal GW
Drawn By	LES	*Company*	The Bears Home Project Management
Date	6/09/2021	*File Name*	Section C.slmd

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Clayey SILT/Sandy SILT		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Hard Pan		20	Mohr-Coulomb	15	35	Water Surface	Custom	1
Med Dense Sand		18	Mohr-Coulomb	4	35	Water Surface	Custom	1
Interbedded Dense/ V.Stiff Material		18	Mohr-Coulomb	3	32	Water Surface	Custom	1
Colluvium		18	Mohr-Coulomb	3	28	Water Surface	Custom	1
FILL		18	Mohr-Coulomb	5	32	Water Surface	Custom	1



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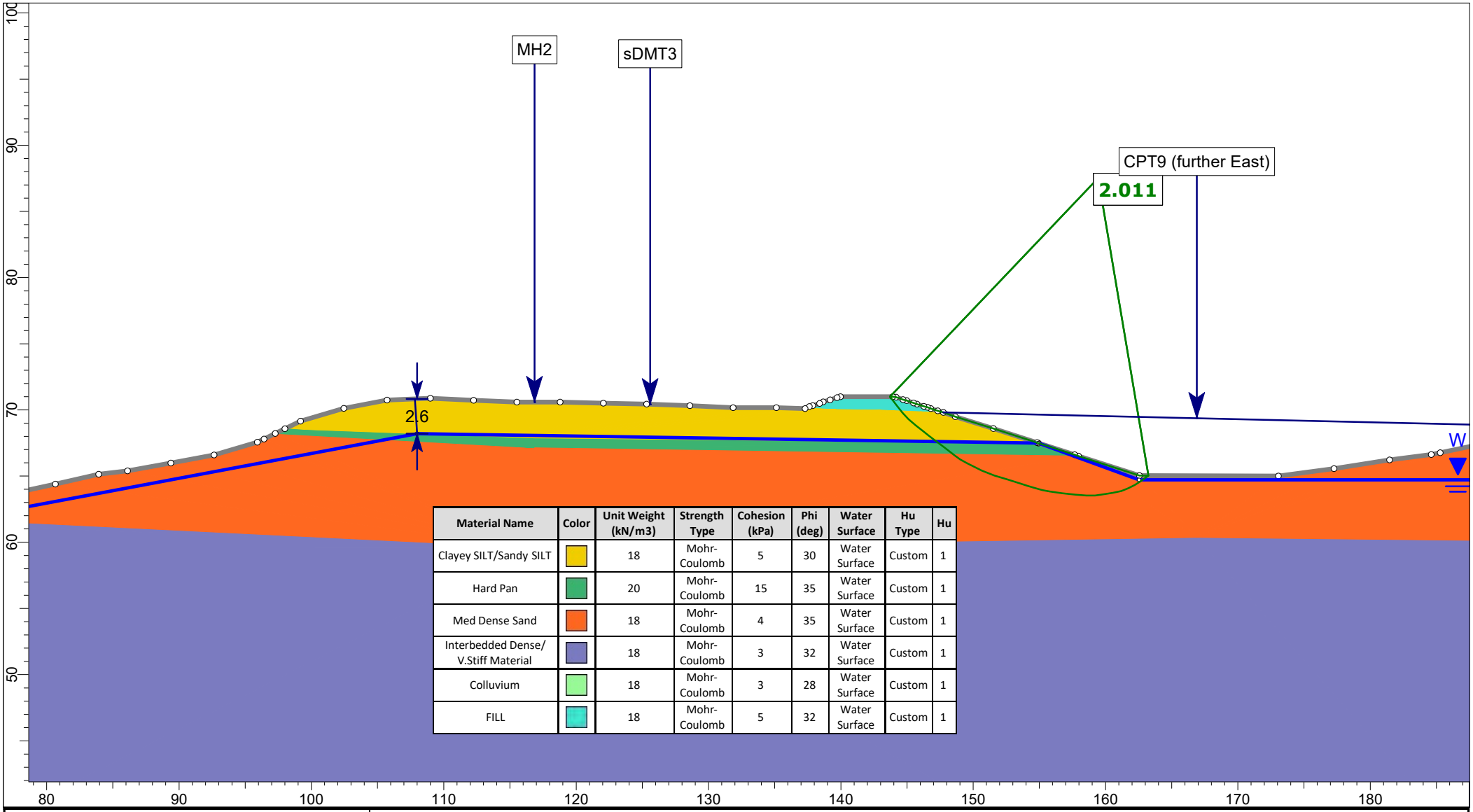
SLIDEINTERPRET 9.017

Project	Muriwai Downs		
Group	Section D	*Scenario*	Static, Full Sat
Drawn By	LES	*Company*	The Bears Home Project Management
Date	4/09/2021	*File Name*	Section D.slmd

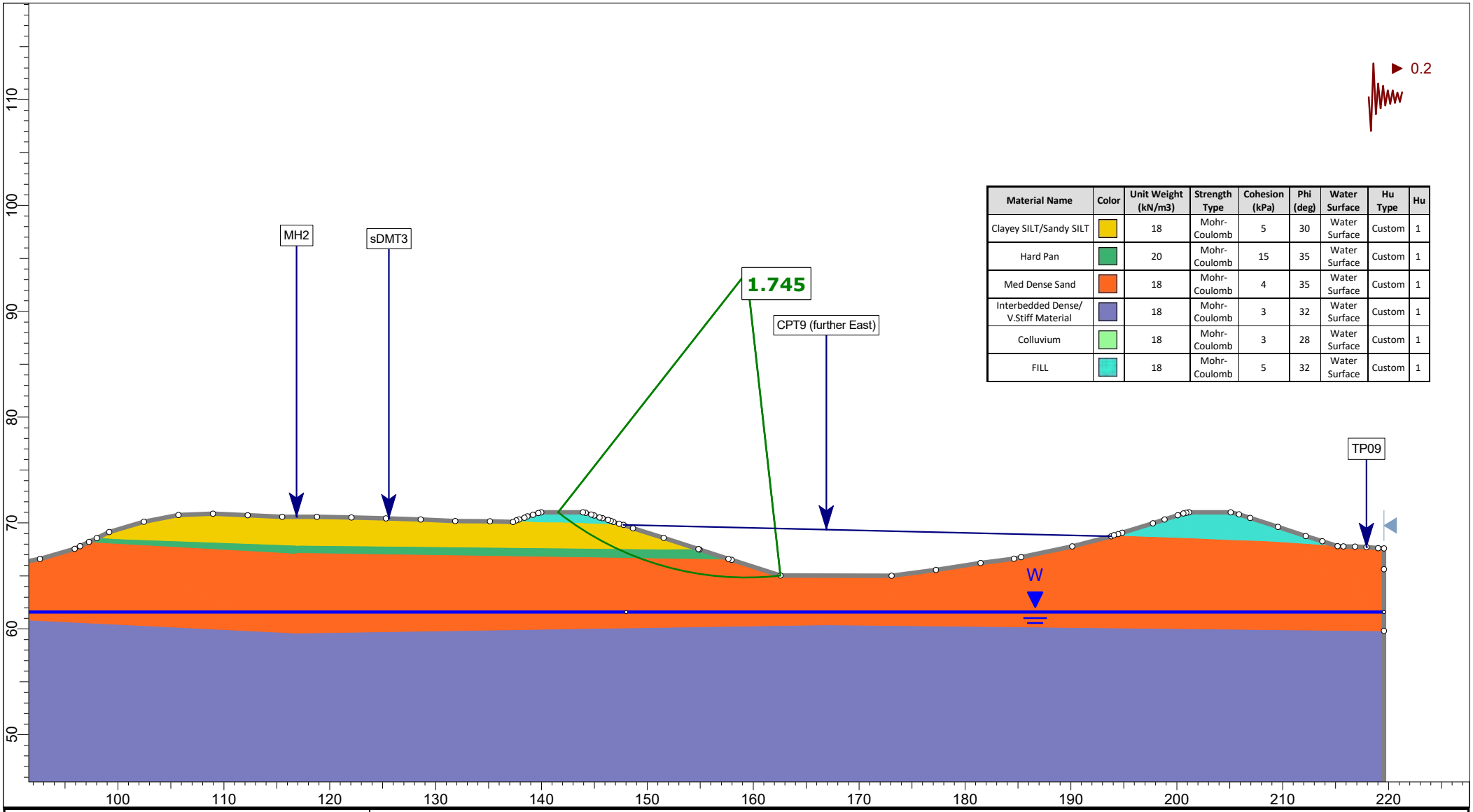


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Clayey SILT/Sandy SILT		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Hard Pan		20	Mohr-Coulomb	15	35	Water Surface	Custom	1
Med Dense Sand		18	Mohr-Coulomb	4	35	Water Surface	Custom	1
Interbedded Dense/ V.Stiff Material		18	Mohr-Coulomb	3	32	Water Surface	Custom	1
Colluvium		18	Mohr-Coulomb	3	28	Water Surface	Custom	1
FILL		18	Mohr-Coulomb	5	32	Water Surface	Custom	1

RILEY CONSULTANTS

SLIDEINTERPRET 9.017

Project	Muriwai Downs		
Group	Section D	*Scenario*	Static, Existing, High GW
Drawn By	LES	*Company*	The Bears Home Project Management
Date	4/09/2021	*File Name*	Section D.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Clayey SILT/Sandy SILT		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Hard Pan		20	Mohr-Coulomb	15	35	Water Surface	Custom	1
Med Dense Sand		18	Mohr-Coulomb	4	35	Water Surface	Custom	1
Interbedded Dense/ V.Stiff Material		18	Mohr-Coulomb	3	32	Water Surface	Custom	1
Colluvium		18	Mohr-Coulomb	3	28	Water Surface	Custom	1
FILL		18	Mohr-Coulomb	5	32	Water Surface	Custom	1

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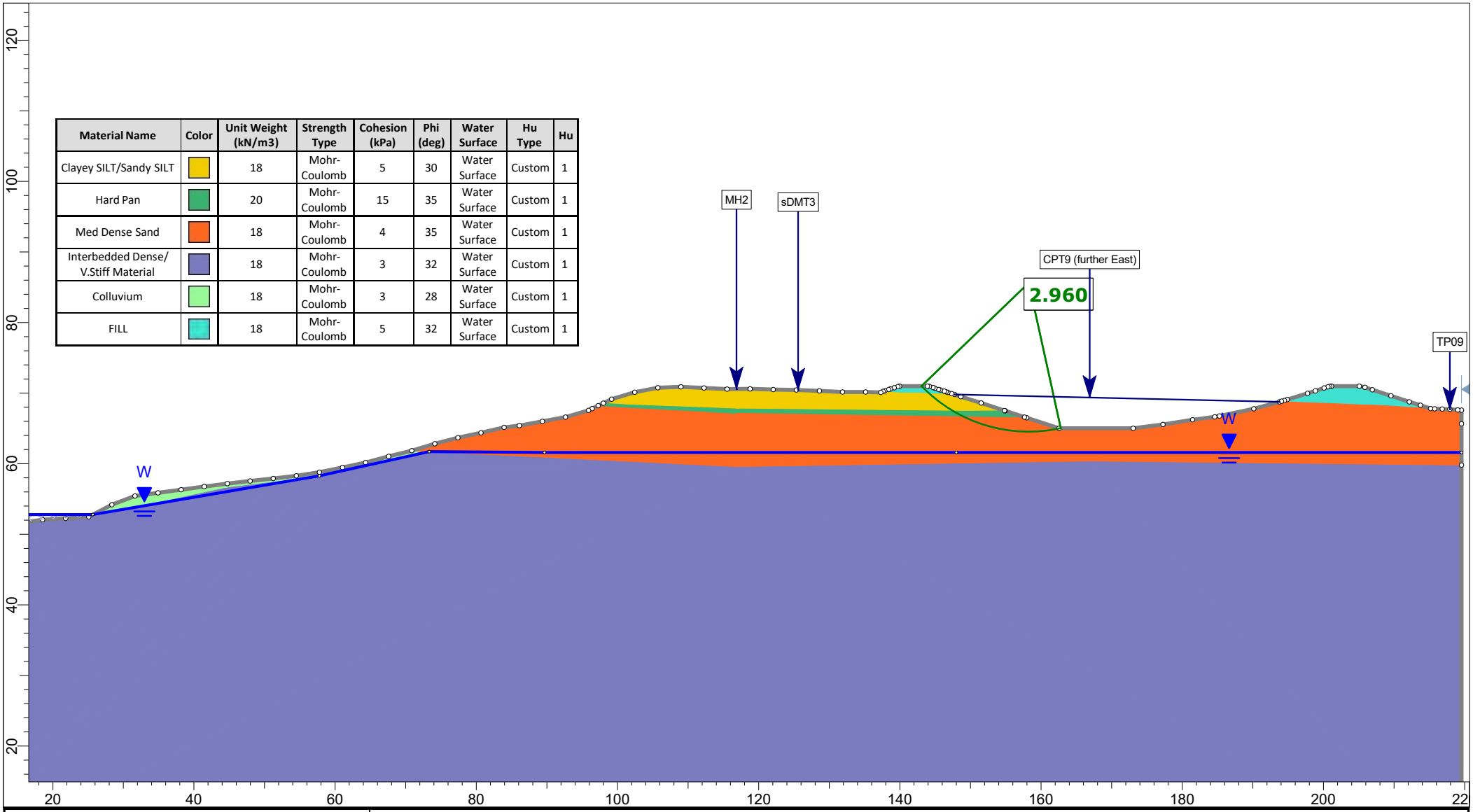
SLIDEINTERPRET 9.017

Project	Muriwai Downs		
Group	Section D	*Scenario*	Seismic, Normal GW
Drawn By	LES	*Company*	The Bears Home Project Management
Date	4/09/2021	*File Name*	Section D.slmd

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Clayey SILT/Sandy SILT		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Hard Pan		20	Mohr-Coulomb	15	35	Water Surface	Custom	1
Med Dense Sand		18	Mohr-Coulomb	4	35	Water Surface	Custom	1
Interbedded Dense/ V.Stiff Material		18	Mohr-Coulomb	3	32	Water Surface	Custom	1
Colluvium		18	Mohr-Coulomb	3	28	Water Surface	Custom	1
FILL		18	Mohr-Coulomb	5	32	Water Surface	Custom	1



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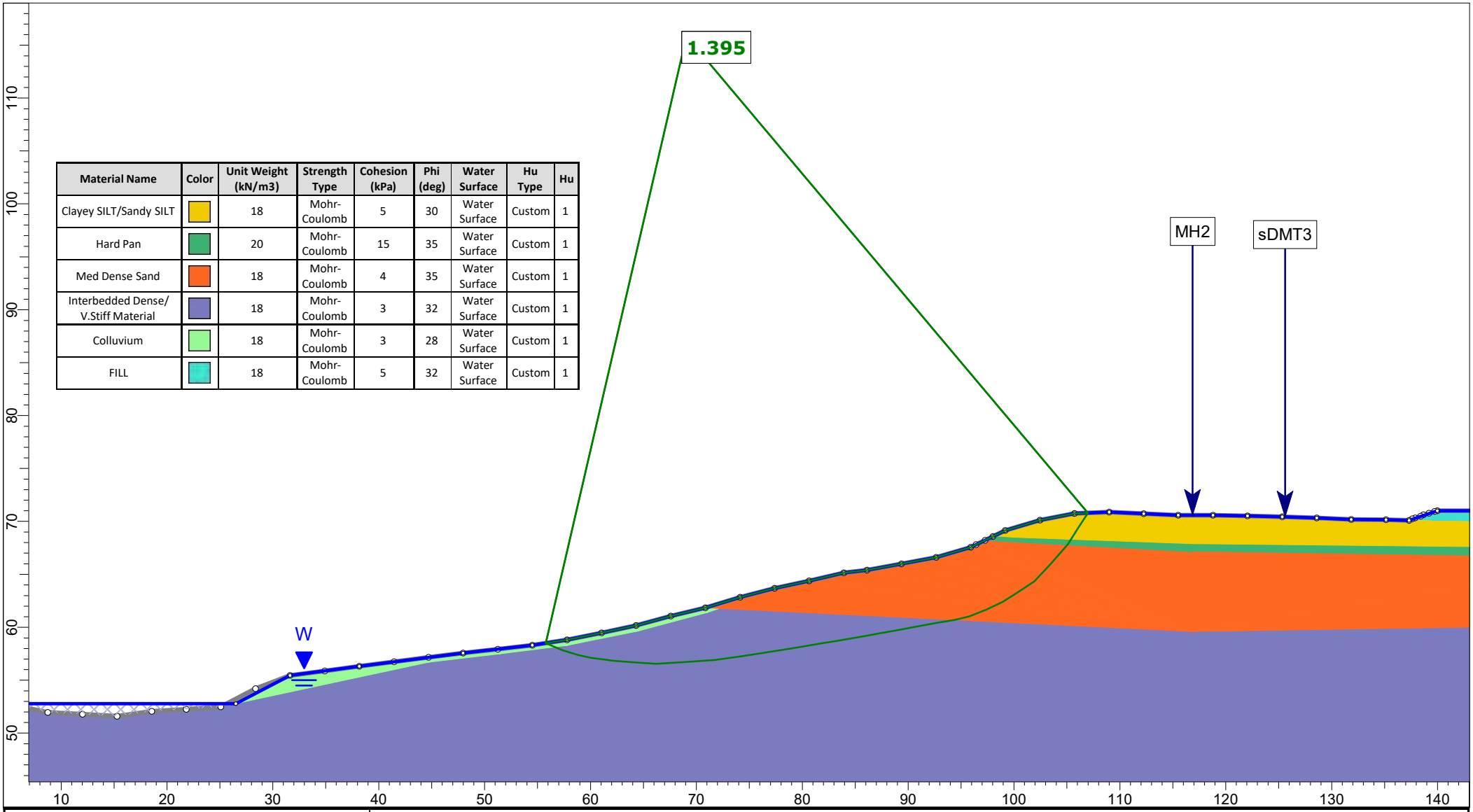
SLIDEINTERPRET 9.017

Project	Muriwai Downs		
Group	Section D	*Scenario*	Static, Existing, Des GW
Drawn By	LES	*Company*	The Bears Home Project Management
Date	4/09/2021	*File Name*	Section D.slmd

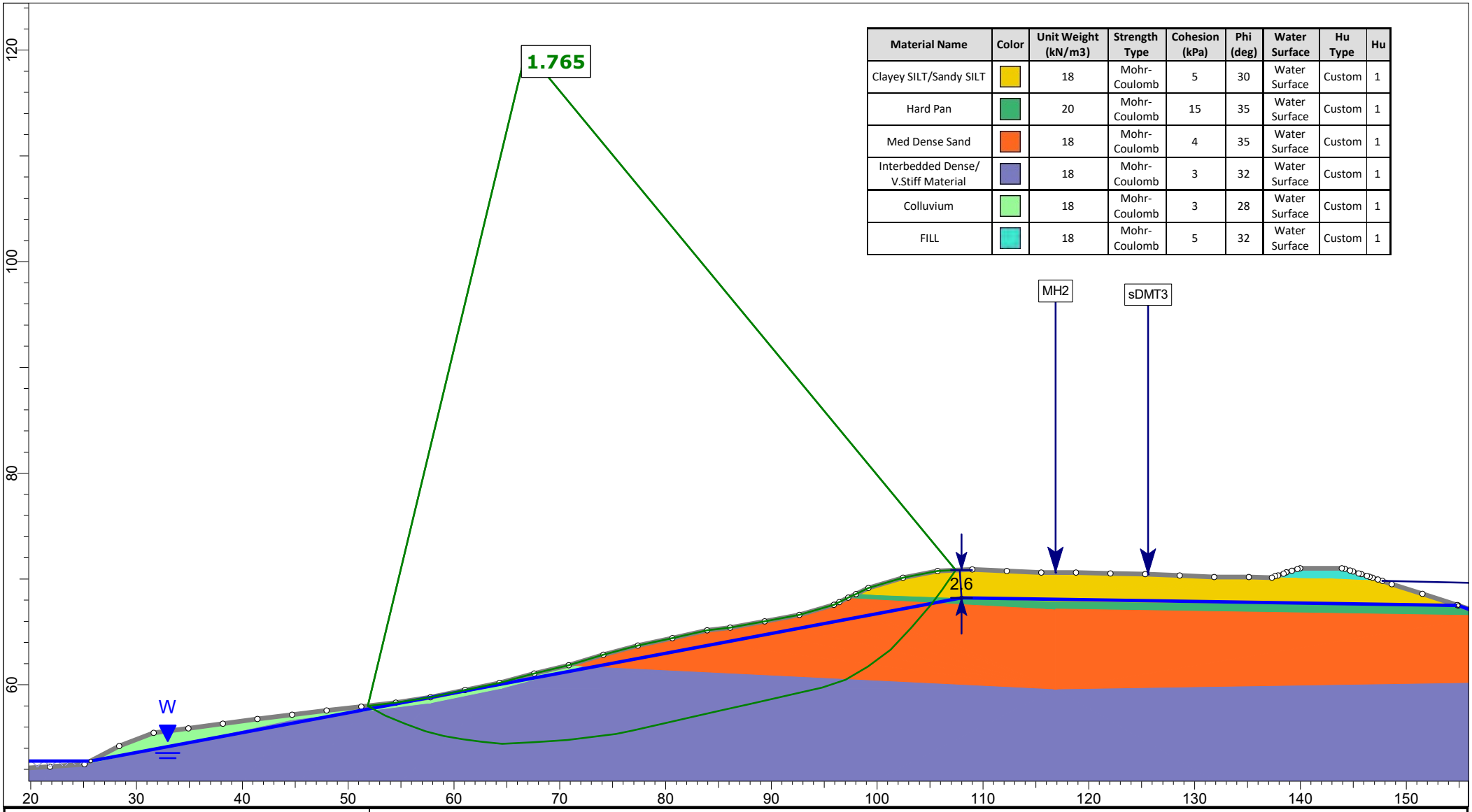
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Clayey SILT/Sandy SILT		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Hard Pan		20	Mohr-Coulomb	15	35	Water Surface	Custom	1
Med Dense Sand		18	Mohr-Coulomb	4	35	Water Surface	Custom	1
Interbedded Dense/ V.Stiff Material		18	Mohr-Coulomb	3	32	Water Surface	Custom	1
Colluvium		18	Mohr-Coulomb	3	28	Water Surface	Custom	1
FILL		18	Mohr-Coulomb	5	32	Water Surface	Custom	1



RILEY CONSULTANTS

SLIDEINTERPRET 9.017

Project	Muriwai Downs		
Group	Section D	Scenario	Static, Full Sat
Drawn By	LES	Company	The Bears Home Project Management
Date	4/09/2021	File Name	Section D.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Clayey SILT/Sandy SILT		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Hard Pan		20	Mohr-Coulomb	15	35	Water Surface	Custom	1
Med Dense Sand		18	Mohr-Coulomb	4	35	Water Surface	Custom	1
Interbedded Dense/ V.Stiff Material		18	Mohr-Coulomb	3	32	Water Surface	Custom	1
Colluvium		18	Mohr-Coulomb	3	28	Water Surface	Custom	1
FILL		18	Mohr-Coulomb	5	32	Water Surface	Custom	1

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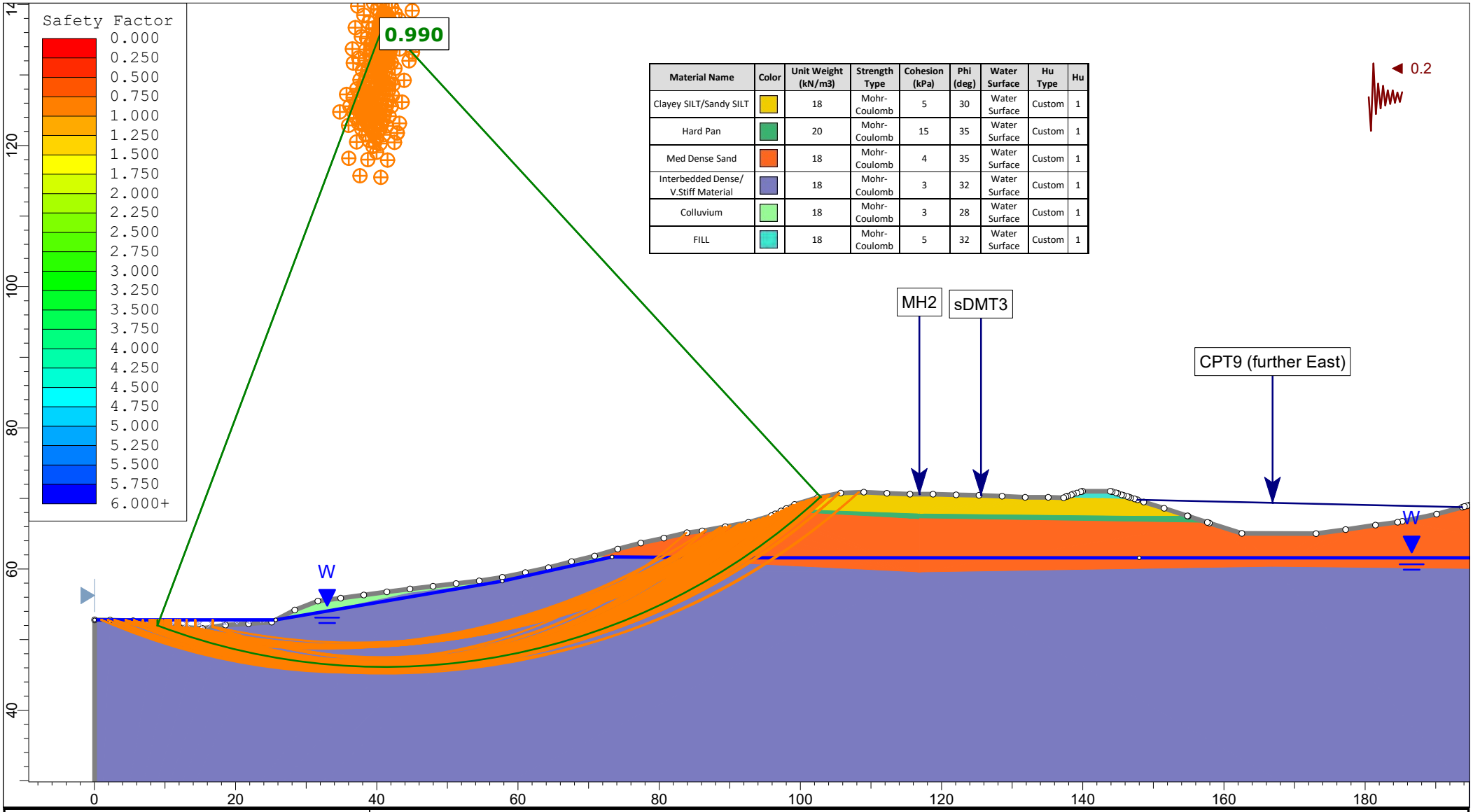
SLIDEINTERPRET 9.017

Project	Muriwai Downs		
Group	Section D	*Scenario*	Static, Existing, High GW
Drawn By	LES	*Company*	The Bears Home Project Management
Date	4/09/2021	*File Name*	Section D.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Clayey SILT/Sandy SILT		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Hard Pan		20	Mohr-Coulomb	15	35	Water Surface	Custom	1
Med Dense Sand		18	Mohr-Coulomb	4	35	Water Surface	Custom	1
Interbedded Dense/ V.Stiff Material		18	Mohr-Coulomb	3	32	Water Surface	Custom	1
Colluvium		18	Mohr-Coulomb	3	28	Water Surface	Custom	1
FILL		18	Mohr-Coulomb	5	32	Water Surface	Custom	1

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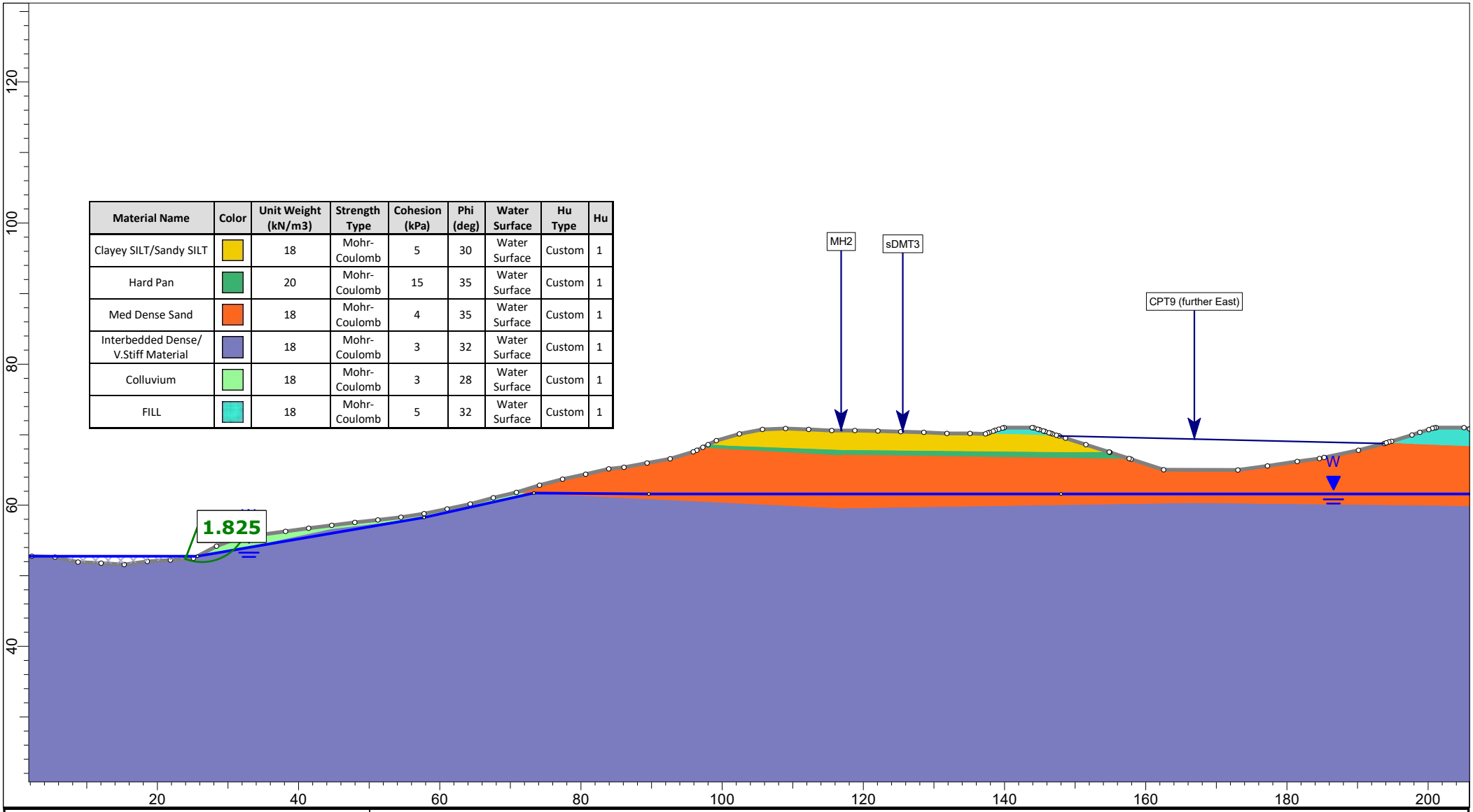
SLIDEINTERPRET 9.017

Project	Muriwai Downs		
Group	Section D	*Scenario*	Seismic, Normal GW
Drawn By	LES	*Company*	The Bears Home Project Management
Date	4/09/2021	*File Name*	Section D.slmd

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Clayey SILT/Sandy SILT		18	Mohr-Coulomb	5	30	Water Surface	Custom	1
Hard Pan		20	Mohr-Coulomb	15	35	Water Surface	Custom	1
Med Dense Sand		18	Mohr-Coulomb	4	35	Water Surface	Custom	1
Interbedded Dense/ V.Stiff Material		18	Mohr-Coulomb	3	32	Water Surface	Custom	1
Colluvium		18	Mohr-Coulomb	3	28	Water Surface	Custom	1
FILL		18	Mohr-Coulomb	5	32	Water Surface	Custom	1



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SLIDEINTERPRET 9.017

Project	Muriwai Downs		
Group	Section D	*Scenario*	Static, Existing, Des GW
Drawn By	LES	*Company*	The Bears Home Project Management
Date	4/09/2021	*File Name*	Section D.slmd

APPENDIX H

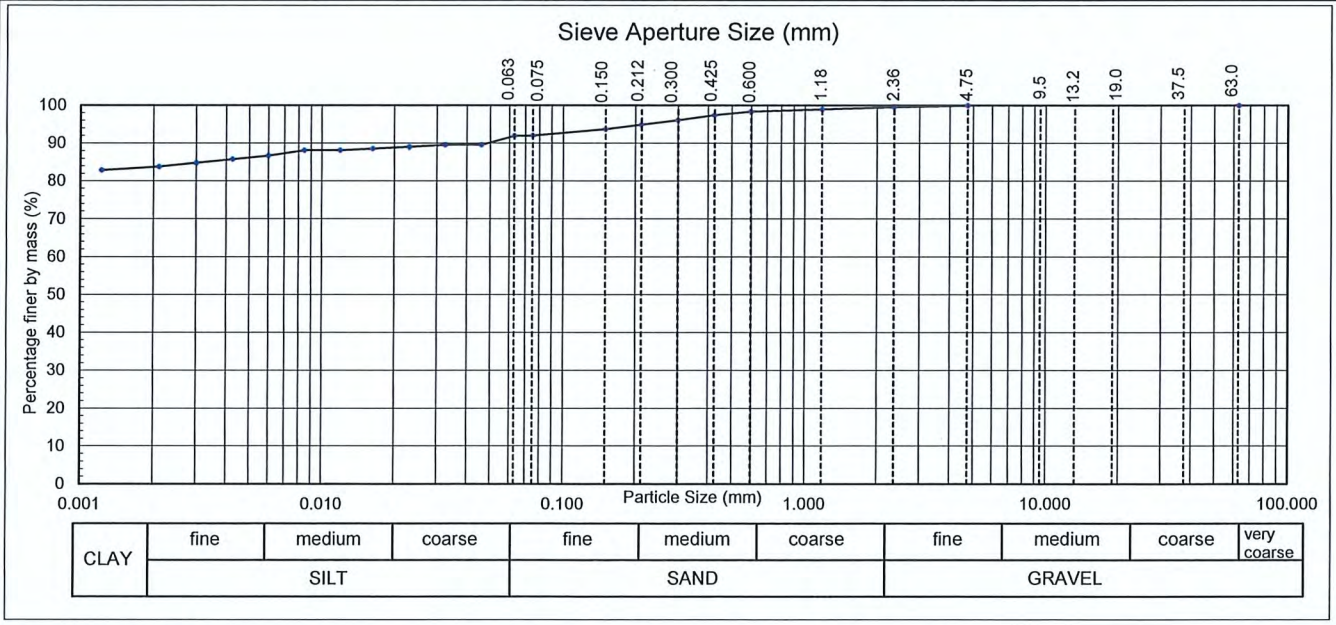
Laboratory Test Results

PARTICLE SIZE ANALYSIS (HYDROMETER METHOD)
TEST REPORT

Project :	Muriwai Downs
Location :	710 Muriwai Road
Client :	Riley Consultants Ltd c/o The Bears Home Project Management Limited
Client Ref :	210339
Contractor :	Not Stated
Borehole No:	TP2 Depth: 1.80 metres
Sampled by :	GB
Date received :	10/08/21
Sampling method :	Bulk samples
Sample condition :	As received
Sample description :	CLAY with minor sand and silt
Solid Particle Density (t/m^3):	2.86 Tested
Water Content (as received):	65.9 %

Project No:	1-LA614.00
Lab Ref No:	AL6732/1
Client Ref:	210339

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
63.0	--	4.75	100	0.300	96	0.0460	90	0.0060	87
37.5	--	2.36	100	0.212	95	0.0325	90	0.0042	86
19.0	--	1.18	99	0.150	94	0.0231	89	0.0030	85
13.2	--	0.600	98	0.075	92	0.0163	89	0.0021	84
9.5	--	0.425	97	0.063	92	0.0119	88	0.0012	83
Note:	"--" denotes sieve not used and/or hydrometer analysis not tested					0.0084	88		



Test Methods	Notes
Particle Size Analysis: NZS 4402:1986: Test 2.8.4 (Washed Grading & Hydrometer Method)	pH of suspension : 9.4 (Electrometric Method) Refer to report AL6732/5 for solid particle density test All information supplied by Client

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

This report may only be reproduced in full

Date Tested: 29/09/21 - 04/10/21

Date Reported: 18/10/21

IANZ Approved Signatory Thirushen Pillay

Designation : *Senior Civil Engineering Technician*

Date : 19/10/21

ACCREDITED IANZ TESTING LABORATORY

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

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Quality Management Systems Certified to ISO 9001

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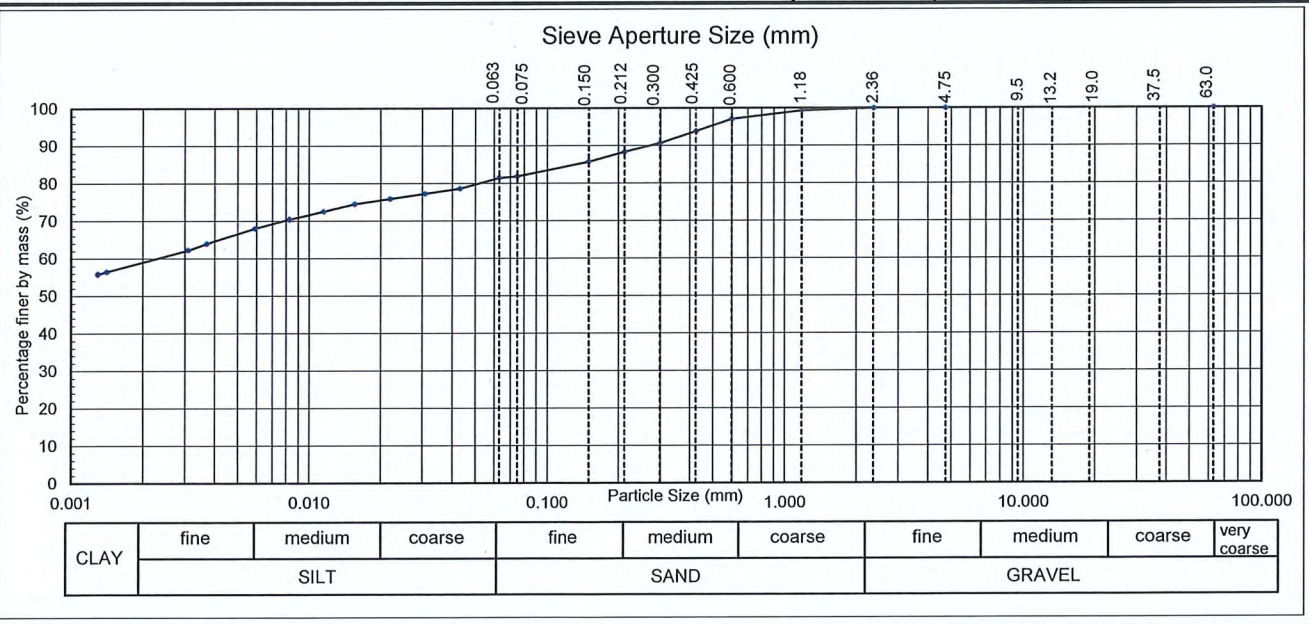
Telephone +64 9 415 4660
Website www.wsp.com/nz

PARTICLE SIZE ANALYSIS (HYDROMETER METHOD)
TEST REPORT

Project :	Muriwai Downs
Location :	710 Muriwai Road
Client :	Riley Consultants Ltd c/o The Bears Home Project Management Limited
Client Ref :	210339
Contractor :	Not Stated
Borehole No:	TP6 Depth: 2.10 metres
Sampled by :	GB
Date received :	10/08/21
Sampling method :	Bulk samples
Sample condition :	As received
Sample description :	silty CLAY with some sand
Solid Particle Density (t/m^3):	2.74 Assumed
Water Content (as received):	59.2 %

Project No:	1-LA614.00
Lab Ref No:	AL6732/2
Client Ref:	210339

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
63.0	--	4.75	100	0.300	91	0.0432	79	0.0059	68
37.5	--	2.36	100	0.212	88	0.0308	77	0.0037	64
19.0	--	1.18	99	0.150	86	0.0219	76	0.0031	62
13.2	--	0.600	97	0.075	82	0.0156	75	0.0014	57
9.5	--	0.425	94	0.063	81	0.0115	73	0.0013	56
Note:	"--" denotes sieve not used and/or hydrometer analysis not tested					0.0083	70		



Test Methods	Notes
Particle Size Analysis: NZS 4402:1986: Test 2.8.4 (Washed Grading & Hydrometer Method)	pH of suspension : 8.9 (Electrometric Method) All information supplied by Client

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

Date Tested: 27/09/21 - 04/10/21

This report may only be reproduced in full

Date Reported: 18/10/21

IANZ Approved Signatory Thirushen Pillay

Designation : *Senior Civil Engineering Technician*

Date : 19/10/21

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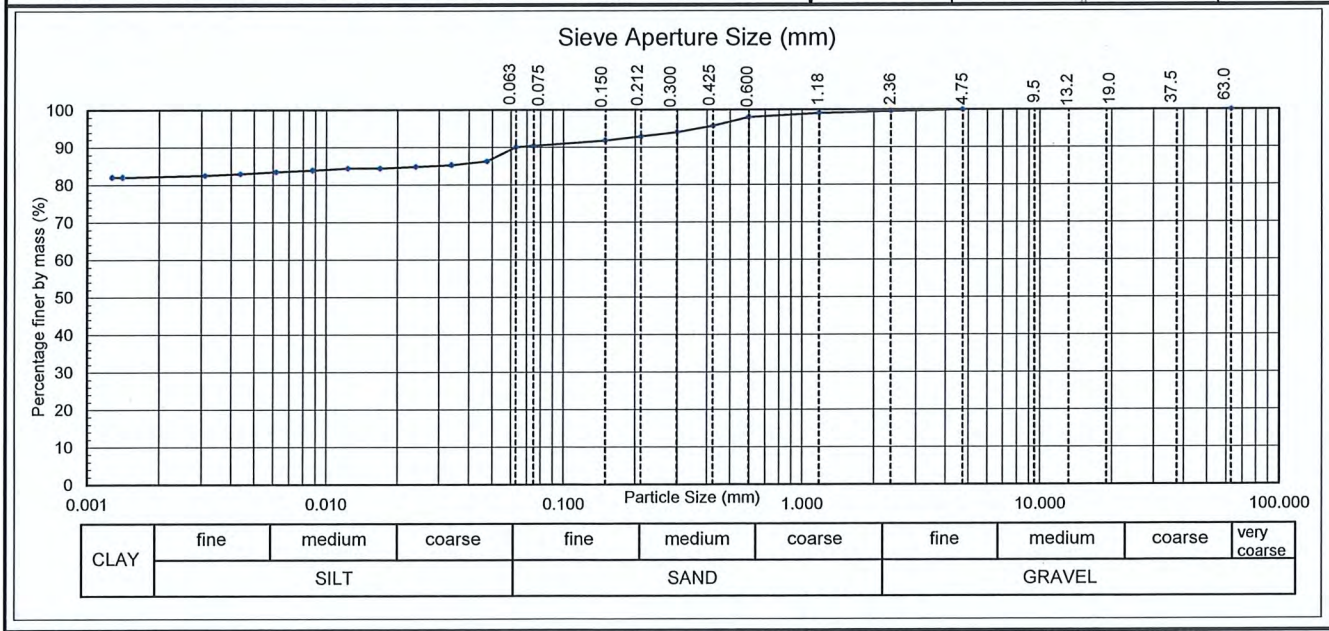
PARTICLE SIZE ANALYSIS (HYDROMETER METHOD)
TEST REPORT

Project :	Muriwai Downs
Location :	710 Muriwai Road
Client :	Riley Consultants Ltd c/o The Bears Home Project Management Limited
Client Ref :	210339
Contractor :	Not Stated
Borehole No:	TP10 Depth: 1.80 metres
Sampled by :	GB
Date received :	10/08/21
Sampling method :	Bulk samples
Sample condition :	As received
Sample description :	CLAY with minor sand and silt
Solid Particle Density (t/m^3):	2.74 Assumed
Water Content (as received):	65.5 %

Project No:	1-LA614.00
Lab Ref No:	AL6732/3
Client Ref:	210339

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
63.0	--	4.75	100	0.300	94	0.0476	86	0.0062	83
37.5	--	2.36	100	0.212	93	0.0338	85	0.0044	83
19.0	--	1.18	99	0.150	92	0.0239	85	0.0031	83
13.2	--	0.600	98	0.075	90	0.0169	84	0.0014	82
9.5	--	0.425	96	0.063	90	0.0124	84	0.0013	82
Note:	"--" denotes sieve not used and/or hydrometer analysis not tested					0.0088	84		



Test Methods	Notes
Particle Size Analysis: NZS 4402:1986: Test 2.8.4 (Washed Grading & Hydrometer Method)	pH of suspension : 9.5 (Electrometric Method) All information supplied by Client

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

This report may only be reproduced in full

Date Tested: 01-05/10/21

Date Reported: 18/10/21

IANZ Approved Signatory Thirushen Pillay

Designation : *Senior Civil Engineering Technician*

Date : 19/10/21

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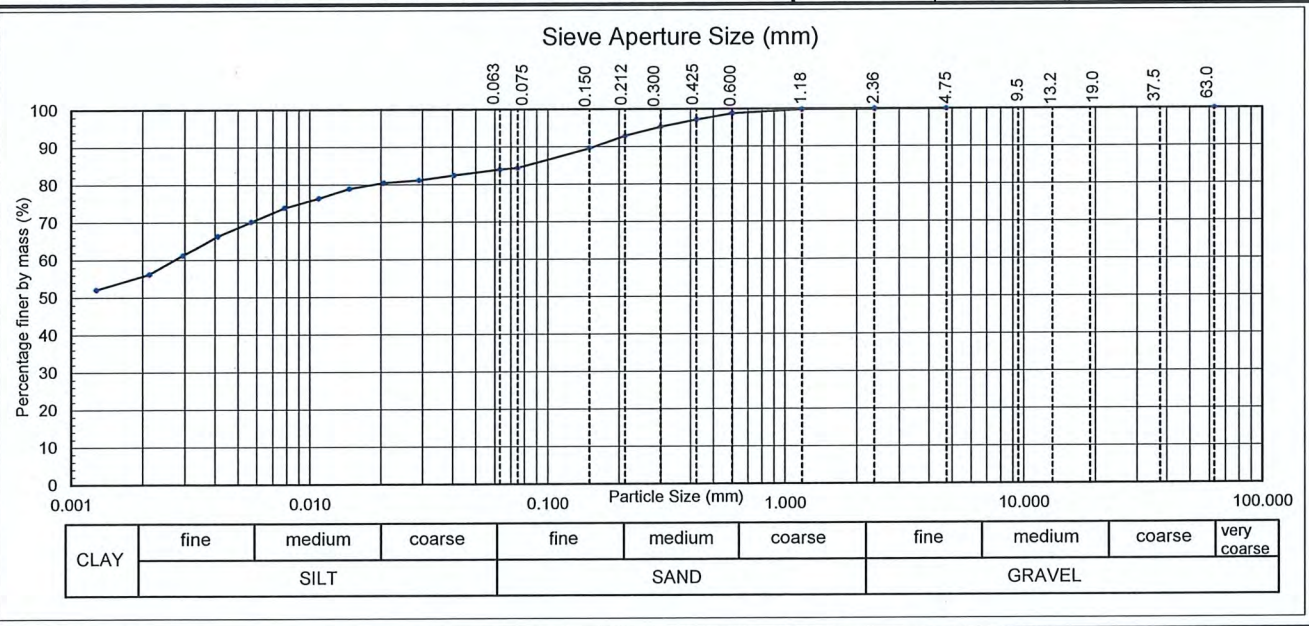
Telephone +64 9 415 4660
Website www.wsp.com/nz

PARTICLE SIZE ANALYSIS (HYDROMETER METHOD)
TEST REPORT

Project :	Muriwai Downs
Location :	710 Muriwai Road
Client :	Riley Consultants Ltd c/o The Bears Home Project Management Limited
Client Ref :	210339
Contractor :	Not Stated
Borehole No:	TP11 Depth: 1.70 metres
Sampled by :	GB
Date received :	10/08/21
Sampling method :	Bulk samples
Sample condition :	As received
Sample description :	silty CLAY with some sand
Solid Particle Density (t/m^3):	2.74 Assumed
Water Content (as received):	52.0 %

Project No:	1-LA614.00
Lab Ref No:	AL6732/4
Client Ref:	210339

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
63.0	--	4.75	100	0.300	95	0.0406	82	0.0057	70
37.5	--	2.36	100	0.212	93	0.0290	81	0.0041	66
19.0	--	1.18	100	0.150	90	0.0206	81	0.0030	61
13.2	--	0.600	99	0.075	84	0.0147	79	0.0021	56
9.5	--	0.425	97	0.063	84	0.0109	76	0.0013	52
Note:	"--" denotes sieve not used and/or hydrometer analysis not tested					0.0078	74		



Test Methods	Notes
Particle Size Analysis: NZS 4402:1986: Test 2.8.4 (Washed Grading & Hydrometer Method)	pH of suspension : 9.3 (Electrometric Method) All information supplied by Client

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

Date Tested: 05-06/10/21

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Date Reported: 18/10/21

IANZ Approved Signatory Thirushen Pillay

Designation : *Senior Civil Engineering Technician*

Date : 19/10/21

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SOLID DENSITY FOR FINE TO MEDIUM SOILS TEST REPORT

Project:	Muriwai Downs
Location:	710 Muriwai Road
Client:	The Bears Home Project Management Limited c/o Riley Consultants Ltd
Contractor:	Not Stated
Sampled by:	GB
Date sampled:	04-05/08/21
Sampling method:	Bulk samples
Sample description:	CLAY with minor sand and silt
Sample condition:	As Received
Sample reference:	TP2
Sample depth:	1.80m

Project number:	1-LA614.00
Lab ref number:	AL6732/5
Client ref number:	210339
Folder number:	-

Test Results

Solid Density (t/m³): 2.86

Test Methods		Notes
Solid Density:	NZS 4402 : 1986 : Test 2.7.2	Sample descriptions are not covered by IANZ accreditation Test performed on: Fraction Passing 19mm Test sieve History: Unknown All information supplied by Client

Date tested : 1/10/21
Date reported : 18/10/21

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
This report may only be reproduced in full

IANZ Approved Signatory
Thirushen Pillay
Designation : *Senior Civil Engineering Technician*
Date : 19/10/2021

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Website www.wsp.com/nz

PLASTICITY INDEX FOR SOILS
TEST REPORT

Project :	Muriwai Downs
Location :	710 Muriwai Road
Client :	Riley Consultants Ltd c/o The Bears Home Project Management Limited
Contractor :	Not Stated
Sampled by :	GB
Date sampled :	04-05/08/21
Sampling method :	Bulk samples
Sample description :	CLAY with minor sand and silt
Sample condition :	As Received
Sample reference:	TP2
Sample depth:	1.80m

Project No :	1-LA614.00
Lab Ref No :	AL6732/6
Client Ref No :	210339
Folder number:	-

Test Results

Liquid Limit :	124
Plastic Limit :	46
Plasticity Index :	78
Natural Water Content :	65.9

Test Methods		Notes
Liquid Limit	NZS 4402 : 1986, Test 2.2	Materials used: Passing 425um sieve
Plastic Limit	NZS 4402 : 1986, Test 2.3	
Plasticity Index	NZS 4402 : 1986, Test 2.4	
Water Content	NZS 4402 : 1986, Test 2.1	All information supplied by Client

Date tested : 01/10/21
Date reported : 18/10/21

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
This report may only be reproduced in full

IANZ Approved Signatory
Thirushen Pillay
Designation : *Senior Civil Engineering Technician*
Date : 19/10/21

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PLASTICITY INDEX FOR SOILS
TEST REPORT

Project :	Muriwai Downs
Location :	710 Muriwai Road
Client :	Riley Consultants Ltd c/o The Bears Home Project Management Limited
Contractor :	Not Stated
Sampled by :	GB
Date sampled :	04-05/08/21
Sampling method :	Bulk samples
Sample description :	silty CLAY with some sand
Sample condition :	As Received
Sample reference:	TP6
Sample depth:	2.10m

Project No :	1-LA614.00
Lab Ref No :	AL6732/7
Client Ref No :	210339
Folder number:	-

Test Results

Liquid Limit :	105
Plastic Limit :	64
Plasticity Index :	41
Natural Water Content :	59.2

Test Methods		Notes
Liquid Limit	NZS 4402 : 1986, Test 2.2	Materials used: Passing 425um sieve
Plastic Limit	NZS 4402 : 1986, Test 2.3	
Plasticity Index	NZS 4402 : 1986, Test 2.4	
Water Content	NZS 4402 : 1986, Test 2.1	All information supplied by Client

Date tested : 01/10/21
Date reported : 18/10/21

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IANZ Approved Signatory
Thirushen Pillay
Designation : *Senior Civil Engineering Technician*
Date : 19/10/21

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PLASTICITY INDEX FOR SOILS
TEST REPORT

Project :	Muriwai Downs
Location :	710 Muriwai Road
Client :	Riley Consultants Ltd c/o The Bears Home Project Management Limited
Contractor :	Not Stated
Sampled by :	GB
Date sampled :	04-05/08/21
Sampling method :	Bulk samples
Sample description :	CLAY with minor sand and silt
Sample condition :	As Received
Sample reference:	TP10
Sample depth:	1.80m

Project No :	1-LA614.00
Lab Ref No :	AL6732/8
Client Ref No :	210339
Folder number:	-

Test Results

Liquid Limit :	136
Plastic Limit :	49
Plasticity Index :	87
Natural Water Content :	65.5

Test Methods		Notes
Liquid Limit	NZS 4402 : 1986, Test 2.2	Materials used: Passing 425um sieve
Plastic Limit	NZS 4402 : 1986, Test 2.3	
Plasticity Index	NZS 4402 : 1986, Test 2.4	
Water Content	NZS 4402 : 1986, Test 2.1	All information supplied by Client

Date tested : 01/10/21
Date reported : 18/10/21

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
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IANZ Approved Signatory
Thirushen Pillay
Designation : *Senior Civil Engineering Technician*
Date : 19/10/21

ACCREDITED IANZ TESTING LABORATORY

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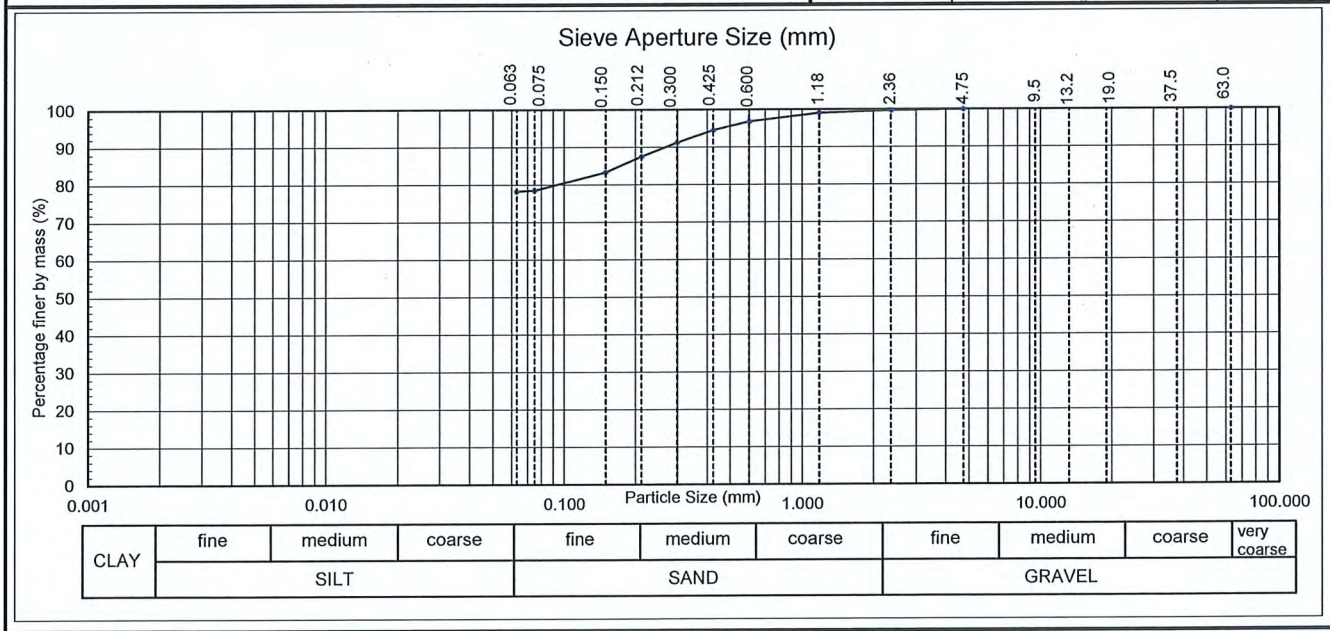
Website www.wsp.com/nz

PARTICLE SIZE ANALYSIS (WET SIEVE METHOD)
TEST REPORT

Project :	Muriwai Downs
Location :	710 Muriwai Road
Client :	Riley Consultants Ltd c/o The Bears Home Project Management Limited
Client Ref :	210339
Contractor :	Not Stated
Borehole No:	TP2 Depth: 2.00 metres
Sampled by :	GB
Date received :	10/08/21
Sampling method :	Bulk samples
Sample condition :	As received
Sample description :	sandy SILT/CLAY
Solid Particle Density (t/m^3):	-
Water Content (as received):	69.8 %

Project No:	1-LA614.00
Lab Ref No:	AL6732/9
Client Ref:	210339

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
63.0	--	4.75	100	0.300	91	--	--	--	--
37.5	--	2.36	100	0.212	88	--	--	--	--
19.0	--	1.18	99	0.150	83	--	--	--	--
13.2	--	0.600	97	0.075	79	--	--	--	--
9.5	--	0.425	95	0.063	78	--	--	--	--
Note:	"--" denotes sieve not used and/or hydrometer analysis not tested					--	--		



Test Methods	Notes
Particle Size Analysis: NZS 4402:1986: Test 2.8.1 (Wet Sieve Method)	All information supplied by Client

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

This report may only be reproduced in full

Date Tested: 05/10/21

Date Reported: 18/10/21

IANZ Approved Signatory Thirushen Pillay

Designation : *Senior Civil Engineering Technician*

Date : 19/10/21

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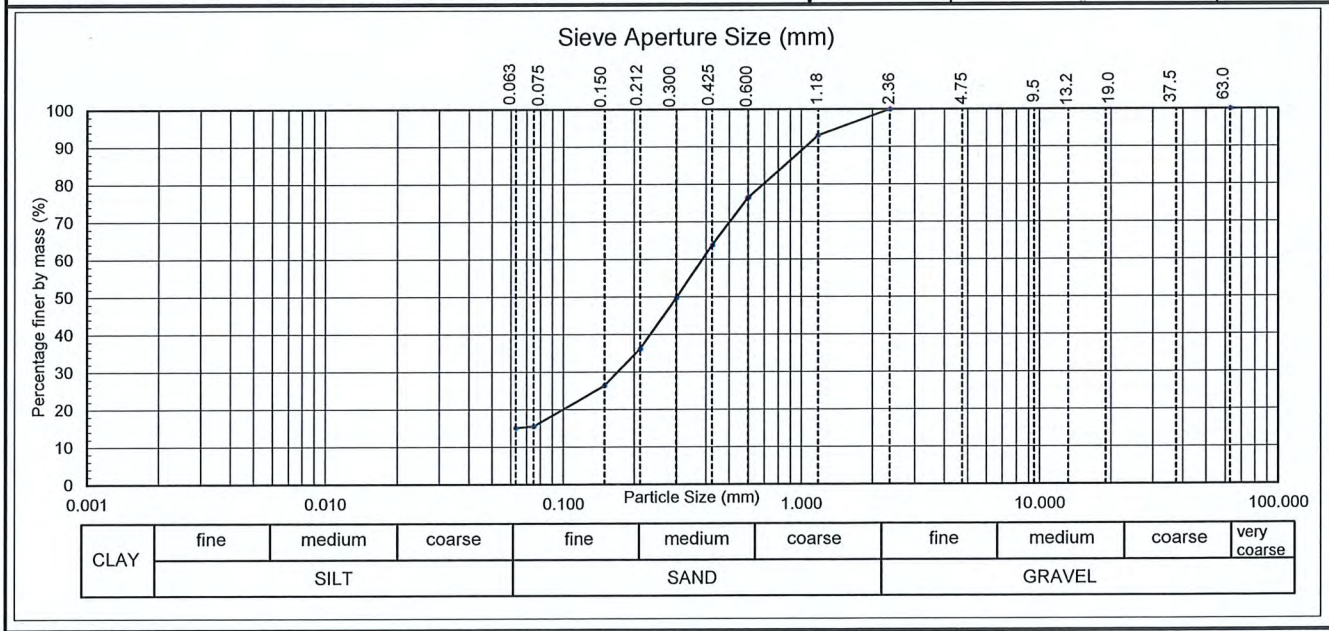
PARTICLE SIZE ANALYSIS (WET SIEVE METHOD)
TEST REPORT

Project :	Muriwai Downs
Location :	710 Muriwai Road
Client :	Riley Consultants Ltd c/o The Bears Home Project Management Limited
Client Ref :	210339
Contractor :	Not Stated
Borehole No:	TP2 Depth: 3.40 metres
Sampled by :	GB
Date received :	10/08/21
Sampling method :	Bulk samples
Sample condition :	As received
Sample description :	SAND with minor silt and clay
Solid Particle Density (t/m^3):	-
Water Content (as received):	38.8 %

Project No:	1-LA614.00
Lab Ref No:	AL6732/10
Client Ref:	210339

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
63.0	--	4.75	--	0.300	50	--	--	--	--
37.5	--	2.36	100	0.212	36	--	--	--	--
19.0	--	1.18	93	0.150	26	--	--	--	--
13.2	--	0.600	77	0.075	16	--	--	--	--
9.5	--	0.425	64	0.063	15	--	--	--	--
Note:	"--" denotes sieve not used and/or hydrometer analysis not tested					--	--		



Test Methods	Notes
Particle Size Analysis: NZS 4402:1986: Test 2.8.1 (Wet Sieve Method)	All information supplied by Client

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

This report may only be reproduced in full

Date Tested: 05/10/21

Date Reported: 18/10/21

IANZ Approved Signatory Thirushen Pillay

Designation : *Senior Civil Engineering Technician*

Date : 19/10/21

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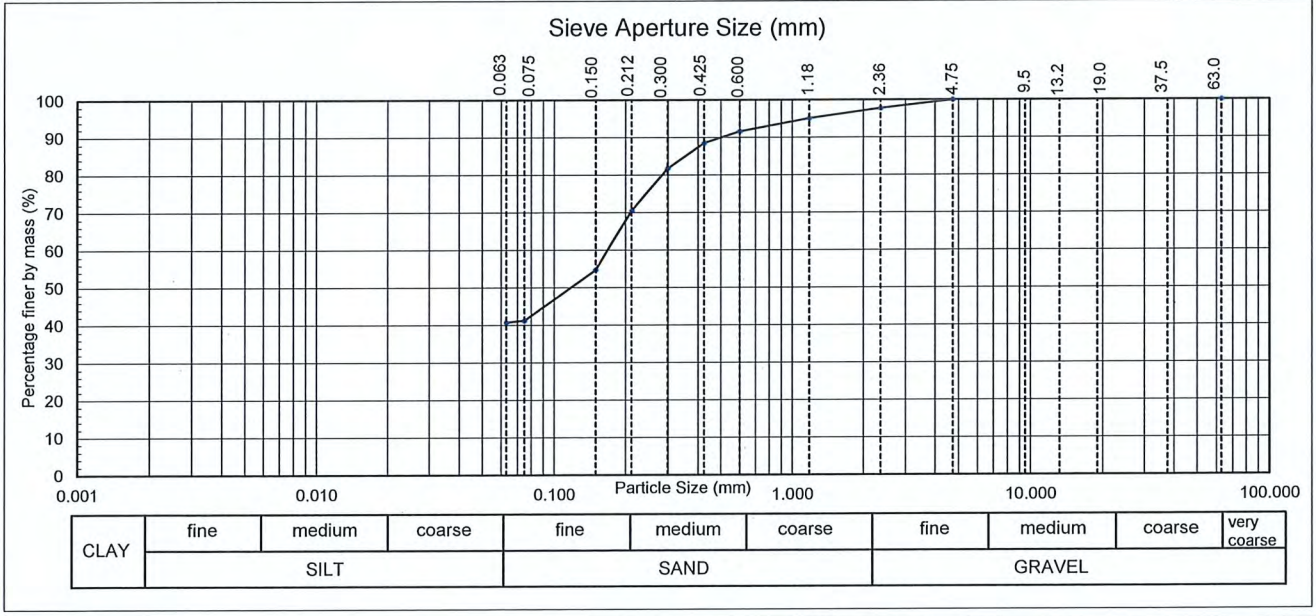
PARTICLE SIZE ANALYSIS (WET SIEVE METHOD)
TEST REPORT

Project :	Muriwai Downs
Location :	710 Muriwai Road
Client :	Riley Consultants Ltd c/o The Bears Home Project Management Limited
Client Ref :	210339
Contractor :	Not Stated
Borehole No:	TP4 Depth: 2.40 metres
Sampled by :	GB
Date received :	10/08/21
Sampling method :	Bulk samples
Sample condition :	As received
Sample description :	clayey silty SAND with traces of gravel
Solid Particle Density (t/m^3):	-
Water Content (as received):	34.0 %

Project No:	1-LA614.00
Lab Ref No:	AL6732/11
Client Ref:	210339

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
63.0	--	4.75	100	0.300	82	--	--	--	--
37.5	--	2.36	98	0.212	71	--	--	--	--
19.0	--	1.18	95	0.150	55	--	--	--	--
13.2	--	0.600	92	0.075	41	--	--	--	--
9.5	--	0.425	89	0.063	41	--	--	--	--
Note:	"--" denotes sieve not used and/or hydrometer analysis not tested					--	--		



Test Methods	Notes
Particle Size Analysis: NZS 4402:1986: Test 2.8.1 (Wet Sieve Method)	All information supplied by Client

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

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Date Tested: 05/10/21

Date Reported: 18/10/21

IANZ Approved Signatory Thirushen Pillay

Designation : *Senior Civil Engineering Technician*

Date : 19/10/21

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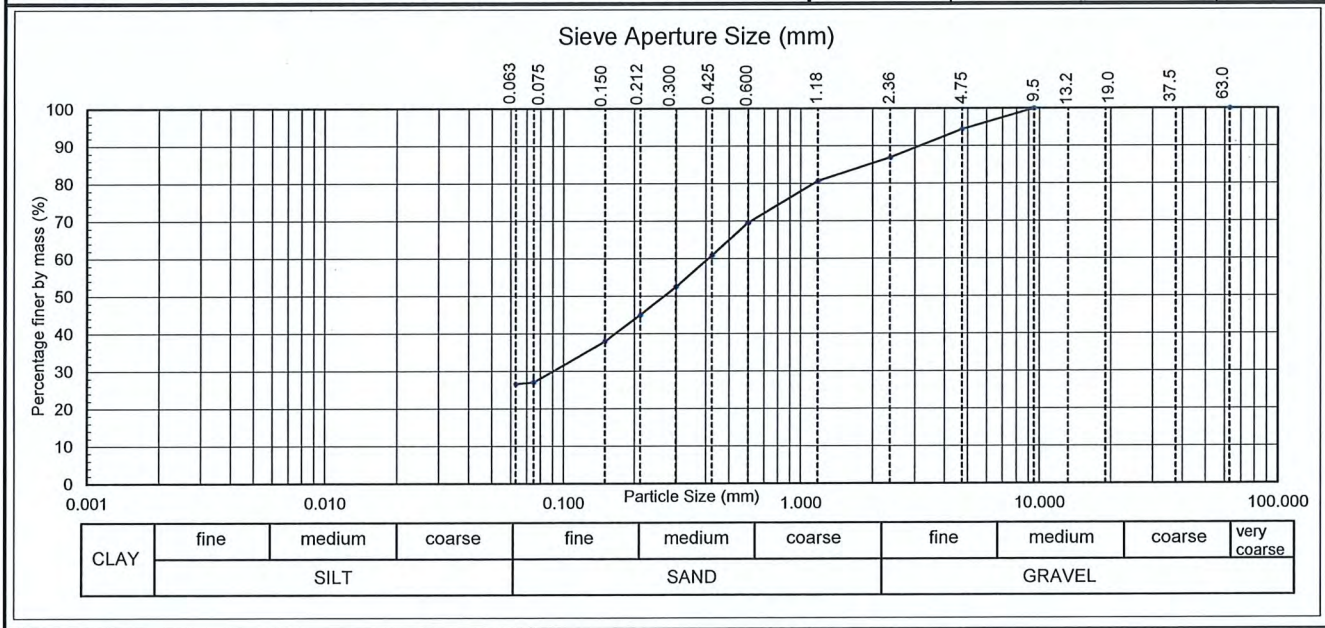
PARTICLE SIZE ANALYSIS (WET SIEVE METHOD)
TEST REPORT

Project :	Muriwai Downs
Location :	710 Muriwai Road
Client :	Riley Consultants Ltd c/o The Bears Home Project Management Limited
Client Ref :	210339
Contractor :	Not Stated
Borehole No:	TP6 Depth: 2.90 metres
Sampled by :	GB
Date received :	10/08/21
Sampling method :	Bulk samples
Sample condition :	As received
Sample description :	clayey silty SAND with some gravel
Solid Particle Density (t/m^3):	-
Water Content (as received):	37.7 %

Project No:	1-LA614.00
Lab Ref No:	AL6732/12
Client Ref:	210339

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
63.0	--	4.75	94	0.300	53	--	--	--	--
37.5	--	2.36	87	0.212	45	--	--	--	--
19.0	--	1.18	81	0.150	38	--	--	--	--
13.2	--	0.600	70	0.075	27	--	--	--	--
9.5	100	0.425	61	0.063	27	--	--	--	--
Note:	"--" denotes sieve not used and/or hydrometer analysis not tested					--	--		



Test Methods	Notes
Particle Size Analysis: NZS 4402:1986: Test 2.8.1 (Wet Sieve Method)	All information supplied by Client

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

Date Tested: 05/10/21

Date Reported: 18/10/21

IANZ Approved Signatory Thirushen Pillay

Designation : *Senior Civil Engineering Technician*

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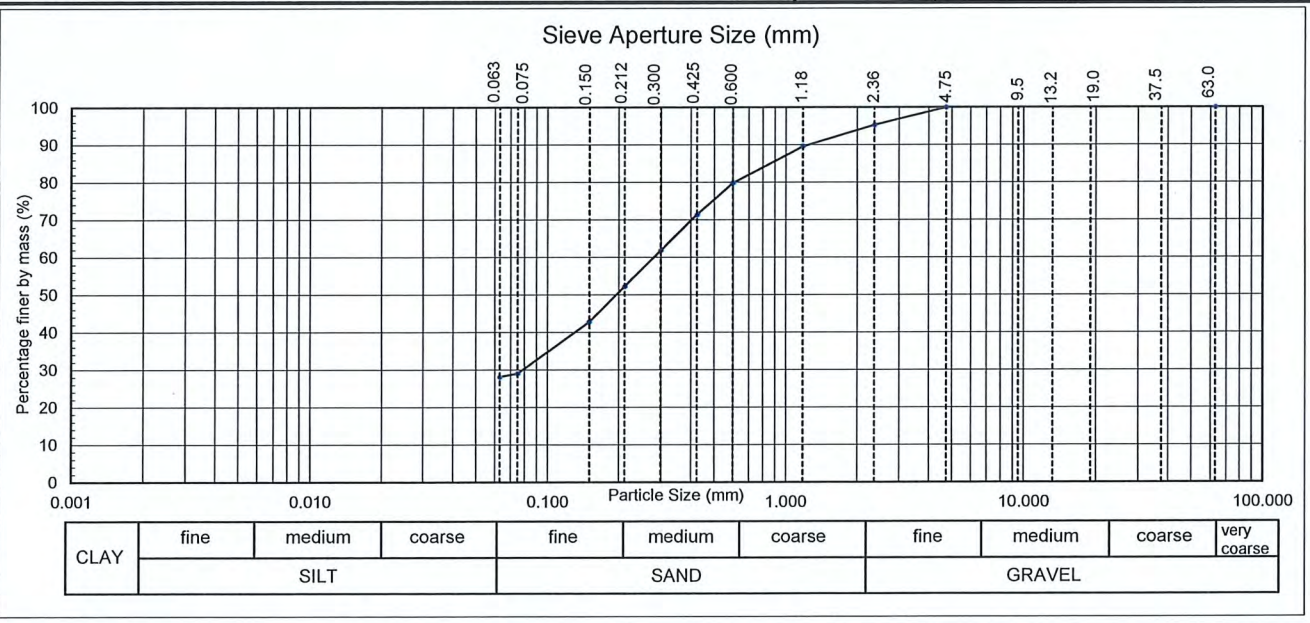
PARTICLE SIZE ANALYSIS (WET SIEVE METHOD)
TEST REPORT

Project :	Muriwai Downs
Location :	710 Muriwai Road
Client :	Riley Consultants Ltd c/o The Bears Home Project Management Limited
Client Ref :	210339
Contractor :	Not Stated
Borehole No:	TP11 Depth: 2.00 metres
Sampled by :	GB
Date received :	10/08/21
Sampling method :	Bulk samples
Sample condition :	As received
Sample description :	clayey silty SAND with minor gravel
Solid Particle Density (t/m^3):	-
Water Content (as received):	45.1 %

Project No:	1-LA614.00
Lab Ref No:	AL6732/13
Client Ref:	210339

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
63.0	--	4.75	100	0.300	62	--	--	--	--
37.5	--	2.36	95	0.212	52	--	--	--	--
19.0	--	1.18	90	0.150	43	--	--	--	--
13.2	--	0.600	80	0.075	29	--	--	--	--
9.5	--	0.425	71	0.063	28	--	--	--	--
Note:	"--" denotes sieve not used and/or hydrometer analysis not tested					--	--		



Test Methods	Notes
Particle Size Analysis: NZS 4402:1986: Test 2.8.1 (Wet Sieve Method)	All information supplied by Client

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

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Date Tested: 05/10/21

Date Reported: 18/10/21

IANZ Approved Signatory Thirushen Pillay

Designation : *Senior Civil Engineering Technician*

Date : 19/10/21

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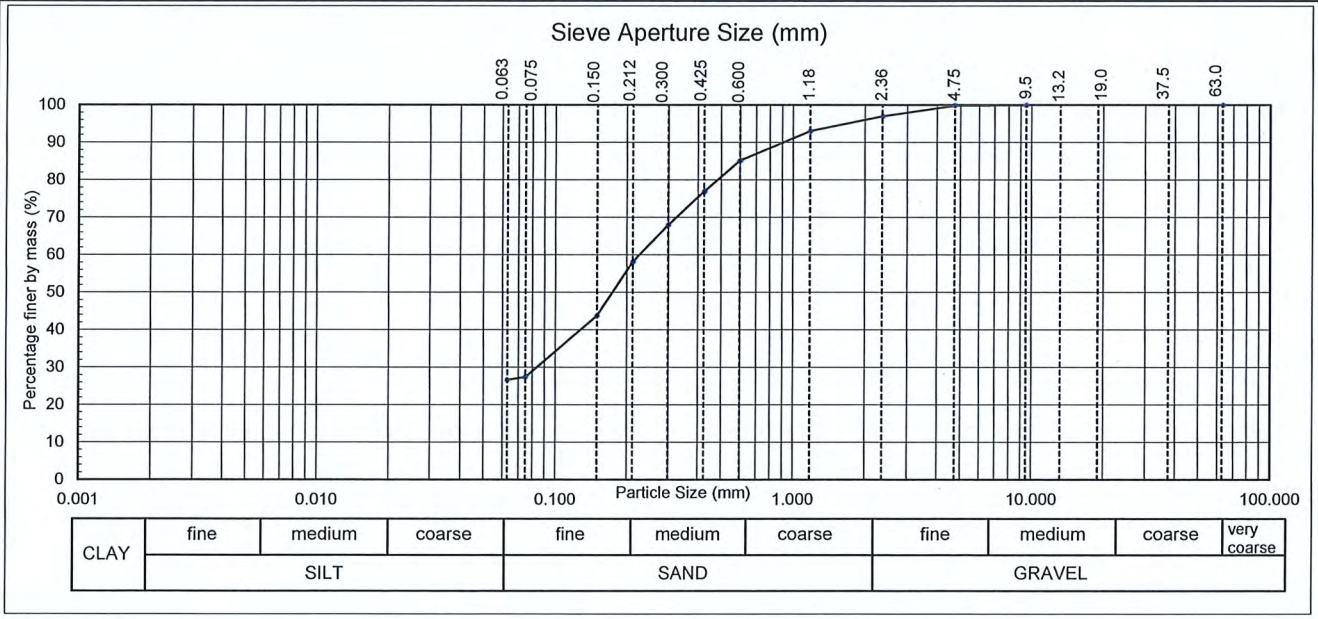
PARTICLE SIZE ANALYSIS (WET SIEVE METHOD)
TEST REPORT

Project :	Muriwai Downs
Location :	710 Muriwai Road
Client :	The Bears Home Project Management Limited c/o Riley Consultants Ltd
Client Ref :	210339
Contractor :	Not Stated
Borehole No:	TP8 Depth: 2.50 metres
Sampled by :	GB
Date received :	10/08/21
Sampling method :	Bulk samples
Sample condition :	As received
Sample description :	clayey silty SAND with traces of gravel
Solid Particle Density (t/m^3):	-
Water Content (as received):	40.7 %

Project No:	1-LA614.00
Lab Ref No:	AL6732/14
Client Ref:	210339

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
63.0	--	4.75	100	0.300	68	--	--	--	--
37.5	--	2.36	97	0.212	58	--	--	--	--
19.0	--	1.18	93	0.150	44	--	--	--	--
13.2	--	0.600	85	0.075	27	--	--	--	--
9.5	100	0.425	77	0.063	27	--	--	--	--
Note:	"--" denotes sieve not used and/or hydrometer analysis not tested					--	--		



Test Methods	Notes
Particle Size Analysis: NZS 4402:1986: Test 2.8.1 (Wet Sieve Method)	All information supplied by Client

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

Date Tested: 06/10/21

Date Reported: 18/10/21

IANZ Approved Signatory Thirushen Pillay

Designation : *Senior Civil Engineering Technician*

Date : 19/10/21

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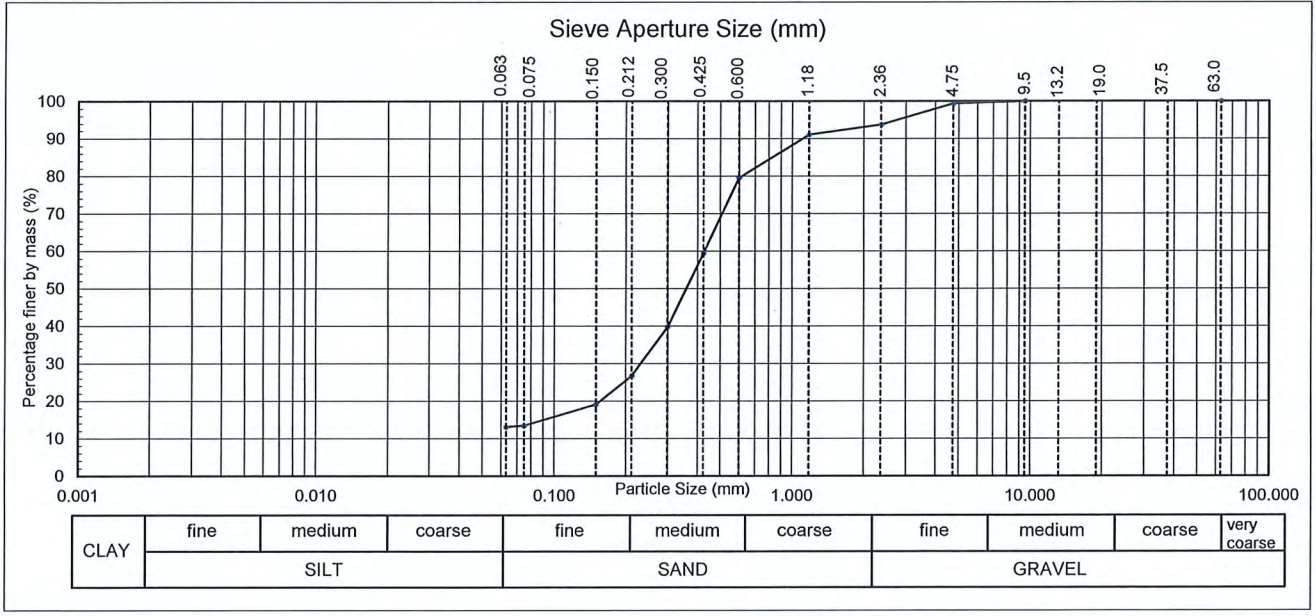
PARTICLE SIZE ANALYSIS (WET SIEVE METHOD)
TEST REPORT

Project :	Muriwai Downs
Location :	710 Muriwai Road
Client :	The Bears Home Project Management Limited c/o Riley Consultants Ltd
Client Ref :	210339
Contractor :	Not Stated
Borehole No:	TP10 Depth: 3.40 metres
Sampled by :	GB
Date received :	10/08/21
Sampling method :	Bulk samples
Sample condition :	As received
Sample description :	SAND with minor silt,clay and gravel
Solid Particle Density (t/m^3):	-
Water Content (as received):	30.6 %

Project No:	1-LA614.00
Lab Ref No:	AL6732/15
Client Ref:	210339

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
63.0	--	4.75	99	0.300	40	--	--	--	--
37.5	--	2.36	94	0.212	27	--	--	--	--
19.0	--	1.18	91	0.150	19	--	--	--	--
13.2	--	0.600	80	0.075	13	--	--	--	--
9.5	100	0.425	59	0.063	13	--	--	--	--
Note:	"--" denotes sieve not used and/or hydrometer analysis not tested					--	--		



Test Methods	Notes
Particle Size Analysis: NZS 4402:1986: Test 2.8.1 (Wet Sieve Method)	All information supplied by Client

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.

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Date Tested: 06/10/21

Date Reported: 18/10/21

IANZ Approved Signatory Thirushen Pillay

Designation : *Senior Civil Engineering Technician*

Date : 19/10/21

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DRY DENSITY / WATER CONTENT RELATIONSHIP
STANDARD COMPACTION

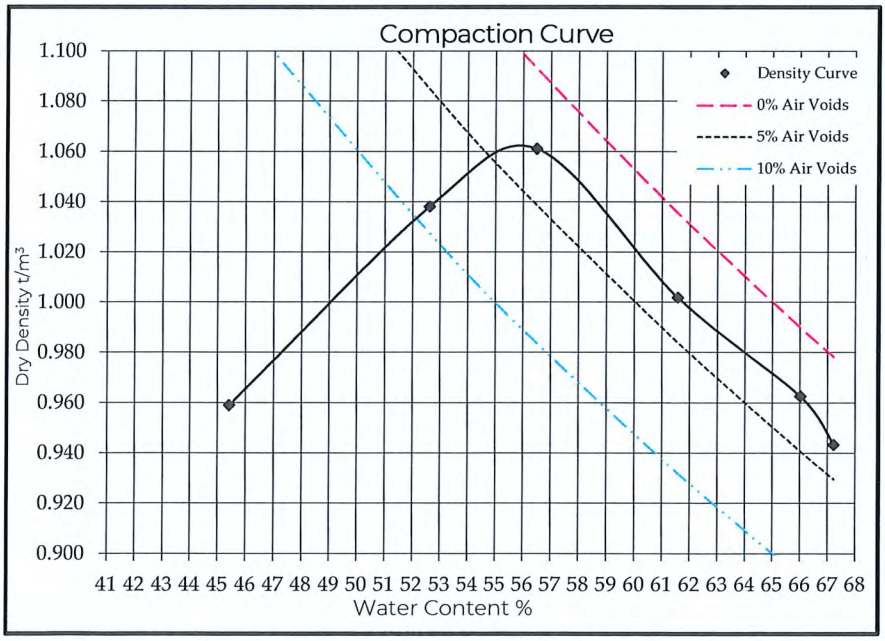
Project :	Muriwai Downs
Location :	710 Muriwai Road
Client :	Riley Consultants Ltd c/o The Bears Home Project Management Limited
Contractor :	Not Stated
Sampled by :	GB
Date sampled :	04-05/10/21
Sampling method :	Bulk samples
Sample description :	CLAY with minor sand and silt
Sample condition :	As received
Solid density :	2.86 t/m³ (Tested)
Source:	TP2 1.80m

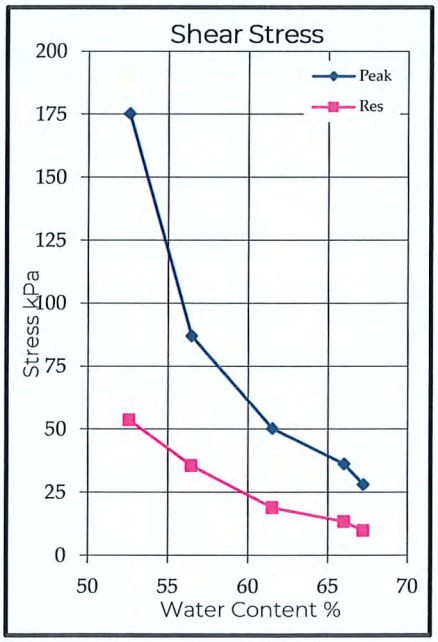
Project No :	1-LA614.00
Lab Ref No :	AL6732/16
Client Ref No :	210339

Test Results

Maximum dry density	1.06 t/m³	Natural water content	67.2 %
Optimum water content	56 %	Fraction tested	Passing 19mm test sieve

Sample ID		A	B	C	D	E	Nat	
Bulk density	t/m³	1.394	1.584	1.661	1.619	1.598	1.577	
Water content	%	45.4	52.6	56.5	61.6	66.0	67.2	
Dry density	t/m³	0.959	1.038	1.061	1.002	0.963	0.943	
Sample condition		Moist-Dry	Moist-Dry	Moist-Wet	Moist-Sat	Sat	Sat	
Peak stress	kPa	UTP	175	87	50	36	28	
Remoulded stress	kPa	-	54	36	19	14	10	





Test Methods		Notes
Compaction	NZS 4402 : 1986 Test 4.1.1 (Standard)	Sample description is not IANZ accredited
		Refer to report AL6732/5 for solid particle density test
Shear Strength using a Hand Held Shear Vane, NZ Geotechnical Soc Inc 8/2001		All information supplied by Client

Date tested : 17/08/21 - 23/09/21
Date reported : 18/10/2021

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
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IANZ Approved Signatory
Thirushen Pillay
Designation : *Senior Civil Engineering Technician*
Date : 01/11/21

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DRY DENSITY / WATER CONTENT RELATIONSHIP
STANDARD COMPACTION

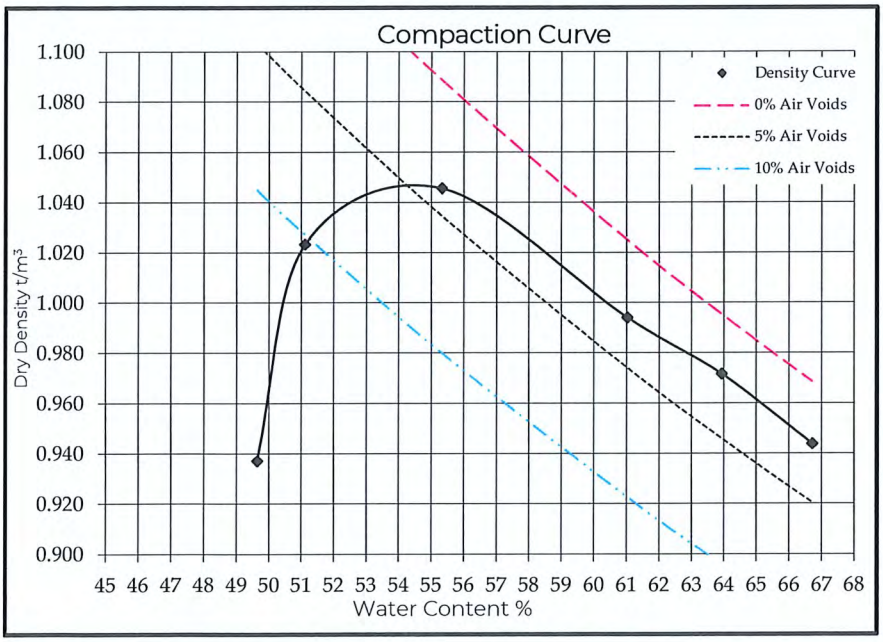
Project :	Muriwai Downs
Location :	710 Muriwai Road
Client :	Riley Consultants Ltd c/o The Bears Home Project Management Limited
Contractor :	Not Stated
Sampled by :	GB
Date sampled :	04-05/8/21
Sampling method :	Bulk samples
Sample description :	silty CLAY with some sand
Sample condition :	As received
Solid density :	2.74 t/m³ (Assumed)
Source:	TP6 2.10m

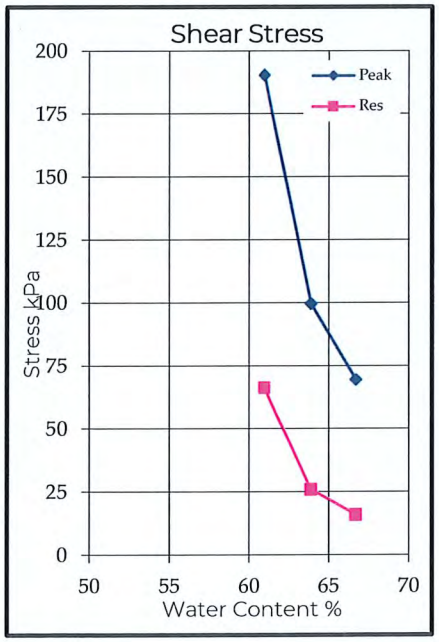
Project No :	1-LA614.00
Lab Ref No :	AL6732/17
Client Ref No :	210339

Test Results

Maximum dry density	1.05	t/m³	
Optimum water content	54	%	
Natural water content	61.0	%	
Fraction tested	Passing 19mm test sieve		

Sample ID		A	B	C	Nat	D	E	
Bulk density	t/m³	1.402	1.546	1.624	1.601	1.593	1.573	
Water content	%	49.6	51.1	55.3	61.0	63.9	66.7	
Dry density	t/m³	0.937	1.023	1.046	0.994	0.972	0.944	
Sample condition		Dry	Dry-Moist	Moist-Dry	Moist	Moist-Wet	Moist-Wet	
Peak stress	kPa	UTP	UTP	140+	190	100	70	
Remoulded stress	kPa	-	-	-	66	26	16	





Test Methods		Notes
Compaction	NZS 4402 : 1986 Test 4.1.1 (Standard)	Sample description is not IANZ accredited
Shear Strength using a Hand Held Shear Vane, NZ Geotechnical Soc Inc 8/2001		All information supplied by client

Date tested : 29/09/21-04/10/21
Date reported : 18/10/2021

Sampling is not covered by IANZ Accreditation. Results apply only to sample tested.
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IANZ Approved Signatory
Thirushen Pillay
Designation : *Senior Civil Engineering Technician*
Date : 01/11/21

ACCREDITED IANZ TESTING LABORATORY

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CRUMB TEST FOR DISPERSIBILITY OF SOILS
TEST REPORT

Project :	Muriwai Downs
Location :	710 Muriwai Road
Client :	Riley Consultants Ltd c/o The Bears Home Project Management Limited
Contractor :	-
Sampled by :	GB
Date sampled :	Not stated
Date received :	10/08/21
Sampling method :	Bulk samples
Sample condition :	As received

Project No :	1-LA614.00
Lab Ref No :	AL6732/18-20
Client Ref No :	210339

Test Results

Sample Lab Ref No :	AL6732/18	AL6732/19	AL6732/20
Location ID :	TP2	TP6	TP10
Depth (m) :	1.80	2.10	1.80
Description :	CLAY with minor sand and silt	Silty CLAY with some sand	CLAY with minor sand and silt
Grade :	1	1	1
Water Content as rec'd (%) :	66.9	59.0	65.2
Water Content as tested (%) :	66.9	59.0	65.2

Grade 1 : Nondispersive : No reaction - no turbid water created by colloids
Grade 2 : Intermediate : Slight reaction - faint , barely visible colloidal suspension
Grade 3 : Dispersive : Moderate reaction - easily visible cloud of suspended clay colloids around crumb surface
Grade 4 : Highly Dispersive : Strong reaction - dense profuse cloud of suspended clay colloids around bottom of dish

Test Methods		Notes
Crumb Test :	ASTM D6572 - 13	1) Whole soil tested.
Water Content :	NZS 4402 : 1986 Test 2.1	2) Samples were tested at natural water content.
		3) Samples tested were natural crumbs.

Date tested : 12/10/21
Date reported : 21/10/21

Approved

Designation : *Senior Civil Engineering Technician*
Date : 21/10/21

WSP
Hamilton (Fox St)
Quality Management Systems Certified to ISO 9001

4 Fox Street
Private Bag 3057, Waikato Mail Centre, 3240,
Hamilton, New Zealand

Telephone +64 7 856 2870
Website www.wsp.com/nz

APPENDIX I

RILEY Dwgs:
210339-1 to -4

MURIWAI ROAD

CPT01 CPT02 CPT03 CPT04 CPT05 CPT06 CPT07 CPT08 CPT09 CPT10 CPT11 CPT12

sDMT01 sDMT02 sDMT03 sDMT04

MH1 MH2 MH3

TP1 TP2 TP3 TP4 TP5 TP6 TP7 TP8 TP9 TP10 TP11 TP12

A 3 B 3 C 4 D 4

N

20 0 40 80m

SCALE 1:2000

LEGEND

- BOUNDARIES
- EXISTING CONTOURS
- PROPOSED CONTOURS
- MH1 MACHINEHOLE LOCATION
- TP7 TESTPIT LOCATION
- sDMT01/CPT1 DMT/CPT LOCATION

NOTE:

- AERIAL PHOTO FROM LINZ DATA SERVICE.
- CONTOURS BASED ON AUCKLAND COUNCIL DEM.
- DESIGN CONTOURS SUPPLIED BY

FOR INFORMATION

REV	DATE	ISSUE	BY
1		ISSUED FOR INFORMATION	JM

DESIGN	DES CHECK	APPROVED FOR ISSUE
EM	SLP	D TATE
DRAWN	CAD CHECK	
JM	JM	
DATE DRAWN		ISSUE DATE
AUG 2021		22 / 09 / 21

RILEY CONSULTANTS
www.riley.co.nz

CLIENT	THE BEARS HOME PROJECT MANAGEMENT LTD
ADDRESS	710 MURIWAI ROAD, MURIWAI VALLEY, AUCKLAND
PROJECT	MURIWAI DOWNS GOLF COURSE
SHEET TITLE	GEOTECHNICAL INVESTIGATION - SITE PLAN

ACENZ ISO 9001 CERTIFIED GCS

CADFILE	210339-1.dwg
SCALE (A3)	1:2000
ORIG. SHEET SIZE	A3
DRAWING No.	210339-1
REV.	1

MURIWAI ROAD

27°

20 0 40 80m

SCALE 1:2000

LEGEND

- BOUNDARIES
- EXISTING CONTOURS
- PROPOSED CONTOURS
- HEADSCARP
- INFERRED HEADSCARP
- INFERRED ALIGNMENT OF TOP OF CEMENTED SAND LAYER (FORMS STEEP SLOPES)
- ELEVATED AND DEGRADED ALLUVIAL TERRACES
- DEBRIS
- SPRING AND SUSPECTED SPRING
- HUMMOCKY GROUND
- 27° SLOPE ANGLE

FOR INFORMATION

REV	DATE	ISSUE	BY
1		ISSUED FOR INFORMATION	JM

DESIGN	DES CHECK	APPROVED FOR ISSUE
SLP	SLP	D TATE
DRAWN	CAD CHECK	
JM	JM	
DATE DRAWN		ISSUE DATE
AUG 2021		22 / 09 / 21

RILEY CONSULTANTS
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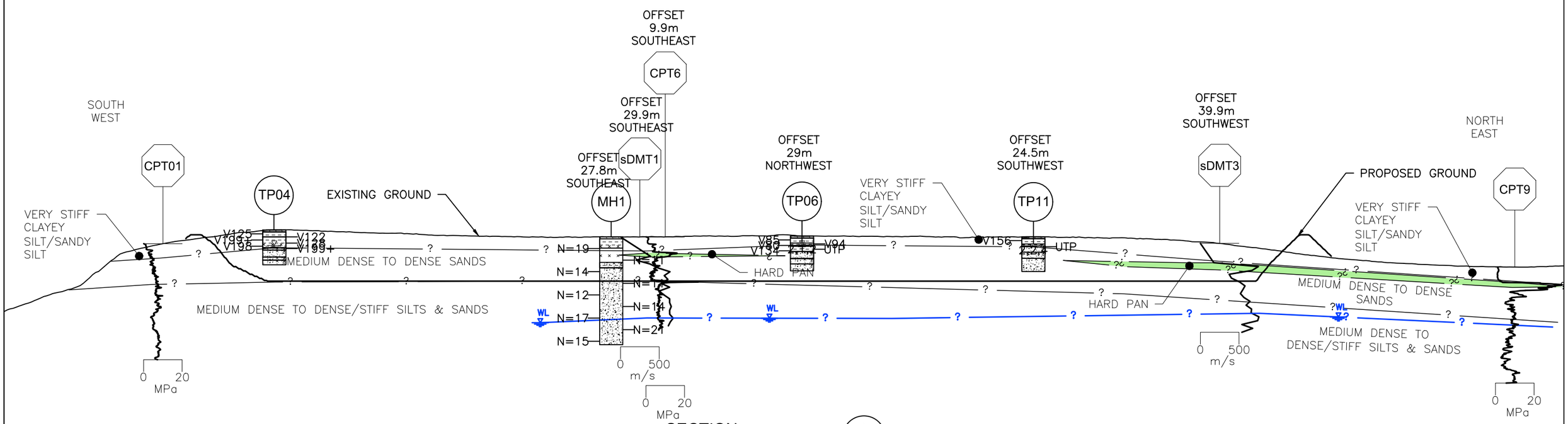
CLIENT	THE BEARS HOME PROJECT MANAGEMENT LTD
ADDRESS	710 MURIWAI ROAD, MURIWAI VALLEY, AUCKLAND
PROJECT	MURIWAI DOWNS GOLF COURSE
SHEET TITLE	GEOMORPHIC PLAN

ACENZ ISO GCS

CADFILE	210339-2.dwg
SCALE (A3)	1:2000
ORIG. SHEET SIZE	A3
DRAWING No.	210339-2
REV.	1



SECTION A 1

HORIZONTAL SCALE 1:1500
VERTICAL SCALE 1:500

LEGEND

MH1 TP1 TESTPIT/MACHINEHOLE LOCATION

sDMT1 CPT11 CPT/sDMT LOCATION

FILL CLAY ORGANICS

SILT SAND

— v188+ INSITU UNDRAINED SHEAR STRENGTHS (kPa)

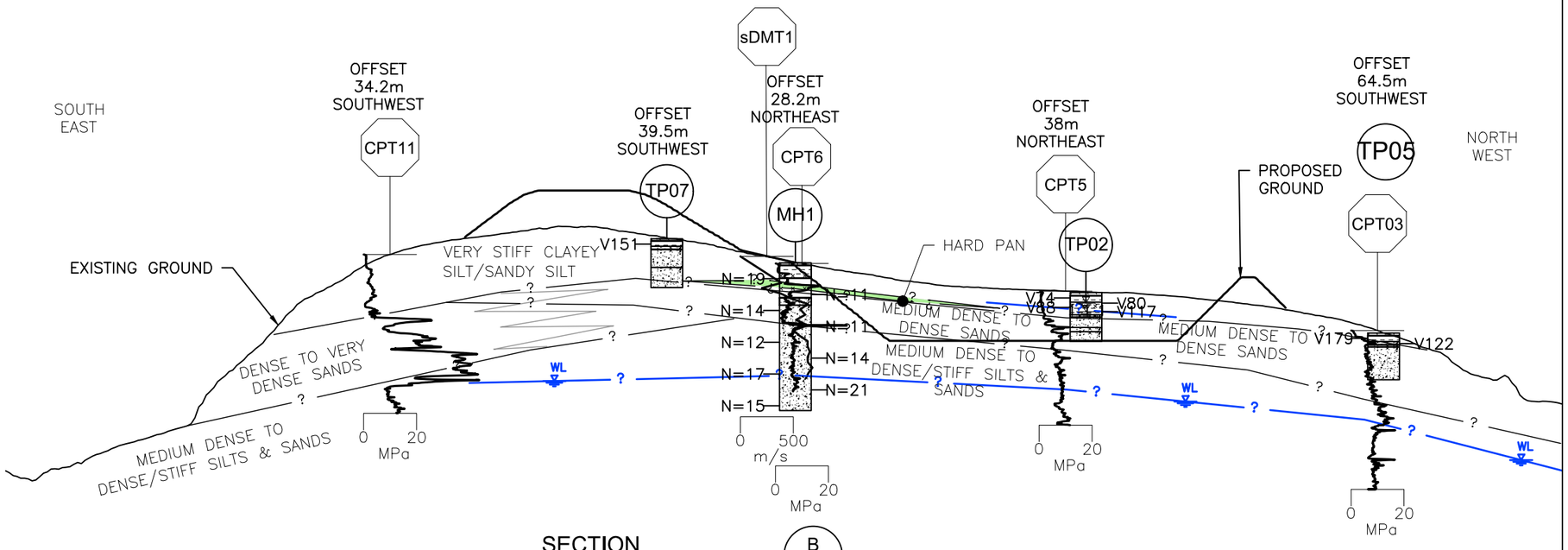
N=15 SPT N COUNTS

WL GROUNDWATER LEVEL

LATERAL TRANSITIONAL BOUNDARY

NOTE:

SECTIONS ARE VERTICALLY EXAGGERATED BY A FACTOR OF 3



SECTION B 1

HORIZONTAL SCALE 1:1500
VERTICAL SCALE 1:500

0 15 30 45 60 90 (m) SCALE 1:1500

0 5 10 15 20 30 (m) SCALE 1:500

FOR INFORMATION

REV	DATE	ISSUE	BY
1		ISSUED FOR INFORMATION	JM

DESIGN	DES CHECK	APPROVED FOR ISSUE
EM	SLP	D TATE
DRAWN	CAD CHECK	
JM	JM	
DATE DRAWN		ISSUE DATE
AUG 2021		22 / 09 / 21

RILEY CONSULTANTS
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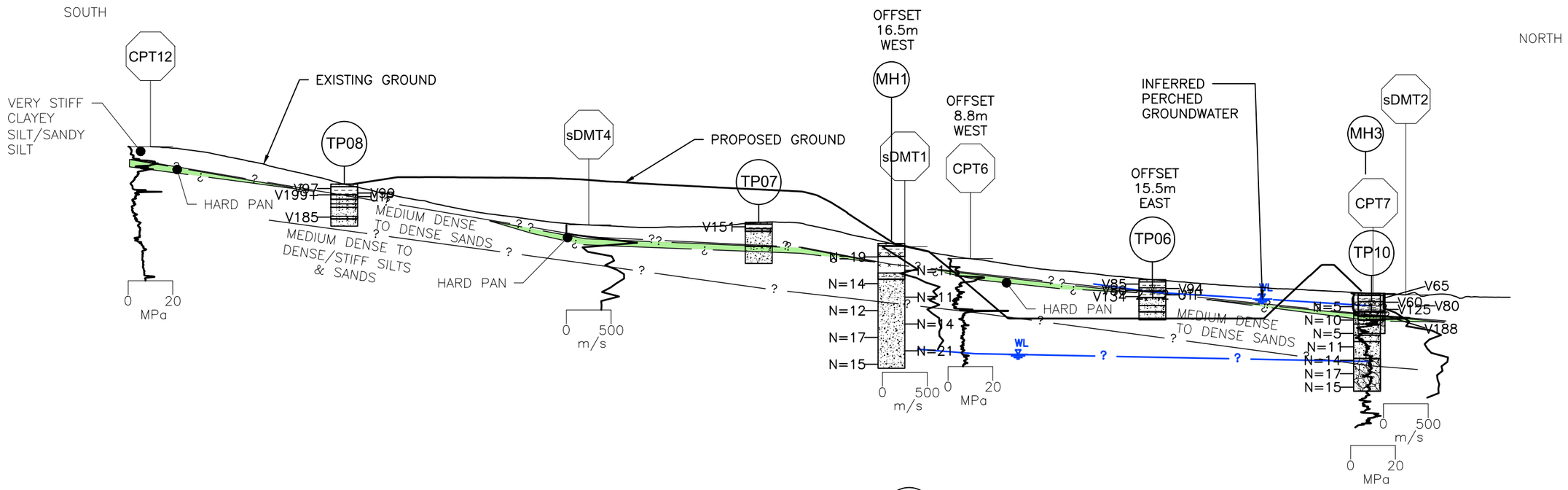
CLIENT	THE BEARS HOME PROJECT MANAGEMENT LTD
ADDRESS	710 MURIWAI ROAD, MURIWAI VALLEY, AUCKLAND
PROJECT	MURIWAI DOWNS GOLF COURSE
SHEET TITLE	CROSS SECTIONS - SHEET 1 OF 2

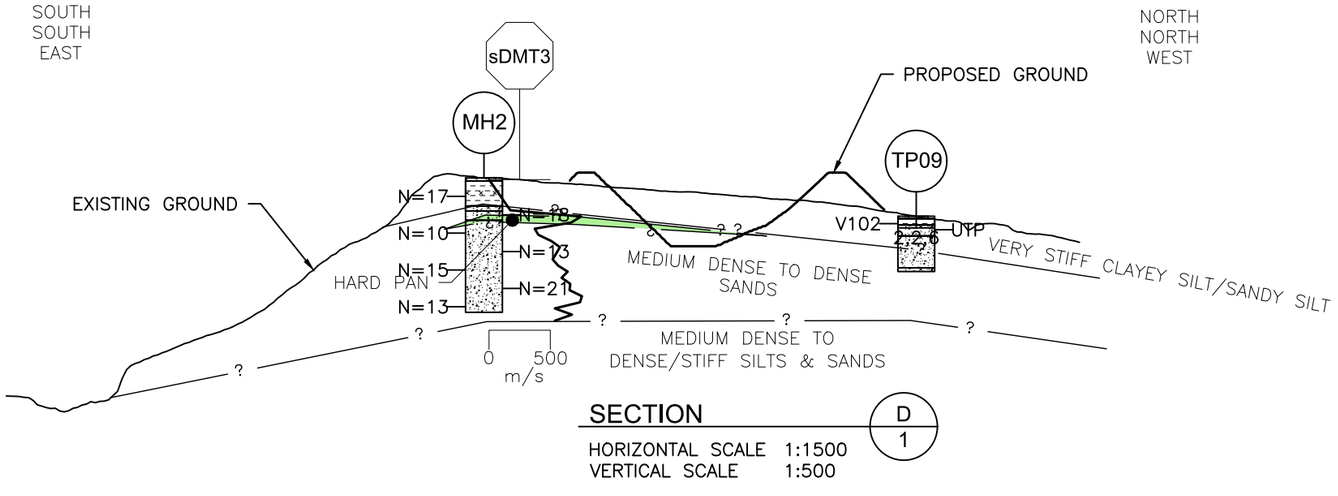
ACENZ ISO CERTIFIED GCS

CADFILE	210339-3&4.dwg
SCALE (A3)	AS SHOWN
ORIG. SHEET SIZE	A3
DRAWING No.	210339-3
REV.	1



SECTION C 1

HORIZONTAL SCALE 1:1500
VERTICAL SCALE 1:500



SECTION D 1

HORIZONTAL SCALE 1:1500
VERTICAL SCALE 1:500

LEGEND

MH1 TP1 — TESTPIT/MACHINEHOLE LOCATION

sDMT1 CPT11 — CPT/sDMT LOCATION

FILL CLAY ORGANICS

SILT SAND

— v188+ INSITU UNDRAINED SHEAR STRENGTHS (kPa)

N=15 SPT N COUNTS

WL GROUNDWATER LEVEL

LATERAL TRANSITIONAL BOUNDARY

NOTE:

SECTIONS ARE VERTICALLY EXAGGERATED BY A FACTOR OF 3

0 15 30 45 60 90 (m) SCALE 1:1500

0 5 10 15 20 30 (m) SCALE 1:500

FOR INFORMATION

REV	DATE	ISSUE	BY
1		ISSUED FOR INFORMATION	JM

DESIGN	DES CHECK	APPROVED FOR ISSUE
EM	SLP	D TATE
DRAWN	CAD CHECK	
JM	JM	
DATE DRAWN		ISSUE DATE
AUG 2021		22 / 09 / 21

RILEY CONSULTANTS
www.riley.co.nz

CLIENT	THE BEARS HOME PROJECT MANAGEMENT LTD
ADDRESS	710 MURIWAI ROAD, MURIWAI VALLEY, AUCKLAND
PROJECT	MURIWAI DOWNS GOLF COURSE
SHEET TITLE	CROSS SECTIONS - SHEET 2 OF 2

ACENZ ISO CERTIFIED GCS

CADFILE	
210339-3&4.dwg	
SCALE (A3)	ORIG. SHEET SIZE
AS SHOWN	A3
DRAWING No.	REV.
210339-4	1