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Resumption of PC95 – Further Information
Pencarrow Estate Pongakawa

Dear Abi,

We write following resumption of this plan change. In the intervening time, we note that the following has occurred:

1. Smartgrowth Strategy 2024-2074 comprising the Future Development Strategy (FDS) for the Tauranga/Western Bay of Plenty sub-region has been published (following consultation, in July 2024), as required under the National Policy Statement for Urban Development (NPS-UD); and
2. The 'Going for Housing Growth' central government policy programme, which concerns changes to the NPS-UD, has been publicly developed further.

Addressing the above where relevant, we provide this updated information as part of PC95 resuming, addressing:

- Settlement pattern;
- Highly productive land;
- Natural hazards;
- Three waters (stormwater, water supply, wastewater); and
- Transportation.

Settlement Pattern

Strategic matters in determining PC95 where settlement pattern is concerned are: a) consistency with the Future Development Strategy settlement pattern for the sub-region; b) consistency with the specific objectives and policies of the Bay of Plenty Regional Policy Statement (BOP RPS); and c) consistency with the objectives and policies of the NPS-UD.

Of importance to all of the considerations above is the question of whether or not the site is within an urban environment as defined by the NPS-UD. This is firstly addressed, prior to the FDS, BOP RPS and NPS-UD below.

Urban Environment

The definition of urban environment under the NPS-UD is any area of land (regardless of size or local authority or statistical boundaries) that:

a. *Is, or is intended to be, predominantly urban in character; and*
b. *Is, or is intended to be, part of a housing and labour market of at least 10,000 people.*

We consider that the residential settlement at Arawa Road which PC95 expands and consolidates, both as existing and certainly as proposed to be modified, is 'urban' in character. Noting this is not defined in the WBOPDC District Plan or NPS-UD. This is because, in summary:

- The settlement concentrated on the eastern side of Arawa Road is zoned Residential, comprises sections ranging from $800m^2$ to $1000m^2$ in size (comparable to sections in residential areas of Te Puke and numerous suburbs of Tauranga).
- 76 existing dwellings are clustered at densities higher than $2000m^2$, and the plan change would increase densities within the settlement overall. The operative BOP RPS defines 'urban activities' to include *residential accommodation at a density of more than one dwelling per $2000m^2$ of site area*[1].
- The Bay of Plenty Council Regional Natural Resources Plan defines 'urban area or settlement' as *an area which contains an aggregation of more than 50 lots or sites of an average size of no more than $1000m^2$*[2]. This definition is met by both the existing Arawa Road settlement and certainly as proposed to be modified.
- The NPS-HPL defines 'urban', as a description of zoning, to include 'settlement' zones and any density of 'residential' zones, applicable to the Arawa Road settlement[3].
- The published Smartgrowth Strategy FDS defines urban as '*a concentration of residential, commercial and/or industrial activities, having the nature of a city, town, suburb or a village which is predominantly non-agricultural or non-rural in nature*'[4]. Urban, as most relevantly defined under the FDS and NPS-UD, therefore includes a concentration of residential activities at a town or village scale. The existing settlement at Arawa Road, and certainly as modified by PC 95, is assessed to meet this definition.

For the reasons traversed above, taking into account the recently published FDS, we conclude that the Arawa Road Pongakawa settlement (particularly as intended to be modified by the proposal) is predominantly urban in character, satisfying clause (a) of the definition of urban environment.

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[1] See BOP RPS definitions, page 212
[2] See BOPRC RNRP definitions, page 22
[3] See relevant definition, page 6 NPS-HPL
[4] See page 181, Smartgrowth Strategy 2024-2074

Regarding the second clause (b), concerning being part of a housing and labour market of at least 10,000 people. Please see **accompanying** letter from NERA economist Kevin Counsell dated 22nd August 2024. This confirms the Arawa Road residential settlement is in the same locality and housing market as Te Puke township (as is the settlement at Paengaroa)[5]. Based on the assessment that the land in question will be urban and is in the same housing and labour market as Te Puke township, it is assessed that the land is part of an urban environment and the planning decision to be determined is one that affects an urban environment[6].

Consistency with Future Development Strategy

Framing the FDS are strategic corridors in and around Tauranga city. The Eastern Corridor of the sub-region extends from eastern Tauranga through Te Puke township and Rangiuru/Paengaroa/Pongakawa, and is intended to accommodate the following:

- Rangiuru Business Park;
- Residential housing;
- Wairakei town centre;
- High value food production, port staging areas; and
- Connections to eastern Bay of Plenty and further horticultural production.

See image below for confirmation[7].

[5] Memorandum from Kevin Counsell, NERA, *Plan Change 95: Analysis of the geographic boundaries of local housing markets*, dated 22 August 2024, page 7
[6] Section 1.3, NPS-UD
[7] Sourced from Smartgrowth Strategy 2024-2074, page 146

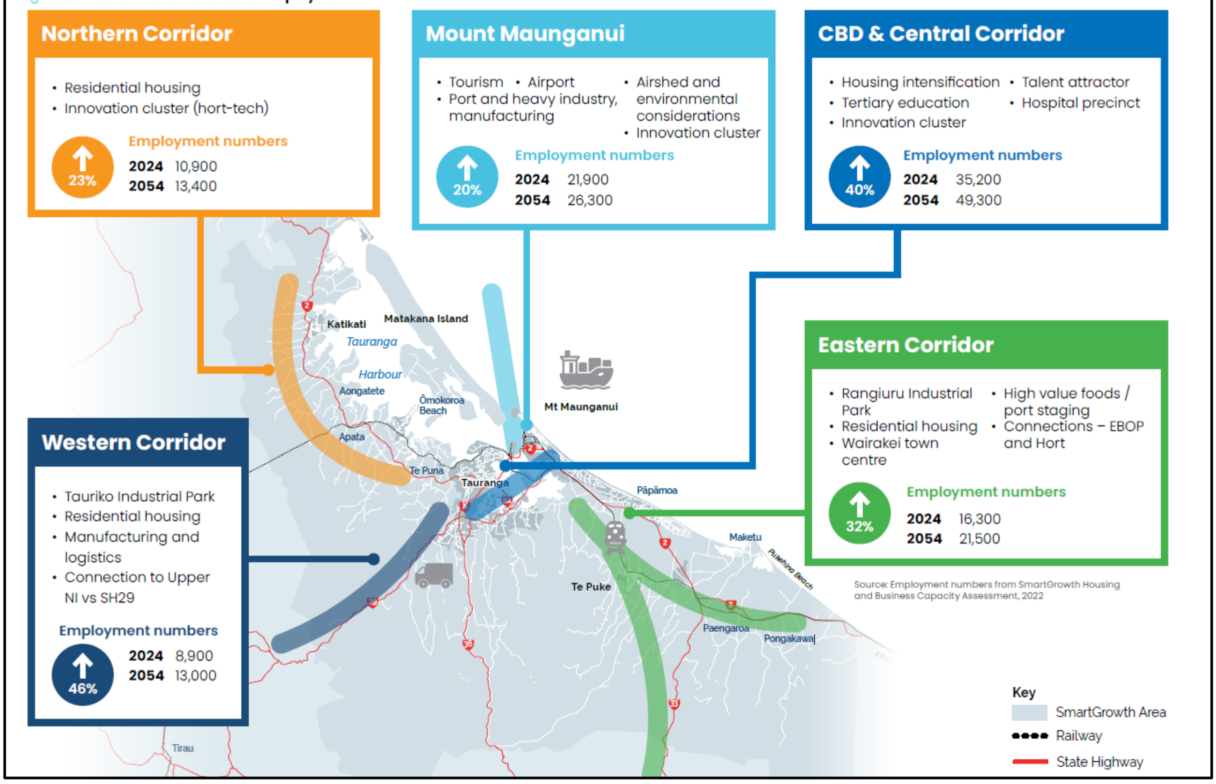

Figure 27: **Economic Corridors and Employment**

The final FDS itself is premised on a Connected Centres approach, central to which are two core concepts:

1. Increasing dwellings in existing urban and new growth areas; and
2. Being able to access local social and economic opportunities within a 15-minute journey time (walking or cycling), and sub-regional social and economic opportunities within 30-45 minutes[8].

The plan change gives effect to these core concepts, increasing the supply of dwellings in the existing urban area of Pongakawa. This is with integrated social (commercial, health and recreational amenities) close to growing employment sources and a local school, to deliver on the live-work-play intent of the Connected Centres approach.

It is acknowledged key centres and growth areas are specified within each corridor, as are broad indications[9] of the staged growth areas, and it is acknowledged Pongakawa is not specified as such. However, the FDS applies to all urban development[10], which includes Arawa Road and PC95, not just those expressly targeted as growth areas in the FDS. As the FDS also demonstrates that some demand is expected to be met in part in 'rural, lifestyle and small settlement locations', with the FDS allocating a growth share of 500 dwellings over the short

[8] Smartgrowth Strategy 2024-2074 page 155
[9] As required by 3.13(2) of the NPS-UD
[10] Smartgrowth Strategy 2024-2074 page 155

through long terms[11]. These locations are not spatially defined, nor is there a specified distribution of this supply across rural areas and small settlements beyond the indication of total supply across these locations generally. The Arawa Road urban settlement proposed to be consolidated is considered to clearly fit as a location suitable for accommodation of some of this small-settlement allocation within the FDS.

We finally note that the text accompanying Map 18: Future Development Strategy – Staging Map makes clear *“the future development areas shown are indicative only. Detailed information for individual areas is available in the respective City or District Plan or will be developed through future planning processes”*. Such as private plan changes like PC95.

When having regard to all relevant components of the FDS as described above, inconsistency exists only in terms of alignment with indicative locations nominated for growth. It is assessed that the proposal is consistent on-balance with the intent of the FDS overall, particularly concerning general provisions for growth of small urban settlements.

Consistency with the BOP RPS

Based on the above, the assessment of the proposal against Objective 23 and related Policy UG 7A of the BOP RPS is included below as these are strongly pertinent to the proposal (as modified by Plan Change 6 to the RPS giving effect to the NPS-UD, updated February 2024). These are worded as follows:

Objective 23: *A compact, well designed and sustainable urban form that effectively and efficiently accommodates the region’s urban growth.*

Policy UG 7A*: Providing for unanticipated or out-of-sequence urban growth - urban environments.*

Given Pongakawa is not specified in the FDS as a growth area with a target of dwellings (only subject to a general provision for some growth across numerous rural locations and small urban settlements), PC95 is not ‘plan enabled’ and as such is considered ‘unanticipated’ as defined by the NPS-UD and BOP RPS. Responsive consideration of such opportunities is expressly promoted by the NPS-UD which the BOP RPS gives effect to, to enable responsive planning decisions affecting urban environment that would add significantly to development capacity and contribute to well-functioning urban environments.

Out-of-sequence/unanticipated development is explained in the context of Policy UG 7A as adding ‘significantly to development capacity’ by way of satisfying the following criteria:

[11] Smartgrowth Strategy 2024-2074, page 152

(a) The development is of large enough scale to contribute to meeting demand for additional urban land identified through the HBA[12] for the area, including meeting housing bottom lines or meeting needs for specific housing typologies or price points, or business types. Where there is no HBA, there is evidence that there is a need for additional urban land, and

Comment: The most up-to-date HBA assessments illustrate insufficient housing development capacity in the sub region[13]. This is across short, medium and long-terms, accounting for supply currently predicted to be added over those same time periods. As stated, *"Over time, this strategy seeks to address these shortfalls through identified growth areas and allocations. However, without significant intervention there will remain a lack of housing that meets peoples need, in particular limited delivery of housing that is affordable for low and middle-income households"*.

The shortfall has been further examined in the local area of Pongakawa, by Mr Counsell see **accompanying** letter dated 8th April 2024 (given the lack of specific or finer-grain HBA assessment to the area). This assessment, drawing on Statistics NZ data, illustrates 137 dwellings in the Pongakawa local area can be expected to be demanded in the area over the next five years.

PC95 would contribute to the supply of residential land servicing the Eastern Corridor alleviating the shortfall in the local area. A range of price points are deliberately provided for by way of Lower Density and Higher Density areas within the proposed Structure Plan. It is anticipated the Plan Change area would be developed in the short-term, as it would be the only location able to provide in-demand further dwellings (once plan-enabled).

(b) For Tauranga City and Western Bay of Plenty District urban environments, the development is large scale (5 hectares or more), and sufficient to support multi modal transport options, and

Comment: The developable area to be delivered is approximately 9.7ha[14]. The density of development enabled and expected yield of approximately 120-130 further dwellings is expected to support alternative transport modes as opposed to a pure reliance on private vehicles in the area, particularly for school bus transport.

(c) For all other urban environments, the development is at a scale commensurate with the size of the urban environment and includes a structure plan for the land use change that meets the requirements of Method 18, and

[12] HBA = Housing and Business Assessment in accordance with NPS-UD. The most recent HBA analysis is contained within the FDS published July 2024 (pages 152-153).
[13] Urban areas in the WBOPDC District as at 2024 are short 2590 dwellings, growing to an expected shortfall of 2700 in the long-term post 2034. See page 153, FDS.
[14] Using RPS definition of developable land.

Comment: A structure plan has been prepared to show how the land will be serviced and includes proposed development staging. Up-to-date structure plan drawings are submitted with this package and should be read with structure-plan pre-requisites for each stage.

(d) *The development is located with good accessibility between housing, employment, community and other services and open space, and*

Comment: The site is proposed to be developed in response to increasing housing demand in the area. Central to the vision of the development is improving the social infrastructure offering, including play spaces and parks, and enabling commercial, health and educational opportunities through the proposed Commercial zoning to serve the Pongakawa community not provided for at the Arawa Road residential settlement. The development is therefore considered to proactively provide for and respond to housing and employment opportunities, and provision of community infrastructure, ensuring good accessibility between all features and to the important transport link of SH2.

(e) *The development is likely to be completed earlier than the anticipated urban development and/or land release sequence, and*

Comment: The entire development is likely to completed in the short-term given the pressing demand for housing in the area. It would therefore be completed far earlier than strictly planned or anticipated urban development based on planning documents prepared to date. In particular, the future 'Eastern Centre' between Rangiuru and Paengaroa is not expected to supply any dwellings until sometime between 2034-2054[15].

(f) *Required development infrastructure can be provided efficiently, including the delivery, funding and financing of infrastructure without materially reducing the benefits of other existing or planned development infrastructure, or undermining committed development infrastructure investment.*

Comment: Relevant infrastructure providers have confirmed feasibility of servicing the development enabled by the proposed plan change. This will be provided and funded by the developer. This confirms existing infrastructure investment by Council is not undermined.

Another potentially relevant RPS policy is UG 14B, should commissioners be of the view that the site is not within an urban environment (not that this precludes a finding of the decision affecting an urban environment due to being in the same market as Te Puke). This policy is worded as follows:

Policy UG 14B: *Restrict urban activities outside of urban environments*

[15] See page 157, Smartgrowth Strategy 2024-2074.

Restrict development outside of urban environments unless it can be demonstrated that sound resource management principles are achieved, including:

a) The efficient development and use of the finite land resource, and

b) Providing for the efficient, planned and co-ordinated use and development of infrastructure.

Comment: This policy is concerned with avoiding a sporadic settlement pattern and inefficient use of natural and physical resources. Development enabled in this location is not sporadic or isolated – rather, an existing urban area would be consolidated.

In respect of settlement pattern, the proposal is considered to efficiently and effectively accommodate growth near sources of employment and provide commercial and social infrastructure to deliver on live-work-play principles (as sought by the BOP RPS).

Coordinated three-waters, roading and public transport infrastructure development to service the community is provided for by the plan change. This would be completely funded by future developers, therefore not undermining existing infrastructure investments elsewhere in the district made by any Council, with future rates captured from new properties enabled by the plan change able to cover ongoing maintenance.

Regarding Policy UG 14B, it is noted BOPRC '*staff consider that Policy UG 14B does not conflict with Policy UG 7A and the expansion of existing settlements can be achieved where they meet the criteria of Policy UG 7A*'[16]. The criteria within Policy UG 7A have been assessed to be met by the plan change request.

For the reasons traversed above the proposal is therefore considered to be consistent with Objective 23 and specifically Policies UG 7A and UG 14B, being strongly relevant objective and policy directions of the BOP RPS.

Consistency with NPS-UD

MPAD remains of the view as previously assessed and expressed in the plan change application documents that the proposal is consistent with relevant objectives and policies of the NPS-UD. This is summarised below:

- The proposal consolidates the urban settlement of Pongakawa with commercial and recreational amenities, enabling locals to better provide for their social and economic well-being in particular by being able to locate close to employment sources and have reduced distances to travel to access amenities (Objective 1; Policy 1).

[16] 'Proposed Change 6 (National Policy Statement on Urban Development) to the BOP RPS – Overview Report on Submissions', dated 6th June 2023, pg. 9.

- A planning decision approving the plan change would improve housing affordability by introducing more supply to the connected urban environment encompassing Te Puke, Paengaroa and Pongakawa settlements/towns (Objective 2);
- A planning decision approving the plan change would enable significant development capacity to be added to a local market of an urban environment where housing shortage and demand is known to exist, being responsive to the housing supply pressure the NPS-UD is seeking to address (Objective 6; Policy 8), in a manner consistent with the FDS where small settlement urban area contributions are concerned (Policy 6).

Whilst not yet formal changes, we note that the Going for Housing Growth programme with inherent changes to the NPS-UD has advanced particularly in July 2024 with direction published on the scope of changes coming to the NPS-UD. These include (as applicable to a Tier 1 authority such as WBOPDC):

- Live-zoning 30-years worth of feasible capacity to maximise competition in land development and disincentivise land banking (NPS-UD does not require live-zoning to the same extent); and
- Improving the direction on responsiveness to private plan change proposals contributing to meeting housing targets (30-years live zoned) to clearly reduce planning barriers where all infrastructure is to be funded by developers.

As previously explained, the WBOP district currently has a shortage of over 2500 dwellings based on expert HBA assessments, with this expected to grow to 2700 once all growth allocations are given effect to. Therefore enabling the plan change would be clearly responsive and contribute towards the live-zoning (in an appropriate location) for 30-years capacity as signalled and expected to become formal planning policy under the NPS-UD.

For the reasons discussed above, the proposal is considered to be consistent with the relevant objectives and policies of the NPS-UD as it currently exists and more so as signalled to be altered.

Highly Productive Land

We are of the view that the requirements of section 3.6 of the NPS-HPL concerning urban rezoning of highly productive land are appropriately satisfied. This is summarised below, as informed by expert land productivity analysis **accompanying** this letter, prepared by agricultural and soil science and management experts Land Vision, dated August 2024. This report confirms that the plan change site comprises fragmented soil classified as LUC's 2, 3, 4 and 7. The LUC's 2 and 3 being 'highly productive land' under the NPS-HPL. The assessment is subdivided into the three clauses making up section 3.6.

3.6(1)(a) – Necessary to Add Development Capacity

Section 3.6(1)(a) enables a Tier 1 authority such as WBOPDC to allow urban re-zoning of highly productive land only if:

> *(a) the urban rezoning is required to provide sufficient development capacity to meet demand for housing or business land to give effect to the National Policy Statement on Urban Development 2020; and '*

Comment: The previous discussion under settlement pattern has confirmed that the Pongakawa residential settlement at Arawa Road is in the same housing market as Te Puke township, and as such is part of an urban environment under the NPS-UD. Whilst there have been questions from WBOPDC as to what degree successive HBA's assessments (calculating inadequacy of housing supply) have considered Pongakawa, there is no question that they have considered supply and demand in Te Puke. As traversed above, the District is currently short 2590 dwellings, growing to 2700 in the long term (once expected allocations within indicated growth areas in the FDS are utilised), with 137 expected to be necessary in Pongakawa over the next five years[22]. Over 10 years, 266 dwellings are predicted to be demanded[23] i.e. before any capacity is added by the future Eastern town centre within the Eastern Corridor of the FDS. As such the shortage is not going to be alleviated District wide or specific to Pongakawa/east of Te Puke, without further intervention. As such, we are of the view that further urban rezoning in WBOPDC such as PC 95 is required to provide sufficient development capacity to meet demand for housing land so as to give effect to the current NPS-UD. Therefore clause 3.6(1)(a) is assessed to be satisfied. Noting that the capacity requirements to be live-zoned and feasible to develop will only increase under the Going for Housing Growth amendments signalled to the NPS-UD, from 3-years feasible to 30-years feasible and live-zoned.

3.6(1)(b) – No Other Reasonably Practicable and Feasible Options

Section 3.6(1)(b) requires that:

> *(b) there are no other reasonably practicable and feasible options for providing at least sufficient development capacity within the same locality and market while achieving a well-functioning urban environment; and*

Comment: Beyond the s.32 analysis submitted, hypothetical options for achieving a well-functioning urban environment contiguous or close to existing urban settlements (reflecting the PC95 concept), in the same locality and market, have been explored. These are considered to be development adjacent to the townships/settlements of Te Puke and Paengaroa.

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[22] Paragraph 9, Economic Appraisal Report – Kevin Counsell, NERA, dated 8th April 2024
[23] Ibid

In satisfying clause 3.6(1)(b), consideration by the territorial authority must be had to reasonably practicable and feasible options (in the same locality and market) as directed by clause 3.6(2), which states:

In order to meet the requirements of subclause (1)(b), the territorial authority must consider a range of reasonably practicable options for providing the required development capacity, including:

(a) greater intensification in existing urban areas; and

Comment: Considerably greater infill intensification and addition to capacity has been plan-enabled in Te Puke township by way of Plan Change 92. This, combined with similar growth potential added in Ōmokoroa and specifically targeted elsewhere in the District under the FDS, is expressly acknowledged in the FDS however remains insufficient to provide the required development capacity.

The existing residential zone and settlement of Paengaroa, not benefitting from Plan Change 92, appears to have limited and constrained intensification and infill potential in our view. This is due to the current zone and settlement having been mostly subdivided down to 500-850m^2 sections and over time developed with housing and incidental buildings across most lots. This is considered to reflect typical residential living sought of smaller settlements outlying larger towns or cities, and the potential for intensification is not considered to be realistically comparable in terms of yield to development capacity in comparison to PC95.

(b) rezoning of land that is not highly productive land as urban; and

Comment: The **accompanying** assessment of Land Vision demonstrates that all land adjoining the Te Puke and Paengaroa urban areas are LUC 2 or 3 (ascertained via desktop review). The exception to this is a 15ha area to the south of Te Puke which is LUC 4, however is observed as currently in use as a kiwifruit orchard.

The same desktop information indicates the PC95 site is LUC 2, however with the benefit of site survey and investigation it has been revealed to be a fragmented mixture of LUC 2, 3, 4 and 7.

Land Vision concludes that whilst there are some select areas surrounding Paengaroa and Te Puke urban areas with strictly less soil versatility, their overall productive capacity is higher than the plan change site when considering the different constraints applying to the land areas. Large tracts of land surrounding Te Puke and Paengaroa are high LUC 2 land generally considered unfavourable as alternatives for urban development. Particularly considering the physical characteristics of the land as subject to investment, improvement and management and now operating as orchards substantially surrounding Te Puke and Paengaroa and contributing to the local economy, as well as size and contiguity of highly productive land uses surrounding these areas.

As such, based on the expert advice of Land Vision, rezoning of other land near urban areas in the same locality and market not as highly productive is not an option in this instance, as other options result in consumption of more highly productive land which has been subject to substantial horticultural investment.

> *(c) rezoning different highly productive land that has a relatively lower productive capacity.*

For the same reasons discussed above, based on the expert advice of Land Vision, rezoning of other land near urban areas in the same locality and market of a relatively lower productive capacity is not an option in this instance, as the PC95 site has the lower productive capacity.

The assessment above supports in our view the position that the overwhelming majority of land surrounding Te Puke and Paengaroa are not reasonably practicable or feasible options as sites for adding similar development capacity whilst better preserving land productivity as sought by the NPS-HPL. However, nonetheless regard has been had to these locations beyond a strict land productivity perspective. It is acknowledged that there is a general location that may be considered within the scope of 3.6(1)(b) as a potential reasonably practicable option, being immediately north of Te Puke township where are there are some clear gaps in orchards between urban areas and infrastructure i.e. providing consolidation potential similar to Arawa Road.

Developing in this location would introduce residential development adjacent to horticultural, dairy farming, and industrial (Station Road) land uses. Being sources of reverse sensitivity generators to all immediate boundaries of the area. It would also introduce development incursion into mapped flood-risk areas, which future urban stormwater management and earthworks floodwater displacement would need to respond to. See image below (sourced from WBOPDC's Eplan).

Considering the degree of constraint upon the land considered above, it is not considered to be reasonably practicable and feasible.

For the reasons as traversed above, no other reasonably practicable and feasible options are considered to exist in adding development capacity adjoining the Te Puke or Paengaroa locations whilst delivering well-functioning urban environments. As such, clause 3.6(1)(b) is assessed to be satisfied.

3.6(1)(c) – Benefits of Re-Zoning Outweighing Costs

Section 3.6(1)(b) requires that:

> *(c) the environmental, social, cultural and economic benefits of rezoning outweigh the long-term environmental, social, cultural and economic costs associated with the loss of highly productive land for land-based primary production, taking into account both tangible and intangible values.*

Comment: The Land Vision assessment accompanying this report provides productive land expert opinion that the plan change site is the least adverse to productive capacity of land adjoining urban areas in the same locality and market[24]. It further provides expert opinion that a

[24] *Land Productivity Assessment for Proposed Private Plan Change – Pencarrow Estate, SH2 Pongakawa*, prepared by Land Vision, dated August 2024, see discussion at section 9 and summary at section 9.6.

calculated loss of 9.9ha of effective highly productive land against the 44,000ha of the districts highly productive land is considered insignificant[25].

The cost of the loss of this productive land can be compared to benefits including:

- Provision of housing supply, in a locality experiencing deficiency, close to growing employment sectors of horticulture (significant kiwifruit expansion) and industrial (Rangiuru Business Park)[26];
- Enabling commercial and community amenities to directly serve the Pongakawa community, through the proposed Commercial zoning, with associated improved social resilience, and reductions in vehicle kilometres travelled and greenhouse gas emissions.
- Improved resilience of water supply network to service the Pongakawa community, and potential for that community to be serviced via reticulated wastewater network.
- Improved safety of use at the Arawa Road/SH2 intersection;
- Additional recreational amenity within walking and cycling distance of the Arawa Road community, complementing recreational investments planned by WBOPDC in the paper road of Arawa Road; and
- Environmental and ecological improvements in terms of local stormwater treatment, stream quality and quantum of terrestrial flora;

The above reinforces our assessment that genuine cost of loss of productive land would be outweighed by genuine benefits gained. Particularly when considering the Land Vision comparison to alternative land adjoining existing settlements/townships at Paengaroa/Te Puke and the productive land costs of developing at the edge of those urban areas. As such clause 3.6(1)(b) is assessed to be satisfied.

Natural Hazards – Risk of Loss of Life due to Flood Hazard

We wish to provide WBOPDC with further information on natural hazard risk from flooding. The below is supported by accompanying *Proposed Private Plan Change: Engineering Servicing Report, Pencarrow Estate*, Revision 7 dated 22nd August 2024.

The assessment demonstrates flooding velocities in the OLFP depressions of less than the BOPRC 2 m/s threshold occur for the 100-year flood event, and concludes that the risk of loss of life due to floodwater velocity and depth in overland flowpaths is adequately mitigated[27]. This is through evacuation routes not needing to cross those paths, and further discouragement of access into vegetated OLFP's through planting and/or fencing. This can be secured through

[25] Ibid, discussed at pages 2 and 22

[26] See page 153, Smartgrowth Strategy 2024-2074 for analysis of the District-wide shortages; see letter of Kevin Counsell dated 8th April 2024 for evidence of expected demand in the Pongakawa area.

[27] See section 5.7 – Lysaght Engineering Services report dated 22nd August 2024.

precise structure plan pre-requisites and during detailed design of the subdivision landform, roads and infrastructure.

Regarding downstream flood risk to loss of life, the engineering assessments[28] explains and further reiterates reduced runoff rates downstream across storm events with the proposed attenuation and treatment features in place as part of stormwater management. Therefore, flooding effects downstream and risk of loss of life is also considered suitably mitigated.

Three Waters

Wastewater

With respect to wastewater, we wish to provide further clarification on:

- Whether groundwater levels at winter interfere with the wastewater field;
- The risk of contaminants entering the neighbouring stream;
- The ability to extend the system to cater for the community; and
- Typical site layout with separation of on-site stormwater soakage and wastewater treatment features.

Further relevant information on these points is as follows:

- Groundwater levels have been investigated in August 2024 in the wastewater field area, via re-excavation of a test pit that informs the current geotechnical report (previous testing done at summer time). The groundwater table was observed at a minimum depth of 1.5m below ground level. See photos below evidencing the recent investigations undertaken. This is consistent with previous investigations that showed groundwater tables at depths of 1.4-1.8m in the same area[29]. Given separation of 600mm is sufficient between drip field level and groundwater level, the testing at summer and winter is considered to adequately demonstrate at this plan-change stage the wastewater field location is appropriate for a drip irrigation field.

[28] Ibid
[29] See CMW Geosciences report submitted with PC95.

- Table R2 of AS/NZ1547:2012 requires a 20m setback of the wastewater field from the Puanene Stream. This widened space is secured in the reserve adjacent to the wastewater field. As such, risk of contaminants/nutrient loading on the stream are considered to be appropriately mitigated by the structure plan design and appropriate location of the wastewater field. Further risk assessment when compliance with this standard is achieved is not considered necessary at this plan change stage, considering this will also be subject to further BOPRC consent requirements.

- The wastewater infrastructure provisions of the Structure Plan allow for the maximum land and system requirements necessary to service the development (primary field size of 3.5ha[30], see **accompanying** revised Structure Plan drawings). The precise size and extent of the system will be determined at subdivision/OSET consenting stage and is expected to be reduced from the current land estimated to be required. Similar soil conditions prevail outside of the nominated wastewater disposal field area. If WBOPDC determine a course of action to extend the vested system to service the wider Arawa Road community, this will be possible with primary infrastructure delivery already in place.
- Necessary on-site stormwater soakage and wastewater treatment devices can be accommodated within expected lots to result from future subdivision[31].

Stormwater

Further information with respect to overland flowpath performance is provided to demonstrate that appropriate overland flowpath infrastructure accounting for upstream and on-site stormwater/floodwater will be implemented[32]. Please also see attached Staging Plan providing further certainty that suitable overland flowpaths reflecting Lysaght recommendations will be secured and delivered with future development as required to appropriate service the site. Collectively this ensures that the appropriate overland flowpath sizes and therefore potential for appropriate performance is being secured by the plan change.

Three Waters Maintenance

Future maintenance costs following vesting of the infrastructure is a point that has been raised in submissions.

It is observed that currently, and as provided for in the current 2021 Long Term Plan (LTP), targeted rates are and can be used by WBOPDC if required to ensure cost-neutrality[33] and no passing of maintenance costs on to wider District ratepayers. As such, maintenance cost-neutrality can be secured whilst unlocking short-term housing growth consolidating an existing urban area and enabling services appropriate to service growth demanded in the area. As all

[30] Based on further analysis of the soil by CMW Geosciences confirming the wastewater disposal area is Class 3 soil under AS/NZ1547:2012 (personal communication to Vincent Murphy, August 2024), reducing the necessary primary field size from 4.5ha for 130 dwellings down to 3.5ha.
[31] See section 5.2 – Lysaght Engineering Services report dated 22nd August 2024.
[32] See section 5.8 – Lysaght Engineering Services report dated 22nd August 2024.
[33] For example, targeted wastewater rates apply to Ongare Point and Maketu owing to the on-site effluent treatment schemes servicing those communities maintained by Council.

installation and establishment costs are developer-funded and are not passed onto ratepayers, we therefore do not see this as 'inefficient' against the potential benefits to accrue.

To elaborate, it is noted that the 2021 LTP does signal uniformity of rates charges as much as possible across the District. Utilising publicly-available rate information for three waters services to Arawa Road properties (assuming consistency with the 2021 LTP uniform rate direction), the following amounts would be collected as a matter of standard rating practice per year for maintenance of the additional three-waters infrastructure provided[34]:

- Metered water – treatment and supply - $380/lot = $49,400/year for water network maintenance;
- Wastewater – $58/lot District Wide maintenance = $7540/year towards District wastewater infrastructure maintenance.
- Stormwater – now part of Uniform Annual General Charge, previously covered by an 'environmental protection' charge at $65/lot = $8450/year.

Given the use of a decentralised on-site wastewater network, it is anticipated that a targeted rate will (as is possible) be imposed on future property owners to benefit from the infrastructure (currently only those within the plan change site, however this could be expanded in the future at Council's discretion). The following annual operation and maintenance costs of the decentralised system are advised by routine suppliers of this infrastructure to developers and Council authorities Innoflow[35]:

Annual Costs at Full Development (130 houses + commercial sites = 140,000 L/day)

- *140 x On-lot Prelos tanks preventative maintenance at $90 per tank = $12,600*
- *On-lot Prelos tank sludge pump out allowance = $14,000*
- *Wastewater treatment tank preventative maintenance (at full development)- $25,000*
- *Chemical dosing top ups (sucrose and soda ash) - $5,000*
- *Consumables allowance = $5,000*
- *Effluent sample collection and analysis = $3,000*
- *Annual compliance reporting = $2,000*
- *4.7ha lawnmowing and light maintenance = $8,000*
- ***Total: $74,600 + GST/annum or $533 + GST/lot per annum***

[34] The figures are sourced from WBOPDC public information concerning rates applicable to Arawa Road. Verification with WBOPDC staff has not been possible prior to issue of this document.
[35] Estimates are subject to detailed design to confirm precise operation. Estimates provided August 2024.

The potential charge of $533/lot/annum is less than that applying to similar schemes at Maketu[36] and Ongare Point[37] ($963.07/lot/annum currently).

Wastewater maintenance costs can therefore be managed to deliver no impact to District ratepayers, in that routine maintenance costs for the de-centralised network would be funded by targeted rates. Nearly $50,000 per year will be collected per year from PC95 dwellings once fully developed, to be allocated for water network and stormwater infrastructure maintenance. Considering larger maintenance expenses typically occur in cycles of years or decades (for example, dredging of ponds; replacement of pipes), this is considered to be sufficient to cover likely maintenance burden to Council in the future.

Transportation

Please find attached further email correspondence with Waka Kotahi accompanying this letter, dated 14th August 2024. This correspondence demonstrates that subject to detailed design and marking requirements being first approved by Waka Kotahi, inclusive of further safety audit and the upgraded intersection being complete prior to any dwellings being occupied, Waka Kotahi are comfortable with the proposed intersection treatment. This is secured by proposed Structure Plan requisites to be inserted to Chapter 12 of the District Plan, which require the intersection to be upgraded to NZTA's satisfaction prior to titles for individual sections being able to be released (proposed Rule 12.4.24.3). As such, safety and geometry concerns are considered to be appropriately provided for, delivering benefit to the existing community through safer turning potential and visibility available at the intersection.

The formality of text changes to the current safety audit report requested by NZTA have been completed by the auditors Abley Transport Consultants and have been passed back to NZTA as requested in the same email.

We therefore consider there to be no outstanding issues in terms consideration of the design of the intersection with NZTA Waka Kotahi.

[36] Based on 'Property and Rates Search' via WBOPDC website, for site selected at random in Maketu – 12 Otimi Street. https://www.westernbay.govt.nz/property-rates-and-building/property-and-rates-search?searchBy=streetAddress&streetNumber=12&streetName=OTIMI%20STREET&property=0693011000

[37] Based on 'Property and Rates Search' via WBOPDC website, for site selected at random in Ongare Point – 26 Esplanade Road. https://www.westernbay.govt.nz/property-rates-and-building/property-and-rates-search?searchBy=streetAddress&streetNumber=26&streetName=ESPLANADE%20ROAD%20%28ONG-PT%29&property=0680814200

Conclusion

Two important strategic considerations which open the pathway to approval of this plan change stem from the NPS-UD and the NPS-HPL. These have been considered particularly in light of the published Smartgrowth Strategy 2024-2074, being the Future Development Strategy required for the Tauranga/Western Bay of Plenty sub-region under the NPS-UD.

Regarding the **NPS-UD,** drawing on expert economist advice where relevant, we conclude the following:

1. The Pongakawa residential settlement at Arawa Road can clearly be considered to be urban, given consistency with numerous relevant definitions in local planning documents and the clustering of residential-scale activity in that area.
2. PC95 intends to consolidate and expands the urban settlement at Arawa Road, by way of provision of further housing, and social (commercial, health and recreational) amenities.
3. As such, the land is, and is intended to be as a result of PC95, urban in character.
4. The settlement is part of the same housing market as Te Puke and Paengaroa. This population exceeds 10,000 people with Te Puke alone projected to exceed that number.
5. Therefore the land in question is part of an urban environment as defined by the NPS-UD, and the effect of the planning decision in respect of this private plan change would affect that urban environment.
6. The urban environment, collectively with all urban environments in the District, have been expertly defined in HBA analysis to be subject to a housing shortfall. This is allowing for expected uplift in supply across a 30-year timeframe in the District, including recent considerable uplift in Te Puke and Ōmokoroa through intensification Plan Change 92. A 2700-dwelling shortfall remains expertly predicted in the long-term (10-30 years). A finer grain local demand assessment by economist Kevin Counsell confirms reasonable demand in Pongakawa over the next five years, in the order of 137 dwellings.
7. The FDS under the NPS-UD anticipates some supply towards addressing the shortfall to be in small urban settlements such as Pongakawa.
8. The proposal introduces greater housing and social amenities in a location close to growing employment sources (horticulture and the Rangiuru Business Park), very close to an important private and public transport corridor (SH2). The nearest other development capacity to meet this demand is Te Puke (15km away) or Papamoa East (18km away), with greater vehicle kilometres travel required and associated greenhouse gas emissions particularly for horticultural employment opportunities.
9. With parks and play spaces, shops, and walking links located within the development, opening up and linking with the existing community, in close proximity to employment sources, close to Pongakawa School (with dedicated and safe bus stop proposed particularly for the schools benefit), and the important transport corridor of SH2, well-functioning urban environment principles are assessed to be met.

10. Overall the proposal is considered to be consistent with relevant objectives and policies of the NPS-UD and the intent of the FDS produced under it.
11. We note live-zoned capacity requirements under the NPS-UD are expected to increase by way of signalled amendments to the NPS-UD in the 'Going for Housing Growth' policy reforms.

Regarding the **NPS-HPL**, in particular section 3.6 concerning urban re-zoning of highly productive land, drawing on expert land productivity advice where relevant, we conclude the following:

1. Insufficient development capacity for the relevant urban environment exists as determined under the NPS-UD;
2. No other reasonably practicable and feasible options for providing at least sufficient development capacity with reduced impact upon productivity of land appear to exist in or adjacent to urban settlements in the same locality and market at Te Puke and Paengaroa. Use of the PC 95 site is preferred over use of land adjoining Te Puke and Paengaroa due to higher productive capacities in those locations, with substantial tracts of land already in operation as working orchards. Growth of this horticultural activity has progressed east towards Pongakawa in recent years.
3. The loss of 9.9ha of effective highly productive land against the 44,000ha of the Districts highly productive land is expertly considered insignificant. Against the benefits of providing housing close to employment sources and transport corridors, with important social infrastructure such as local shops and amenities, parks and play spaces to be enabled in walking distance of the existing (and proposed) residential community, the benefits of the loss of the HPL as incurred by PC95 are assessed to outweigh the costs.

Therefore the proposal satisfies Clause 3.6 of the NPS-HPL enabling the plan-change of highly productive land.

It is inherent in our view that the above conclusions are open to Council planning officers to conclude in s.42 reporting in balancing the considerations of settlement pattern, demand for housing and growth, proximity to employment sources, and loss of productive land.

The proposal is also considered to be overall consistent with expected outcomes as informed by the BOP RPS, with appropriate justification pursuant to s.32 of the RMA and appropriate environmental effects mitigation or avoidance.

Next steps:

We trust this response assists WBOPDC officers in closing out technical assessments and the s.42A planning reporting in advance of the November hearing.

We look forward to further engagement upon review of this information by Officers to offer any assistance with positive resolution of the matters addressed above.

Yours sincerely

Richard Coles

Director/Planner MNZPI

richard@mpad.co.nz

Vincent Murphy

Senior Planner MNZPI

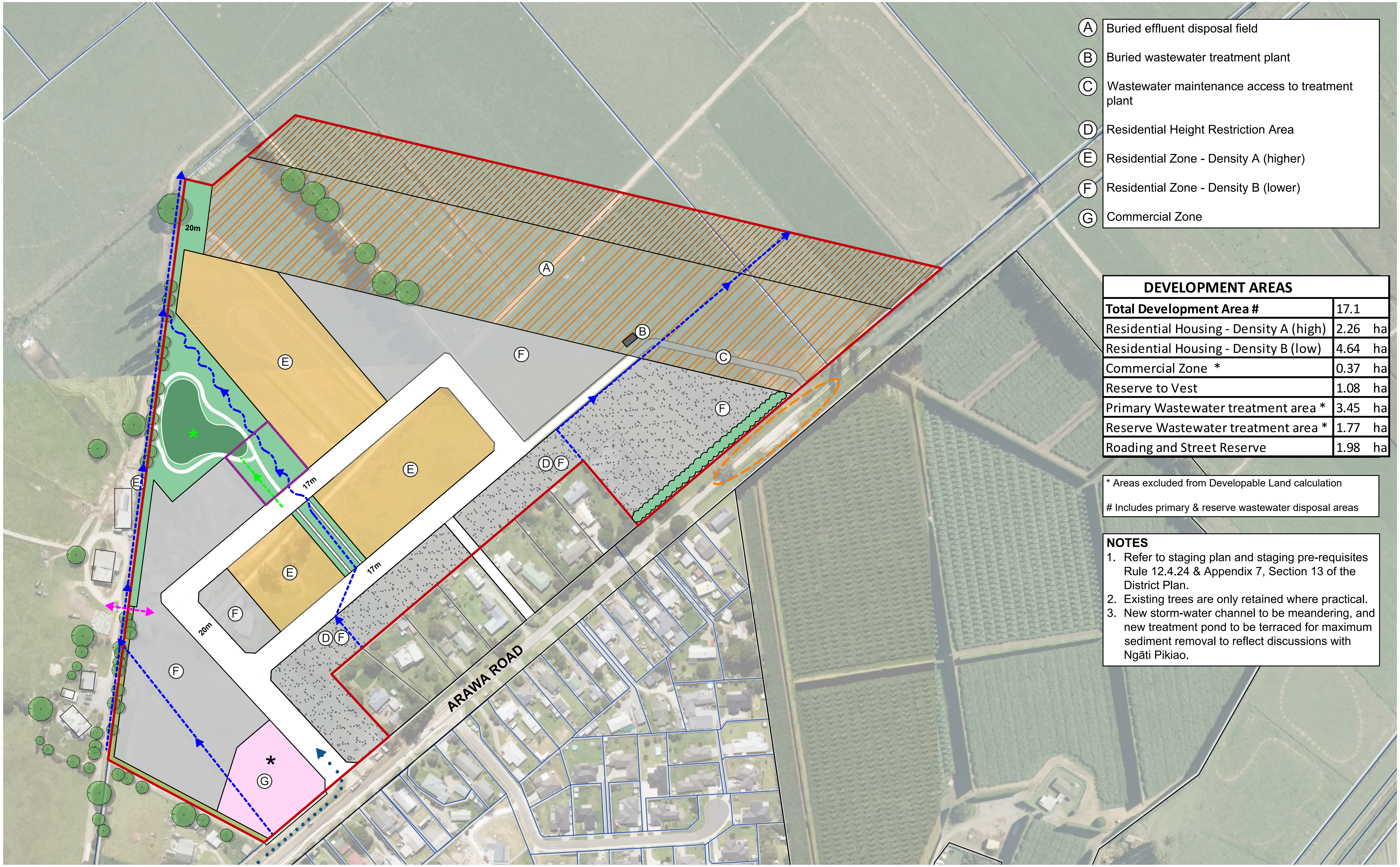
vincent@mpad.co.nz

Appendix A – Economic Locality and Market Assessment – Kevin Counsell, NERA, dated 22 August 2024; Economic Appraisal Report – Kevin Counsell, NERA, dated 8th April 2024

Appendix B – Land Productivity Assessment for Proposed Private Plan Change: Pencarrow Estate, SH2 Pongakawa – Land Vision, dated August 2024

Appendix C – Lysaght Engineering Report (Revision 7), dated 22nd August 2024

Appendix D – NZTA Correspondence August 2024



A	Buried effluent disposal field
B	Buried wastewater treatment plant
C	Wastewater maintenance access to treatment plant
D	Residential Height Restriction Area
E	Residential Zone - Density A (higher)
F	Residential Zone - Density B (lower)
G	Commercial Zone

DEVELOPMENT AREAS		
Total Development Area #	17.1	
Residential Housing - Density A (high)	2.26	ha
Residential Housing - Density B (low)	4.64	ha
Commercial Zone *	0.37	ha
Reserve to Vest	1.08	ha
Primary Wastewater treatment area *	3.45	ha
Reserve Wastewater treatment area *	1.77	ha
Roading and Street Reserve	1.98	ha

* Areas excluded from Developable Land calculation

\# Includes primary & reserve wastewater disposal areas

NOTES

1. Refer to staging plan and staging pre-requisites Rule 12.4.24 & Appendix 7, Section 13 of the District Plan.
2. Existing trees are only retained where practical.
3. New storm-water channel to be meandering, and new treatment pond to be terraced for maximum sediment removal to reflect discussions with Ngāti Pikiao.

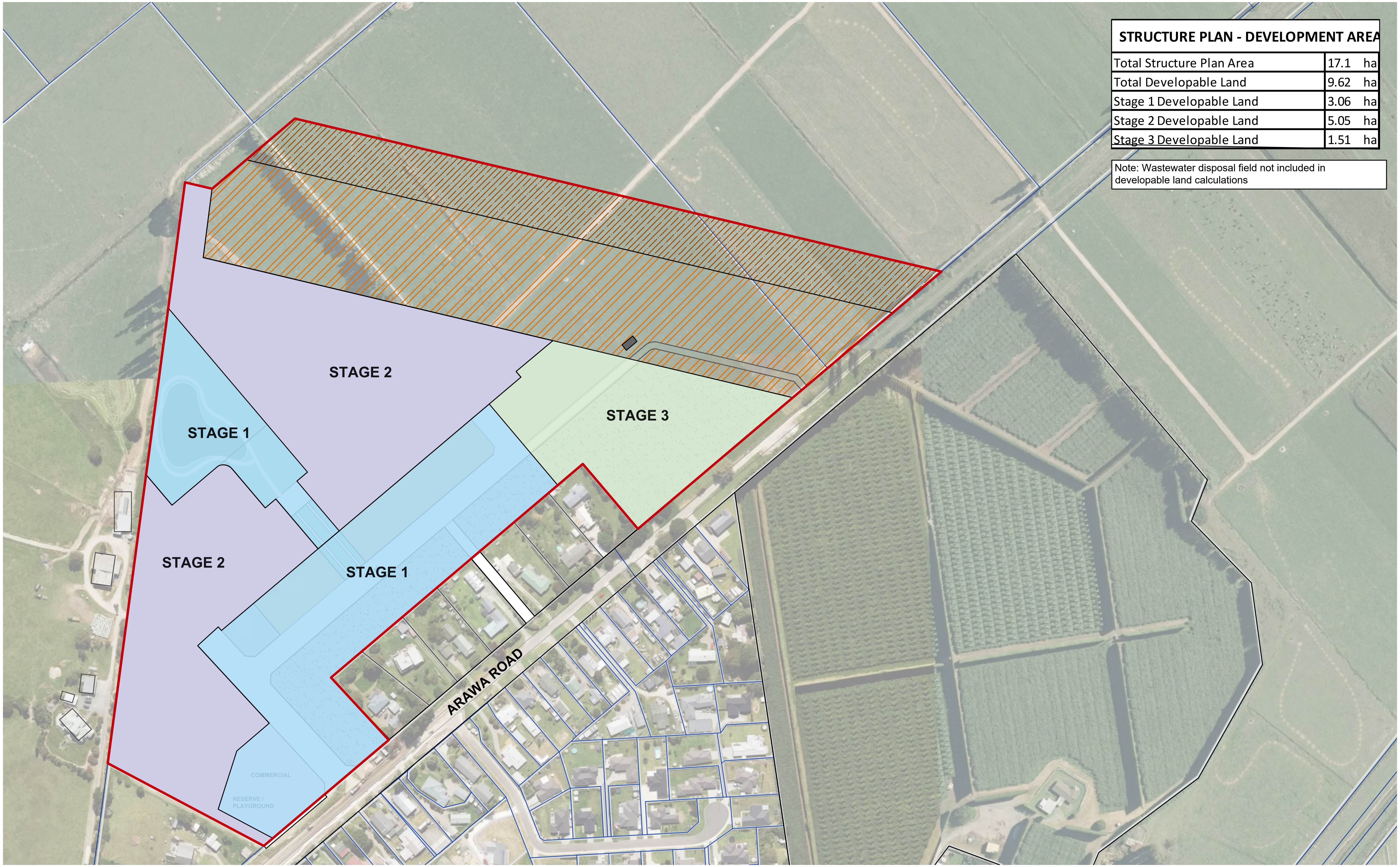
Pencarrow Estate Pongakawa - General Layout & Infrastructure

LEGEND

- Higher-Density Housing
- Lower-Density Housing
- Residential Height Restriction Area
- Shelterbelt Planting
- Commercial
- Development Site
- Village Green
- Maintained Property Access
- Overland Flowpath
- Stormwater
- Water Supply
- * Proposed Playground Area
- * Stormwater Reserve / Infrastructure
- Stormwater/Riparian Reserve - 6m
- Landscape Buffer - 4m
- Access & Utility Corridors
- Planned Public Recreation Upgrades (path, pump trucks, playground by WBOPDC)
- Primary Wastewater Disposal Area
- Reserve WW Field
- Existing Trees

MOMENTUM
PLANNING AND DESIGN

Date: 30.08.2024
Drawing : **001**
Reference: Pencarrow Estate Pongakawa
Scale: 1:2500 at A3
Drawn: PT
Reviewed: VM



STRUCTURE PLAN - DEVELOPMENT AREA		
Total Structure Plan Area	17.1	ha
Total Developable Land	9.62	ha
Stage 1 Developable Land	3.06	ha
Stage 2 Developable Land	5.05	ha
Stage 3 Developable Land	1.51	ha

Note: Wastewater disposal field not included in developable land calculations

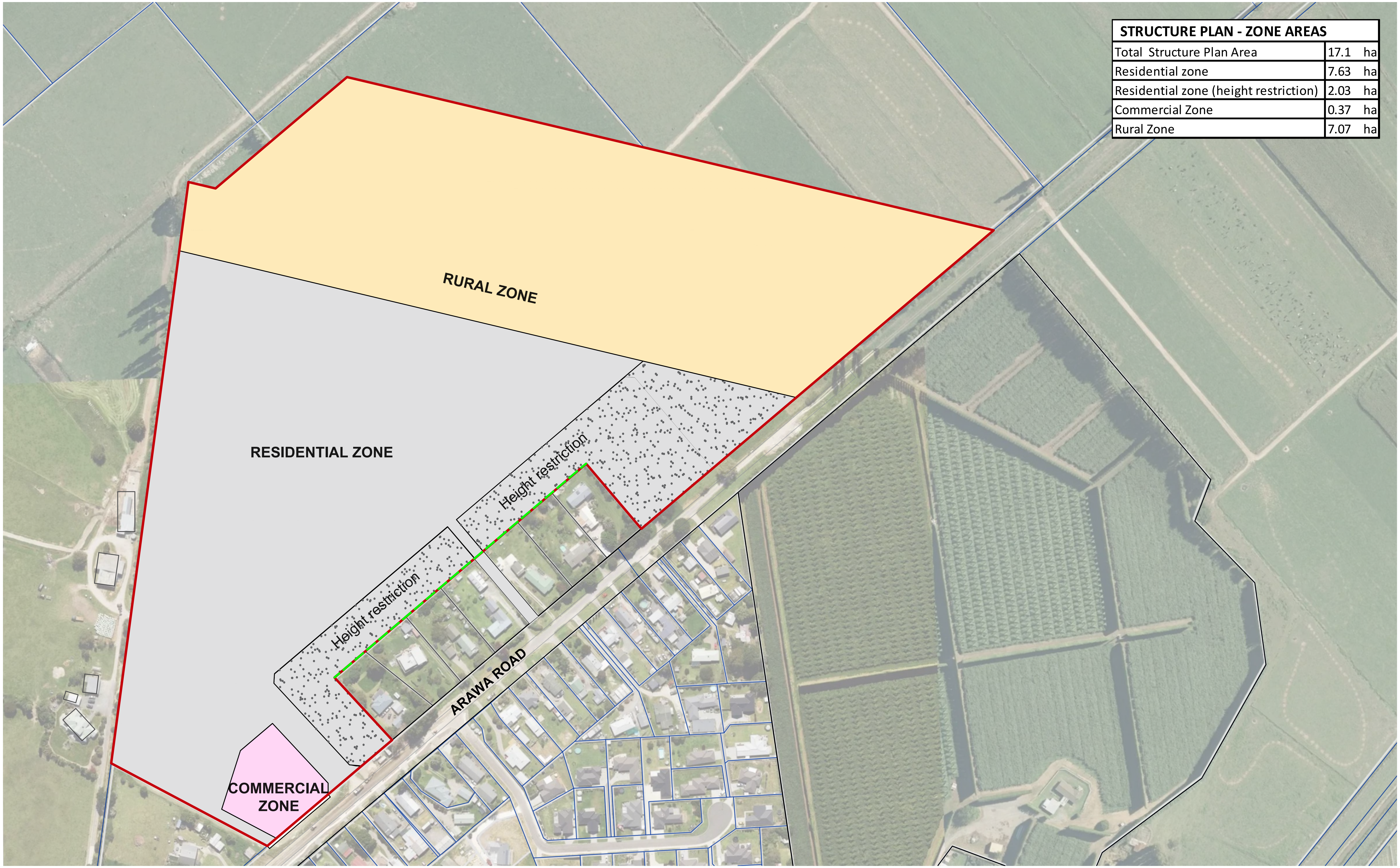
Pencarrow Estate Pongakawa - Staging Plans

LEGEND

- STAGE 1 Development Area
- STAGE 2 Development Area
- STAGE 3 Development Area

MOMENTUM
PLANNING AND DESIGN

Date: 30.08.2024
Drawing : **002**
Reference: Pencarrow Estate Pongakawa
Scale: 1:2500 at A3
Drawn: PT
Reviewed: VM



STRUCTURE PLAN - ZONE AREAS		
Total Structure Plan Area	17.1	ha
Residential zone	7.63	ha
Residential zone (height restriction)	2.03	ha
Commercial Zone	0.37	ha
Rural Zone	7.07	ha

Pencarrow Estate Pongakawa - Zoning

LEGEND

- Rural Zone
- Residential Zone
- Residential Height Restriction Area
- Commercial Zone
- Reserve to Vest
- Structure Plan Area
- Residential Rear Yard Boundary

Date: 09.05.2024
Drawing : **003**
Reference: Pencarrow Estate Pongakawa
Scale: 1:2500 at A3
Drawn: PT
Reviewed: VM

(A) Effluent disposal field with wide spaced groups of trees

(B) Street tree area planting zone min 4sqm per tree

(C) Boundary buffer planting - 4m wide strip provided

(D) Boundary buffer planting - 6m wide reserve provided

(E) Stormwater Reserve trees

(F) Wastewater Landscaped buffer (20m wide)

(G) Residential Rear Yard Boundary

TREES

All trees within the proposed road reserve shall be minimum 45 litre size at the time of planting and be planted no closer than 1.5m from boundary fences or road kerbs. All other trees to be minimum 18 litre size at the time of planting. Trees to be selected from the following lists, or aimilar species as available at the time of planting:

Streetscape Trees - Large:
- Titoki (*Alectryon excelsus*)
- Puriri (*Vitex lucens*)
- Tarere (*Beilschmiedia taraire)*
- Kohekohe (*Dysoxylum spectabile*)

Streetscape Trees - Medium:
- Kowhai (*Sophora tetraptera*)
- Puka (*Meryta sinclairii*)
- Karaka (*Corynocarpus laevigatus*)

Other Trees - Large:
- Rewarewa (*Knightia excelsa*)
- Totara (*Podacarpus totara*)
- Kahikatea (*Dacrycarpus dacrydioides*)

Other Trees - Medium:
- Lemonwood (*Pittosporum eugenioides*)
- Cabbage tree (*Cordyline australis*)
- Putaputawheta (*Carpodetus serratus*)

STREAM PLANTING

Sedges, Rushes, Ferns and Ground Covers for Lower Bank (or similar at time of planting)
- Pukio (*Carex secta/ virgata*)
- Umbrella sedge (*Cyperus ustulatus*)
- Marsh Clubrush (*Bulboschoenus fluviatilis*)

Shrubs and Trees for Crest or Levee (or similar at time of planting)
- Manuka (*Leptospermum scoparium*)
- Karamu (*Coprosma robusta*)
- Nikau (*Rhopalostylis sapida*)

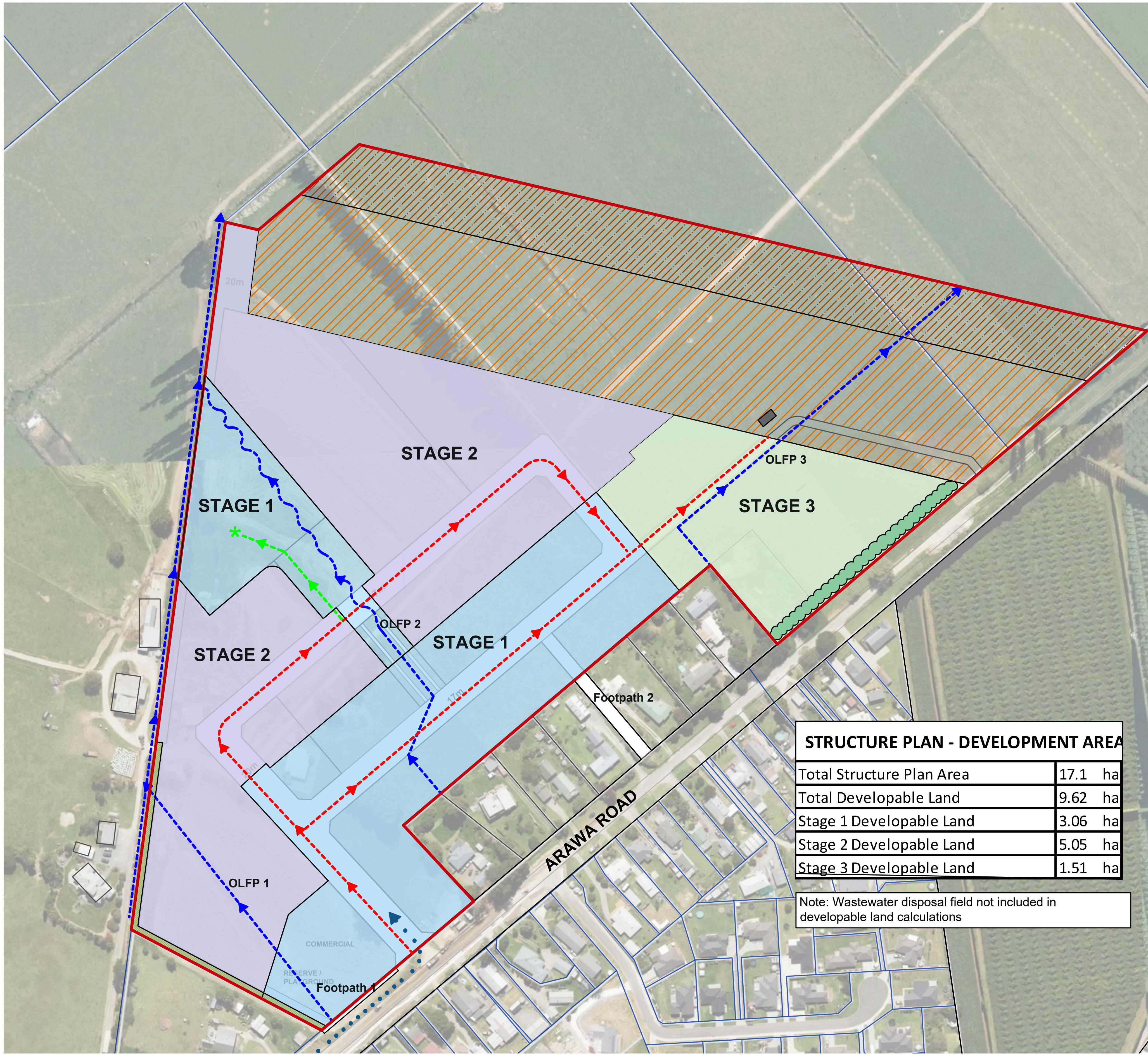
Pencarrow Estate Pongakawa - Landscaping Plan

LEGEND

- Higher-Density Housing
- Lower-Density Housing
- Residential Height Restriction Area
- Shelterbelt Planting
- Commercial
- Development Site
- Village Green
- Riparian Planting to Stream Bank
- Existing Trees
- Proposed Large Trees
- Proposed Medium Trees
- Maintained Property Access
- Proposed Playground Area
- Stormwater Reserve / Infrastructure
- Stormwater / Riparian Reserve - 6m
- Landscape Buffer - 4m
- Access & Utility Corridors
- Planned Public Recreation Upgrades (path, pump trucks, playground by WBOPDC)
- Primary Wastewater Disposal Area
- Reserve Wastewater Disposal Area

MOMENTUM PLANNING AND DESIGN

Date: 30.08.2024
Drawing : **004**
Reference: Pencarrow Estate Pongakawa
Scale: 1:2500 at A3
Drawn: PT
Reviewed: VM



STRUCTURE PLAN - DEVELOPMENT AREA

Total Structure Plan Area	17.1	ha
Total Developable Land	9.62	ha
Stage 1 Developable Land	3.06	ha
Stage 2 Developable Land	5.05	ha
Stage 3 Developable Land	1.51	ha

Note: Wastewater disposal field not included in developable land calculations

Pencarrow Estate Staged Infrastructure Requirements:

All to be completed to WBOPDC satisfaction through design, consenting and construction approvals. See also corresponding Pencarrow Estate Structure Plan stage pre-requisites, Chapter 12 WBOPDC District Plan, and Structure Plan drawings.

Future subdivisions to enable dwelling construction within Stages 1-3 of Pencarrow Estate Structure Plan to vest the infrastructure and accompanying land specified below with WBOPDC, unless otherwise stated.

Stage 1:

Roading and Access

- Intersection of Arawa Road and State Highway 2 to be upgraded to include left-turn deceleration lane, also to Waka Kotahi NZTA satisfaction.
- Intersection of Arawa Road and entrance into the site, and road corridor within Stage 1, to be upgraded and constructed as road suitable to vest with WBOPDC.
- Footpaths 1 and 2 to be formed. Footpath 1 fronting the commercial area as a standard concrete footpath adjacent to Arawa Road; Footpath 2 may be to an alternative standard.
- Access to, and bus stop established within Commercial zone (protected via right of way easement in gross).

Stormwater, Wastewater and Water Infrastructure

- Stormwater treatment wetland and attenuation pond and outlet to Puanene Stream drain to be formed and planted in stormwater reserve area.
- Stormwater conveyance infrastructure servicing Stage 1, installed and reticulated to the stormwater pond.
- Construction of overland flowpaths 1 and 2 and discharge points into Puanene Stream drain.
- Installation of reticulated wastewater network within Stage 1, and supporting treatment infrastructure and drip field to service Stage 1 in the wastewater field area.
- Water supply pipework installed to supply Stage 1, either from pipe upgrade at SH2 or via reservoir solution.

Landscaping, Reserves

- Tree and shrub planting along Puanene Stream bank within stormwater reserve to vest to be planted.
- Tree planting within remainder of Stage 1 to be established.

Reverse Sensitivity:

- All effluent pond infrastructure shall be re-located west of the Puanene Stream and north of the existing farm milking shed/stock pad.

Commercial Land:

- The commercially-zoned land shall be formed and available for development.

Stage 2:

Roading and Access

- New roads and footpaths within Stage 2 constructed.
- Extension of Footpath 2 through to 'Village Green' at the start of the stormwater reserve, completed.

Stormwater, Wastewater and Water Infrastructure

- Stormwater conveyance infrastructure servicing Stage 2, installed and reticulated to the stormwater pond.
- Extension of reticulated wastewater network within Stage 2 installed, and supporting treatment infrastructure and drip field to service Stages 1 and 2 installed in the wastewater field area.
- Water supply pipework extended to supply Stage 2.

Landscaping, Reserves

- Completion of landscaping to create the stormwater reserve to vest, inclusive of 'village green' seating area.
- Tree planting within remainder of Stage 2 to be established.

Reverse Sensitivity:

- Milking shall cease to occur at the existing milking shed.

Stage 3:

Roading and Access

- New roads or privateways, and footpaths, within Stage 3 constructed.

Stormwater, Wastewater and Water Infrastructure

- Stormwater conveyance infrastructure servicing Stage 3, installed and reticulated to the stormwater pond.
- Overland flowpath 3 to be constructed, utilising privateway corridor through Lot 3 to then convey water through the wastewater field with gap to be provided if necessary.
- Extension of reticulated wastewater network within Stage 2 installed, and supporting treatment infrastructure and drip field to service Stages 1 and 2 installed in the wastewater field area.
- Water supply pipework extended to supply Stage 3.

Landscaping, Reserves

- Formation of the private playground reserve within the Commercial Area as shown on the structure plan.
- Landscaping within Stage 3 boundaries established in general accordance with the structure plan landscaping plan.

Reverse Sensitivity

- Shelterbelt planting to Arawa Road frontage of Stage 3 to be planted and established.

Pencarrow Estate Pongakawa - Infrastructure Staging Plan

LEGEND

- STAGE 1 Development Area
- STAGE 2 Development Area
- STAGE 3 Development Area
- Overland Flowpath
- Stormwater Pipe - Road to Pond
- Wastewater Network
- Water Supply
- Stormwater Pond Reserve / Infrastructure
- Landscape Buffer - 4m
- Primary Wastewater Disposal Area
- Reserve Wastewater Disposal Area
- Access (Utility Corridor)

MOMENTUM PLANNING AND DESIGN

Date: 30.08.2024
Drawing : **005**
Reference: Pencarrow Estate Pongakawa
Scale: 1:2500 at A3
Drawn: YW
Reviewed: VM

Appendix A

NERA

Kevin Counsell
Director
NERA
20 Customhouse Quay
Wellington, New Zealand 6011
64 4 8192551
kevin.counsell@nera.com

Memo

To:	Kevin and Andrea Marsh
Date:	8 April 2024
From:	Kevin Counsell, Director, NERA
Subject:	**High-level preliminary economic appraisal of Plan Change 95**

Introduction

1. Plan Change 95 (**PC95**) is a private plan change application to the Western Bay of Plenty District Council (**WBOPDC**) to rezone approximately 7.5 hectares of Rural-zoned land to Residential, with a small Commercial zone, in Pongakawa.[1]
2. You have asked me to undertake a high-level preliminary economic appraisal of PC95, with specific consideration of:
   a. The provisions of clause 3.6(1) of the National Policy Statement for Highly Productive Land (**NPS-HPL**); and
   b. The economic viability of the proposed Commercial zone.
3. The results of my appraisal are set out in the remainder of this memo.

Assessment against clause 3.6(1) of the NPS-HPL

4. Clause 3.6(1) of the NPS-HPL, which applies to Tier 1 and 2 territorial authorities (with WBOPDC being Tier 1), states that urban rezoning of highly productive land may be allowed if:
   a. "the urban rezoning is required to provide sufficient development capacity to meet demand for housing or business land to give effect to the National Policy Statement on Urban Development 2020"; and
   b. "there are no other reasonably practicable and feasible options for providing at least sufficient development capacity within the same locality and market while achieving a well-functioning urban environment"; and

---

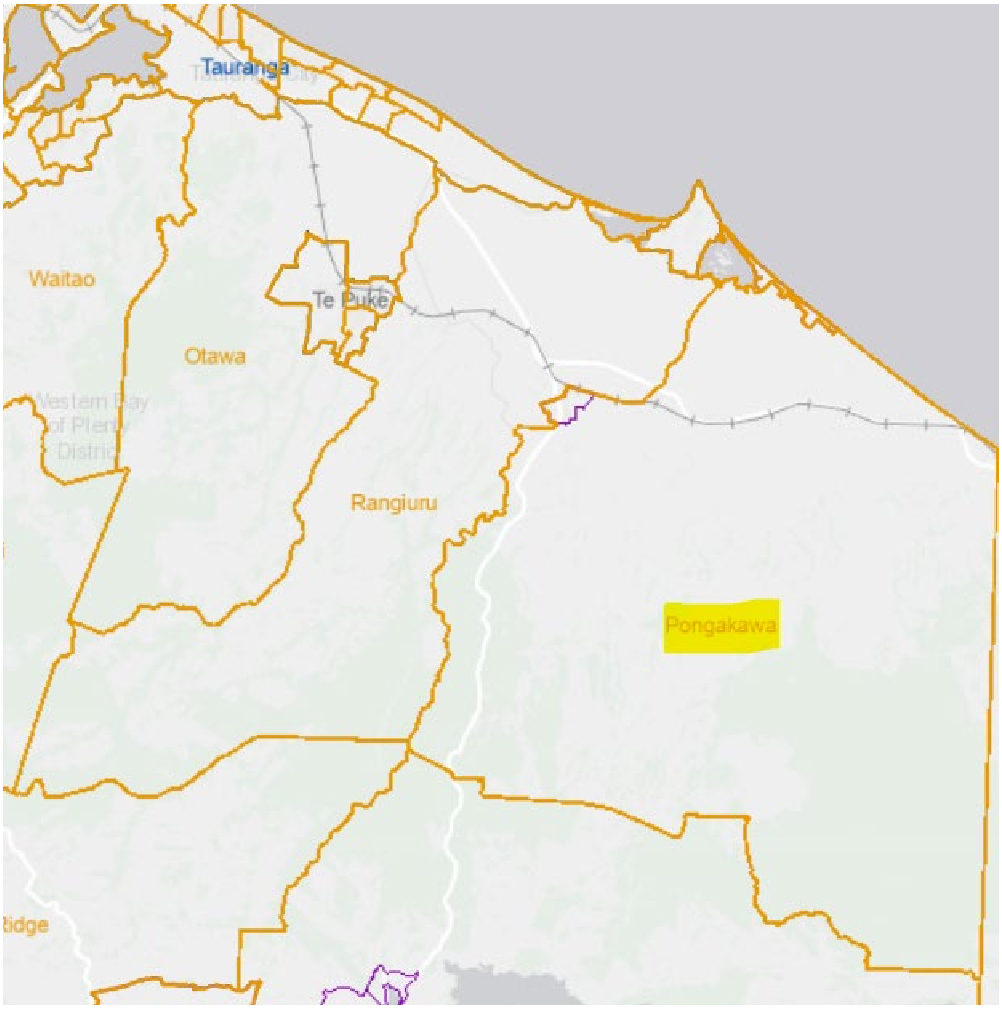
1 As per the area figures provided within the Pencarrow Estate Pongakawa – Structure Plan drawing set dated 31 October 2023 submitted with the PC95 Application for Plan Change.

c. "the environmental, social, cultural and economic benefits of rezoning outweigh the long-term environmental, social, cultural and economic costs associated with the loss of highly productive land for land-based primary production, taking into account both tangible and intangible values."

Clause 3.6(1)(a)

5. I consider first clause 3.6(1)(a). In respect of this clause, an assessment of the sufficiency of development capacity to meet demand for housing typically starts by assessing population and household forecasts for an area, and converting these to an indicator of residential housing demand. The forecast data that I analyse is based on a geographic area defined by Statistics New Zealand (**Stats NZ**) as "Statistical Area 2" (**SA2**). I focus on the Pongakawa SA2, with the boundaries of this area shown in Figure 1. The Pongakawa SA2 is the most disaggregated level for which Stats NZ's forecasts are available.

Figure 1: Pongakawa SA2



Source: Stats NZ Geographic Boundary Viewer, https://maps-by-statsnz.hub.arcgis.com/

6. An analysis of Stats NZ population forecasts for the Pongakawa SA2 shows that the population is projected to grow in the next 10 years[2] by 290 people in the "low growth" forecast scenario, 450 people in the "medium growth" forecast scenario, and 620 people in the "high growth" forecast scenario.

7. I analyse the next 10 years based on the NPS-HPL *Guide to implementation*, which specifies that a test for "sufficient development capacity" should be done over the short-term (the next three years) or medium-term (the next ten years).[3] The Stats NZ population forecasts are not available over a three-year period, although there is a five-year period,[4] for which the Pongakawa SA2 is projected to grow by 170, 240 and 320 people in the low growth, medium growth and high growth scenarios respectively. It is also helpful to consider an analysis over the longer-term. In the next 25 years,[5] the Pongakawa SA2 is projected to grow by 490, 940 and 1,920 people in the low growth, medium growth and high growth scenarios respectively.

8. In my view, there is a strong case for using the high growth scenario in this economic assessment. This is because the *actual* population for the Pongakawa SA2 in 2023, of 3,740, is only slightly below the high growth forecast population for 2023, of 3,750, and well above the medium growth forecast population of 3,670. (These population forecasts were published in December 2022). The high growth scenario also allows the analysis to err on the side of caution, recognising inherent uncertainties in this analysis, the risk of a false sense of precision, and the need to address issues such as high housing prices.

9. Taking the high growth population forecasts, I convert these to forecasts of the number of households using an average household size for the Pongakawa SA2 of 2.8 people per household.[6] The resulting forecast is for the number of households to increase by 114 households in the next 5 years, 221 households in the next 10 years and 507 households in the next 25 years – see Table 1. These numbers are without applying the competitiveness margins set out in the National Policy Statement on Urban Development (**NPS-UD**). With the NPS-UD margins added (of 20% in the short-term and medium-term and 15% in the long-term), the forecast increases in households are 137, 266 and 583 for the next 5, 10 and 25 years respectively.

Table 1: Pongakawa forecast increase in households

Time period	Increase in households without NPS-UD margins	Increase in households with NPS-UD margins
Next 5 years	114	137
Next 10 years	221	266
Next 25 years	507	583

2 Stats NZ produces population projections for 2023 and 2033, so the 10-year interval is based on projections for these years.

3 Ministry for the Environment (2022), "National Policy Statement for Highly Productive Land: Guide to implementation", December, at p.42.

4 The 5-year interval is based on Stats NZ's population projections for 2023 and 2028.

5 The 25-year period is based on Stats NZ's population projections for 2023 and 2048.

6 This figure is the Stats NZ projection for the average household size in the Pongakawa SA2 in the high growth scenario.

10. The following evidence also supports a finding of strong demand for housing in Pongakawa:

    a. I understand that a large number of dairy and drystock farms in the surrounding area have recently converted to horticulture. This is evident in employment numbers in the Pongakawa SA2: there were 200 dairy farm employees in 2017, but this has steadily fallen to 80 employees in 2023. In contrast, employment in horticulture was 140 in 2017 and has increased to 390 by 2023.[7] The gain in horticulture employment has more than offset the loss in dairy farming employment, and overall employment in the region has increased over this time period (from 970 in 2017 to 1,200 in 2023). This in turn is likely to have driven strong demand for horticultural workers to live nearby;

    b. The nearby Tauranga Eastern Motorway was completed in 2015. There is robust economic theory to show that accessibility improvements such as new or improved roads can result in increases in housing demand in an area;[8]

    c. The Rangiuru Business Park has recently been completed, with titles due to be issued in 2024,[9] which will bring new employment to the area;

    d. The 2022 Housing and Business Assessment (**HBA**) for WBOPDC identified a shortfall in housing in the Western Bay of Plenty Region in the short-term, medium-term and long-term, as well as a specific "urgent need" to investigate housing shortages in the Eastern Corridor, which I understand includes Pongakawa.[10] An updated 2023 HBA shows the same housing shortages for the Western Bay of Plenty Region, and notes specifically the need for more housing in the region, particularly in the context of a "highly constrained environment" subject to natural hazards and the effects of climate change;[11]

    e. House prices and rents have grown strongly in Pongakawa in recent years, indicating that there is currently insufficient land supply to meet increasing demand by households. In Figure 2 below I have shown data from the Ministry of Housing and Urban Development's Urban Development Dashboard, with the top graph showing the 12-month rolling average of median house sales prices and the bottom graph showing the 12-month rolling average of mean house rents (the data goes through to the end of the March quarter 2024). Prices/rents in Pongakawa (the black line) are benchmarked against a selection of territorial authorities. I make the following observations from Figure 2:

        i. Average house prices in Pongakawa started increasing sharply from around mid-2019, to the point where average prices are now even higher than in Auckland. While Pongakawa prices fell back from a peak in September 2022, this is consistent with trends seen elsewhere. However, in contrast to the trends in the other territorial authorities shown (where house prices have flattened off at the end of the series),

7 Data is Stats NZ Business Demography employee count data for the "dairy cattle farming" and "fruit and tree nut growing" industries, sourced from NZ.Stat.

8 See the discussion and literature cited in D. Hanson, K. Counsell, S. Cohen, T. Delibasi, and M. Gatti (2021), "Dynamic clustering and transport appraisal", Waka Kotahi New Zealand Transport Agency research report 680.

9 PC95 Application for Plan Change, November 2023, at p.51.

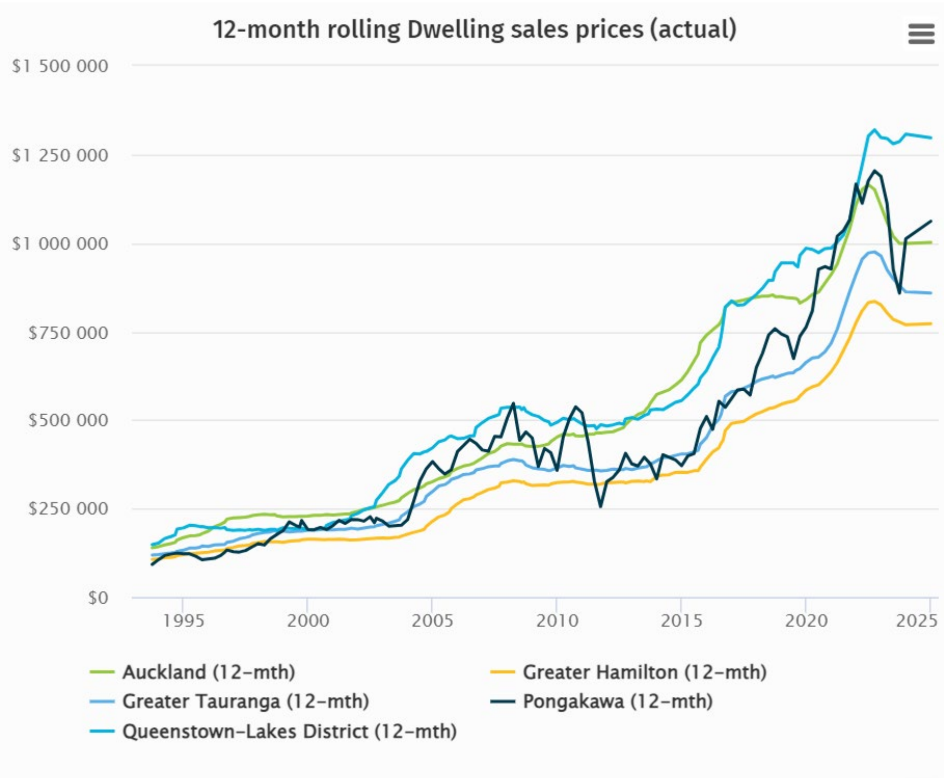
10 Smartgrowth Housing and Business Capacity Assessment 2022 Summary.

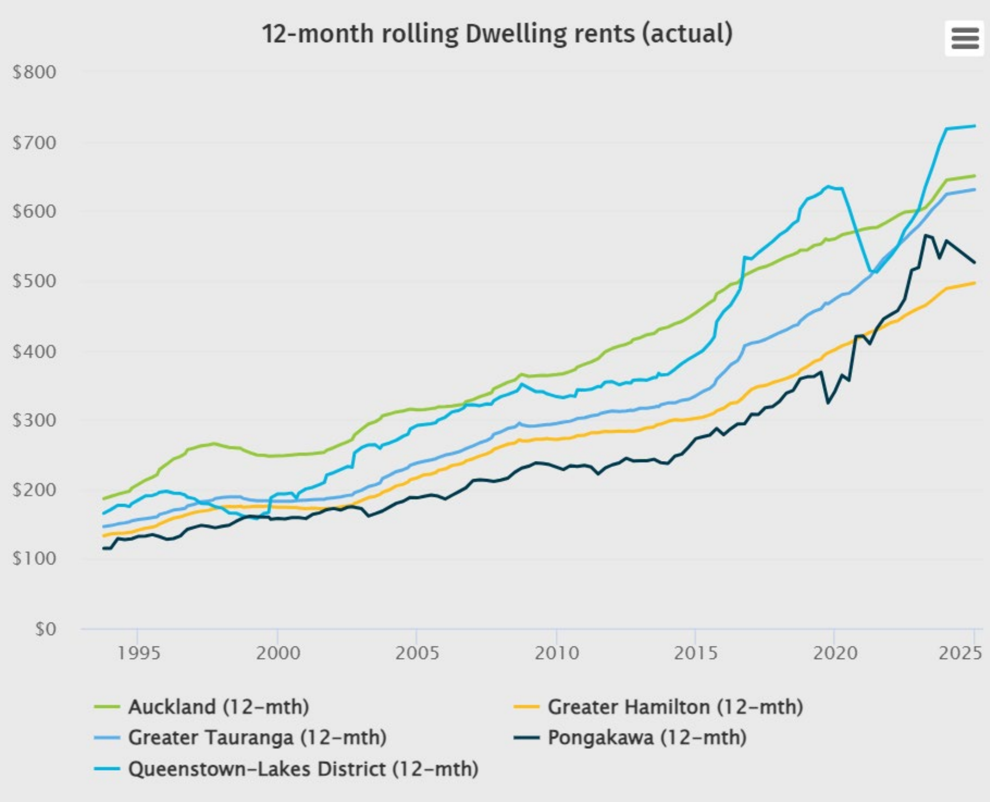
11 Smartgrowth Strategy 2023-2073, Draft for Consultation.

house prices have increased sharply again in Pongakawa at the end of 2023/start of 2024. This is consistent with excess demand for housing pushing up prices; and

ii. Average house rents in Pongakawa started increasing from around the end of 2019, and while rents still remain below what they are in Auckland and Tauranga, at their peak (in 2023) the gap in rents between Auckland, Tauranga and Pongakawa was much smaller than it has been historically. While rents in Pongakawa have fallen back in late 2023 and early 2024, there appears to be a slight lag between high house prices and high rents, so it is plausible that the recent sharp increase in the former will flow through into rents in the remainder of 2024.

Figure 2: Average house selling prices (top panel) and house rents (bottom panel) for Pongakawa and selected territorial authorities, September quarter 1993 to March quarter 2024





Source: MHUD Urban Development Dashboard, https://huddashboards.shinyapps.io/urban-development/

11. PC95 is intended to supply up to 130 dwellings. I understand also that there are no other sources of new residential dwelling supply that would be expected to absorb the growth in demand for housing in Pongakawa. While there may be some new supply in areas further away (such as the Te Mania development in Te Puke), these areas are unlikely to cover off the demand specific to Pongakawa. With forecast household growth in Pongakawa of 137 households, 266 households, and 583 households in the next 5, 10 and 25 years respectively (see Table 1), my preliminary analysis indicates there will be a shortfall in supply in Pongakawa in the next 5, 10 and 25 year periods, which PC95 will go towards meeting. PC95 therefore meets clause 3.6(1)(a) of the NPS-HPL, by contributing to the provision of sufficient development capacity to meet demand for housing.

Clause 3.6(1)(b)

12. Clause 3.6(1)(b) requires consideration of reasonably practicable and feasible options for providing sufficient development capacity within the same locality and market. This assessment has been undertaken in the PC95 Application for Plan Change, which, in summary, finds that:[12]

    a. There is no other land zoned for residential growth in Pongakawa;

    b. Other flat and isolated locations near SH2 are also classified as highly productive land;

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[12] PC95 Application for Plan Change, November 2023, at pp.49-50 and Table 2 of Appendix 11.

c. Land around other commercial entities along SH2 is further distanced from the Pongakawa residential community, restricted in size, and susceptible to reverse sensitivity effects; and

d. Land surrounding Pongakawa school is classified as a reserve and is further distanced from the Pongakawa residential community.

13. This assessment has given due consideration to other options for providing residential development capacity, and the reasoning is sound. In my opinion, it is therefore reasonable to conclude that PC95 satisfies the conditions of clause 3.6(1)(b) of the NPS-HPL.

Clause 3.6(1)(c)

14. Clause 3.6(1)(c) of the NPS-HPL requires an assessment of the environmental, social, cultural and economic benefits and costs of rezoning highly productive land. My analysis is only in respect of the economic benefits and costs, for which I set out a qualitative discussion of these benefits and costs.

15. An important economic benefit of PC95 is that it will expand the supply of residential housing, benefiting purchasers of housing by lowering prices and providing them with more housing choice, in proximity to multiple growing employment land-uses. An expansion in housing supply releases a binding supply constraint. In particular, the evidence discussed earlier shows that demand for residential housing in Pongakawa is likely to be greater than supply in the short-term, medium-term and long-term. PC95 goes towards releasing this supply constraint. If the supply of housing in Pongakawa were to remain unchanged at its current level, then continued increases in demand would result in continued price increases for existing housing (which is already being seen in house price data – see Figure 2 earlier). It would also result in unmet demand, as those that would otherwise seek to reside in Pongakawa will be forced to find housing elsewhere.

16. By expanding supply, PC95 facilitates the operation of a competitive land market, which is consistent with the NPS-UD. In particular, the substance of Policy 1(d) of the NPS-UD is as follows:

> ***Policy 1:*** *Planning decisions contribute to well-functioning urban environments, which are urban environments that, as a minimum:*
>
> ***…***
>
> *(d) support, and limit as much as possible adverse impacts on, the competitive operation of land and development markets.*

17. There is also an economic benefit arising from PC95 due to its proximity to nearby residential housing in Pongakawa. This allows PC95 to better utilize the existing infrastructure, relative to an alternative site that is located further away from the existing residential housing, and as such may need to incur larger additional infrastructure costs. Moreover, PC95 will provide reserves and playground facilities that are currently lacking within the existing residential community,[13] and the ability to utilize these facilities over a larger population base can be considered an economic benefit.

[13] PC95 Application for Plan Change, November 2023, at p.36.

18. The proposed commercial space that is part of PC95 will bring a benefit by providing employment opportunities for local residents. It will also allow residents to meet their needs in respect of general grocery items in closer proximity to their home, thereby reducing local vehicle movements.

19. PC95 will involve some costs related to the provision of infrastructure. The infrastructure costs that relate to the development site itself will be incurred by the developer. Given that a developer is willing to invest to undertake a development, it is reasonable to assume that the benefits that developers receive will exceed these costs, so that there is an overall net (private) benefit. This follows from a common principle in economics that individuals and businesses will make decisions that are in their own best interests. That is, in making a choice, an economic agent will choose a course of action that makes them better off, rather than worse off.

20. There will also be a cost associated with the loss of the productive capacity of the land being re-zoned. However, this is only a small proportion of the productive land in the locality[14] and the re-zoning does not inhibit practical use of the remaining farm. On this basis, the cost of the lost productive capacity of land in this instance is unlikely to be material.

21. In summary, the aforementioned economic benefits of PC95 are likely to significantly outweigh any economic costs. This goes towards satisfying the requirements of clause 3.6(1)(c) of the NPS-HPL.

Economic viability of the proposed Commercial zone

22. I have been asked to consider the economic viability of PC95's proposed Commercial zone, particularly in respect of the population being served by the proposed convenience store.

23. To assess this, I have undertaken a benchmarking analysis which assesses the population of nearby areas in the Western Bay of Plenty District. I have focused on areas classified by Stats NZ as "small urban areas" or "rural settlements" – this classification is different to the SA2 classification referred to earlier, with the SA2 generally being larger in land area. In Table 2 I show those areas within the District that have at least one dairy, convenience store or supermarket (which I collectively refer to as "grocery stores"), along with their 2023 population and a calculation of the population per store.

[14] As an indication of the extent of productive land in Pongakawa, Zespri has stated that there is 458 hectares of land attributed to Kiwifruit growing in Pongakawa (see Appendix 5 to the PC95 Application for Plan Change, November 2023). This only relates to Kiwifruit growing; it does not account for productive land in other farming activities, such as other horticulture, dairying or drystock farming.

Table 2: Population and number of grocery stores for areas in the Western Bay of Plenty District

Area	Population in 2023	Number of grocery stores (dairies, convenience stores and supermarkets)	Population per grocery store
Plummers Point	280	1	280
Te Puna West	350	1	350
Paengaroa	960	1	960
Katikati	5,800	6	967
Omokoroa	4,770	3	1,590
Te Puke	10,250	7	1,464
Waihi Beach-Bowentown	2,780	4	695

24. The results of Table 2 suggests that the population necessary to support a grocery store can vary, as low as 280 in Plummers Point and up to 1,590 in Omokoroa. There may be location-specific factors that are relevant to this – for example, the grocery stores serving Plummers Point and Te Puna West are both located on SH2, and therefore are likely to be supported by through traffic as well as local residents. Similar circumstances are likely to apply to the proposed PC95 grocery store, given its proximity to SH2. However, to be conservative, I set aside these two locations, and the results of Table 2 suggest that a population of around 900-1,500 is needed to support a given grocery story.

25. The population of the Pongakawa SA2 is 3,740 in 2023. Benchmarked against Table 2, this population would be more than sufficient to support a grocery store. However, the Pongakawa SA2 is a relatively large area (see Figure 1 above) relative to many of the small urban areas and rural settlements in Table 2. This might therefore be considered an upper bound on the population that might be serviced by the proposed PC95 grocery store.

26. At the other extreme, I consider only the population in the Pongakawa residential area around Arawa Rd and Penelope Place. I estimate that there are approximately 76 dwellings in this area. Assuming 2.8 people per household,[15] this amounts to 213 people currently living in this residential area. PC95 will add a further 130 dwellings, or 364 people at 2.8 people per household. This gives a total estimated population for this residential area of 577.

27. A population of 577 might be a little too low, on its own, to support a grocery store (when benchmarked against the 900-1,500 figure derived from Table 2). However, this can be considered a lower bound, given that it only focuses on the narrow Pongakawa residential area, and does not capture areas of population outside of this area that would still be relatively close to the proposed PC95 commercial area.

[15] This figure is the Stats NZ projection for the average household size in the Pongakawa SA2 in the high growth scenario.

28. Given a lower bound of close to 600 and an upper bound of approximately 3,700, it seems reasonable to conclude that the actual population serviced by the proposed PC95 grocery store would be similar to the benchmark range in Table 2 of 900-1,500. This does not account for the location of the proposed grocery store on SH2 – as noted from Plummers Point and Te Puna West in Table 2, grocery stores in these areas serve populations of 280 and 350 respectively.

29. On this evidence, it is reasonable to conclude that the existing population in nearby areas, combined with the additional population enabled by PC95, is likely to be sufficient to support the economic viability of the proposed PC95 grocery store.

Conclusions

30. In summary, my high-level preliminary economic appraisal of PC95 finds the following:

    a. PC95 will provide 130 dwellings, which goes towards meeting demand for 137, 266 and 583 dwellings in Pongakawa over the next 5, 10 and 25 years respectively. This satisfies clause 3.6(1)(a) of the NPS-HPL, by contributing to the provision of sufficient development capacity to meet demand for housing;

    b. The PC95 Application for Plan Change has considered reasonably practicable and feasible options for providing sufficient development capacity within the same locality and market, and finds that there are no feasible alternatives. PC95 thereby satisfies the conditions of clause 3.6(1)(b) of the NPS-HPL;

    c. PC95 will expand the supply of housing and release the supply constraint, benefiting purchasers through lower prices and more housing choice. Its proximity to existing residential housing will bring benefits from better utilizing existing infrastructure and providing new facilities currently lacking in the community. The proposed Commercial zone will bring employment opportunities to local residents and reduce vehicle kilometres travelled. Overall, these economic benefits are likely to significantly outweigh any economic costs, which goes towards satisfying the requirements of clause 3.6(1)(c) of the NPS-HPL; and

    d. By benchmarking against the population servicing stores in nearby areas, I find that the existing population in Pongakawa, combined with the additional population enabled by PC95, is likely to be sufficient to support the economic viability of the proposed PC95 grocery store.

NERA

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Draft

Memo

To: Kevin and Andrea Marsh
Date: 22 August 2024
From: Kevin Counsell, Director, NERA

Subject: **Plan Change 95: analysis of the geographic boundaries of local housing markets**

Introduction

1. Plan Change 95 (**PC95**) is a private plan change application to the Western Bay of Plenty District Council (**WBOPDC**) to rezone approximately 7.5 hectares of Rural-zoned land to Residential,[1] with a small Commercial zone, in Pongakawa.
2. I understand that a consideration for PC95 is the "locality and market" in which the PC95 site lies. The National Policy Statement for Highly Productive Land (**NPS-HPL**) allows urban rezoning of highly productive land if certain requirements are met, which include that (clause 3.6(1)(b), emphasis added):

   *…there are no other reasonably practicable and feasible options for providing at least sufficient development capacity **within the same locality and market** while achieving a well-functioning urban environment.*
3. The NPS-HPL states that development capacity is within the same locality and market if it (clause 3.6(3)):

   (a) is in or close to a location where a demand for additional development capacity has been identified through a Housing and Business Assessment (or some equivalent document) in accordance with the National Policy Statement on Urban Development 2020; and

   (b) is for a market for the type of dwelling or business land that is in demand (as determined by a Housing and Business Assessment in accordance with the National Policy Statement on Urban Development 2020).
4. The National Policy Statement on Urban Development (**NPS-UD**) also refers to a "housing market" in the context of an urban environment, which is defined as (clause 1.4, emphasis added):

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[1] As per the area figures provided within the Pencarrow Estate Pongakawa – Structure Plan drawing set dated 31 October 2023 submitted with the PC95 Application for Plan Change.

Urban environment means any area of land (regardless of size, and irrespective of local authority or statistical boundaries) that…is, or is intended to be, ***part of a housing and labour market*** *of at least 10,000 people.*

5. The urban environment has been considered in the Housing and Business Development Capacity Assessment (**HBA**) for WBOPDC and Tauranga City Council (**TCC**), commissioned by SmartGrowth. The HBA for WBOPDC and TCC was initially published in July 2021,[2] updated in December 2022,[3] with further updates published in June 2024 in the final SmartGrowth Strategy 2024-2074.[4] The urban environment in the HBA covers "the urban areas of Tauranga City and the Western Bay of Plenty District".[5] This traverses a considerable geographic area. In contrast, I note that that the recent Plan Change 92 to the WBOPDC District Plan considers Te Puke township alone to be an urban environment, with a planned projected population of 10,000 or more residents.[6]
6. However, there are likely to be distinctions within a broad geographic area such that sub-areas may not necessarily all be part of the same locality and market. From my review of the succession of HBA documents, I have not been able to determine if specific individual localities and/or markets have been identified for the purpose of the HBA.
7. In this regard, I have been asked to consider whether the PC95 site (in Pongakawa) is in the same locality and market as Te Puke. I approach this issue from an economics perspective, in that I focus my assessment on the concept of a 'housing market', and how economists think about defining the geographic extent of such a market. My analysis of this issue is set out in the remainder of this memo.

An economic framework for assessing the geographic extent of housing markets

8. From an economics perspective, a 'market' can be defined as a collection of buyers and sellers that interact to exchange a particular product.[7] The specific buyers and sellers that are included in a market depend on the boundaries of that market. The boundaries of the market include the range of products across which buyers and sellers interact and the geographic areas in which they interact.
9. An economic framework that is widely used to determine the boundaries of a market involves assessing the extent of substitution by buyers and sellers across potential products or geographic areas. This approach is used by the New Zealand Commerce Commission (as well

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2 *Housing Development Capacity Assessment for Tauranga and the Western Bay of Plenty*, July 2021.

3 *Housing and Business Capacity Assessment 2022 Summary*, December 2022.

4 *SmartGrowth Strategy 2024-2074*, June 2024.

5 *Housing Development Capacity Assessment for Tauranga and the Western Bay of Plenty*, July 2021, p.6; and *Housing and Business Capacity Assessment 2022 Summary*, December 2022, p.3.

6 Western Bay of Plenty District Council, "Plan Change 92 Omokoroa and Te Puke Enabling Housing Supply and Other Supporting Matters", Section 32 Evaluation Report, at p.8 and p.22.

7 See, for example, Robert S. Pindyck and Daniel L. Rubinfeld (2009), *Microeconomics*, Seventh Edition, Pearson Prentice Hall, at p.7. A similar definition is presented in the "Markets" section (written by Geoffrey M. Hodgson) of *The New Palgrave Dictionary of Economics*, 2008, edited by Steven N. Durlauf and Lawrence E. Blume.

as competition authorities overseas) to define the boundaries of markets in which firms compete.[8] If two products or geographies are sufficiently close substitutes for one another, then they are likely to lie within the same market.

10. As a simple example, buyers that are looking to purchase a mobile phone might consider the different brands (Samsung, Oppo, iPhone, etc) to be sufficiently substitutable, such that all of these brands are part of a 'market for mobile phones'. In the context of housing, if home buyers that are looking to purchase a house in one particular area would readily substitute to purchasing in a second area, then those two areas are likely to lie within the same market.
11. To assess substitution possibilities, a range of factors can be considered. In assessing the geographic boundaries of a market, relevant factors include the features of different geographies, how closely prices for different geographies move together, and the distance and cost/difficulty for buyers and sellers to travel between the geographies.
12. Therefore, in assessing whether the PC95 site in Pongakawa is in the same housing market as Te Puke, the key is assessing whether home buyers would consider Pongakawa and Te Puke to be sufficiently substitutable. I consider the evidence for this assessment in the next section.

Substitutability between the PC95 site at Pongakawa and Te Puke

13. In this section I analyse four factors that are relevant to an assessment of the substitutability between the PC95 site at Pongakawa and Te Puke:
    a. Geographic proximity;
    b. Access to amenities;
    c. Access to employment opportunities; and
    d. Relationship between house prices.
14. First, regarding geographic proximity, the proposed PC95 site is located approximately 15km from Te Puke.[9] This seems relatively close, although on its own it is difficult to know whether 15km is 'enough' to warrant the two areas being sufficiently substitutable.
15. However, some guidance on geographic proximity in relation to housing markets can be gained from where competition authorities have assessed the boundaries of housing markets. While such assessments are relatively sparse, I am aware of the following two:
    a. In 2014, the UK Competition and Markets Authority (**CMA**) looked at the geographic boundaries of housing markets for a proposed merger of two residential housing developers.[10] The CMA found that a radius of 11 miles (approximately 18km) was a reasonable approximation for the geographic extent of housing markets; and

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8 This approach is set out in New Zealand Commerce Commission (2022), *Mergers and acquisitions Guidelines*, May.

9 I have measured this distance using Google Maps, from 1491 State Highway 2, Pongakawa (the road frontage to the PC95 development) to "Te Puke" (which defaults broadly to the centre of Te Puke).

10 CMA (2014), "Completed Acquisition of Banner Homes Group PLC by CALA 1 Limited", ME/6435/14.

b. The Australian Competition and Consumer Commission (**ACCC**) is currently considering a merger of two residential housing developers.[11] While its investigation is still ongoing, in a preliminary statement the ACCC has generally used a radius of 15km as a geographic boundary for housing markets.[12]

16. A recent private plan change decision in Waiuku, Auckland (Plan Change 73, **PC73**) also provides some context. In a decision by Independent Hearings Commissioners regarding PC73, Commissioners considered whether Waiuku was in its own locality and market, or whether it was part of a broader locality and market covering Franklin, including areas such as Pukekohe, Clarks Beach, Glenbrook and Kingseat. The Commissioners ultimately found that Waiuku was part of that broader locality and market.[13] The distances from Waiuku to these other areas are approximately: Pukekohe, 20km; Clarks Beach, 25km; Glenbrook, 14km; and Kingseat, 20km.[14]

17. In addition, both Te Puke and the PC95 site at Pongakawa have broadly similar distances to other locations within the Western Bay of Plenty District, as shown in Table 1. While Te Puke is closer to the Tauranga CBD, it is further from Pukehina Beach, and both Te Puke and the PC95 site are relatively equi-distance from Paengaroa.

Table 1: PC95 site and Te Puke distances to various other locations

	Approximate distance from PC95 site	Approximate Distance from Te Puke
Tauranga CBD	37km	25km
Paengaroa	8km	10km
Pukehina Beach	10km	25km

Source: Google Maps travel distances. For the PC95 site I measure from 1491 State Highway 2, Pongakawa, while for each other location I measure from the name of the location (which defaults broadly to the centre of each location).

18. Second, in respect of access to amenities, as the principal township of the Western Bay of Plenty District east of Tauranga, Te Puke provides closer access to social infrastructure typical of a larger concentration of population (for example, supermarkets, a library, churches, and healthcare providers). However, the relatively close distance between Te Puke and the PC95 site at Pongakawa means that these amenities remain reasonably accessible by Pongakawa residents. While the broader Pongakawa area is a more rural area than Te Puke, the PC95 site itself is adjacent to existing residential zoning accommodating a cluster of over 70 dwellings, including the recently developed Penelope Place subdivision, and includes a direct connection to water, telecommunications and electricity infrastructure.

19. Furthermore, Pongakawa itself currently provides access to amenities such as an existing primary school, swimming pool, community hall, and sports/recreational facilities around the

11 ACCC (2024), "Stockland and Supalai – proposed acquisition of 12 residential masterplanned communities from Lendlease Group", Statement of Issues, 4 July.

12 In one region in North West Perth, the ACCC has proposed a 5km radius, although this distinction appears to be because of the limited beach access for properties further away.

13 Decision following the hearing of a Plan Change to the Auckland Unitary Plan under the Resource Management Act 1991, Plan Change 73 – O'Hara, Waiuku, at paragraph [280].

14 I have measured these distances using Google Maps, measuring from "Waiuku" to each of "Pukehoke", "Clarks Beach", "Glenbrook" and "Kingseat", which defaults broadly to the centre of each area.

Arawa Road and Pongakawa School Road locations. Importantly, the proposed PC95 site will add to these amenities through the provision of a proposed commercial centre (with a convenience store and space for community services such as health or educational services), a playground, and natural reserves.

20. Third, both Te Puke and the PC95 site and Pongakawa have similar access to employment opportunities. This includes:

    a. The recently completed Rangiuru Business Park, which is currently selling titles for stage 1,[15] and is located approximately 8km from Te Puke and also 8km from the PC95 site.[16] The Rangiuru Business Park is expected to attract up to 4,000 employees when it is fully operational;[17]

    b. Horticultural farms in the broader rural area around Te Puke and Pongakawa. In 2023, there were 1,250 people employed in horticulture in the Western Bay of Plenty district, with the majority of these employees in Pongakawa (390), Rangiuru (260), and Otawa (120);[18] and

    c. Other job opportunities in Te Puke itself and Tauranga.

21. Lastly, an indication of the substitutability between two products can be gained by considering the relationship between their prices. In particular, if the prices for two products are highly correlated, then this can be indicative of strong substitution.[19] This arises because if, for example, the price of one product were to increase, consumers would switch to a substitute product, increasing the demand for the substitute product and thus also the price. In respect of housing markets, we can consider whether house prices at Pongakawa and Te Puke are highly correlated.

22. Using data from the Ministry of Housing and Urban Development's Urban Development Dashboard, in Figure 1 I have plotted the last 10 years of data showing the 12-month rolling average of median house sales prices, by quarter, for Pongakawa, Te Puke East and Te Puke West. It is clear that prices across all three areas follow a similar trend, with a generally increasing trend over the last 10-years. I have calculated the correlation coefficient between Pongakawa and Te Puke East prices to be 0.94, and between Pongakawa and Te Puke West prices to be 0.96. The correlation coefficient lies between 0 and 1, with a correlation of 1 representing perfect correlation. Therefore, the correlation results show that house prices across the Pongakawa, Te Puke East and Te Puke West areas are very strongly correlated.

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15 https://rangiuru.co.nz/selling-now/, accessed 2 August 2024.

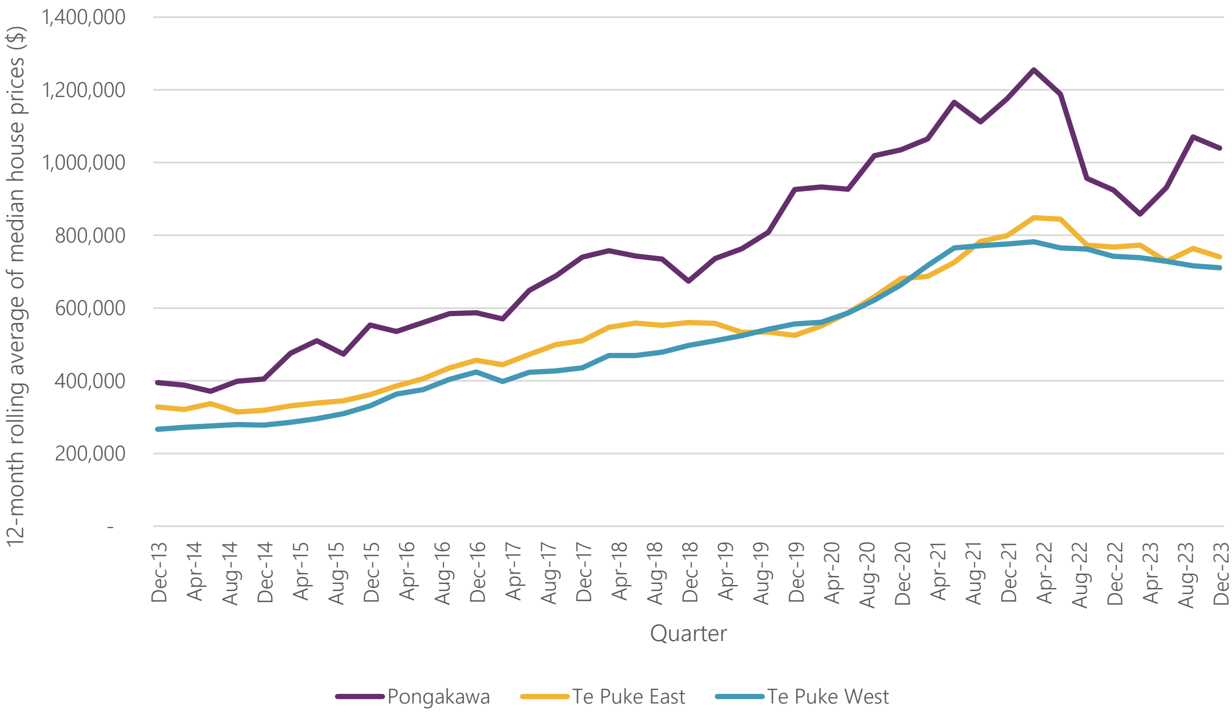
16 PC95 Application for Plan Change, November 2023, at p.51.

17 NZIER (2021), "Economic impact assessment of the Rangiuru business park", NZIER report to Quayside Holdings Limited, April.

18 Data is Stats NZ Business Demography employee count data by Statistical Area 2 for the "fruit and tree nut growing" industry, sourced from NZ.Stat.

19 See, for example, Davis and Garces (2010, p.171), who state that "price correlation analysis is based on the idea that prices of close substitutes will move together". Peter Davis and Eliana Garces (2010), *Quantitative Techniques for Competition and Antitrust Analysis*, Princeton University Press.

Figure 1: Pongakawa, Te Puke East and Te Puke West house prices, 2013-2023



Source: NERA analysis of Urban Development Dashboard data

23. I note, however, that there can be some risk in calculating correlations from trending variables such as those shown in Figure 1, in that the correlation may be 'spurious'. A relationship between two or more variables is said to be spurious when a correlation between the variables is shown but they are in fact not causally linked. This can be, for example, because the two series both follow the same upward trend.[20] However, a relationship can be meaningful (i.e., not spurious) if the variables are 'cointegrated', which in broad terms means that the variables have an underlying long-term relationship. In testing the house price variables shown in Figure 1 using a cointegration test,[21] I find that all of these variables are cointegrated. That is, it can be concluded that Pongakawa and Te Puke house prices are meaningfully (and highly) correlated. This indicates that home buyers consider Pongakawa and Te Puke to be strong substitutes.

Conclusions

24. From the analysis in the previous section, I find the following:

    a. The proposed PC95 site is 15km from Te Puke, which is within the radius typically considered to establish the boundaries of a housing market;

[20] This is referred to as 'non-stationarity' in the data.

[21] I use a test known as the Johansen test for cointegration. For a technical description of this test, see Russell Davidson and James G. MacKinnon (2021), *Econometric Theory and Methods*, Oxford University Press, at pp.640-643.

b. The proposed PC95 site, as modified by the plan change, and Te Puke have similar accessibility to amenities such as commercial services, parks, schools, community facilities, and natural amenities;

c. The proposed PC95 site and Te Puke have similar accessibility to employment opportunities such as the Rangiuru Business Park, horticultural farms, and employment in Te Puke and Tauranga; and

d. House prices in Pongakawa and Te Puke are highly correlated, which is indicative of strong substitution between the two locations.

25. Based on these findings taken together, I conclude that home buyers would consider the PC95 site at Pongakawa and Te Puke to be strong substitutes, and thus the PC95 site at Pongakawa and Te Puke lie within a single housing market.

26. In terms of the geographic extent of this market, some caution should be exercised in drawing a boundary (for example, by drawing a radius around a particular point) and determining what is inside and outside the market based solely on that boundary. For example, an area that lies inside a boundary may nonetheless be less of a substitute to other areas inside the boundary because of differences in access to amenities, or constraints arising from the topography of a region. In addition, the extent of geographic boundaries can be dependent on the choice of location for the centre of the boundary.

27. While I have not assessed other areas in detail, the settlement at Paengaroa, which lies between Te Puke and Pongakawa, is also likely to be within the same housing market. Other areas that are relatively close to Te Puke, such as suburbs of Tauranga City (e.g., Arataki and Papamoa) appear to have considerably different features and amenities, so on this basis are likely to be in a different housing market. Similarly, coastal settlements such as Maketu and Pukehina Beach, while relatively close to Te Puke, are likely to be sufficiently distinct in respect of their beachside offerings. On this basis, the extent of the relevant locality and market encompasses Te Puke, Paengaroa and the Pongakawa Arawa Road residential area.

Appendix B

Land Productivity Assessment

for Proposed Private Plan Change

Pencarrow Estate

SH2, Pongakawa

August 2024

LandVision Ltd

55 Golf Road

Mount Maunganui

1 SUMMARY

Pencarrow Estate is proposing a private plan change at 1491 State Highway Two, Pongakawa. This proposal involves the rezoning of one current rural land title into 9.66 ha of residential zone and 0.37 ha of commercial zone. Approximately 7.07 ha will remain as rural zone, being land allocated for primary or reserve wastewater disposal areas.

The purpose of this report is to provide a land productivity assessment to satisfy the National Policy Statement for Highly Productive Land (NPS-HPL). This report summarises the land resources and land use capability units of Pencarrow Estate, assesses the productive capacity of the site and considers whether the criteria to satisfy Clause 3.6 and 3.13 of the NPS for urban rezoning has been met.

A detailed soil and land use capability survey at the paddock scale (1:6,000) was undertaken for Pencarrow Estate The total area mapped is 17.1 ha of which approximately 43% is flat to gently undulating terraces, with the remaining 53% as rolling hills. The vegetative cover currently comprises of approximately 15.5 ha of effective pasture and 0.3 ha in maize. The remaining 1.3 ha are in utilities and other non-effective areas. The predominant rock type for the higher terraces and rolling hills is patchy Kaharoa tephra over ancient tephra. The lower terraces are formed from peat and pumiceous alluvium. Five different soil types were identified on the property each with different characteristics. There was no erosion recorded on the property. Five different LUC (Land Use Capability) units and four LUC classes (II, III, IV & VIII) were recorded as part of the survey.

The effective area of highly productive land proposed for residential/commercial development in Pencarrow Estate is 6.5 ha. These areas include highly versatile soils, flat to rolling topography, and are suited, with correct management to a number of different land uses. However, the overall productive capacity of the site may be affected by

- the fragmentation and lack of size and scale of the HPL land units.
- site location and current surrounding land uses.

As part of satisfying Clause 3.13 of the NPS-HPL a number activities and effects associated with highly productive land that should be anticipated in a rural environment were identified. These included stock grazing, nutrient and agrichemical, and effluent application, cultivation and sowing of crops and irrigation. The loss of 9.9 ha of effective highly productive land – which is well fragmented into small units and may be difficult to amalgamate with some adjacent HPL land - out of 44,000 ha of the districts HPL is considered insignificant.

To satisfy Clause 3.6 of the NPS-HPL, this report assessed a number of alternative sites for residential development around the satellite towns of Te Puke, Paengaroa, and Pongakawa. Areas already in kiwifruit production were considered unfavourable for residential development as this land use best utilizes the land resources and favourable climatic conditions in these areas. Additionally, the costs of removing these orchards may outweigh any benefits gained from reverting the use of the land into residential development. Areas which were susceptibility to flooding, as per the Western Bay of Plenty District Council's overlays, and areas already zoned as industrial were also deemed unsuitable. On the remaining land, there were areas identified on the outskirts of Paengaroa and Pongakawa which have a lower land use versatility, but still have a high productive capacity, particularly to sustain intensive kiwifruit production. These were identified as large scale, contiguous land units, with versatile soil types. The overall productive capacity of these sites is deemed to be higher than that of Pencarrow Estate.

This report concludes that Clause 3.6 of the NPS-HPL has been met and that Pencarrow Estate is an appropriate area for residential development.

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LandVision Ltd.

LandVision Ltd is an independent technical agricultural/land and resource management consultancy company with offices in Hawkes Bay, Nelson, Wanganui, and Tauranga. It has a team of multi- skilled staff with extensive experience across farm planning and management, soil and LUC mapping, nutrient budgeting, environmental management, compliance, and policy.

LandVision is New Zealand's most experienced private soil /LUC mapping specialist with over 1.2 million hectares mapped for various clients, including councils, farmers, and Iwi.

LandVision Ltd provide technical and strategic advice to clients throughout Aotearoa across multiple scales from small farms to large councils, industry groups, Iwi farming trusts and corporates. Its advice ranges from comprehensive farm plans and nutrient budgets, advice on development options and due diligence to full effects assessments to support resource consent applications.

3 BACKGROUND

Pencarrow Estate is proposing a private plan change at 1491 State Highway Two, Pongakawa. This is located entirely within the Western Bay of Plenty District as identified in the Location Map in Appendix 1.

The total area of the proposed plan change is 17.10 ha. and involves the legal parcels with the title number SA62A/30. Currently the land is utilized for dairy farming. The private plan change would seek to rezone approximately 9.66 ha of rural land to residential zone and 0.37 ha to commercial zone. Approximately 7.07 ha of land would remain as rural. This rezoning proposal is summarised in the Proposed Zoning Map in Appendix 2.

Adjoining sites along Arawa Road to the southeast are already zoned residential with the remaining surrounding land zoned rural.

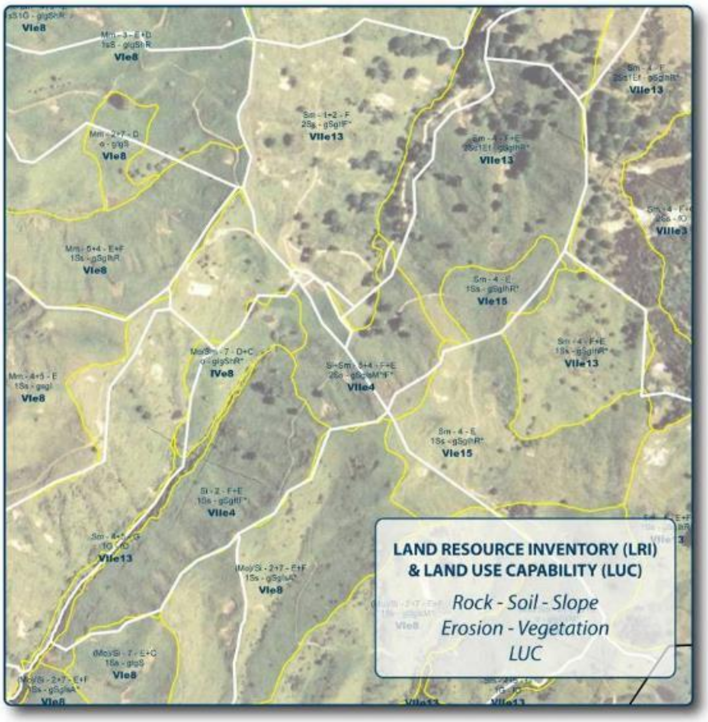
4 PURPOSE

The purpose of this report is to provide:

1. A paddock scale Land Resource Inventory and Land Use Capability survey.
2. An assessment of the productive capacity of the land within the proposed residential zone (proposed development site) as required under the NPS for Highly Productive Land (NPS-HPL).
3. An assessment, as per Clause 3.13 of the NPS-HPL, and identification of the activities and environmental effects that should be anticipated in a productive rural environment as well as any cumulative effects from the proposed residential development.
4. An assessment on whether the criteria in Clauses 3.6 under the NPS-HPL is met – that there are no other reasonably practicable and feasible options within the same locality suitable for residential development.

5 PADDOCK SCALE RESOURCE AND ENVIRONMENTAL ASSESSMENT

5.1 Land Resources



The land resource has been described and evaluated according to the Land Resource Inventory (LRI) and Land Use Capability classification system (LUC). The land resources survey was undertaken at a 1:6,000 scale.

The LRI system involves mapping landscape units according to five inventory factors (rock type, soil unit, slope class, erosion type and severity, and vegetation).

From the LRI assessment, the area was then classified as LUC, which further groups similar units according to their capacity for sustainable production under arable, pastoral, forestry or conservation uses across the region. The LUC code is broken down into three components, which show the general capability (I-VIII classes), the major limitations (four subclass limitations of wetness, erosion, soil and climate), and the capability unit to link with regional classifications and known best management practices. The LUC unit is shown in bold in Figure 1, (e.g., VIIe4) and the LRI is shown by a series of symbols laid out in a set pattern as shown in the bottom right corner.

The LUC units mapped on the Pencarrow Estate at paddock scale (1:6,000) were also compared to those depicted in the Regional Scale mapping (1:50,000) as a means of highlighting the potential inaccuracies with using the NZLRI data. This is discussed in further detail in Section 6.6. As part of the NPS-HPL assessment the regional scale NZLRI data was used to assess comparable alternative areas within the district with the potential for residential development. Regional scale LRI data for each alternative or sample areas is shown in Section 9.

5.2 Summary of the Land Resource Inventory Assessment

The total area of the proposed site is 17.1 ha of which approximately 85% is flat to gently undulating terraces, with the remaining 15% as rolling hills*.

The vegetative cover currently comprises of approximately 15.5 ha of effective pasture and 0.3 ha in maize. The remaining 1.3 ha are in utilities and other non-effective areas.

The predominant rock type for the higher terraces and rolling hills is patchy Kaharoa tephra over ancient tephra. The lower terraces are formed from peat and pumiceous alluvium.

Five different soil types were identified on the property each with different characteristics. There was no erosion recorded.

N.B. the results of the Land Resource Assessment are depicted in the Land Resource Inventory Map in Section 5.3 and summarised in the Land Resource Legends in Appendix 3.

**Areas provided on consent scheme differ slightly from mapped areas – these are insignificant and relate to inconsistencies from differences in GIS systems used.*

5.3 Paddock Scale Land Resource Inventory Map

5.4 Paddock Scale Land Use Capability Map

5.5 Land Use Capability Assessment

Five different land use capability units were identified as part of the land resource survey undertaken at a scale of 1:6,000 and the extent of these are summarised in the Table 1. Detailed descriptions of the units are summarised in Appendix Two and a LUC map is shown in Section 6.4.

Table 1. Distribution of LUC units.

LUC Class	Area (ha)	%	LUC Unit	Area (ha)	%
Class II	12.8	75	IIw1	7.2	42
			IIs1	5.6	33
Class III	1.5	9	IIIw1	1.5	9
Class IV	2.5	15	IVe2	2.5	15
Class VIII	0.3	2	VIIIw1	0.3	2
Total	**17.1 ha**	**100 %**		**17.1 ha**	**100 %**

Table 1 shows the site contains 12.8 ha of LUC class II land, 1.5 ha of LUC class III land, 2.5 ha of LUC class IV land and 0.3 ha of LUC class VIII land.

5.6 Paddock Scale Mapping vs Regional Scale Mapping in Classifying Land

Table 2 below shows the LUC classification from both the regional scale and paddock scale mapping.

Table 2: LUC classification for the proposed subdivision lots from both the regional and paddock scale mapping. Note: LUC class of paddock scale mapping is always denoted in roman numerals where regional scale mapping is denoted in normal numerals.

Regional scale mapping (1:50,000)		Paddock scale mapping (1:6,000)	
LUC Unit	**Area (ha)**	**LUC unit**	**Area (ha)**
2w1	16.9	**IIw1**	7.2
3e2	0.2	**IIs1**	5.6
		IIIw1	1.5
		IVe2	2.5
		VIIIw1	0.3
Total	**17.1 ha**	**Total**	**17.1 ha**

When undertaking land resource mapping the size of the smallest unit is about 1 cm^2 irrespective of scale. Under regional scale mapping (1:50,000 scale) the smallest mapping unit is about 25 ha whilst paddock scale mapping

(1:6,000 scale) the smallest mapping unit is about 3600 m^2. Under regional scale mapping there were two LUC units identified whilst under paddock scale mapping five units were recorded. The level of detail from paddock scale mapping is significantly greater than that from regional scale mapping. For the proposed subdivision the total area is significantly smaller than the smallest mapping unit under regional scale mapping.

The difference of scale between regional and paddock scale LUC/LRI mapping is reflected in the extent of all the land resource inventory characteristics (geology, soils, slope, erosion and vegetation) and the resulting LUC unit. Below are several examples for this site.

5.6.1 Example 1 – Differences in Soil Classification

Under the NZLRI classification (regional scale 1:50,000), most of the proposed area is mapped with Opiki complex soils (2b) and Pongakawa soils (107f). The LUC classification is 2w1. There is a small area of 3e2 mapped on the eastern boundary which is dominated by Paengaroa soils (14). The soil characteristics of Opiki series are poorly drained gley soils formed from alluvium and peat (Cowie, 1978) whilst the Pongakawa soils are typically poorly drained organic soils formed from peat and tephra alluvium. The distribution of these is shown in the following map.

<u>NZLRI soil map.</u>

Paddock scale mapping showed that the property actually consists of two distinct terraces and rolling inter-terrace margins or gullies with the following characteristics:

- The lower terrace is formed from tephric alluvium and peat and dominated by the Pukehina soils (Pow).
- The higher terrace is derived from tephra and dominated by Paengaroa soils.
- The inter-terrace margin or gullies are dominated by the rolling phase of the Paengaroa soils.

The distribution of the above soils from paddock scale mapping is shown in the following map.

Paddock scale soil map

The physical differences between these soils are shown in the soil descriptions in Appendix 3.

5.6.2 Example 2 – Differences in slope classification

Slope is an important determinant for LUC classification. The following two maps show the slope classification under regional and paddock scale mapping respectively.

NZLRI slope map.

Paddock scale slope map.

5.6.3 Example 3 – Smallest Mapping Unit

Under regional scale (1:50,000) mapping the smallest mapping unit is about 25 ha whilst at paddock scale mapping (1:6,000) the smallest mapping unit is 3,600 m2. At the regional scale mapping it will amalgamate distinctive areas less than 25 ha into adjacent areas whereas at paddock scale mapping (1:6,000) distinctive areas greater than 3,600 m2 have their own polygon. The main drain along the western boundary is an example of this.

6 NPS FOR HIGHLY PRODUCTIVE LAND (NPS-HPL)

The NPS-HPL came into force on 17 October 2022 and aims to protect highly productive land for use in land-based primary production, both now and for future generations. It requires councils to map and zone highly productive land and manage subdivision, use and development of that land.

6.1 Definition of NPS-HPL

From the date that the NPS-HPL comes into force, and until the mapping of highly productive land in the Bay of Plenty Region becomes operative, the NPS-HPL applies to all consent applications involving land that meets the "transitional definition" of HPL i.e., land that as of 17 October 2022:[1]

is:

- zoned general rural or rural production; and
- identified as land use capability class (**LUC**) 1, 2, or 3 land; but

is not:

- identified for future urban development; or
- subject to a council initiated, or an adopted, notified plan change to rezone it from general rural or rural production to urban or rural lifestyle.

The proposed subdivision does not meet these requirements and as a result needs to meet clause 3.6 and 3.13 of the NPS HPL in particular for the private plan change to be granted.

6.2 Extent of Highly Productive Land (HPL) on the site.

The plan change proposal is for the rezoning of approximately 9.9 ha of current rural land to residential and commercial areas. Approximately 7.4 ha will remain as rural zone land.

Note: To avoid confusion with other district planning nomenclature, this report will refer to areas proposed for residential and commercial development as "proposed development area" and the areas to remain in rural production as "production area".

Table 5. Summary of highly productive land and not highly productive land found on the proposed development and production areas.

LUC Class	Land definition under the NPS-HPL	Proposed development area			Production area		
		LUC Unit	**Area (ha)**	**Overall %**	**LUC Unit**	**Area (ha)**	**Overall %**
Class 2	Highly productive land	2w1	9.7	56	2w1	7.4	43
Class 3		3e2	0.2	3	-	-	-

	Total		**9.9 ha**	**59%**		**7.4 ha**	**43%**

Table 5 shows the proposed development area includes 9.7 ha of LUC class 2 and 0.2 ha of LUC class 3. This is summarised in the map below. The proposed plan change site is therefore implicated by the NPS-HPL.

<u>Map of NZLRI per zone on Pencarrow Estate.</u>

6.3 Definition of Productive Capacity

Productive capacity, in relation to land, is defined in Clause 1.3 of the NPS-HPL as:

> *…the ability of the land to support land-based primary production over the long term, based on an assessment of:*
>
> a. *physical characteristics (such as soil type, properties, and versatility); and*
>
> b. *legal constraints (such as consent notices, local authority covenants, and easements); and*
>
> c. *the size and shape of existing and proposed land parcels.*

The relevant factors contributing to the existing productive capacity will vary depending on the local context and will influence the type of land-based primary production suitable for that site.

6.4 NPS-HPL Clause 3.13

Clause 3.13 of the NPS-HPL ensures territorial authorities manage the revere sensitivity and cumulative effects by:

(1) (a) identifying the activities and effects associated with the land based primary production on highly productive land that should be anticipated in a productive rural environment; and
(b) requiring the avoidance if possible, or otherwise the mitigation, of any reverse sensitivity effects from urban rezoning or rural lifestyle development that could affect land-based primary production on highly productive land; and
(c) require consideration of the cumulative effects of any subdivision, use, or development on the availability and productive capacity of highly productive land in their district.

6.5 NPS-HPL Clause 3.6

Clause 3.6 of the NPS_HPL allows territorial authorities to undertake urban rezoning of highly productive land only if the following criteria are met:

(1) (a) the urban rezoning is required to provide sufficient development capacity to meet demand for housing or business land to give effect to the National Policy Statement on Urban Development 2020; and
(b) there are no other reasonably practicable and feasible options for providing at least sufficient development capacity within the same locality and market while achieving a well-functioning urban environment;
(c) the environmental, social, cultural and economic benefits of rezoning outweigh the long-term environmental, social, cultural and economic costs associated with the loss of highly productive land for land-based primary production, taking into account both tangible and intangible values.

(2) In order to meet the requirements of subclause (1)(b), the territorial authority must consider a range of reasonably practicable options for providing the required development capacity, including:

(a) greater intensification in existing urban areas; and

(b) rezoning of land that is not highly productive land as urban; and

(c) rezoning different highly productive land that has a relatively lower productive capacity.

7 PRODUCTIVE CAPACITY

The current productive capacity of the site has been assessed by acknowledging the physical features of the site (including any constraints), the shape and distribution of the current and proposed land titles as well as any legal constraints. This is as per Clause 1.3 of the NPS-HPL which defines productive capacity.

7.1 Productive Capacity

7.1.1 Land resource features and potential land uses

The main features and potential land uses of the proposed development area are summarized in Table 6 below.

Table 6. Summary of the main features and potential land uses of the proposed development area.

<table>
<tr><td>LUC classes</td><td colspan="3">Comprises 7.3 ha of highly productive land (5.8 ha of LUC class II, 1.5 ha of LUC class III). There is also 2.6 ha of not highly productive land (2.2 ha of LUC class IV and 0.4 ha of LUC class VIII)</td></tr>
<tr><td>Current land use/s</td><td colspan="3">Dairy farming</td></tr>
<tr><td>Surrounding land uses</td><td colspan="3">Dairy farming to the north and east; resident and State Highway to the south; residential, road and horticulture to the east.</td></tr>
<tr><td rowspan="4">Soils and constraints</td><td colspan="3">4.8 ha of Pgls (Paengaroa loamy sand) and 2.1 ha of PglsR (Paengaroa loamy sand, rolling phase).
<u>Constraints</u>
• Fragile topsoil structure.
• Sandy soils susceptible to summer droughts.</td></tr>
<tr><td colspan="3">0.5 ha of Rppl (Raparapahoe sandy peaty loam) and 1.0 ha of Rpzl (Raparapahoe silt loam)
<u>Constraints</u>
• Poor natural drainage.
• Drainage affected by runoff from adjacent areas.</td></tr>
<tr><td colspan="3">0.2 ha of Pow (Pukehina silt loam, peaty subsoil phase).
<u>Constraints</u>
• Poor natural drainage.</td></tr>
<tr><td colspan="3">Rest of the areas are already developed into ponds, races, utilities.</td></tr>
<tr><td>Slope constraints</td><td colspan="3">7.7 ha of flat land (A slope class) and 2.2 ha of rolling land (C slope class) with no slope constraints for highly productive primary activities.</td></tr>
<tr><td rowspan="2">Potential land uses*</td><td>IIw1</td><td>0.2</td><td rowspan="2">Intensive pastoral farming.
Horticulture.
Cereal crops.
Root and green fodder cropping.</td></tr>
<tr><td>IIIw1</td><td>1.5</td></tr>
</table>

	IIs1	5.6 ha	Intensive pastoral farming. Citrus and sub-tropical fruit orchards. Orchards. Horticulture. Cereal crops. Root green and fodder cropping.
	IVe2	2.5 ha	Intensive pastoral farming. Citrus and sub-tropical fruit orchards.
	VIIIw1	0.5 ha	Retirement.
Other constraints/limitations	• The presence of the State Highway, Arawa Road and Arawa Road residential area limits amalgamation with highly productive land to the south, south-east and east. • Highly productive land areas (LUC Class II and III) are intersected by non-highly productive areas (LUC class IV, VIII) causing the fragmentation of the HPL units. • IIIw1 units within flood flow paths which may limit highly productive land activities.		

**from Blaschke (1985).*

The proposed non-production area of the subject land contains several highly productive land units including LUC class IIw1, IIs1 and IIIw1. As per Lynn et al. (2009), the LUC class II units have slight limitations for arable use, whereas, the LUC class III units have moderate limitations for arable use. The limitations or constraints in the case of Pencarrow Estate are the poor soil structure and susceptibility to summer drought (IIs1 units) and the high water table and poor natural drainage (IIw1, IIIw1). However, with correct management these limitations or constraints can be overcome. For example, with the installation of open drains on the IIw and IIIw units, the land is suited for intensive pastoral farming, some horticulture practices, cereal cropping and root and green fodder cropping. The LUC class IIs units, with the installation of irrigation is suited for the same land uses as well as citrus and sub-tropical fruit orchards as well as other orchards.

7.1.2 Fragmentation and lack of size of HPL Soils and LUC units.

As shown in the paddock scale LRI and LUC maps in Section 6, the highly productive soils and corresponding LUC units on the proposed development area are fragmented. This is a result of non-highly productive land units (IVe2, VIIIw1) intertwined within the highly productive land units. In addition, there are several utility areas (races, buildings) already built which have also contributed to this fragmentation.

This fragmentation may pose management challenges and difficulties as there is not one large contiguous highly productive land unit to utilise. Additionally, the lack of size and scale of these HPL units may pose challenges. For example, the lack of size and scale may impact investment into infrastructure, machinery, irrigation etc if there was a desire to change to more highly productive growing activities.

7.1.3 Site location and surrounding land uses

The proposed development area is located in the south-eastern corner of the land parcel. The immediately surrounding land to the south includes State Highway 2 and to the east is existing residential development as well as Arawa Road. The presence of these features may limit the potential for the highly productive land within the proposed development site to be amalgamated with highly productive land units further to the south and east.

7.1.4 Summary

From strictly a land resource perspective, the highly productive land units (LUC class IIw, IIs and IIIw) within the proposed development site are suited, with correct management, to a range of different land uses. However, the overall productive capacity of the site to sustain a number of different land uses may be affected by the fragmentation and lack of size and scale of the HPL land units, as well as the site location and current surrounding land uses.

8 TECHNICAL ASSESSMENT OF NPS-HPL WITH REGARD TO THE CRITERIA IN NPS-HPL – CLAUSE 3.13

8.1 Clause 3.13 1(a) identify the activities and effects associated with the land based primary production on highly productive land that should be anticipated in a productive rural environment.

Table 7 below identifies the activities related to the potential land uses for the proposed development site of the subject land. These potential land uses were described in Section 8. The associated environmental effects of each activity are also summarised below.

Table 7. Activities and environmental effects associated with each potential land use on the non-production area of the subject land.

Activities	Relevant Land Use/s	Environmental effects/risks	Significance of risk	Management of risks
Stock grazing	Intensive pastoral grazing. Root and green fodder cropping.	Pugging of soils.	Medium risk on poorly drained Pow soils and low on Pg soils.	Managed through adequate stock rotation, visual soil assessments.
		Contaminant loss of nutrients from stock through leaching and runoff.	Low risk on poorly drained Pow soils and medium on Pg soils.	Managed through adequate stock rotation.
			Low risk of runoff on flats and medium on rolling hills.	Managed through adequate stock rotation, allowing grass buffers around waterways etc.
Nutrient application	Intensive pastoral grazing. Horticulture. Orcharding. Root and green fodder cropping.	Contaminant loss of nutrients through leaching and runoff.	Low leaching risk on poorly drained Pow, soils but medium on Pg soils. Mainly low runoff losses because of mainly flat topography. Medium runoff risk on rolling slopes.	Leaching managed through nutrient budget and nutrient application plans. Runoff risk managed through continuing to allow grass buffers at the

				base of slope etc.
Agrichemical application	Intensive pastoral grazing. Horticulture. Orcharding. Root and green fodder cropping.	Spray drift.	Low risk	Managed through district plan regulations.
		Contaminant loss of nutrients through leaching	Low/medium risk of leaching on Paengaroa soils.	Managed through agricultural application plans.
Effluent application	Intensive pastoral grazing.	Spray drift.	Low risk	Managed through resource consenting and regional regulations.
		Contaminant loss of nutrients through leaching and runoff.	Low risk on Pow soils to medium leaching on Pg soils. Low runoff risk on flats, medium risk on rolling topography.	Managed through nutrient budgeting effluent application plans – buffers around waterways, continuing to allow grass buffers at base of slopes etc.
Cultivation and sowing of crops	Horticulture. Root and green fodder cropping.	Loss of topsoil through wind and surface erosion.	Medium risk on Pg soils particularly on rolling slopes.	Direct drill methods, little fallow periods, cultivation plans – best practice.
		Contaminant loss of nutrients through leaching and runoff.	Low/medium risk of leaching on Pg soils.	Nutrient application plans. Nutrient budgeting.
			Medium runoff risk on rolling topography. Low on flats.	Graze crops towards waterways, allow grass buffers.

8.2 Clause 3.13 1(b) require the avoidance if possible, or otherwise the mitigation, of any reverse sensitivity effects from urban rezoning or rural lifestyle development that could affect land-based primary production on highly productive land.

See reverse sensitivity issues covered in report produced by MPAD.

8.3 Clause 3.13 1(c) require consideration of the cumulative effects of any subdivision, use, or development on the availability and productive capacity of highly productive land in their district.

The breakdown of the HPL within the Western Bay of Plenty Council Area is summarised in Table 8 below.

Table 8. Breakdown of LUC classes for the Western Bay of Plenty Council (from the NZLRI).

Land Class under the NPS-HPL	LUC class (from NZLRI)	Area (ha)	Percentage (%)
Highly productive land	1	-	-
	2	19,197	9
	3	25,188	12
Not highly productive land	4	32,320	15
	5	659	<1
	6	70,627	33
	7	28,466	13
	8	18,018	9
	Other (rivers, estuary, towns, other areas not classed)	17,270	8
Total		**211, 745 ha**	**100 %**

Based on the NZLRI, there is approximately 44,400 ha of highly productive land in the Western Bay of Plenty District which constitutes 21% of the district. For the proposed Pencarrow Estate plan change, 9.9 ha of highly productive land– is well fragmented, small in scale, and which may pose challenges with amalgamating with adjacent HPL – will be lost to development. This is considered insignificant.

In addition, a large proportion of the highly productive land in the district is surrounding the main town centres such as Te Puke, Paengaroa and Pongakawa. This makes any development on rural land, whether it be small scale subdivision or rezoning for larger developments, challenging as criteria within the NPS-HPL will always need to be satisfied. Therefore, it is critical to balance the housing demand with the need for urban rezoning preferably by selecting areas with lower productive capacity and/or areas with long term constraints for sustaining highly productive activities. The following section assesses the productive capacity of the areas surrounding the main town centres named above and whether these have higher productive capacity and are therefore less favourable for residential development.

9 ALTERNATIVE POTENTIAL AREAS FOR DEVELOPMENT

The following section analyses alternative potential areas for residential development within the locality of Pencarrow Estate. This is called for under Section 3.6 (1)b of the NPS-HPL which states "there are no other reasonably practicable and feasible options for providing at least sufficient development capacity within the same locality and market while achieving a well-functioning urban environment".

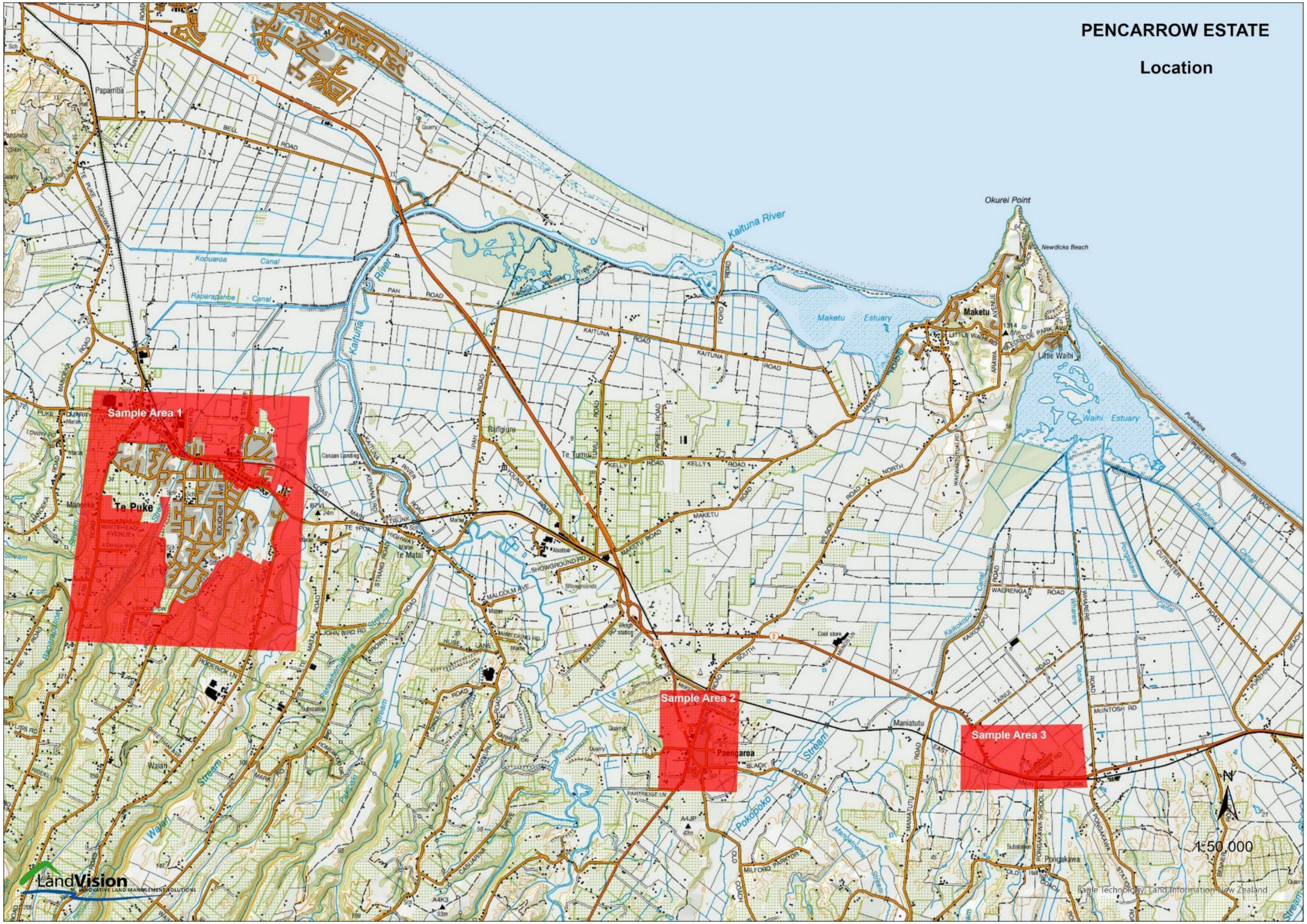
9.1 Assessment of Clause 3.6 (1)(b)

In order to evaluate the criteria in Clause 3.6 (1)(b), a comparison between the productive capacity of Pencarrow Estate and that of three other reasonably practical alternative land options, with similar development capacity and located in the same locality and market, were made. This included land on the fringes of Te Puke, Paengaroa, and Pongakawa– see Location of Alternative Sample Areas Map in Section 10.2.

The assessment of the land resources utilized the NZLRI mapping system – a national database of New Zealand's physical resource information. This database is a collection of information gathered from published and unpublished material, stereo aerial photography and extensive fieldwork. The database obtained from the LRIS portal is present in 1:50,000 scale. Paddock scale mapping of these larger scale areas was not considered a feasible option due to cost and time restraints.

It is noteworthy that the assessment to satisfy Clause 3.6 was a desktop exercise. Paddock scale mapping could have revealed different LUC units to what is presented by the NZLRI, such as with the paddock scale mapping exercise at Pencarrow Estate.

9.2 Location of Alternative Sample Areas



9.3 Sample Area 1: Area surrounding Te Puke

9.3.1 Sample Area

Te Puke is situated approximately 13 km to the west of Pencarrow Estate.

A sample area of approximately 1,034.3 ha was assessed incorporating land on the fringes of Te Puke (see Location map in Section 10.2). This area excludes the Plan Change 92 area within in and around Te Puke township already defined for future development – a plan change which became operative in May 2024.

9.3.2 Summary of Land Resource and Land Use Capability Information

A summary of the land resource and land use capability information for Sample Area 1 is presented in Table 9 below.

Table 9. Summary of land resource and land use capability information for Sample Area 1 – areas on the fringes of Te Puke.

Sample	Area (ha)	LUC unit	Area and distribution (%)	LUC class	Area and distribution (%)	Slope (class and definition)	Parent material and soils	Land use
Te Puke (minus Plan Change 92 area)	1034.3	2s1	533.2 ha (52%)	2	666.4 ha (65%)	Undulating (B)	Tephra over unconsolidated sands and volcanics Soils 14a and 16	Pastoral Farming Orchards Buildings (Industrial)
		2w1	133.2 ha (13%)			Flat (A)	Taupo pumice Soil 107f and 2b	Pastoral Farming Orchards Buildings (Industrial)
		3w1	137.4 ha (13%)	3	137.4 ha (13%)	Flat (A)	Peat and Taupo pumice Soil 107f	Pastoral Farming Orchards
		4e2	15.6 ha (2%)	4	15.6 ha (2%)	Rolling (C)	Tephra Soil 14a	Orchards
		7e1	131.5 ha (13%)	7	131.5 ha (13%)	Steep to moderately steep (F+E)	Tephra over volcanics Soil 16H	Pastoral Farming Native bush.

		8e3	22.8 ha (2%)	8	22.8 ha (2%)	Very steep G	Tephra over volcanics Soil 126	Pastoral Farming Native bush.
		Town	60.7 ha (6%)	Town	60.7 ha (6%)	Flat A	Town	Houses/Buildings (Town)

As Table 9 illustrates, approximately 803.8 ha or 78% of the sample area is classified as either LUC class 2 or 3 and therefore defined as highly productive land under the NPS-HPL. These areas are generally flat to undulating and are either formed from volcanic tephra (2s1), pumiceous alluvium (2w1), or peat and pumiceous alluvium (3w1) parent materials. Four different soil types on the highly productive land were identified as part of this assessment. Currently, pastoral farming, and kiwifruit orchards are the main land uses on the LUC class 2 and 3 land. Industrial buildings are also present on the LUC class 2 land.

Approximately 169.9 ha of the sample area includes LUC classes 4-8, or areas defined under the NPS-HPL as not highly productive land. This constitutes 17% of the sample area with the remaining 6% classified as town. Each of these units are formed from tephra parent material, have different soil types and range from rolling to very steep contour. Currently, the land uses range from orchards on the LUC class 4 units to pastoral farming and native bush on the LUC class 7 and 8 units. Land-uses to the east, south and west are overwhelmingly established kiwifruit orchards.

9.3.3 Productive Capacity

Table 10. Summary of resource information, current sample area features and potential land uses.

LUC classes	Comprises 666.4 ha of LUC class 2, 137.4 ha of LUC class 3, 15.6 ha of LUC 4, 131.5 ha of LUC class 7 and 22.8 ha of LUC class 8. 60.7 ha is classified as town.	
Current land use/s	**Sample site locality**	**Land use/s**
	West and South	Existing Kiwifruit orchards.
	Northwest	Existing industrial areas.
	North	Pastoral Grazing – Dairy Existing Kiwifruit orchards
	West	Pastoral Grazing – Dairy Existing Kiwifruit orchards Cropping
Surrounding land use/s	**Sample site locality**	**Land use/s**
	Areas further to the west and south	Existing Kiwifruit orchards.
	Areas further to the northwest, north and northeast	Pastoral Grazing – Dairy

<table>
<tr><td></td><td colspan="2">Areas further to the east</td><td colspan="2">Existing Kiwifruit orchards</td></tr>
<tr><td rowspan="5">Soils* and constraints</td><td colspan="4">255.0 ha of 107f (Pongakawa peaty loam)
<u>Constraints</u>
• Poor natural drainage.
• Fragile topsoil structure.
• Fluctuating ground water levels.</td></tr>
<tr><td colspan="4">363.9 ha of 14a (Paengaroa shallow sand).
<u>Constraints</u>
• Fragile topsoil structure.
• Summer droughts.</td></tr>
<tr><td colspan="4">316.4 ha of 16 (Oropi sand) and 41.6 ha of 16H (Oropi sand, hill soil).
<u>Constraints</u>
• Fragile topsoil structure.
• Low fertility.
• Steep slopes on hill soil.</td></tr>
<tr><td colspan="4">15.6 ha of 2b (Opiki complex)
<u>Constraints</u>
• Poor natural drainage.
• Fragile topsoil structure.</td></tr>
<tr><td colspan="4">22.8 ha of 126 (Otanewainuku steepland soil)
<u>Constraints</u>
• Very steep slopes.
• Low fertility.
• Cool climate.</td></tr>
<tr><td>Slope constraints</td><td colspan="4">270.6 ha of flat land (A slope class), 533.2 ha of gently undulating (B slope) and 15.6 of rolling land (C slope) with no slope constraints for highly productive activities.
154.3 ha of steep to very steep land (F and G slope class) with extreme constraints for highly productive activities.</td></tr>
<tr><td rowspan="2">Potential land uses**</td><td>2w1, 3w1</td><td colspan="2">270.6 ha</td><td>Intensive pastoral farming.
Horticulture.
Cereal crops.
Root and green fodder cropping.</td></tr>
<tr><td>2s1</td><td colspan="2">533.2 ha</td><td>Intensive pastoral farming.</td></tr>
</table>

			Citrus and sub-tropical fruit orchards. Orchards. Horticulture. Cereal crops. Green and fodder cropping.
	4e2	15.6 ha	Intensive pastoral farming. Citrus and sub-tropical fruit orchards. Root green and fodder cropping.
	7e1, 8e3	154.3 ha	Extensive pastoral farming Forestry.

**cross-referenced from (Roberts & Jarman, 1979) and (Rijkse & Guinto, 2010), **from Blaschke (1985).*

2s1 land

The most versatile soils/land within Sample Area 1 is LUC class 2s1 which includes the well-drained Paengaroa shallow sand (14a) and Oropi sand (14) soil types. The versatile soils, flat topography, large contiguous area and slight physical constraints (low natural fertility and fragile topsoil structure) means this land has a moderate to high productive capacity.

Within the sample area the distribution of the LUC class 2s1 land is predominantly in the east and south with smaller pockets in the north. Here, the current land use is predominantly kiwifruit orchards. This is a prime example of where best land use is matched to land type. In these areas, the land resources as well as the climatic conditions are favourable for intensive kiwifruit production.

2w1 land

The LUC class 2w1 includes the poorly drained Pongakawa peaty loam (107f) and Opiki complex (2b). This soil is not as versatile as those found on the LUC class 2s1 unit. Albeit, still classed as LUC class 2, the poor natural drainage has a greater influence on the land use potential on these units. For example, there is the potential for orcharding and citrus and sub-tropical fruit orchards on LUC class 2s1 land but not 2w1 units as these land uses cannot withstand poor natural drainage conditions. The moderate to versatility, flat topography, large contiguous areas, and slight physical constraints (poor natural drainage) means this land still has a moderate to high productive capacity. This capacity is lower than that of 2s1 but higher than that of 3w1.

The LUC class 2w1 units are found predominantly in the north of the sample area. Currently the predominant land use is pastoral grazing – dairy farming.

3w1 land

The LUC class 3w1 land includes the poorly drained Pongakawa peaty loam (107f). Albeit the same soil present in the LUC class 2w1 land, this unit is positioned along the Waiari Stream on the eastern boundary of the sample area where it is susceptible to flooding and runoff from higher areas. This susceptibly to flooding, moderately high water table year round, poor natural drainage and runoff from higher areas classes the unit as 3w1 and not 2w1. The soils themselves are still able to sustain a number of different primary activities, however, it is the susceptibility to runoff, and flooding which is moderate limitation affecting the lands versatility of use. Overall, the flat topography, large contiguous areas, and moderate physical constraints (poor natural drainage, susceptibility to runoff and flooding) means that this land still has a moderate to low productive capacity.

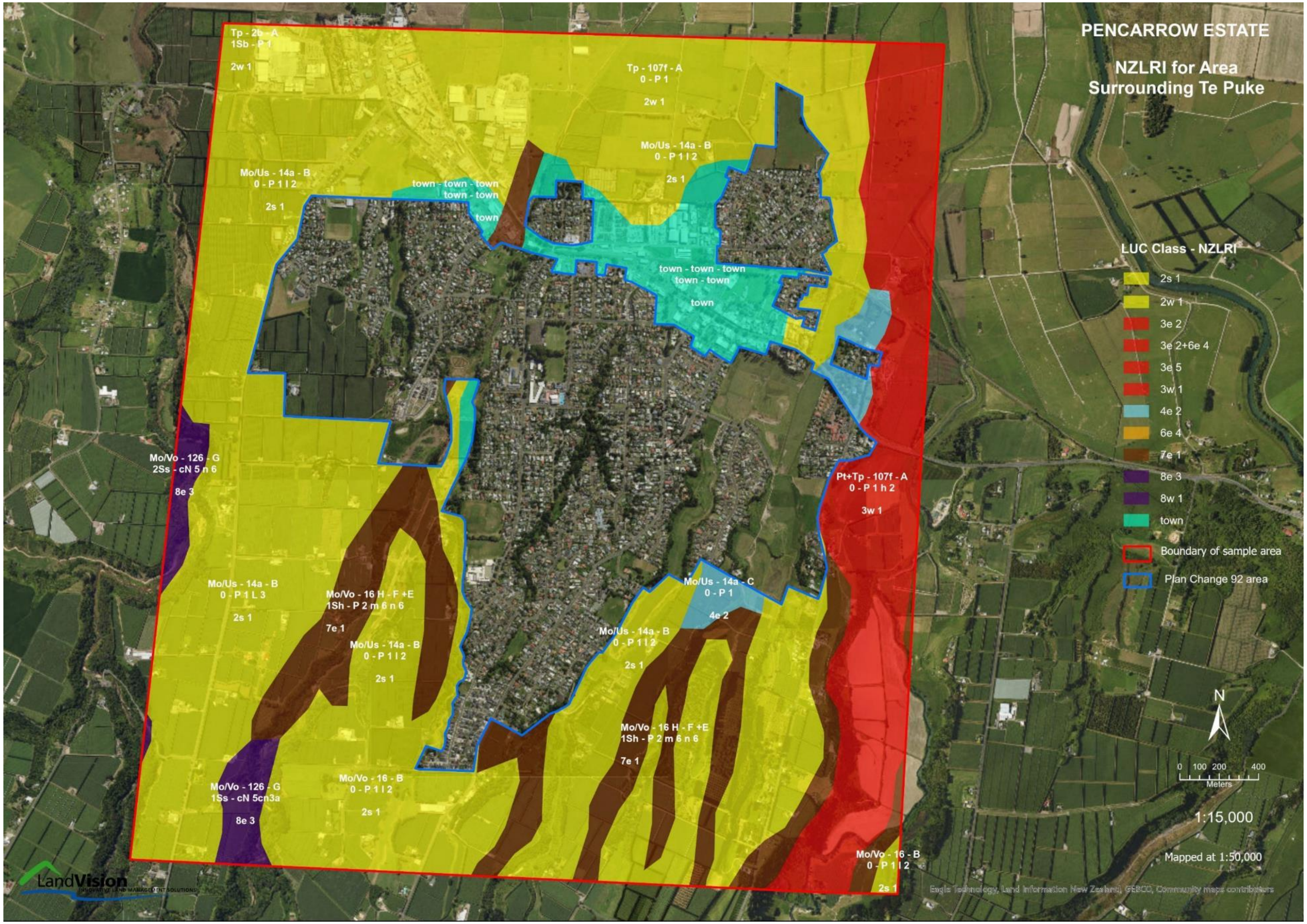
4e2 land

The 4e2 unit includes rolling tephra hills with Paengaroa soils (14a). These soils have relatively high versatility, however, with increased slope there is the potential for moderate to severe erosion when cultivated. This presents a severe limitation to highly productive activities, particularly arable uses. The versatility of land use is therefore low and overall productive capacity is low to moderate. Currently the unit is in Kiwifruit orchards.

7e8, 8e3

The LUC class 7e8 and 8e3 units include steep to very steep hills formed from tephra over volcanics. The soils include Oropi hill soils (16H) and Otanewainuku steepland soils (126). These units which are prone to severe erosion are unsuitable for highly productive land uses.

9.3.4 NZLRI for Sample Area surrounding Te Puke



9.4 Sample Area 2: Area Surrounding Paengaroa

9.4.1 Sample Area

Paengaroa is situated approximately 5 km to the west of Pencarrow Estate.

A sample area of approximately 207 ha was assessed incorporating the areas on the fringes of Paengaroa (see Location Map in Section 10.2).

9.4.2 Summary of Land Resource and Land Use Capability Information

A summary of the land resource and land use capability information for Sample Area 2 is presented in Table 11 below.

Table 11. Summary of land resource and land use capability information for Sample Area 2 – areas on the fringes of Paengaroa.

Sample site	Area (ha)	LUC unit	Area and distribution (%)	LUC class	Area and distribution (%)	Slope (class and definition)	Parent material and soils	Land use
Paengaroa	206.6	2s1	108.6 ha (61%)	2	108.6 ha (53%)	Flat A+B	Tephra over unconsolidated sands Soil 14a	Pastoral Farming Orchards Houses/Buildings (Town)
		3e5	98.0 ha (39%)	3	98.0 ha (47%)	Rolling C+B	Tephra Soil 14	Pastoral Farming Orchards Houses/Buildings (Town)

The area on the fringes of Paengaroa is classified as either LUC class 2 (108.6 ha) or 3 (98.0 ha). The LUC class 2 land is generally flat and is formed from tephra overlying unconsolidated sands. The soil type is well-drained Paengaroa shallow sand (14a) and current land uses include pastoral farming – drystock, orchards, as well as some House/Buildings present. The LUC class 3 is generally rolling and is formed from tephra. The soil type is the well-drained Paengaroa sand (14) and current land uses include pastoral farming – drystock, orchards, as well as some house/buildings present.

9.4.3 Productive Capacity

Table 12. Summary of resource information, current sample area features and potential land uses.

LUC classes	Comprises 108.6 ha of LUC class 2 and 98.0 ha of LUC class 3.	
Current land use/s	**Sample site locality**	**Existing land use/s**
	North, northeast, southwest, west and northwest,	Kiwifruit orchards.
	East, southeast and south	Pastoral Grazing – Drystock

<table>
<tr><td></td><td colspan="2"></td><td colspan="2">Kiwifruit orchards.</td></tr>
<tr><td rowspan="4">Surrounding land use/s</td><td colspan="2">Sample site locality</td><td colspan="2">Existing land use/s</td></tr>
<tr><td colspan="2">Further northeast, south, southwest, and northwest</td><td colspan="2">Kiwifruit orchards.</td></tr>
<tr><td colspan="2">Further west</td><td colspan="2">Quarrying</td></tr>
<tr><td colspan="2">Further north, east, and southeast</td><td colspan="2">Pastoral Grazing – Drystock
Kiwifruit orchards.</td></tr>
<tr><td>Soils* and constraints</td><td colspan="4">98.0 ha of 14 (Paengaroa sand) and 108.6 ha of 14a (Paengaroa shallow sand).
<u>Constraints</u>
• Fragile topsoil structure.
• Prone to summer droughts.</td></tr>
<tr><td>Slope constraints</td><td colspan="4">108.6 ha of flat and gently undulating land (A, B slope class) and 98.0 ha of rolling land (C slope) with no slope constraints highly productive primary activities.</td></tr>
<tr><td rowspan="2">Potential land uses**</td><td>2s1,</td><td colspan="2">108.6 ha</td><td>Intensive pastoral farming.
Citrus and sub-tropical fruit orchards.
Orchards.
Horticulture.
Cereal crops.
Root green and fodder cropping.</td></tr>
<tr><td>3e5</td><td colspan="2">98.0 ha</td><td>Intensive pastoral farming.
Orchards.
Horticulture.
Root green and fodder cropping.</td></tr>
</table>

**cross-referenced from (Roberts & Jarman, 1979) and (Rijkse & Guinto, 2010), **from Blaschke (1985).*

<u>2s1</u>

Similar to Sample Area 1, the most versatile soils/land within Sample Area 2 is LUC class 2s1. This area includes the well-drained Paengaroa shallow sand (14a). The versatile soils, flat topography, large contiguous area and slight physical constraints (low natural fertility and fragile topsoil structure) means this land has a moderate to high productive capacity.

The main distribution of this unit is to the north and west, where kiwifruit orchards are the predominant land use. Similarly to Te Puke, Paengaroa offers favourable climatic conditions for intensive kiwifruit production.

<u>3e5</u>

The LUC class 3e5 unit dominates the eastern and southern fringes of the sample area. These are large contiguous units containing the well-drained Paengaroa sand (14). These soils have low natural fertility and fragile topsoil structure. Coupled with the rolling topography these units have moderate physical limitations with the main limitation being erosion. As a result this unit has moderate productive capacity, slightly lower than that of LUC class 2s1.

Currently the predominant land use is pastoral grazing – drystock with some kiwifruit orchards also present.

9.4.4 NZLRI for Sample Area surrounding Paengaroa

9.5 Sample Area 3: Area surrounding Pongakawa

9.5.1 Sample Area

Sample Area 3 includes 191.2 ha immediately surrounding Pencarrow Estate.

9.5.2 Summary of Land Resource and Land Use Capability Information

Table 13. Summary of Land Resource and Land Use Capability Information for Sample Area 3 – areas on the fringes of Pencarrow Estate and Pongakawa.

Sample site	Area (ha)	LUC unit	Area and distribution (%)	LUC class	Area and distribution (%)	Slope (class and definition)	Parent material and soils	Land use
Surrounding Pongakawa	191.2	2w1	110.0 ha (58%)	2	110.0 ha (58%)	Flat A	Pumiceous alluvium and peat 2b + 107f	Pastoral Farming Orchards
		3e2	62.9 ha (33%)	3	73.6 ha (38%)	Undulating to strongly rolling B+D	Tephra and Lapilli over unconsolidated sands Soil 14b	Pastoral Farming Orchards
		3w1	10.7 ha (5%)			Flat A	Pumiceous alluvium Soil 2	Pastoral Farming
		4e2	6.1 ha (3%)	4	6.1 ha (3%)	Rolling B+C	Tephra over Lapilli Soil 14	Pastoral Farming Orchards
		6e4	1.6 ha (1%)	6	1.6 ha (1%)	Mod Steep E		Pastoral Farming

Approximately 183.6 ha or 96% of the sample area is classified as either LUC class 2 or 3 (see Table 13). These areas are defined as highly productive land under the NPS-HPL. The area on the fringes of Pongakawa is classified as either LUC class 2 (110.0 ha) or 3 (73.6 ha). The LUC class 2 land is generally flat and is formed from pumiceous alluvium. The soil type is the poorly-drained Opiki complex and Pongakawa peaty loam. Current land uses include pastoral farming – dairy, with some Kiwifruit orchards present. The LUC class 3 is also generally flat and is formed from pumiceous alluvium. The soil type is the poorly drained Kairanga soil (2). Current land uses include pastoral farming – dairy.

In addition, approximately 6.1 ha of the area is classified as LUC class 4 and 1.6 ha as LUC class 6. This constitutes approximately 4% of the sample area, which is classed as not highly productive land under the NPS-HPL. Each of these units are formed from tephra parent material, have different soil types and range from rolling to moderately steep contour. Both units are currently used for pastoral farming – dairy.

Productive capacity

Table 14. Summary of land resource and potential land uses for areas surrounding Pongakawa.

LUC classes	Comprises 110.0 ha of LUC 2, 73.6 ha of LUC class 3, 6.1 ha of LUC class 4 and 1.6 ha of LUC 6.	
Current land use/s	**Sample site locality**	**Existing land use/s**
	North, northeast, southwest, west and northwest.	Pastoral grazing - Dairy
	East	Kiwifruit orchards Pastoral grazing - Dairy
	South	Residential Kiwifruit orchards
	Southwest	Kiwifruit orchards
Surrounding land use/s	**Sample site locality**	**Existing land use/s**
	North, northeast, east, southeast, and northwest.	Pastoral grazing - Dairy
	South	Kiwifruit orchards
	Southwest, west	Kiwifruit orchards Pastoral grazing - Dairy
Soils* and constraints	68.9 ha of 14 (Paengaroa sand) **Constraints** • Fragile topsoil structure. • Summer droughts.	
	0.1 ha of 14b (Paengaroa shallow sand on sand) and 1.6 ha of 14bH (Paengaroa shallow sand on sand, hill soil). **Constraints** • Fragile topsoil structure. • Summer droughts. • Steep soils on hill soils	
	10.7 ha of 2 (Kairanga silt loam) **Constraints** • Poor natural drainage.	
	110.0 ha of 2b (Opiki complex) and 107f (Pongakawa peaty loam) **Constraints**	

	• Poor natural drainage. • Fragile topsoil structure.		
Slope constraints	120.7 ha of flat land (A slope) and 69.0 ha of gently undulating to rolling land (B and C slope class) with no slope constraints for highly productive primary activities. 1.6 ha of moderately steep land (E slope) which will severely constrain a number of highly productive land uses.		
Potential land uses**	2w1, 3w1:	120.7 ha	Intensive pastoral farming. Horticulture. Cereal crops. Root and green fodder cropping.
	3e2:	62.9 ha	Intensive pastoral farming. Citrus and sub-tropical fruit orchards. Orchards. Horticulture. Cereal crops. Root green and fodder cropping.
	4e2:	6.1 ha	Intensive pastoral farming. Citrus and sub-tropical fruit orchards. Root green and fodder cropping.
	6e4:	1.6 ha	Semi-extensive pastoral farming.

**cross-referenced from (Roberts & Jarman, 1979) and (Rijkse & Guinto, 2010), **from Blaschke (1985).*

2w1 land

The 2w1 unit is predominantly in the north of Sample Area 3. The unit includes pumiceous alluvium and peat rock types. The topography is flat and the soils include the Opiki complex (2b) as well as Pongakawa peaty loam (107f). The main limiting factor is wetness because of the occasional surface flooding, poorly drained soils and moderately high winter water table. This limits the soil's versatility to support a number of highly productive land uses. The current land use is pastoral grazing – dairy.

3e2 land

The 3e2 unit includes gently undulating to strongly rolling hills predominantly in the south of the sample area. This unit includes tephra and lapilli over unconsolidated sands rock types with Paengaroa sand (14) soil type. The current land uses are pastoral farming – dairy and kiwifruit orchards.

The main limiting factor to this unit is that the coarse textured soils are prone to erosion when cultivated. This limits the versatility of the soils to sustain a number of highly productive land uses.

3w1 land

There is a small unit of LUC class 3w1 in the south-eastern corner of the sample area. This flat unit includes pumiceous alluvium rock type with the poorly drained Kairanga soil (2). Similar to the 2w1 unit, the main limiting factor is wetness because of the presence of poorly drained soils, the presence of a moderately high-water table all year round, and the susceptibility to runoff from adjacent higher areas. The prolonged wetness limitation throughout the year classes the soil as LUC class 3 with moderate limitations.

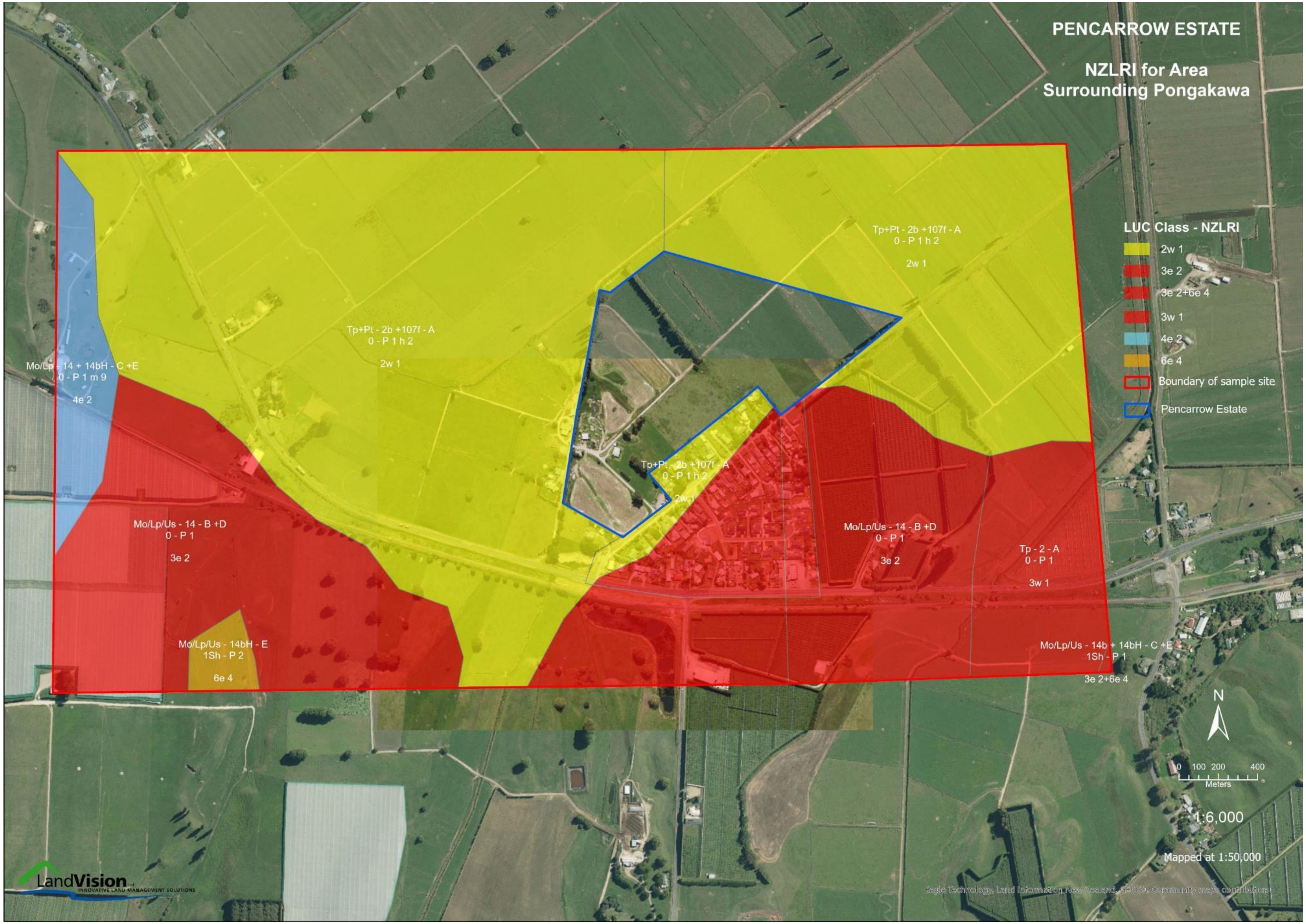
4e2 land

The 4e2 unit within the sample area includes gently undulating to rolling tephra hills with Paengaroa soil (14b). These coarse textured soils are prone to moderate wind, sheet and rill erosion when cultivated. This creates a severe limitation for highly productive land uses. Currently this unit is in pastoral farming – dairy and kiwifruit orchards.

6e4 land

The 6e4 land is a small unit identified in the southern western corner of the sample area. The unit includes moderately steep tephra laden hills with Paengaroa hill soils present. The main limiting factor is the presence of slight erosion and potential for moderate erosion. This combined with the moderately steep slope presents extreme limitations which makes the unit not favorable for highly productive land uses. Overall, there is no productive capacity to support highly productive land uses

9.5.3 NZLRI for Sample Area surrounding Pongakawa



9.6 Summary

The LUC class 2s1 areas in the east and south of Te Puke, north and west of Paengaroa, and southwest of Paengaroa are currently in kiwifruit orchards. This land use best utilizes the land resources and favourable climatic conditions in these areas. Residential development into these areas could be seen as unfavourable as this would require the removal of these orchards. The costs of removing these orchards may outweigh any benefits gained from reverting the use of the land into residential development.

The LUC class 2w1 and 3w1 units in the north and west of Te Puke and north and south-east of Pongakawa are predominantly in intensive pastoral grazing – dairy farming with some kiwifruit orchards and cropping present. Albeit not as versatile as LUC class 2s1, these large contiguous units still have a high productive capacity to sustain a number of highly productive land uses. The expansion of residential development into these areas would be unfavourable, as large areas with high productive capacity would be lost and the large contiguous units would be fragmented. More importantly, these areas lie either within the rural/small settlements and Te Puke floodable areas or flood hazard areas as per the Western Bay of Plenty District Councils' overlays. This alone suggests the areas are unsuitable for residential development.

The 3e5 units on the east and southern fringes of Paengaroa, and the 3e2 unit on the southern fringes of Pongakawa are currently in intensive pastoral grazing – dairy or kiwifruit orchards. These units have lower versatility than the 2s1 units, mainly due to rolling topography and the susceptibility of the fragile topsoil to erosion when cultivated. With no other planning constraints the LUC class 3e5 and 3e2 units are considered suitable for residential development. Nevertheless, these large contiguous units do still a moderately high productive capacity to sustain highly productive activities such as kiwifruit production. This is evident from the kiwifruit orchards present on these units.

There are other land units with lower versatility and productive capacity in the sample areas. However, these are not suitable for residential development for a number of reasons. These include:

- The LUC class 4e2 in the south of Te Puke which are already in kiwifruit orchards. For the same reasons mentioned above these areas are unfavourable for residential development.
- The LUC class 4e2 unit in the west of Pongakawa which lies within the flood hazard area of the WBOPDC overlay.
- The small area of 6e4 in the south of Pongakawa is unsuitable for residential development because of the moderately steep slope.
- Steep to very steep LUC classes 7e1 and 8e1 in the south of Te Puke which follow floodable areas along the Ohineangaanga Stream as well as an unnamed tributary to the east. The steep contour and positioning within a flood plain make these areas unsuitable for residential development.
- The area in the northwest of Te Puke which is already zoned for industrial purposes. Because of this there is very little potential for the expansion of residential development into this area.

There is approximately 9.9 ha of effective highly productive land within the proposed development area of Pencarrow Estate. When assessed in the field, this land includes highly versatile soils and flat to rolling topography and with correct management is suitable for a range of different land uses.

From merely a land resource perspective there are areas of land within the same locality and market with lower versatility than Pencarrow Estate. These areas are suitable for housing development and can be found on the eastern and southern fringes of Paengaroa and southern fringes of Pongakawa. These large contiguous land units, however, still have a high productive capacity to sustain highly productive activities including intensive kiwifruit production.

In comparison, Pencarrow Estate includes land units with lesser constraints and higher versatility. However, the overall productive capacity may be diminished by:

1. Small fragmented HPL units because of intertwined non-HPL units.
2. Small scale of site, and
3. Difficulty in combining with some adjacent HPL units because of:
    - State Highway 2 to the south.
    - The existing residential development and Arawa Road to the east.

10 CONCLUSION

The rezoning of Pencarrow Estate meets the requirements of Clause 3.6 of the NPS-HPL in that overall productive capacity of Pencarrow Estate is considered lower than the other sites assessed. Pencarrow Estate is therefore considered a suitable site for housing development.

With regard to Clause 3.13, the loss of 6.5 ha of effective highly productive land - which is highly fragmented and has low overall productive capacity and difficult to amalgamate with adjacent HPL units - out of 44,000 ha of the district's HPL is considered insignificant.

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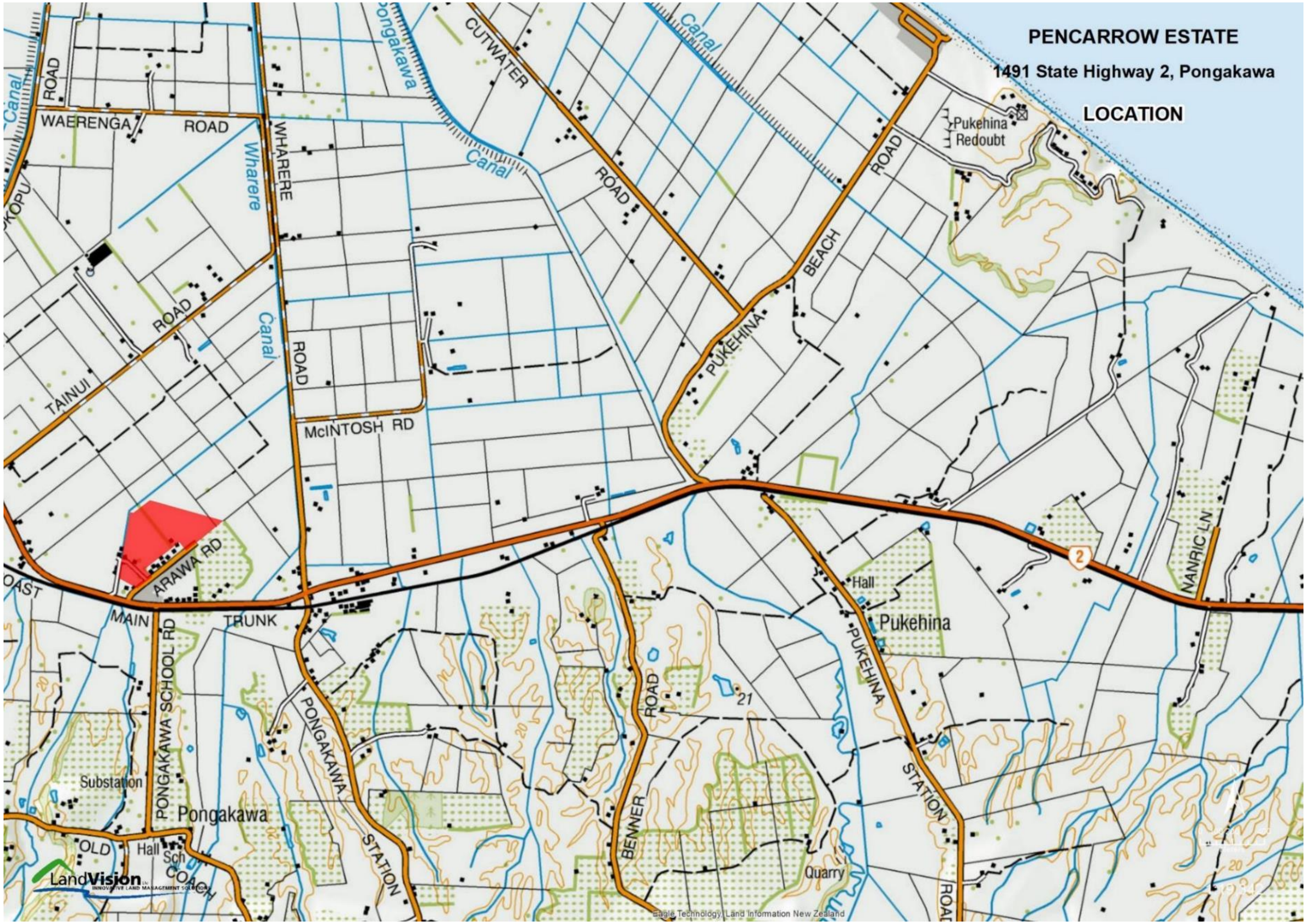
12 APPENDICES

12.1 Appendix One: Location Map of Pencarrow Estate



12.2 Appendix Two: Proposed Private Plan Change Map

12.3 Appendix Three: Land resources from paddock scale mapping

12.3.1 Parent Material

The following table describes the rock types present on the property. Note: Sample pictures are provided.

Table 15. Parent materials found on Pencarrow Estate.

	**Ashes older than Taupo ash (Mo);** is found on the flat to easy hill country slopes. It is described as compact to very compact, moderately to completely weathered clay-rich, surface or near surface, bedded or massive, ash and some lapilli. Grassed and forested slopes formed on tephra are generally stable where less than 20 degrees. Slopes steeper than 20 degrees are subject to sheet erosion while soil slip or slump erosion may occur with slip planes on weathered layers or tephra interfaces. The soils formed from this ash are typically yellow-brown loams.
	**Pumiceous alluvium (Tp**) is a very loose to compact, fresh to moderately weathered pumiceous block lapilli and ash, which is typically poorly sorted, frequently containing charcoal material, and is found as a surface or near surface deposit. This was deposited from the Taupo volcanic centre, and locally in the Okataina area, approximately 1800 years ago, along with pumice alluvium derived from these deposits. Typically this tephra would be mapped on its own or in association with Kaharoa and Taupo ashes overlying ashes older than Taupo ash. Since this tephra is loose and the pumice can float, it is prone to fluvial erosion processes such as gully, tunnel gully, stream bank and sheet erosion.
	**Kaharoa and Taupo ashes (Kt)** is found on the flat to easy hill country slopes. It is described as loose to compact, fresh to moderately weathered rhyolitic ash with some lapilli. A surface or near surface deposit approximately 40 cm or more deep. Deposited as a result of eruptions from the Okataina (Kaharoa ashes) area 900 years ago, and from the Taupo areas approximately 1800 years ago. Typically this tephra would be mapped as a stratigraphic sequence overlaying older, weathered ashes (Mo). This rock type is subject to sheet, wind and rill erosion and only occurs when exposed.
	**Peat (Pt):** Extremely weak, dark brown or black organic residue mixed with various amounts of mineral matter. Surface or near surface deposits thicker than 50 cm. A widespread Quaternary deposit produced by the partial decomposition and disintegration of vegetation.

12.3.2 Soil types

The soil types for the property are summarised and described in Table 16. The Soil Resources Map for the property is shown in Section 11.1.3.

Table 16. Soil types identified on the subject land.

Soils of the terraces	
	**Name: Pukehina silt loam. peaty subsoil phase.** **Map symbol**: Pow **Soil profile coordinates:** -37.818889, 176.475645. **LUC Unit:** IIw1 **Parent material**: Pumiceous alluvium and peat. **Drainage status**: Poorly drained. **Topsoil consistence**: Friable. **Degree of topsoil development**: Well developed. **Profile description:** 25 cm of well developed, friable, medium block breaking to medium nut structure, very dark brown (10YR 2/2) silt loam.: On:10 cm of moderately developed, friable, fine nut and crumb structure, black (10YR 2/1) peaty silt loam. On: 10 cm of loose, structureless dark yellowish brown (10YR ¾) sand with medium pumiceous fragments and orange staining. On: 5 cm of loose, structureless, coarse white (7.5YR 8/1) sand. On: reddish brown (5YR 4/3) fibrous peat. **Comments:** Found on the lower terraces in the northern section of the site. **Management considerations:** Consider drainage on these soils.
	**Name: Paengaroa loamy sand on shallow sand.** **Map symbol**: Pgls **Soil profile coordinates:** -37.820355, 176.475164. **LUC Unit:** IIs1 **Parent material**: Kaharoa tephra over ancient tephra. **Drainage status:**:Well drained. **Topsoil consistence:** Very friable. **Degree of topsoil development:** Moderately developed. **Profile description:** 20 cm of moderately developed, very friable, medium block breaking to nut and crumb structure, dark brown (10YR 3/3) loamy sand. On: 20 cm of loose, structureless, light grey (2.5Y 6/1) sand. On: 25 cm of very friable, fine nut and crumb structure, dark yellowish brown (10YR 3/6) sandy loam to loamy sand. On: loose, structureless, white (7.5YR 8/1) sand. **Comments:** Found on the higher terraces. **Management considerations:** Maintain soil fertility.

	**Name: Raparapahoe silt loam** **Map symbol**: Rpzl **Soil profile coordinates:** -37.820589, 176.473648. **LUC Unit:** IIIw1 **Parent material**: Pumiceous alluvium and peat. **Drainage status**: Poorly drained. **Topsoil consistence:** Friable. **Degree of topsoil development:** Moderately developed. **Profile description**: 15 cm of friable, fine nut and crumb structure, reddish brown (5YR 4/3) sandy loam. On: 5 cm of friable, fine to medium nut structure, dark brown (7.5YR 3/2), silt loam. On: 20 cm of friable, medium nut structure, light olive brown (2.5YR 4/3) silt loam. On: 10 cm of friable, fine nut and crumb structure, dark brown (7.5YR 3/2), peaty silt loam. On: 10 cm of loose, structureless, white (10YR 8/1) pumiceous sand. On: sedge peat. **Comments:** Found in the low narrow valleys of the property where drainage in influenced from runoff from the surrounding hills. **Management considerations:** Care with heavy stock and machinery during extended wet periods to avoid pugging and compaction damage.
	**Name: Paengaroa loamy sand, rolling phase.** **Map symbol**: PglsR **Soil profile coordinates:** -37.821787, 176.472987. **LUC Unit:** IIIe2 **Parent material:** Kaharoa tephra over ancient tephra. **Drainage status**: Well drained. **Topsoil consistence**: Very friable. **Degree of topsoil development**: Moderately developed. **Profile description**: 20cm of moderately developed, very friable, medium nut and fine crumb structure dark brown (10YR 3/3) loamy sand. On: 10 cm loose, structureless, light grey (7.5YR 7/1) loamy sand. On: friable, fine crumb structure, dark yellowish brown (10YR 3/6) sandy loam. **Comments:** Found on the rolling valley sides where there is less coverage of Kaharoa tephra. **Management considerations:** Keep pasture coverage to avoid sheet and wind erosion.

Name: Raparapahoe sandy peat loam.

Map symbol: Rpspl

Soil profile coordinates: -37.822006, 176.472861.

LUC Unit: IIIw1

Parent material: Peat over tephra alluvium.

Drainage status: Poorly drained.

Topsoil consistence: Friable.

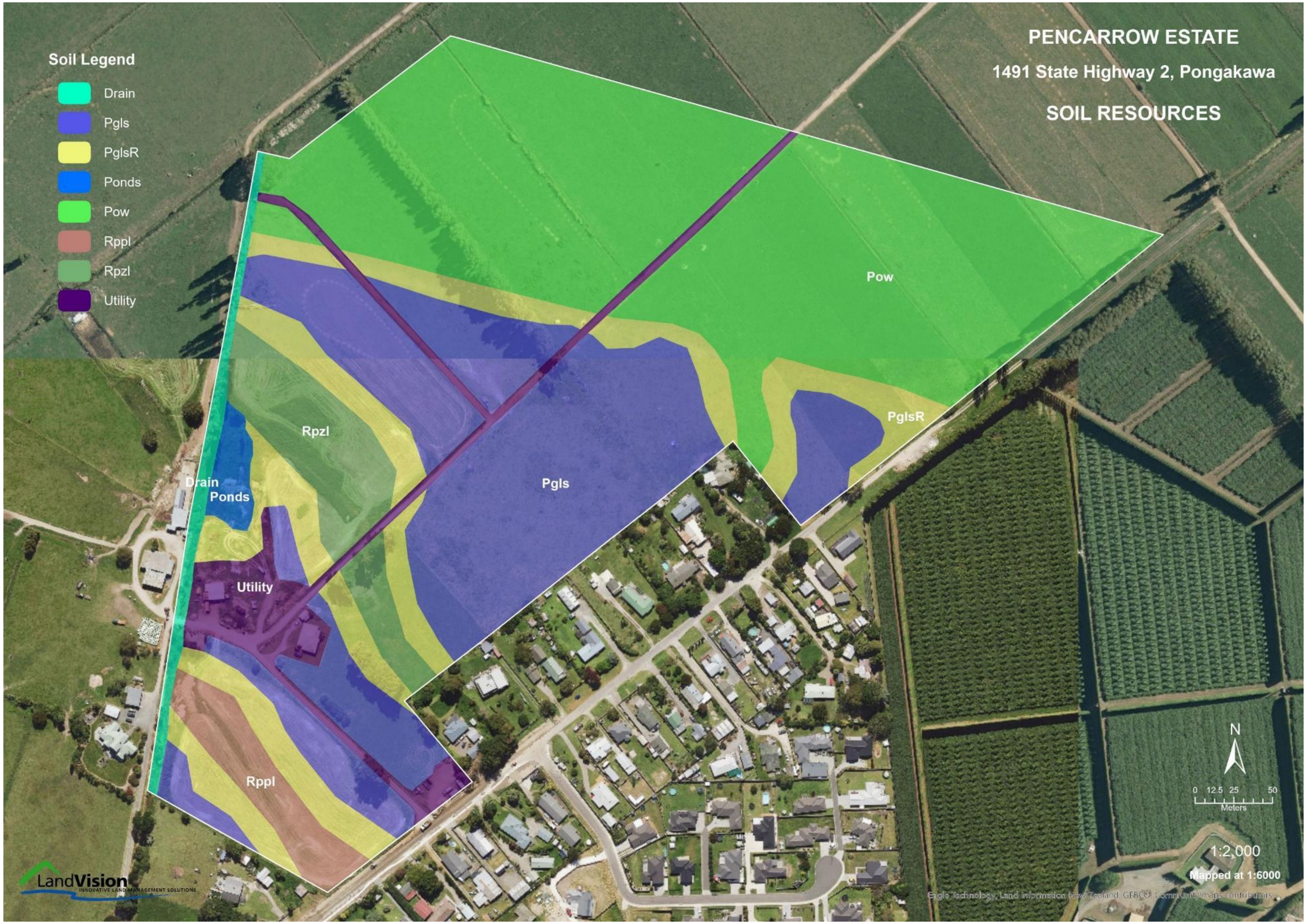
Degree of topsoil development: Moderately developed.

Profile description: 25 cm of moderately developed, friable, medium nut and block structure, reddish brown (5YR 5/3) sandy peat loam: On:15 cm of friable, medium nut and fine crumb structure, reddish brown (5YR 5/3) peaty loam. On: loose, structureless, white (10YR 8/1) sand.

Comments: Similar to Rpzl – found on the lower river valley terraces where drainage is influence by runoff from the surrounding hills.

Management considerations: Care with heavy stock and machinery during extended wet periods to avoid pugging and compaction damage.

12.3.3 Soil Resources Map



12.3.4 Slope Legend

The definitions of the slope classes mapped on the Land Resources Map are shown in the tables below, along with a summary of the various slope classes found on the property.

Table 17. Definition of slope classes.

Slope class	Degrees	Slope description	Access suitability
A	0-3º	Flat to gentle undulating	Tractor
B	4-7 º	Undulating	Tractor
C	8-15 º	Rolling	Tractor
D	16-20 º	Strongly rolling	Some tractor, four-wheel bike
E	21-25 º	Moderately steep	Two-wheel bike
F	26-35 º	Steep	Walking and some two-wheel bike
G	>35	Very steep	Walking
+	*Indicates a compound slope*		
/	*Indicates average slope is borderline between two slope classes*		
‘	*Indicates a dissected slope*		

Table 18. Summary of slope classes identified on Pencarrow Estate.

Slope class	Area (ha)	Percentage (%)
A	14.6	85
C	2.5	15
Total	**17.1 ha**	**100 %**

12.3.5 Erosion Legend and Severity Ranking

No erosion was recorded on the property.

12.3.6 Vegetation Cover

The following table summarises the vegetation cover identified on Pencarrow Estate.

Table 19. Vegetation cover for Pencarrow Estate.

Erosion severity	LRI symbol	Area affected (ha)	Percentage (%)
Improved pasture	gI	15.5	91
Maize	cM	0.3	1
Utilities/non-effective areas	Utility, Ponds, Drains	1.3	8
Total		**17.1 ha**	**100%**

12.4 Appendix Four: LUC Descriptions for Pencarrow Estate

Table 20. Descriptions of each of the LUC units on the Pencarrow Estate site.

Description	Area (ha)	Parent material	Dominant soil	Slope	Vegetation and area (ha)	Erosion degree and severity		Strengths	Weaknesses	Land use suitability	Conditions of use
						Actual	Potential				
IIw1 Flat river terraces near sea level with recent, gley recent and organic soils. Occasional surface flooding and moderately high winter water table levels limit versatility. 	7.2	Pumiceous alluvium and peat (Tp+Pt).	Pow.	0-3	Pasture (7.1 ha) Utilities (0.1 ha)	Nil.	Nil.	Contour. Access.	Often easily pugged. Fluctuating water table. Occasional surface flooding.	Intensive pastoral farming with drainage.	Care with stock during wet periods to minimise risk of pugging damage. Drainage required to optimise production potential. Stopbanks may be required to protect from surface flooding.
IIs1 Gently undulating to undulating terraces near sea level with coarsely textured soils. 	5.6	Patchy Kaharoa tephra over ancient tephra (pKt/Mo).	Pgls.	0-3	Pasture (4.7 ha) Maize (0.1 ha) Utilities (0.8 ha)	Nil.	Slight wind erosion when cultivated.	Contour. Access. Good natural drainage.	Drought prone. Low natural fertility.	Intensive pastoral farming. Horticulture.	Maintain soil fertility.
IIIw1 Flat narrow valley floors and poorly drained flats with a moderately high water table, subject to runoff from adjacent higher areas.	1.5	Pumiceous alluvium and peat (Tp+Pt).	Rpzl. Rppl.	0-3	Pasture (1.4 ha) Maize (0.1 ha)	Nil.	Slight streambank erosion.	Contour. Access. Holds on longer under drought conditions. Good soil physical properties. Good natural fertility.	Wetness limitation even after drainage due to high water table. Often easily pugged with heavy cattle following	Intensive pastoral farming with drainage.	Care with heavy cattle during wet periods to prevent treading and pugging damage. When undertaking cultivation ensure that the moisture levels are sufficient to prevent compaction or creating a plough pan.

Description	Area (ha)	Parent material	Dominant soil	Slope	Vegetation and area (ha)	Erosion degree and severity		Strengths	Weaknesses	Land use suitability	Conditions of use
						Actual	Potential				
								Potential for cropping following drainage. Sheltered.	prolonged wet periods. Cropping versatility is restricted by wetness that can delay planting. Low lying areas may flood. Potential for slight streambank erosion.		Drainage is required to maximise production however it maybe ineffective. Adjacent stream banks may require erosion protection. Rushes can be controlled with grazing management, fertiliser, lime or herbicide.
IVe2 Rolling to strongly rolling slopes near sea level with coarsely textured soils formed from a thin mantle of Kaharoa ash over more weathered ashes. Soils are less fertile and more drought-prone than those of 1Ve1. There is a potential for moderate to severe sheet, wind and rill erosion when cultivated. 	2.5	Patchy Kaharoa tephra over ancient tephra (pKt/Mo).	PglsR.	7-20	Pasture (2.2 ha) Maize (0.2 ha) Utilities (0.1 ha)	Nil.	Nil to slight sheet. Moderate to severe sheet, rill and wind when cultivated.	Good soil physical properties. Contour. Access.	Potential for severe sheet and rill erosion under cultivation.	Intensive pastoral production. Forestry.	Use minimum tillage techniques when cultivating.
VIIIw1 Low lying lake, river and seaside areas that are difficult to drain and have a permanent severe wetness limitation.	0.3	Drain/Ponds	Drain/Ponds	0-3	Drains/Pond (0.3 ha)	Nil.	Nil.	Biodiversity values.	Not suited to any kind of pastoral farming. Recreational activities.	Retirement.	Enhancement planting with riparian species Animal pest control

Description	Area (ha)	Parent material	Dominant soil	Slope	Vegetation and area (ha)	Erosion degree and severity		Strengths	Weaknesses	Land use suitability	Conditions of use
						Actual	Potential				
											

12.5 Appendix Five: NZRLI Map for Pencarrow Estate

12.6 Appendix Six: NZLRI Data for all alternative sample sites

Site Name	Area sampled (ha)	LUC Class Distribution		LUC Unit Distribution		Slope	Soils	Current Landuses
		LUC Class	Area and Percentage of Area (ha and %)	LUC	Area and Percentage of Area (ha and %)	Slope Category		
Paengaroa	206.6	2s1	108.6 ha (61%)	2	108.6 ha (53%)	Flat A+B	Tephra over unconsolidated sands Soil 14a	Pastoral Farming Horticulture Houses/Buildings (Town)
		3e5	98.0 ha (39%)	3	98.0 ha (47%)	Rolling C+B	Tephra Soil 14	Pastoral Farming Horticulture Houses/Buildings (Town)
Surrounding Pongakawa	191.2	2w1	110.0 ha (58%)	2	110.0 ha (58%)	Flat A	Taupo pumice and Peat 2b + 107f	Pastoral Farming Horticulture
		3e2	62.9 ha (33%)	3	73.6 ha (38%)	Undulating to rolling B+C	Tephra and Lapilli over unconsolidated sands Soil 14b	Pastoral Farming Horticulture
		3w1	10.7 ha (5%)			Flat A	Taupo pumice Soil 2	Pastoral Farming
		4e2	6.1 ha (3%)	4	6.1 ha (3%)	Rolling B+C	Tephra over Lapilli Soil 14	Pastoral Farming Horticulture
		6e4	1.6 ha (1%)	6	1.6 ha (1%)	Mod Steep E		Pastoral Farming
Te Puke (minus Plan Change 92 area)	1034.3	2s1	533.2 ha (52%)	2	666.4 ha (65%)	Undulating B	Tephra over unconsolidated sands and volcanics Soils 14a and 16	Pastoral Farming Horticulture Buildings (Industrial)
		2w1	133.2 ha (13%)			Flat A	Taupo pumice Soil 107f and 2b	Pastoral Farming Horticulture Buildings (Industrial)
		3w1	137.4 ha (13%)	3	137.4 ha (13%)	Flat A	Peat and Taupo pumice Soil 107f	Pastoral Farming Horticulture
		4e2	15.6 ha (2%)	4	15.6 ha (2%)	Rolling C	Tephra Soil 14a	Horticulture

		7e1	131.5 ha (13%)	7	131.5 ha (13%)	Steep to moderately steep F+E	Tephra over volcanics Soil 16H	Pastoral Farming Native bush. Horticulture
		8e3	22.8 ha (2%)	8	22.8 ha (2%)	Very steep G	Tephra over volcanics Soil 126	Pastoral Farming Native bush. Horticulture
		Town	60.7 ha (6%)	Town	60.7 ha (6%)	Flat A	Town	Houses/Buildings (Town)

12.7 Appendix Seven: Summary of features for each alternative sample site

Feature	**Sample Area**				
	Pencarrow Estate (Non production area) **Paddock Scale Mapping (1:5,000)**	**Pencarrow Estate (Non-production)** **Regional Scale Mapping (1:50,000)**	**Paengaroa** **Regional Scale Mapping (1:50,000)**	**Surrounding Pongakawa** **Regional Scale Mapping (1:50,000)**	**Te Puke (minus Plan Change 92 area)** **Regional Scale Mapping (1:50,000)**
LUC classes	Comprises 7.3 ha of highly productive land (5.8 ha of LUC class II, 1.5 ha of LUC class III). There is also 2.7 ha of not highly productive land (2.2 ha of LUC class IV and 0.5 ha of LUC class VIII)	Comprises 17.1 ha of LUC class 2 and 0.2 ha of LUC class 3.	Comprises 108.6 ha of LUC class 2 and 98.0 ha of LUC class 3.	Comprises 110.0 ha of LUC 2, 73.6 ha of LUC class 3, 6.1 ha of LUC class 4 and 1.6 ha of LUC 6.	Comprises 666.4 ha of LUC class 2, 137.4 ha of LUC class 3, 15.6 ha of LUC 4, 131.5 ha of LUC class 7 and 22.8 ha of LUC class 8. 60.7 ha is classified as town.
Soils and constraints	4.8 ha of Pgls (Paengaroa loamy sand) and 2.1 ha of PglsR (Paengaroa loamy sand, rolling phase). **Constraints** • Fragile topsoil structure. • Summer droughts.	0.2 ha of 14 (Paengaroa sand) 108.6 ha of 14a (Paengaroa shallow sand). **Constraints** • Fragile topsoil structure. • Summer droughts.	98.0 ha of 14 (Paengaroa sand) and 108.6 ha of 14b (Paengaroa sand, hill soil). **Constraints** • Fragile topsoil structure. • Summer droughts.	68.9 ha of 14 (Paengaroa sand) **Constraints** • Fragile topsoil structure. • Summer droughts.	255.0 ha of 107f (Pongakawa peaty loam) **Constraints** • Poor natural drainage. • Fragile topsoil structure. • Fluctuating ground water levels.
	0.5 ha of Rppl (Raparapahoe sandy peaty loam) and 1.0 ha of Rpzl (Raparapahoe silt loam) **Constraints** • Poor natural drainage. • Perched water table.			0.1 ha of 14b (Paengaroa shallow sand on sand) and 1.6 ha of 14bH (Paengaroa shallow sand on sand, hill soil). **Constraints** • Fragile topsoil structure. • Summer droughts. • Steep soils on hill soils	363.9 ha of 14a (Paengaroa shallow sand). **Constraints** • Fragile topsoil structure. • Summer droughts.
	0.2 ha of Pow (Pukehina silt loam, peaty subsoil phase). **Constraints** • Poor natural drainage. • Summer droughts.			10.7 ha of 2 (Kairanga silt loam) **Constraints** • Poor natural drainage.	316.4 ha of 16 (Oropi sand) and 41.6 ha of 16H (Oropi sand, hill soil). **Constraints** • Fragile topsoil structure. • Low fertility. • Steep slopes on hill soil.

										110.0 ha of 2b (Opiki complex) **Constraints** • Poor natural drainage. • Fragile topsoil structure.			15.6 ha of 2b (Opiki complex) **Constraints** • Poor natural drainage. • Fragile topsoil structure.		
													22.8 ha of 126 (Otanewainuku steepland soil) **Constraints** • Very steep slopes. • Low fertility. • Cool climate.		
Slope constraints	7.7 ha of flat land (A slope class) and 2.2 ha of rolling land (C slope class) with no slope constraints for highly productive primary activities.			17.3 ha of flat and gently undulating land (A and B slope) with no slope constraints for highly productive primary activities.			108.6 ha of flat and gently undulating land (A, B slope class) and 98.0 ha of rolling land (C slope) with no slope constraints highly productive primary activities.			120.7 ha of flat land (A slope) and 69.0 ha of gently undulating to rolling land (B and C slope class) with no slope constraints for highly productive primary activities. 1.6 ha of moderately steep land (E slope) which will severely constrain a number of highly productive land uses.			270.6 ha of flat land (A slope class), 533.2 ha of gently undulating (B slope) and 15.6 of rolling land (C slope) with no slope constraints for highly productive activities. 154.3 ha of steep to very steep land (F and G slope class) with extreme constraints for highly productive activities.		
Potential land uses	IIw1	0.2	Intensive pastoral farming. Horticulture. Cereal crops. Root and green fodder cropping.	2w1	17.1 ha	Intensive pastoral farming. Horticulture. Cereal crops. Root and green fodder cropping.	2s1,	108.6 ha	Intensive pastoral farming. Citrus and sub-tropical fruit orchards. Orchards. Horticulture. Cereal crops. Root green and fodder cropping.	2w1, 3w1:	120.7 ha	Intensive pastoral farming. Horticulture. Cereal crops. Root and green fodder cropping.	2w1, 3w1	270.6 ha	Intensive pastoral farming. Horticulture. Cereal crops. Root and green fodder cropping.
	IIIw1	1.5													
	IIs1	5.6 ha	Intensive pastoral farming. Citrus and sub-tropical fruit orchards. Orchards. Horticulture. Cereal crops. Root green and fodder cropping.							3e2:	62.9 ha	Intensive pastoral farming. Citrus and sub-tropical fruit orchards. Orchards. Horticulture. Cereal crops. Root green and fodder cropping.	2s1	533.2 ha	Intensive pastoral farming. Citrus and sub-tropical fruit orchards. Orchards. Horticulture. Cereal crops. Green and fodder cropping.
	IVe2	2.5 ha	Intensive pastoral farming. Citrus and sub-tropical fruit orchards.	3e2	0.2 ha	Intensive pastoral farming. Citrus and sub-tropical fruit orchards. Orchards. Horticulture.	3e5	98.0 ha	Intensive pastoral farming. Orchards. Horticulture.	4e2:	6.1 ha	Intensive pastoral farming. Citrus and sub-tropical fruit orchards. Root green and fodder cropping.	4e2	15.6 ha	Intensive pastoral farming. Citrus and sub-tropical fruit orchards. Root green and fodder cropping.

	VIIIw1	0.5 ha	Retirement.			Cereal crops. Root green and fodder cropping.			Root green and fodder cropping.	6e4:	1.6 ha	Semi-extensive pastoral farming.	7e1, 8e3	154.3 ha	Extensive pastoral farming Forestry.

Appendix C

LYSAGHT

MOMENTUM PLANNING AND DESIGN
PROPOSED PRIVATE PLAN CHANGE
ENGINEERING SERVICING REPORT
PENCARROW ESTATE
1491 STATE HIGHWAY 2
PONGAKAWA
REVISION 7

Client Momentum Planning and Design

Project Pencarrow Estate, 1491 State Highway 2, Pongakawa

LCL Ref 225216

Report Type Proposed Private Plan Change - Engineering Servicing Report

Report Date 22/08/2024

Prepared By

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DOCUMENT CONTROL					
DOCUMENT ID:					
REV.	DATE	REVISION DETAILS	AUTHOR	VERIFIER	APPROVER
1	02/05/22	Draft for comment	JH	DH	DH
2	26/05/22	For Private Plan Change	JH	DH	DH
3	22/07/22	Water Modelling Added	JH	DH	DH
4	01/09/22	Minor Amendments	JH	DH	DH
5	12/12/22	Amendments to number of lots	JH	DH	DH
6	27/03/24	Amendments in response to BOPRC/WBOPDC submissions	DH	-	DH
7	22/08/24	Amendments in response to WBOPDC emails	DH	-	DH

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APPENDICES

1.0 INTRODUCTION

Lysaght Consultants Ltd ("Lysaght") was engaged by Momentum Planning and Design to provide a high-level engineering servicing review for a Private Plan Change consent application for a proposed residential development at 1491 State Highway 2, Pongakawa. The scope of the review included:

- Flood Levels
- Stormwater Discharge
- Wastewater Reticulation
- Potable and Fire Fighting Water Provisions

The review was undertaken in general accordance with the requirements of Western Bay of Plenty District Council's ("WBOPDC") Development Code ("DC"), NZS 4404:2012, relevant NZ Standards and standard engineering practice.

1.1 Site Description

SITE LOCATION:	1491 State Highway 2, Pongakawa LOT 1 AND LOT 2 DPS 79072
DESCRIPTION AND TOPOGRAPHY:	The site is located between SH2 and the township of Pongakawa, with access off Arawa Road. The existing 17 Ha site slopes gently to the northeast towards neighbouring properties. The site is generally flat with levels between 5 and 8m RL but has a bank to the northeast that drops from 8 to 4m RL.
EXISTING STRUCTURES:	The underlying parcel is predominantly pasture but contains several buildings. The portion of the site to be developed contains an existing dwelling and several farm buildings, which will be removed to enable construction of the proposed road.
PROPOSED DEVELOPMENT:	It is proposed to submit a Private Plan to rezone the property from rural to residential land, to enable the land to be developed into as many as 130 residential lots and accompanying access roads. Approximately 12.4Ha of land is to be rezoned, with approximately 8.2Ha of this land developable.
SURROUNDING PROPERTIES:	Rural properties, and residential properties to the southeast, along Arawa Road.

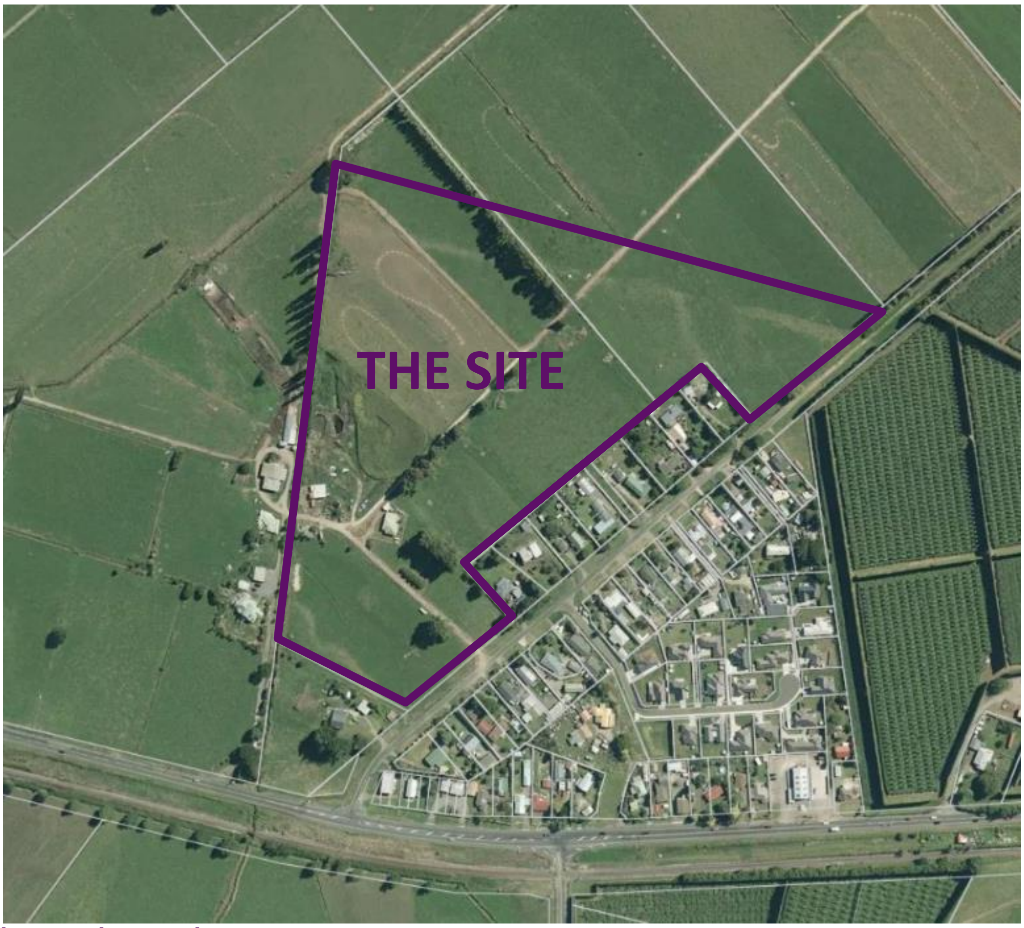


Figure 1: Site Location

2.0 EARTHWORKS AND GEOTECHNICAL INVESTIGATIONS

A detailed Geotechnical Investigation has been undertaken by CMW Geosciences, with their "Geotechnical Investigation Report for Plan Change" ("GIR"), *TGA2021-0096AC Rev 0*, dated 11th of February 2022, confirming that the site is geotechnically suitable for rezoning and residential development. Specifically designed foundations will be required for all residential buildings due to the potential for liquefaction and lateral spreading on site.

The report indicates that stormwater disposal to soakage may be possible in the more elevated parts of the site, however no soakage testing has been undertaken. Further testing is required to determine the suitability of soakage for stormwater discharge from the proposed residential dwellings. Section 5.0 of this report discusses stormwater disposal in more detail.

3.0 TRANSPORTATION

A preliminary Transportation Assessment Report ("TAR") has been undertaken by Harrison Transportation, dated December 2022, and has been appended as part of the wider plan change application. This report recommends the following road upgrades be constructed due to the increase in traffic on Arawa Rd due to the development:

- The Arawa Rd carriageway be widened to 8.5m to the intersection with the proposed new road entrance to the Plan Change area.
- A left turn deceleration lane be provided at the intersection of Arawa Rd with State Highway 2, with a length appropriate for the design speed of the road.

All roading design and construction is to be in accordance with the WBOPDC Development Code and Austroads guidelines, in terms of both the off-site roading upgrades recommended in the TAR, and the site's internal roading infrastructure.

4.0 FLOODING

Flood mapping from WBOPDC's online maps shows that the site is subject to flooding in intense rainfall events. As shown in Figure 2 below, the flooding appears primarily to be within two significant overland flow paths through the west of the site, and a minor section of flooding through the east of the site. The significant overland flow paths link to the wider flood plains north of the site, which are shown in Figure 3. This figure shows that there is extensive flooding in the region that reaches from the proposed development site to the coast, a distance of 5.5km, with a total flood plain area of 3,758Ha (according to WBOPDC Map query), not including the area of the ocean which the flood plain links to. Therefore, the 2Ha of flood plain measured within the site is considered to be negligible in relation to the overall capacity of the flood plain. From flood mapping data sent through by WBOPDC, the maximum flood level on site is 6.5m RL (NZVD) in a small, ponded section in the middle of the site, however the two major overland flow paths have maximum flood levels of 5.93 and 4.72m RL (NZVD) respectively. The flood levels drawing can be found in Appendix 1. Infilling on site may need to be undertaken to raise road and building pad levels above adjacent flood levels to ensure sufficient freeboard is achieved.


Figure 2: Flood mapping on site (from WBOPDC Maps)


Figure 3: Flood mapping in the wider area, the site is located at the purple circle

An estimate of the flood storage displacement generated by the development has been presented in Table 1 below. The figures are based on an assumed average flood depth of 0.5m within the areas on site identified as floodable (approximately 42,000m²), for a total volume of displacement of 21,000m³. When spread across the flood plain downstream, the resulting displacement is approximately 0.53mm

TABLE 1: FLOOD IMPACT CALCULATIONS	
Displaced flood volume based on assumed flood level + 0.5m factor of safety	21,000m³
Downstream flood plain area from WBOPDC Maps	3,758Ha
Indicative Increase in downstream flood depth due to site filling	0.53mm

Note that the increase in floodwater depth calculated in the table assumes that the flood plain is not contiguous with the ocean, which is not actually the case. The actual effect of filling within a floodplain that is contiguous with the ocean of effectively infinite area is infinitesimally small. It is clear, based on this very conservative flood estimate, that the downstream effects of filling the site will be less than the +15mm allowance generally accepted by Bay of Plenty Regional Council ("BOPRC") as the trigger for a "More than Minor" effect. The filling is highly unlikely to increase the risk of flooding of existing downstream buildings. It is noted however that filling of existing overland flow paths on site would block flow through the site and result in flooding of upstream properties. Therefore, the functionality of the overland flow paths on site will be maintained by constructing grassed channels through the site, which will maintain the capacity and entry and exit points of overland flow through the site.

Management of flood hazards on site is not considered a significant constraint for development of the site given the existing site elevation and location adjacent to very large flood plain.

5.0 STORMWATER DESIGN

5.1 Existing Discharge

Stormwater runoff from the site currently flows overland to an existing constructed watercourse that runs along the north-western boundary of the site. This watercourse flows to the northeast of the site to a small farm pond, as shown inFigure 4 below. It is expected that in significant storm events this pond overtops, and stormwater flows across the adjacent properties, as WBOPDC flood mapping indicates.

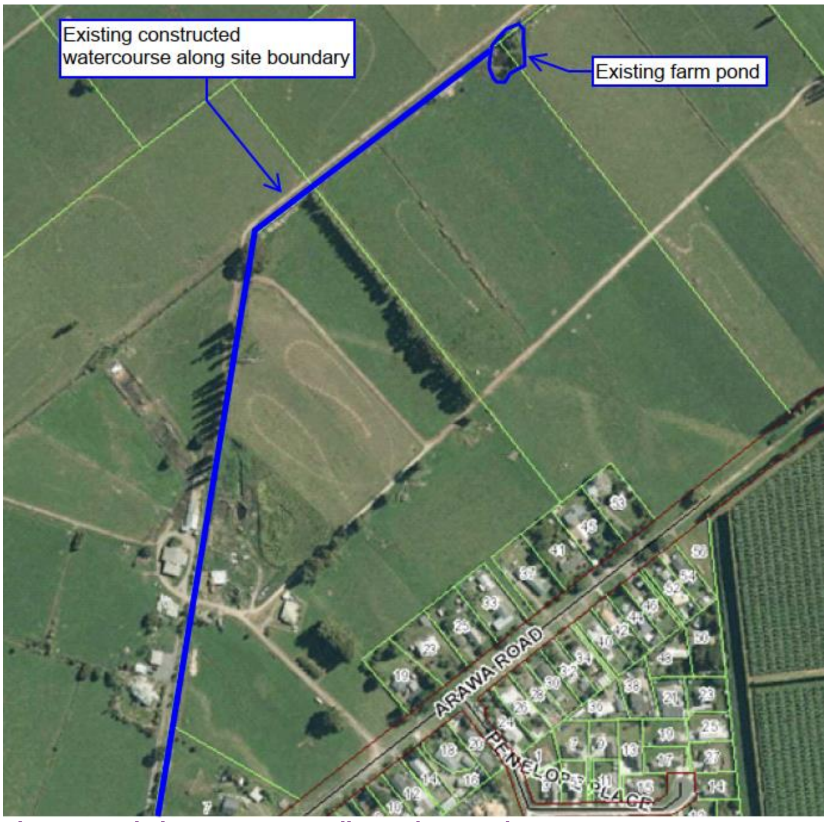


Figure 4: Existing stormwater disposal network

5.2 Proposed Stormwater System

There is no reticulated stormwater network available to the site. Due to soakage testing results on nearby sites, it is proposed that stormwater from residential sites on site will be discharged to soakage. Soakage rates in the underlying soils on site are expected to be in the order of 200mm/hr, based on previous soakage testing in these soils at Pongakawa. The development of the nearby Penelope Place indicates that disposal of primary stormwater to on site soakage is feasible in the soils present at site. An example soakage design has been presented in Appendix 3, which shows an indicative sizing for a soakage system for an individual residential lot. A design soakage rate of 100mm/hr has been used for this calculation, after a factor of safety of 0.5 has been applied to the assumed soakage rate. Rainfall data has been taken from WBOPDC Development Code Rainfall Intensity Charts, using the SW3A data for rural Zone A areas. Table 2 below summarises the assumptions and results of this soakage calculation.

TABLE 2: EXAMPLE SOAKAGE DESIGN SUMMARY	
LARGE LOT AND DWELLING	
Soakage Rate	100mm/hr
Assumed Lot Size	450m^2
Catchment Area	210m^2 (assuming 160m^2 dwelling and 50m^2 hardstand/driveway area)
Design Storm	10yr, 60minute storm
Required design criteria	Storage for 10yr, 60minute storm provided, system draining within 24hrs
Required system dimensions	5.72m x 1.60m x 1.28m (L x W x D) Base area 9.15m^2

SMALL LOT AND DWELLING	
Soakage Rate	100mm/hr
Assumed Lot Size	300m²
Catchment Area	165m² (assuming 120m² dwelling and 45m² hardstand/driveway area)
Design Storm	10yr, 60minute storm
Required design criteria	Storage for 10yr, 60minute storm provided, system draining within 24hrs
Required system dimensions	5.72m x 1.20m x 1.28m (L x W x D) Base area 6.86m²

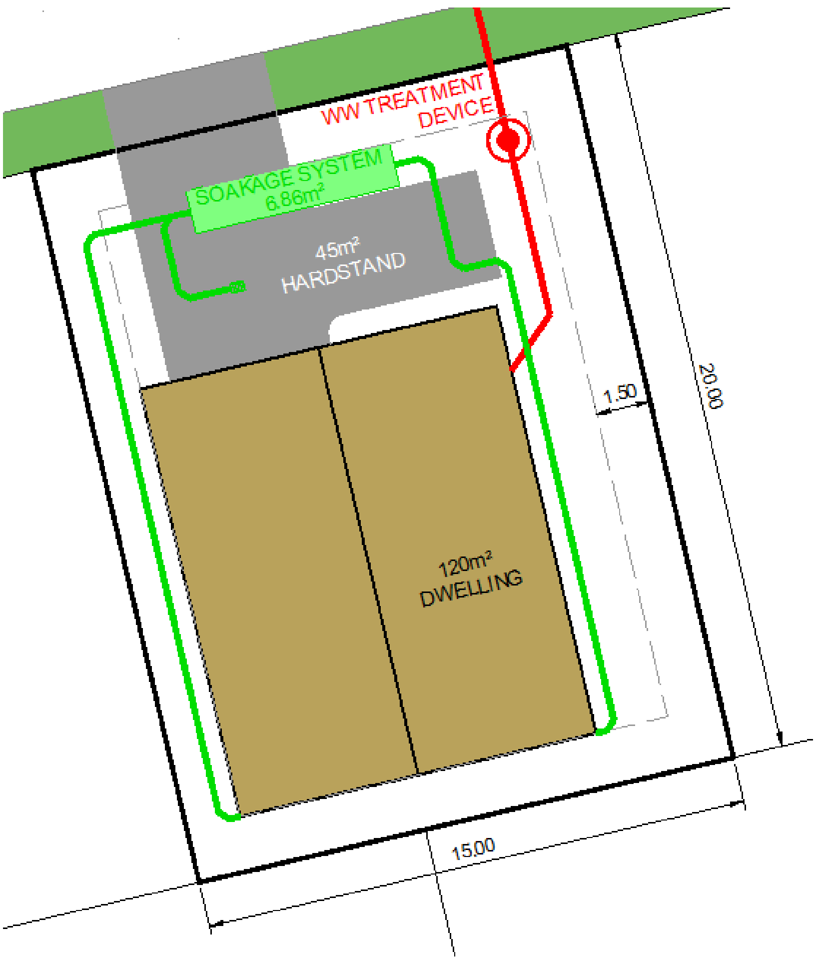


Figure 5: Sample lot layout, showing how a stormwater soakage system and wastewater treatment device can be sited within a 300m² lot.

A review of the records of groundwater depths encountered by CMW Geosciences ("CMW") is summarised in the table below. CMW have advised that Cone Penetrometer Tests ("CPT") records of groundwater are more reliable than test pits, so the table below summarises only the CPT results. Note that the CPT's undertaken in the lower lying areas (generally the wastewater disposal field area) are included in the table for completeness, but are highlighted grey and excluded from the calculation of the average, as no soakage is proposed in those areas. The ground levels listed are based on the site survey undertaken by drone, and are approximate only, as no survey data was collected to describe the exact test pit locations.

TABLE 3: GROUNDWATER DEPTH SUMMARY			
CPT #	GROUNDWATER DEPTH (m)	APPROXIMATE GROUND LEVEL (m, NZVD)	APPROXIMATE GROUNDWATER LEVEL (m, NZVD)
CPT01	4.1m	RL 3.5m	RL 0.6m
CPT02	Not recorded		
CPT03	1.2m	RL 3.2m	RL 2.0m
CPT04	1.0m	RL 3.6m	RL 2.6m
sCPT05	4.0m	RL 6.6m	RL 2.6m
CPT06	1.8m	RL 4.5m	RL 2.7m
CPT07	2.87m	RL 3.9m	RL 1.0m
CPT08	3.9m	RL 6.9m	RL 3.0m
CPT10	1.6m	RL 4.1m	RL 2.5m
CPT11	4.3m	RL 7.6m	RL 3.3m
sCPT12	4.5m	RL 7.6m	RL 3.1m
		Average	RL 2.6m

As per the table above, the average groundwater level at the time of investigation was RL 2.6m. While there will naturally be an increase in the groundwater level during winter months, CMW have advised that they don't expect that rise to be significant. The general ground level across the developable areas is between RL 6m and RL 8m, meaning that the groundwater won't compromise the functionality of soakage systems to be installed at a maximum of 2.5m below ground level.

Grassed yard areas are expected to bypass the soakage systems and flow to the roads within the site. Runoff from the yards, berms and roads will be collected in catchpits and piped to the central swale, which will then convey it to the stormwater pond as shown in MPAD's site plans. The swale is to be designed and constructed in accordance with the BOPRC Stormwater Management Guidelines, and therefore will provide a degree of treatment to the runoff. From the pond, stormwater will be discharged to the adjacent constructed watercourse, as per the existing scenario. As per the table below, it is expected that the peak flows rates running off the site in primary storm events will not be increased as a result of the development, due to the soakage systems for the residential lots compensating for the increase of impervious areas across the site. It is however expected that the peak flow rates off site in secondary events will be increased. The stormwater pond shown in the MPAD site plans will mitigate this increase in runoff in secondary storm events, which will control the outlet flow back to pre-development flow rates. This is discussed further in Section 5.4.

Since the outlet flow from the stormwater pond will be changing the flow into the constructed watercourse to a point discharge, the watercourse will need to be upgraded at this point to prevent erosion of the watercourse banks in large storm events.

In storm events exceeding the 10% AEP event, individual soakage systems within residential lots will overflow to the roads within the site, adding to the runoff sent to the pond.

5.3 Water quality storm event treatment

The proposed stormwater pond will provide treatment for the "first flush" of contaminants from the road runoff, by way of a wetland constructed in the bottom of the basin. The rainfall rate for the water quality storm event has been taken as 43mm/hr, the 2-year 1-hour rainfall intensity (in accordance with the BOPRC Stormwater Management Guidelines, refer to the calculations in appendix 3).

5.4 Stormwater Modelling

A model of the site has been constructed using DRAINS hydraulic modelling software (using the Horton/ILSAX method). The following input parameters were used in the model:

- Impervious area depression storage: 1mm.
- Pervious are depression storage: 5mm.
- Soil type: 2.5 (representing soils with moderate to slow infiltration rates, that may have layers that impede downward movement of water).
- Storm data taken from the TCC IDC (in the absence of appropriately climate change adjusted data in the WBOPDC Development Code), with primary storm events climate change adjusted to 2055, and secondary storm events climate change adjusted to 2130 (RCP 8.5).

A pre-development catchment was modelled, representing the entire development area, with an estimated impervious percentage of 5% (houses, farm buildings, tracks, etc.). A post development model was also created, with the following features:

- A 'lots' catchment, representing the private lot areas that are to drain to soakage, and assumed to be 70% impervious. For conservatism, the model assumes that the soakage systems have been designed to dispose of critical primary storm event, equivalent to approximately 45% of the critical secondary storm event.
- A 'roads and yards' catchment, representing the road reserves and a 50m² yard allowance for each lot assumed not to be drained to the soakage devices. This catchment is assumed to be 55% impervious.
- A stormwater basin with the following characteristics:
    - A 1.0m deep permanently wet 'wetland' in the base, to provide treatment of primary runoff from the roads and yards.
    - An extended detention outlet 1.0m above the base of the wetland, sized to release the extended detention volume of 570m³ over a 24-hour period.
    - A 2.0m deep detention basin above the wetland water level (for a total depth of 3.0m from base of wetland to the top of the basin), to provide attenuation of secondary storms.
    - A secondary storm outlet, with an invert level immediately above the extended detention storage volume.
    - An emergency spillway to discharge large storms.
    - A total volume of 3,400m³, and a footprint of approximately 2,150m².

The results from the model are presented in Tables 4 (primary storm) and 5 (secondary storm) below. The critical primary and secondary storms are both the 60-minute event.

TABLE 4: PEAK PRIMARY FLOWS OFF-SITE (CRITICAL 60-MINUTE STORM)

CATCHMENT	ASSUMED AREA	% IMPERVIOUS	PEAK RUNOFF IN 10YR, 60 MINUTE STORM EVENT	DISCHARGING TO
Existing	9.98Ha	5%	**1.31m^3/s**	Off-site overland
Buildings and driveways	8.01Ha	70%	1.90m^3/s	Soakage
			0.00m^3/s	To pond
Roads and Yards	1.96Ha	55%	0.40m^3/s	To pond
Pond Discharge	N/A	N/A	0.09m^3/s	Off-site overland
		Change in peak flow off site	**-1.22m^3/s**	

TABLE 5: PEAK SECONDARY FLOWS OFF-SITE (CRITICAL 60-MINUTE STORM)				
CATCHMENT	ASSUMED AREA	% IMPERVIOUS	PEAK RUNOFF IN 10YR, 60 MINUTE STORM EVENT	DISCHARGING TO
Existing	9.98Ha	5%	**5.33m^3/s**	Off-site overland
Buildings and driveways	8.01Ha	70%	2.20m^3/s	Soakage
			3.15m^3/s	To pond
Roads and Yards	1.96Ha	55%	1.18m^3/s	To pond
Pond Discharge	N/A	N/A	4.02m^3/s	Off-site overland
		Change in peak flow off site	**-1.31m^3/s**	

5.5 Volumetric Analysis

The Little Waihi Drainage Scheme is in operation downstream of the site, consisting of a series of canals, drains, and pumps designed to drain the large flat catchment shown in the figure below.

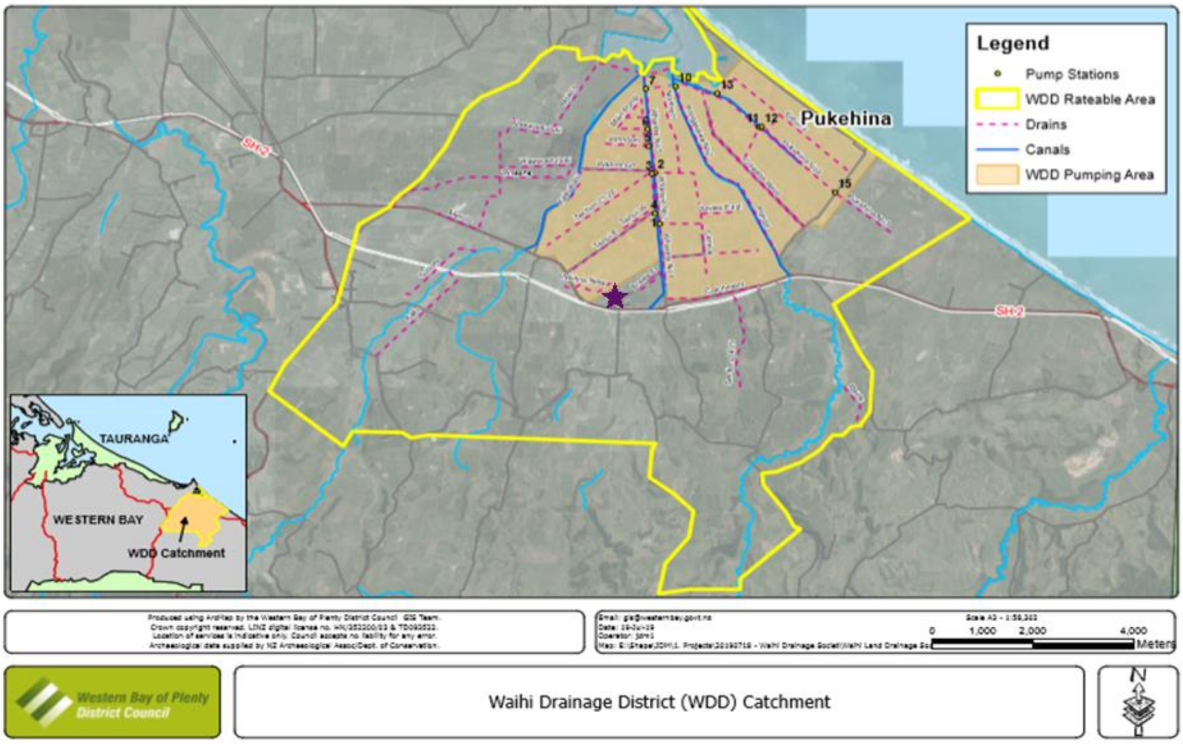


Figure 6: WBOPDC drawing depicting the area downstream of the site served by the Little Waihi Drainage Scheme (Provided by WBOPDC). The purple star represents the approximate site location.

The volumes discharged from the site are tabulated below. As per that table, the total volume discharged from the site is reduced in all modelled storms with the only exception being the 10-year, 24-hour storm (Pre-development: 1842m³, post-development: 2030m³). In that storm, the soakage systems within the lots are not overwhelmed and dispose of hardstand runoff from the entire storm, and the pond discharges into the drain to the north at a peak flow rate less than half (50 l/s) of the pre-development site (135 l/s). It is unlikely that runoff from the site in that storm would induce flooding in the area or compromise the functionality of the Little Waihi Drainage Scheme. The development can therefore be considered to reduce the total volume of runoff discharged from the site, and to therefore reduce the risk of flooding in downstream properties, and the risk of the Little Waihi Drainage Scheme being overwhelmed in a storm event.

TABLE 5: VOLUMETRIC ANALYSIS OF DISCHARGE FROM SITE

STORM DURATION	PRIMARY STORM EVENTS (10-YEAR)		SECONDARY STORM EVENTS (100-YEAR)	
	PRE-DEVELOPMENT (m^3)	POST-DEVELOPMENT (m^3)	PRE-DEVELOPMENT (m^3)	POST-DEVELOPMENT (m^3)
10 minutes	252	221	2302	1337
20 minutes	745	390	4754	3223
30 minutes	1345	558	6446	4411
1 hour	2355	869	11379	7126
2 hours	3670	1249	16494	7898
6 hours	4818	1778	20343	4897
12 hours	3983	1977	18926	5107
24 hours	1842	2030	16860	5535

5.6 Overland Flow from Upstream Properties

Additional runoff is expected to enter the site from the residential properties along Arawa Rd. Figure 7 below shows the additional catchment draining through the site to be approximately 10.2Ha and shows the location of the three overland flow paths. The catchment further upstream of the site is effectively diverted clear of the site by State Highway 2.

The three overland flow paths through the site will be retained as shown on the scheme plan, flowing in formed overland flowpaths or along road/ROW corridors. A Rational Method calculation has been presented in Table 6 below, estimating the total peak flow rate post-development through each of the overland flow paths on site.

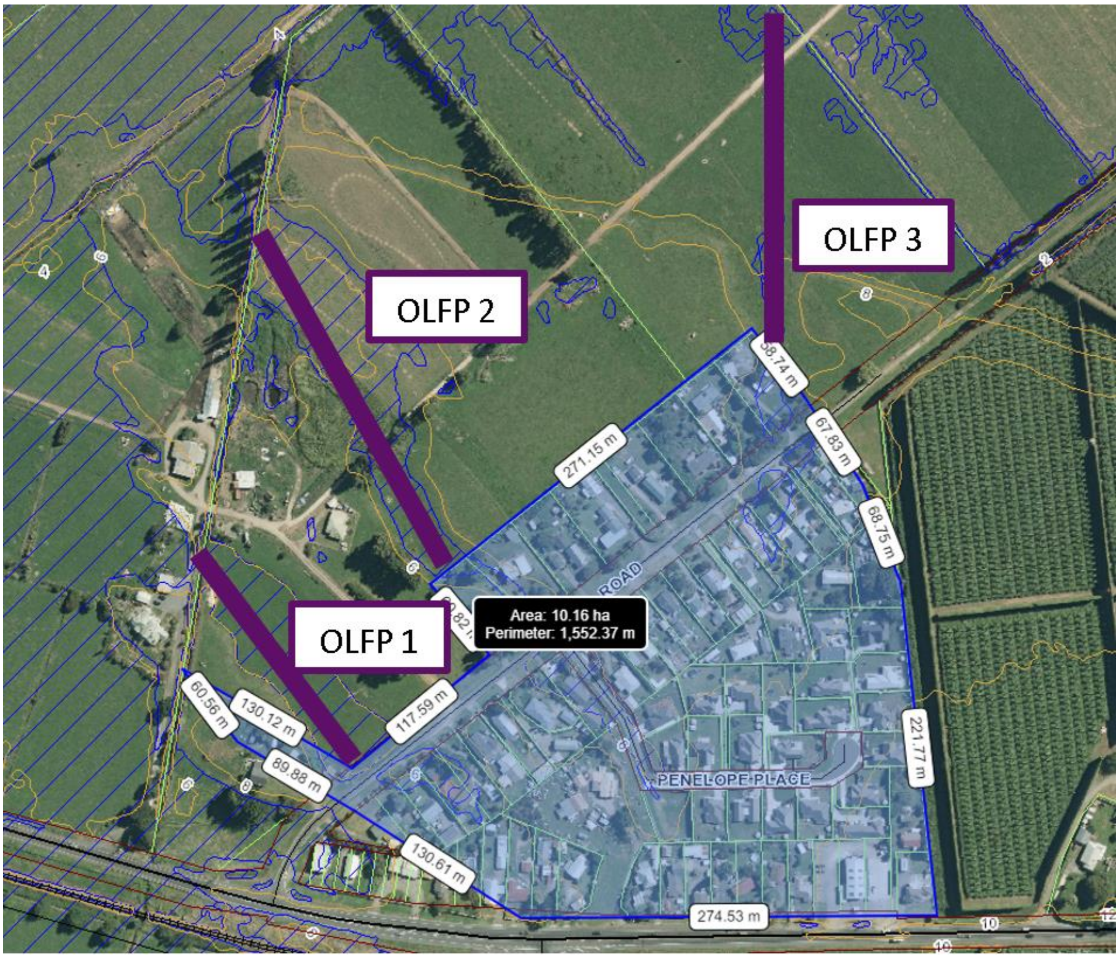


Figure 7: Additional catchment from neighbouring properties and OLFP diversions

TABLE 5: PEAK SECONDARY FLOW RATES IN OVERLAND FLOW PATHS (RATIONAL METHOD)			
OVERLAND FLOW PATH	CATCHMENT FROM SOUTH OF ARAWA ROAD	ASSUMED RUNOFF COEFFICIENT*2	PEAK RUNOFF IN 100YR, 10 MINUTE STORM EVENT (270mm/hr) *1
OLFP 1	2.0Ha (20%)	0.75	1.13m^3/s
OLFP 2	7.1Ha (70%)	0.75	3.99m^3/s
OLFP 3	1.0Ha (10%)	0.75	0.56m^3/s

*1: Rainfall intensity of 270/hr taken from TCC IDC Rainfall Intensity Table (DS-5, Appendix B), which includes adjustment for climate change to the year 2130, RCP 8.5.
*2: Runoff coefficient increased from primary event as the ground is assumed to be waterlogged in the secondary storm event, increasing runoff. This coefficient also allows for some discharge to soakage within the catchment.

Table 6 below shows examples of channel shapes capable of conveying the necessary runoff for each overland flow path on site. However, alternative channel profiles (for example, wider and shallower) could also be used to achieve the same result. Each channel is assumed to be a grassed channel with a Manning's roughness coefficient of 0.03, and 150mm of freeboard has been added to the flow depth.

TABLE 6: OLFP REQUIRED CHANNEL DIMENSIONS

OVERLAND FLOW PATH	CHANNEL SHAPE	ASSUMED GRADE	ASSUMED BASE WIDTH	FLOW DEPTH	REQUIRED CHANNEL DEPTH	RESULTING CHANNEL WIDTH
OLFP 1	Trapezoidal	1%	1.0m	400mm	550mm	4.3m
OLFP 2	Trapezoidal	1%	1.3m	670mm	820mm	6.3m
OLFP 3	Trapezoidal	1%	1.0m	280mm	430mm	3.6m

In addition to this, culverts will also be required along OLFP 2 as the flow path crosses roads in the development. These are to be designed during the detailed design phase.

'Hydraulic Toolbox' calculations showing the required channel dimensions presented in Table 5 above are shown below in Figures 7-9 below. Sketches of the channel dimensions are presented in Figure 11 below.

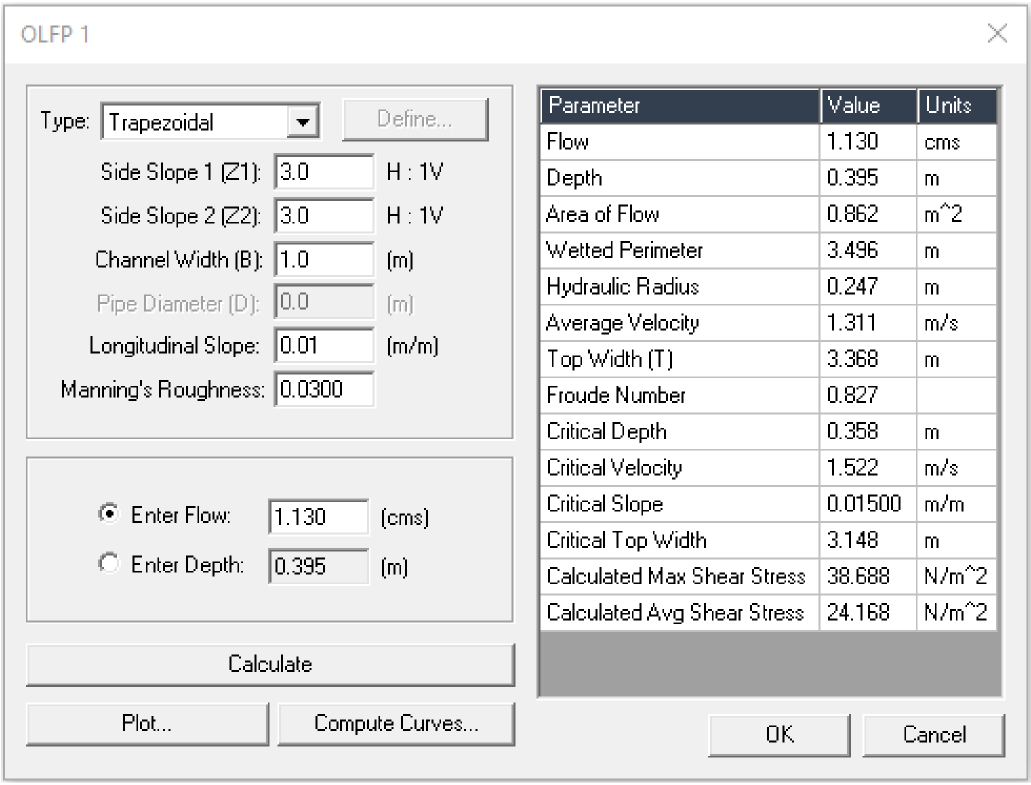


Figure 8: Hydraulic Toolbox results of required flow depth for OLFP 1 in the secondary storm event, assuming a 1% channel grade trapezoidal channel.

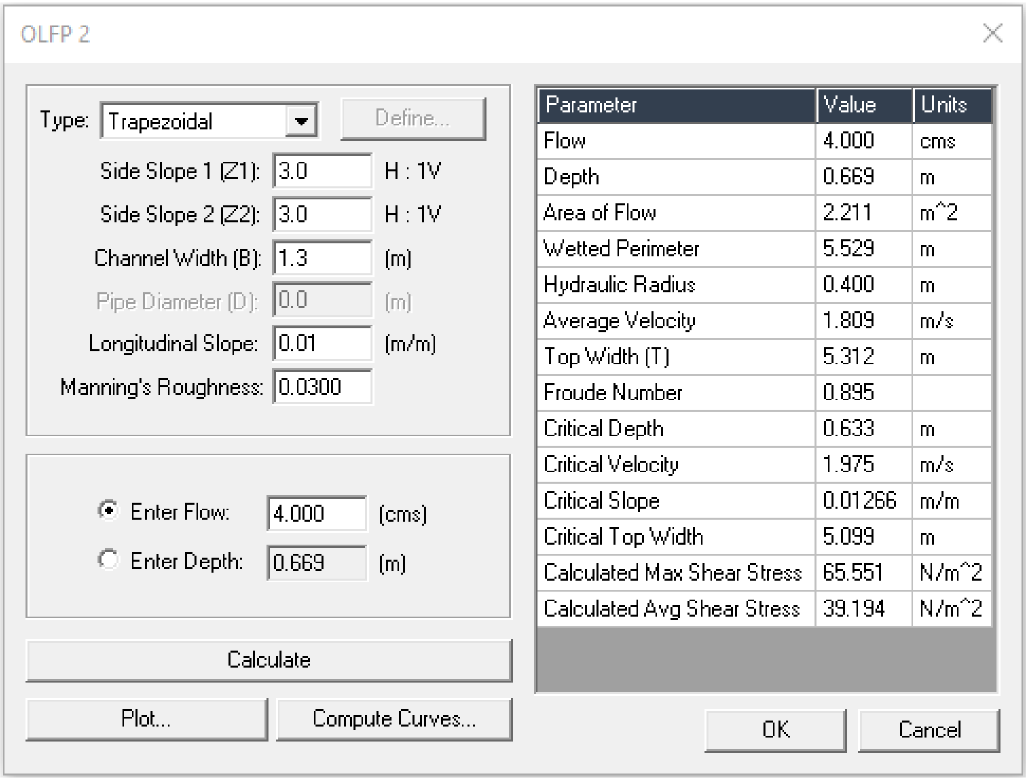


Figure 9: Flowmaster results of required flow depth for OLFP 2 in the secondary storm event, assuming a 1.3m base width and 1% channel slope in a trapezoidal channel

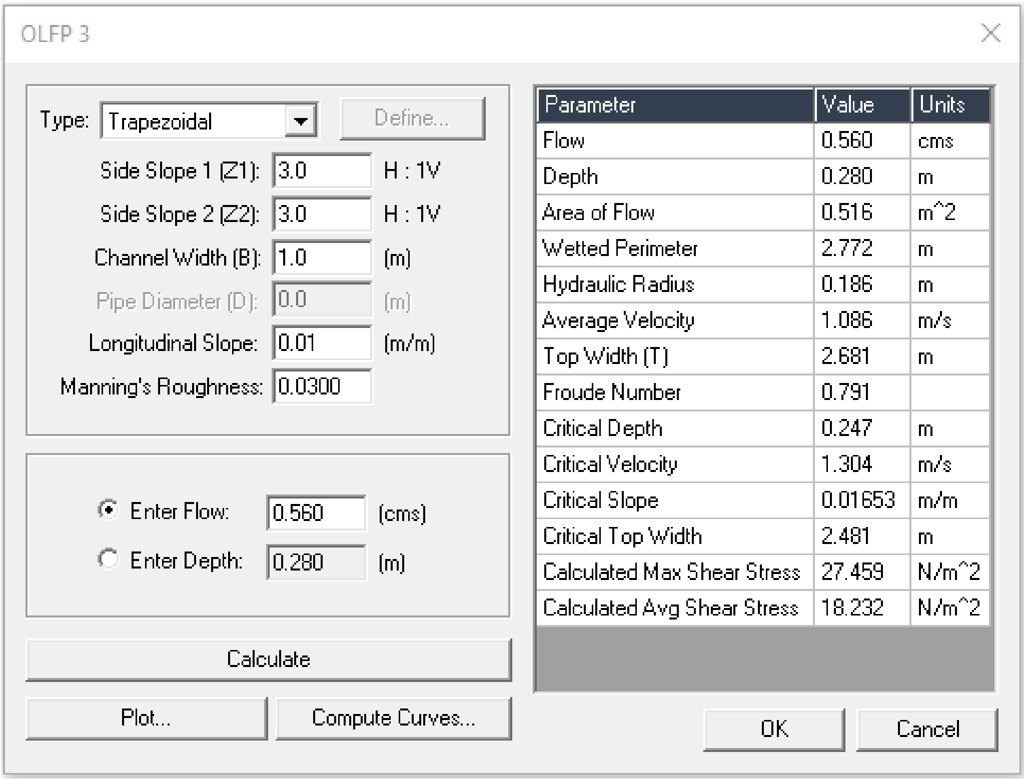


Figure 10: Flowmaster results of required flow depth for OLFP 3 in the secondary storm event, assuming a 0.5% channel grade triangular channel (no bottom width)

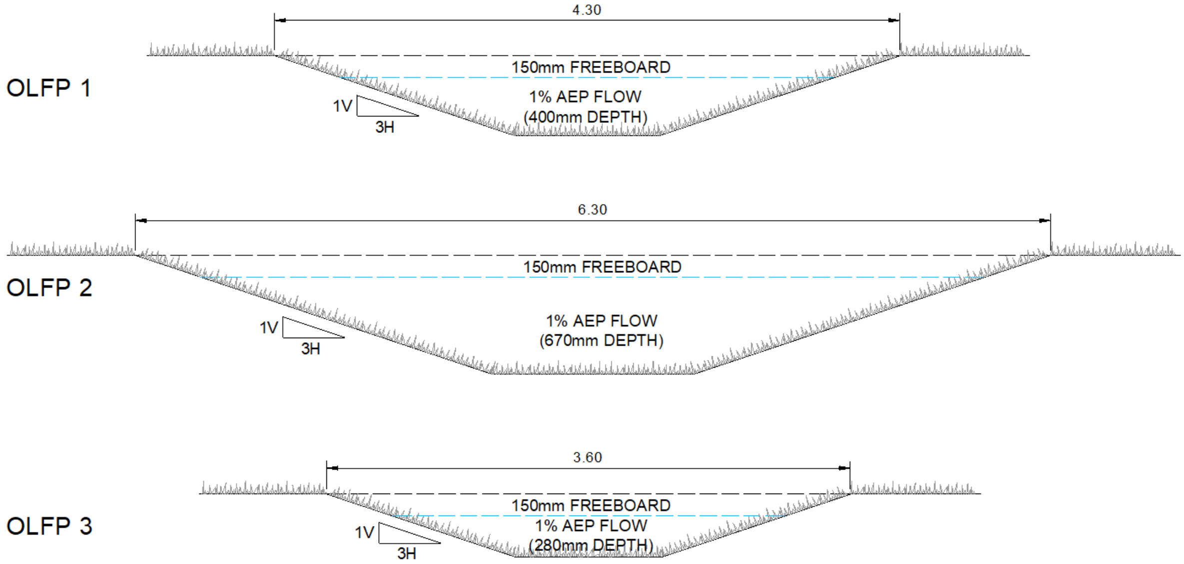


Figure 11: Sketches of overland flow paths 1-3

5.7 Safety in Design - Stormwater

As above, the overland flowpaths have flow depths ranging from 280mm to 670mm, and critical velocities ranging from 1.3m/s to 1.98m/s. According to the graph below (extracted from New South Wales Government Floodplain Development Manual, and referenced locally in TCC's Plan Change 27 Guidance Document), those flow characteristics aren't necessarily safe for people or vehicles. However, safe evacuation from all parts of the site can be achieved without the need to enter or cross any of the overland flowpaths. Therefore, entry into the overland flowpaths is very unlikely during the 100-year storms during which the channels will flow full, and can be further prevented with the use of fencing and/or planting. It is recommended that vegetation be planted within the flowpaths anyway, to lessen the maintenance burden. Therefore, the risk of loss of life presented by the overland flowpaths (which will only be apparent during particularly large storms) is very low, and can be mitigated by physically preventing entry into them.

In terms of the off-site risk brought about by the stormwater attenuation pond, the modelling summarised in sections 5.4 and 5.5 confirms that the pond can be sized to reduce runoff rates from the site into the downstream environment in all design storms up to and including the 100-year critical storm. Further, runoff volumes from the site are also reduced in all storms up to and including all 100-year temporal storms, with the only exception being the 10-year 24-hour storm. Therefore, the risk to downstream properties of loss of life as a result of discharge from this site can be considered low. More than that, the proposal is arguably reducing the risk of loss of life as both runoff rates and volumes from the site are being reduced in almost all theoretical design storms. As for the overland flowpaths and the neighbouring drain along the site's north-west boundary, loss of life from entry into these features can be prevented by preventing access to the pond using carefully designed and located vegetation or fencing as required.

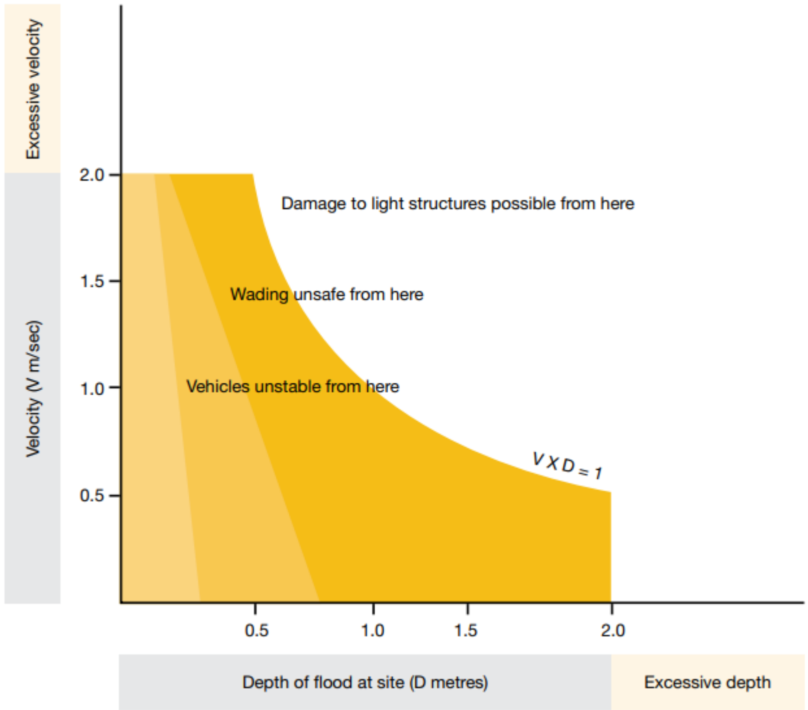


Figure 12: Example indication of flood depth and velocity influence on flood hazards from New South Wales Government Floodplain Development Manual (2005).

5.8 Staging of Stormwater Infrastructure

In order to ensure that runoff from any and all stages of development can be appropriately treated and attenuated, the stormwater pond must be constructed as part of the first stage of development. Further, the three overland flowpaths must be physically formed as part of the first stage of development, though not necessarily to their final shape. They are to be shaped into a functional state in terms of flow capacity, and then finished with planting and/or fencing only as development stages in their immediate vicinity are completed. Once those key pieces of infrastructure are in place, the only remaining infrastructure required is the soakage within each lot and the piped infrastructure to convey runoff from roads to the stormwater pond, which are to be constructed as required by the staging of the development.

6.0 WASTEWATER

WBOPDC's GIS system shows that there is no public wastewater reticulation within Pongakawa, and therefore wastewater will be treated and disposed of on-site. A pressurised liquid-only sewer system is proposed, and a preliminary design has been undertaken by Innoflow, which has been attached in Appendix 4.

The wastewater demand from the proposed development has been calculated by Innoflow. The derived peak daily flow was 140,000L/day, based on 130 3 bedroom homes, with people in each at an allowance of 200 L/person/day and 200 staff/users of the commercial area at 50 L/person/day.

Wastewater will undergo primary treatment via septic tanks within individual lots, which will be installed by homeowners at the time of building. Effluent is then pumped from the septic tank systems to mainlines within road berms, which transport the wastewater to secondary treatment. After secondary treatment the treated wastewater will be discharged via drip irrigation to a disposal field. The disposal zone is shown in the MPAD site plans.

7.0 WATER SUPPLY

Section 7.4.1 of WBOPDC's Development Code requires a domestic supply allowance of 220l/person/day with a peak hour peaking factor of 5. Total demand from the development has been presented in Table 7 below, assuming 130 residential houses with an average occupancy of 3 persons/dwelling and 1600m^2 of medium water using commercial buildings is to be constructed.

TABLE 8: WATER DEMAND CALCULATIONS	
Average Demand	1.23 L/s
Average Daily Demand	106.5 m^3/d
Peak Hour Demand	6.17 L/s

WBOPDC's GIS confirms that a 50mm ID MDPE rider main is located within the berm on the northern side of Arawa Road alongside the site. This rider main is ring fed from an 80mm ID MDPE water main located within the berm on the southern side of Arawa Rd. A 100mm ID MDPE water main runs alongside SH2 to the south of the site.

The recent development of Penelope Place made use of a reservoir and pump at the entrance to the site, to allow the delivery of the necessary pressure to the dwellings and fire hydrant within. It is therefore considered unlikely that the proposed development could be supplied from the existing network in Arawa Road without the use of a similar reservoir and pump system. Whilst WBOPDC's DC doesn't provide specific guidance on how many dwellings can be serviced by watermains of given diameter, NZS4404:2010 does. Table 6.2 of that standard states that generally, a single ended 100mm feed like the one feeding the Arawa Road catchment can serve 10 rural residential lots. There are already more than 30 residential lots connected to the main.

A water supply model has been created to demonstrate how the development could be serviced, which is discussed in further detail in sections 7.3 and 7.4 below. In short, the existing watermain arrangement cannot supply the proposed development without either:

1. Upgrading the 100mm ID main connecting the Arawa Road development to Maniatutu Road (a 2km long length of watermain) to a 225mm OD MDPE main.
2. The provision of a reservoir and pump arrangement at the connection point to the development.

Both options have been explored in the modelling discussion in sections 7.3 and 7.4, and both are hydraulically feasible.

Internal to the development, firefighting supply will be designed to comply with SNZ PAS 4509, with hydrants located at 135m maximum spacing (in accordance with the WBOPDC DC for residential areas).

7.1 Water Pressure Testing

To demonstrate the feasibility of each of the options above, water pressure testing was carried out on the 100mm main in SH2, and a water model was built based on its findings. Pressure testing was undertaken for a 48-hour period between 9:30am, 13/07/22 and 9:30am, 15/07/22, at the air valve 90m west of the SH2/Arawa Road intersection. The pressure varied between 627.4kPa and 562.9kPa, as shown in Figure 13 below.

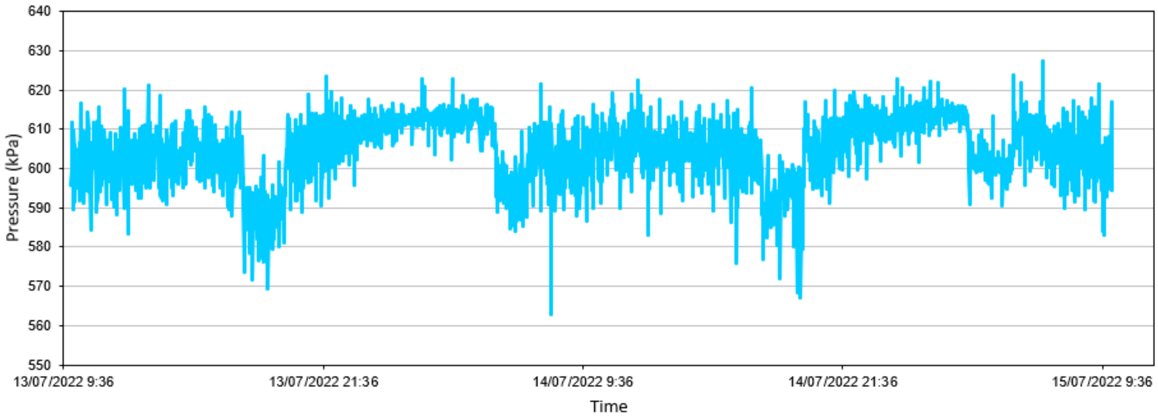


Figure 13: Pressure monitoring results, provided by Alec Coory of Rolec. Monitoring was undertaken at the air valve on the pipe bridge 90m west of the SH2/Arawa Road intersection.

For simplicity and conservatism, a pressure of 510kPa was adopted for use in static models built with EPANet, to demonstrate code compliance even at the lowest ebb of pressure over the 48-hour period, and with an additional reduction of 50kPa to allow for the fact that the readings were taken in winter (where demand is lower than in the summer months). Notably, for most of the monitoring run, pressure was consistently between 590kPa and 615kPa.

7.2 Existing Network Model

Figure 14 below shows the model of the existing network. That model contains all existing mains with diameters and lengths in accordance with the data available on WBOPDC's MAPI GIS database. Elevations at each node of the model were estimated using MAPI contours. Given the flat landform in the area, the relative elevations of the nodes are not considered critical to the way the model functions. Demand from existing properties was derived using table 3.2 of AS/NZS 3500.1:2003, which provides the probable simultaneous demand ("PSD") for multiple dwellings. For example, the node east of the Arawa Road/SH2 intersection (at the bottom of the figure) represents the demand from the 29 properties serviced by that main, and table 3.2 of AS/NZS 3500.1:2003 states that the PSD for 29 lots is 3.32 l/s. For the five rural properties along the line from Maniatutu Road to the Arawa Road area, the PSD has been doubled, to represent their likely heightened demand. A Hazen-Williams roughness coefficient of 150 has been adopted for all pipes, representative of plastic pipes.

The demand for the Penelope Place development was derived differently, given that it is served by an internal main with a reservoir and pump at the development entry point. For that development, the daily demand was derived based on the Development Code parameters and averaged across a 24-hour period to represent the trickle feeding of the reservoir.

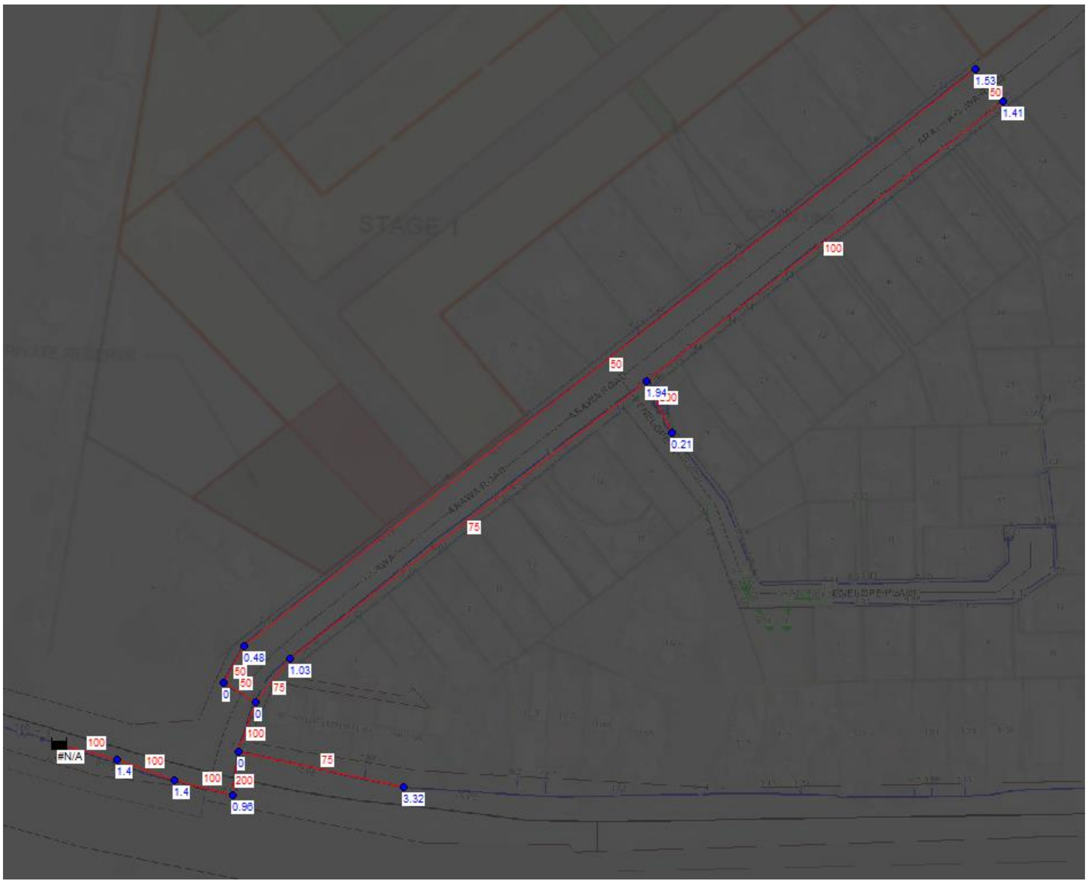


Figure 14: Screenshot of the EPANet water pressure model for the existing network. Red lines/text denote pipes and their respective diameters (in mm), blue dots/text represent nodes in the network and their estimated demand (in l/s). The green reservoir at bottom left represents the 100mm main in SH2, with 63m head within it (560kPa and 7m elevation).

To model the 2km long (not drawn to scale in the figure) 100mm ID MDPE main feeding the area from the west, the reservoir at the bottom left of the figure was set with a head of 100m, given that hydraulic calculations suggest that approximately 41m of head are lost along the 2km length of pipe. Therefore, the pressure within the main at the testing location is 59m (or an internal pressure of 51m as per the pressure testing detailed in section 7.1, given the elevation at that location of 8m).

Figure 14 below shows the modelling results of the pre-development model, with pressures at each node shown in green text. Note that in this model no firefighting has been modelled, as there are no hydrants present within the network other than the one at the cul-de-sac head of Penelope Place. That hydrant is not considered relevant to the functioning of the wider area in terms of pressure, as it is within a development served by a reservoir and pump. At no point within the model does the water pressure drop below 54m.

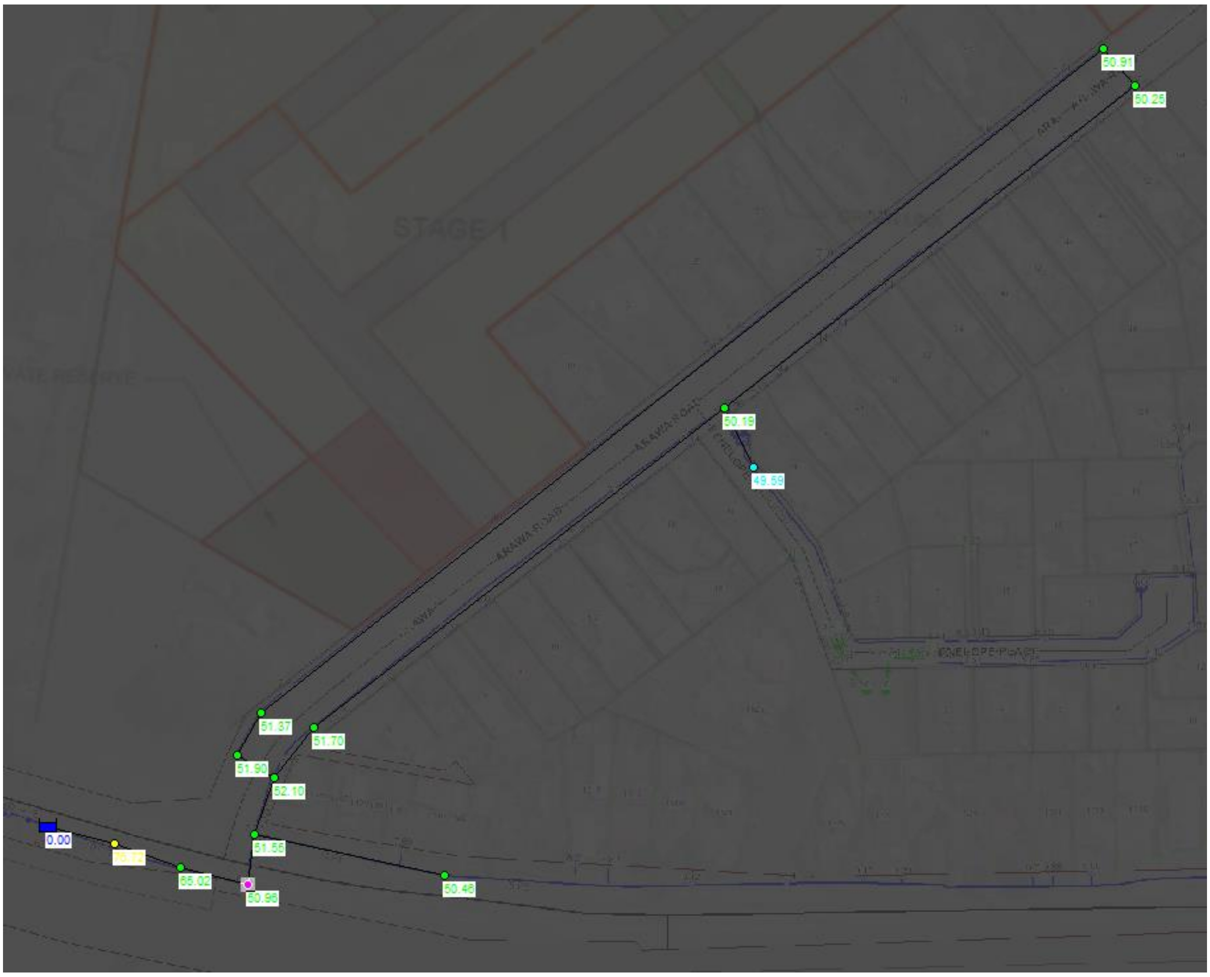


Figure 15: Screenshot of the EPANet water pressure model for the existing network. Black lines denote pipes green dots/text represent nodes in the network and their modelled pressure (in metres head).

7.3 Option 1 – State Highway 2 Watermain Upgrade

Figure 16 below shows the model that was constructed for this option, with existing mains within SH2, Arawa Road, and Penelope Place included, as well as a conceptual representation of a reticulation network within the proposed development. The blue text represents estimated demand, and the red text denotes pipe diameter. The demand at each node of the existing network is as per the pre-development model. The demand for the proposed plan change area was also largely derived using table 3.2 of AS/NZS 3500.1:2003, with the proposed 130 lots evenly distributed throughout the development, and the commercial area included at the appropriate node. Of note are the following model features:

- There are two open hydrants within the proposed development, each delivering 12.5 l/s in accordance with SNZ PAS4509-2008.
- The 2km main (not drawn to scale in the figure) from Maniatutu Road to the development area has been modelled as having been upgraded to a 225mm OD MDPE pipe as part of the proposed development (SDR13.6, PN12.5, with an internal diameter of 191mm). By iteration, this was deemed the minimum diameter to provide a code compliant level of service to the development.

- The connection from the main to the development will be a 140mm OD MDPE pipe, which was deemed the minimum diameter to provide a code compliant level of service to the development.

Figure 16: Screenshot of the EPANet water pressure model for Option 1. Red lines/text denote pipes and their respective diameters (in mm), blue dots/text represent nodes in the network and their estimated demand (in l/s). The blue reservoir at bottom left represents the 100mm main in SH2, with 63m head within it (560kPa and 7m elevation).

The pipework within the plan change area is generally a standard layout with a 100mm main on one side of the road and a 50mm ridermain on the other.

Figure 17 below shows the modelling results, with the text representing the pressure at each node within the network. As shown, the residual pressure across the proposed network remains above the WBOPDC DC mandated 10m while the two fire hydrants are running, and the pressure within the existing Arawa Road doesn't drop below 63m (compared with the 50m in the pre-development model). Therefore, the option of upgrading the main from Maniatutu Road is considered a suitable solution to enable water to be supplied to the proposed plan change area.

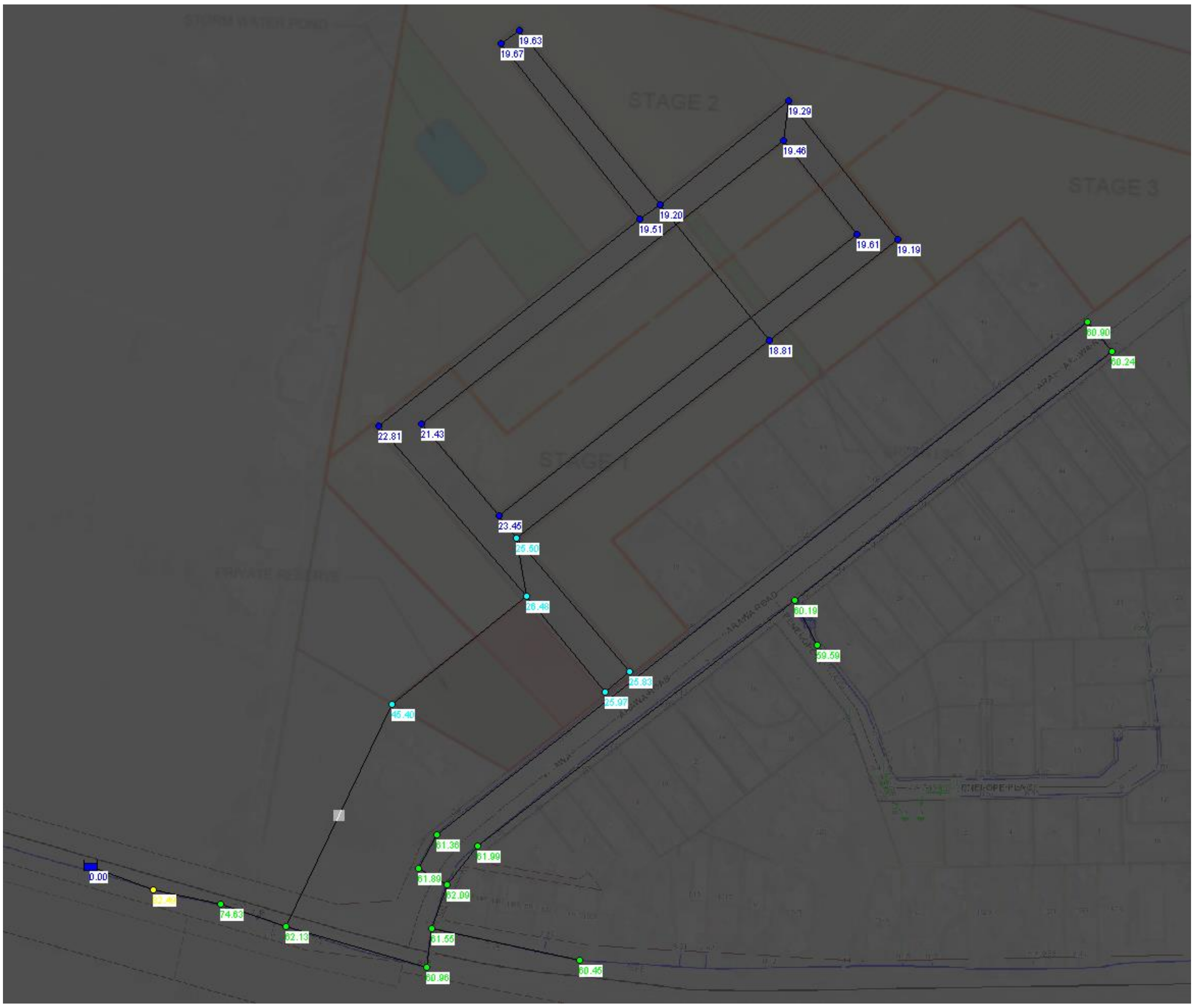


Figure 17: Screenshot of the EPANet water pressure model for Option 1. Blue and Green dots/text represent nodes in the network and their modelled residual pressures when two fire hydrants are each drawing 12.5l/s within the proposed plan change area.

The system could further be improved by upgrading the 75mm and 50mm mains in Arawa Road, but those upgrades aren't considered necessary to enable the development of the plan change area.

7.4 Option 2 – Reservoir and Pump at Development Connection Point

This option requires no off-site upgrades, but instead the installation of a reservoir and pump at the connection point to the plan change area, in a similar vein to what was done at the Penelope Place development. As for the previous two models, the existing network and the pressure monitoring results are incorporated. The average demand of the development (refer to section 7.0) of 1.23 L/s has been adopted (and rounded up to 1.3l/s) as the trickle feed rate required to keep the reservoirs full, and it has been assumed that 48 hours of emergency storage is to be provided, which equates to 225m³. In addition to that volume, a further 45m³ of storage is proposed for use as firefighting storage. The exact storage arrangement has not been explored in detail here, but it could be achieved by way of a series of above ground tanks (Devan plastic tanks or similar), or by way of one larger reservoir (Kliptank or similar). Either way, the storage must be arranged such that the fire fighting storage is available at all times, even in the unlikely event of the potable supply being exhausted. Figure 18 below is a diagrammatic representation of how that might be achieved.

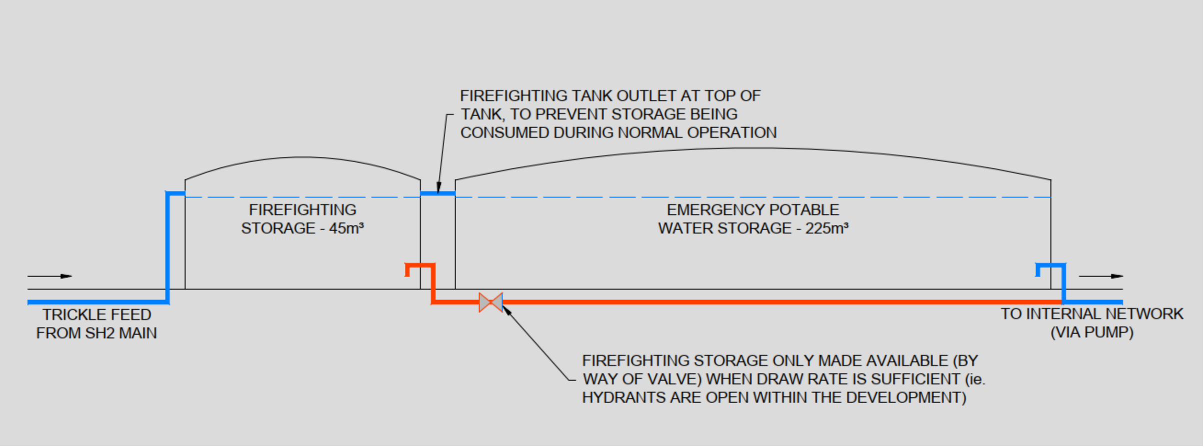


Figure 18: Diagrammatic representation of a potential conceptual reservoir arrangement at the site entrance.

Based on initial discussions with Pump and Valve Specialties Limited ("Pump and Valve"), the pump station would likely consist of a number of pumps operating in parallel, such that their collective duty can be matched to what is required by the development at any one time (be it peak hourly demand, low flow situations, or firefighting flows). When firefighting flow is required, the pump station would be programmed to engage all of its pumping capacity, and to open the valve on the firefighting storage outlet line, such that that storage can be drained during such an emergency.

Further, Pump and Valve indicated that the flow rate and head characteristics of the network are within the capabilities of readily available pumps, and that a system of pumps operating efficiently within their pump curves could be designed to suit such a situation.

Figure 19 below shows the model that was constructed for this option, which is the same as that for option 1, with the exception of the SH2 main upgrade not being in place, and the reservoir and pump system being incorporated. Key features of the model include:

- There are two open hydrants within the proposed development, each delivering 12.5 l/s in accordance with SNZ PAS4509-2008.
- The 2km main from Maniatutu Road to the development area remains at 100mm internal diameter.

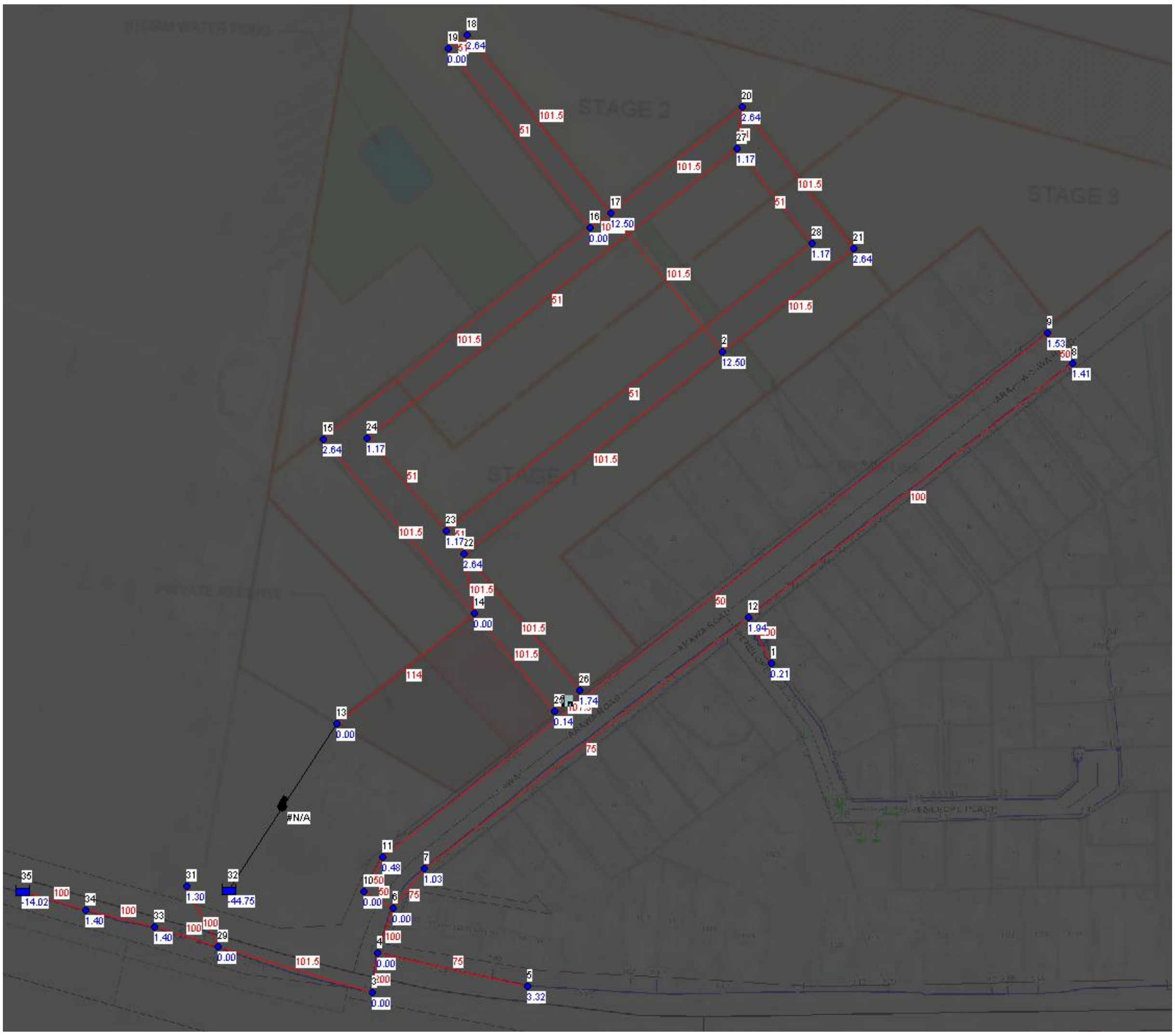


Figure 19: Screenshot of the EPANet water pressure model for Option 2. Red lines/text denote pipes and their respective diameters (in mm), blue dots/text represent nodes in the network and their estimated demand (in l/s). The black reservoirs at bottom left represents the 100mm main in SH2, with 100m of theoretical head within it, 2km from the site, and the proposed reservoir to supply the proposed plan change area.

- In terms of the hydraulics of the wider network, the development draws only 1.3 l/s, which is representative of the trickle feed into the development reservoir.
- The internal reservoir has been represented in the model, with only approximately 2m of pressure within it (the approximate height of an assumed tank, above ground level).
- EPANet has modelled a theoretical pump curve for the pump supplying the development. The pumping parameters required have been discussed with Pump and Valve and understood to be within a normal operating range for watermain pump applications.

Figure 20 below shows the modelling results for Option 2, with the pressure at each node shown (whilst two hydrants are drawing from the network within the development).

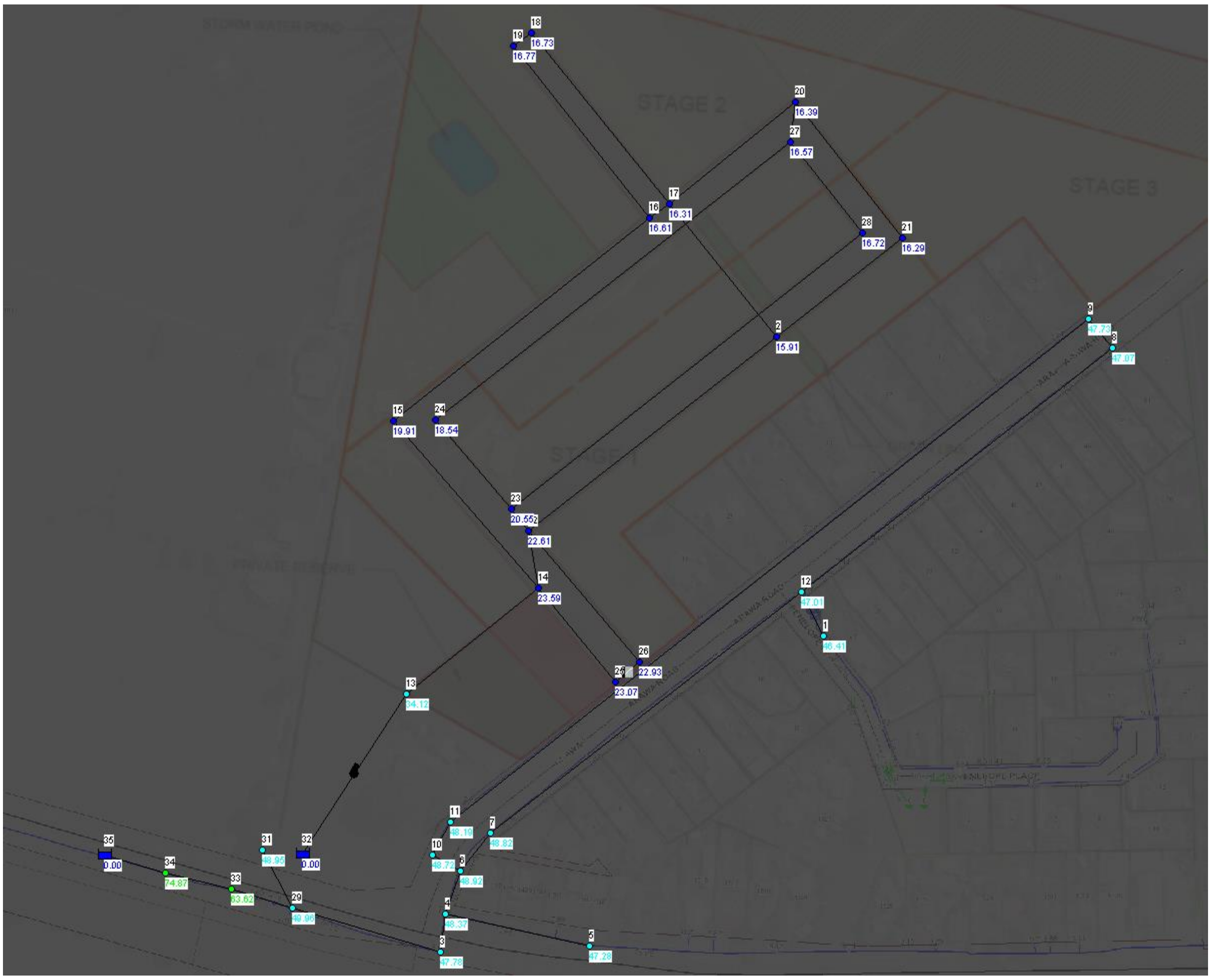


Figure 20: Screenshot of the EPANet water pressure model for Option 2. Blue and Green dots/text represent nodes in the network and their modelled residual pressures when two fire hydrants are each drawing 12.5l/s within the proposed plan change area.

As per the figure, the pressure within the main remains above 10m in all cases and is therefore compliant with the WBOPDC DC. Further, the pressure within the existing mains in Arawa Road and Penelope Place do not drop below 46m (compared to 54m in the pre-development scenario).

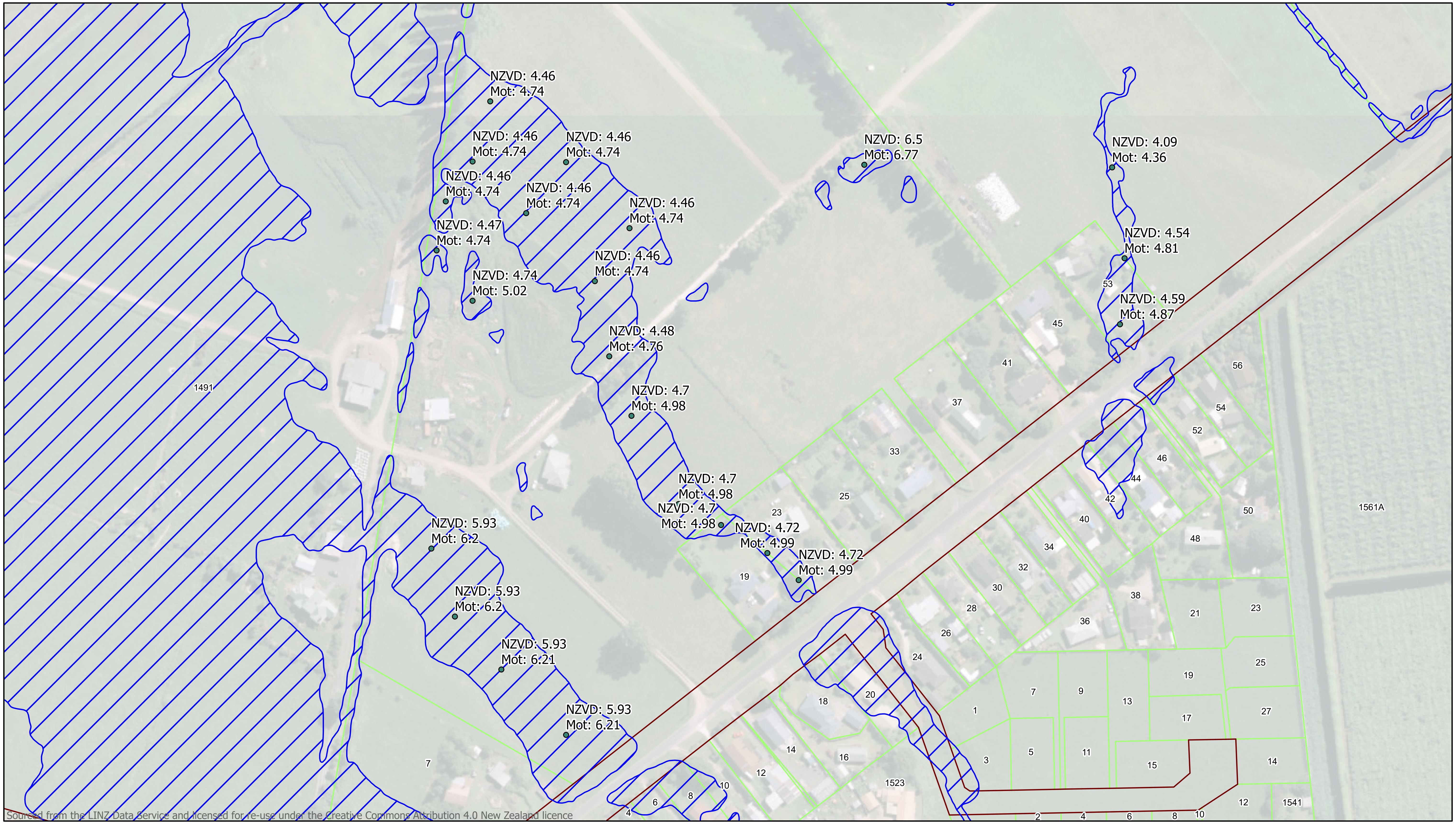
Sensitivity analysis was carried out on the existing network, and whilst the proposed development theoretically needs only a 1.3l/s trickle feed to operate, as much as 3.7l/s could be taken from the existing network at the point of supply without the pressure in the existing mains dropping below 30m of pressure, the minimum required by the WBOPDC DC.

Therefore, a reservoir and pump solution such as the one described here is considered a suitable solution to provide water to the proposed plan change area without compromising the functionality of the existing infrastructure.

8.0 POWER, GAS & TELECOMMUNICATIONS

MPAD are undertaking a review of power, telecommunication and gas services availability. Feedback has been received from Powerco confirming that the development can be supplied from the infrastructure in the vicinity of the site, with the provision of one or two new transformers. The email from this communication has been attached in Appendix 6. Responses from telecommunications and gas providers are still being sought.

APPENDIX 1 – FLOOD LEVELS DRAWING



Produced using ArcMap by the Western Bay of Plenty District Council GIS Team.
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Location of services is indicative only. Council accepts no liability for any error.
Archaeological data supplied by NZ Archaeological Assoc/Dept. of Conservation.

Email: gis@westernbay.govt.nz
Date: 14/09/2021
Operator: mbl
Map:

Scale (A3) : 1:7,500

Western Bay of Plenty District Council

Flood Levels

N

APPENDIX 2 – GEOTECHNICAL INVESTIGATION REPORT

11 February 2022

PENCARROW ESTATE

1491 STATE HIGHWAY 2, PONGAKAWA

GEOTECHNICAL INVESTIGATION REPORT FOR PLAN CHANGE

Kevin and Andrea Marsh

TGA2021-0096AC Rev 0

TGA2021-0096AC		
Date	**Revision**	**Comments**
3 February 2022	A	Initial draft for internal review
11 February 2022	0	Final issue to support Plan Change Application

	Name	Signature	Position
Prepared by	Lydia Lysaght		Project Engineering Geologist
Reviewed by	Rob Telford		Associate Engineering Geologist Accredited Category 1 Geo-professional
Authorised by	Matt Packard		Principal Geotechnical Engineer CMEngNZ, CPEng (Geotechnical) Accredited Category 1 Geo-professional

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Appendices

1 INTRODUCTION

CMW Geosciences (CMW) was engaged by Kevin and Andrea Marsh to carry out a geotechnical investigation of a rural site located at 1491 State Highway 2, Pongakawa, which is being considered for a residential plan change.

The scope of work and associated terms and conditions of our engagement were detailed in our services proposal Ref. TGA2021-0096AB Rev 0, dated 3 November 2021. The purpose of this report is to describe the investigation completed, the ground conditions encountered and to provide recommendations with respect to geotechnical considerations for the proposed plan change.

This report may be used as one of the documents to support a plan change application to Western Bay of Plenty District Council (WBoPDC).

2 SITE DESCRIPTION

2.1 Site Location

The site comprises an area of approximately 8.8ha and is located at 1491 State Highway 2 as shown on Figure 1 below.

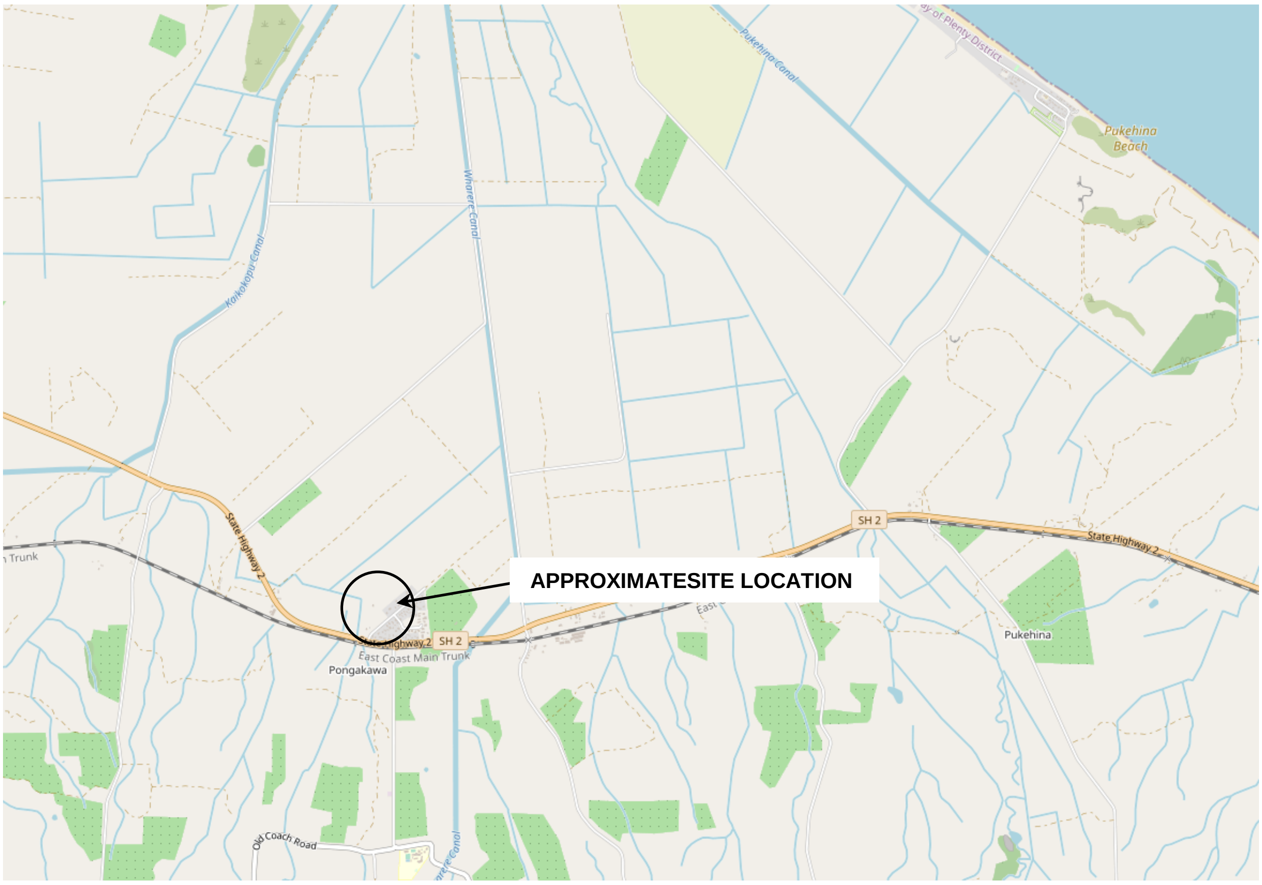

Figure 1: Site Location Plan (openstreetmaps.org)

2.2 Landform

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

The majority of the site is essentially near level and occupies a broad plateau with existing ground levels ranging from RL 6m to 8m (Moturiki Datum). Several shallow swales bisect the plateau in the south, centre and north-eastern areas. Immediately to the north, the site grades gently down to level, low lying topography at RL 3m.

The site is occupied by farmland, with a small dwelling and ancillary sheds in the south. It is bound to the north, west and south by rural properties and farm buildings, and to the east by residential properties and Arawa Road. A small pond is present in the far west.

2.3 Historic Aerial Photographs

Historical aerial photographs[1] show:

- 1943: The site was in grazed pasture, with small farm sheds in the west. Localised depressions (swales) are evident in the south, central and north-eastern areas of the site;
- 1961: The site remained in grazed pasture, with several hedgerows and a central accessway present;
- 2003: The majority of the hedgerows had been removed. The small pond in the west of the site was evident. Residential dwellings along Arawa Road, immediately to the east had been constructed;
- 2007: A cropped area was present in the west of the site, adjacent to the small pond and farm building. The dwelling was present in the central/southern area;

Little change was noted from 2007 until the present day.

No signs of significant earthworks were noted in our review. Minor earthworks in the west of the site are likely to have occurred as a result of cropping and pond construction.

3 PROPOSED DEVELOPMENT

At the time of undertaking this investigation and of writing this report the project was in the early planning stages and a scheme plan had not been supplied. However, it is understood that the site is being considered for a plan change application, to rezone the land from its existing ‘rural’ status to ‘residential’.

Due to the level nature of the site, minor levelling earthworks are anticipated to form building areas and associated roads and infrastructure.

Localised peat undercuts within the swales or low-lying parts of the site may also be undertaken.

Based on discussion with the project planners, Momentum Planning and Design Ltd (MPAD), it is understood that the strip of land immediately to the north of the site (as depicted on ***Drawing 01***) is being considered as a future wastewater disposal zone.

The stormwater disposal method(s) for a future residential development at this site is currently unknown.

4 INVESTIGATION SCOPE

Following a dial before you dig search, and onsite service location, the field investigation was carried out between 17th and 18th February 2022. All fieldwork was carried out under the direction of CMW Geosciences in general accordance with the NZGS specifications[2] and logged in accordance with NZGS guidance[3].

The scope of fieldwork completed was as follows:

- An engineering geologist undertook a walkover survey of the site to assess the general landform, site conditions and adjacent structures / infrastructure;

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

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

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

- An on-site services search was carried out by a specialist contractor to identify the presence of any underground obstructions or hazards prior to the field investigation program commencing;
- Nine Cone Penetrometer Tests (CPTs) and two seismic CPTs (sCPTs) denoted CPT01 to CPT08, and CPT10 to sCPT12 were pushed to depths of up to 20m to define the ground model through the site and for use in liquefaction and static settlement analyses. Results of the CPT's, presented as traces of tip resistance (qc), sleeve friction (fs), dynamic pore pressure (u2) and friction ratio (Rf) are presented in ***Appendix C****;*
- Twenty test pits, denoted TP01 to TP20, were excavated using a 12-tonne hydraulic excavator to depths of between 2.2m and 4m below existing ground levels. Shear vane readings and dynamic cone penetrometer tests were taken at regular intervals to provide strength information. Engineering logs and photographs of the test pits are presented in ***Appendix C.***

The approximate locations of the respective investigation sites referred to above are shown on the Geotechnical Investigation Plan (***Drawing 01***). Test locations were approximated using onsite features.

5 GROUND MODEL

5.1 Published Geology

The published geological map[4] depicts the regional geology for the area as comprising Pleistocene alluvium consisting of variably degraded terraces dominated by pumiceous soils (Tauranga Group- IQa), as illustrated in Figure 2 below. To the north and west of the site, swamp deposits comprising dark brown to black peat, organic-rich mud, silt and sand (Tauranga Group- Q1a) are anticipated.

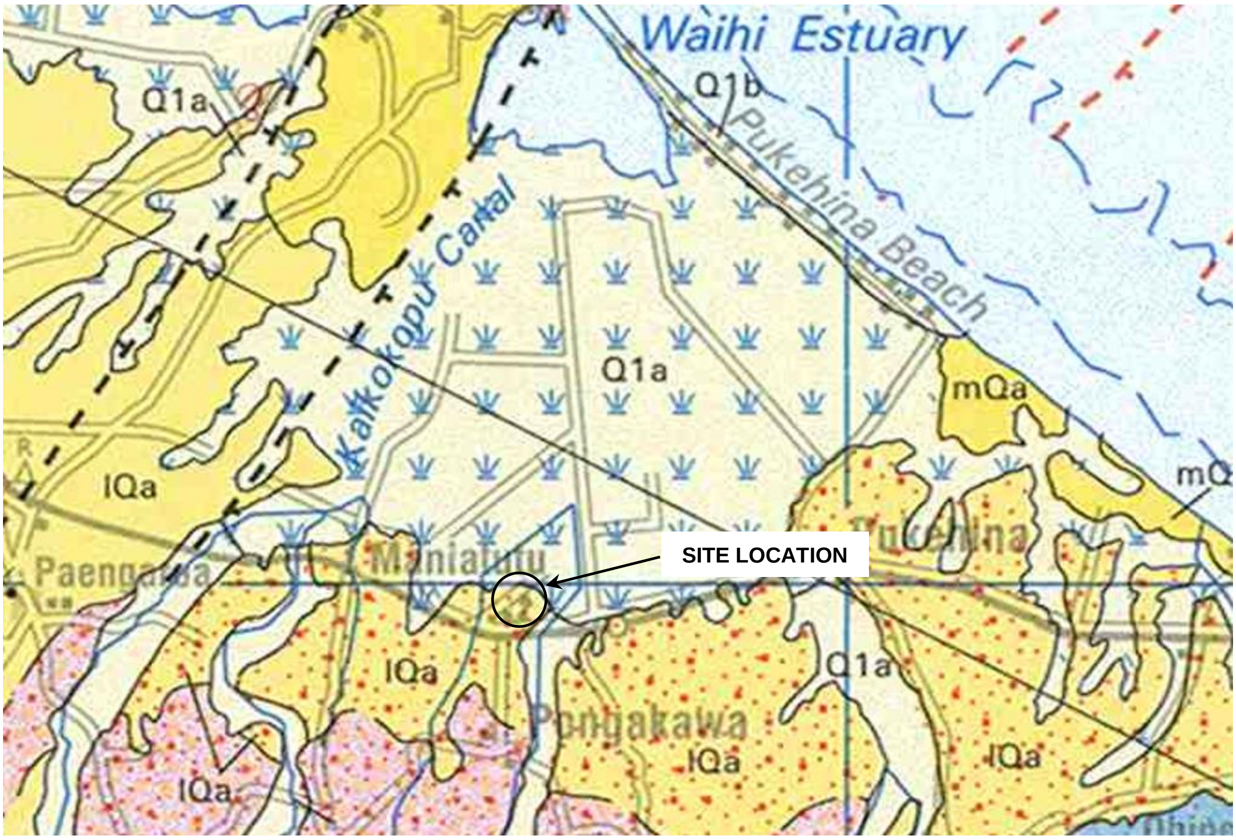

Figure 2: Regional Geology (Leonard and Begg 2010)

[4] Leonard and Begg (2010). Geology of the Rotorua Area. GNS, Geological Map 5.

Based on the known history of the site and surrounding land levels, some superficial depths of fill could be anticipated as a result of soft landscaping.

5.2 Stratigraphic Units

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

The distribution of the various units encountered is presented on the appended Geological Section on ***Drawing 02*** and summarised below.

Table 1: Summary of Strata Encountered

Unit	Top of Unit (mbgl)		Thickness (m)	
	Min	Max	Min	Max
Topsoil – Organic silt	Surface		0.1	0.4
Peat* – Fibrous, soft to stiff	0.4	0.5	0.1	3.0
Pleistocene Alluvium** – Interbedded stiff to very stiff silts and loose to medium dense sands	0.2	3.5	3.0	12.3
Pleistocene Alluvium – Medium dense sands	6.5	12.5	3.0	7.0
Pleistocene Alluvium – Dense to very dense sands	12.5	15.5	>10	

Notes: * Strata only encountered in the low lying far north of site, and within swales
** Areas of loose sand were noted in the upper 1m at several test locations across the site

5.3 Groundwater

During the investigation, which was completed in summer conditions (January 2022), groundwater was encountered within the CPTs and test pits at depths ranging from 1.0m to 4.3m below ground level, which equates to a reduced level of approximately RL 2m to RL4m.

6 GEOHAZARDS ASSESSMENT

6.1 Seismicity

A seismic assessment has been carried out in general accordance with NZGS guidance[5]. The ultimate limit state (ULS) and serviceability limit state (SLS) peak ground accelerations (PGAs) were assessed based on a 50-year design life and Importance Level (IL) 2 buildings in accordance with the New Zealand Building Code.

The recommended PGA values for geotechnical assessment at this site are presented in ***Table 2*** below. Structural designers working on this site should assess seismic parameters in accordance with NZS1170:2004 and using the recommended Site Subsoil Class presented in Section 7.1 below.

Table 2: Design Peak Ground Acceleration (PGA) for Various Limit States

Limit State	AEP	R	PGA(g)[1]	$Magnitude_{eff}$
SLS	1/25	0.25	0.08	6.0

[5] NZ Geotechnical Society publication "Earthquake geotechnical engineering practice, Module 1: Overview of the standards", (November 2021)

Table 2: Design Peak Ground Acceleration (PGA) for Various Limit States				
Limit State	**AEP**	**R**	**PGA(g)[1]**	**$Magnitude_{eff}$**
ULS	1/500	1.0	0.32	6.0
Note: R = return period factor; AEP = annual exceedance probability [1]As per Appendix A1 of NZGS Module 1				

6.2 Preliminary Liquefaction Assessment

6.2.1 General

Soil liquefaction is a process where typically saturated, granular soils develop excess pore water pressures during cyclic (earthquake) loading. Following the onset of liquefaction, the shear strength and stiffness of the liquefied soil is effectively lost causing excessive differential settlement of the ground surface, bearing capacity failure and collapse of structures and low-angle lateral spreading of slopes in liquefiable soils.

In accordance with NZGS guidance[6] the liquefaction susceptibility of the soils at the site has been considered with respect to geological age, soil fabric and soil consistency / density as follows:

- The peat soils are of Holocene geological age, and the silt/sand alluvial deposits are of Pleistocene geological age. Therefore, in terms of geological age, the soils are the site may be susceptible to liquefaction;
- Soils below the water table are predominantly sandy, and therefore are considered susceptible to liquefaction where saturated; and
- Sandy soils below the water table are generally medium dense to dense, and therefore in terms of soil density, may be susceptible to liquefaction.

Based on this, preliminary specific liquefaction analyses were undertaken as detailed below.

6.2.2 Specific Analyses

Liquefaction analyses were undertaken using the software package CLiq by comparing the cyclic stress ratio (CSR) to the cyclic resistance ratio (CRR) from the conventional CPT.

Calculations were carried out to consider the potential for liquefaction across the full depth of the CPT tests (i.e. 20m). Additional calculations were also undertaken to assess the effects of liquefaction within the upper 10m of the soil profile only to allow the results to be classified in accordance with the estimated ‘index settlements’ as per MBIE guidance[5].

Due to the geological age of the underlying deposits we assessed the potential for aging effects and reduced liquefaction susceptibility in accordance with Robertson[7]. The calculations followed the method proposed by Hayati and Andrus[8], which compares the ratio of measured to estimated shear wave velocities within effected soils as derived from seismic sCPTs. The calculations indicate that the soils beneath this site are not affected by significant soil aging and the effects of aging where therefore discounted in the liquefaction analyses.

The results of the liquefaction assessment are summarised in ***Table 3***, below and are presented in terms of the ULS ‘index’ settlements and the depth at which significant liquefaction occurs as this defines the thickness of the crust of non-liquefiable soils below the site Outputs of the calculations are given in ***Appendix D***.

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[6]MBIE, Canterbury Residential Technical Guidance, Part D: Guidelines for the geotechnical investigation and assessment of subdivisions in the Canterbury region, Version 2, December 2012

[7] P. K. Robertson (2015). Comparing CPT and Vs Liquefaction Triggering Methods, Journal of Geotechnical and Geoenvironmental Engineering, May 2015

[8] Hayati, H., and Andrus, R. D. (2009). “Updated liquefaction resistance correction factors for aged sands.” J. Geotech. Geoenviron. Eng., 10.1061/(ASCE)GT.1943-5606.0000118, 1683–1692.

Table 3: Preliminary Liquefaction Analyses Results – Index Settlements

CPT No.	SLS Settlement (mm)	ULS Index Settlement (mm)	ULS Liquefiable Layers (mbgl[2])	ULS Crust Thickness (m)
01	<10	110	4.0 – 9.5[1]	4.0[1]
02		85	4.0 – 5.5, 6.5 – 10[1]	4.0[1]
03		110	3.5 – 10[1]	3.5[1]
04		90	5.0 – 10	5.0
05		45	7.0 – 10	7.0
06		100	3.5 – 5, 6 – 9.5[1]	3.5[1]
07		110	4.0 – 10	4.0
08		60	4.5 – 6.5, 8.5 – 10	4.5
10		60	4.5 – 101	4.5[1]
11		100	4.5 – 10	4.5
12		<10	N/A	N/A

Note: 1. The effects of isolated shallow layers < 0.1m thick are discounted from this assessment
2. Settlements and depths are based on the existing ground profile
3. N/A = not applicable due to there being no ULS liquefiable layers

Liquefaction mitigation recommendations are discussed in Section 7.2.

6.3 Slope Stability

6.3.1 General

The site is near level to gently graded with no significant slopes or escarpments. The risk of slope movement under static (i.e. non-earthquake) conditions is therefore assessed as ‘low’ and specific static slope stability analyses have not been undertaken.

6.3.2 Lateral Spread Assessment

Following the onset of liquefaction, the liquefied soils behave as a very weak undrained material, which can give rise to lateral spreading where a free face is present within the vicinity of the site or where slopes are present over or within liquefied soils. To the north of the site, a gently graded, 2m high slope is present where the subject site slopes down towards the near level peat area in the north. Due to the presence of potentially liquefiable soils and low strength peat in this area, lateral spread analyses were undertaken for this slope.

Seismic stability analyses were undertaken for Geological Section A (***Drawing 02***). A liquefied soil strength ratio of 0.1 was applied to the upper interbedded silts/sands of the Pleistocene Alluvium. Liquefied strengths were not applied to the deeper, dense sand of the Pleistocene Alluvium or to soils above the groundwater table as calculations indicated that these are unlikely to liquefy in the SLS or ULS earthquakes.

The calculations considered to stability cases:

1. The stability of the slope assuming liquefied soil conditions under peak (ULS) ground acceleration to assess lateral spreading risk; and
2. The stability of the slope with liquefied soil parameters and zero ground acceleration to assess the risk of post-earthquake failure (termed ‘flow failure’).

Outputs from the stability models are presented in ***Appendix F***. The calculations indicate that the slope is unlikely to be affected by lateral spreading in an SLS event but may have a low factor of safety (i.e. < 1.0) against lateral spreading in a ULS earthquake. Further analyses using the empirical methods by Bray & Travasarou (2007) and Jibson (2007) indicate that horizontal displacements along the affected slope would be less than approximately 100mm. Displacements of this magnitude would classify the land adjacent to the northern slope as Technical Category 2 (TC2) as defined by the MBIE guidelines for assessing liquefaction risk developed filling the Canterbury earthquakes[9].

The calculations to assess flow failure risk indicate that the northern slope has a factor of safety >1.0 in these conditions and the slope is therefore unlikely to be affected by post-earthquake flow failure.

6.4 Load Induced Settlement

6.4.1 General

Load-induced settlements occur in soils that are subject to static loading (e.g. by placing fill and/or building loads) where the magnitude of settlement is governed by the soil stiffness and the applied pressure.

Preliminary analyses have been undertaken to assess the likely magnitudes of settlement on account of future residential building loads. As the magnitude of earthworks is currently unknown, any potential future fill induced settlements have not been assessed.

6.4.2 Preliminary Settlement Analyses for Residential Buildings

Analyses have been undertaken to quantify the predicted settlements on account of future building loads, using the geotechnical software package CPeT-IT. This program calculates the change in vertical stress due to the loading according to Boussinesq, with a 1-D constrained soil modulus parameter estimated from CPT data.

The results of our analyses are presented in ***Table 4***, below.

Table 4: Preliminary Static Settlement Magnitudes for Anticipated Floor Loads

CPT No.	Widespread Load (kPa) – To represent a single level dwelling	Peat present? (Y/N)	Primary Settlement (mm)
01	10	Y	60
02		Y	40
03		Y	80
04		Transition	35
05		N	12
06		Y	10
07		N	20
08		N	15
10		Y	25
11		N	10
12		N	22

[9] MBIE, 'Canterbury Residential Technical Guidance – Part D: Subdivisions', December 2012.

The results of the preliminary settlement analyses suggest that areas of the site which are underlain by peat soils are likely to experience load induced settlements in excess of the NZ Building Code limits of 1 in 240 (approximately 25mm over a 6-metre length of building).

Additionally, the peat soils are likely to experience significant secondary (creep) settlements, in excess of the reported primary settlement magnitudes in Table 4 above, which are likely to continue for a number of years following construction.

Predicted static settlements due to typical residential building loads on parts of the site not underlain by peat are expected to be within the limits recommended in the NZ Building Code.

Recommendations for remediation of the areas of the site which are underlain by peat soils are provided in Section 7.3.

7 GEOTECHNICAL RECOMMENDATIONS

7.1 Seismic Site Subsoil Category

The geological units encountered beneath the site comprise soil strength materials, which with respect to the seismic site subsoil category defined in Section 3.1.3 of NZS1170.5, is defined as having an unconfined compressive strength (UCS) < 1MPa.

Based on those ground conditions and the results, the seismic site subsoil category is assessed as being Class D (deep soil site) in accordance with NZS1170.5.

7.2 Liquefaction Mitigation

Under the ULS event, the NZ Building Code requires that dwellings do not collapse and therefore preserve life but do not need to remain serviceable. The predicted free-field liquefaction induced settlements under the ULS seismic event are in the order of 45 to 110mm over a 10m depth, with the larger settlements generally occurring beneath more low-lying parts of the site where the non-liquefiable surface crust is less thick.

Reference is made to Ishihara (1985)[10] with respect to assessing the contribution of a non-liquefiable crust and the risk of surface manifestation. This assessment suggests a minimum 6m thick non-liquefiable crust may be required to prevent liquefaction induced ground damage for a ULS seismic event and an Importance Level 2 (IL2) building at this site. Given that the existing crust thickness ranged from 3.5m to 7m, there is the potential for surface manifestation (e.g. sand boils) to occur during a ULS seismic event which can result in further exaggerated differential settlements and affect the ultimate bearing capacity beneath shallow footings.

Therefore, based on the index liquefaction settlement values presented in Table 3 and the marginal non-liquefiable crust present at the site, we recommend adopting an MBIE TC2/TC3 hybrid foundation solution as outlined in Section 15.4.6 of the MBIE Part C Canterbury Rebuild Technical Guidance[11] to address the liquefaction hazard for the proposed development.

Further detail on this has been detailed in Section 7.2.1, below.

7.2.1 Enhanced TC2/TC3 Raft

A TC2/TC3 hybrid solution involves the construction of an 800mm thick, geogrid reinforced granular fill raft supporting an engineer designed or proprietary TC2 raft foundation.

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[10] Ishihara, K., (1985) "Stability of Natural Deposits During Earthquakes," Proc. Of the Eleventh International Conference on Soil Mechanics and Foundation Engineering, San Francisco, 12- 16th August 1985, Vol. 1, Theme Lectures Conferences, pp321- 376.

[11] Repairing and Rebuilding Houses Affected by the Canterbury Earthquake: TC3 Technical Guidance , Part C, MBIE (2015).

Prior to the construction of the gravel raft, ground improvement will be required in some areas of the site (such as to undercut loose near surface sands or remediate peat soils). This has been detailed in Section 7.3 and 7.4.2 below.

7.3 Ground Improvement for Static Settlement

To minimise post construction static ground settlements on account of the presence of compressible peat, several options have been proposed, including the following:

- Locating buildings and infrastructure on the more elevated plateau areas of the site which are unlikely to experience excessive static settlements under typical residential building loads. Less critical infrastructure such as stormwater ponds may be located within the swales and peat areas, subject to appropriate engineering design;
- Construct a temporary pre-load embankment over and above design ground levels where peat is present to reduce post construction total and differential settlements;
- Remove (excavated) the peat and replace with engineered fill. This would likely require significant dewatering to achieve; and
- Pile building foundations to intercept the dense sands at depths of between approximately 14m and 20m below ground level, which are shown not to be susceptible to liquefaction.

7.4 Earthworks

7.4.1 General

All earthwork activities must be carried out in general accordance with the requirements of NZS 4431[12] and the requirements of the Western Bay of Plenty District Council Development Code under the guidance of a Category 1 Geo-professional.

High level earthworks recommendations have been provided in Sections 7.4.2 to 7.4.4 below.

7.4.2 Subgrade Preparation

Preparation of the stiff and loose/medium dense subgrade beneath the proposed fill areas should comprise stripping of all vegetation, topsoil, any pre-existing fill materials or loose sands/weak silts.

Where any particularly weak materials are encountered (such as the upper 1m of loose sands), they should be undercut and reworked prior to placing engineered fill.

As discussed in Section 7.3, the peat soils will require specific ground improvement/remediation.

7.4.3 Cut and Fill Batters

To reduce the effects of ongoing minor slumping or scour, self-supporting long term cut and fill batters in the friable volcanic ashes should be formed to no steeper than 1(V):2.5(H).

All formed batters should be covered by topsoil and then grassed as soon as practicable following construction to reduce the effects of surficial scour or alternatively supported to full height by specifically designed retaining walls.

7.4.4 Quality Control

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

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

Most of the on-site soils material, excluding the peat, should be suitable for reuse as Engineer Certified Fill. Soil textures and moisture contents will however vary widely and careful management, conditioning and compaction control will be required.

For granular (sand and gravel) fill materials, testing following compaction should be principally in terms of the maximum dry density within the appropriate water content range, with accompanying Dynamic Cone Penetrometers (DCPs).

Where silts and clays are used as filling, alternative test criteria using vane shear strength and air voids should be used.

7.4.5 Service Trenches

We anticipate that service trenches could be several metres deep. Based on the field investigation results, the soils to be encountered within this depth are likely to comprise stiff silts and/or loose to medium dense sands across the terrace but with fresh and fibrous peat deposits present within the swale areas.

Provided any organic or otherwise unsuitable material is cut to waste, the natural soils excavated for the trench may be used as backfill. The backfill should be compacted in thin lifts to a strength and consistency equal to the surrounding ground.

7.5 Stormwater Disposal

The depth of groundwater beneath the more elevated parts of the site is such that disposal of stormwater to ground soakage could be considered for building sites on the main plateau. Shallow groundwater below the more low-lying areas and the swales may preclude the use of ground soakage in these areas.

Stormwater pond(s) and/or raingardens would also be a suitable method of stormwater disposal for flows from future roofs and hardstand areas. An appropriate location for permanent ponds would be within the swales which cut through the site.

Stormwater disposal options should be further assessed at the resource consent stage for the development.

7.6 Wastewater Disposal

Based on discussions with the project planners, MPAD, it is understood that the strip of land immediately to the north of the site (depicted on ***Drawing 01***) is being considered as a potential wastewater disposal field.

Although this has not been assessed in detail, it is anticipated that for wastewater disposal in this zone, a raft of fill would be required to separate the standing groundwater table from the disposal field. There would also need to be an acceptance that differential settlement magnitudes in this area may be significant, particularly on account of fill placement. The effects of this settlement on the disposal system may be reduced by pre-loading the filled disposal field and/or by using a pressure compensating drip line irrigation network.

Further geotechnical input would be required during design of the system (by others), to confirm suitability.

7.7 Roading and Services

The main roads are expected to extend across the terrace. Following earthworks and subgrade trimming, a CBR of between 3 and 5 is anticipated for the natural subsoils, whilst for Engineer Certified Fill areas a CBR of 7 may be adopted.

We recommend that a programme of penetration resistance testing is carried out when the roads and pavement areas are being formed to their final levels to confirm actual CBR values.

8 FURTHER WORK

Additional geotechnical inputs to support the design and construction of a residential development at this site may include, but not be limited to:

- Investigations including additional test pits, hand auger boreholes, machine boreholes and/or Cone Penetrometer Tests (CPTs) to refine ground model and further assess the extent and depth of peat soils;
- Additional analyses for the proposed development, including liquefaction, static settlement and bearing capacity, to confirm the preliminary recommendations provided in this report;
- Preparation of geotechnical reports to support the resource consent application and detailed design process; and
- Earthworks and construction observations to confirm fill compaction and finished landform.

9 CONCLUSION

Provided the recommendations given in this report are followed and subject to appropriate assessment during the resource consent process, the property is considered geotechnically suitable for rezoning and residential development.

Elevated parts of the site would be classified as Technical Category TC2 or TC3 due to potential for liquefaction induced settlement as defined by the MBIE earthquake design guidelines developed for the Christchurch rebuild. Ground adjacent to the slope along the site's northern boundary may also be classified as TC2 due to the potential for lateral spreading in this area.

Residential buildings on this site would therefore require specifically designed foundations. The hybrid TC2/TC3 fill/raft foundation solutions developed in Christchurch would be appropriate for this site.

USE OF THIS REPORT

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

Your geotechnical report is based on project specific criteria

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

Subsurface conditions can change

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

Interpretation of factual data

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

Your report's recommendations require confirmation during construction

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

Interpretation by other design professionals

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

Appendix A: Drawings

LEGEND:

TP01	TEST PIT LOCATION		WASTEWATER DISPOSAL ZONE/ FUTURE DEVELOPMENT AREA
CPT01	CPT/sCPT LOCATION		APPROXIMATE EXTENT OF PEAT
	SITE BOUNDARY	[1.2m]	APPROXIMATE THICKNESS OF PEAT

NOTES:

1. BASE PLAN ADAPTED FROM WESTERN BAY OF PLENTY DISTRICT COUNCIL MAPI.
2. CONTOURS ARE IN 1.0m INTERVALS AND ARE IN TERMS OF MOTURIKI DATUM.
3. TEST LOCATIONS ARE APPROXIMATE ONLY.

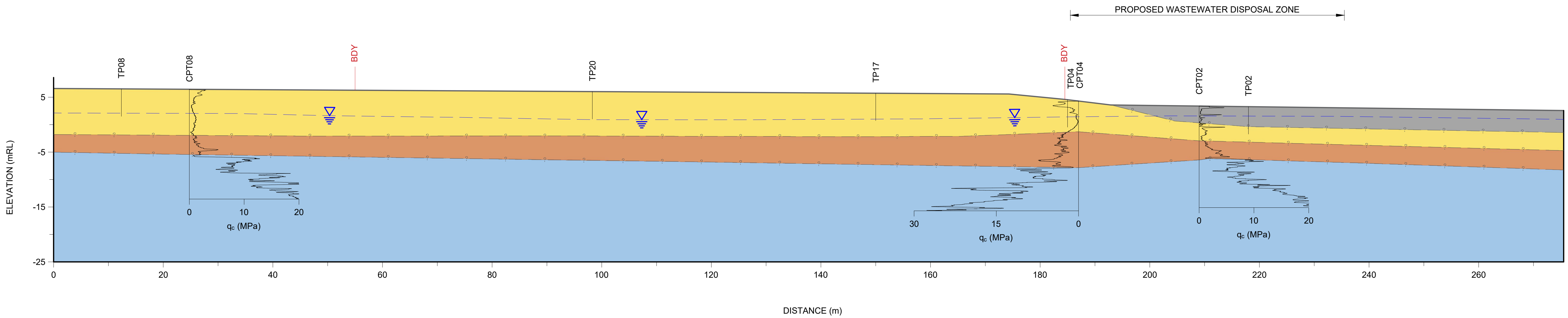
0 30 60 90 120 150 m

1:3000

CMW Geosciences

CLIENT: KEVIN AND ANDREA MARSH	DRAWN: HR	PROJECT No: TGA2021-0096	
PROJECT: PENCARROW ESTATE, 1491 ARAWA ROAD, PONGAKAWA	CHECKED: LGL	DRAWING: 01	
	REVISION: 0	SCALE: 1:3000	
TITLE: GEOTECHNICAL INVESTIGATION PLAN	DATE: 28/01/2022	SHEET: A3	

C:\USERS\HYSHAMRASHEED\CMW GEOSCIENCES PTY LTD\CMW CONNECT – TGA2021-0096 PENCARROW ESTATE, PONGAKAWA\DRAWINGS\TGA2021-0096 SITE PLAN + SECTION.DWG



LEGEND:

- DESIGN GROUND SURFACE
- EXISTING GROUND SURFACE
- —?— APPROXIMATE GEOLOGICAL BOUNDARY
- APPROXIMATE GROUNDWATER LEVEL
- PEAT
- PLEISTOCENE ALLUVIUM (INTERBEDDED SILTS/SANDS)
- PLEISTOCENE ALLUVIUM (MEDIUM DENSE SANDS)
- PLEISTOCENE ALLUVIUM (DENSE SANDS)

NOTES:

1. TEST LOCATIONS ARE APPROXIMATE ONLY.

1:750 — 0 7.5 15 22.5 30 37.5 m

CMW Geosciences

CLIENT: KEVIN AND ANDREA MARSH		DRAWN: HR	PROJECT No: TGA2021-0096
PROJECT: PENCARROW ESTATE, 1491 ARAWA ROAD, PONGAKAWA		CHECKED: LGL	DRAWING: 02
		REVISION: 0	SCALE: 1:750
TITLE: GEOLOGICAL CROSS-SECTION A		DATE: 28/01/2022	SHEET: A3

C:\USERS\HYSHAMRASHEED\CMW GEOSCIENCES PTY LTD\CMW CONNECT – TGA2021-0096 PENCARROW ESTATE, PONGAKAWA\DRAWINGS\TGA2021-0096 SITE PLAN + SECTION.DWG

Appendix B: MPAD Development Plans

Pencarrow Estate

Constraints Map

Drawn - PF
Review - RC
Scale - 1:4000 @ A3
Drawing # - Pencarrow Constraints Map

MOMENTUM
PLANNING AND DESIGN

Appendix C: Investigation Results

CMW Geosciences – SOIL (Field Logging Guide)

SEQUENCE OF TERMS:
Fine: Soil Symbol – Soil Type – Colour – Structure – (Consistency) – (Moisture) – Bedding – Plasticity – Sensitivity – Additional Comments – Origin/Geological Unit
Coarse: Soil Symbol – Soil Type – Colour – Structure – Grading – Particle shape – (Relative Density) – (Moisture) – Bedding – Additional Comments – Origin/Geological Unit

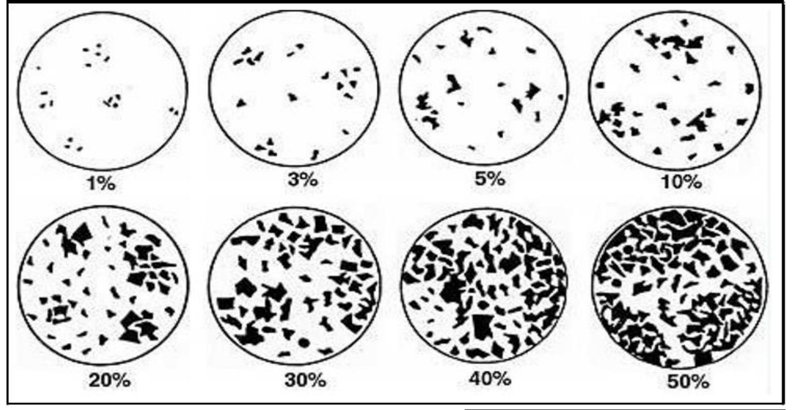
BEHAVIOURAL SOIL CLASSIFICATION SYSTEM

Major Divisions (behaviour based logging)			Soil Symbol	Soil Name
Coarse grained soils more than 65%>0.06mm	Gravel >50% of coarse fraction >2mm	Clean gravel <5% smaller 0.075mm	GW	Well graded gravel, fine to coarse gravel
			GP	Poorly graded gravel
		Gravel with >12% fines	GM	Silty gravel
			GC	Clayey gravel
	Sand ≥50% of coarse fraction <2mm	Clean sand	SW	Well-graded sand, fine to coarse sand
			SP	Poorly graded sand
		Sand with >12% fines	SM	Silty sand
			SC	Clayey sand
Fine grained soils 35% or more <0.06mm	Exhibits dilatant behaviour	inorganic	ML	Silt
			MH	Silt of high plasticity
		organic	OL	Organic silt
	No dilatant behaviour	inorganic	CL	Clay of low plasticity
			CH	Clay of high plasticity
		organic	OH	Organic clay
Highly Organic Soils			Pt	Peat

PROPORTIONAL TERMS DEFINITION

Fraction	Term	% of Soil Mass	Example
Major	(…) [UPPER CASE]	≥50 [major constituents]	GRAVEL
Subordinate	(…) [lower case]	20 – 50	Sandy
Minor	with some…	12 – 20	with some sand
	with minor…	5 – 12	with minor sand
	with trace of (or slightly)	< 5	with trace of sand (slightly sandy)

VISUAL PROPORTION PERCENTAGE



GRAIN SIZE CRITERIA

TYPE	COARSE								FINE		ORGANIC
	Boulders	Cobbles	Gravel coarse	Gravel medium	Gravel fine	Sand coarse	Sand medium	Sand fine	Silt	Clay	Organic Soil
Size Range (mm)	200	60	20	6	2	0.6	0.2	0.06	0.002		
Graphic Symbol											

ADDITIONAL GRAPHIC LOG SYMBOLS

Term	Symbol
Topsoil	
Fill	
Bitumen	
Concrete	

ORGANIC SOILS / DESCRIPTORS

Term	Description
Topsoil	Surficial organic soil layer that may contain living matter. However, topsoil may occur at greater depth, having been buried by geological processes or man-made fill, and should be termed a buried topsoil.
Organic clay, silt or sand	Contains finely divided organic matter; may have distinctive smell; may stain; may oxidize rapidly. Describe as for inorganic soils.
Peat	Consists predominantly of plant remains. **Firm:** Fibres already compressed together **Spongy:** Very compressible and open structure **Plastic:** Can be moulded in hand and smears in fingers **Fibrous:** Plant remains recognisable and retain some strength **Amorphous:** No recognisable plant remains
Rootlets	Fine, partly decomposed roots, normally found in the upper part of a soil profile or in a redeposited soil (e.g. colluvium or fill)
Carbonaceous	Discrete particles of hardened (carbonised) plant material.

SHADE AND COLOUR

1	2	3
light dark mottled streaked	pinkish reddish yellowish brownish greenish bluish greyish	pink red orange yellow brown green blue white grey black

SOIL STRUCTURE

Term	Description
Homogeneous	The total lack of visible bedding and the same colour and appearance throughout
Bedded	The presence of layers
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Polished	Fracture planes are polished or glossy
Slickensided	Fracture planes are striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensoidal	Discontinuous pockets of a soil within a different soil mass

GRADING (GRAVELS & SANDS)

Term	Description	
Well Graded	Good representation of all particle size ranges from largest to smallest	
Poorly Graded	Limited representation of grain sizes – further divided into:	
	Uniformly graded	Most particles about the same size
	Gap graded	Absence of one or more intermediate sizes

ROUNDING/PARTICLE SHAPE

Rounded	Subrounded	Subangular	Angular

CONSISTENCY TERMS FOR FINE SOILS

Descriptive term	Undrained Shear Strength (kPa)	Diagnostic Features	Abbreviation
Very Soft	<12	Easily exudes between fingers when squeezed	VS
Soft	12-25	Easily indented by fingers	S
Firm	25-50	Indented by strong finger pressure and can be indented by thumb pressure	F
Stiff	50-100	Cannot be indented by thumb pressure	St
Very Stiff	100-200	Can be indented by thumb nail	VSt
Hard	200-500	Difficult to indent by thumb nail	H

DENSITY INDEX (RELATIVE DENSITY) TERMS FOR COARSE SOILS

Descriptive term	Density Index (RD)	SPT "N" value (blows/300mm)	Dynamic Cone (blows/100mm)	Abbreviation
Very Dense	> 85	> 50	> 17	VD
Dense	65 - 85	30 - 50	7 - 17	D
Medium dense	35 - 65	10 - 30	3 - 7	MD
Loose	15 - 35	4 - 10	1 - 3	L
Very loose	< 15	< 4	0 - 2	VL

Note:
- No correlation is implied between Standard Penetration Test (SPT) and Dynamic Cone Penetrometer (Scala) Test values.
- SPT "N" values are uncorrected.

MOISTURE CONDITION

Condition	Description	Coarse Soils	Fine Soils	Abbreviation
Dry	Looks and feels dry	Runs freely through hands	Hard, powdery or friable	D
Moist	Feels cool, darkened in colour	Tends to cohere	Weakened by moisture, but no free water on hands when remoulding	M
Wet			Weakened by moisture, free water forms on hands when handling	W
Saturated	Feels cool, darkened in colour and free water is present on the sample			S

BEDDING THICKNESS (Sedimentary)

Term	Bed Thickness
Thinly laminated	< 2mm
Laminated	2mm - 6mm
Very thin	6mm - 20mm
Thin	20mm - 60mm
Moderately thin	60mm - 200mm
Moderately thick	0.2m - 0.6m
Thick	0.6m - 2m
Very thick	> 2m

BEDDING INCLINATION

Term	Inclination (from horizontal)
Sub-horizontal	0º - 5º
Gently inclined	6º - 15º
Moderately inclined	16º - 30º
Steeply inclined	31º - 60º
Very steeply inclined	61º - 80º
Sub vertical	81º - 90º

SENSITIVITY OF SOIL

Descriptive Term	Shear Strength Ratio = $\frac{undisturbed}{remoulded}$
Insensitive, normal	< 2
Moderately sensitive	2 – 4
Sensitive	4 – 8
Extra sensitive	8 – 16
Quick	> 16

PLASTICITY (CLAYS & SILTS)

Term	Description
High plasticity	Can be moulded or deformed over a wide range of moisture contents without cracking or showing any tendency to volume change
Low plasticity	When moulded can be crumbled in the fingers; may show quick or dilatant behaviour

TEST PIT LOG - TP01

Client: Kevin & Andrea Marsh
Project: Pencarrow Estate, 1491 Arawa Road, Pongakawa
Site Location: Pongakawa
Project No.: TGA2021-0096
Date: 17/01/2022
Test Pit Location: Refer to Drawing 01 | Logged by: BM | Checked by: LGL | Scale: 1:25 | Sheet 1 of 1

Position: 336457.1mE; 800518.3mN | Projection: BOP2000 | Datum: Moturiki | Pit Dimensions: m by m | Survey Source: pLog tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15 20	Structure & Other Observations Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
						OL: Organic SILT: with trace sand; dark brownish black. No plasticity; sand, fine. (Topsoil)				
						SP: Fine SAND: light brownish grey. Uniformly graded. (Alluvial Sands)				
	0.5	Peak = 17kPa Residual = 9kPa				Pt: PEAT: dark brownish black. Low plasticity, insensitive to moderately sensitive, organic, fibrous, tree stumps. (Peat)	M	F		
	1.2	Peak = 43kPa Residual = 17kPa		1						
	1.7	Peak = 43kPa Residual = 17kPa					W			
▼						ML: SILT: light brownish grey mottled orange brown. Low plasticity, moderately sensitive. (Pleistocene Alluvium)	S	St		
	2.1	Peak = 78kPa Residual = 35kPa		2						
						Test pit terminated at 2.20 m				
				3						
				4						
				5						

Termination Reason: Hole collapse
Shear Vane No: 3403 DCP No:
Remarks:

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

TEST PIT LOG - TP02

Client: Kevin & Andrea Marsh
Project: Pencarrow Estate, 1491 Arawa Road, Pongakawa
Site Location: Pongakawa
Project No.: TGA2021-0096
Date: 17/01/2022
Test Pit Location: Refer to Drawing 01 | Logged by: BM | Checked by: LGL | Scale: 1:25 | Sheet 1 of 1
Position: 400761.8mE; 793560.9mN | Projection: BOP2000 | Datum: Moturiki
Pit Dimensions: m by m
Survey Source: pLog tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15 20	Structure & Other Observations (Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks)
					OL: Organic SILT: with trace sand; dark brownish black. No plasticity; sand, fine. (Topsoil)	M			
					SP: Fine SAND : light brownish grey. Uniformly graded. (Alluvial Sands)	M			
	0.7	Peak = 32kPa Residual = 17kPa			Pt: PEAT : dark brownish black. Low plasticity, insensitive to moderately sensitive, organic, fibrous, tree stumps. (Peat)	W	F		
				1					
▼	1.4	Peak = 29kPa Residual = 20kPa							
	2.0	Peak = 58kPa Residual = 26kPa		2		S			
	2.6	Peak = 41kPa Residual = 20kPa							
	3.2	Peak = 32kPa Residual = 14kPa		3					
	3.6	Peak = 89kPa Residual = 30kPa			ML: SILT: with minor clay; light brownish grey mottled orange brown. Low plasticity, moderately sensitive (Pleistocene Alluvium)	S	St		
				4	Test pit terminated at 4.00 m				
				5					

Termination Reason: Target Depth
Shear Vane No: 3403 | DCP No:
Remarks:

TEST PIT LOG - TP03

Client: Kevin & Andrea Marsh
Project: Pencarrow Estate, 1491 Arawa Road, Pongakawa
Site Location: Pongakawa
Project No.: TGA2021-0096
Date: 17/01/2022
Test Pit Location: Refer to Drawing 01 | Logged by: BM | Checked by: LGL | Scale: 1:25 | Sheet 1 of 1
Position: 401042.4mE; 793471.9mN | Projection: BOP2000 | Datum: Moturiki | Pit Dimensions: m by m | Survey Source: pLog tablet

Groundwater	Samples & Insitu Tests – Depth	Samples & Insitu Tests – Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations (Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks)
						OL: Organic SILT: with trace sand; dark brownish black. Non-plastic; sand, fine. (Topsoil)	D to M			
						SP: Fine SAND: light brownish grey. Uniformly graded. (Alluvial Sands)	D to M			
						Pt: PEAT: dark brownish black. Low plasticity, moderately sensitive, organic, fibrous, tree stumps. (Peat)	W	F		
	0.6	Peak = 46kPa Residual = 17kPa					W	F		
				1						
	1.1	Peak = 41kPa Residual = 17kPa					S	F		
▼										
	1.6	Peak = 46kPa Residual = 14kPa					S	F		
	2.0	Peak = 72kPa Residual = 43kPa		2			S	St		
	2.5	Peak = 69kPa Residual = 41kPa					S	St		
						SP: Fine to medium SAND: brownish grey. Poorly graded, interbedded with sandy SILT. (Pleistocene Alluvium)	S	L to MD	2	
				3					3	
									2	
									2	
									3	
						Test pit terminated at 3.40 m				
				4						
				5						

Termination Reason: Hole collapse
Shear Vane No: 3403 DCP No: 14
Remarks:

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

TEST PIT LOG - TP04

Client: Kevin & Andrea Marsh
Project: Pencarrow Estate, 1491 Arawa Road, Pongakawa
Site Location: Pongakawa
Project No.: TGA2021-0096
Date: 17/01/2022
Test Pit Location: Refer to Drawing 01 | Logged by: BM | Checked by: LGL | Scale: 1:25 | Sheet 1 of 1
Position: 400851.8mE; 793452.6mN | Projection: BOP2000 | Datum: Moturiki | Pit Dimensions: m by m | Survey Source: pLog tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations (Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks)
					OL: Organic SILT: with trace sand; dark brownish black. Non-plastic; sand, fine. (Topsoil)	D to M			
					SP: Fine SAND: light brownish grey. Uniformly graded. (Pleistocene Alluvium)				
					ML: Silty fine to medium SAND : light greyish yellow. Poorly graded. (Pleistocene Alluvium)	M			
	0.8	Peak = 148kPa Residual = 41kPa		1	ML: Sandy SILT: greyish brown mottled orange brown. Low plasticity, moderately sensitive to sensitive; sand, fine to coarse. (Pleistocene Alluvium)	M	VSt		
	1.3	Peak = 156kPa Residual = 35kPa							
	2.5	Peak = 75kPa Residual = 29kPa		2	MH: Clayey SILT: with minor sand; light grey mottled orange brown. Low plasticity, moderately sensitive to sensitive; sand, fine. (Pleistocene Alluvium)	M	St to VSt		
	3.0	Peak = 119kPa Residual = 29kPa		3					
					SM: Silty Fine to coarse SAND: with some gravel and minor clay; light brownish yellow. Well graded; gravel, fine, weathered. (Pleistocene Alluvium)	M	L to MD	2, 2, 3, 3, 2	
▼	3.8	Peak = 75kPa Residual = 14kPa			ML: SILT: grey. Low plasticity, sensitive. (Pleistocene Alluvium)	W to S	St		
				4	Test pit terminated at 4.00 m				
				5					

Termination Reason: Target Depth
Shear Vane No: 3403 DCP No: 14
Remarks:

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

TEST PIT LOG - TP05

Client: Kevin & Andrea Marsh
Project: Pencarrow Estate, 1491 Arawa Road, Pongakawa
Site Location: Pongakawa
Project No.: TGA2021-0096
Date: 18/01/2022
Test Pit Location: Refer to Drawing 01 | Logged by: BM | Checked by: LGL | Scale: 1:25 | Sheet 1 of 1

Position: 400626.1mE; 793553.3mN | Projection: BOP2000 | Datum: Moturiki
Pit Dimensions: m by m
Survey Source: pLog tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
					OL: Organic SILT: with trace sand; dark brownish black. Non-plastic; sand, fine. (Topsoil)				
					SM: Silty Fine to medium SAND: light brownish yellow. Poorly graded. (Pleistocene Alluvium)		L	2, 2, 2, 2, 1, 2, 1	
					ML: Sandy SILT: light brownish grey mottled orange brown. Low plasticity, moderately sensitive; sand fine to medium. (Pleistocene Alluvium)	M	VSt to St		
	1.0	Peak = 75kPa Residual = 20kPa		1					
	2.0	Peak = 119kPa Residual = 20kPa		2					
					... *at 2.20m, becoming clayey SILT*				
	2.5	Peak = 87kPa Residual = 32kPa							
	3.0	Peak = 84kPa Residual = 32kPa		3					
					SM: Silty Fine to coarse SAND: with minor gravel and clay; light yellowish white. Well graded; gravel, fine to medium, weathered. (Pleistocene Alluvium)				
				4	Test pit terminated at 4.00 m				
				5					

Termination Reason: Target Depth
Shear Vane No: 3403 | DCP No: 14
Remarks:

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

TEST PIT LOG - TP06

Client: Kevin & Andrea Marsh
Project: Pencarrow Estate, 1491 Arawa Road, Pongakawa
Site Location: Pongakawa
Project No.: TGA2021-0096
Date: 17/01/2022
Test Pit Location: Refer to Drawing 01 | Logged by: BM | Checked by: LGL | Scale: 1:25 | Sheet 1 of 1

Position: 400935.7mE; 793429.2mN | Projection: BOP2000 | Datum: Moturiki | Pit Dimensions: m by m | Survey Source: pLog tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15 20	Structure & Other Observations Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
						OL: Organic SILT: with trace sand; dark brownish black. Non-plastic; sand, fine. (Topsoil)	M			
						SP: Fine SAND: light brownish grey. Poorly graded. (Alluvial Sands)		LP		
						Pt: PEAT: dark brownish black. Low plasticity, organic, fibrous, tree stumps. (Peat)		S to F		
						ML: SILT: orange. Low plasticity, moderately sensitive. (Pleistocene Alluvium)		VSt to St		
	0.7	Peak = 46kPa Residual = 17kPa								
				1						
	1.5	Peak = 69kPa Residual = 35kPa				MH: Clayey SILT: with minor sand; light grey. Low plasticity, moderately sensitive; sand, fine to medium. (Pleistocene Alluvium)				
	2.0	Peak = 64kPa Residual = 29kPa		2						
	2.5	Peak = 107kPa Residual = 35kPa								
	3.0	Peak = 116kPa Residual = 32kPa		3						
				4		Test pit terminated at 4.00 m				
				5						

Termination Reason: Target Depth
Shear Vane No: 3403 DCP No:
Remarks:

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

TEST PIT LOG - TP07

Client: Kevin & Andrea Marsh
Project: Pencarrow Estate, 1491 Arawa Road, Pongakawa
Site Location: Pongakawa
Project No.: TGA2021-0096
Date: 18/01/2022
Test Pit Location: Refer to Drawing 01 | Logged by: BM | Checked by: LGL | Scale: 1:25 | Sheet 1 of 1

Position: 400623.5mE; 793505.2mN | Projection: BOP2000 | Datum: Moturiki
Pit Dimensions: m by m
Survey Source: pLog tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit); Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15 20	Structure & Other Observations (Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks)
						OL: Organic SILT: with trace sand; dark brownish black. Non-plastic; sand, fine. (Topsoil)				
						SP: Fine SAND: light brownish grey. Poorly graded. (Pleistocene Alluvium)				
	0.5	Peak = 61kPa Residual = 17kPa				ML: SILT: with some sand; orange. Low plasticity; sand, fine to medium. (Pleistocene Alluvium)				
	1.0	Peak = 75kPa Residual = 26kPa		1		MH: Clayey SILT: with minor sand; light grey. Low plasticity, moderately sensitive. (Pleistocene Alluvium)				
	1.5	Peak = 133kPa Residual = 41kPa					M			
	2.0	Peak = 90kPa Residual = 32kPa		2				VSt to St		
	2.5	Peak = 98kPa Residual = 26kPa								
▼	3.0	Peak = 133kPa Residual = 41kPa		3						
	3.5	Peak = 113kPa Residual = 26kPa					W to S			
				4		Test pit terminated at 4.00 m				
				5						

Termination Reason: Target Depth
Shear Vane No: 3403 DCP No:
Remarks:

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

TEST PIT LOG - TP08

Client: Kevin & Andrea Marsh
Project: Pencarrow Estate, 1491 Arawa Road, Pongakawa
Site Location: Pongakawa
Project No.: TGA2021-0096
Date: 17/01/2022
Test Pit Location: Refer to Drawing 01 | Logged by: BM | Checked by: LGL | Scale: 1:25 | Sheet 1 of 1
Position: 400783.9mE; 793361.7mN | Projection: BOP2000 | Datum: Moturiki | Pit Dimensions: m by m | Survey Source: pLog tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15 20	Structure & Other Observations (Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks)
						OL: Organic SILT: brown. No plasticity. (Topsoil)	M			
						SP: Fine SAND: light brownish grey. Poorly graded. (Pleistocene Alluvium)	M			
	0.5	Peak = 64kPa Residual = 23kPa				ML: SILT: with some sand; orange. Low plasticity, insensitive; sand, fine to medium. (Pleistocene Alluvium)	M	St		
	1.0	Peak = 104kPa Residual = 29kPa		1		MH: Clayey SILT: with minor sand; light grey streaked orange brown. Low plasticity, moderately sensitive; sand, medium. (Pleistocene Alluvium)	M	St to VSt		
	1.5	Peak = 142kPa Residual = 38kPa								
	2.0	Peak = 90kPa Residual = 26kPa		2						
	2.5	Peak = 107kPa Residual = 29kPa								
	3.0	Peak = 142kPa Residual = 41kPa		3						
	3.5	Peak = 122kPa Residual = 29kPa								
						SM: Silty Fine to coarse SAND: with some gravel and minor clay; light brownish yellow; gravel, fine, weathered. (Pleistocene Alluvium)	M			
				4		Test pit terminated at 4.00 m				
				5						

Termination Reason: Target Depth
Shear Vane No: 3403 | DCP No:
Remarks:

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

TEST PIT LOG - TP10

Client: Kevin & Andrea Marsh
Project: Pencarrow Estate, 1491 Arawa Road, Pongakawa
Site Location: Pongakawa
Project No.: TGA2021-0096
Date: 17/01/2022
Test Pit Location: Refer to Drawing 01 | Logged by: BM | Checked by: LGL | Scale: 1:25 | Sheet 1 of 1
Position: 400783.5mE; 793359.2mN | Projection: BOP2000 | Datum: Moturiki
Pit Dimensions: m by m
Survey Source: pLog tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15 20	Structure & Other Observations Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks
						OL: Organic SILT: dark brownish black. Non-plastic; sand, fine. (Topsoil)	M			
						SP: Fine SAND: light brownish grey. poorly graded. (Alluvial Sands)	M	LP		
	0.8	Peak = 43kPa Residual = 20kPa		1		Pt: PEAT: dark brownish black. Low plasticity, , moderately sensitive, organic, fibrous, tree stumps. (Peat)	W	F		
	1.5	Peak = 46kPa Residual = 17kPa					W to S	F		
	2.0	Peak = 38kPa Residual = 17kPa		2			W to S	F		
	2.5	Peak = 43kPa Residual = 20kPa		3			W to S	F		
	3.6	Peak = 104kPa Residual = 29kPa				ML: SILT: light brownish grey. Low plasticity. (Pleistocene Alluvium)	W to S	VSt		
				4		Test pit terminated at 4.00 m				
				5						

Termination Reason: Target epth
Shear Vane No: 3403 | DCP No:
Remarks:

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

TEST PIT LOG - TP11

Client: Kevin & Andrea Marsh
Project: Pencarrow Estate, 1491 Arawa Road, Pongakawa
Site Location: Pongakawa
Project No.: TGA2021-0096
Date: 17/01/2022
Test Pit Location: Refer to Drawing 01 | Logged by: BM | Checked by: LGL | Scale: 1:25 | Sheet 1 of 1

Position: 400673.8mE; 793198.0mN | Projection: BOP2000 | Datum: Moturiki | Pit Dimensions: m by m | Survey Source: pLog tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15 20	Structure & Other Observations (Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks)
						OL: Organic SILT: with trace sand; dark brownish black. Non-plastic; sand, fine. (Topsoil)	M			
	0.5	Peak = 77kPa Residual = 30kPa				ML: SILT: with some sand; orange. Low plasticity, moderately sensitive; sand, fine to medium. (Pleistocene Alluvium)	M	St		
	1.0	Peak = 122kPa Residual = 30kPa		1		MH: Clayey SILT: with minor sand; light grey streaked orange brown. Low plasticity, moderately sensitive; sand, fine to medium. (Pleistocene Alluvium)	M	VSt		
	1.5	Peak = 107kPa Residual = 27kPa								
	2.0	Peak = 119kPa Residual = 30kPa		2						
	2.5	Peak = 137kPa Residual = 45kPa								
	3.0	Peak = 131kPa Residual = 42kPa		3						
	3.5	Peak = 140kPa Residual = 45kPa								
						SM: Silty Fine to coarse SAND: with some gravel and minor clay; light brownish yellow. Well graded, weathered; gravel, fine. (Pleistocene Alluvium)	M to W			
				4		Test pit terminated at 4.00 m				
				5						

Termination Reason: Target Depth

Shear Vane No: 0830 | DCP No:

Remarks:

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

TEST PIT LOG - TP12

Client: Kevin & Andrea Marsh
Project: Pencarrow Estate, 1491 Arawa Road, Pongakawa
Site Location: Pongakawa
Project No.: TGA2021-0096
Date: 17/01/2022
Test Pit Location: Refer to Drawing 01 | Logged by: BM | Checked by: LGL | Scale: 1:25 | Sheet 1 of 1
Position: 400673.7mE; 793197.0mN | Projection: BOP2000 | Datum: Moturiki | Pit Dimensions: m by m | Survey Source: pLog tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15 20	Structure & Other Observations (Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks)
						OL: Organic SILT: with trace sand; dark brownish black. Non-plastic; sand, fine. (Topsoil)				
						SP: Fine SAND : light brownish grey. Uniformly graded. (Pleistocene Alluvium)				
	0.5	Peak = 61kPa Residual = 26kPa				ML: Sandy SILT: orange. Low plasticity, moderately sensitive; sand fine to coarse. (Pleistocene Alluvium)		St		
	1.0	Peak = 119kPa Residual = 26kPa		1						
	1.5	Peak = 78kPa Residual = 29kPa				MH: Clayey SILT: with minor sand; light grey streaked orange brown. Low plasticity, moderately sensitive to sensitive; sand, medium. (Pleistocene Alluvium)		VSt to St		
	2.0	Peak = 90kPa Residual = 26kPa		2			M			
	2.5	Peak = 104kPa Residual = 29kPa								
	3.0	Peak = 116kPa Residual = 29kPa		3				VSt		
	3.5	Peak = 130kPa Residual = 35kPa								
				4		Test pit terminated at 4.00 m				
				5						

Termination Reason: Target Depth
Shear Vane No: 3403 | DCP No:
Remarks:

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

TEST PIT LOG - TP13

Client: Kevin & Andrea Marsh
Project: Pencarrow Estate, 1491 Arawa Road, Pongakawa
Site Location: Pongakawa
Project No.: TGA2021-0096
Date: 17/01/2022
Test Pit Location: Refer to Drawing 01 | Logged by: BM | Checked by: LGL | Scale: 1:25 | Sheet 1 of 1
Position: | Projection: BOP2000 | Datum: Moturiki | Pit Dimensions: m by m | Survey Source: pLog tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15 20	Structure & Other Observations (Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks)
					OL: Organic SILT: with trace sand; dark brownish black. Non-plastic; sand, fine. (Topsoil)	M			
					SP: Fine SAND: light brownish grey. Uniformly graded. (Alluvial Sands)	M			
	0.7	Peak = 41kPa Residual = 17kPa			Pt: PEAT: dark brownish black. Low plasticity, moderately sensitive, organic, fibrous, tree stumps. (Peat)	W	F		
	1.2	Peak = 38kPa Residual = 14kPa		1		W	F		
▼	1.7	Peak = 43kPa Residual = 20kPa				W to S	F		
	2.4	Peak = 43kPa Residual = 23kPa		2		W to S	F		
	2.9	Peak = 32kPa Residual = 14kPa		3		W to S	F		
	3.5	Peak = 75kPa Residual = 29kPa			ML: Sandy SILT: greyish brown streaked orange brown. Low plasticity, moderately sensitive; sand, fine to coarse. (Pleistocene Alluvium)	W to S	St		
				4	Test pit terminated at 4.00 m				
				5					

Termination Reason: Target Depth
Shear Vane No: 3403 | DCP No:
Remarks:

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

TEST PIT LOG - TP14

Client: Kevin & Andrea Marsh
Project: Pencarrow Estate, 1491 Arawa Road, Pongakawa
Site Location: Pongakawa
Project No.: TGA2021-0096
Date: 17/01/2022
Test Pit Location: Refer to Drawing 01 | Logged by: BM | Checked by: LGL | Scale: 1:25 | Sheet 1 of 1
Position: 400974.6mE; 793492.0mN | Projection: BOP2000 | Datum: Moturiki
Pit Dimensions: m by m
Survey Source: pLog tablet

Depth (m)	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)
0.0 – 0.2	OL: Organic SILT: dark brownish black. Non-plastic; sand, fine. (Topsoil)	D to M		
0.2 – 0.4	SP: Fine SAND: light brownish grey. Poorly graded. (Alluvial Sands)	D to M		
0.4 – 3.4	Pt: PEAT : dark brownish black. Low plasticity; moderately sensitive, organic, fibrous, tree stumps. (Peat)	M to W (to 1.5); W to S	F	
3.4 – 4.0	SP: Fine to medium SAND: brownish grey. Poorly graded, interbedded with sandy SILT. (Pleistocene Alluvium)	W to S	L to MD	2, 3, 1, 1
4.00	Test pit terminated at 4.00 m			

Samples & Insitu Tests:

Depth	Type & Results
0.8	Peak = 49kPa Residual = 14kPa
1.3	Peak = 43kPa Residual = 14kPa
1.8	Peak = 43kPa Residual = 17kPa
2.4	Peak = 46kPa Residual = 17kPa
2.9	Peak = 46kPa Residual = 12kPa

Groundwater: encountered at approx. 1.48 m (▼)

Termination Reason: Target Depth
Shear Vane No: 3403 | DCP No: 14
Remarks:

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

TEST PIT LOG - TP15

Client: Kevin & Andrea Marsh
Project: Pencarrow Estate, 1491 Arawa Road, Pongakawa
Site Location: Pongakawa
Project No.: TGA2021-0096
Date: 18/01/2022
Test Pit Location: Refer to Drawing 01 | Logged by: BM | Checked by: LGL | Scale: 1:25 | Sheet 1 of 1

Position: 400622.4mE; 793550.2mN | Projection: BOP2000 | Datum: Moturiki
Pit Dimensions: m by m
Survey Source: pLog tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Structure & Other Observations
				0.0	OL: Organic SILT: with trace sand; dark brownish black. Non-plastic; sand, fine. (Topsoil)	D to M		
					SP: Fine SAND: light brownish grey. Poorly graded. (Alluvial Sands)		LP	
	0.5	Peak = 43kPa Residual = 14kPa			Pt: PEAT : dark brownish black. Low plasticity, moderately sensitive, organic, fibrous, tree stumps (Peat)	M to W	F	
	1.0	Peak = 41kPa Residual = 20kPa		1				
					SW: Fine to coarse SAND: grey. Well graded, pumiceous. (Alluvial Sands)		LP	
▼	1.7	Peak = 43kPa Residual = 20kPa			Pt: PEAT: dark brownish black. Low plasticity, organic, moderately sensitive, fibrous, tree stumps. (Peat)	W to S	F	
				2	SW: Fine to coarse SAND: grey. Well graded, pumiceous. (Pleistocene Alluvium)		L to MD	
				3.5	Test pit terminated at 3.50 m			

Dynamic Cone Penetrometer (Blows/100mm), scale 5 10 15 20 — readings from approx. 1.9 m to 3.5 m:

2, 3, 4, 2, 3, 4, 4, 2, 3, 2, 4, 4, 3, 3, 3, 4

Termination Reason: Hole collapse
Shear Vane No: 3403 | DCP No: 14
Remarks:

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

TEST PIT LOG - TP16

Client: Kevin & Andrea Marsh
Project: Pencarrow Estate, 1491 Arawa Road, Pongakawa
Site Location: Pongakawa
Project No.: TGA2021-0096
Date: 17/01/2022
Test Pit Location: Refer to Drawing 01 | Logged by: | Checked by: LGL | Scale: 1:25 | Sheet 1 of 1

Position: 400640.8mE; 793583.8mN | Projection: BOP2000 | Datum: Moturiki
Pit Dimensions: m by m
Survey Source: pLog tablet

Groundwater	Depth	Type & Results	RL (m)	Depth (m)	Material Description	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations
					OL: Organic SILT: with trace sand; dark brownish black. Non-plastic; sand, fine. (Topsoil)	D to M			
	0.4	Peak = 58kPa Residual = 14kPa			SP: Fine SAND : light brownish grey. Poorly graded. (Alluvial Sands)		LP		
	1.0	Peak = 38kPa Residual = 17kPa		1	Pt: PEAT : dark brownish black. Low plasticity, , moderately sensitive, organic, fibrous, tree stumps. (Peat)	W	F		
	1.5	Peak = 43kPa Residual = 14kPa							
▼				2	SW: Fine to coarse SAND: with trace gravel; light grey. Well graded, pumiceous. (Alluvial Sands) *... from 2.00m to 2.05m, Thin organic layer*		LP		
	2.2	Peak = 67kPa Residual = 17kPa			ML: Sandy SILT: greyish brown streaked orange brown. Low plasticity, moderately sensitive; sand, fine to coarse. (Pleistocene Alluvium)	W to S	St		
					Test pit terminated at 2.40 m				
				3					
				4					
				5					

Termination Reason: Hole collapse
Shear Vane No: 3403 | DCP No:
Remarks:

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

TEST PIT LOG - TP17

Client: Kevin & Andrea Marsh
Project: Pencarrow Estate, 1491 Arawa Road, Pongakawa
Site Location: Pongakawa
Project No.: TGA2021-0096
Date: 17/01/2022
Test Pit Location: Refer to Drawing 01 | Logged by: BM | Checked by: LGL | Scale: 1:25 | Sheet 1 of 1
Position: 400865.3mE; 793446.0mN | Projection: BOP2000 | Datum: Moturiki | Pit Dimensions: m by m | Survey Source: pLog tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations (Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks)
					OL: Organic SILT: with trace sand; dark brownish black. Non-plastic; sand, fine. (Topsoil)				
					SP: Fine SAND: light brownish grey. Uniformly graded. (Pleistocene Alluvium)	D to M		1, 2, 2	
					SM: Silty Fine to medium SAND: light greyish yellow. Poorly graded. (Pleistocene Alluvium)		L to MD	3, 4, 2, 2	
				1	ML: Sandy SILT: greyish brown streaked orange brown. Low plasticity, moderately sensitive; sand, fine to coarse. (Pleistocene Alluvium)				
	1.5	Peak = 142kPa Residual = 43kPa							
	2.0	Peak = 96kPa Residual = 29kPa		2					
					MH: Clayey SILT: with minor sand; light grey streaked orange brown. Low plasticity, moderately sensitive; sand, fine to medium. (Pleistocene Alluvium)	M	St to VSt		
	2.5	Peak = 188kPa Residual = 43kPa							
	3.0	Peak = 101kPa Residual = 29kPa		3					
	3.5	Peak = 174kPa Residual = 29kPa							
				4	Test pit terminated at 4.00 m				
				5					

Termination Reason: Target depth
Shear Vane No: 3403 DCP No: 14
Remarks:

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

TEST PIT LOG - TP18

Client: Kevin & Andrea Marsh
Project: Pencarrow Estate, 1491 Arawa Road, Pongakawa
Site Location: Pongakawa
Project No.: TGA2021-0096
Date: 17/01/2022

CMW Geosciences

Test Pit Location: Refer to Drawing 01 | Logged by: BM | Checked by: LGL | Scale: 1:25 | Sheet 1 of 1

Position: 400924.0mE; 793473.6mN | Projection: BOP2000 | Datum: Moturiki | Pit Dimensions: m by m | Survey Source: pLog tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15 20	Structure & Other Observations (Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks)
					OL: Organic SILT: with trace sand; dark brownish black. Non-plastic; sand, fine. (Topsoil)	D to M			
					SP: Fine SAND: light brownish grey. Poorly graded. (Alluvial Sands)	M to W			
					Pt: PEAT: dark brownish black. Low plasticity, moderately sensitive, organic, fibrous, tree stumps. (Peat)				
	0.7	Peak = 43kPa Residual = 17kPa			ML: Sandy SILT: light brownish grey. Low plasticity, moderately sensitive; sand, fine to medium. (Matua Subgroup)	M	F to St		
	1.2	Peak = 75kPa Residual = 41kPa		1					
	1.8	Peak = 75kPa Residual = 20kPa							
▼				2	MH: Clayey SILT: with minor sand; light grey. Low plasticity; sand, fine to medium. (Matua Subgroup)		VSt		
					... *at 2.20m, Interbedded with thin sand layers*	W to S			
	2.5	Peak = 119kPa Residual = 46kPa							
	3.0	Peak = 104kPa Residual = 41kPa		3					
	3.5	Peak = 116kPa Residual = 26kPa							
					Test pit terminated at 3.60 m				
				4					
				5					

Termination Reason: Hole collapse

Shear Vane No: 3403 DCP No:

Remarks:

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

TEST PIT LOG - TP19

Client: Kevin & Andrea Marsh
Project: Pencarrow Estate, 1491 Arawa Road, Pongakawa
Site Location: Pongakawa
Project No.: TGA2021-0096
Date: 17/01/2022
Test Pit Location: Refer to Drawing 01 | Logged by: | Checked by: LGL | Scale: 1:25 | Sheet 1 of 1

Position: 400988.8mE; 793444.7mN | Projection: BOP2000 | Datum: Moturiki
Pit Dimensions: m by m
Survey Source: pLog tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15 20	Structure & Other Observations (Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks)
						OL: Organic SILT: with trace sand; dark brownish black. Non-plastic; sand, fine. (Topsoil)	D to M			
	0.4	Peak = 43kPa Residual = 26kPa				ML: SILT: orange. Low plasticity, moderately sensitive to sensitive. (Pleistocene Alluvium)		F to St		
	0.9	Peak = 61kPa Residual = 32kPa		1						
						... at 1.20m, becoming light brown				
	1.5	Peak = 127kPa Residual = 26kPa				MH: Clayey SILT: light brown streaked orange. Low plasticity, moderately sensitive to sensitive. (Pleistocene Alluvium)	M	VSt		
	2.0	Peak = 142kPa Residual = 29kPa		2						
	2.5	Peak = 119kPa Residual = 29kPa								
						... at 2.90m, contains minor sand				
	3.0	Peak = 142kPa Residual = 38kPa		3						
	3.5	Peak = 116kPa Residual = 43kPa								
						SW: Fine to coarse SAND: with minor gravel and trace silt; light yellowish white. Well graded, pumiceous. (Pleistocene Alluvium)				
				4		Test pit terminated at 4.00 m				
				5						

Termination Reason: Target Depth
Shear Vane No: 3403 | DCP No:
Remarks:

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

TEST PIT LOG - TP20

Client: Kevin & Andrea Marsh
Project: Pencarrow Estate, 1491 Arawa Road, Pongakawa
Site Location: Pongakawa
Project No.: TGA2021-0096
Date: 17/01/2022
Test Pit Location: Refer to Drawing 01 | Logged by: BM | Checked by: LGL | Scale: 1:25 | Sheet 1 of 1

Position: 400788.4mE; 793433.4mN | Projection: BOP2000 | Datum: Moturiki | Pit Dimensions: m by m | Survey Source: pLog tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15 20	Structure & Other Observations (Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks)
						OL: Organic SILT: with trace sand; dark brownish black. Non-plastic; sand, fine. (Topsoil)	D to M			
						ML: SILT: with some sand; orange. Low plasticity, moderately sensitive; sand, fine. (Pleistocene Alluvium)	M	VSt		
	0.5	Peak = 104kPa Residual = 35kPa								
	1.0	Peak = 104kPa Residual = 29kPa		1						
						MH: Clayey SILT: with minor sand; light grey streaked orange brown. Low plasticity, moderately sensitive; sand, fine to medium. (Pleistocene Alluvium)				
	1.5	Peak = 119kPa Residual = 35kPa								
	2.0	Peak = 104kPa Residual = 29kPa		2						
	2.5	Peak = 174kPa Residual = 43kPa								
	3.0	Peak = 122kPa Residual = 35kPa		3						
	3.5	Peak = 101kPa Residual = 35kPa								
						SM: Silty Fine to coarse SAND: light brownish grey. Well graded. (Pleistocene Alluvium)		LP		
				4		Test pit terminated at 4.00 m				
				5						

Termination Reason: Target Depth
Shear Vane No: 3403 DCP No:
Remarks:

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

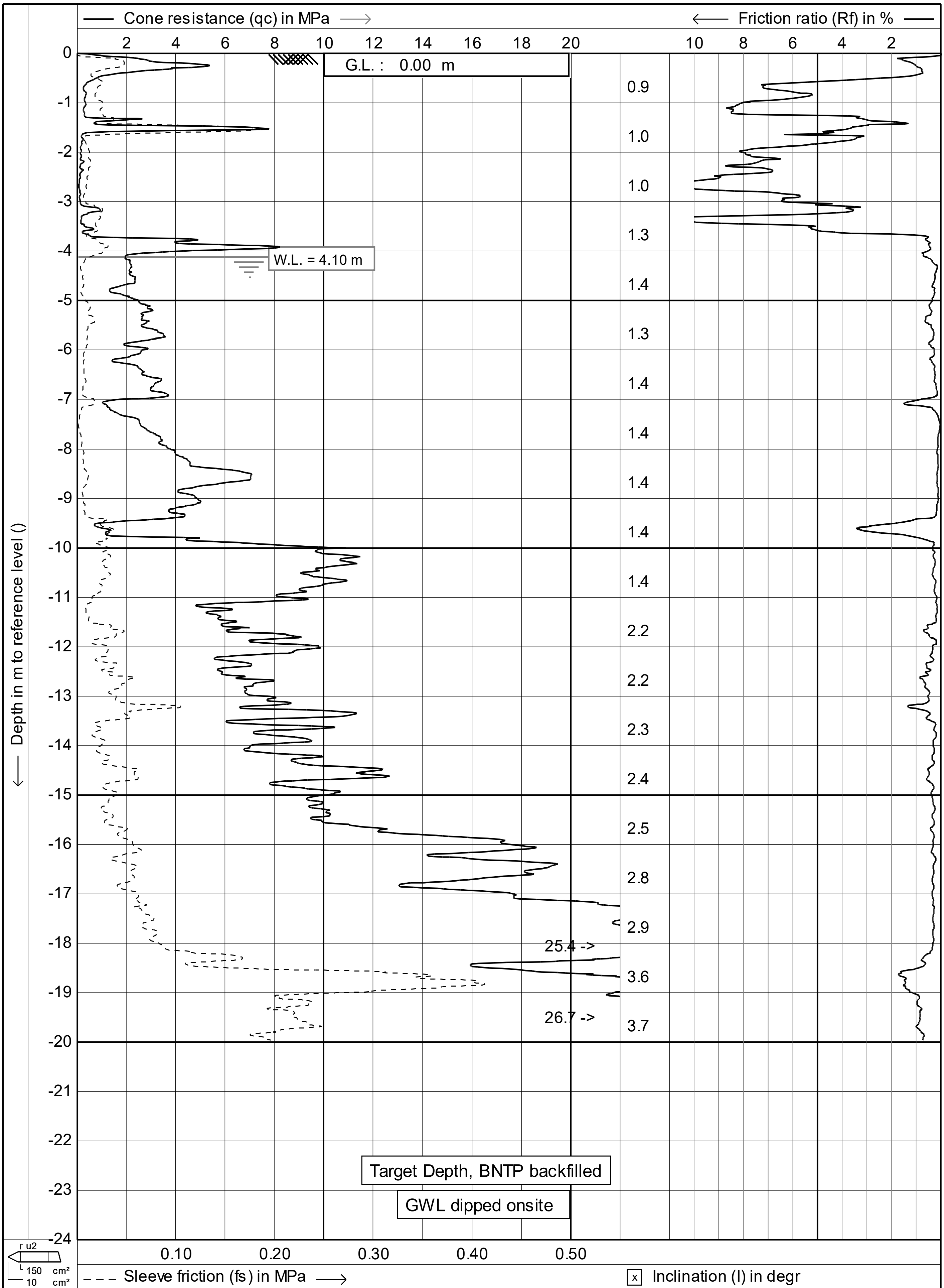
TEST PIT LOG - TP21

Client: Kevin & Andrea Marsh
Project: Pencarrow Estate, 1491 Arawa Road, Pongakawa
Site Location: Pongakawa
Project No.: TGA2021-0096
Date: 18/01/2022
Test Pit Location: Refer to Drawing 01 | Logged by: BM | Checked by: LGL | Scale: 1:25 | Sheet 1 of 1
Position: 400672.7mE; 793405.6mN | Projection: BOP2000 | Datum: Moturiki | Pit Dimensions: m by m | Survey Source: pLog tablet

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm)	Structure & Other Observations (Discontinuities: Depth; Defect Number; Defect Type; Dip; Defect Shape; Roughness; Aperture; Infill; Seepage; Spacing; Block Size; Block Shape; Remarks)
						OL: Organic SILT: with trace sand; dark brownish black. Non-plastic; sand, fine. (Topsoil)	D to M			
						ML: SILT: light orange. Low plasticity. (Pleistocene Alluvium)				
	0.5	Peak = 90kPa Residual = 17kPa				MH: Clayey SILT: with minor sand; light grey streaked orange brown. Low plasticity, moderately sensitive; sand, fine to medium. (Pleistocene Alluvium)	M to W	St		
	1.0	Peak = 87kPa Residual = 23kPa		1						
	1.5	Peak = 75kPa Residual = 35kPa								
	2.0	Peak = 93kPa Residual = 35kPa		2						
▼						SW: Fine to coarse SAND: grey. Well graded, pumiceous. (Pleistocene Alluvium)	W to S	L to MD	3, 4, 3, 4, 2, 4	
				3		Test pit terminated at 3.00 m				
				4						
				5						

Termination Reason: Hole collapse
Shear Vane No: 3403 DCP No: 14
Remarks:

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



1.48

PERRY GEOTECH

Test according A.S.T.M Standard D 5778-12

Project : **Site Investigations**

Location: **1491 Arawa Rd Pongakawa**

Position: **0, 0**

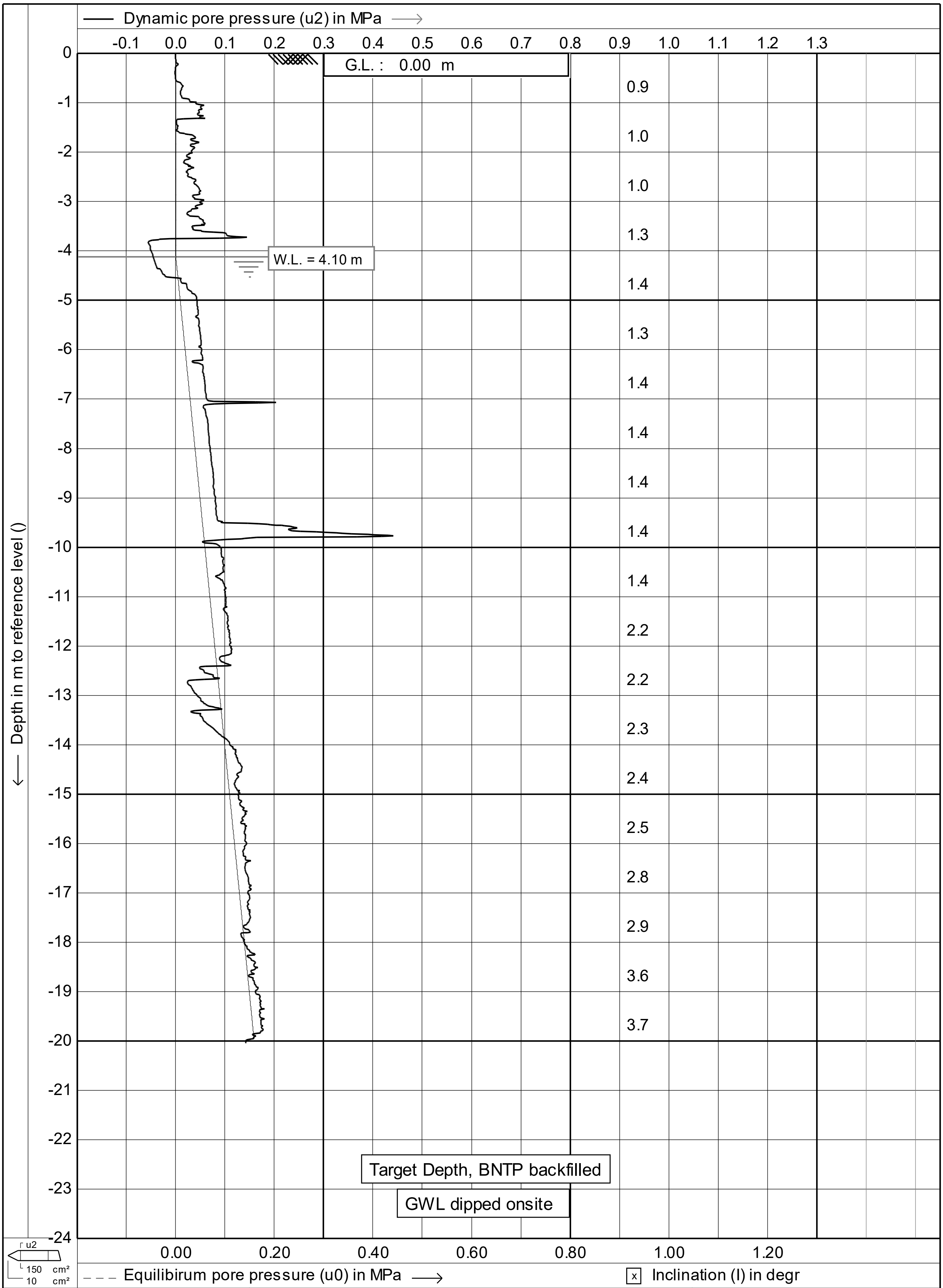
Date : **18/01/2022**

Cone no. : **C10CFIIP.C17803**

Project no. : **05CMW099**

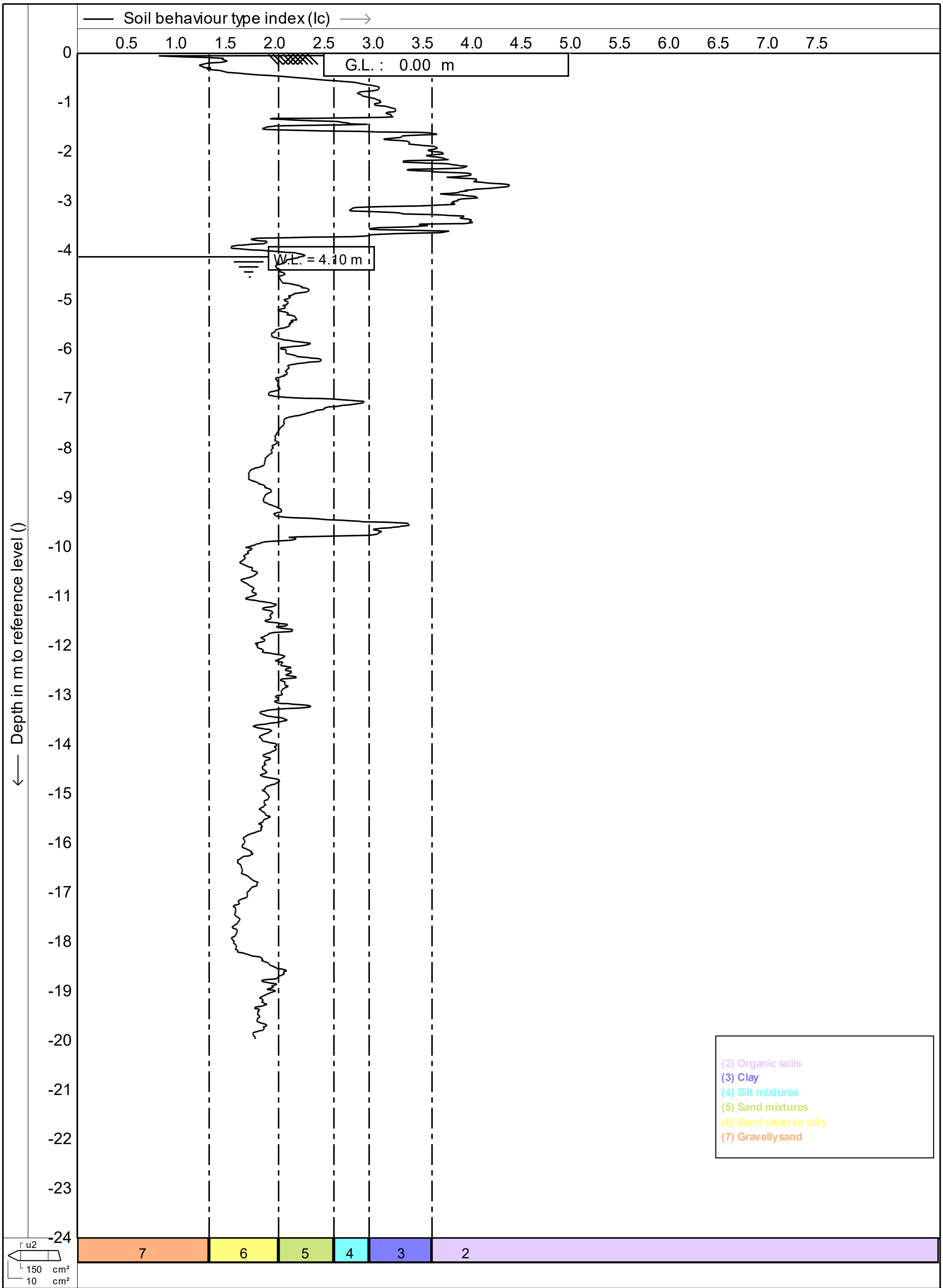
CPT no. : **01**

1/14



PERRY GEOTECH	Test according A.S.T.M Standard D 5778-12	Date : **18/01/2022**	
	Project : **Site Investigations**	Cone no. : **C10CFIIP.C17803**	
	Location: **1491 Arawa Rd Pongakawa**	Project no. : **05CMW099**	
	Position: **0, 0**	CPT no. : **01**	**2/14**

1.48



PERRY GEOTECH

Test according A.S.T.M Standard D 5778-12

Project : **Site Investigations**

Location: **1491 Arawa Rd Pongakawa**

Position: **0, 0**

Date : **18/01/2022**

Cone no. : **C10CFIIP.C17803**

Project no. : **05CMW099**

CPT no. : **01**

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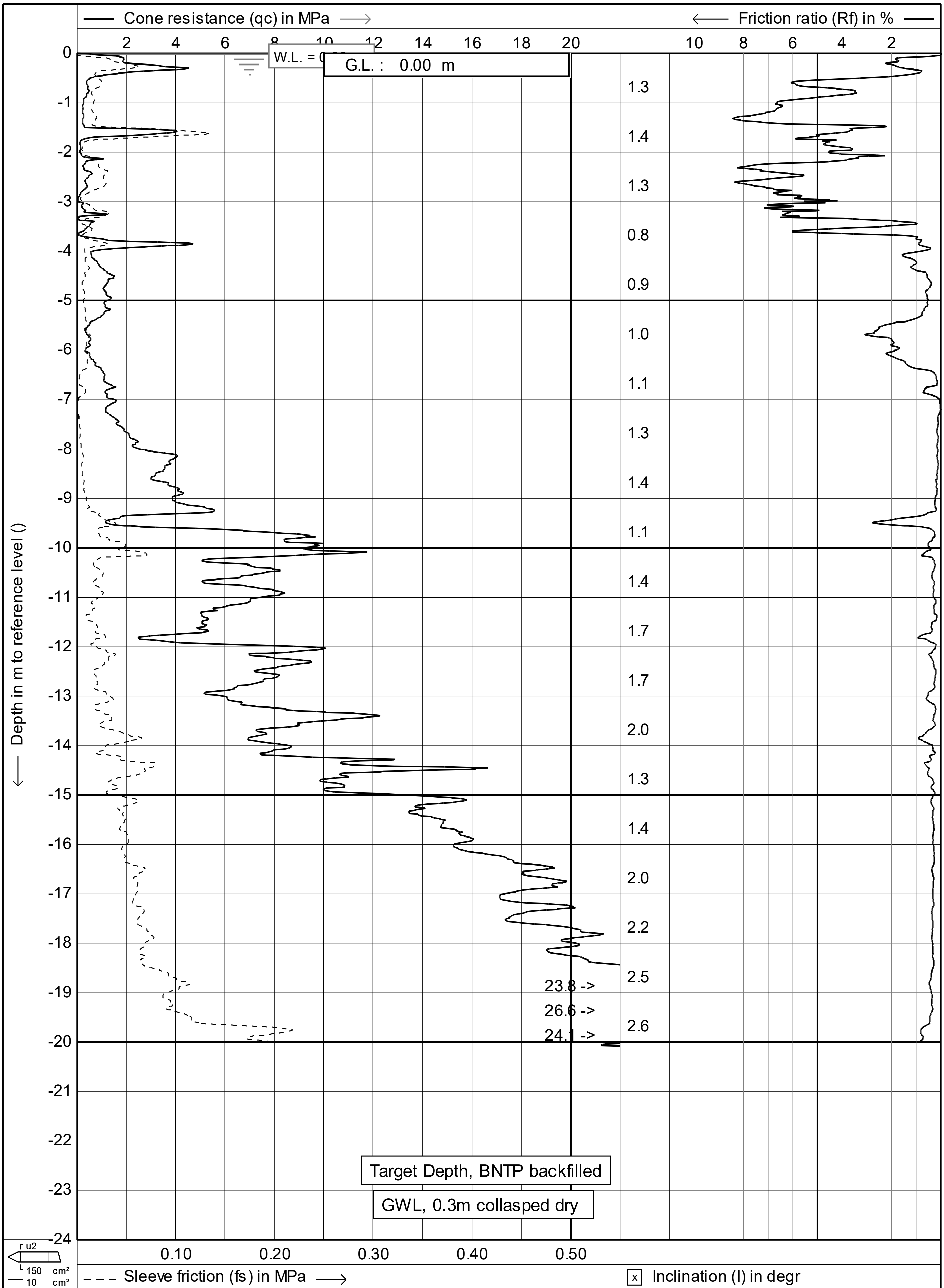
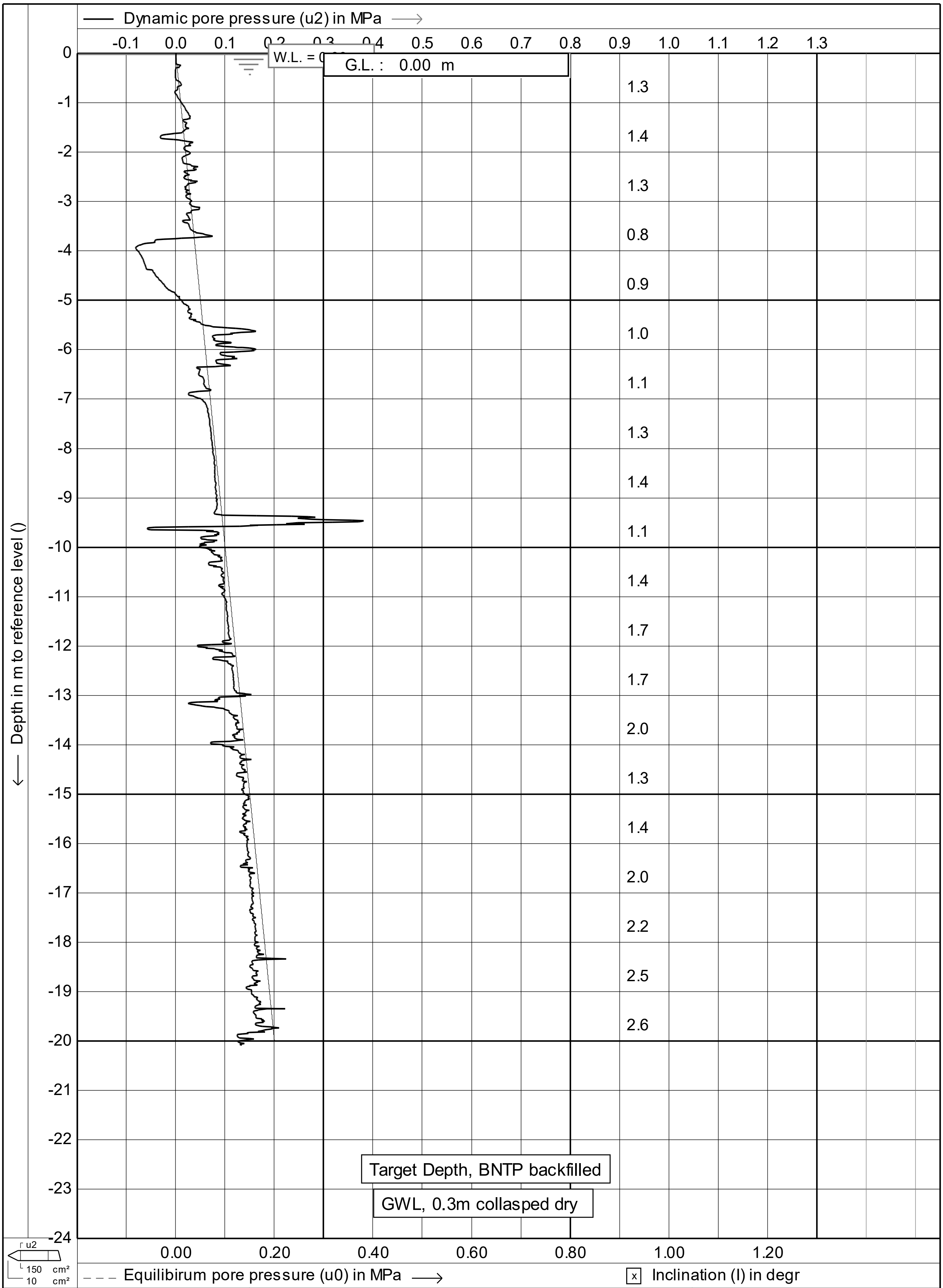


Test according A.S.T.M Standard D 5778-12	Date : **19/01/2022**
Project : **Site Investigations**	Cone no. : **C10CFIIP.C17803**
Location: **1491 Arawa Rd Pongakawa**	Project no. : **05CMW099**
Position: **0, 0**	CPT no. : **02** **1/14**

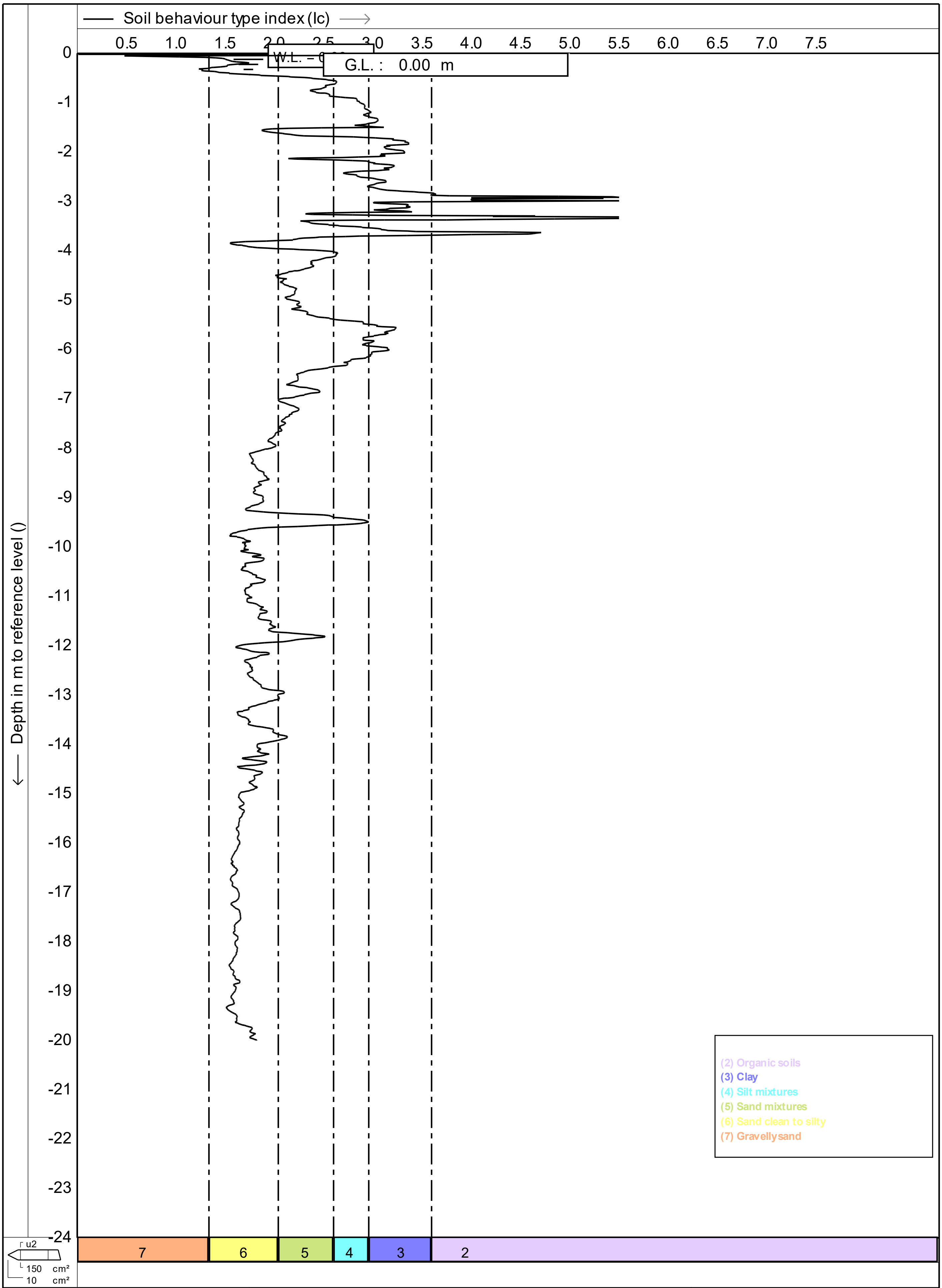
1.48



Test according A.S.T.M Standard D 5778-12

Project : **Site Investigations**	Date	: **19/01/2022**	
Location: **1491 Arawa Rd Pongakawa**	Cone no.	: **C10CFIIP.C17803**	
Position: **0, 0**	Project no. :	**05CMW099**	
	CPT no.	: **02**	**2/14**

1.48



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PERRY GEOTECH

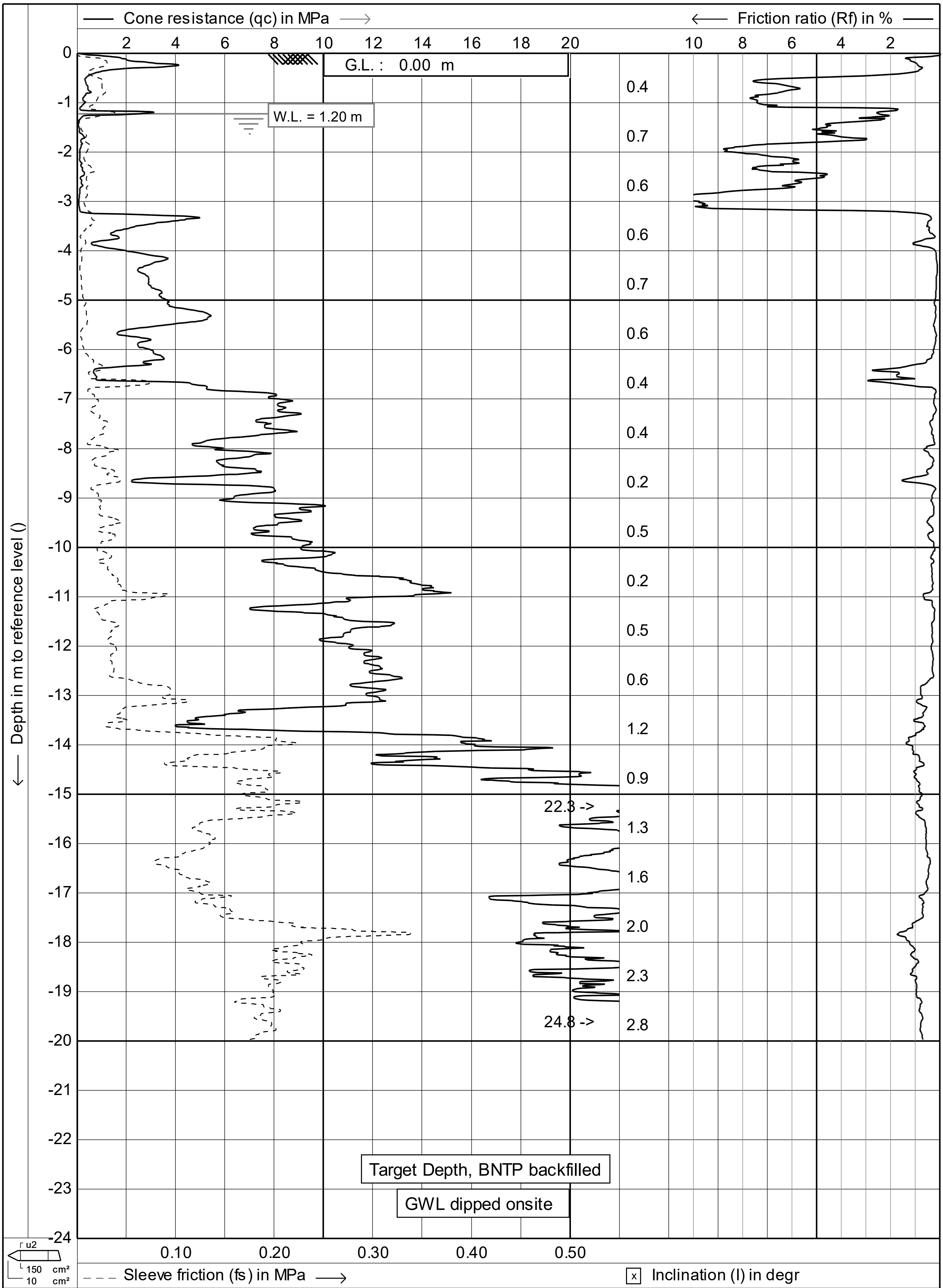
Test according A.S.T.M Standard D 5778-12

Project : **Site Investigations**

Location: **1491 Arawa Rd Pongakawa**

Position: **0, 0**

Date	: **19/01/2022**
Cone no.	: **C10CFIIP.C17803**
Project no.	: **05CMW099**
CPT no.	: **02**



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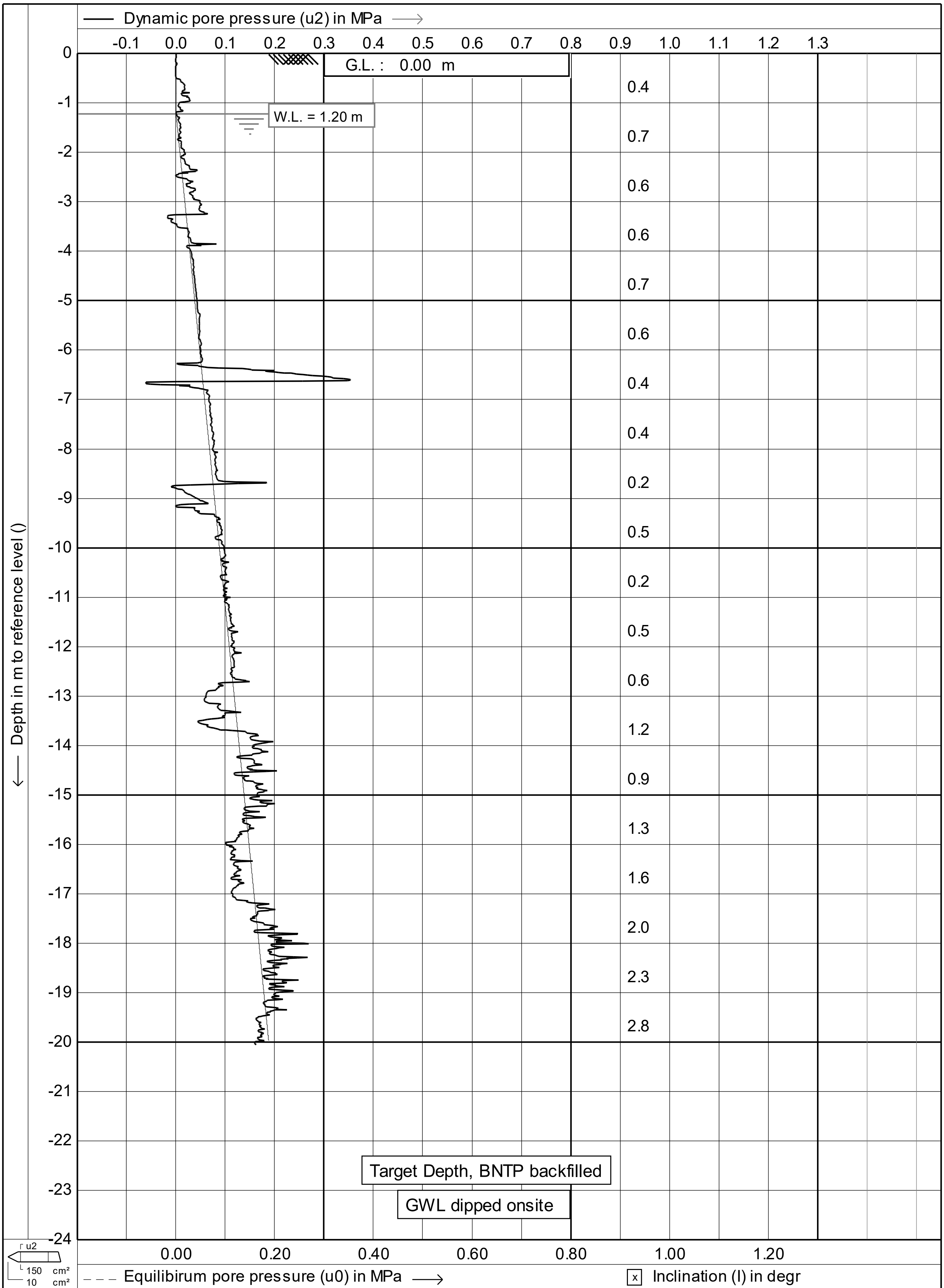
PERRY GEOTECH

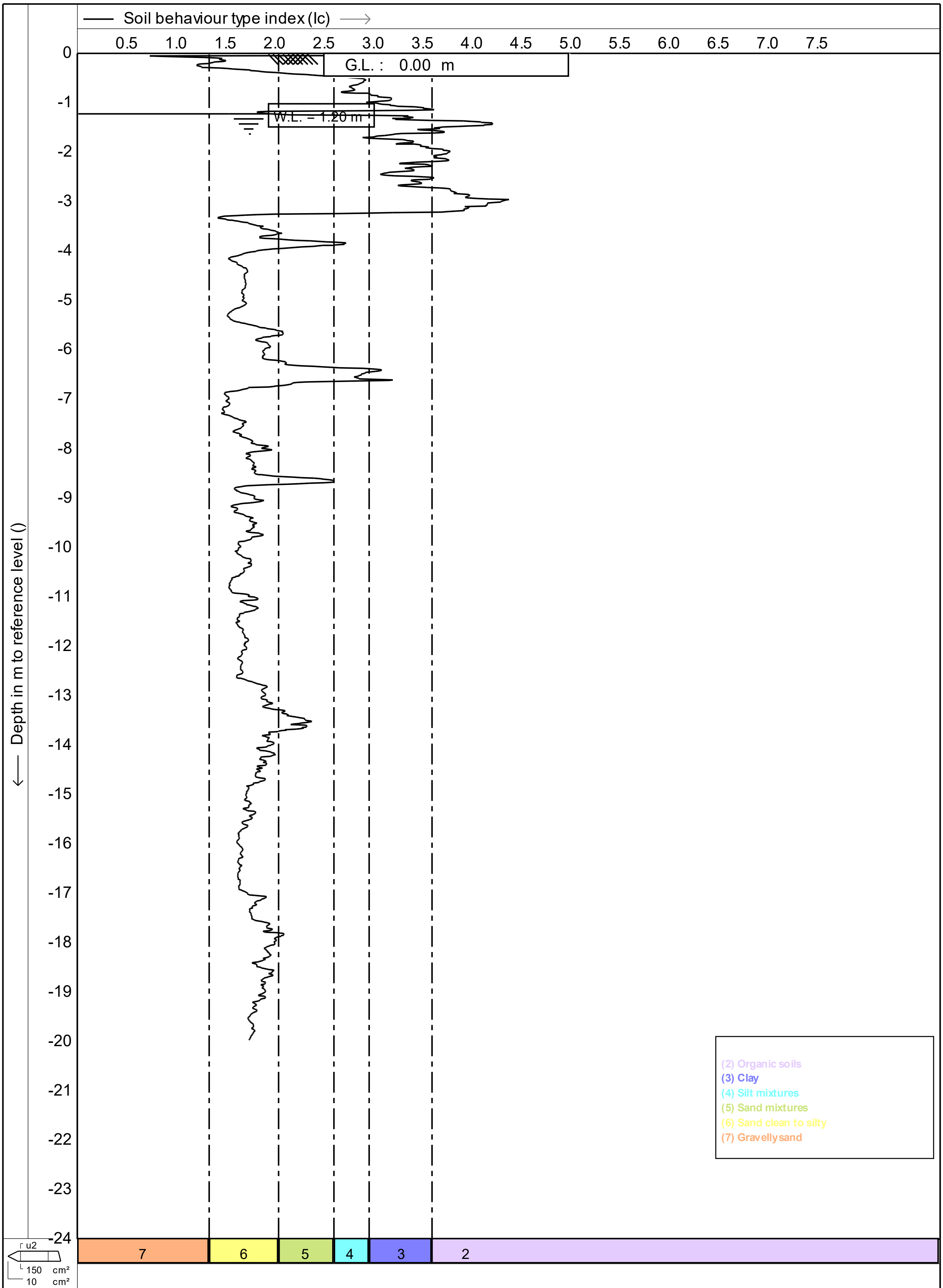
Test according A.S.T.M Standard D 5778-12

Project : **Site Investigations**		Date	: **19/01/2022**
Location: **1491 Arawa Rd Pongakawa**		Cone no.	: **C10CFIIP.C17803**
Position: **0, 0**		Project no. :	**05CMW099**
		CPT no.	: **03** **1/14**



PERRY GEOTECH	Test according A.S.T.M Standard D 5778-12	Date : **19/01/2022**
	Project : **Site Investigations**	Cone no. : **C10CFIIP.C17803**
	Location: **1491 Arawa Rd Pongakawa**	Project no. : **05CMW099**
	Position: **0, 0**	CPT no. : **03** **2/14**

1.48



PERRY GEOTECH

Test according A.S.T.M Standard D 5778-12

Project : **Site Investigations**

Location: **1491 Arawa Rd Pongakawa**

Position: **0, 0**

Date : **19/01/2022**

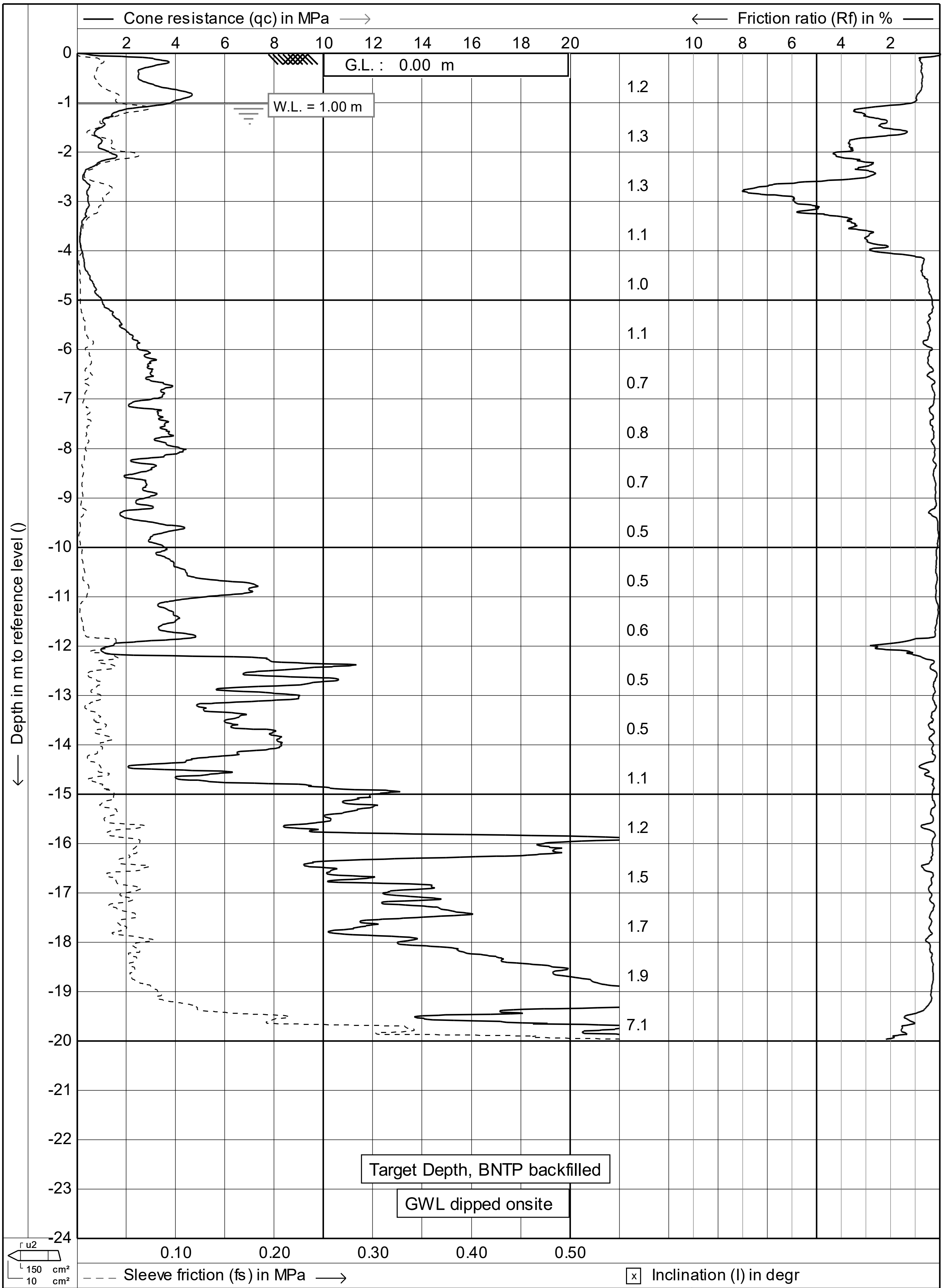
Cone no. : **C10CFIIP.C17803**

Project no. : **05CMW099**

CPT no. : **03**

9/14

1.48



Test according A.S.T.M Standard D 5778-12

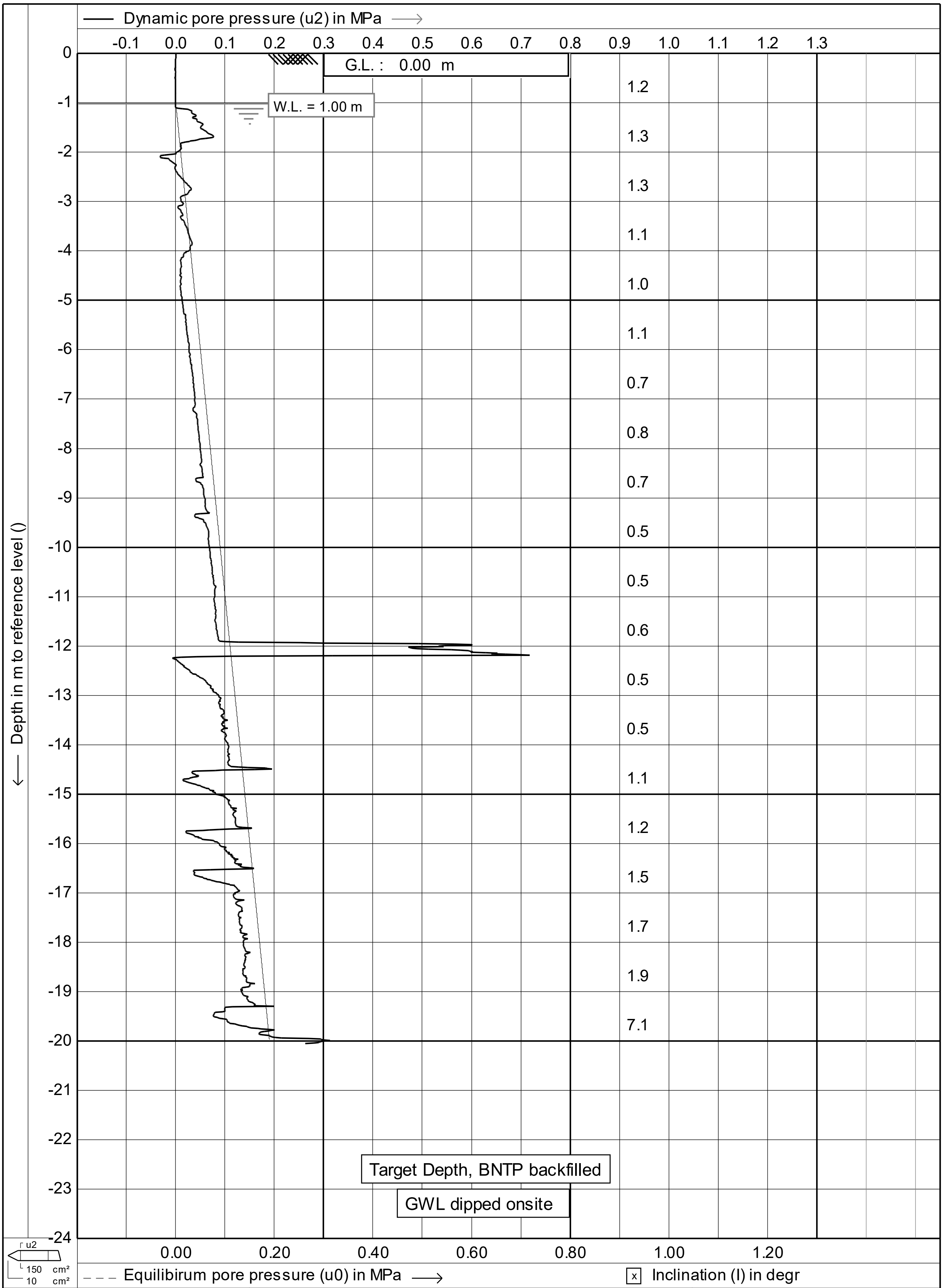
Project :	**Site Investigations**
Location:	**1491 Arawa Rd Pongakawa**
Position:	**0, 0**

Date	: **18/01/2022**
Cone no.	: **C10CFIIP.C17803**
Project no. :	**05CMW099**
CPT no.	: **04**

1/14

PERRY GEOTECH

1.48



PERRY GEOTECH

Test according A.S.T.M Standard D 5778-12

Project : **Site Investigations**

Location: **1491 Arawa Rd Pongakawa**

Position: **0, 0**

Date : **18/01/2022**

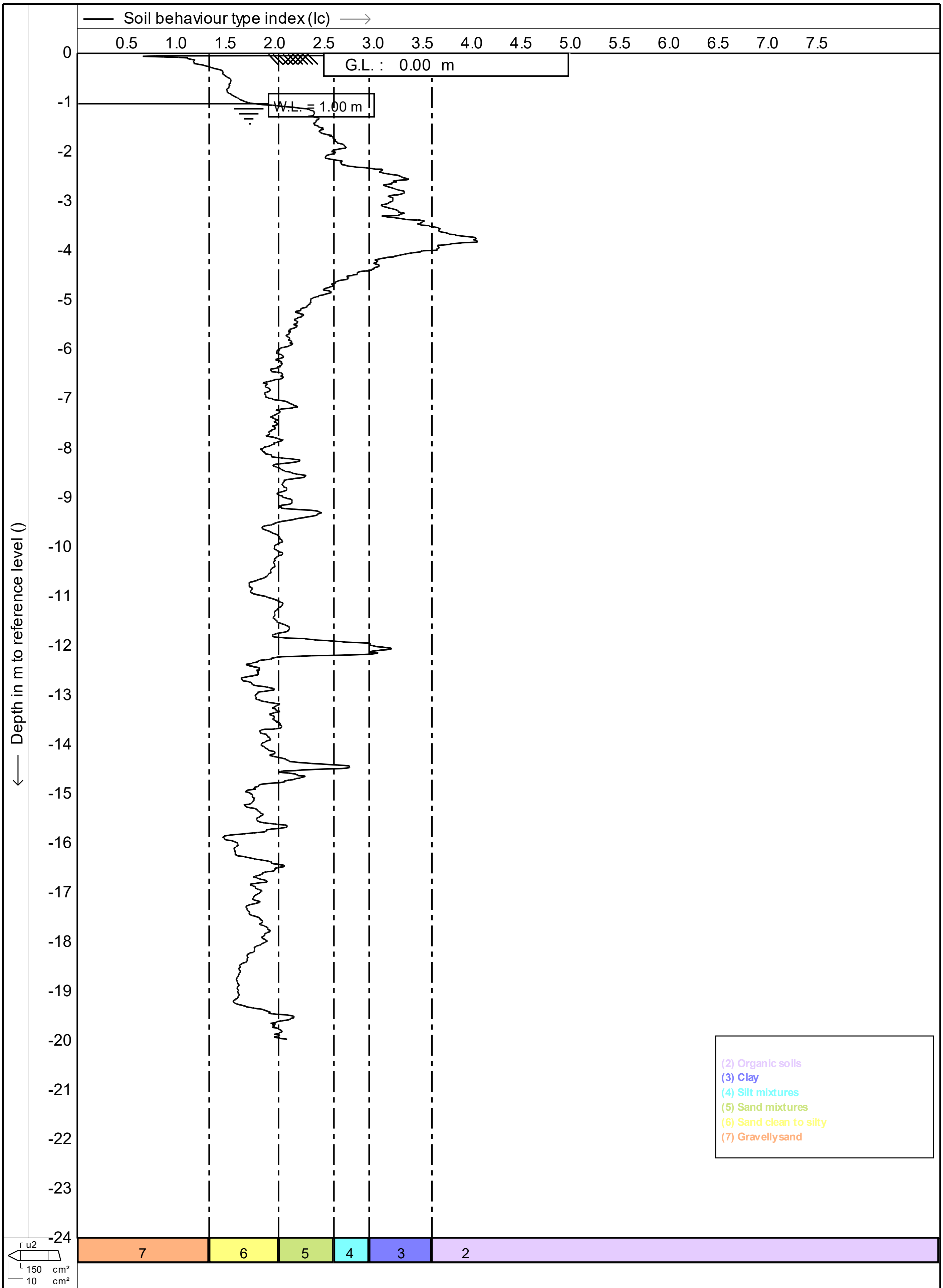
Cone no. : **C10CFIIP.C17803**

Project no. : **05CMW099**

CPT no. : **04**

2/14

1.48

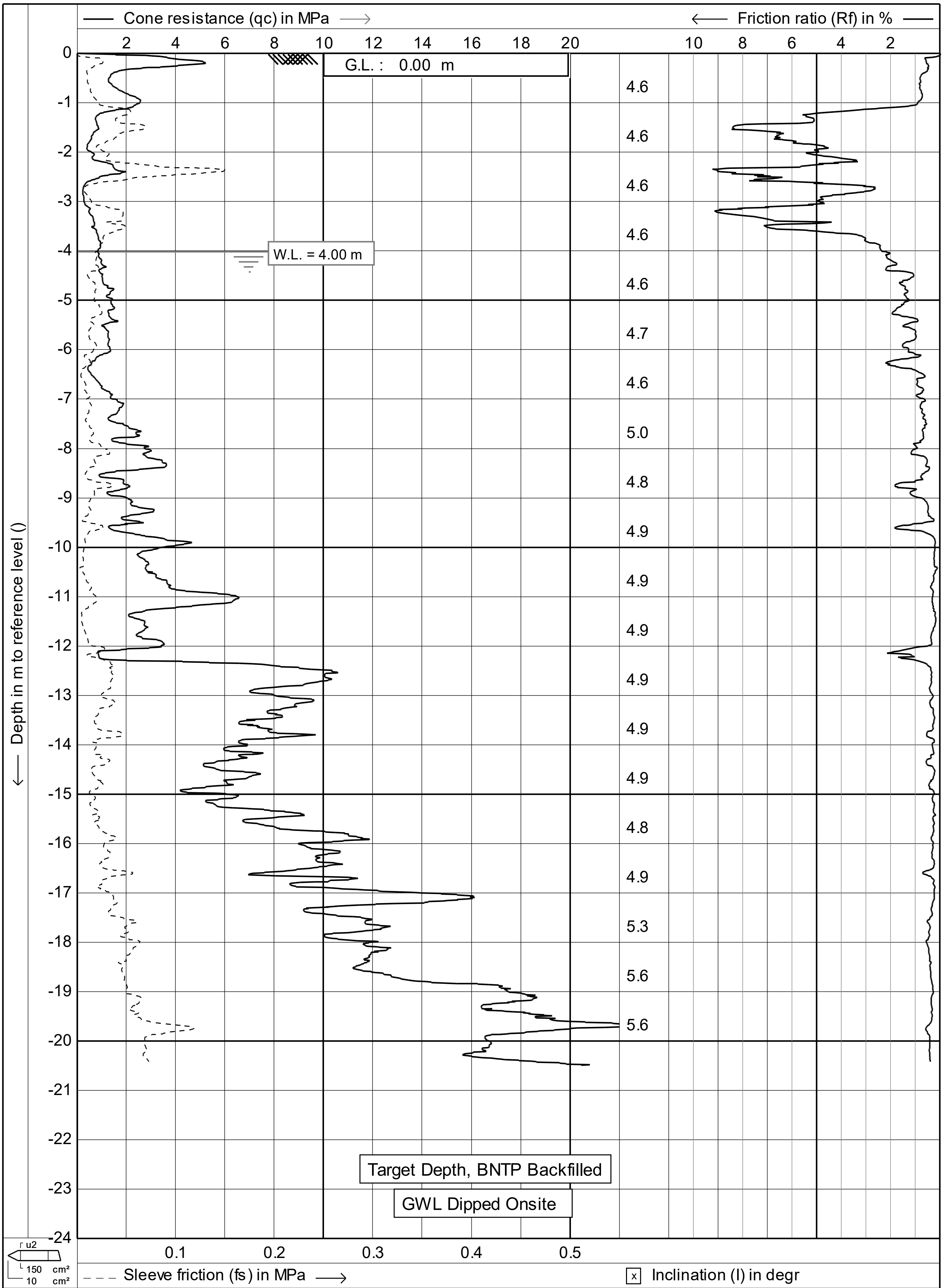


PERRY GEOTECH

Test according A.S.T.M Standard D 5778-12

Project	: **Site Investigations**
Location	: **1491 Arawa Rd Pongakawa**
Position	: **0, 0**
Date	: **18/01/2022**
Cone no.	: **C10CFIIP.C17803**
Project no.	: **05CMW099**
CPT no.	: **04**

1.48



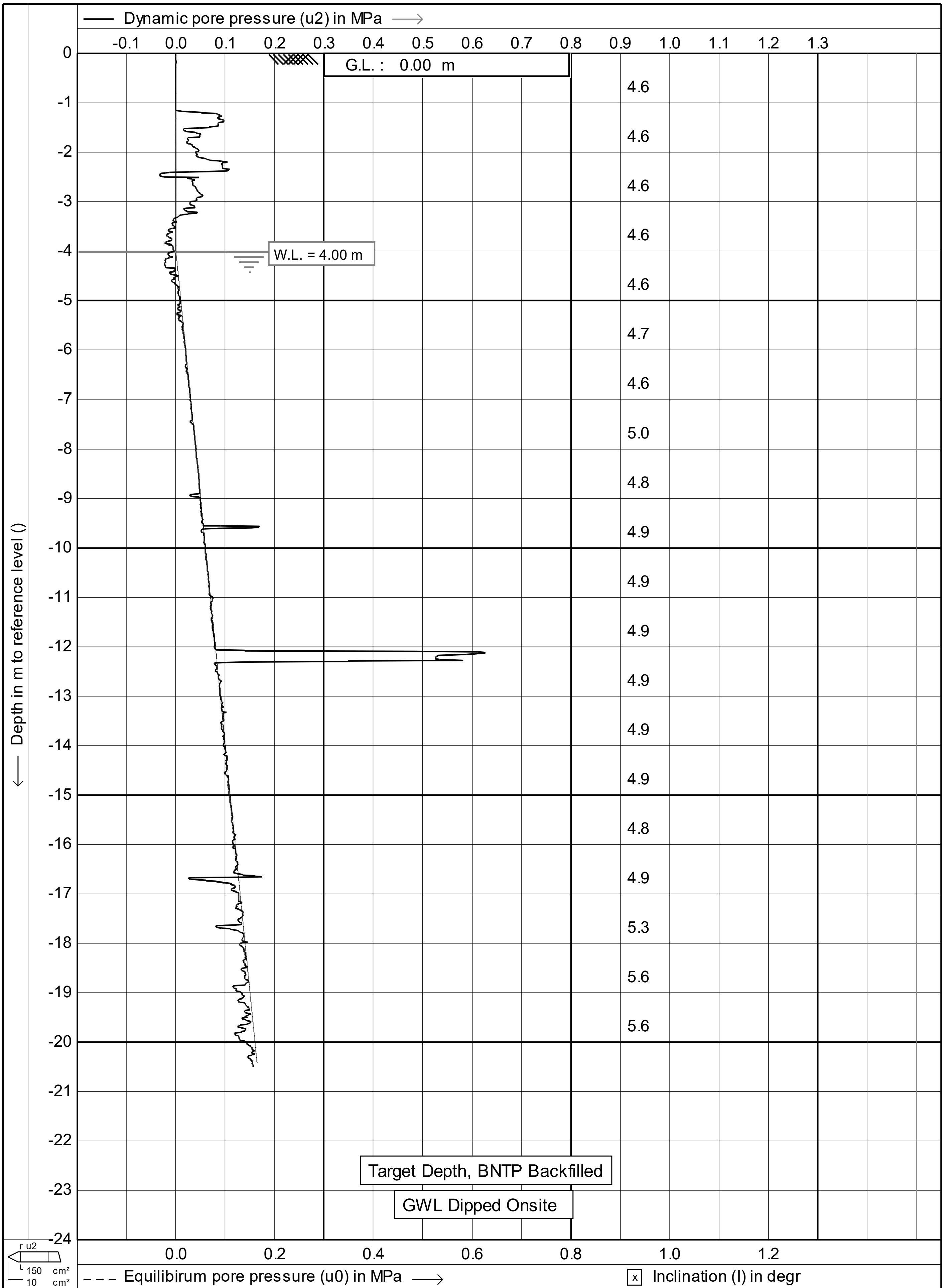
PERRY GEOTECH

A.S.T.M D5778-12

Project : **Site Investigations**
Location: **Arawa Rd - Pongakawa**
Position: **0, 0**

Date	: **19/01/2022**
Cone no.	: **C10CFIIP.C15212**
Project no.	: **02CMW099**
CPT no.	: **SCPT05** **1/14**

1.49



PERRY GEOTECH

A.S.T.M D5778-12

Project : **Site Investigations**

Location: **Arawa Rd - Pongakawa**

Position: **0, 0**

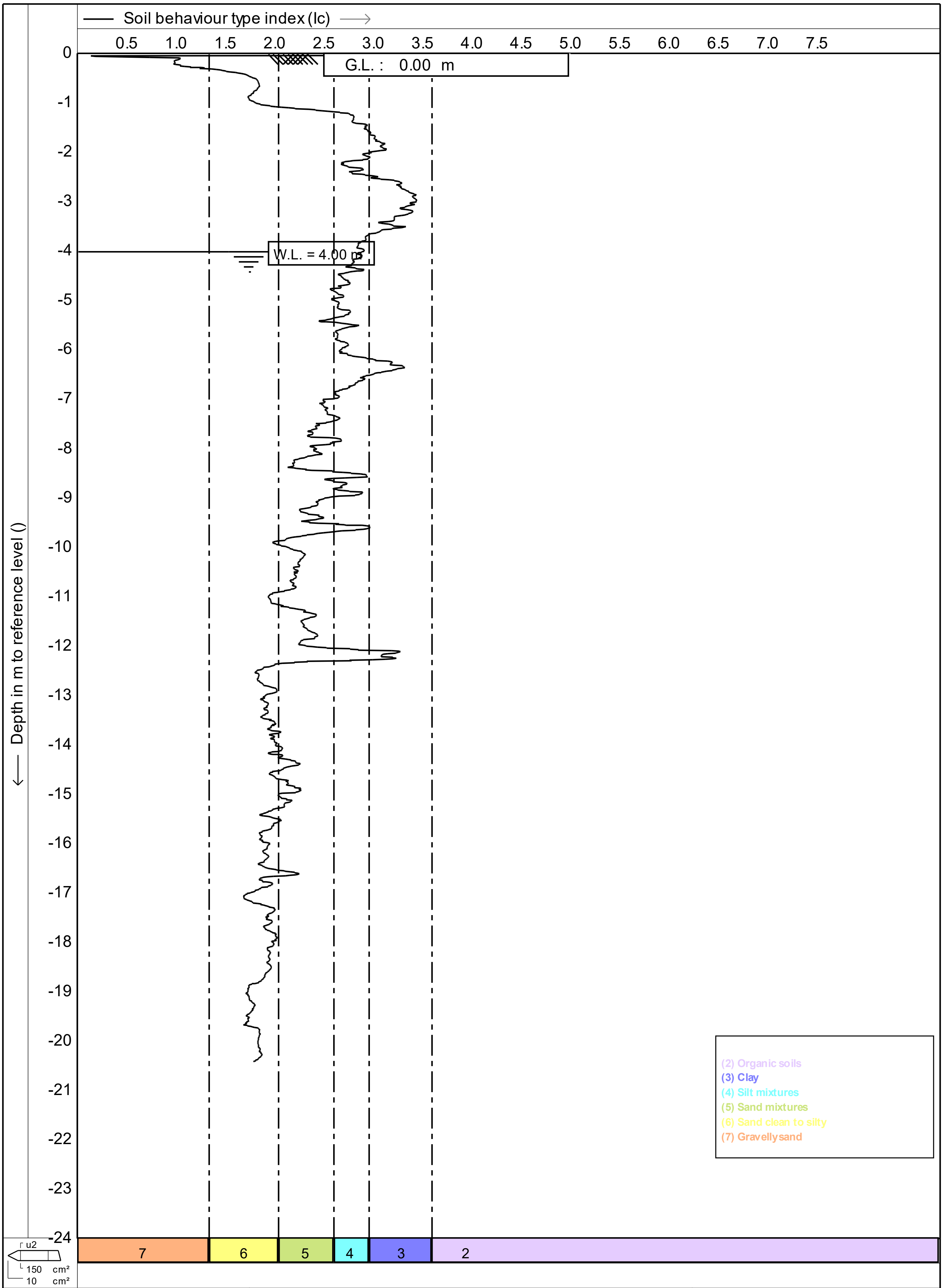
Date : **19/01/2022**

Cone no. : **C10CFIIP.C15212**

Project no. : **02CMW099**

CPT no. : **SCPT05** **2/14**

1.49



PERRY GEOTECH

A.S.T.M D5778-12

Project : **Site Investigations**

Location: **Arawa Rd - Pongakawa**

Position: **0, 0**

Date : **19/01/2022**

Cone no. : **C10CFIIP.C15212**

Project no. : **02CMW099**

CPT no. : **SCPT05** **9/14**

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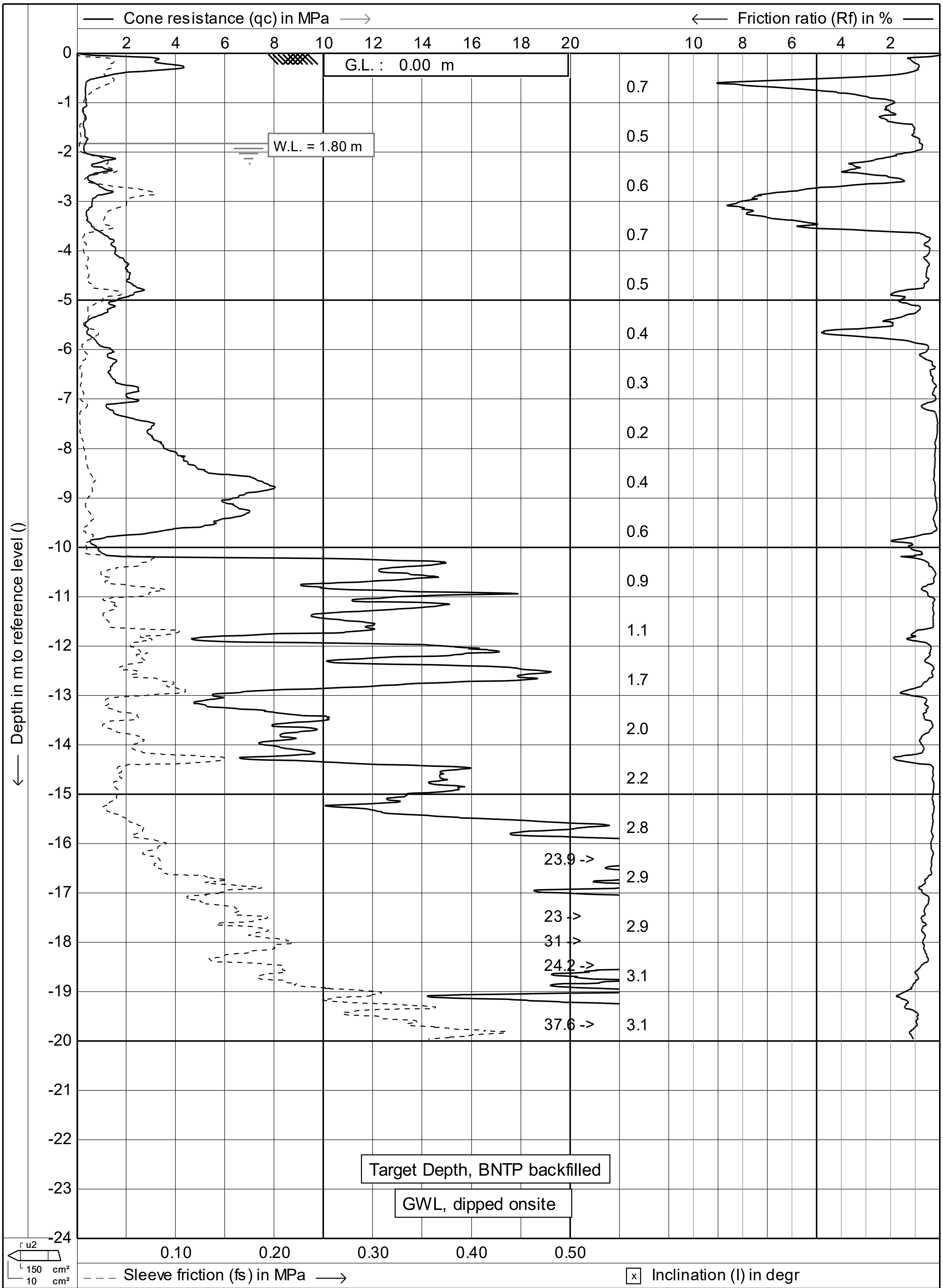
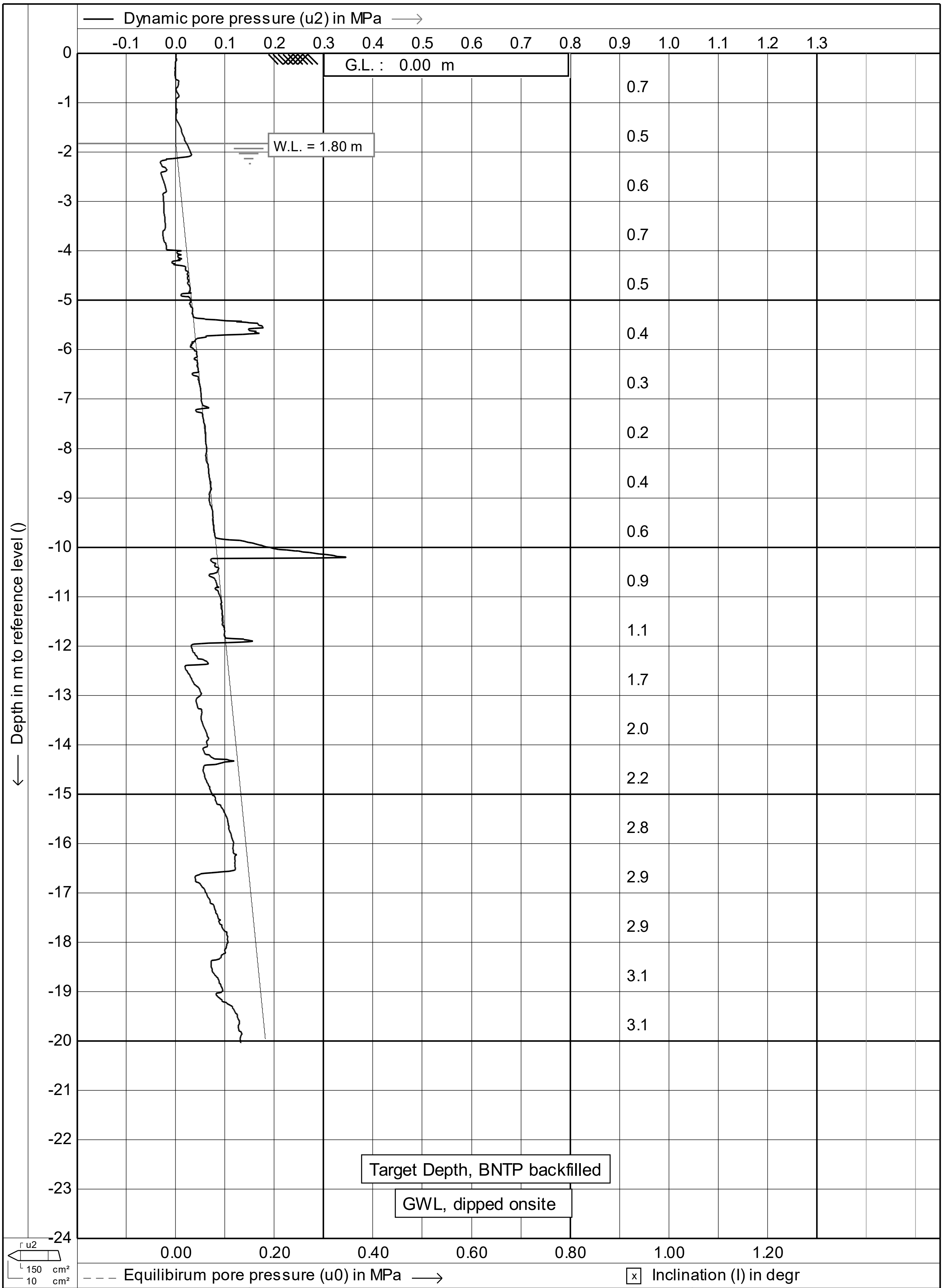


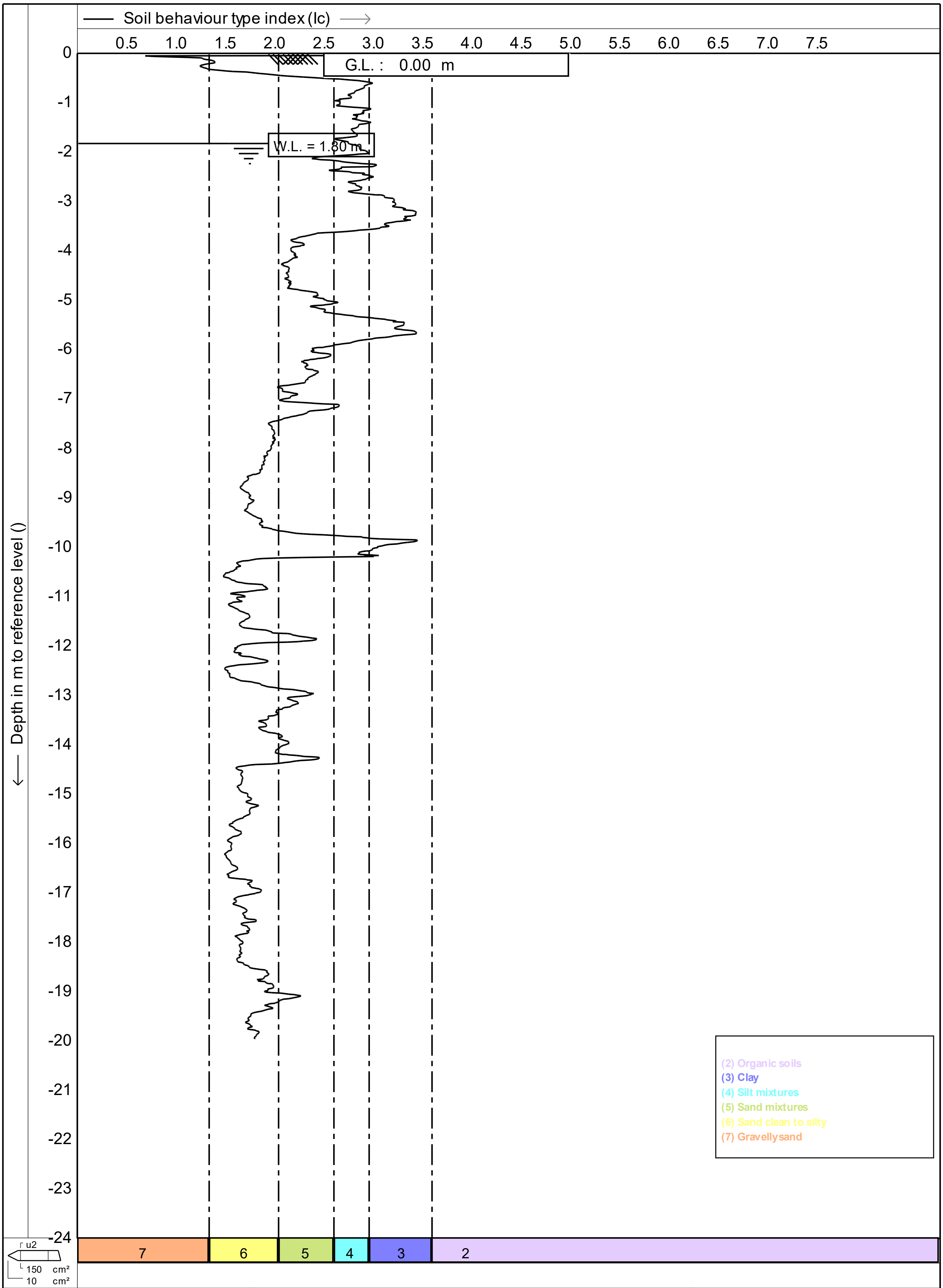
PERRY GEOTECH	Test according A.S.T.M Standard D 5778-12	Date : **19/01/2022**
	Project : **Site Investigations**	Cone no. : **C10CFIIP.C17803**
	Location: **1491 Arawa Rd Pongakawa**	Project no. : **05CMW099**
	Position: **0, 0**	CPT no. : **06** — **1/14**

1.48



PERRY GEOTECH	Test according A.S.T.M Standard D 5778-12	Date : **19/01/2022**
	Project : **Site Investigations**	Cone no. : **C10CFIIP.C17803**
	Location: **1491 Arawa Rd Pongakawa**	Project no. : **05CMW099**
	Position: **0, 0**	CPT no. : **06** **2/14**

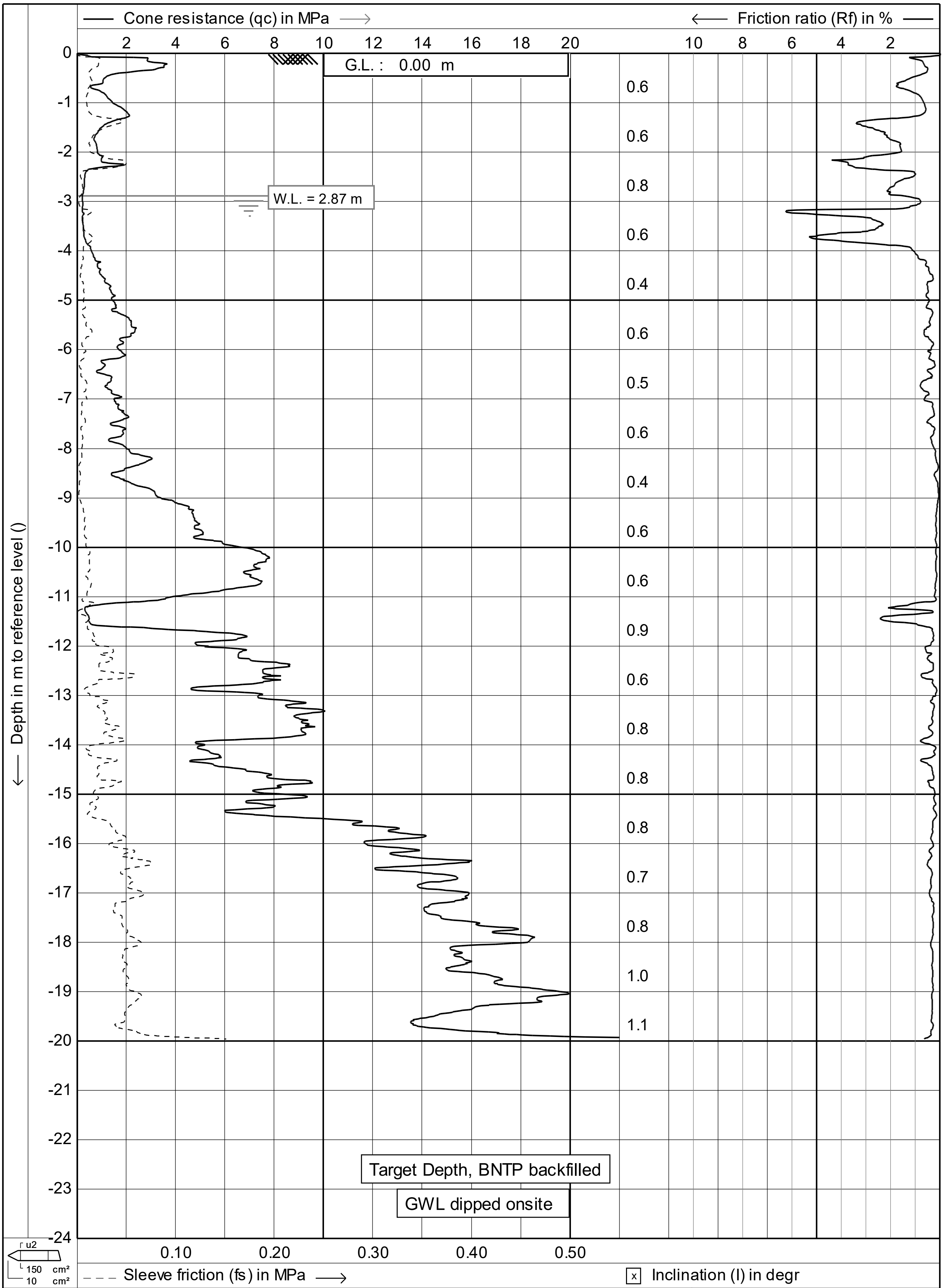
1.48



PERRY GEOTECH

Test according A.S.T.M Standard D 5778-12	Date	: **19/01/2022**
Project : **Site Investigations**	Cone no.	: **C10CFIIP.C17803**
Location: **1491 Arawa Rd Pongakawa**	Project no.	: **05CMW099**
Position: **0, 0**	CPT no.	: **06** **9/14**

1.48



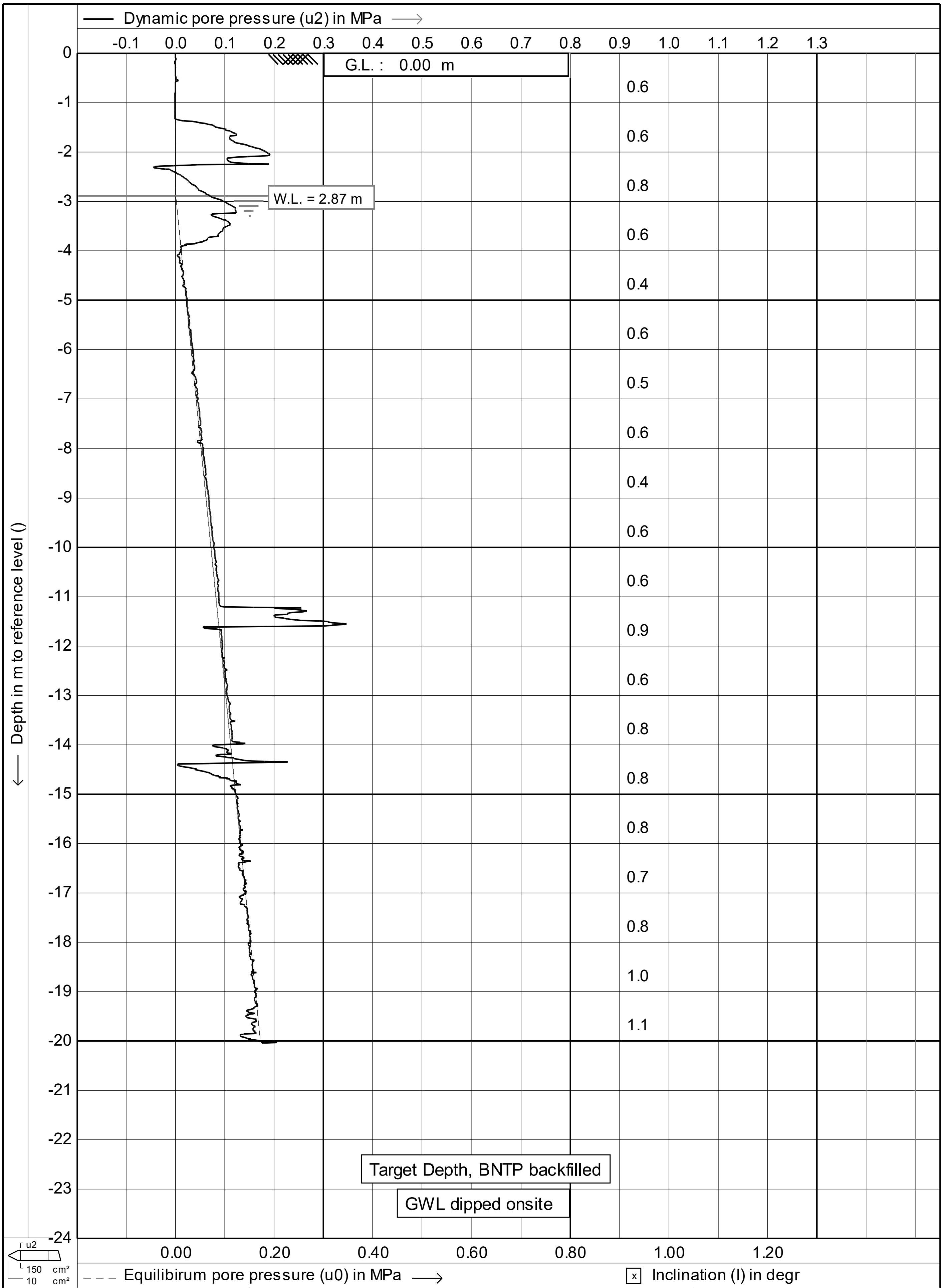
Test according A.S.T.M Standard D 5778-12

Project :	**Site Investigations**
Location:	**1491 Arawa Rd Pongakawa**
Position:	**0, 0**

Date	: **18/01/2022**
Cone no.	: **C10CFIIP.C17803**
Project no. :	**05CMW099**
CPT no.	: **07**

1/14

1.48



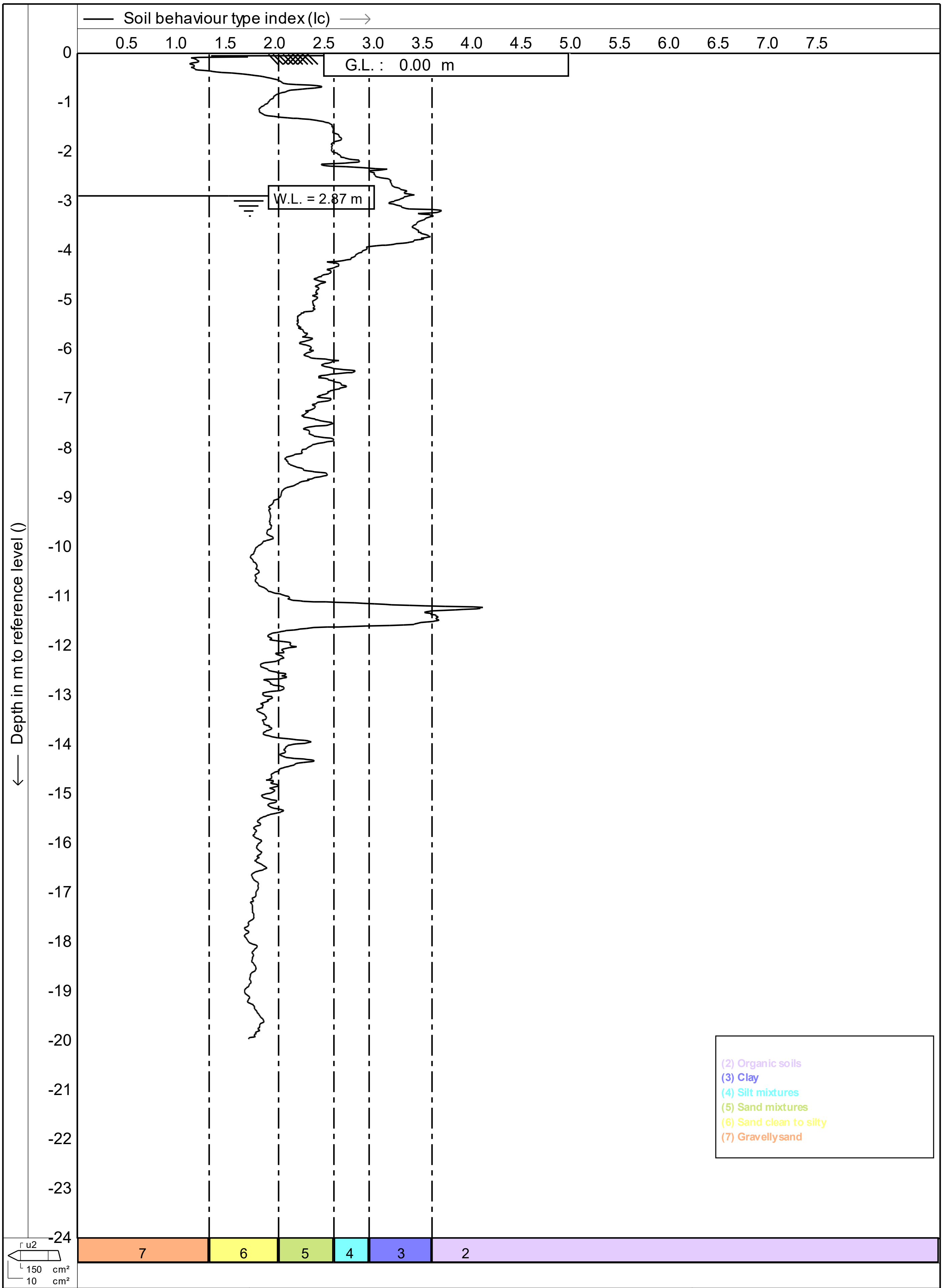
PERRY GEOTECH

Test according A.S.T.M Standard D 5778-12

Project :	**Site Investigations**
Location:	**1491 Arawa Rd Pongakawa**
Position:	**0, 0**

Date	: **18/01/2022**
Cone no.	: **C10CFIIP.C17803**
Project no. :	**05CMW099**
CPT no.	: **07**

1.48



PERRY GEOTECH

Test according A.S.T.M Standard D 5778-12

Project : **Site Investigations**

Location: **1491 Arawa Rd Pongakawa**

Position: **0, 0**

Date : **18/01/2022**

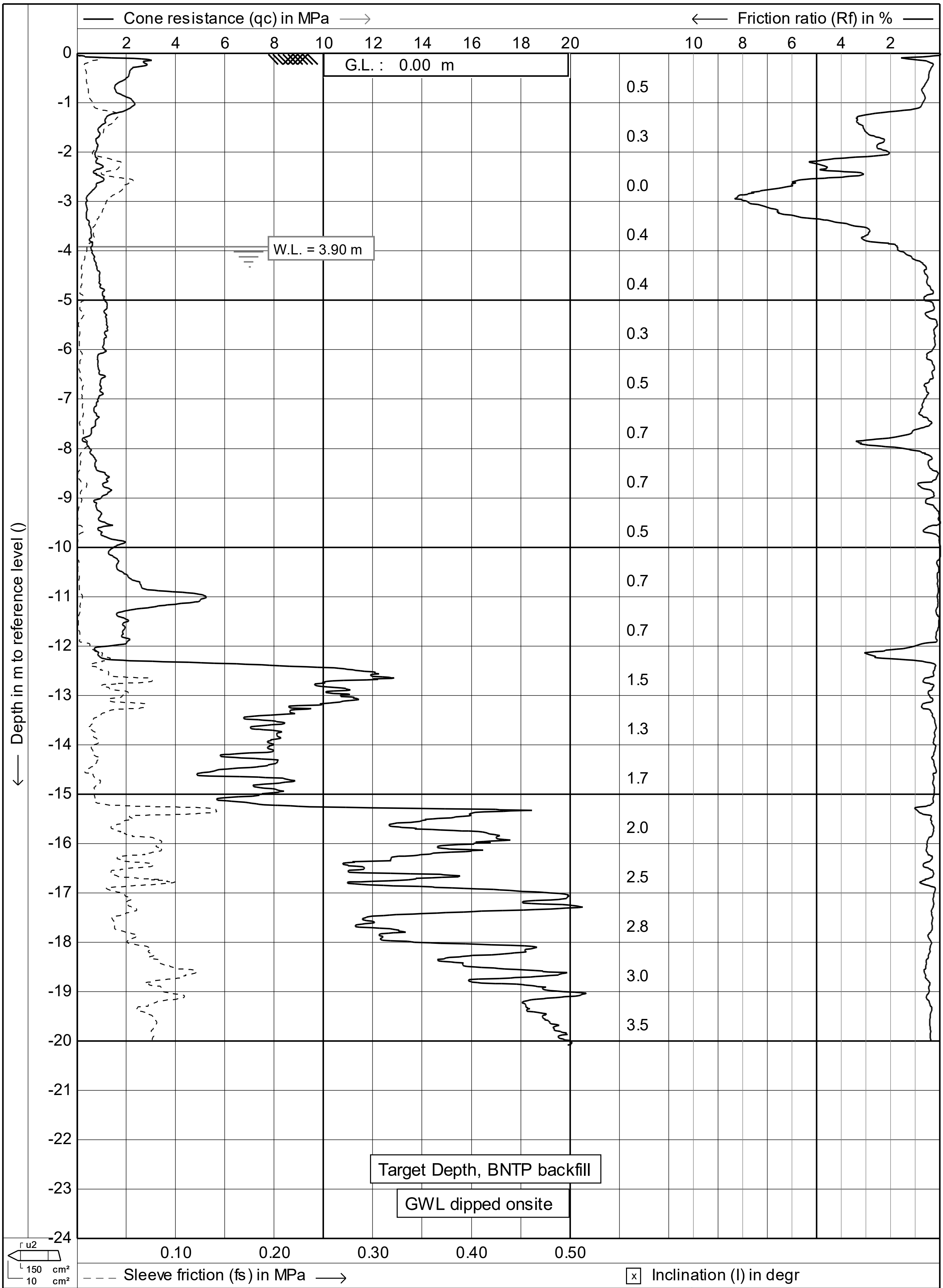
Cone no. : **C10CFIIP.C17803**

Project no. : **05CMW099**

CPT no. : **07**

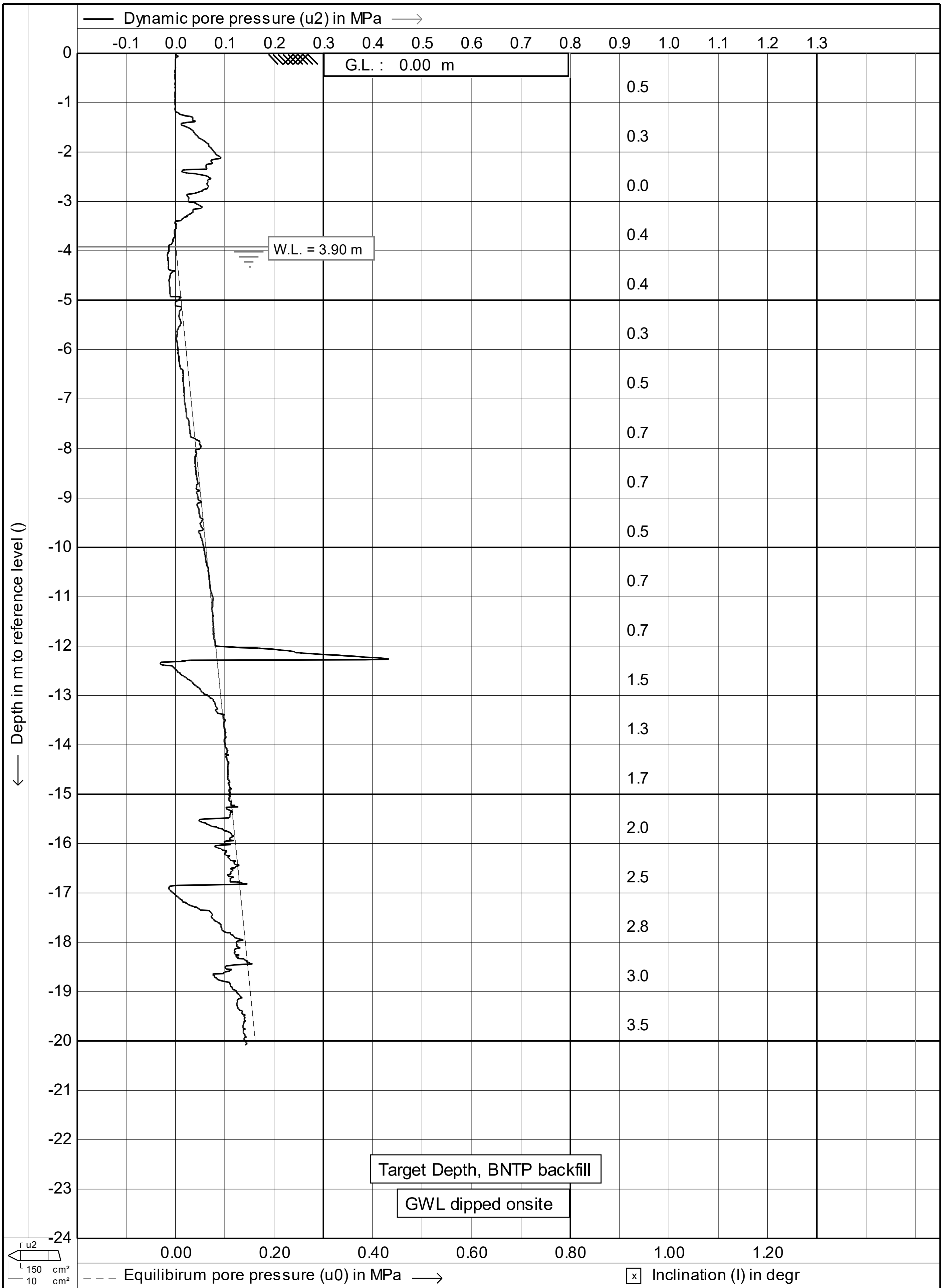
9/14

1.48



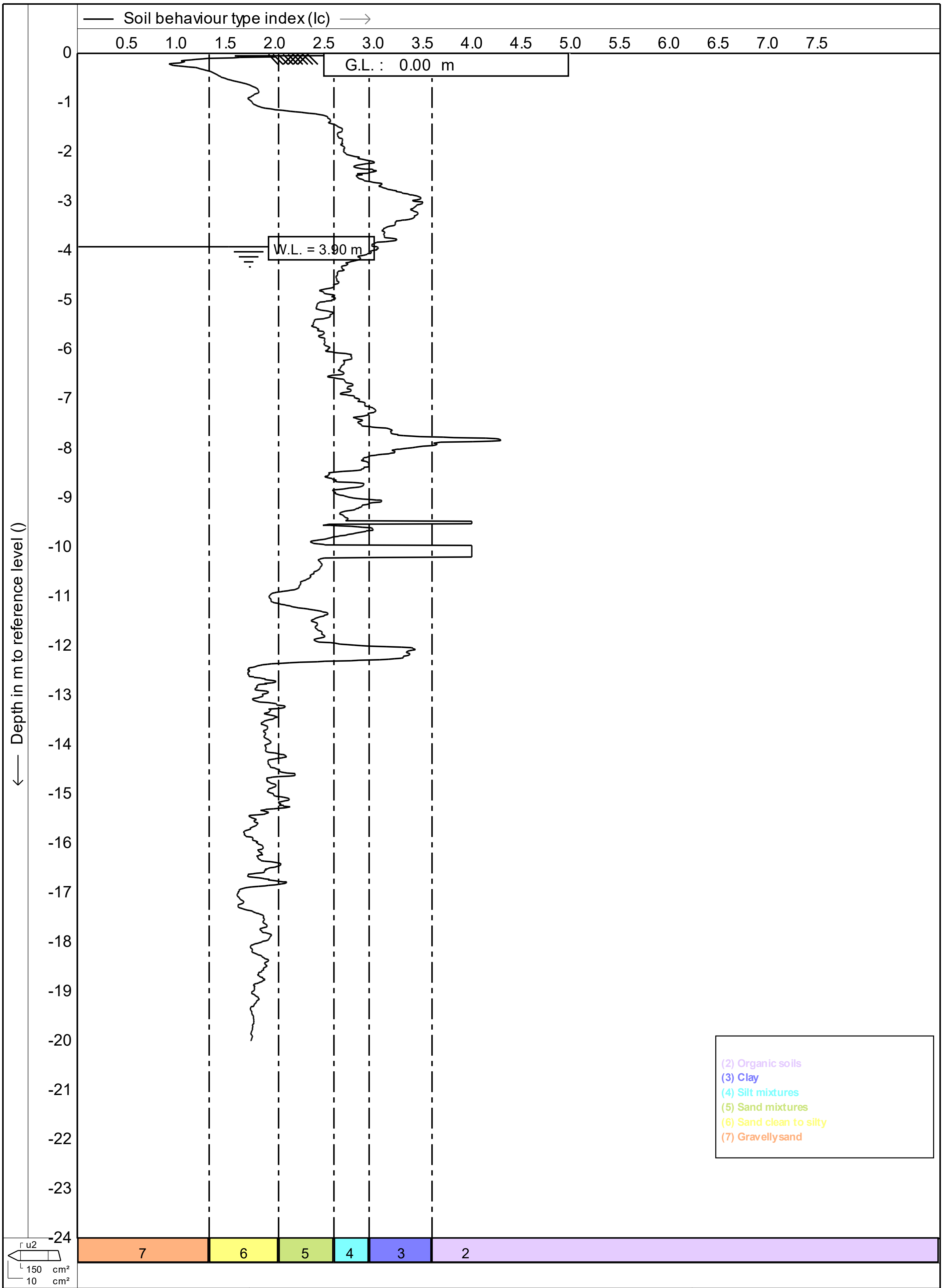
PERRY GEOTECH	Test according A.S.T.M Standard D 5778-12	Date : **18/01/2022**
	Project : **Site Investigations**	Cone no. : **C10CFIIP.C17803**
	Location: **1491 Arawa Rd Pongakawa**	Project no. : **05CMW099**
	Position: **0, 0**	CPT no. : **08** **1/14**

1.48



	Test according A.S.T.M Standard D 5778-12	Date : **18/01/2022**
PERRY GEOTECH	Project : **Site Investigations**	Cone no. : **C10CFIIP.C17803**
	Location: **1491 Arawa Rd Pongakawa**	Project no. : **05CMW099**
	Position: **0, 0**	CPT no. : **08** — **2/14**

1.48



PERRY GEOTECH

Test according A.S.T.M Standard D 5778-12

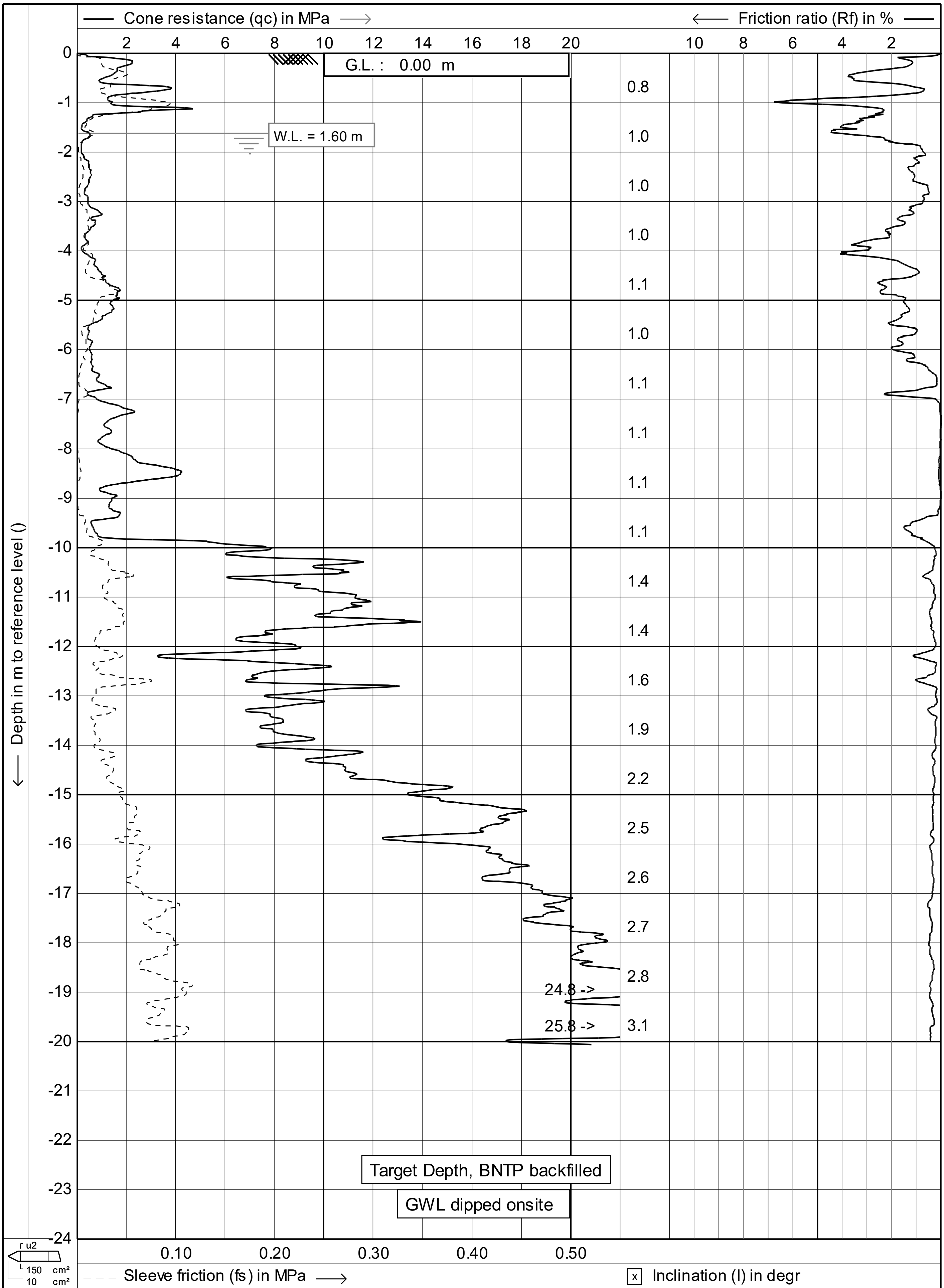
Project : **Site Investigations**

Location: **1491 Arawa Rd Pongakawa**

Position: **0, 0**

Date	: **18/01/2022**
Cone no.	: **C10CFIIP.C17803**
Project no. :	**05CMW099**
CPT no.	: **08**

1.48



1.48

PERRY GEOTECH

Test according A.S.T.M Standard D 5778-12

Project : **Site Investigations**

Location: **1491 Arawa Rd Pongakawa**

Position: **0, 0**

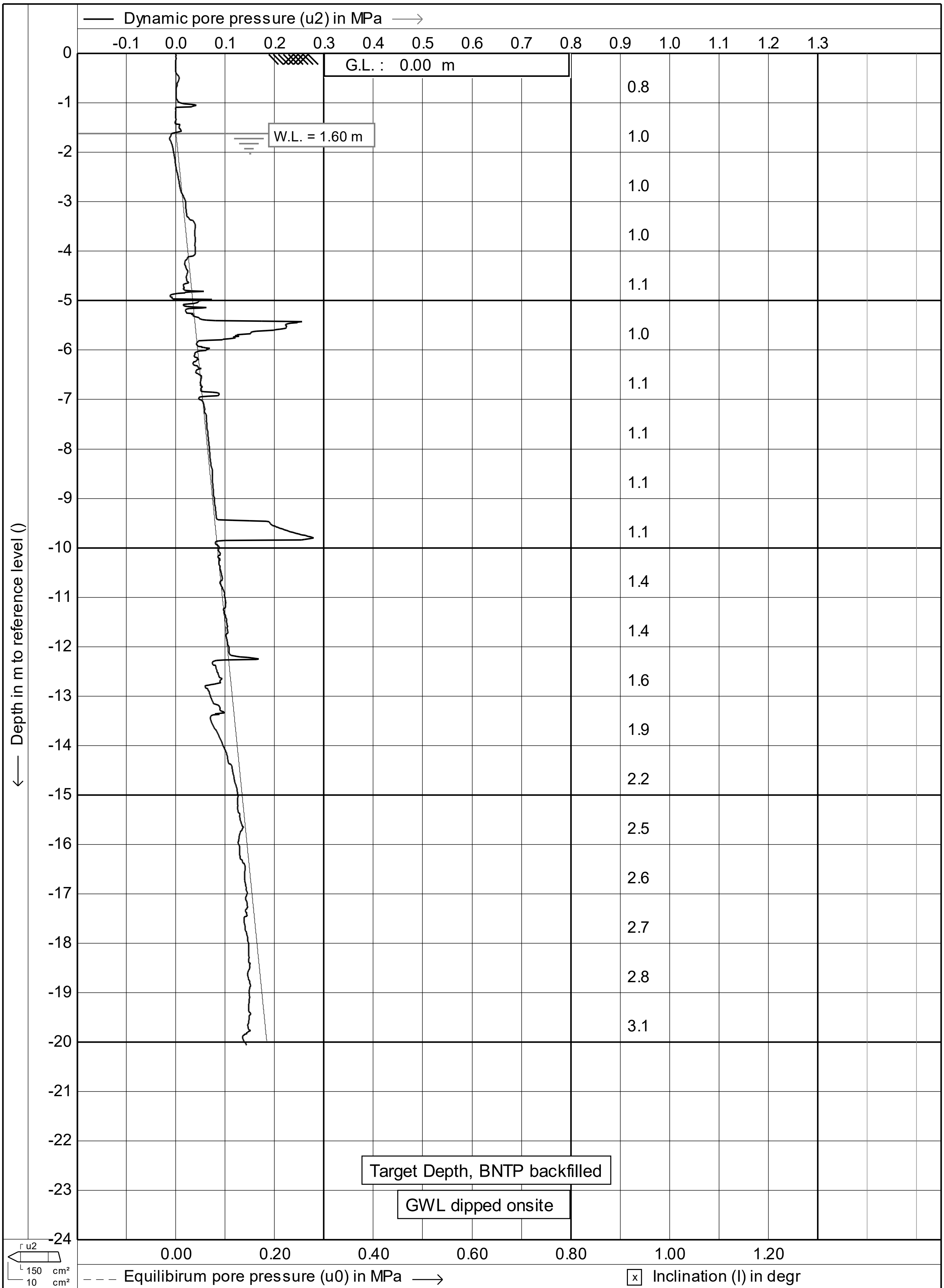
Date : **18/01/2022**

Cone no. : **C10CFIIP.C17803**

Project no. : **05CMW099**

CPT no. : **10**

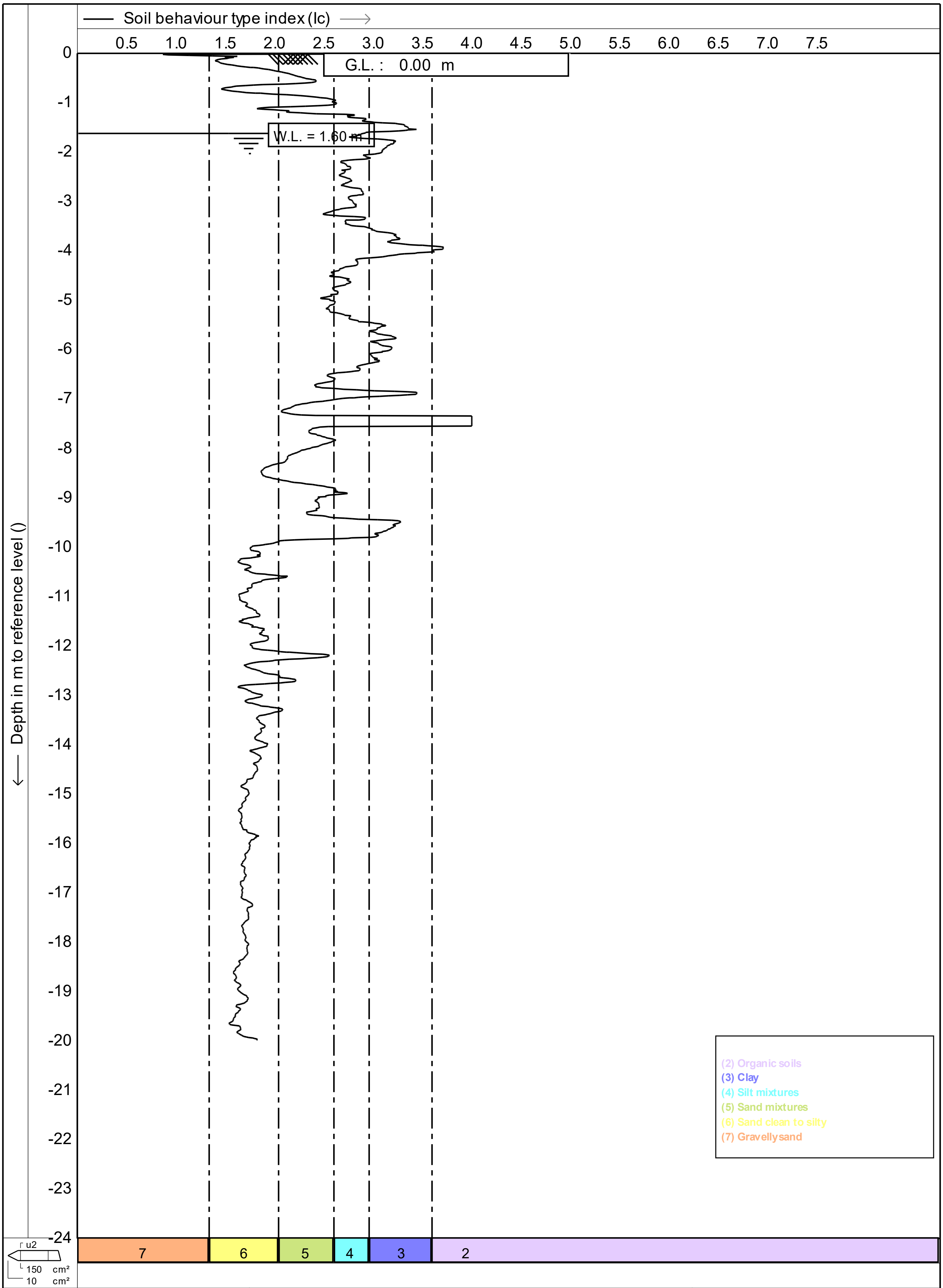
1/14



PERRY GEOTECH

Test according A.S.T.M Standard D 5778-12	Date : **18/01/2022**
Project : **Site Investigations**	Cone no. : **C10CFIIP.C17803**
Location: **1491 Arawa Rd Pongakawa**	Project no. : **05CMW099**
Position: **0, 0**	CPT no. : **10** **2/14**

1.48



PERRY GEOTECH

Test according A.S.T.M Standard D 5778-12

Project : **Site Investigations**

Location: **1491 Arawa Rd Pongakawa**

Position: **0, 0**

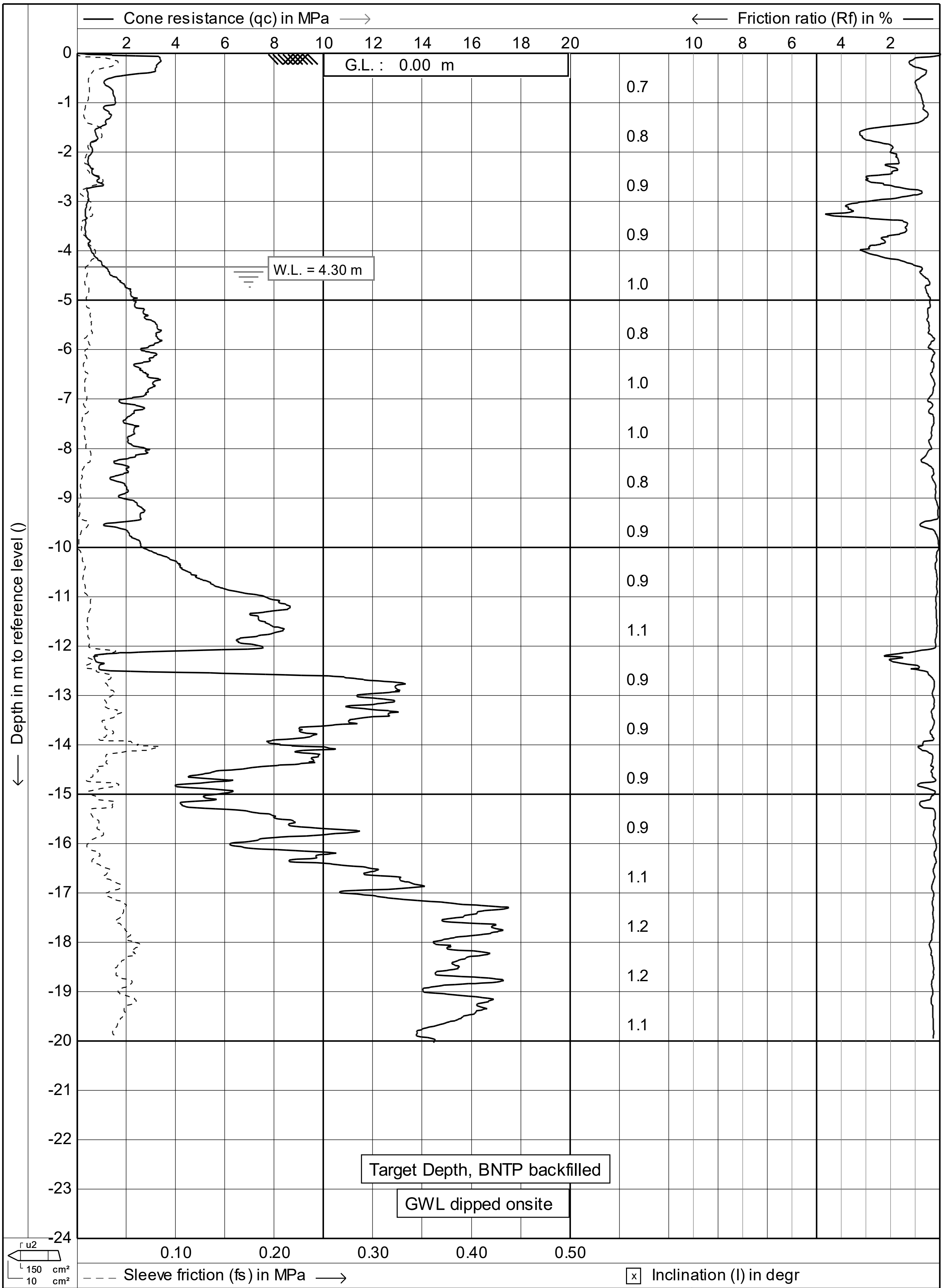
Date : **18/01/2022**

Cone no. : **C10CFIIP.C17803**

Project no. : **05CMW099**

CPT no. : **10**

1.48

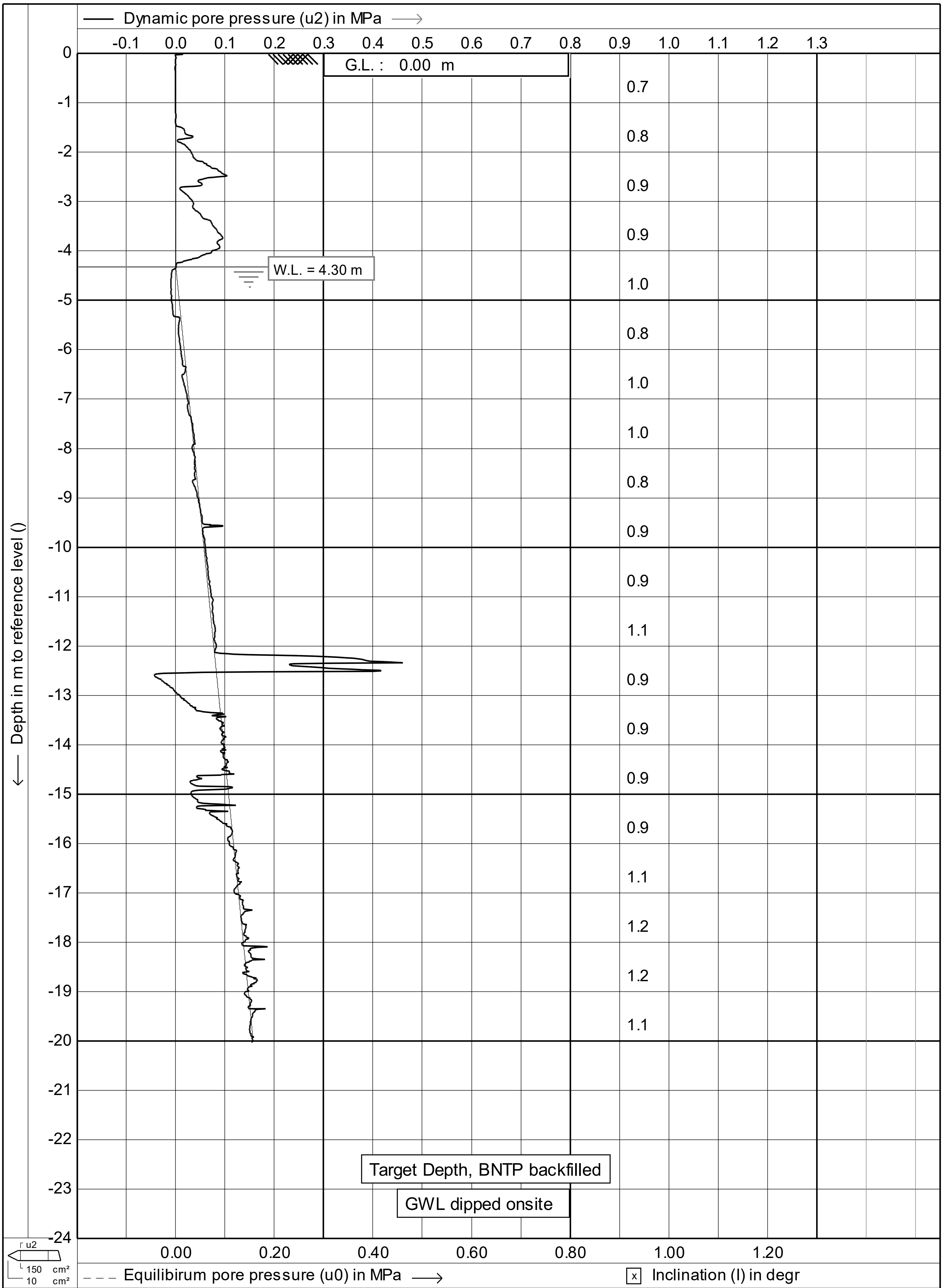


PERRY GEOTECH

Test according A.S.T.M Standard D 5778-12

Project :	**Site Investigations**
Location:	**1491 Arawa Rd Pongakawa**
Position:	**0, 0**
Date :	**18/01/2022**
Cone no. :	**C10CFIIP.C17803**
Project no. :	**05CMW099**
CPT no. :	**11**

1/14



PERRY GEOTECH

Test according A.S.T.M Standard D 5778-12

Project : **Site Investigations**

Location: **1491 Arawa Rd Pongakawa**

Position: **0, 0**

Date : **18/01/2022**

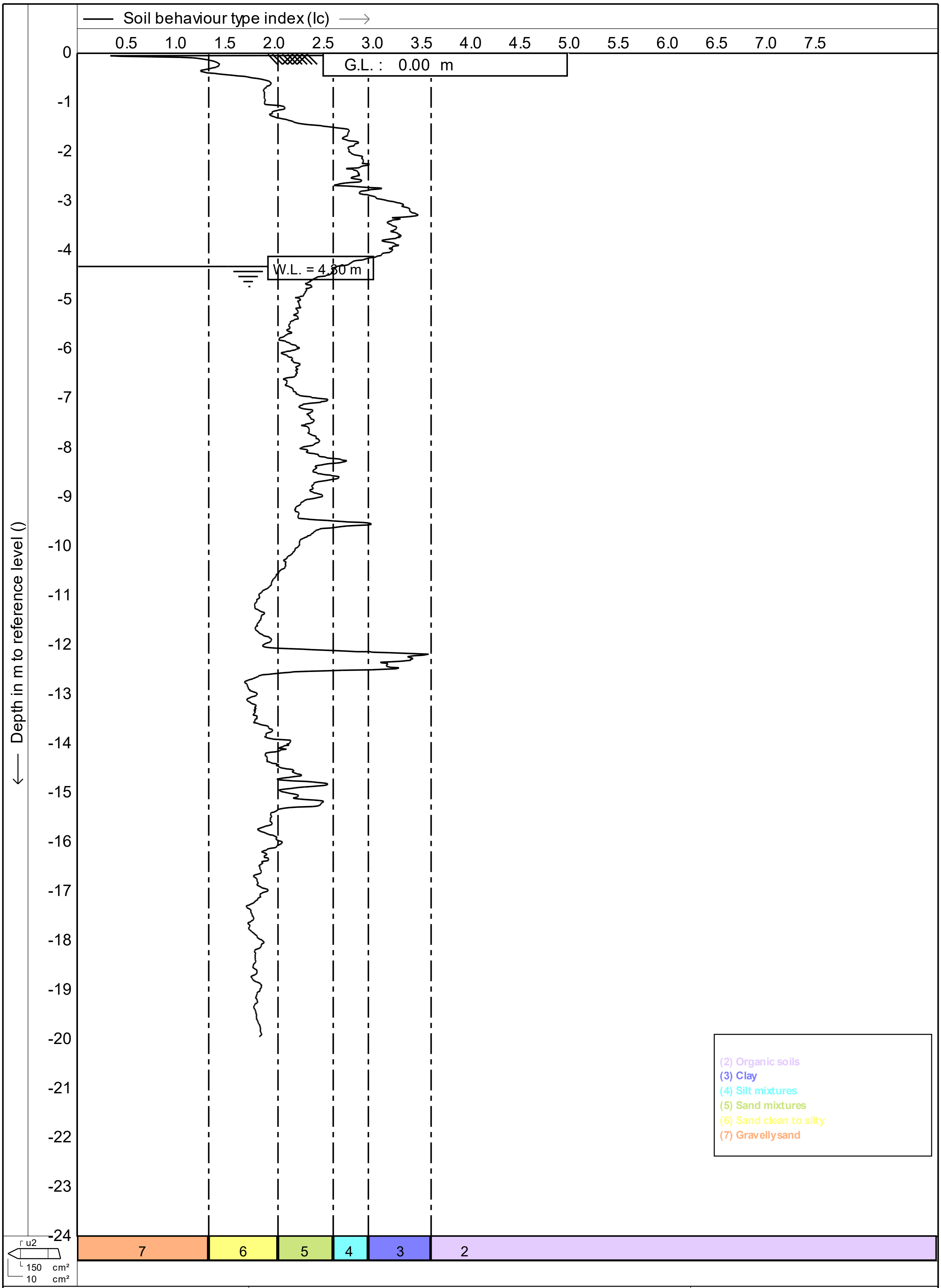
Cone no. : **C10CFIIP.C17803**

Project no. : **05CMW099**

CPT no. : **11**

2/14

1.48



PERRY GEOTECH

Test according A.S.T.M Standard D 5778-12

Project : **Site Investigations**

Location: **1491 Arawa Rd Pongakawa**

Position: **0, 0**

Date : **18/01/2022**

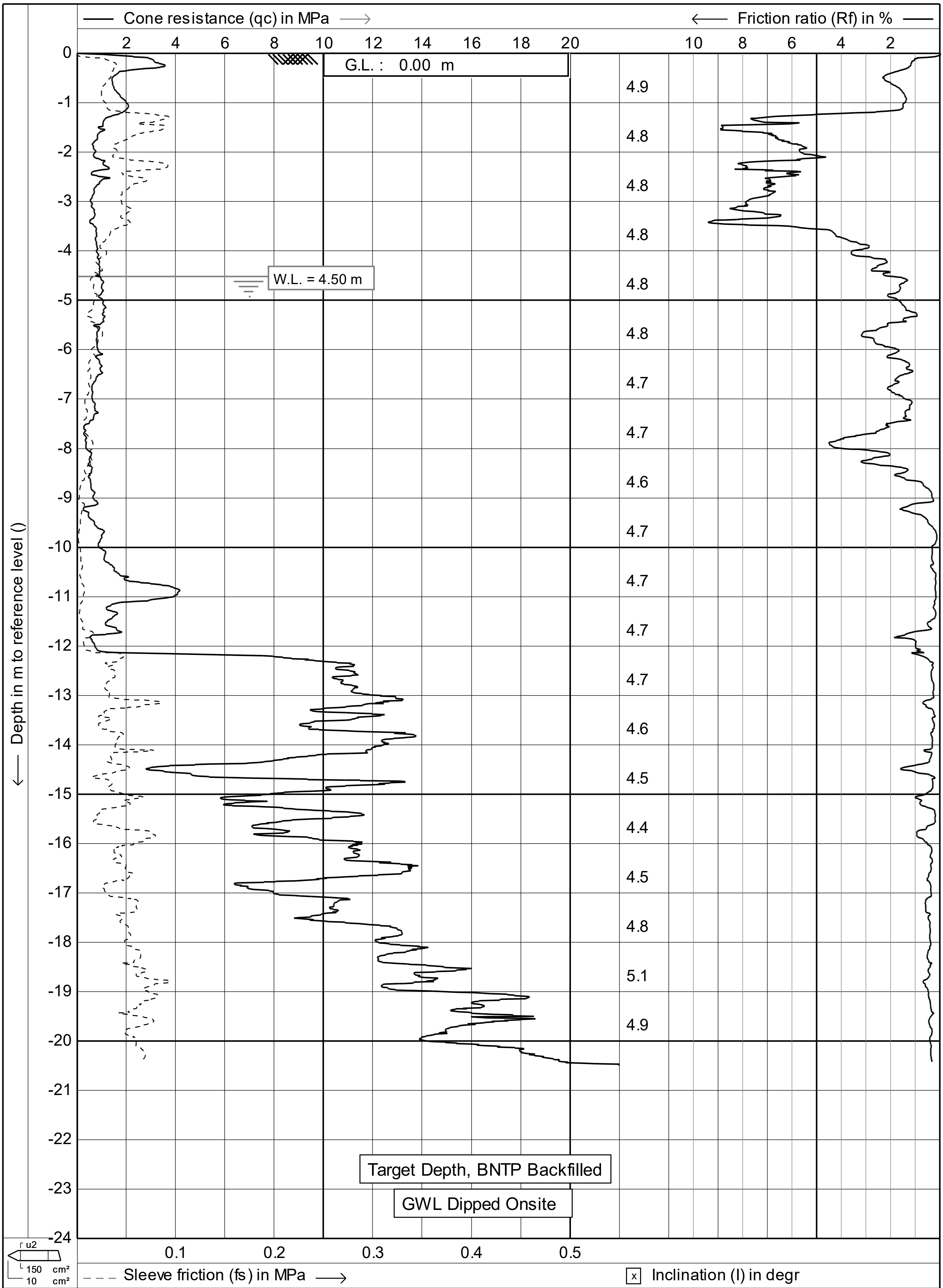
Cone no. : **C10CFIIP.C17803**

Project no. : **05CMW099**

CPT no. : **11**

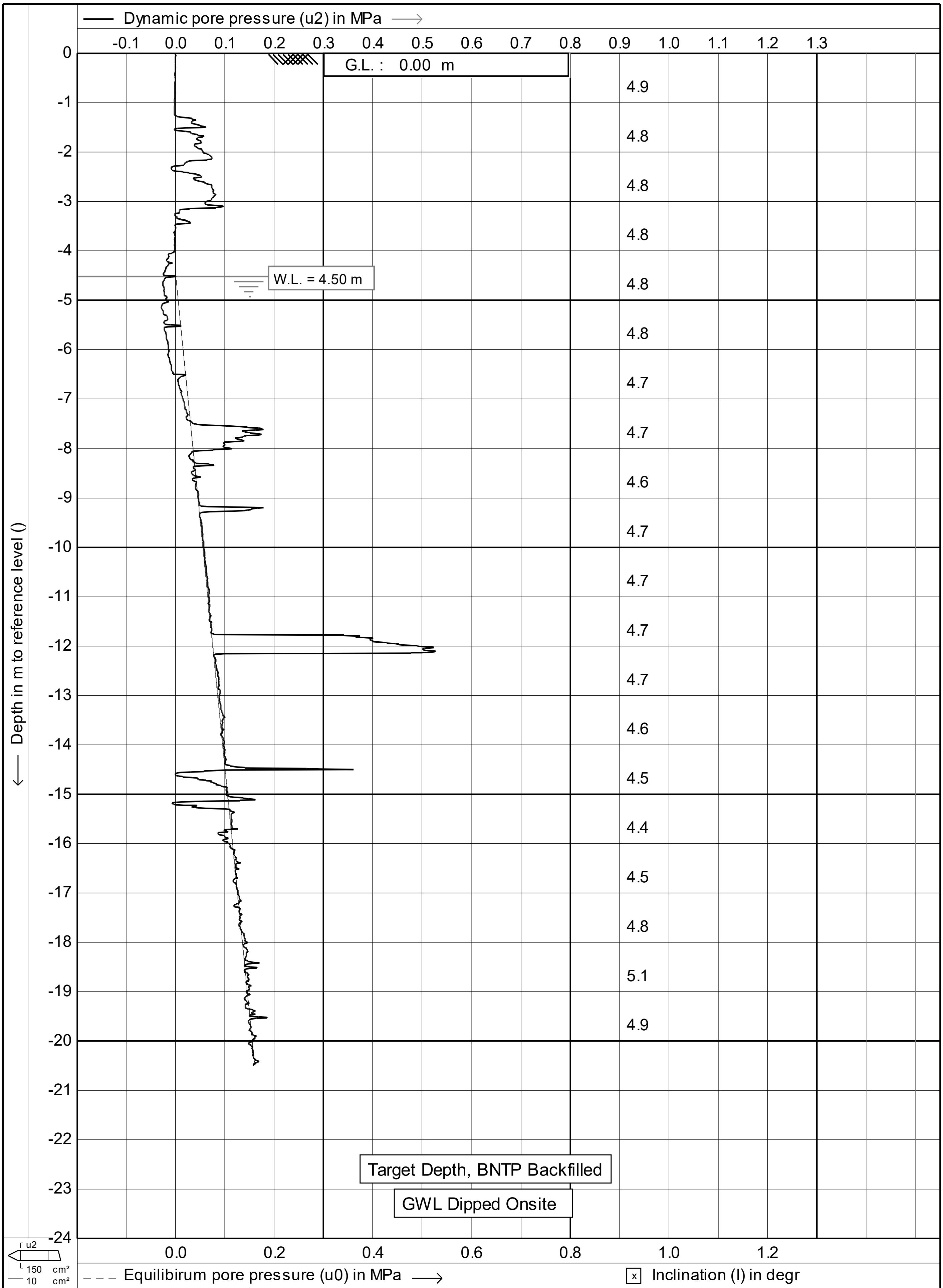
9/14

1.48



PERRY GEOTECH	A.S.T.M D5778-12	Date : **19/01/2022**
	Project : **Site Investigations**	Cone no. : **C10CFIIP.C15212**
	Location: **Arawa Rd - Pongakawa**	Project no. : **02CMW099**
	Position: **0, 0**	CPT no. : **SCPT12** **1/14**

1.49



PERRY GEOTECH

A.S.T.M D5778-12

Project : **Site Investigations**

Location: **Arawa Rd - Pongakawa**

Position: **0, 0**

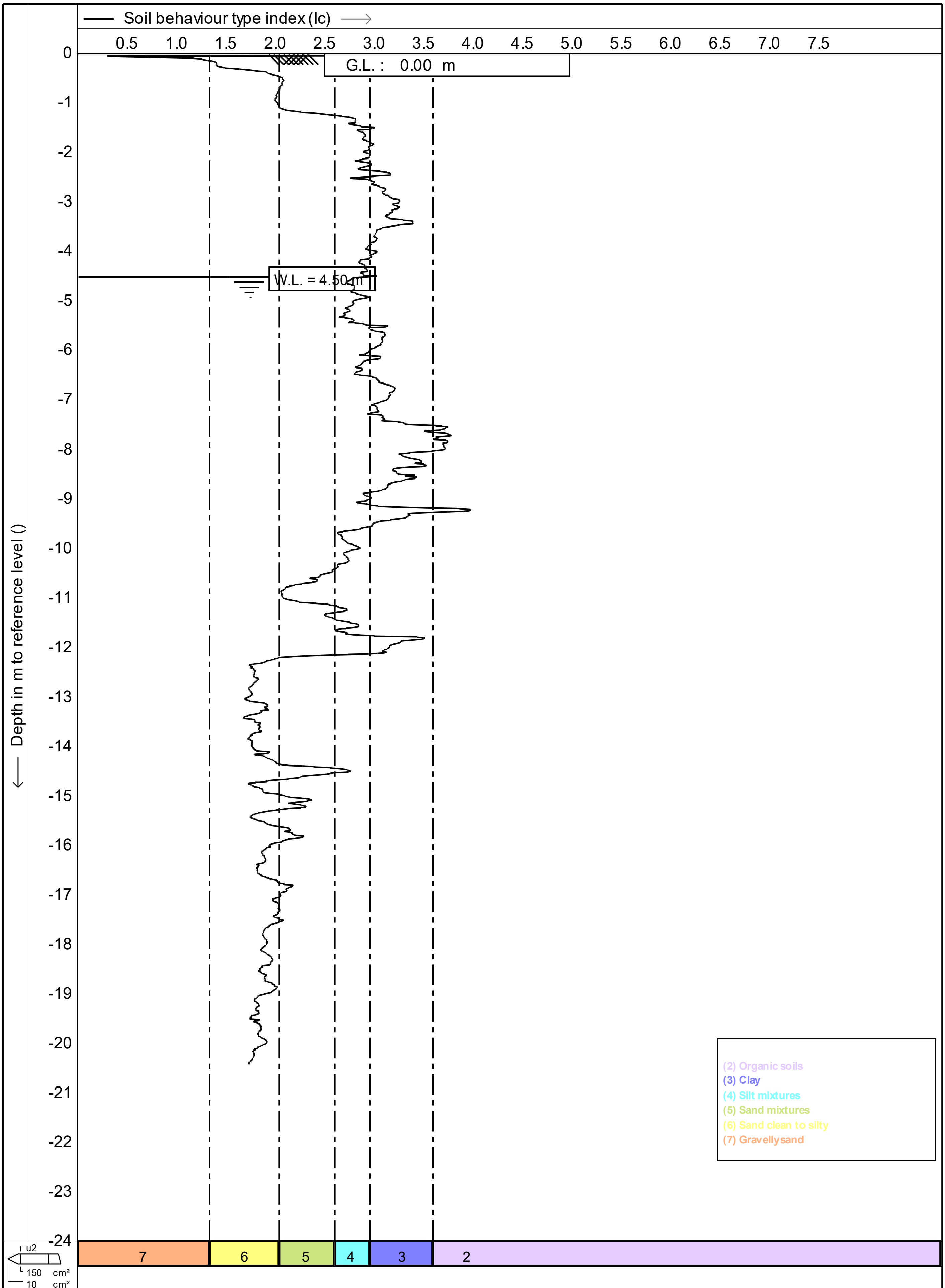
Date : **19/01/2022**

Cone no. : **C10CFIIP.C15212**

Project no. : **02CMW099**

CPT no. : **SCPT12** **2/14**

1.49



1.49

PERRY GEOTECH

A.S.T.M D5778-12

Project : **Site Investigations**

Location: **Arawa Rd - Pongakawa**

Position: **0, 0**

Date : **19/01/2022**

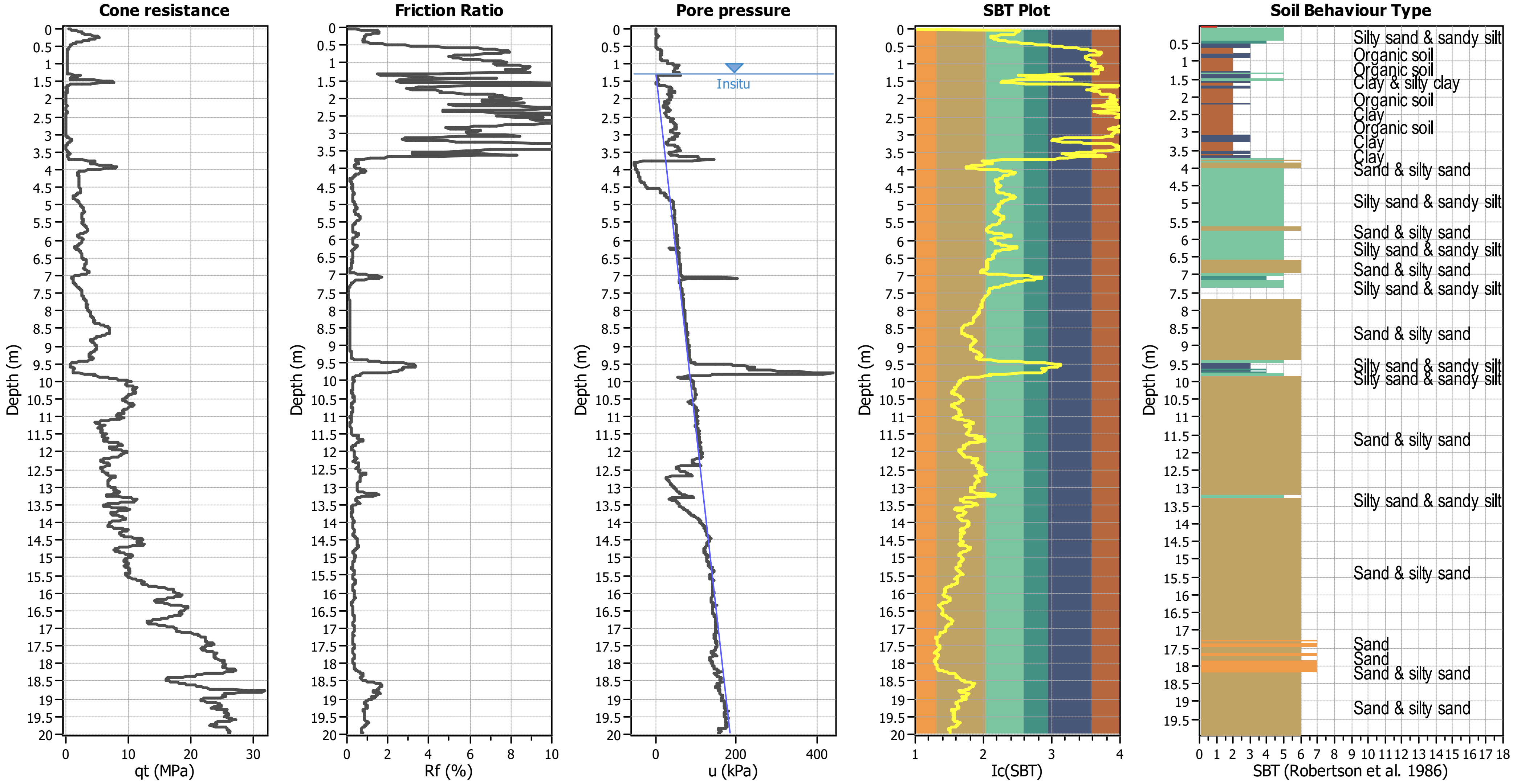
Cone no. : **C10CFIIP.C15212**

Project no. : **02CMW099**

CPT no. : **SCPT12** **9/14**

Appendix D: Liquefaction Analyses

CPT basic interpretation plots



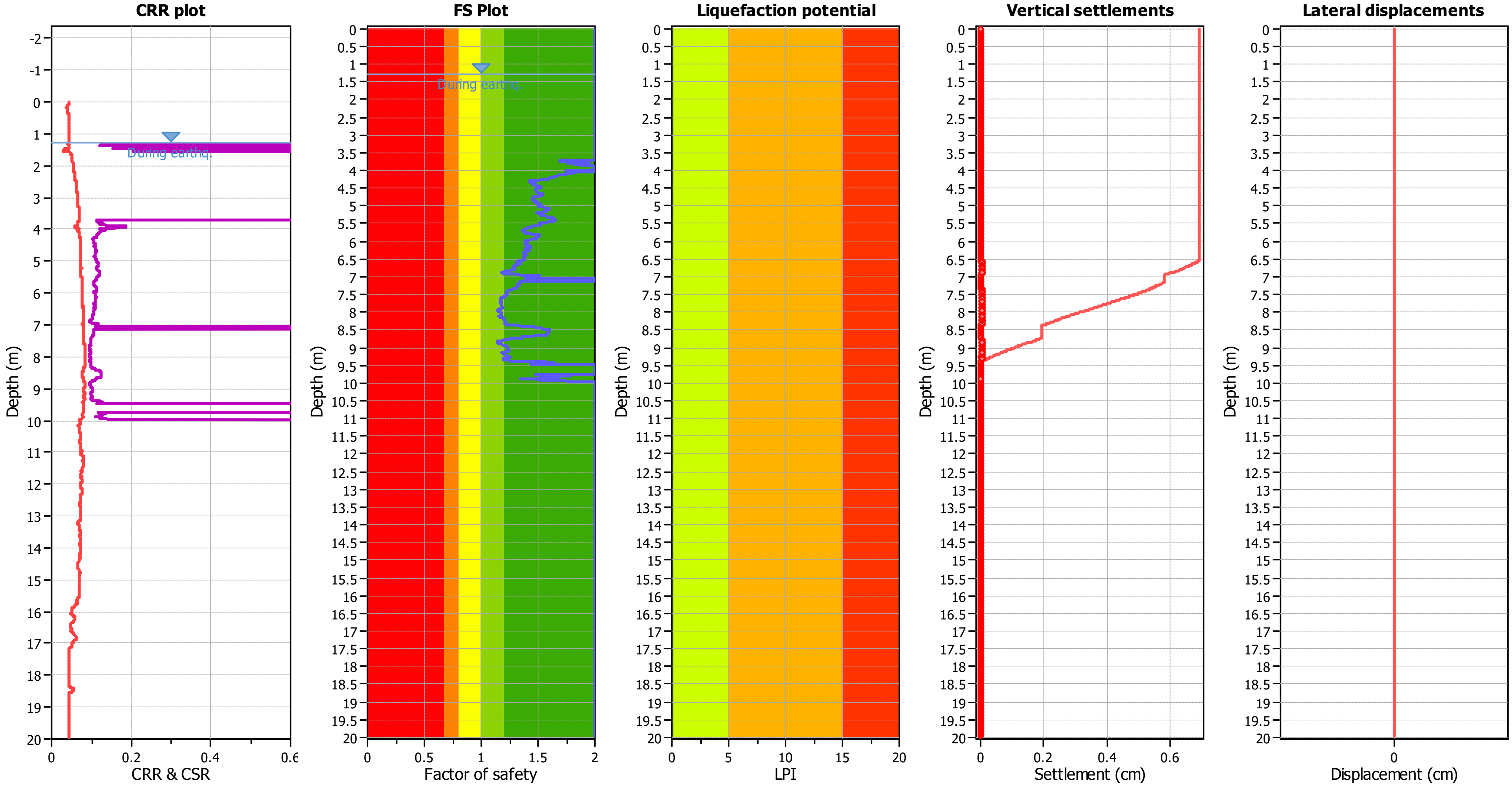
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.30 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.08	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.30 m	Fill height:	N/A	Limit depth:	10.00 m

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.):	1.30 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.08	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.30 m	Fill height:	N/A	Limit depth:	10.00 m

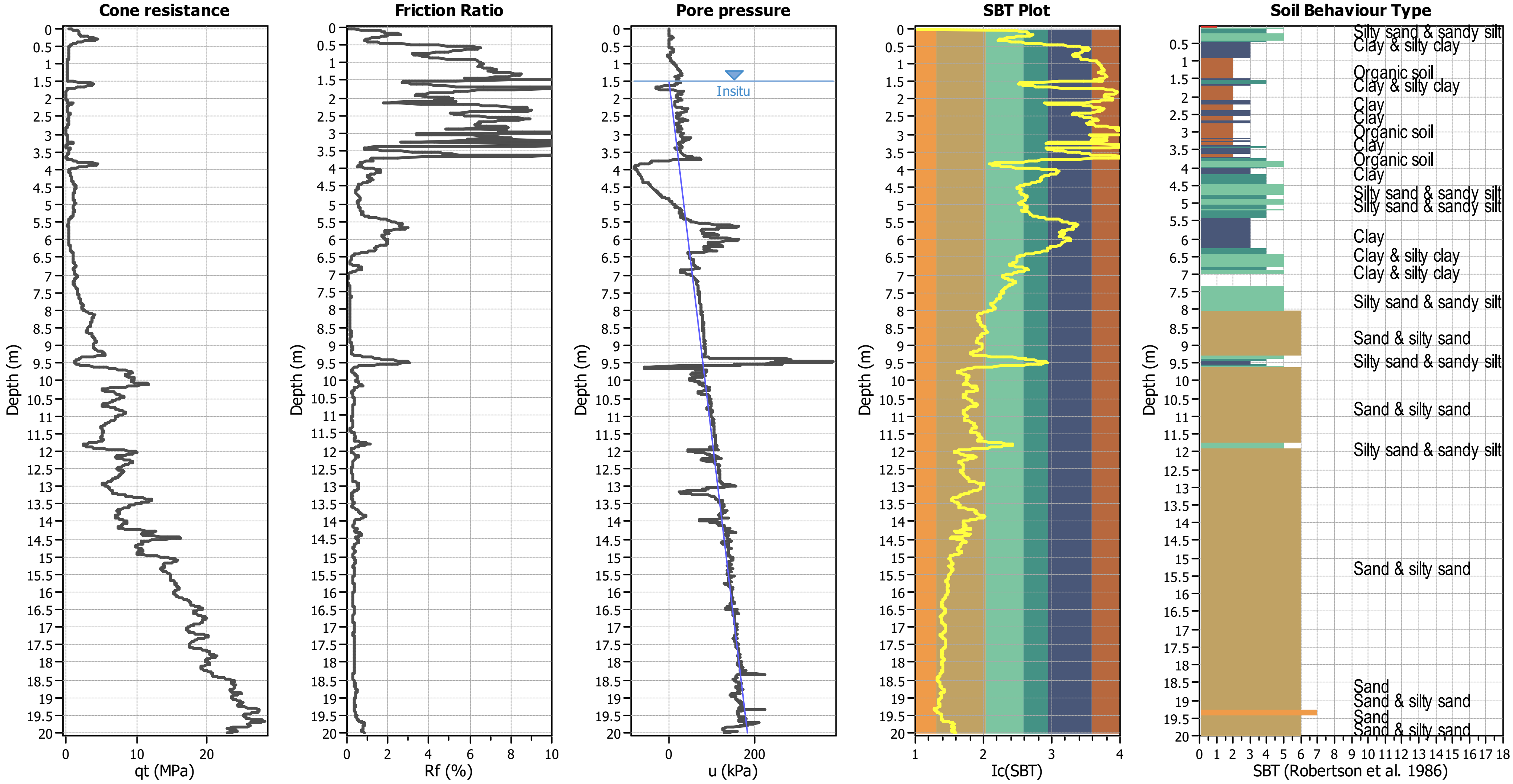
F.S. color scheme

- 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

LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



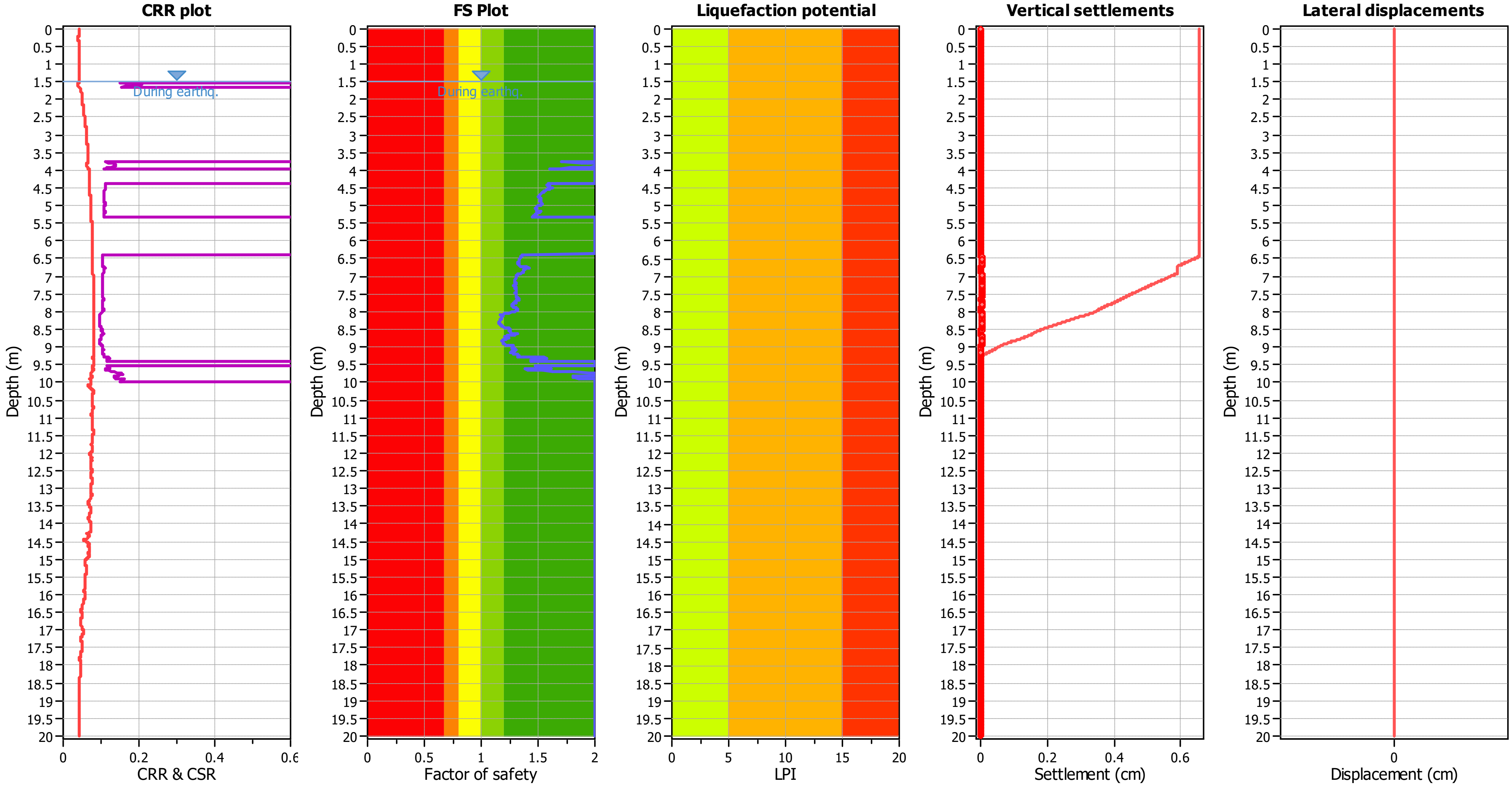
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.08	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.50 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.08	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.50 m	Fill height:	N/A	Limit depth:	10.00 m

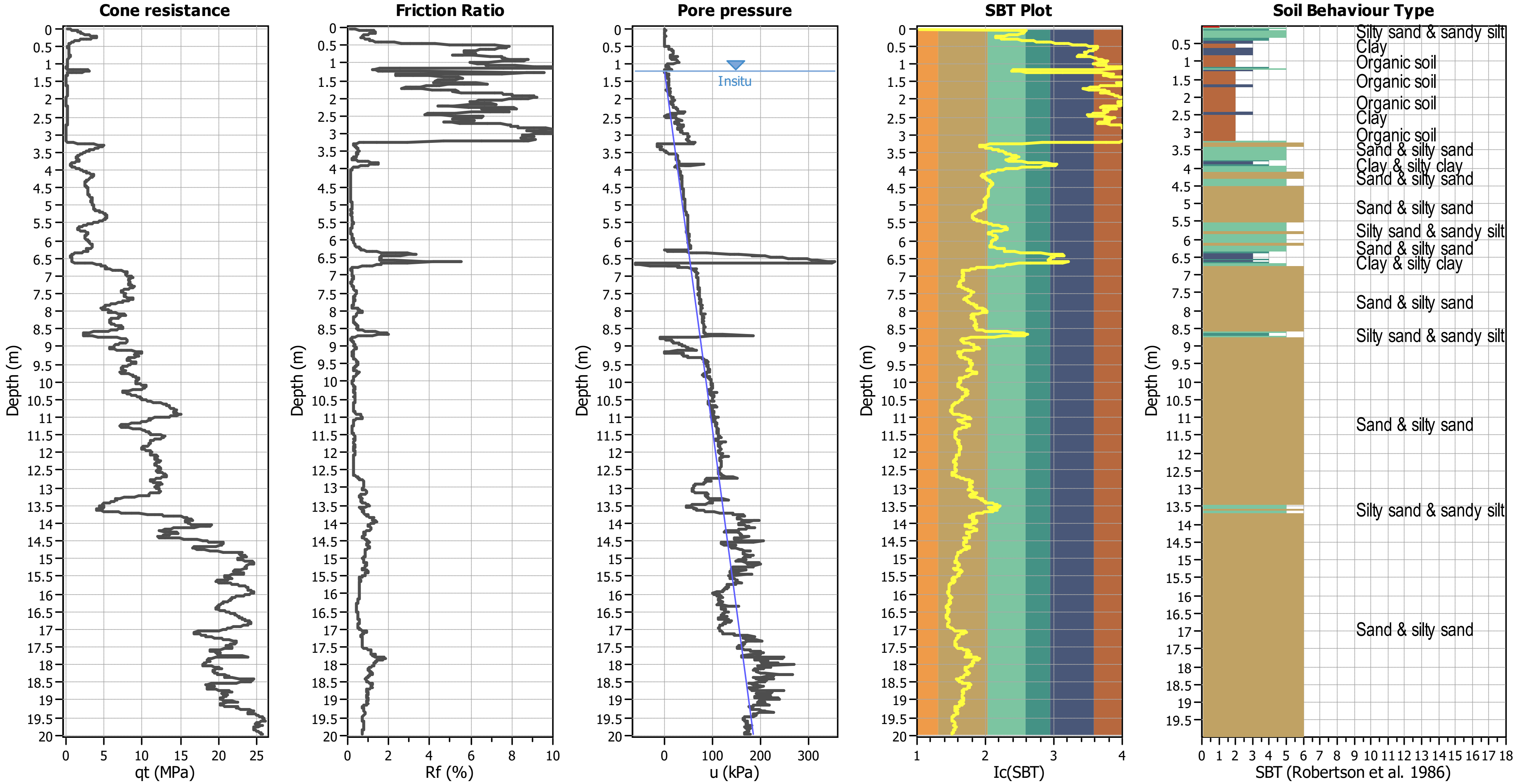
F.S. color scheme

- 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

LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



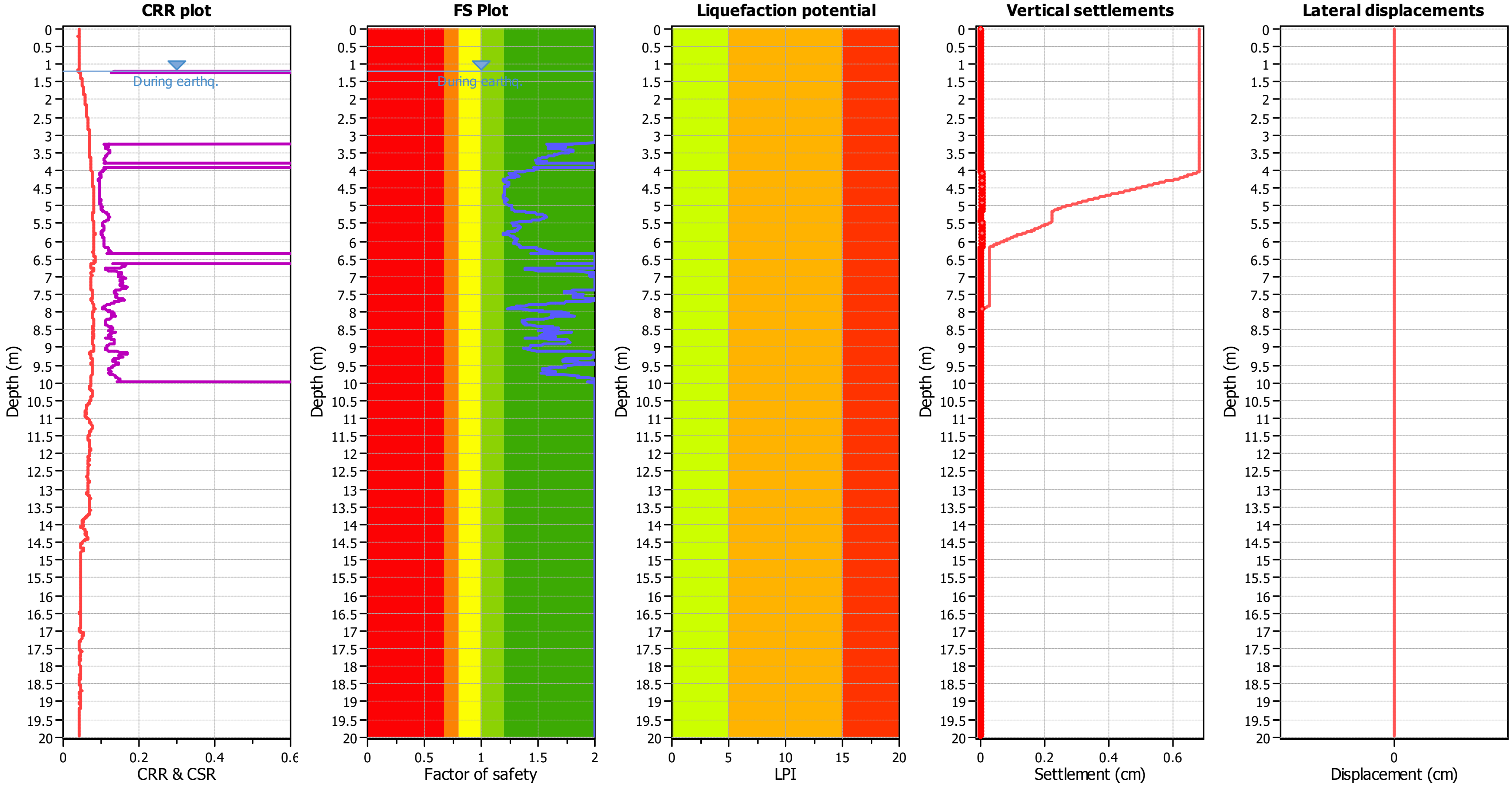
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.08	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.20 m	Fill height:	N/A	Limit depth:	10.00 m

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.):	1.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.08	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.20 m	Fill height:	N/A	Limit depth:	10.00 m

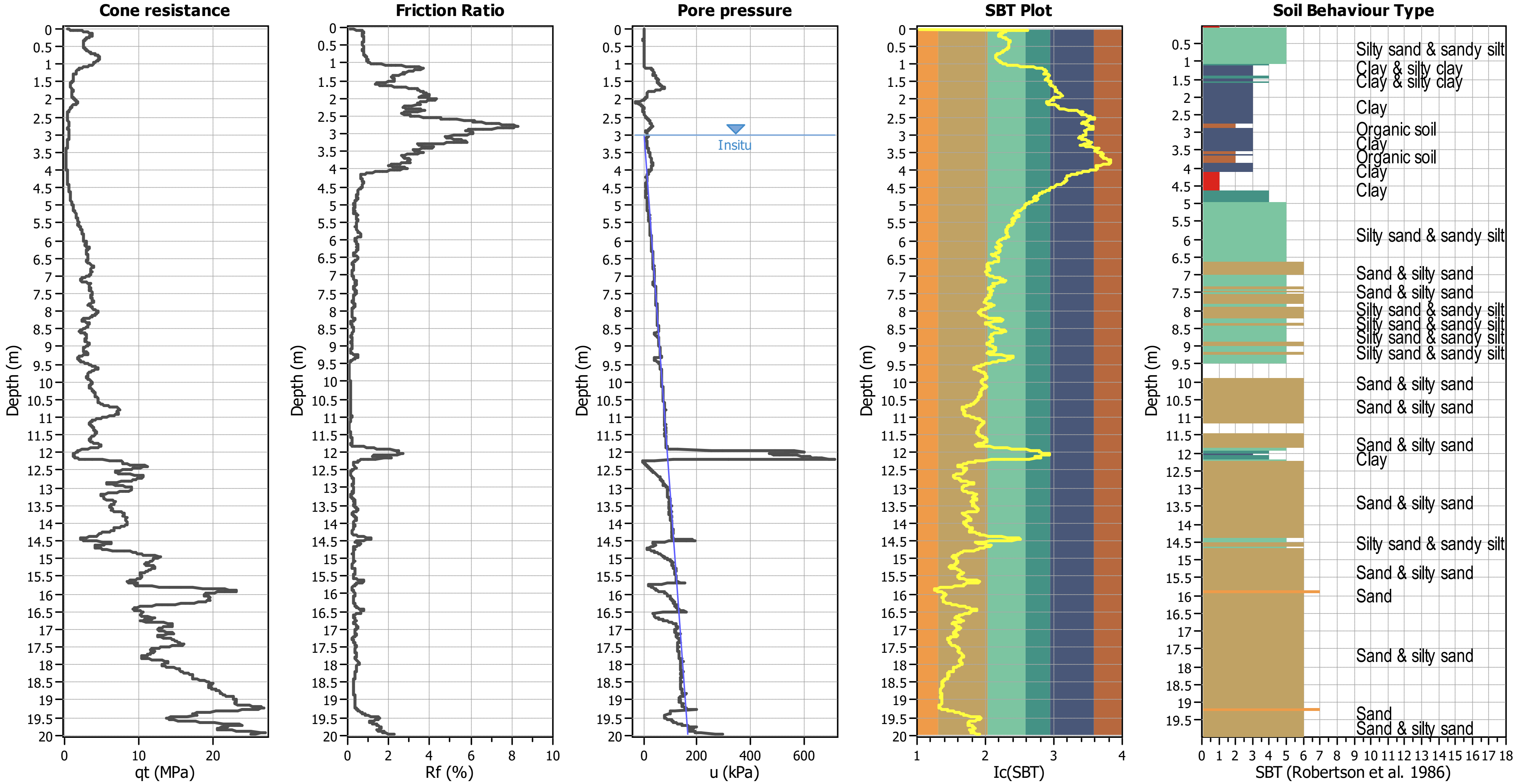
F.S. color scheme

- 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

LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



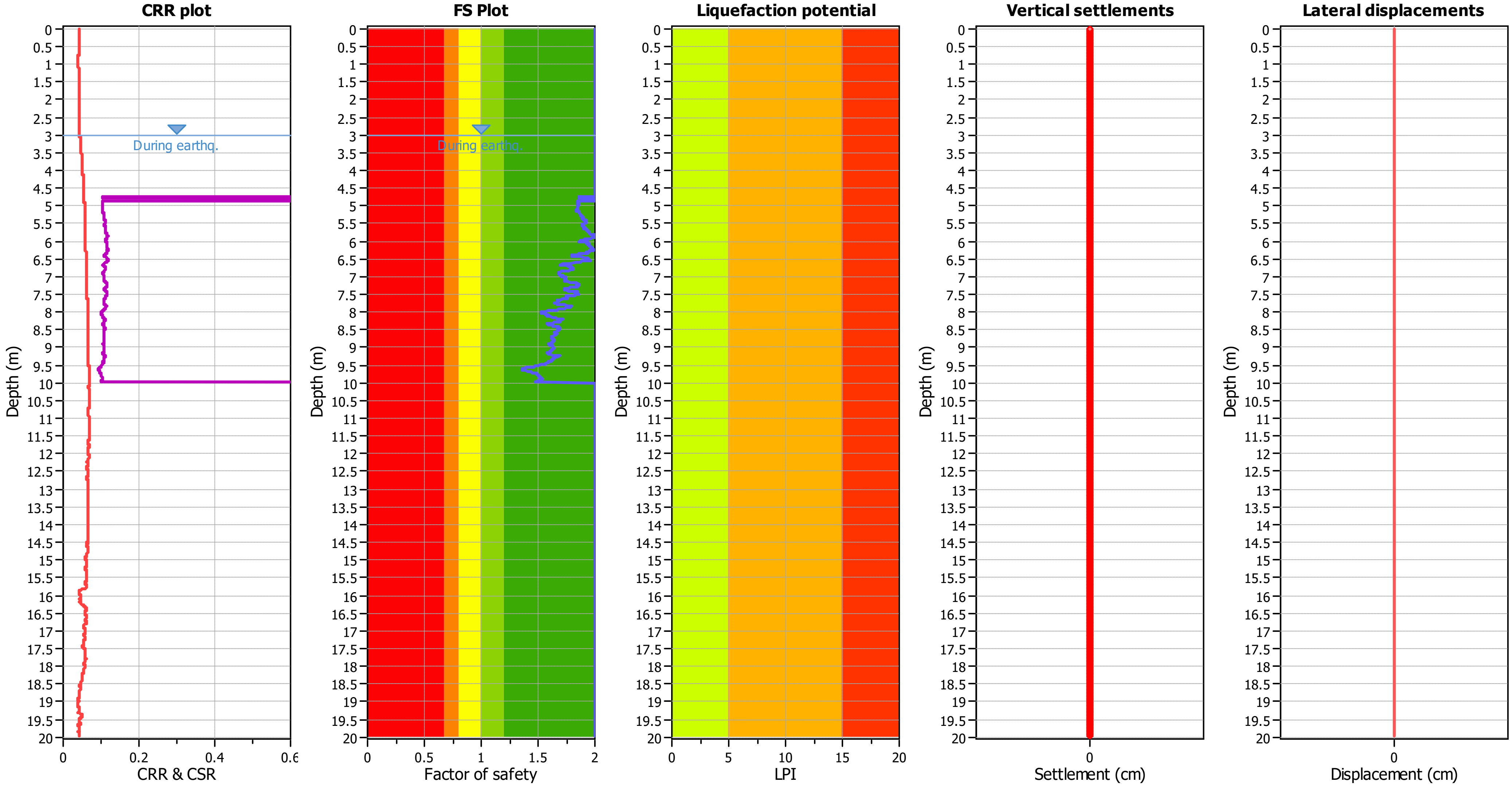
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.08	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	10.00 m

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.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.08	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	10.00 m

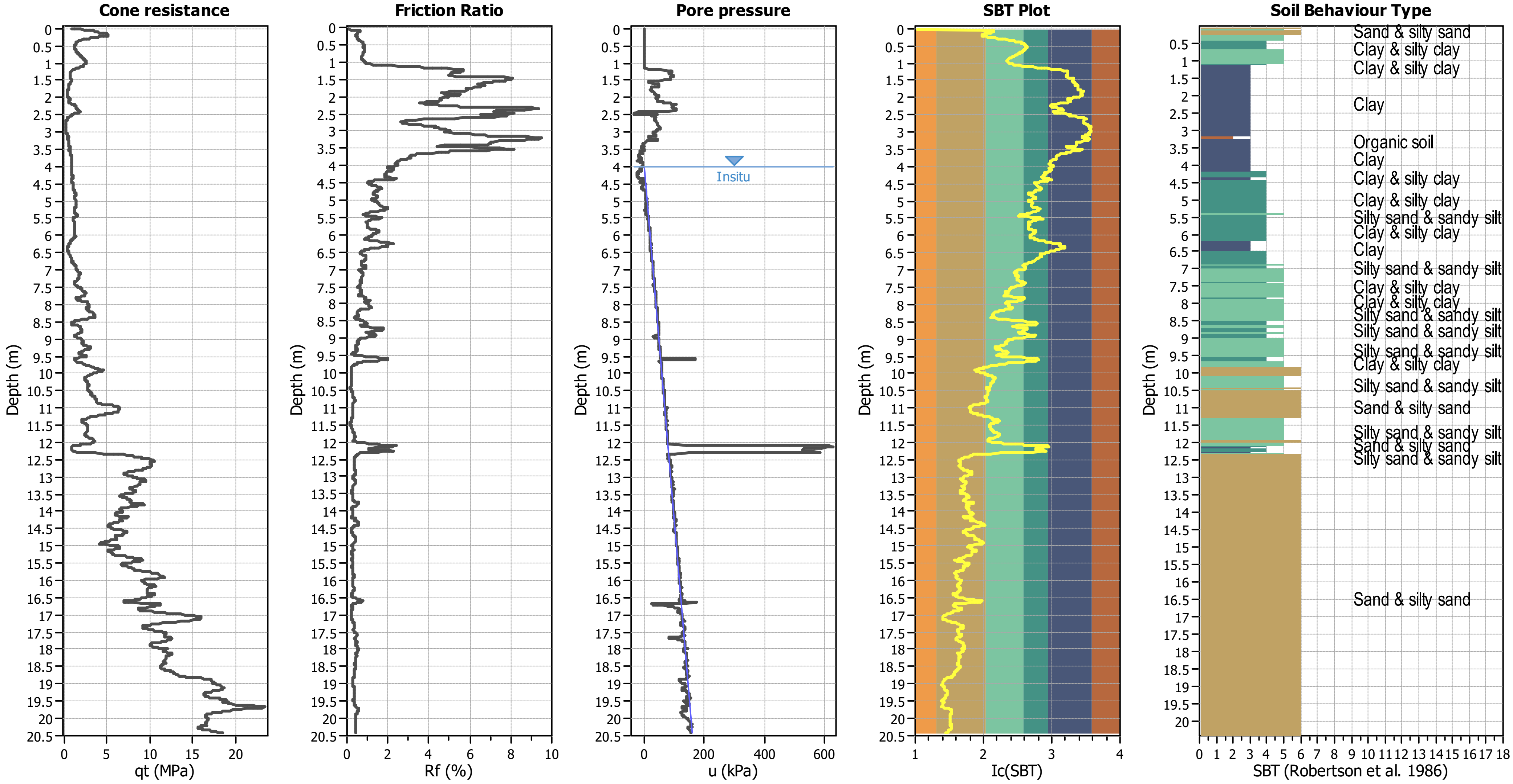
F.S. color scheme

- 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

LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



Input parameters and analysis data

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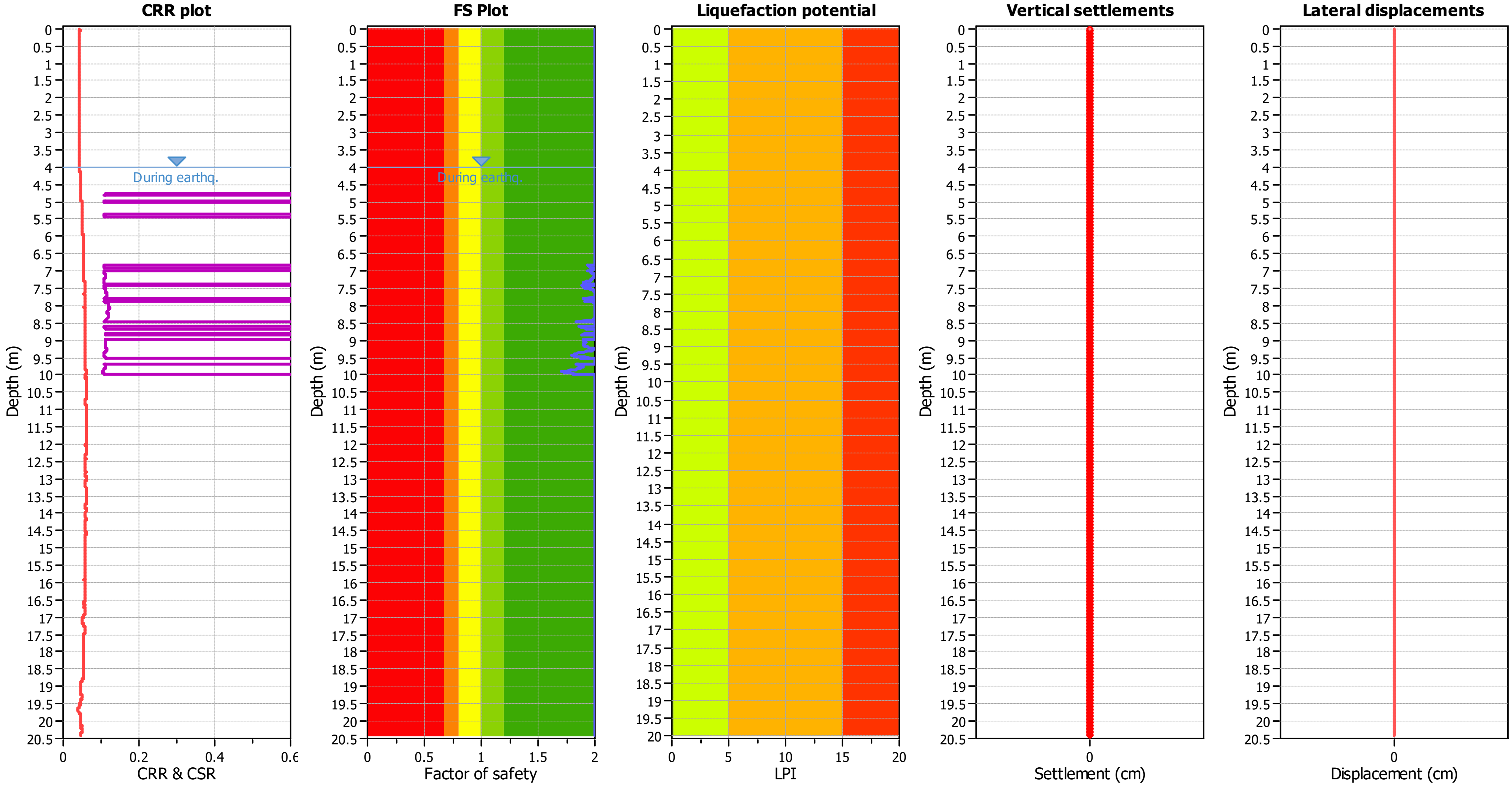
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.08	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	4.00 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.08	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	4.00 m	Fill height:	N/A	Limit depth:	10.00 m

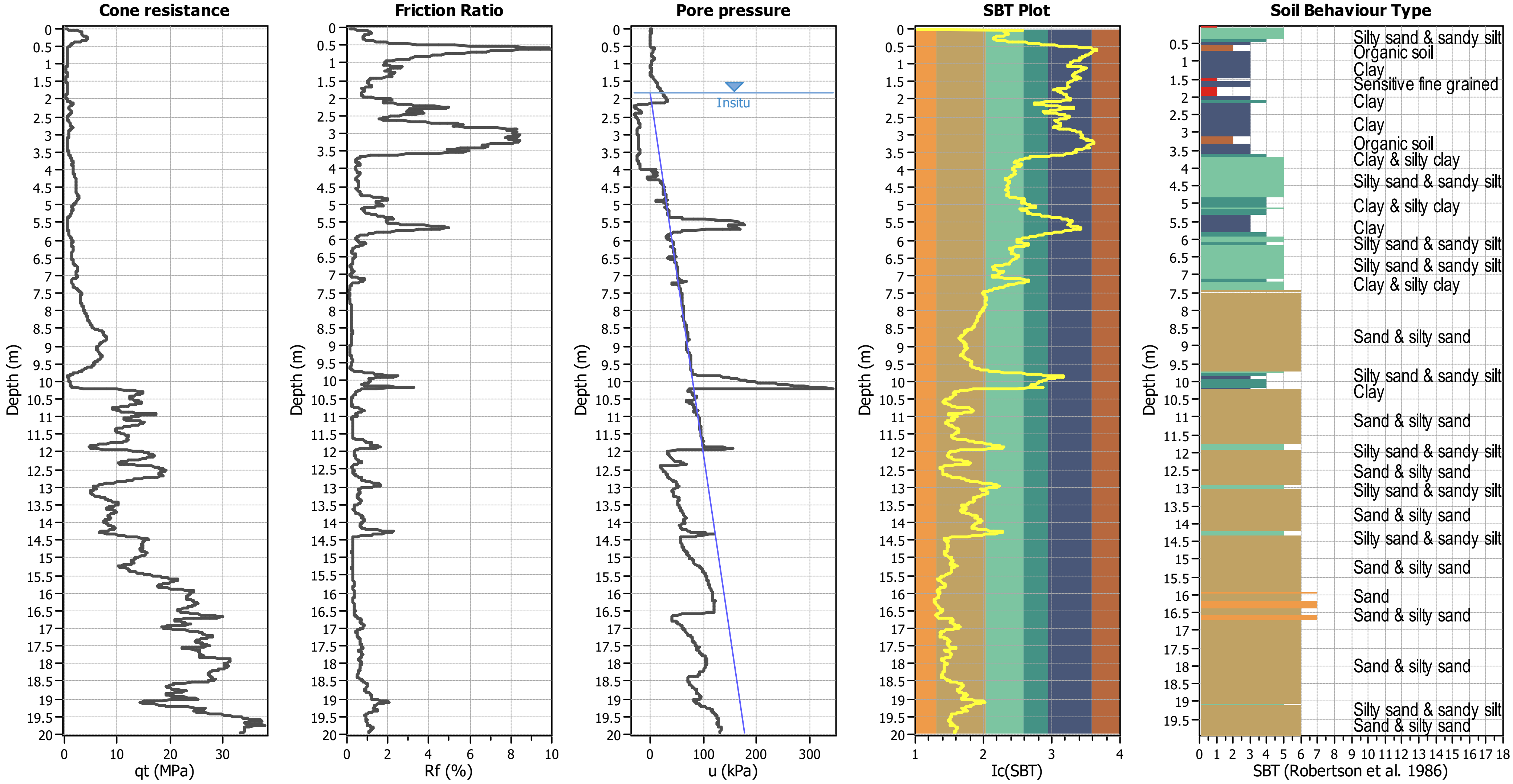
F.S. color scheme

- 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

LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



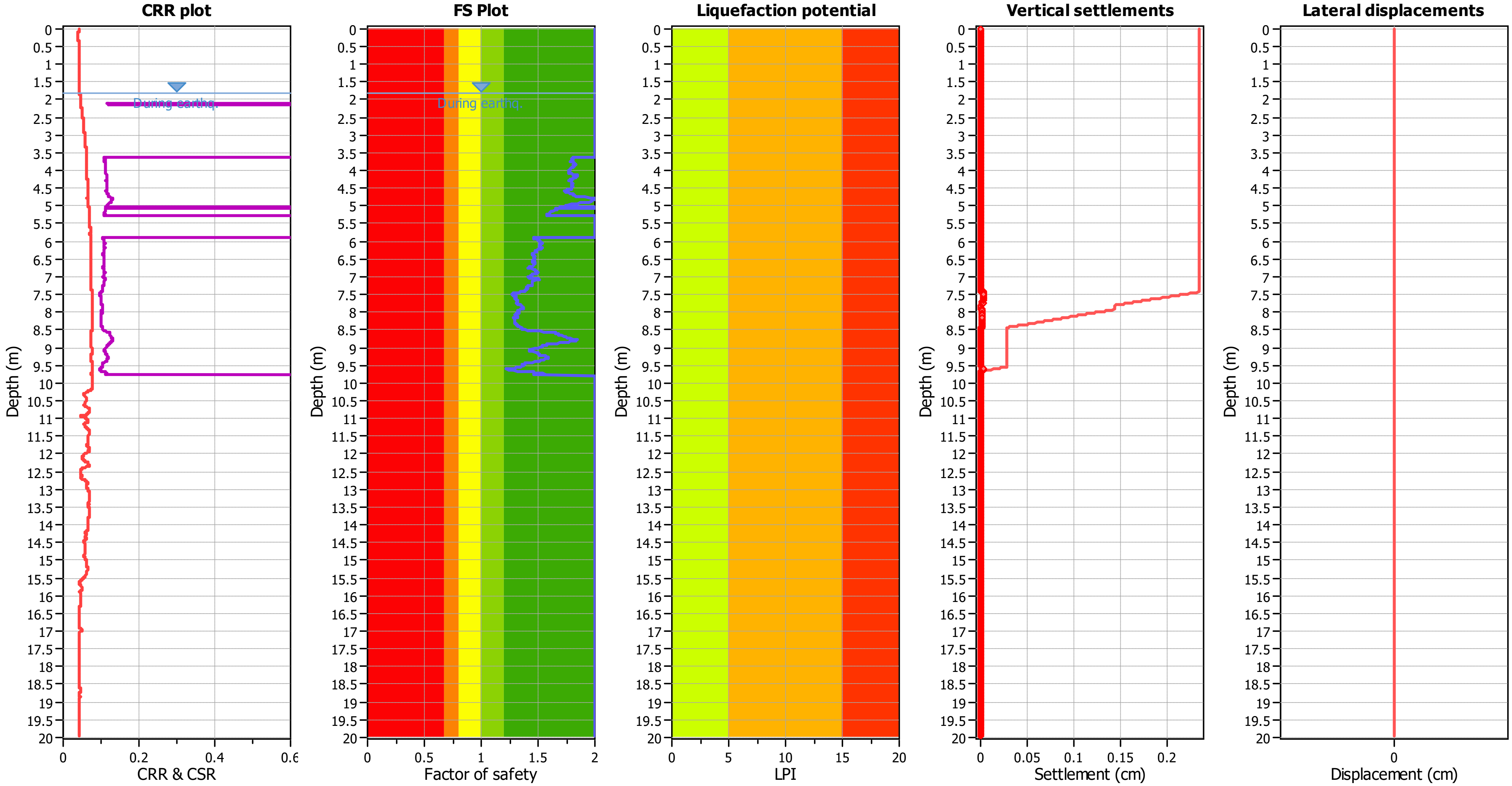
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.80 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.08	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.80 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.80 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.08	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.80 m	Fill height:	N/A	Limit depth:	10.00 m

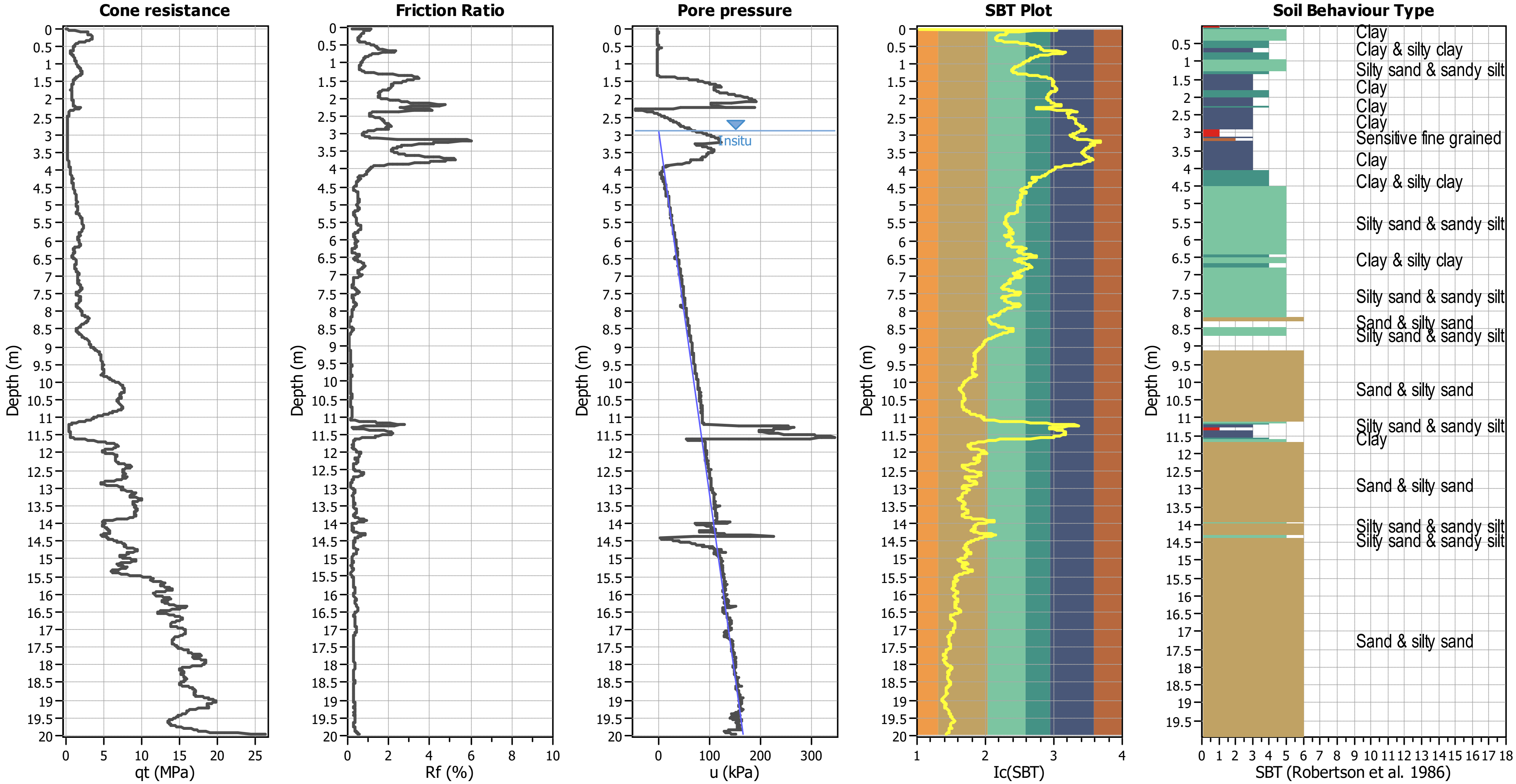
F.S. color scheme

- 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

LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



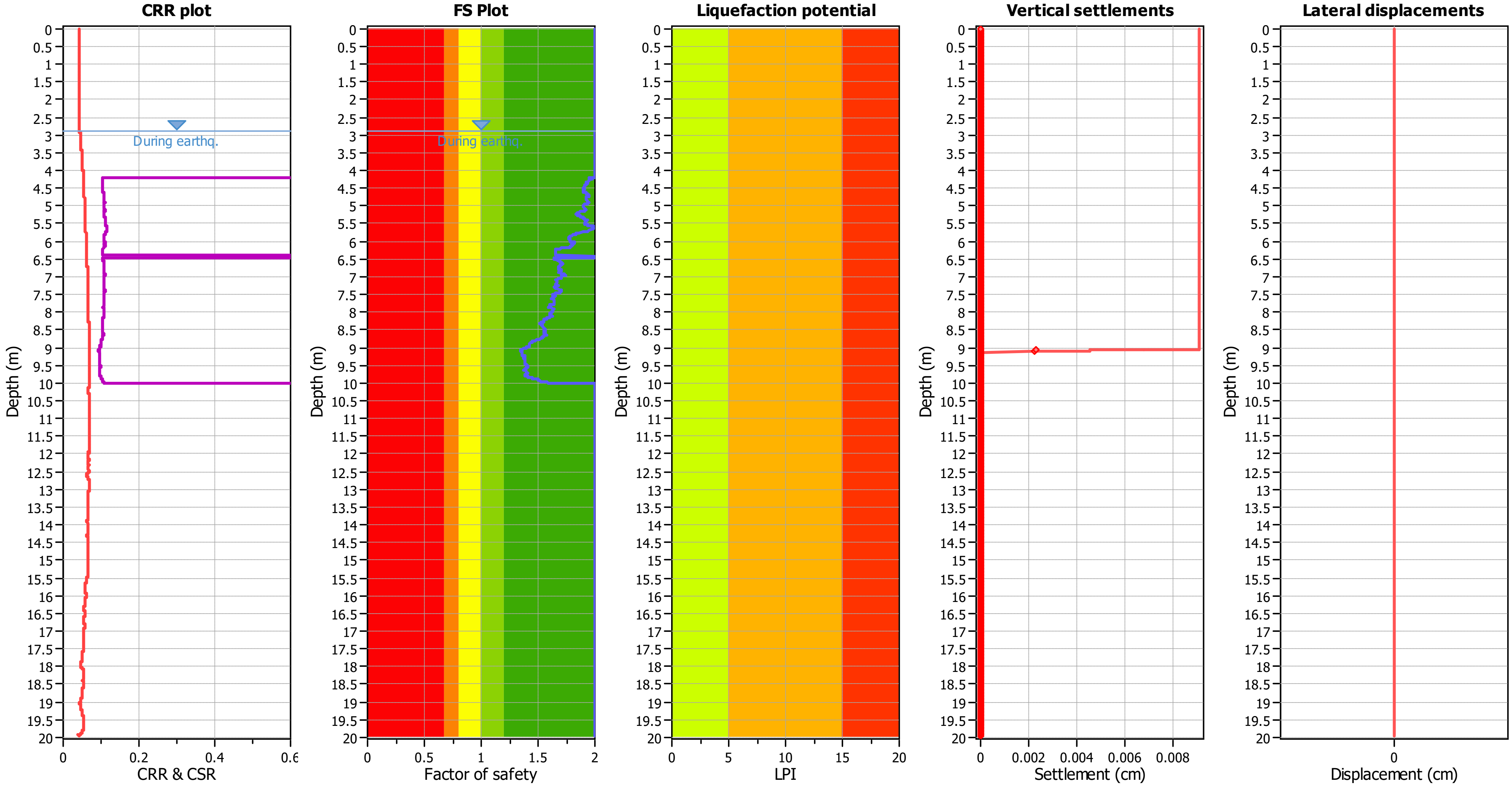
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.90 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.08	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.90 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.90 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.08	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.90 m	Fill height:	N/A	Limit depth:	10.00 m

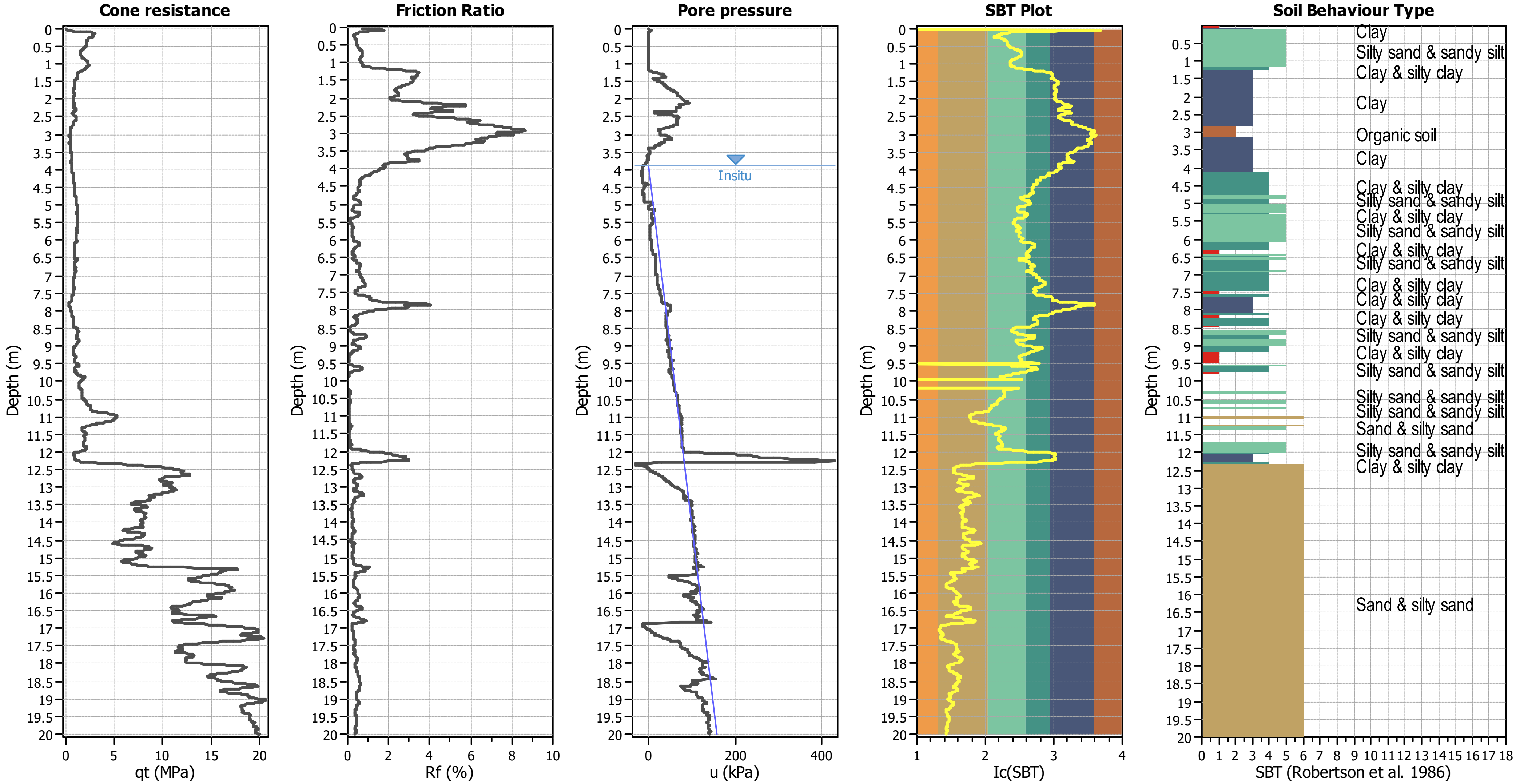
F.S. color scheme

- 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

LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



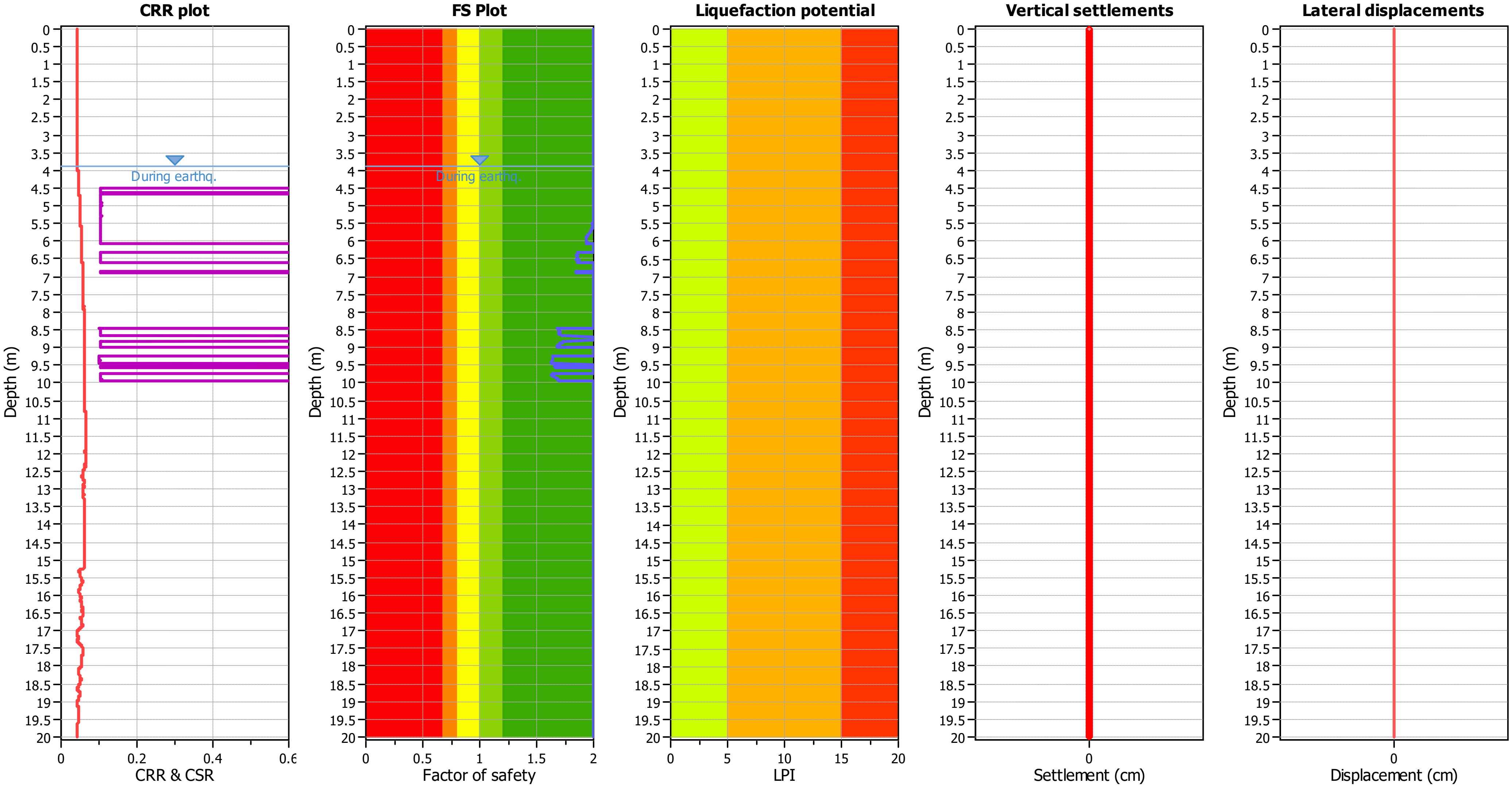
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.90 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.08	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.90 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.90 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.08	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.90 m	Fill height:	N/A	Limit depth:	10.00 m

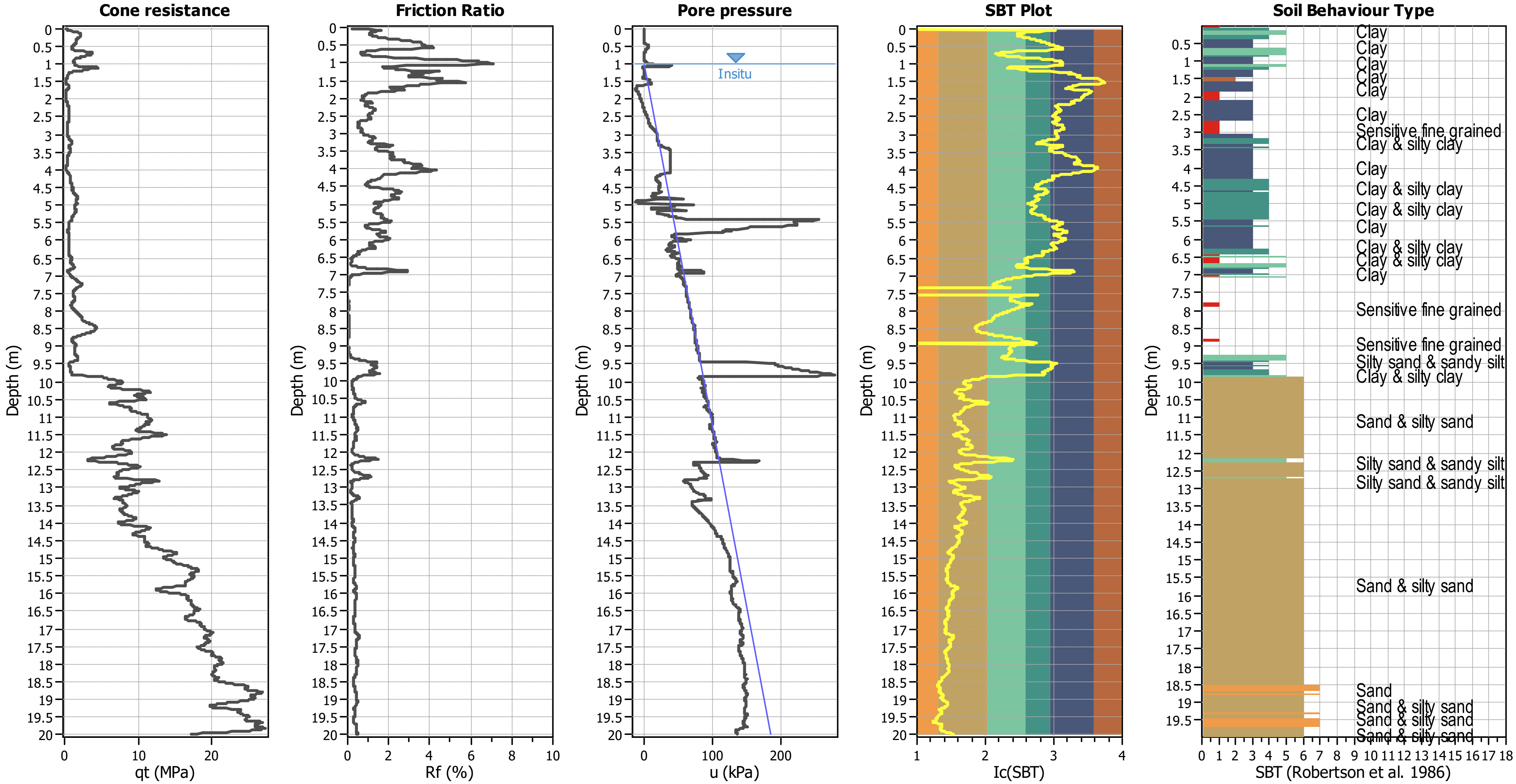
F.S. color scheme

- 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

LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



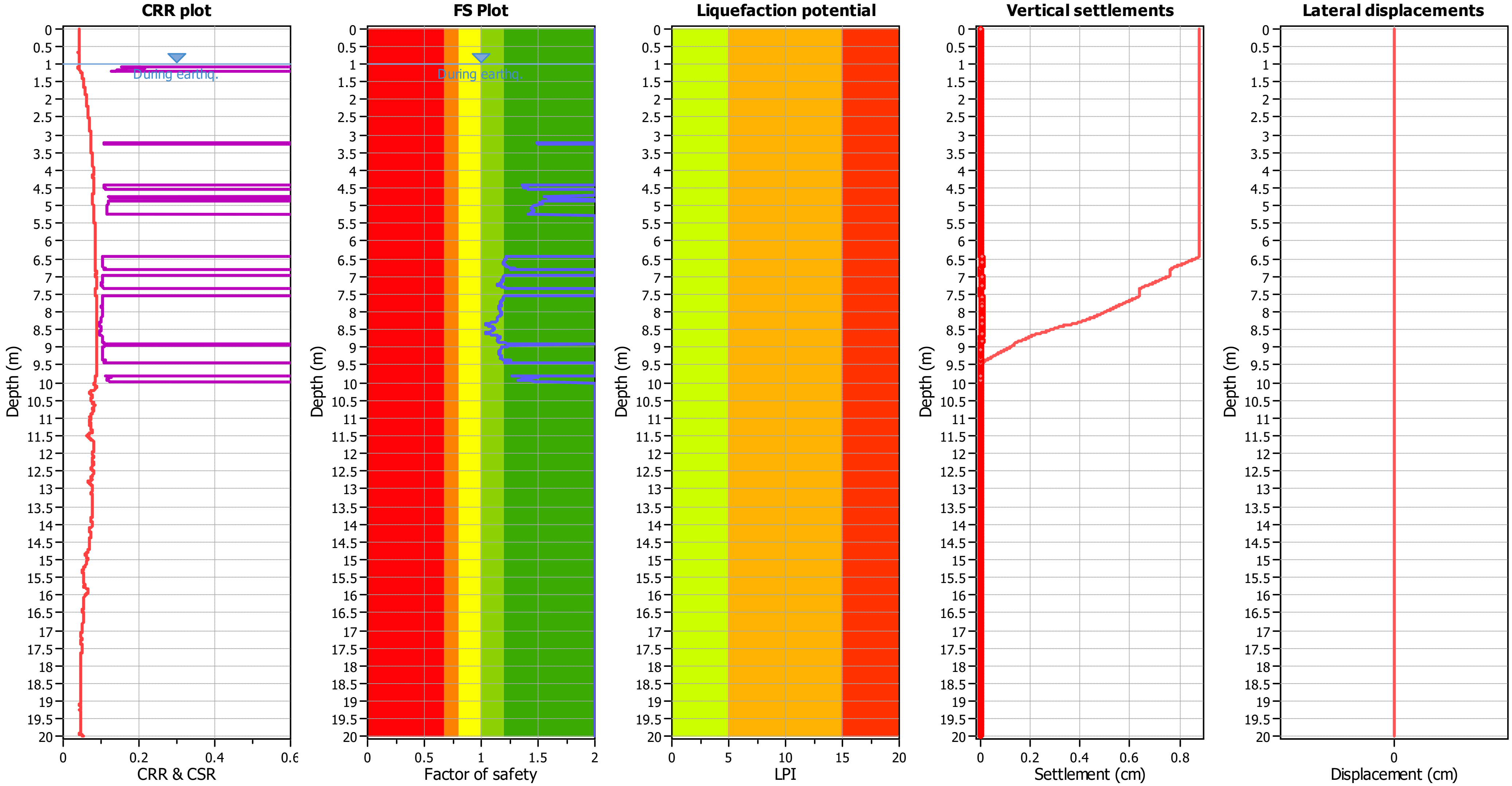
Input parameters and analysis data

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:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.08	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

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:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.08	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

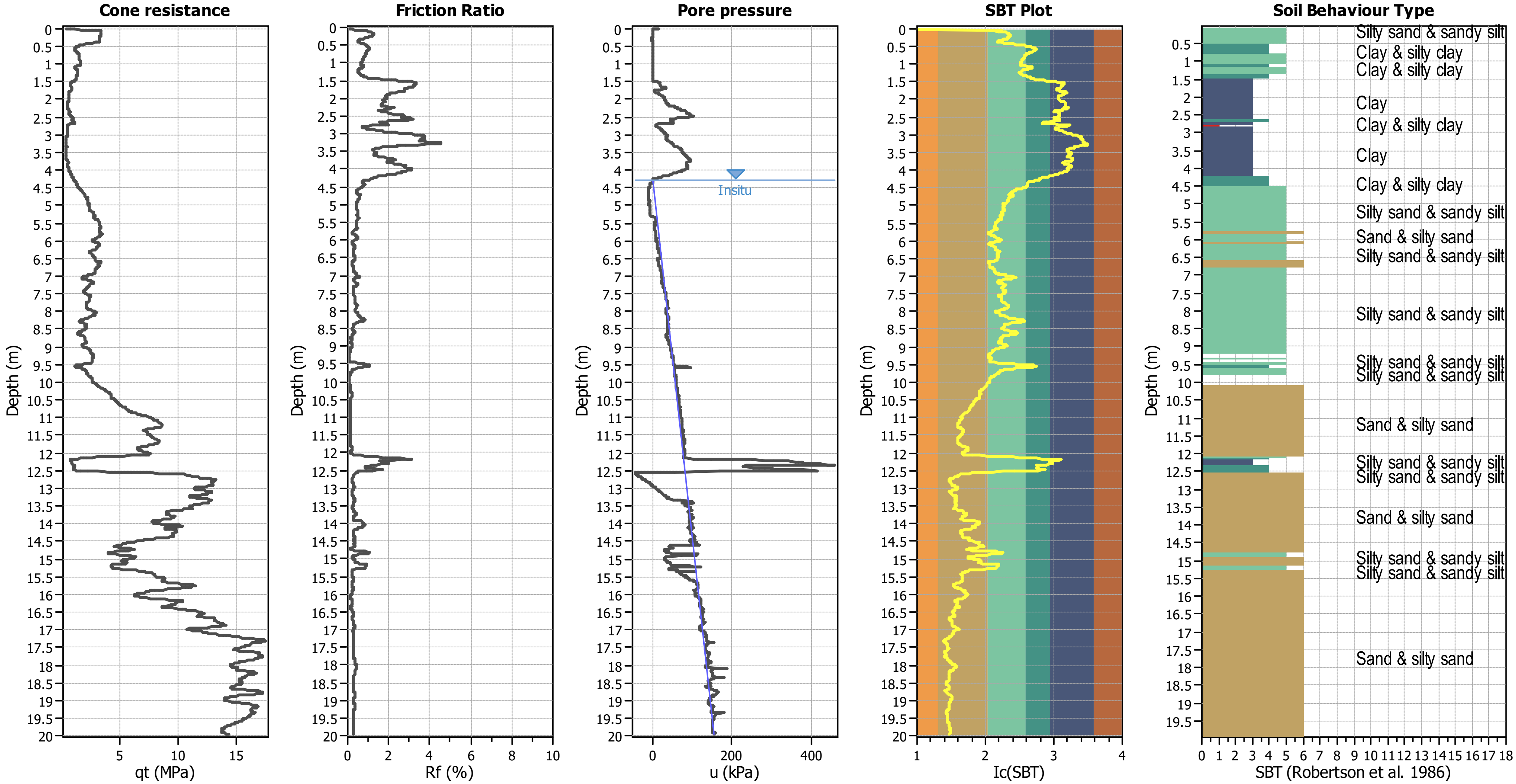
F.S. color scheme

- 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

LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



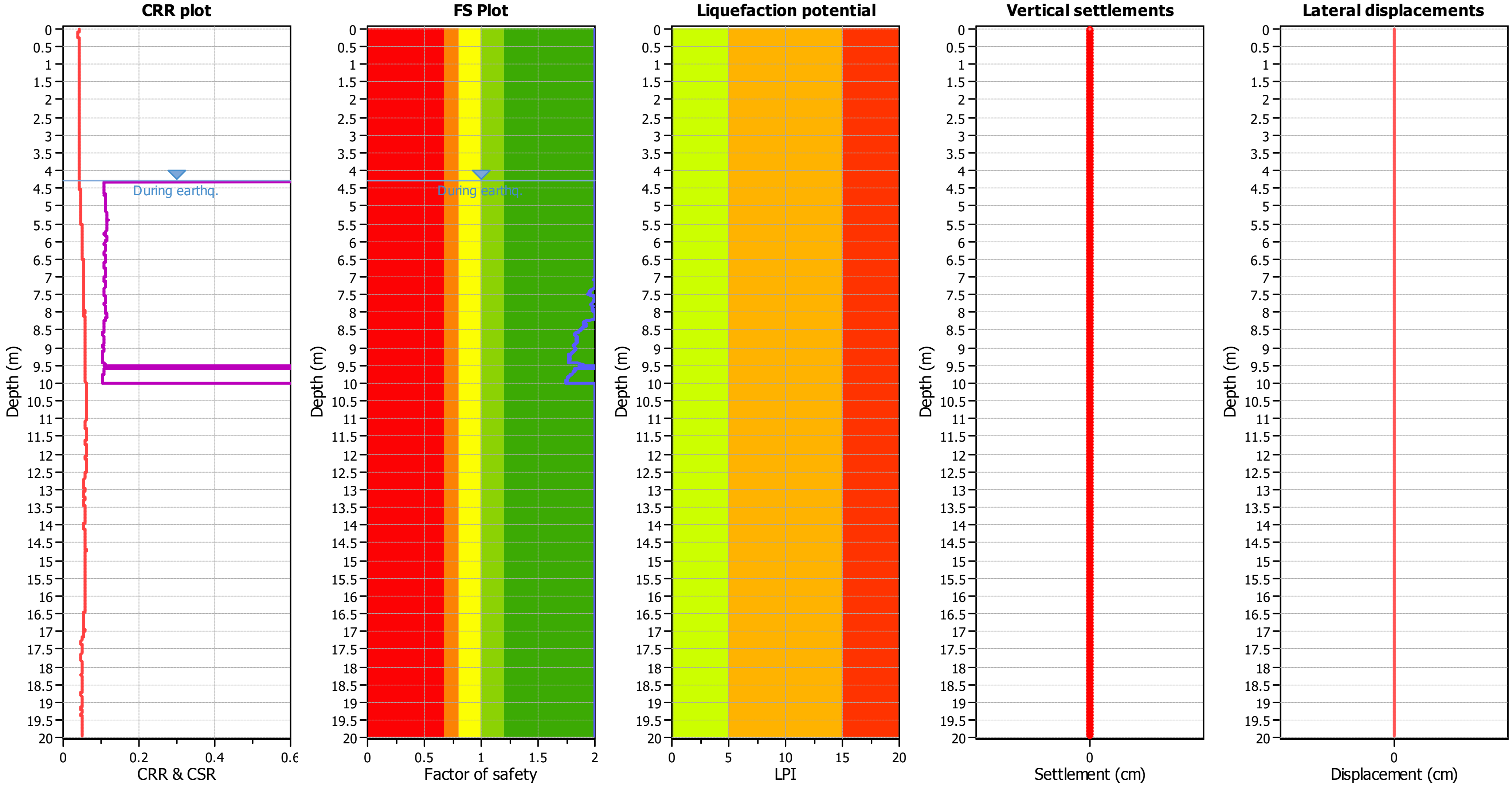
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.30 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.08	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	4.30 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.30 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.08	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	4.30 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

- Almost certain it will liquefy
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- Liquefaction and no liq. are equally likely
- Unlike to liquefy
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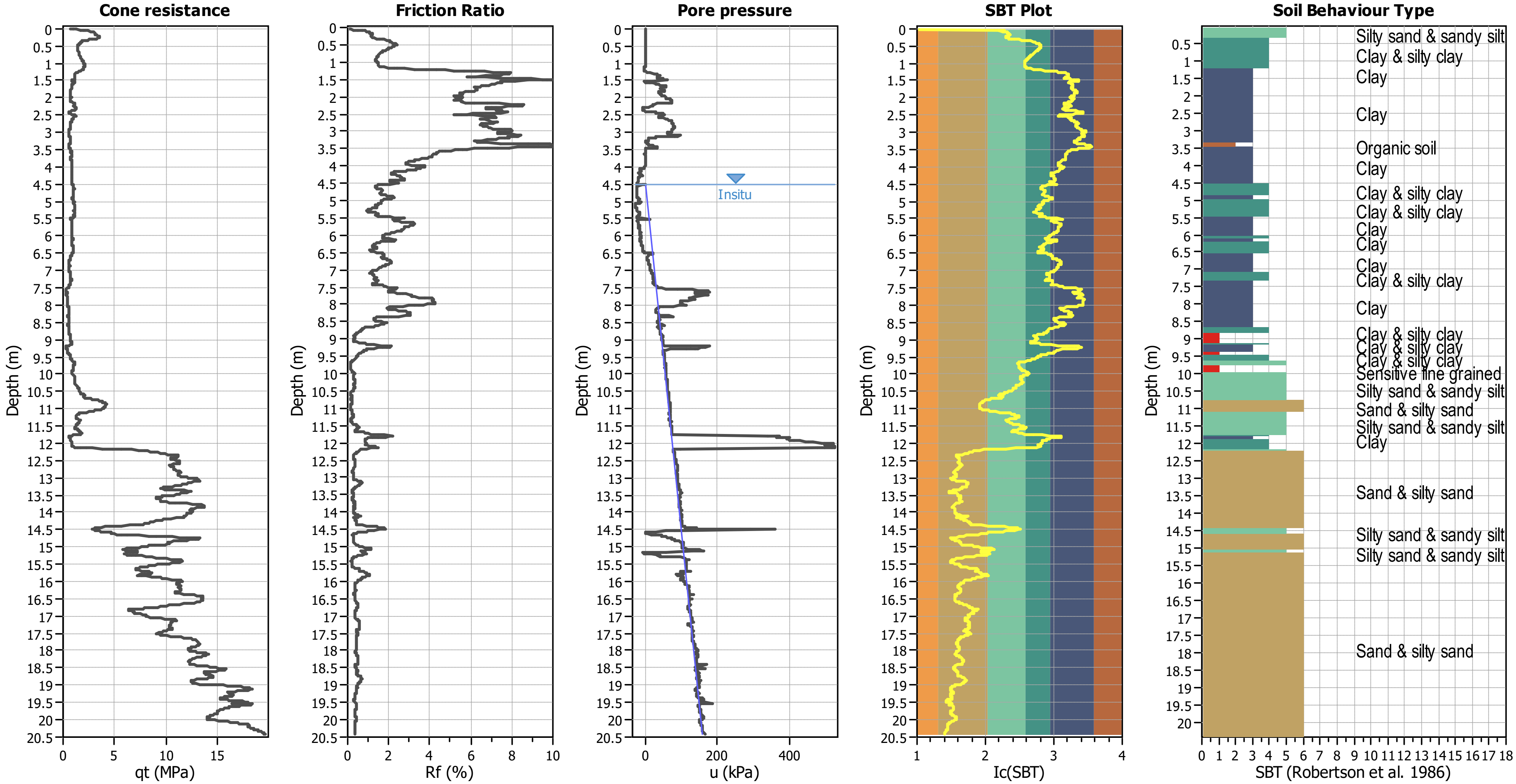
LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



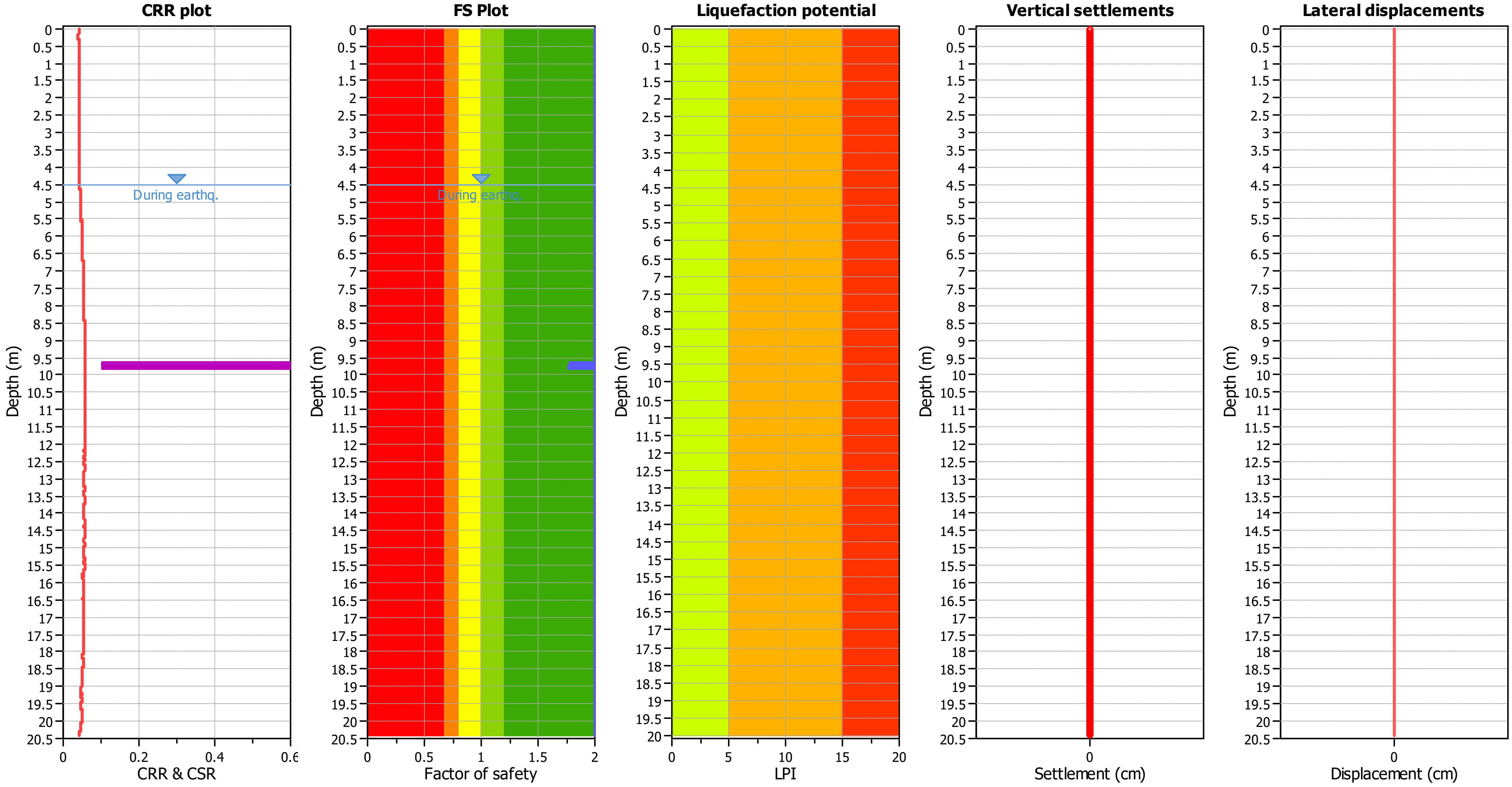
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.08	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	4.50 m	Fill height:	N/A	Limit depth:	10.00 m

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.):	4.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.08	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	4.50 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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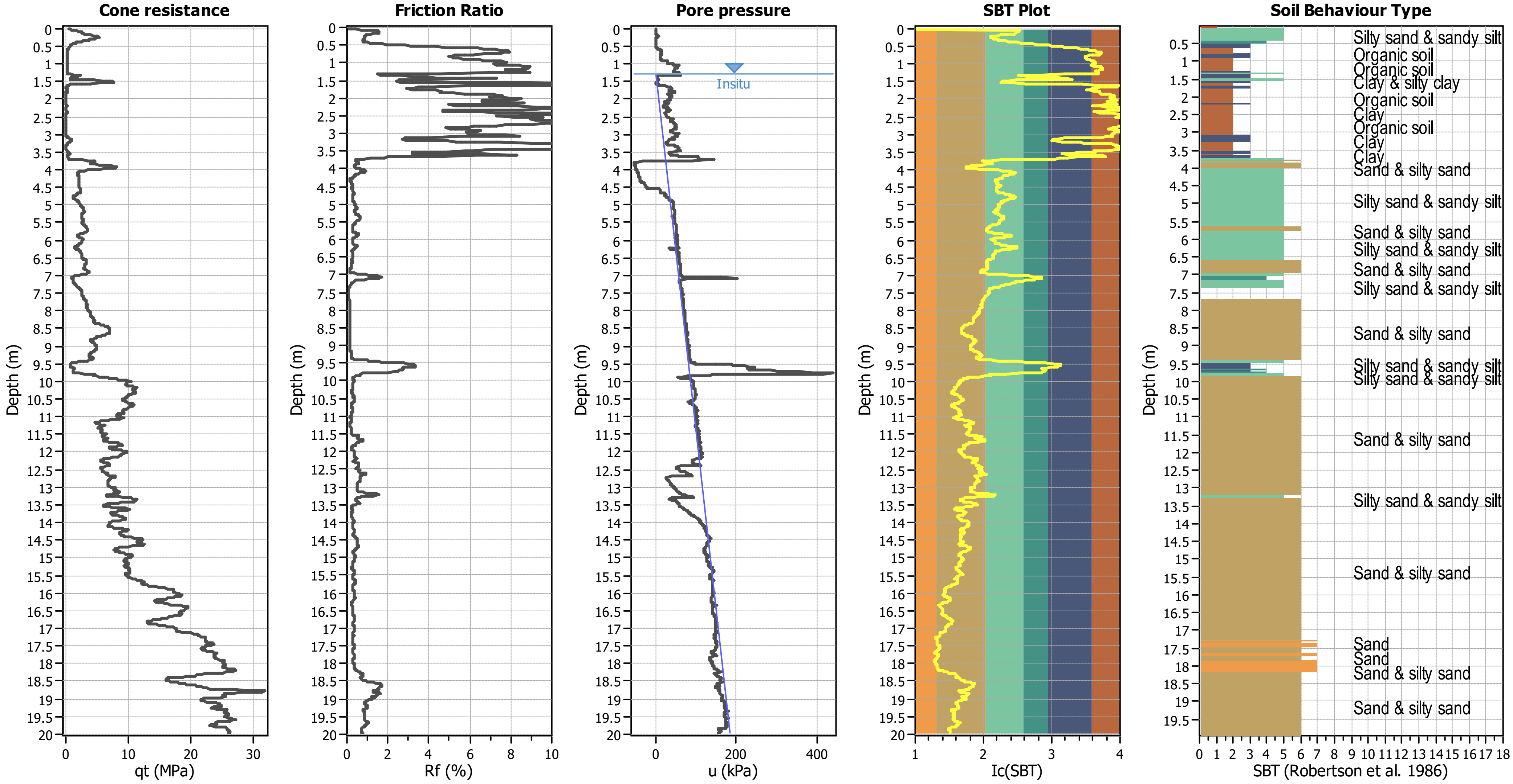
LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



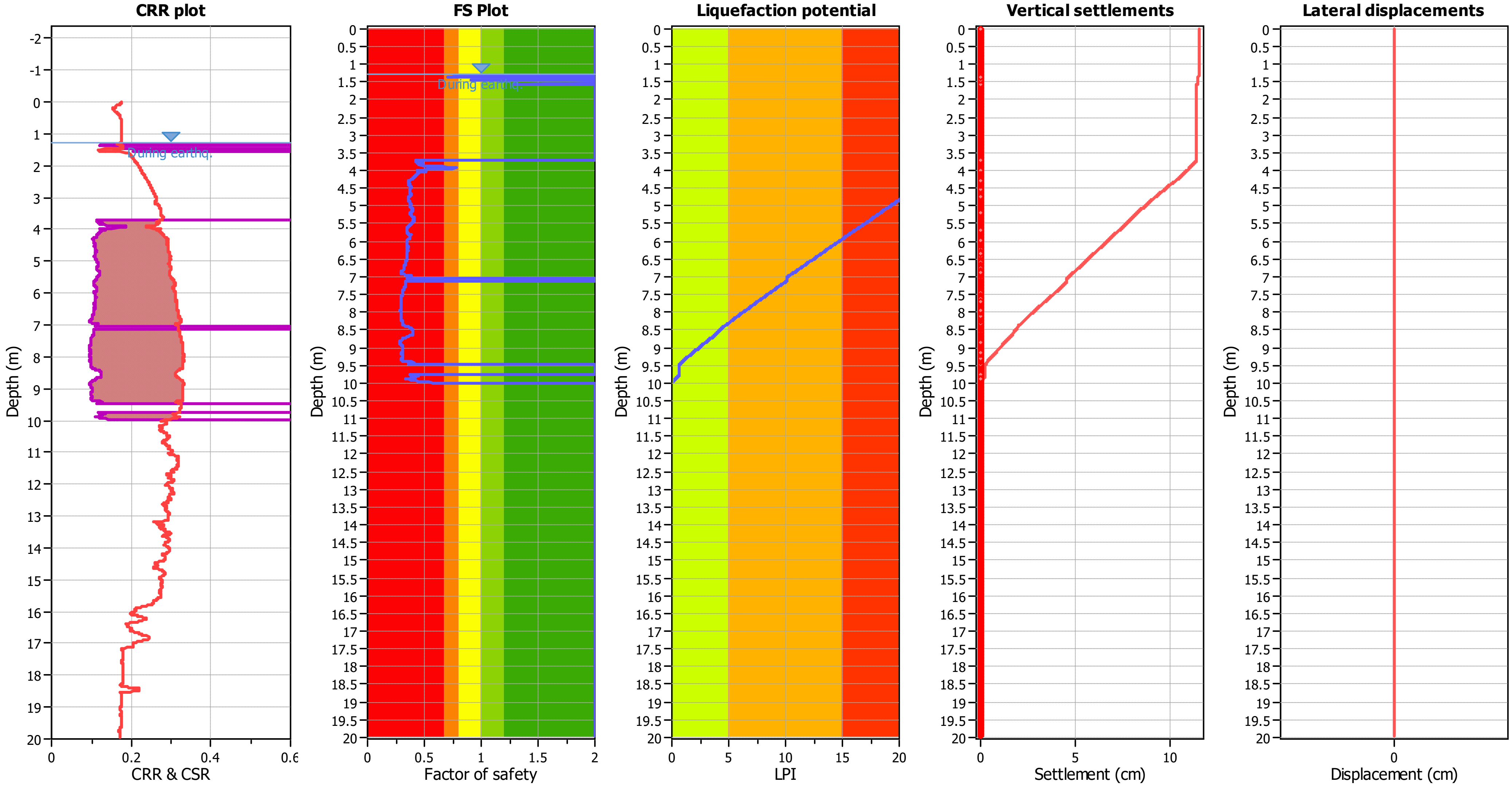
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.30 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.32	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.30 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.30 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.32	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.30 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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- Liquefaction and no liq. are equally likely
- Unlike to liquefy
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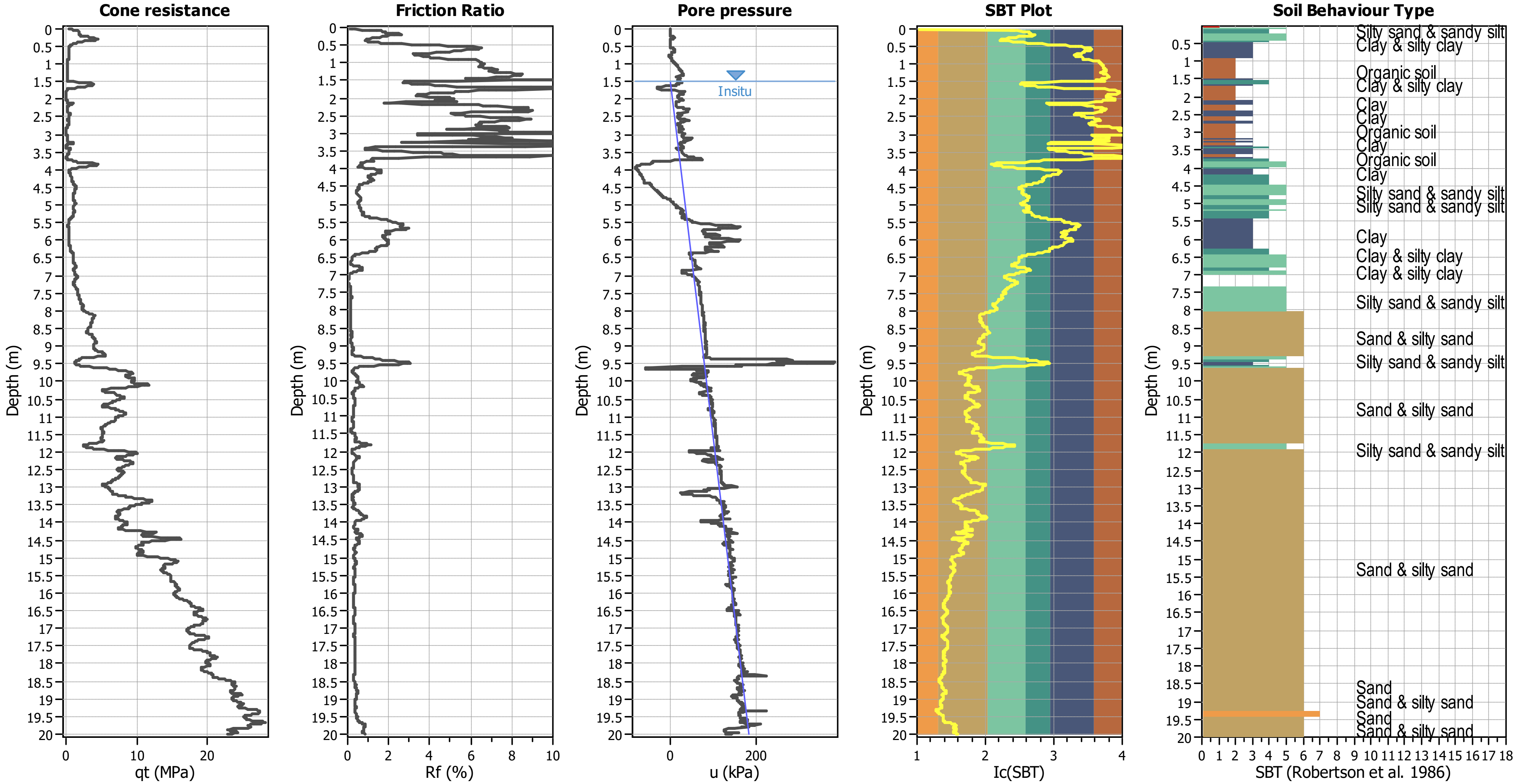
LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



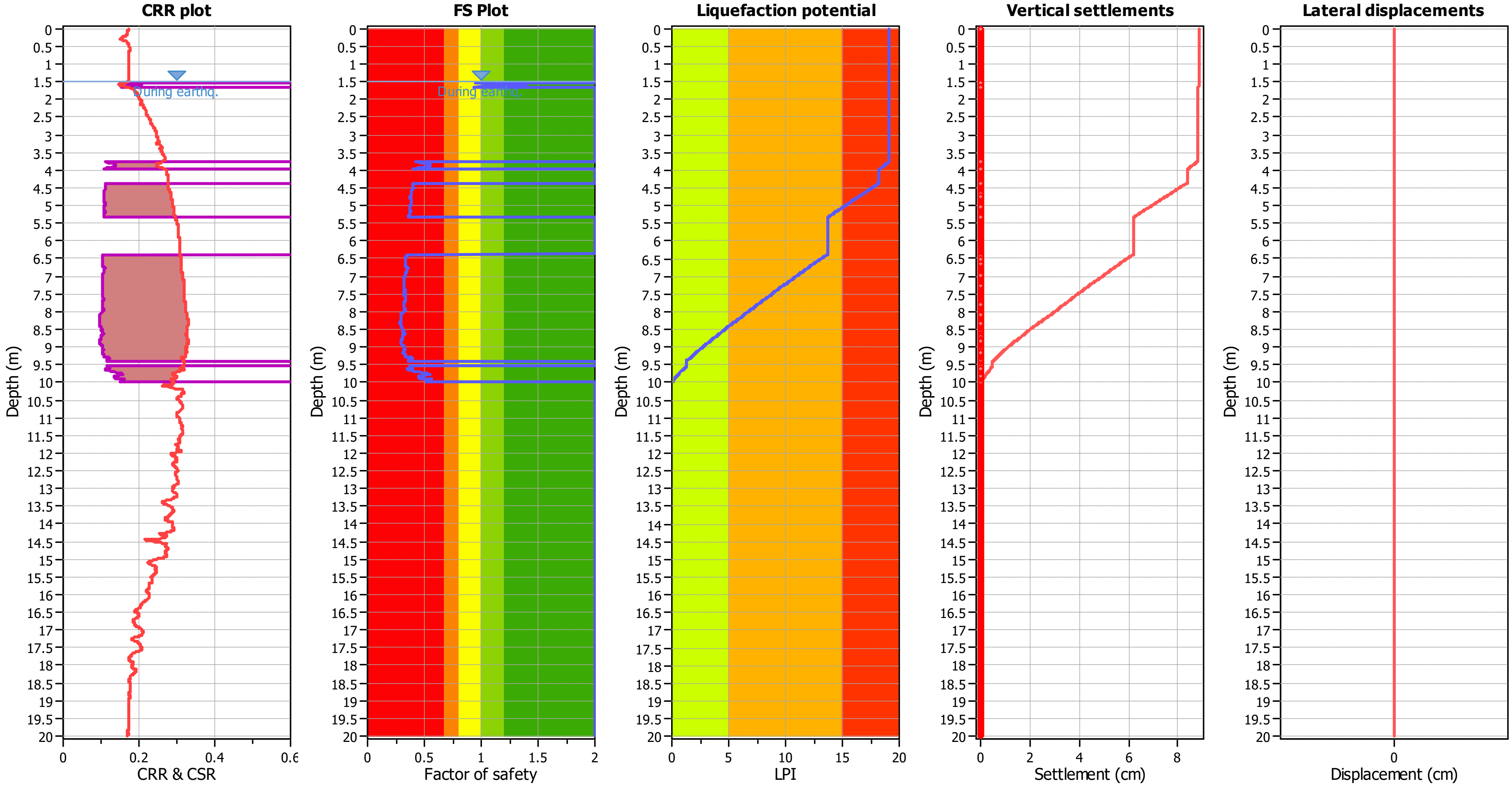
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.32	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.50 m	Fill height:	N/A	Limit depth:	10.00 m

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.):	1.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.32	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.50 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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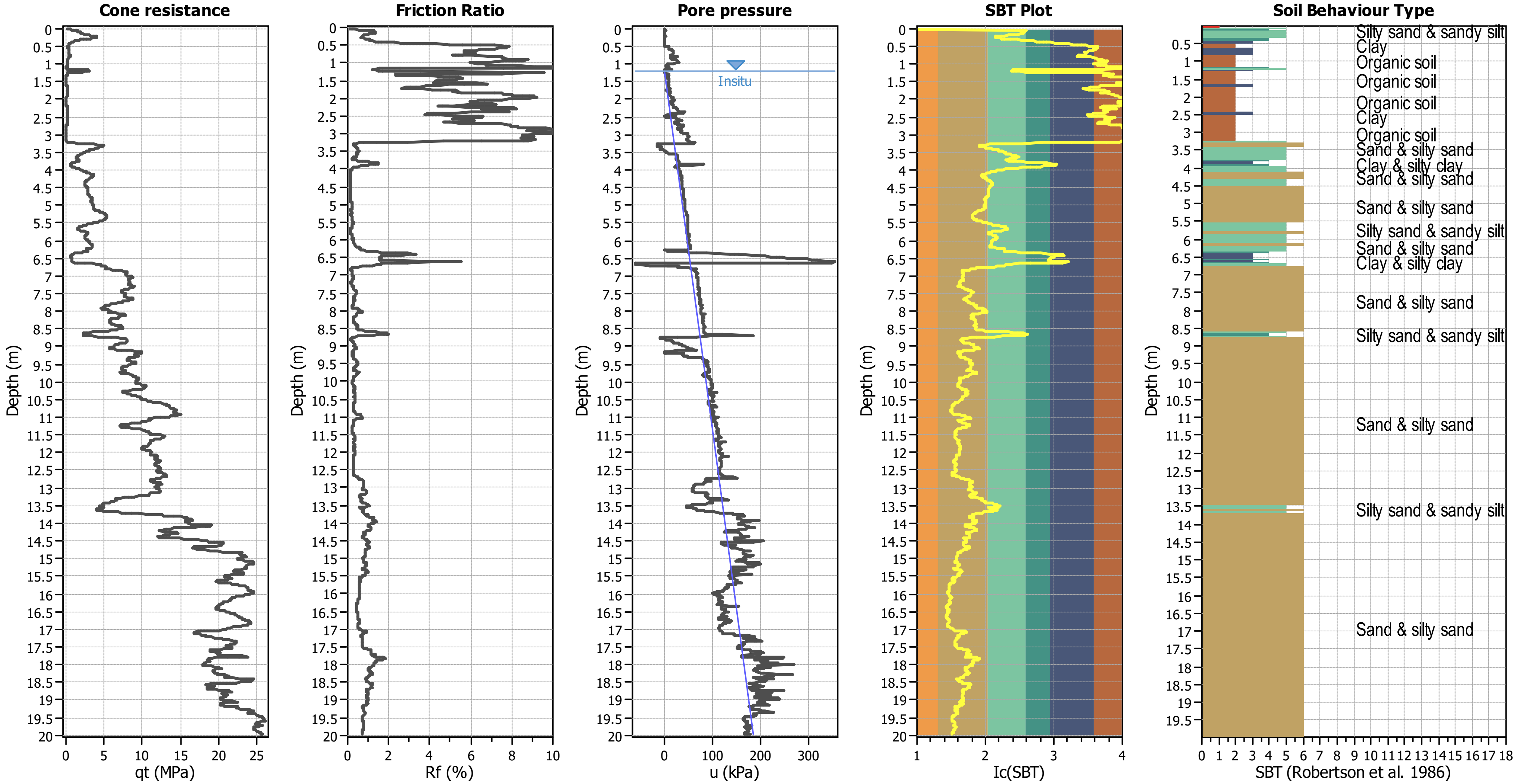
LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



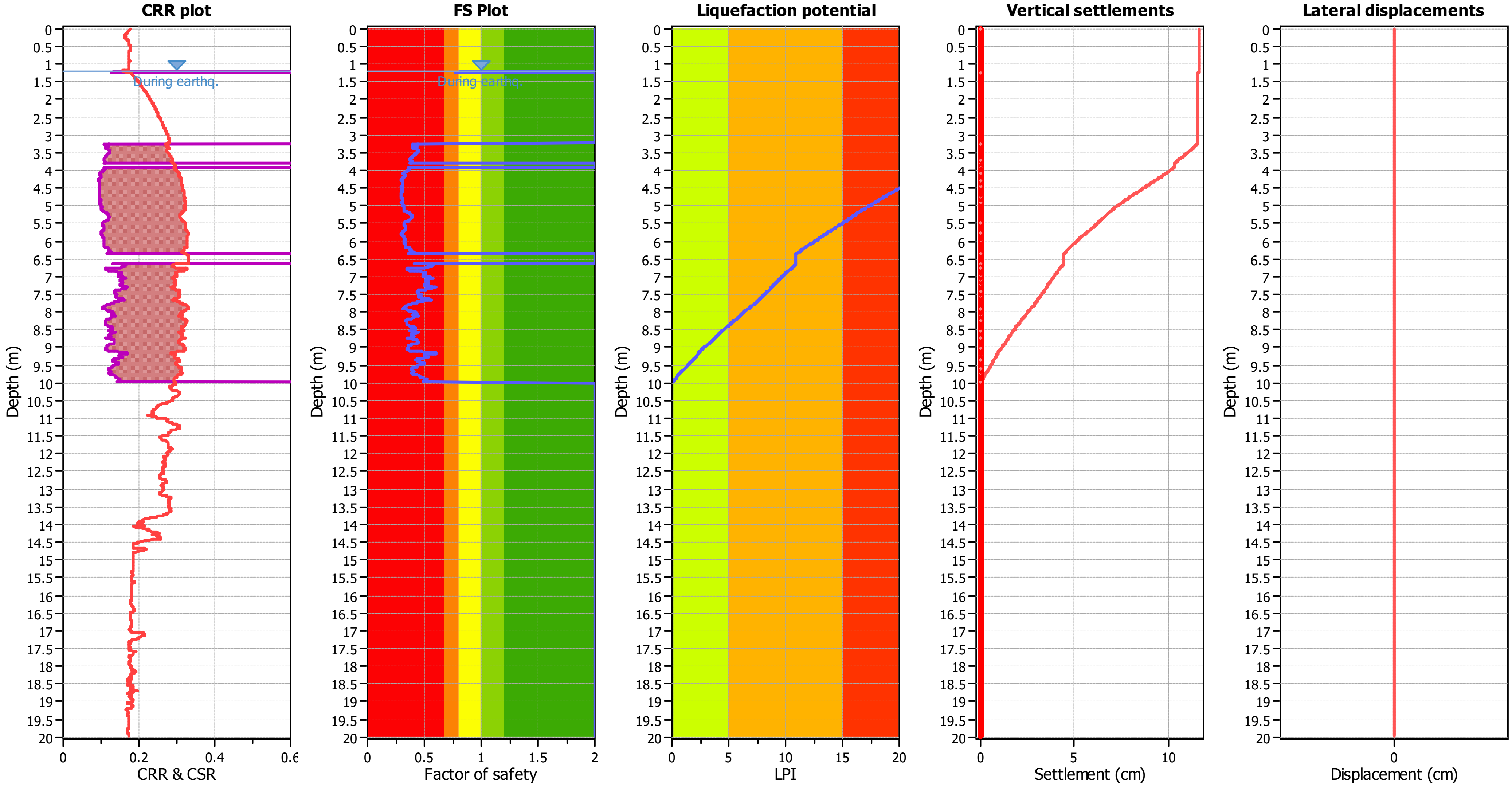
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.32	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.20 m	Fill height:	N/A	Limit depth:	10.00 m

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.):	1.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.32	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.20 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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- Unlike to liquefy
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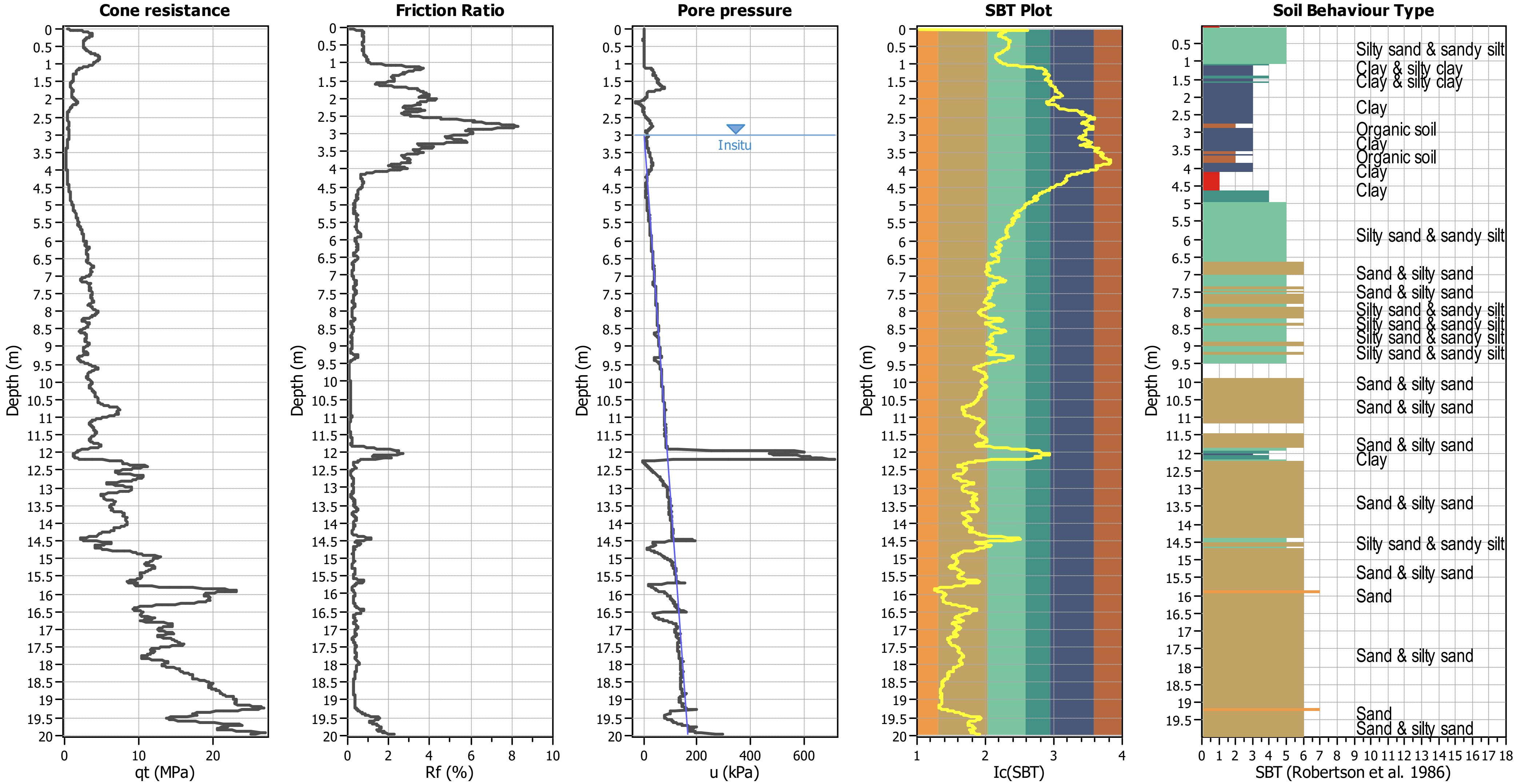
LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



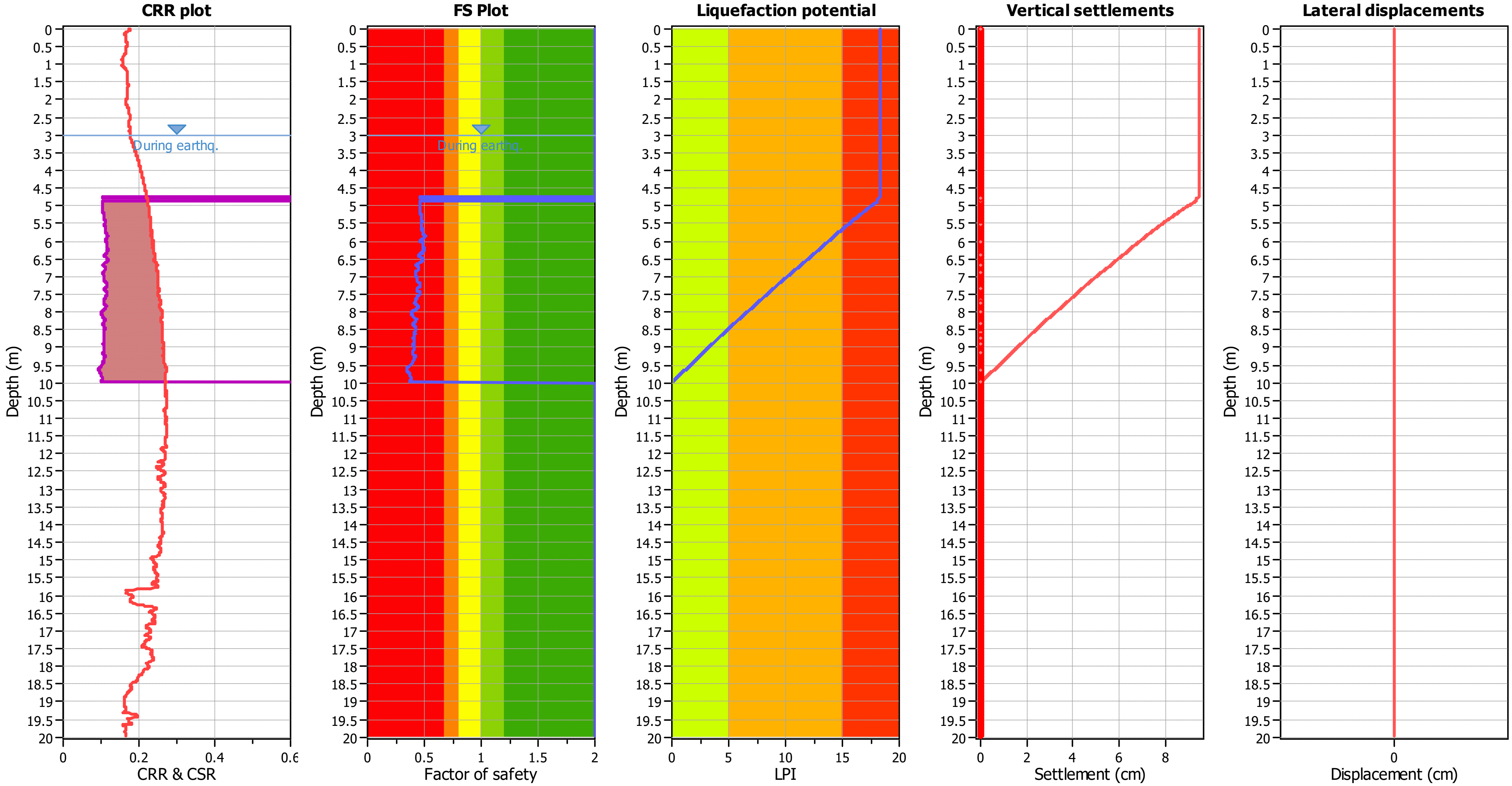
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.32	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	10.00 m

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.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.32	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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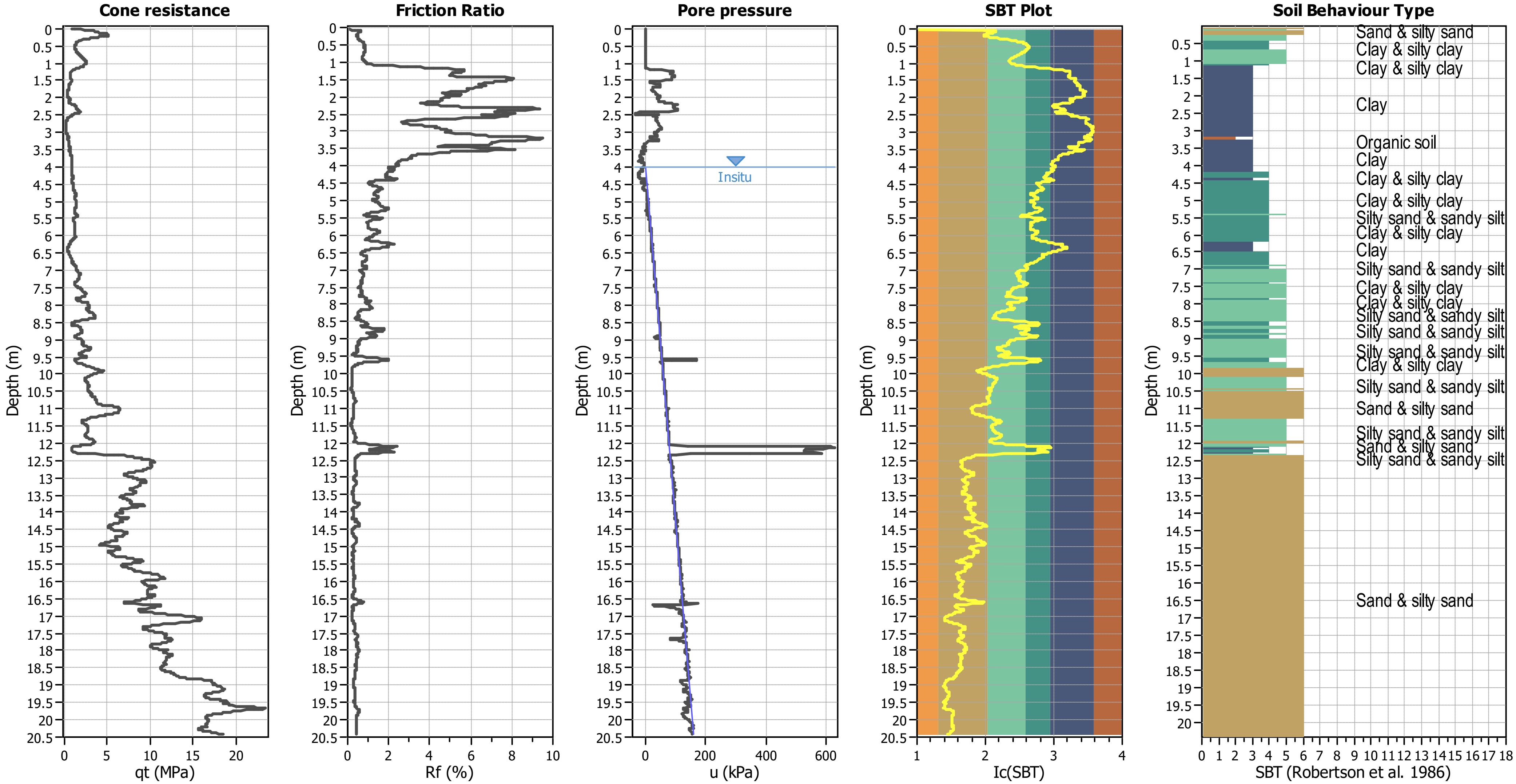
LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



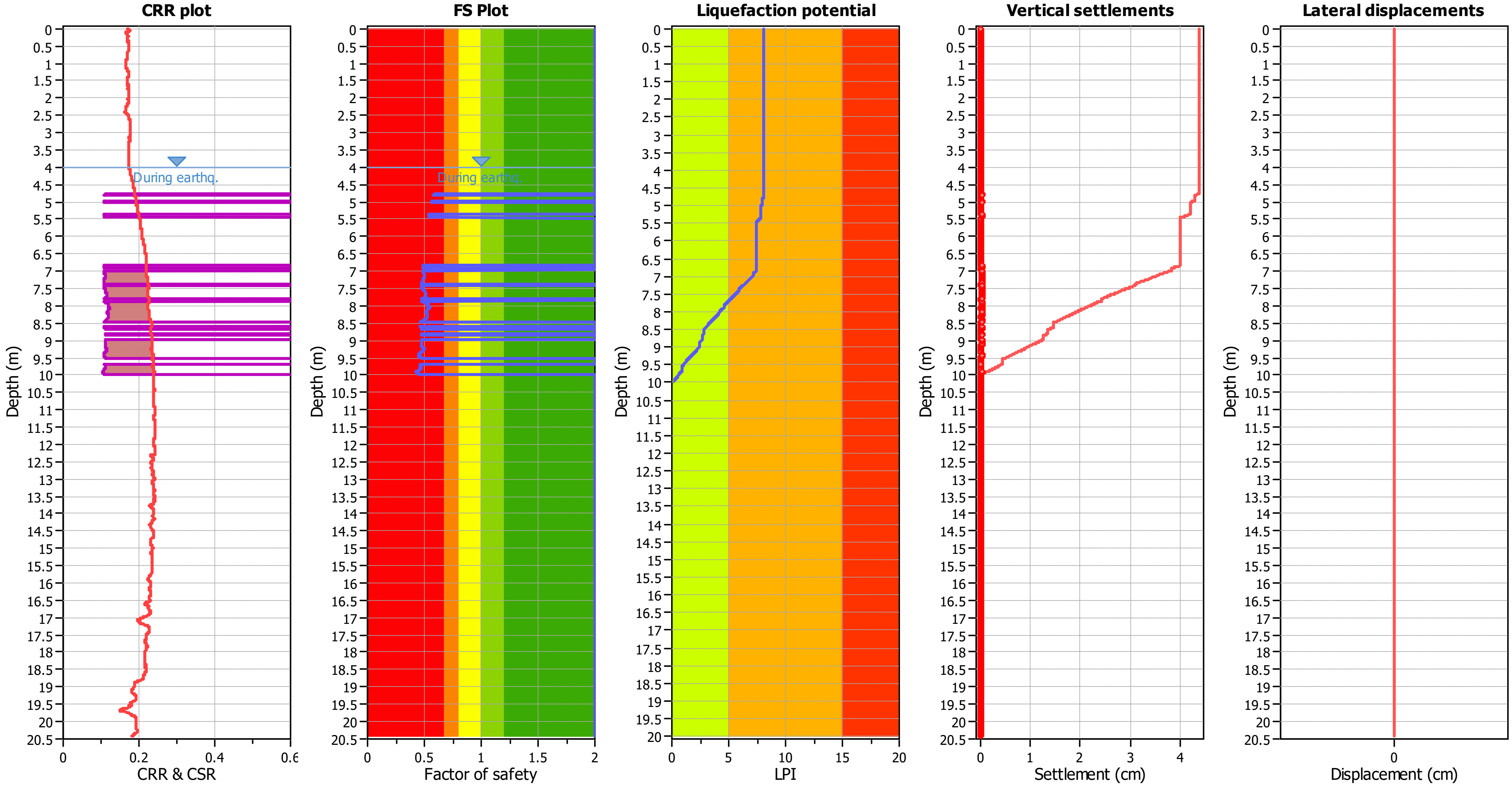
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.32	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	4.00 m	Fill height:	N/A	Limit depth:	10.00 m

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.):	4.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.32	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	4.00 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme
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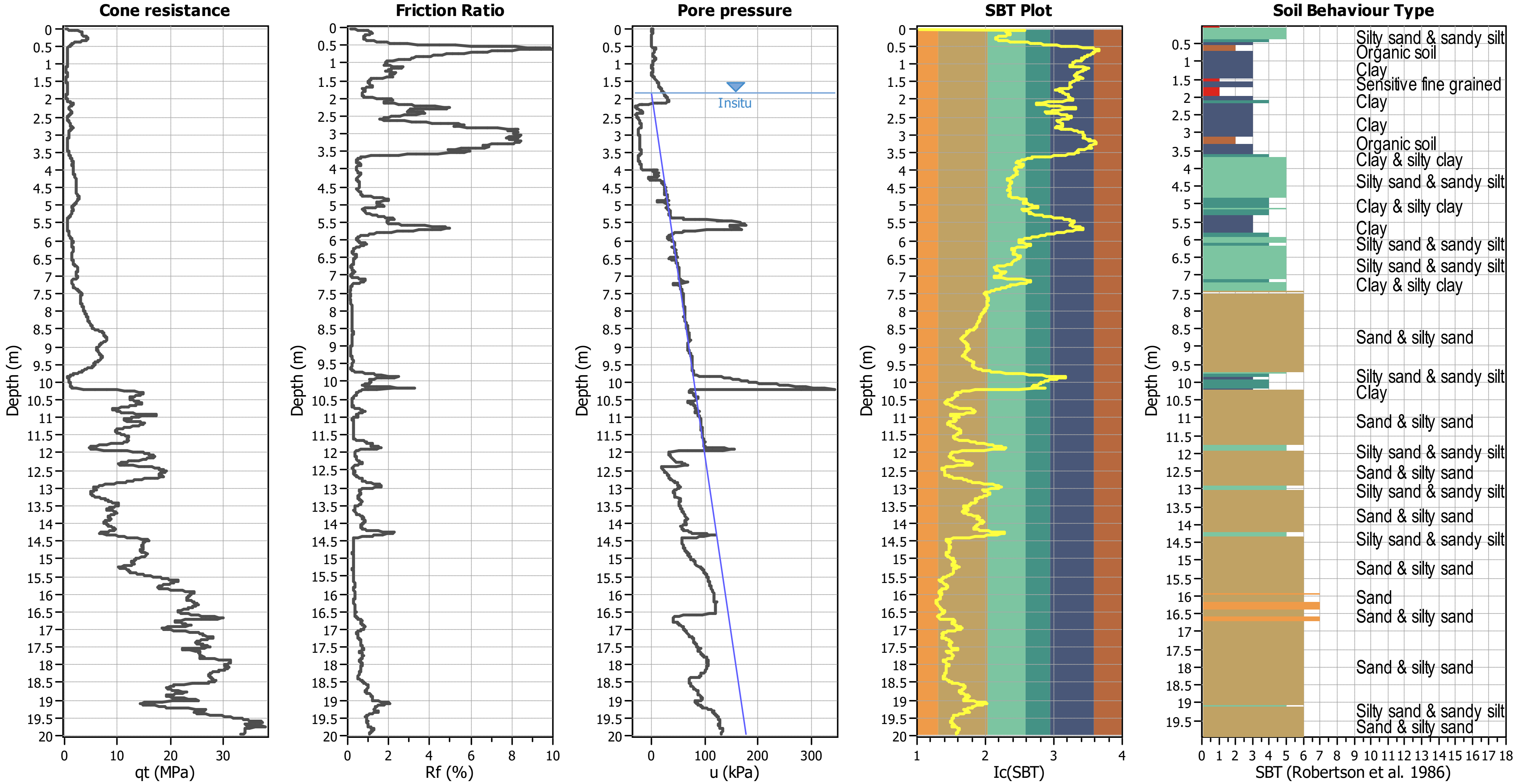
LPI color scheme
- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



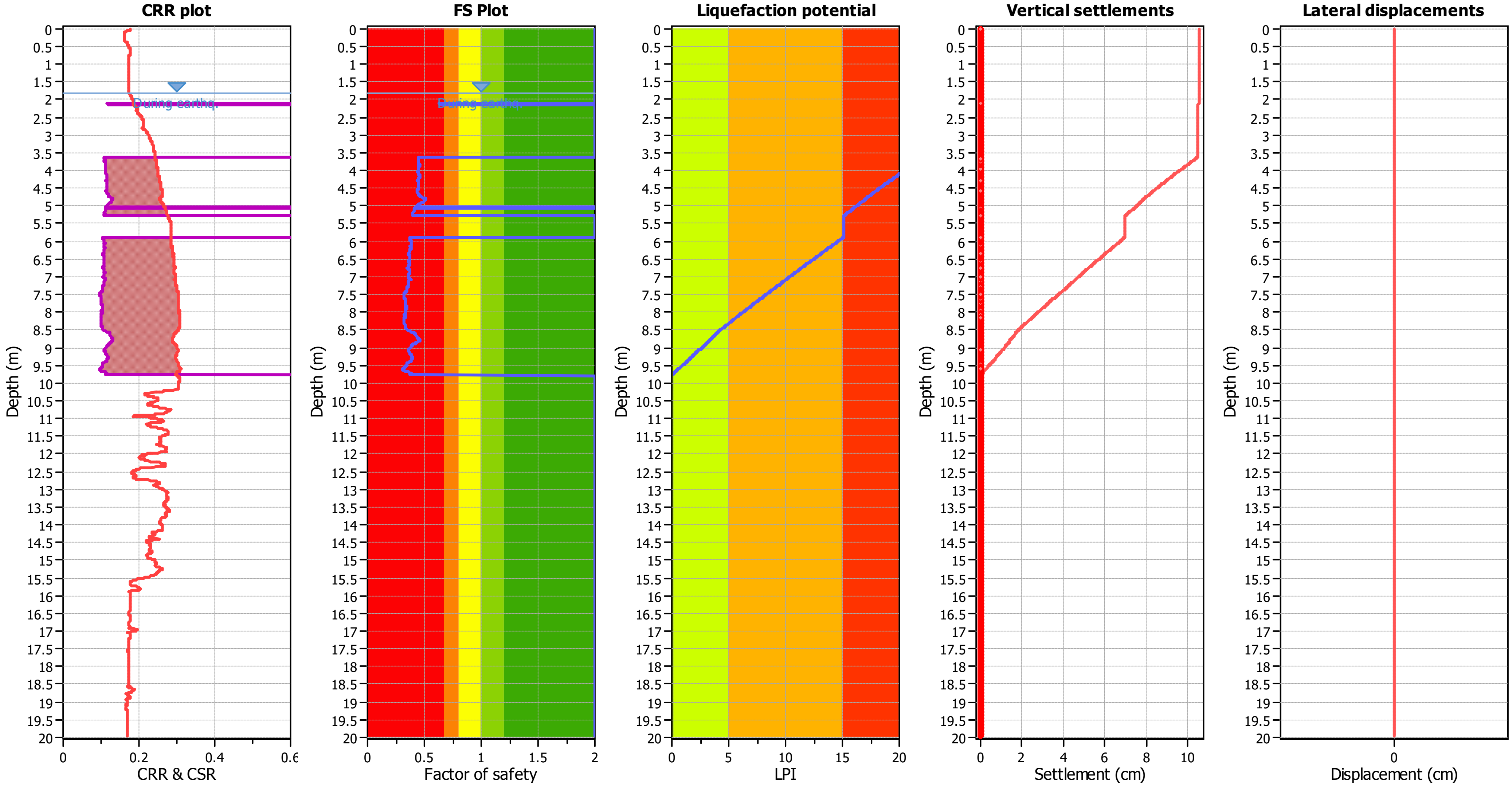
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.80 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.32	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.80 m	Fill height:	N/A	Limit depth:	10.00 m

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.):	1.80 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.32	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.80 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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LPI color scheme

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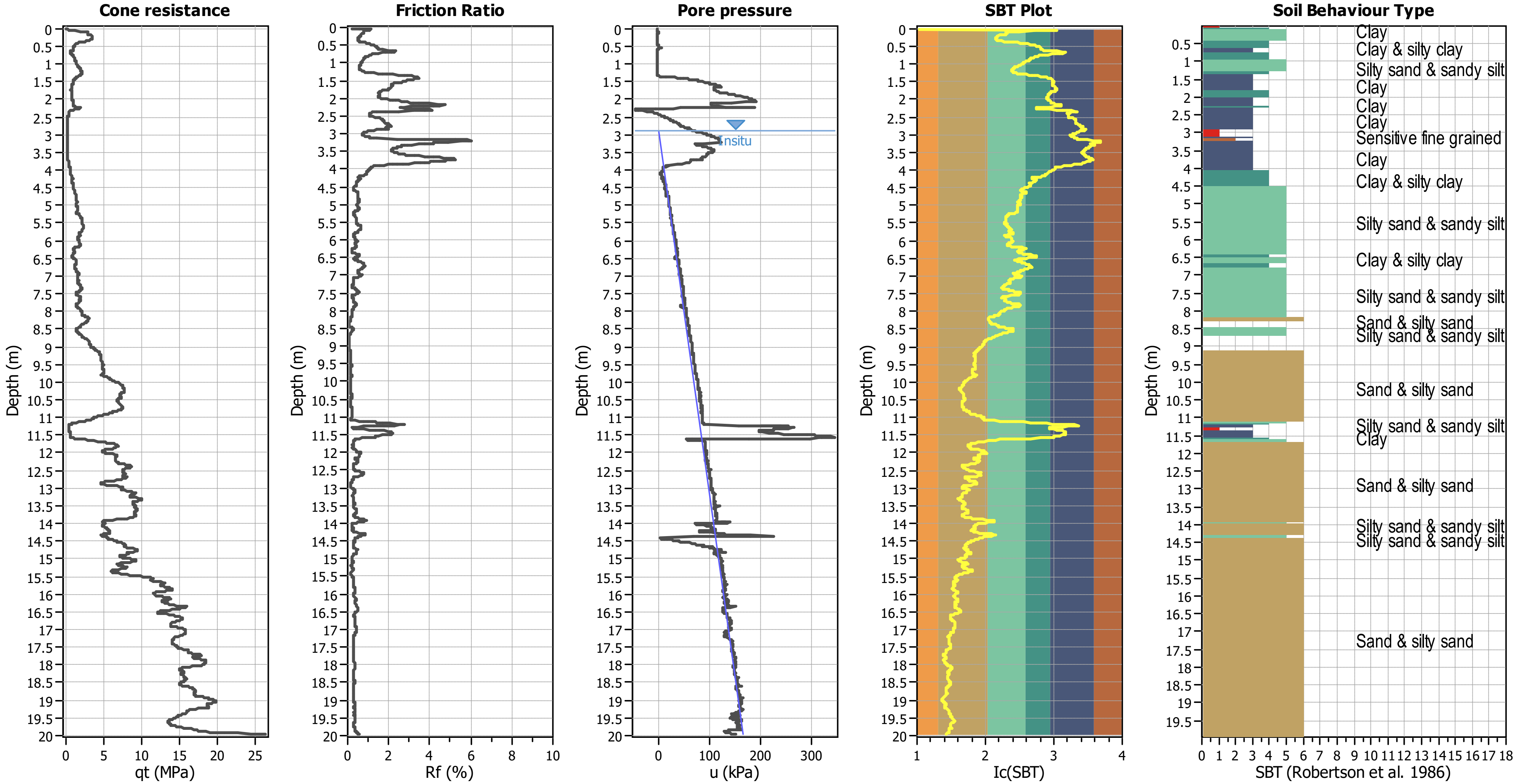
CPT basic interpretation plots



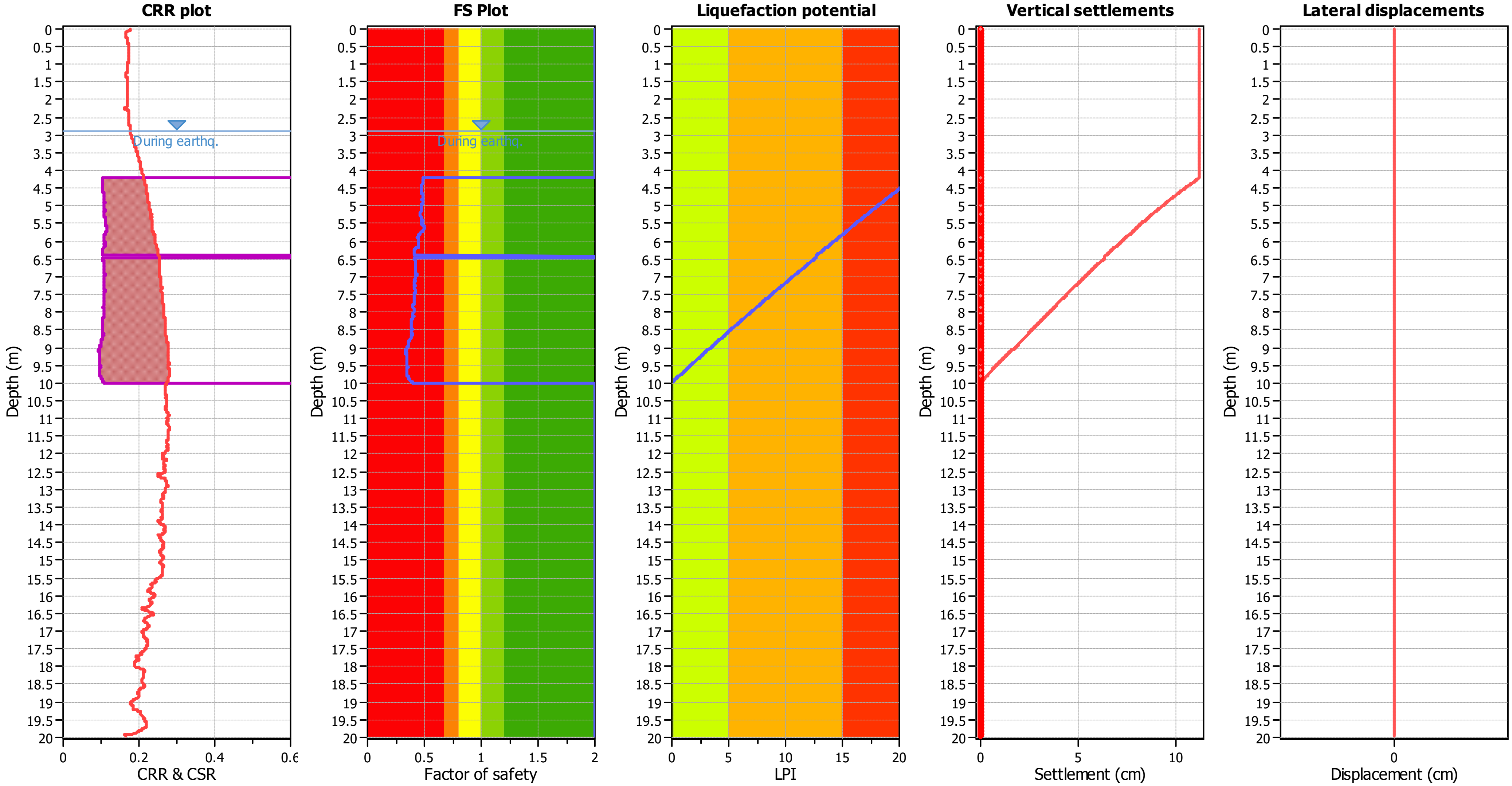
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.90 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.32	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.90 m	Fill height:	N/A	Limit depth:	10.00 m

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.):	2.90 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.32	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.90 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

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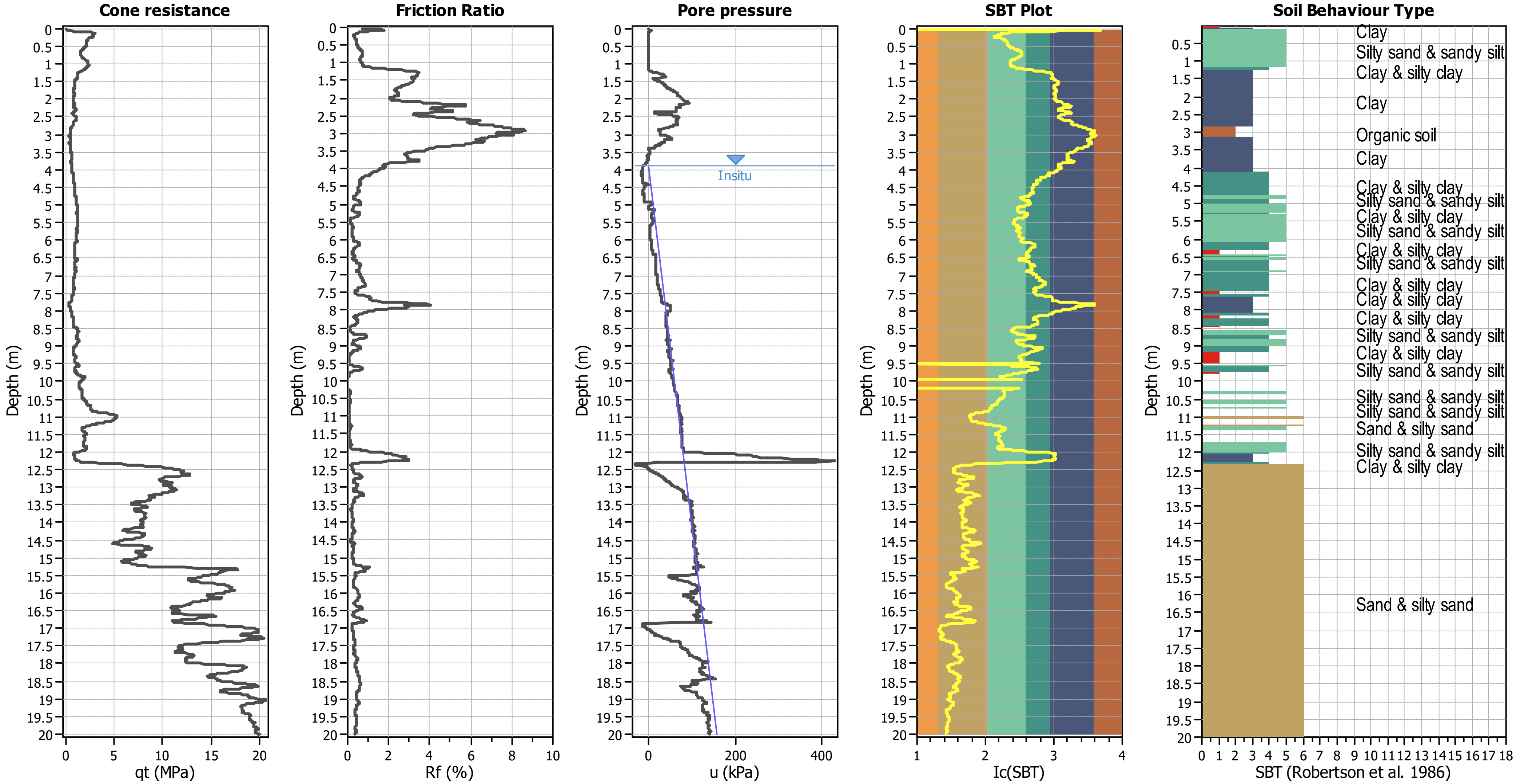
- Low risk

CPT basic interpretation plots



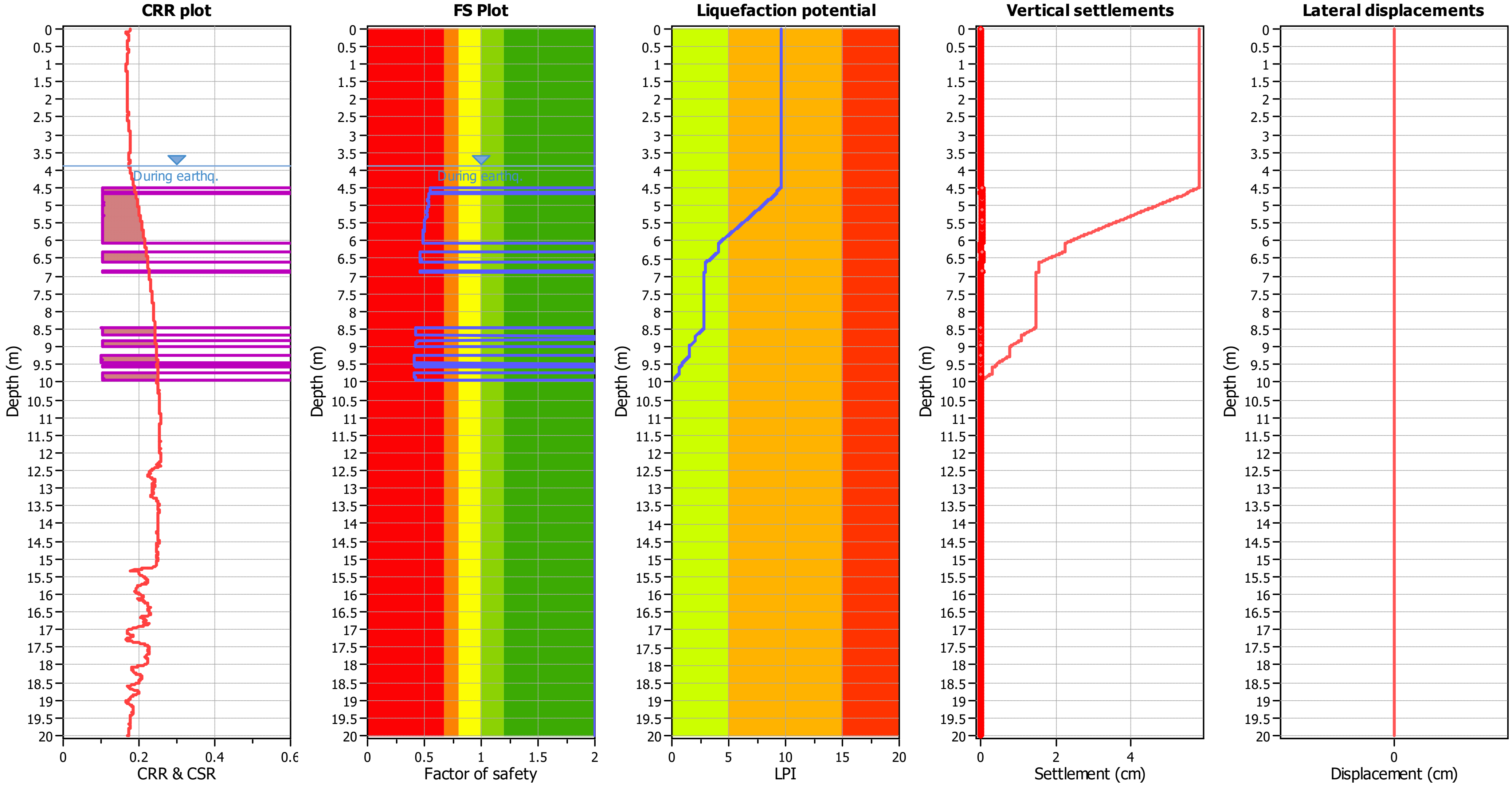
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.90 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.32	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.90 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.90 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.32	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.90 m	Fill height:	N/A	Limit depth:	10.00 m

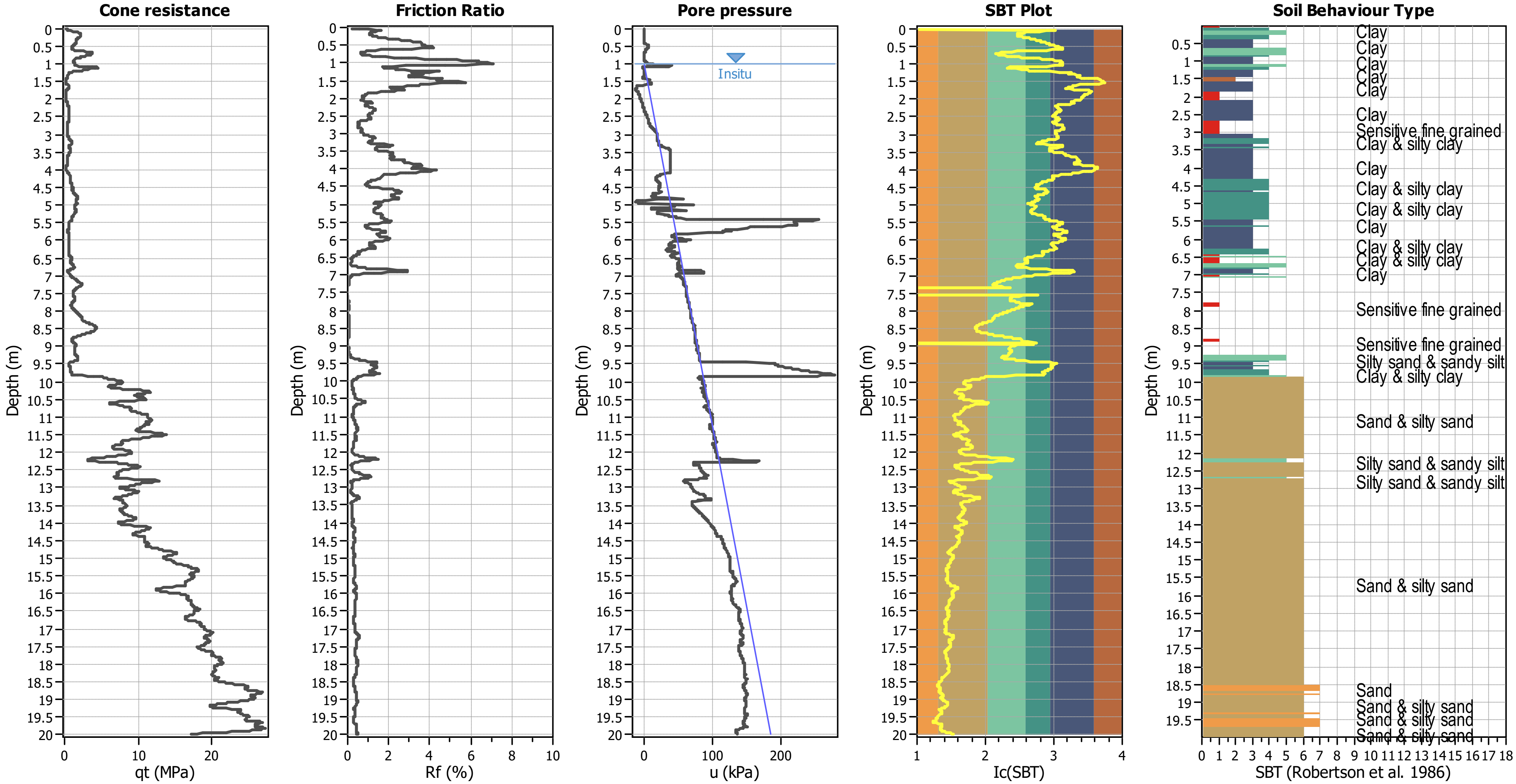
F.S. color scheme

- 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

LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



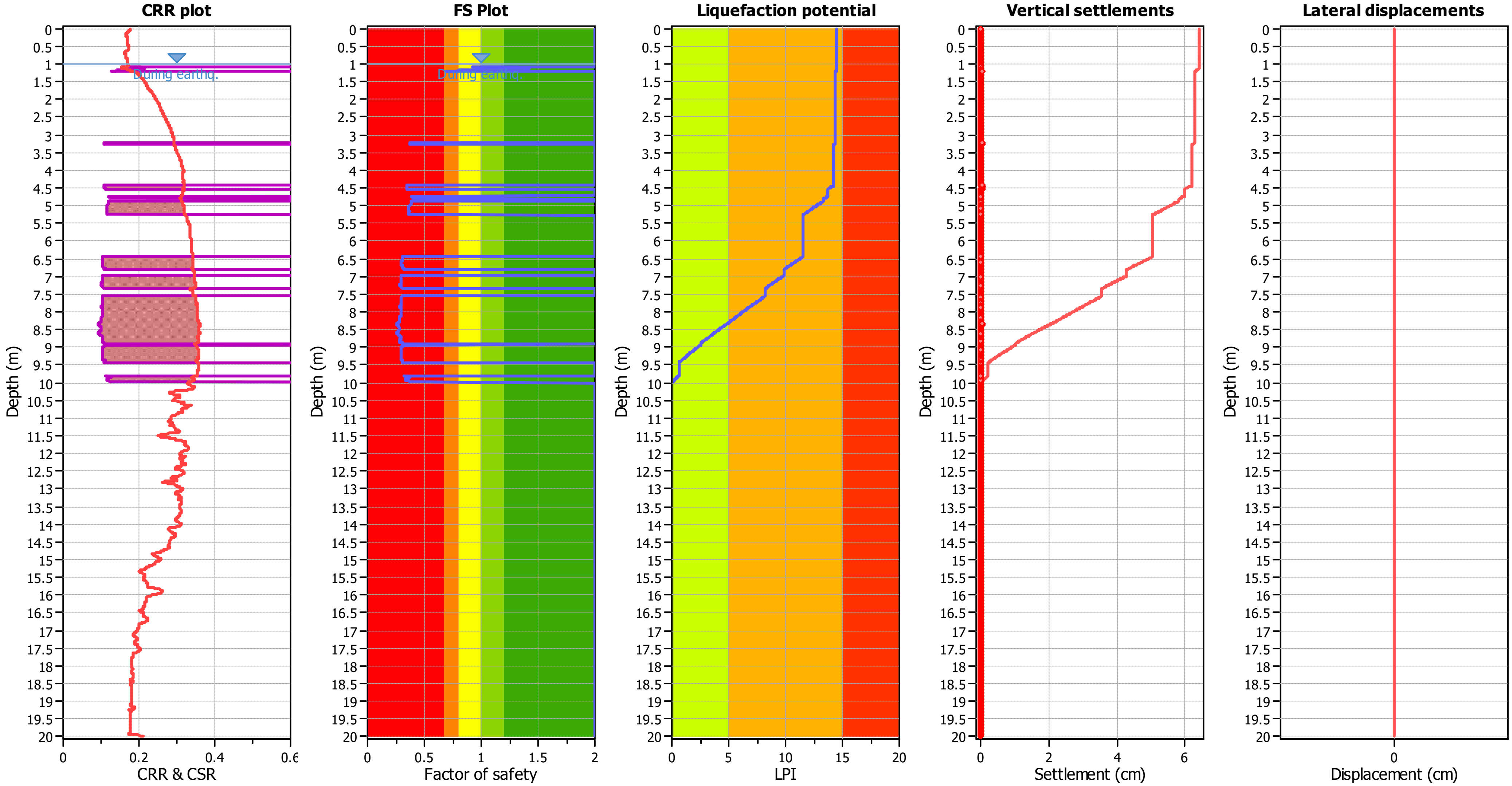
Input parameters and analysis data

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:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.32	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

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:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.32	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	10.00 m

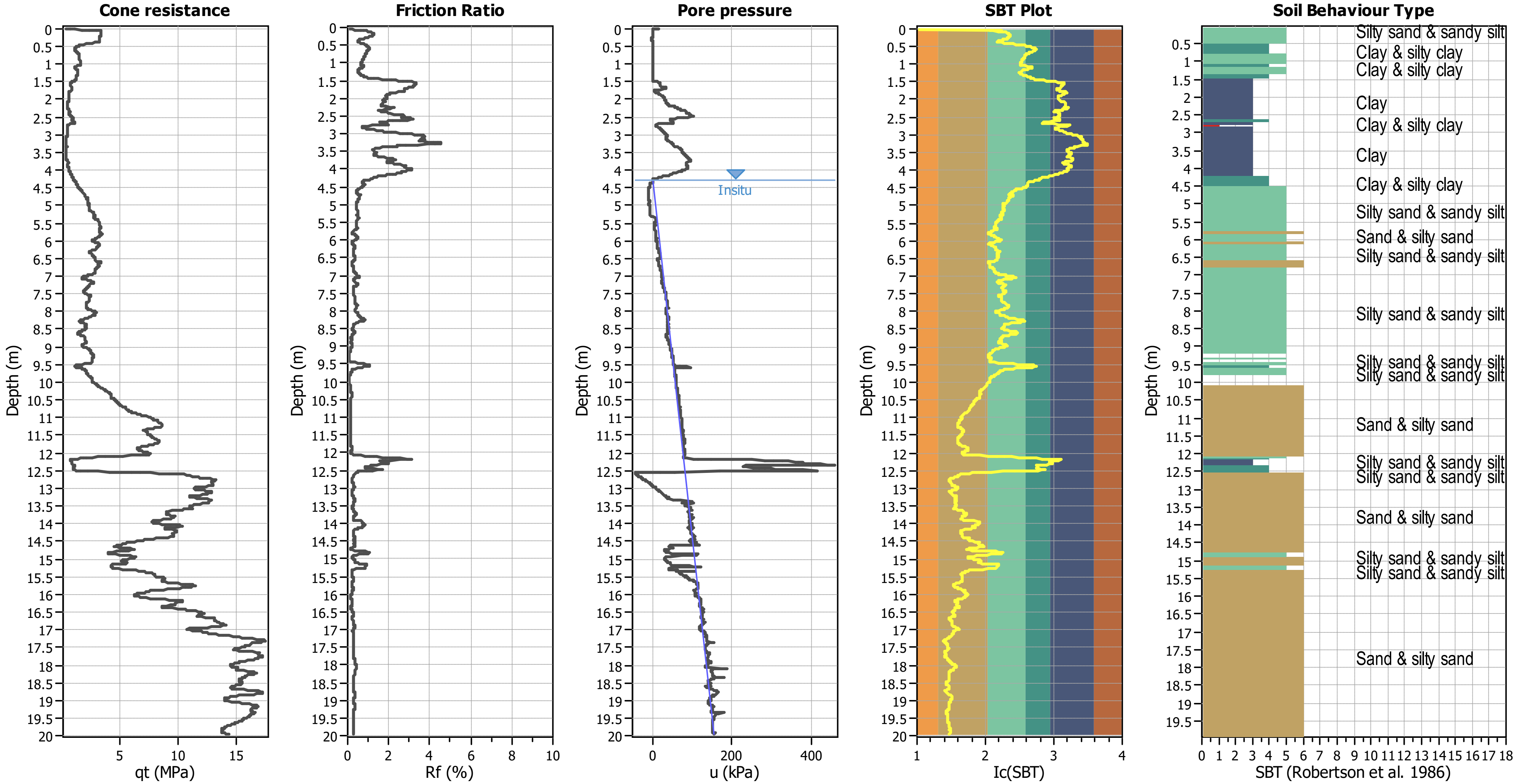
F.S. color scheme

- 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

LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



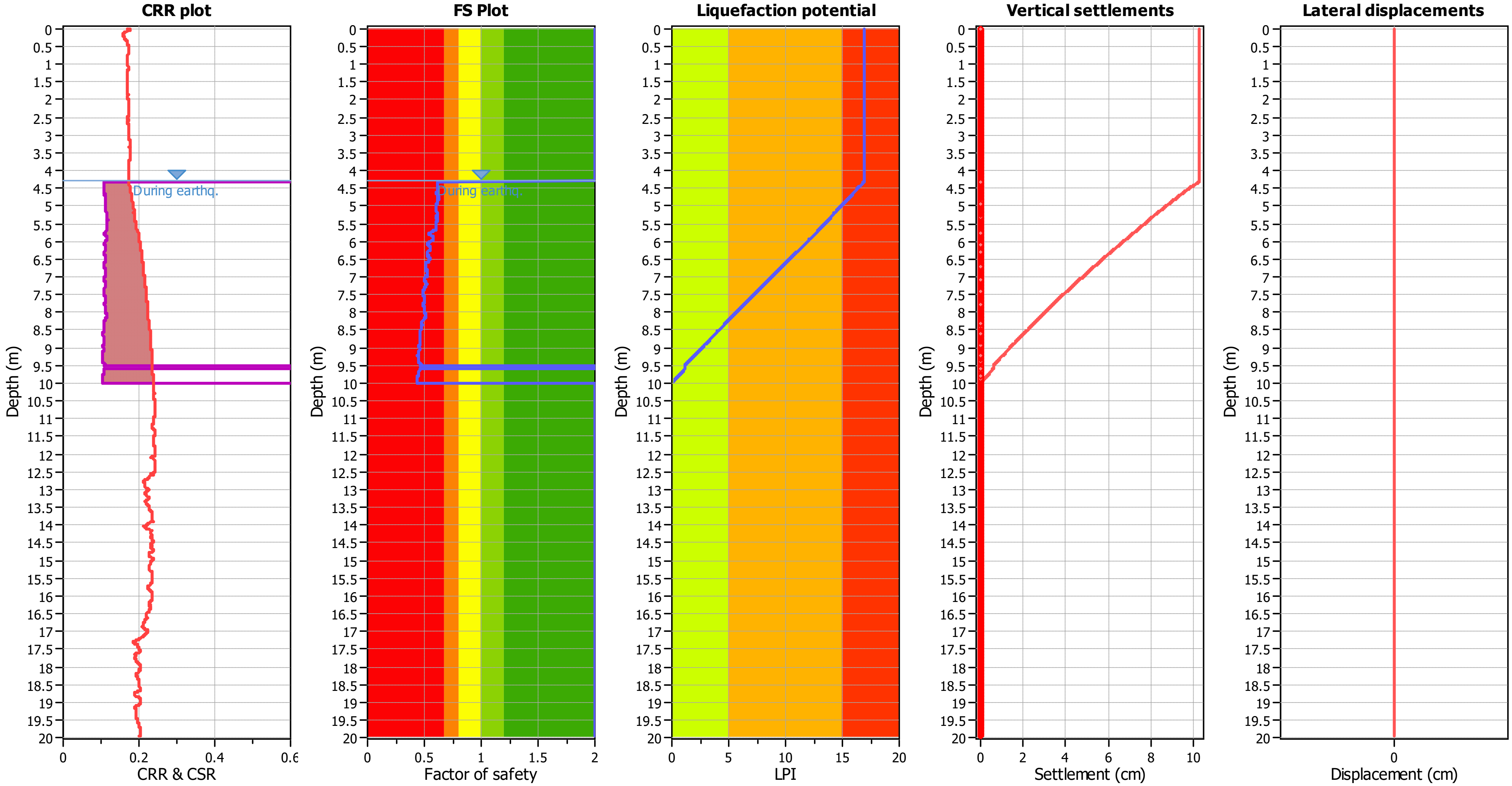
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.30 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.32	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	4.30 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.30 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.32	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	4.30 m	Fill height:	N/A	Limit depth:	10.00 m

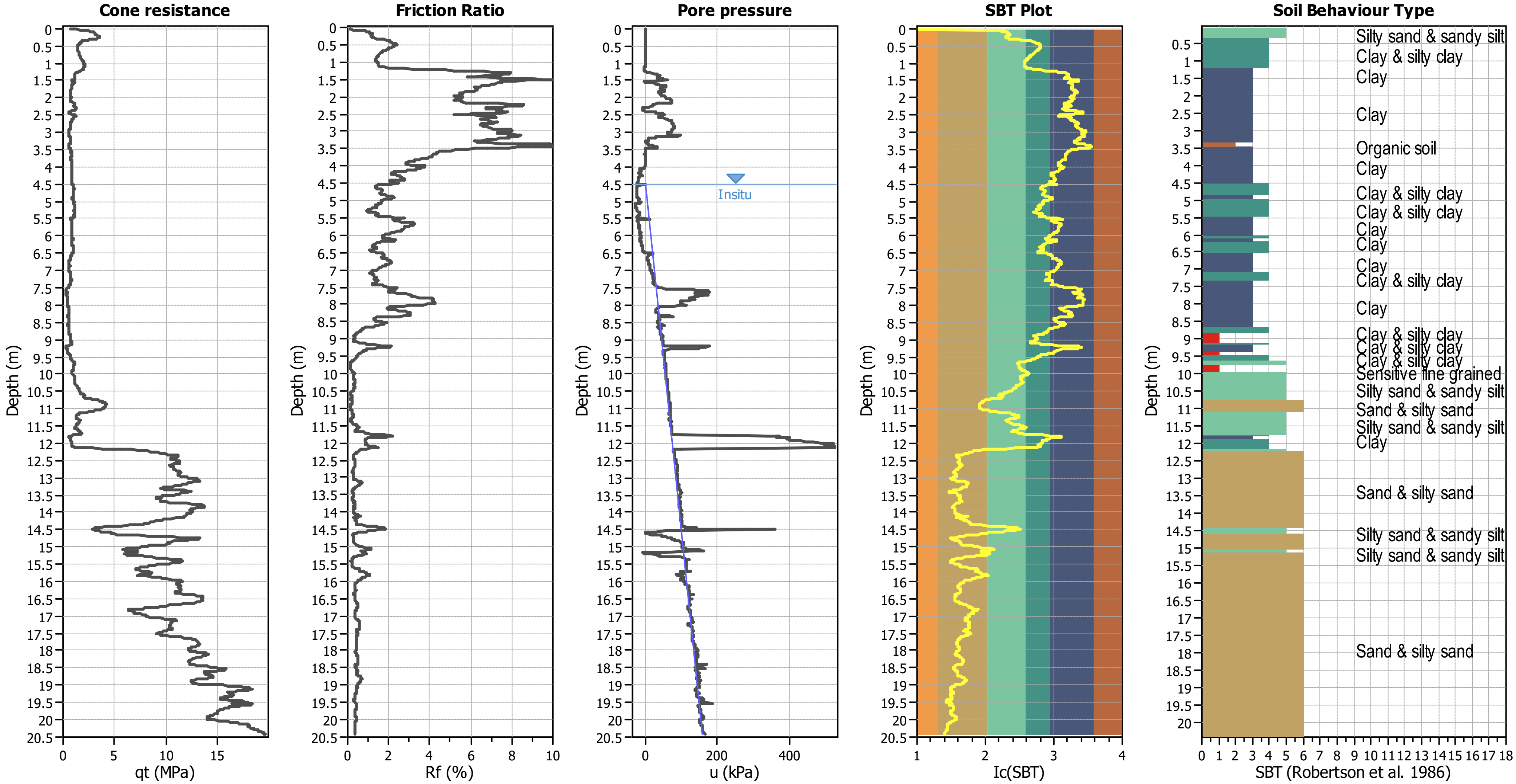
F.S. color scheme

- 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

LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



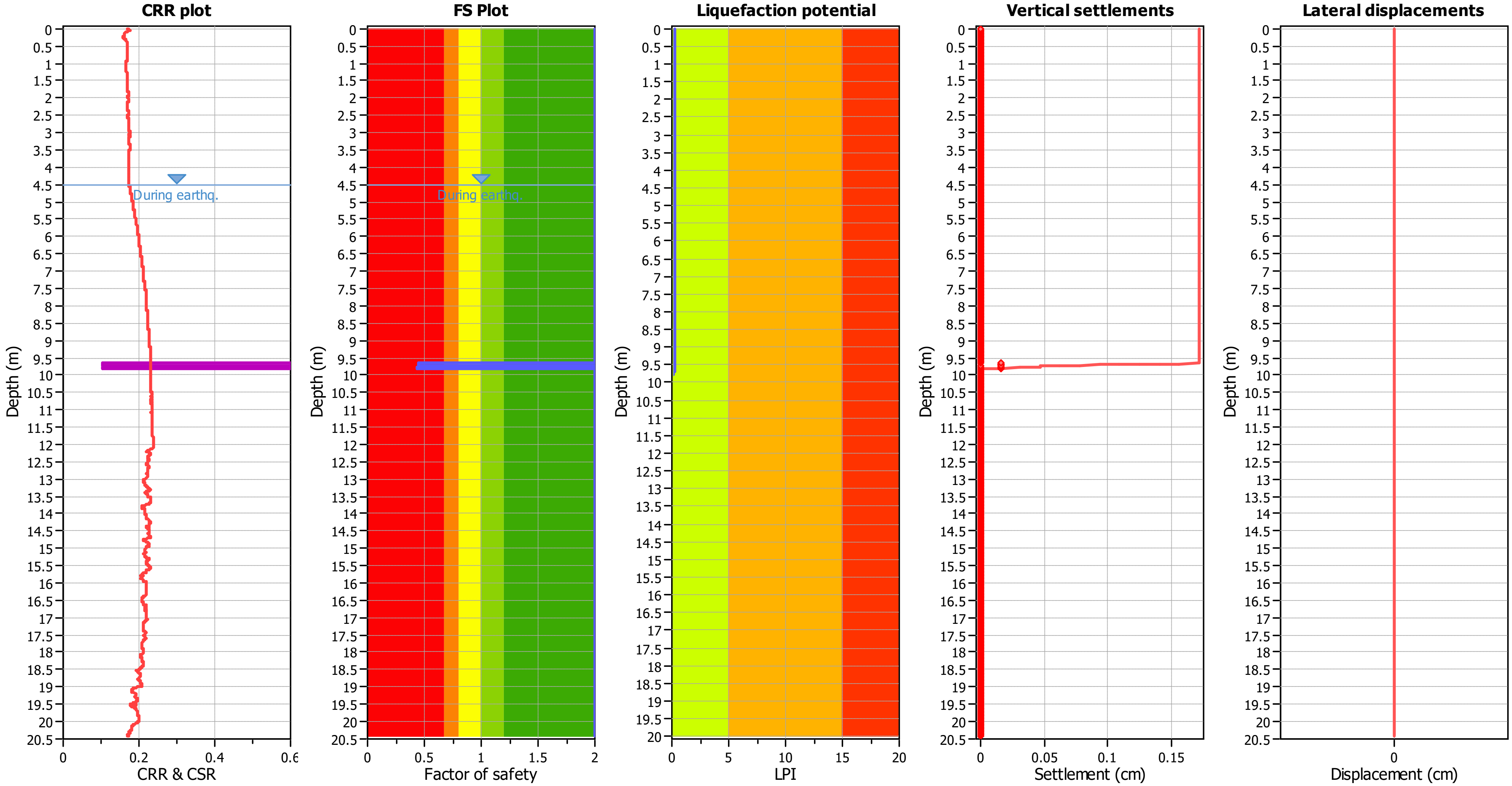
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.32	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	4.50 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.32	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	4.50 m	Fill height:	N/A	Limit depth:	10.00 m

F.S. color scheme

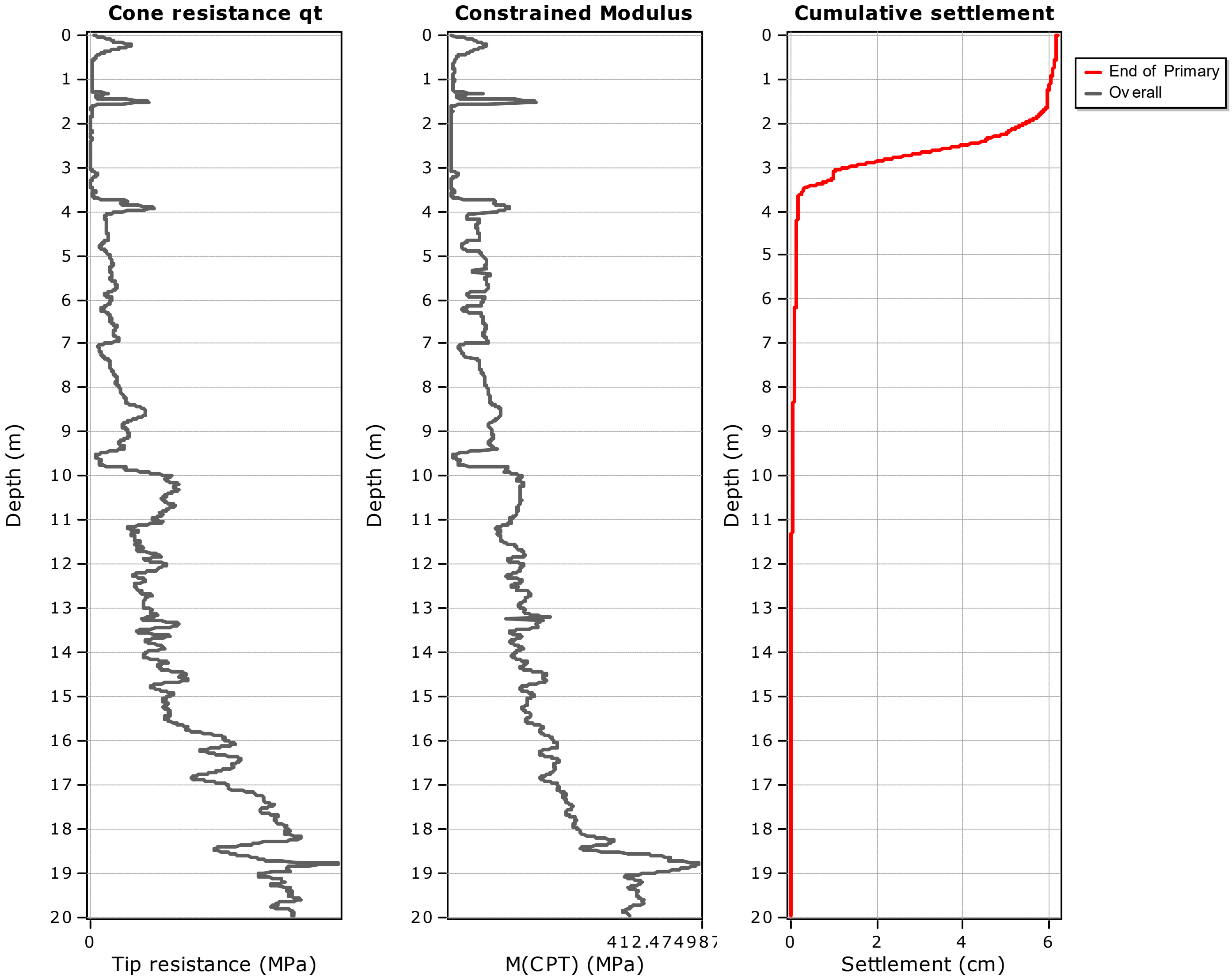
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

Appendix E: Settlement Analyses

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 15.00 (m)
L/B: 1.0
Footing pressure: 10.00 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: No
Time period for primary consolidation: N/A
Time period for second. settlements: N/A

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

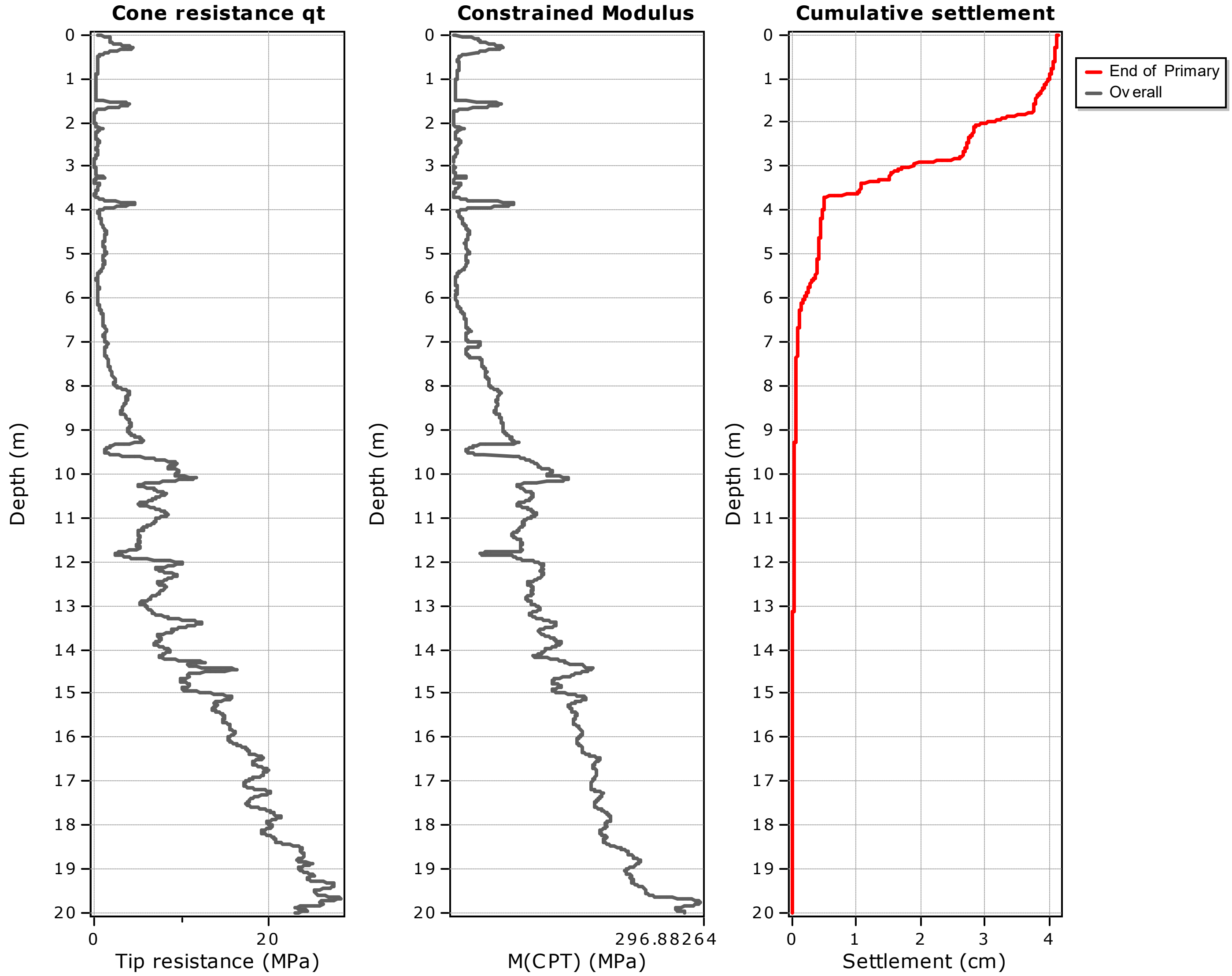
$$S = \sum \frac{\Delta\sigma_v}{M_{CPT}} \Delta z$$

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

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

where t_p is the duration of primary consolidation

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 15.00 (m)
L/B: 1.0
Footing pressure: 10.00 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: No
Time period for primary consolidation: N/A
Time period for second. settlements: N/A

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

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

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

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

where t_p is the duration of primary consolidation

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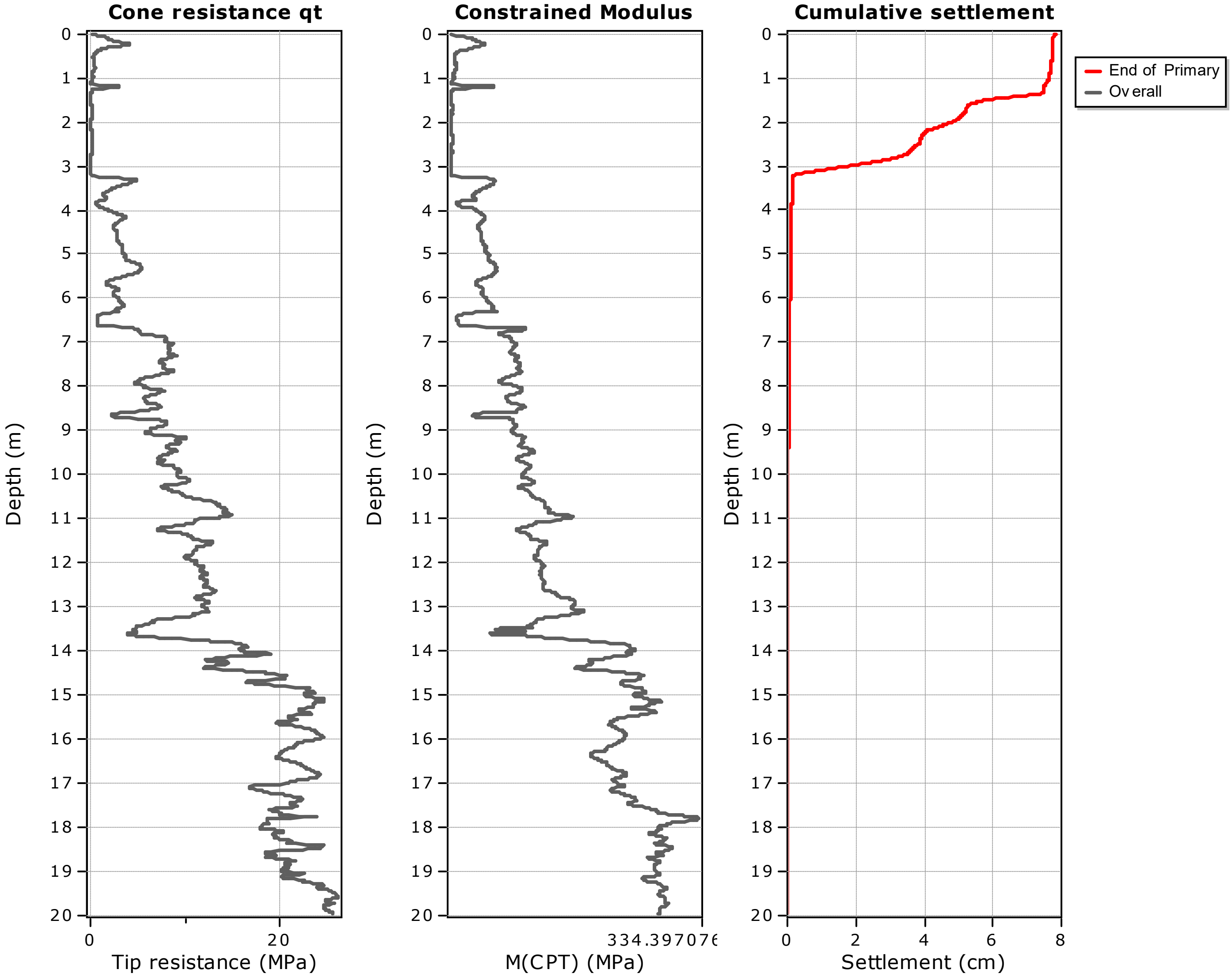
CPT: CPT03
Total depth: 19.97 m, Date: 24/01/2022
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project:
Location:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 15.00 (m)
L/B: 1.0
Footing pressure: 10.00 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: No
Time period for primary consolidation: N/A
Time period for second. settlements: N/A

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

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

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

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

where t_p is the duration of primary consolidation

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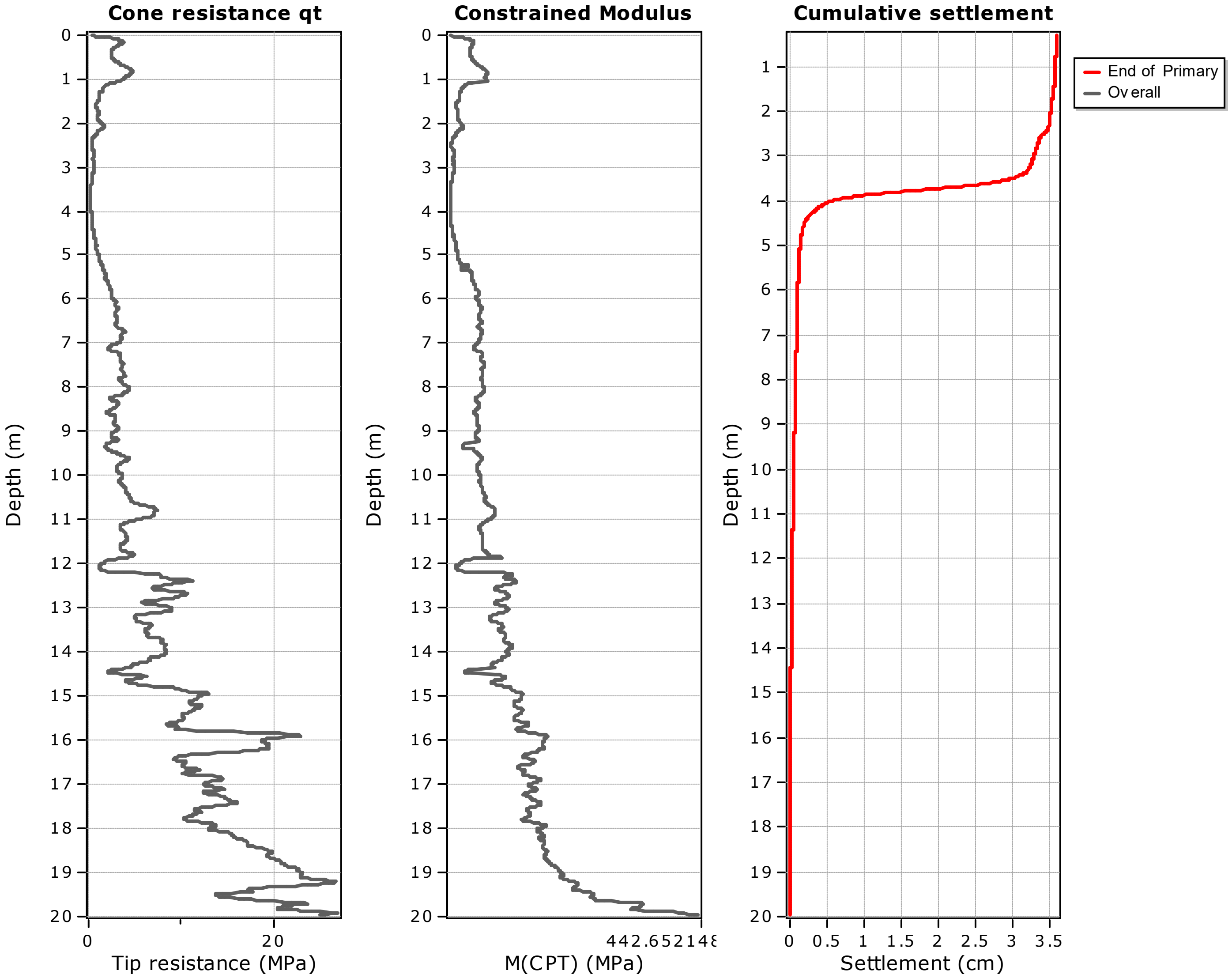
CPT: CPT04
Total depth: 19.97 m, Date: 24/01/2022
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project:
Location:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 15.00 (m)
L/B: 1.0
Footing pressure: 10.00 (kPa)
Embedment depth: 0.30 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: No
Time period for primary consolidation: N/A
Time period for second. settlements: N/A

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

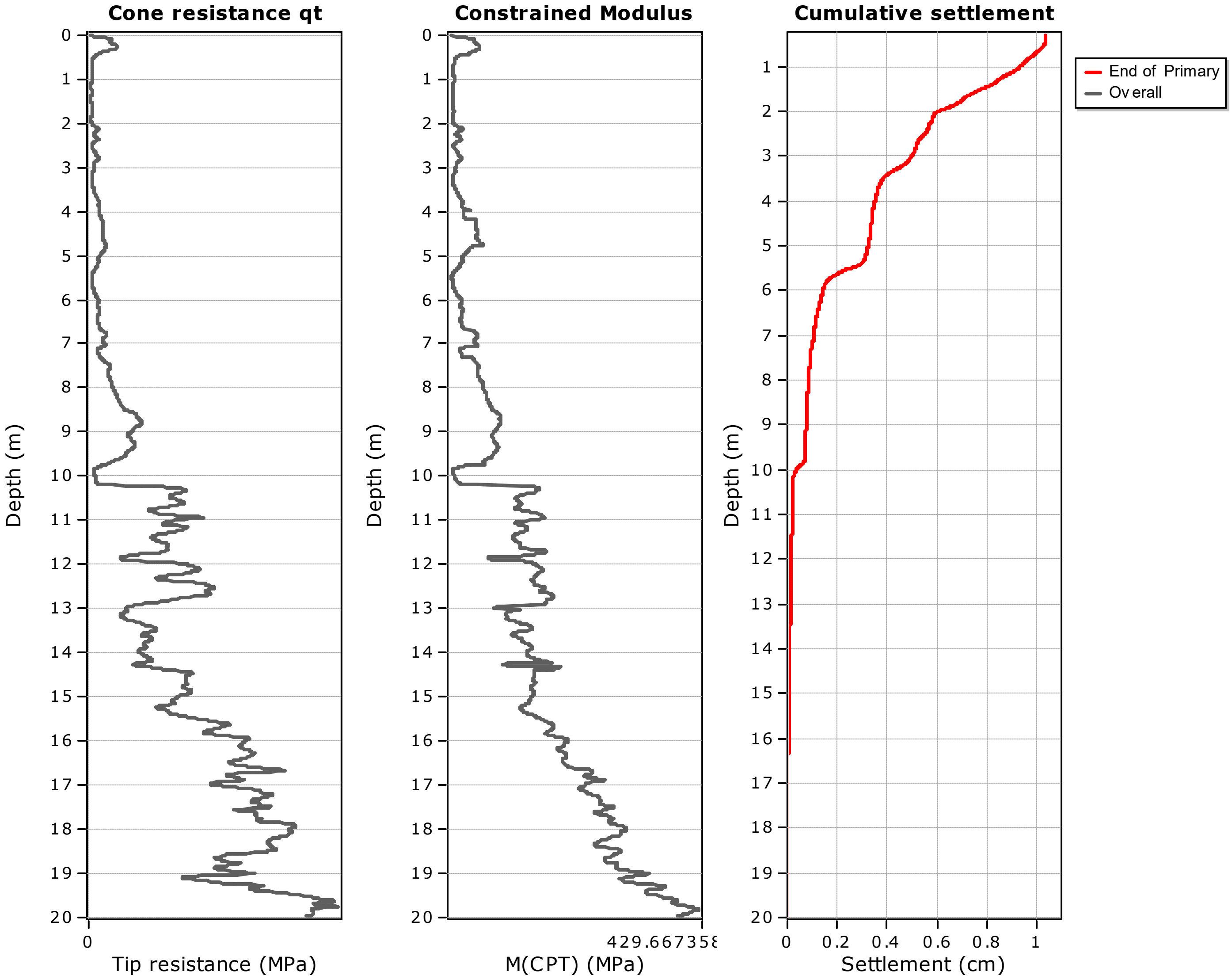
$$S = \sum \frac{\Delta \sigma_v}{M_{CPT}} \Delta z$$

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

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

where t_p is the duration of primary consolidation

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 15.00 (m)
L/B: 1.0
Footing pressure: 10.00 (kPa)
Embedment depth: 0.30 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: No
Time period for primary consolidation: N/A
Time period for second. settlements: N/A

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

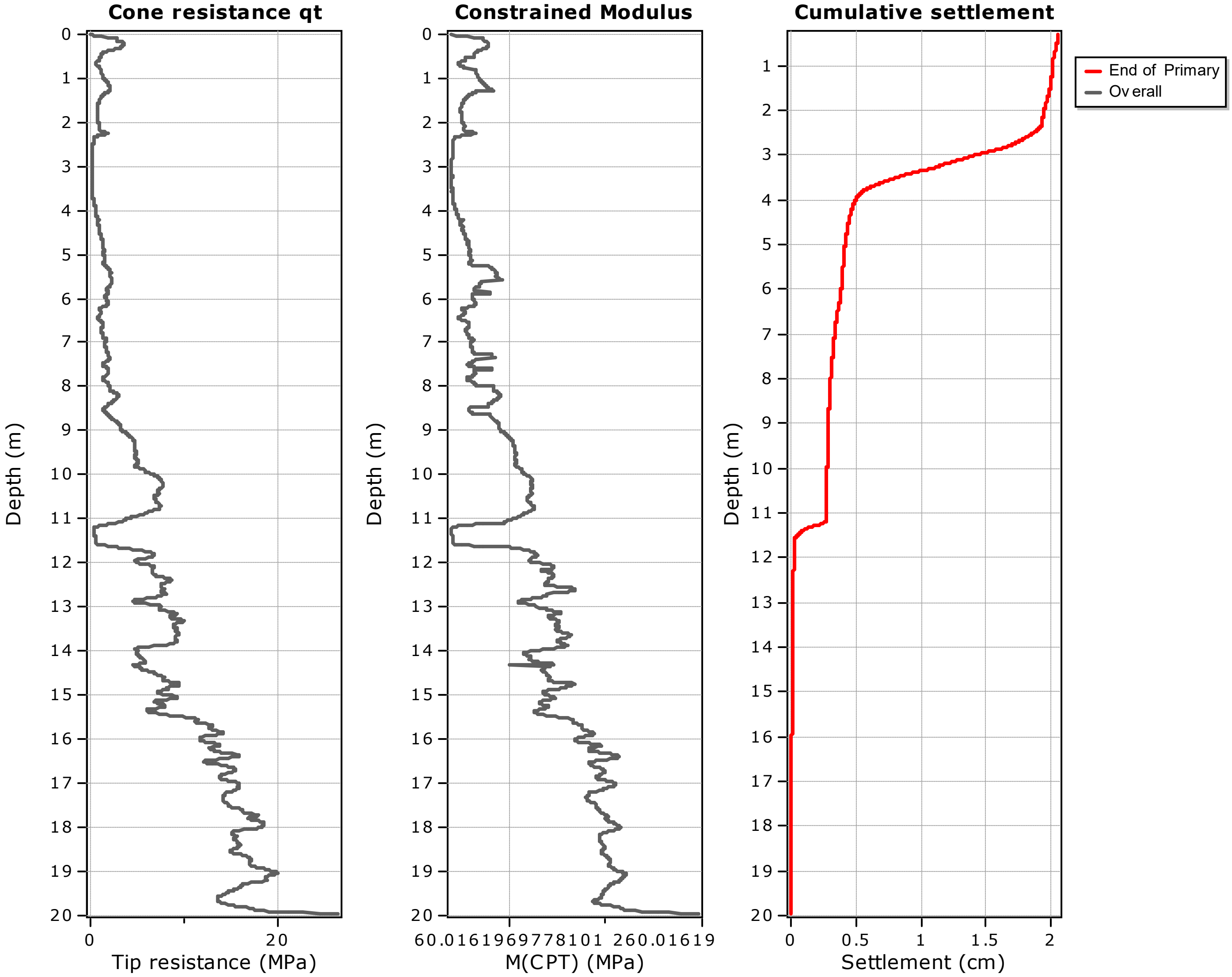
$$S = \sum \frac{\Delta \sigma_v}{M_{CPT}} \Delta z$$

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

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

where t_p is the duration of primary consolidation

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 15.00 (m)
L/B: 1.0
Footing pressure: 10.00 (kPa)
Embedment depth: 0.30 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: No
Time period for primary consolidation: N/A
Time period for second. settlements: N/A

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

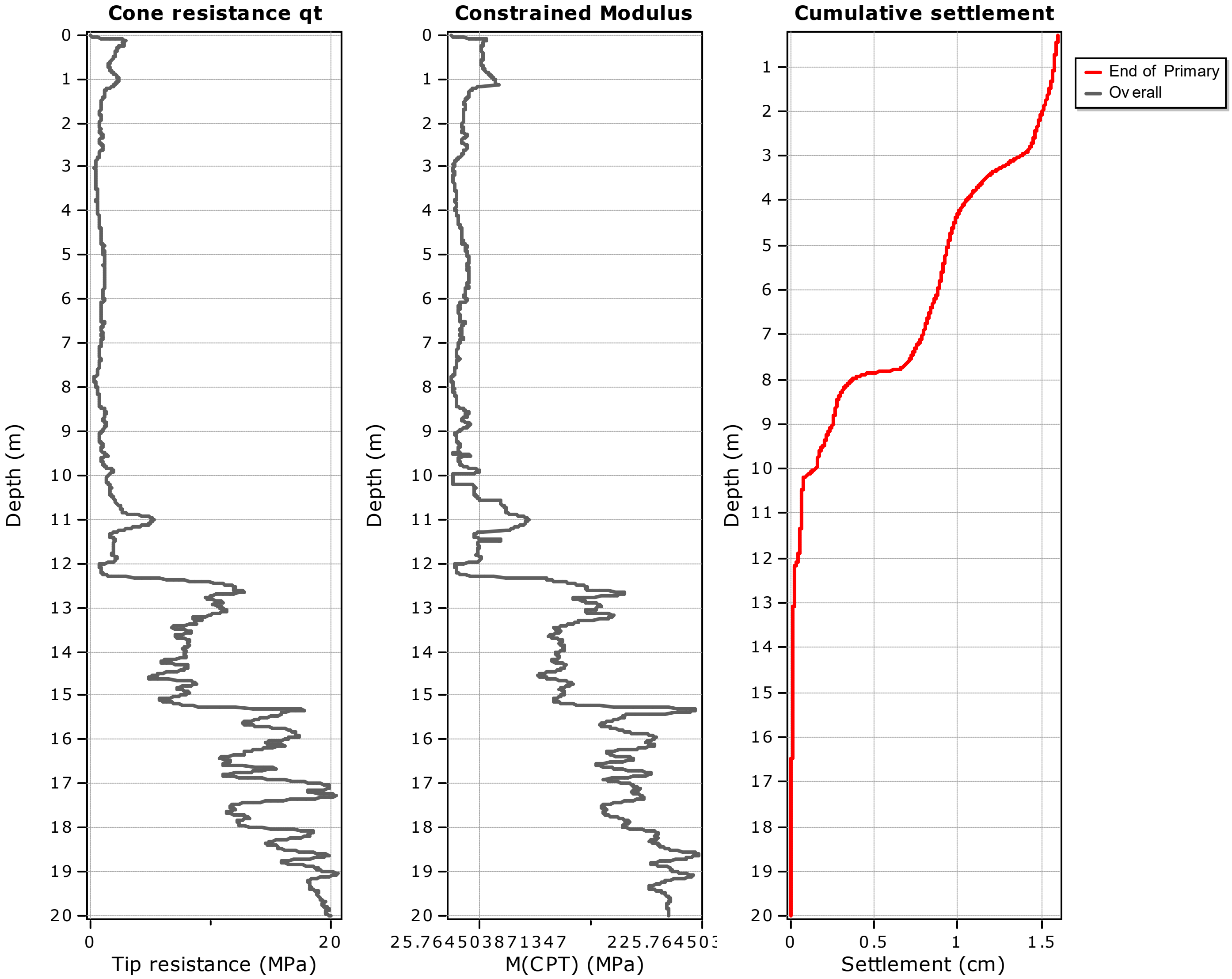
$$S = \sum \frac{\Delta\sigma_v}{M_{CPT}} \Delta z$$

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

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

where t_p is the duration of primary consolidation

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 15.00 (m)
L/B: 1.0
Footing pressure: 10.00 (kPa)
Embedment depth: 0.30 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: No
Time period for primary consolidation: N/A
Time period for second. settlements: N/A

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

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

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

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

where t_p is the duration of primary consolidation

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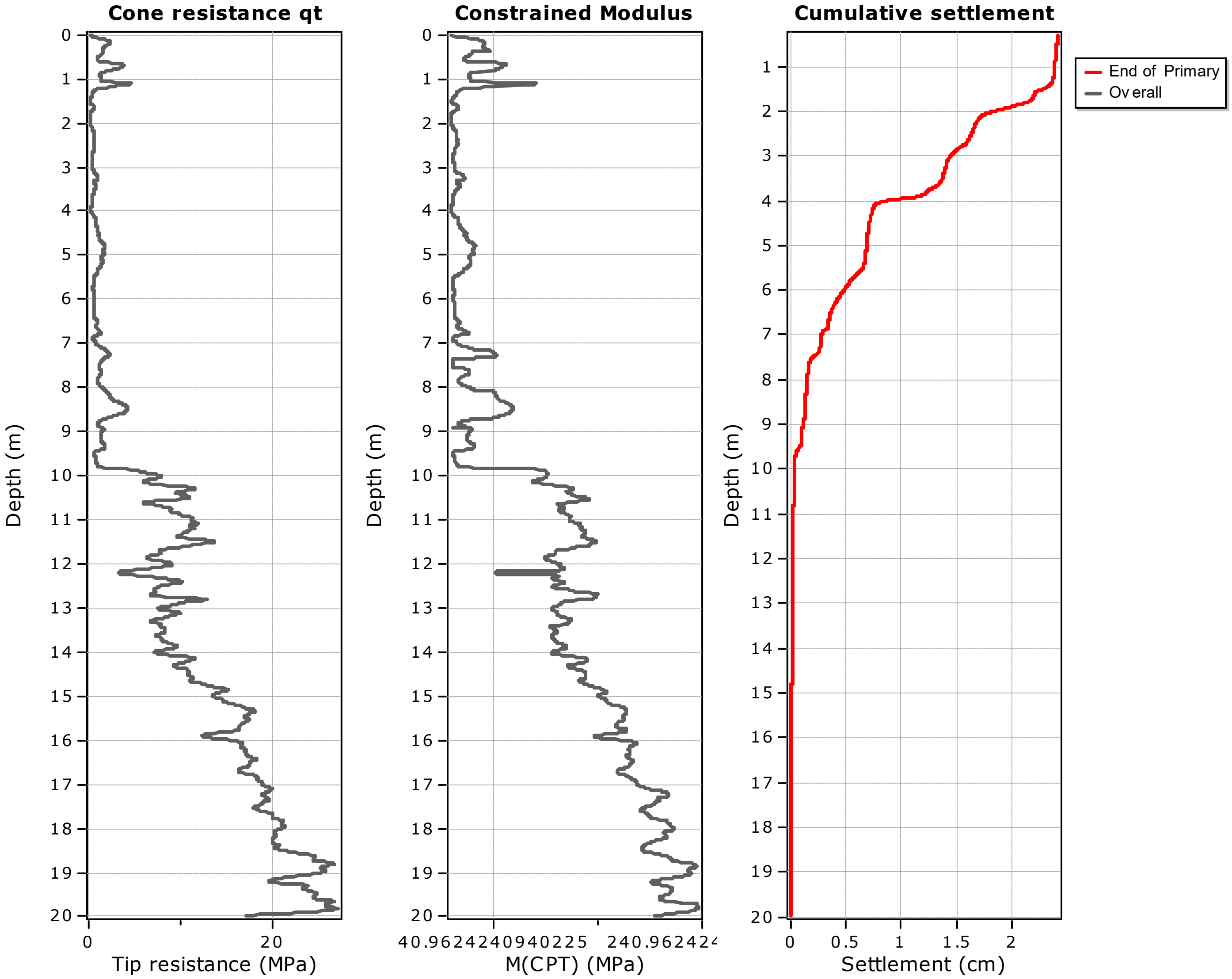
CPT: CPT10
Total depth: 19.98 m, Date: 24/01/2022
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project:
Location:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 15.00 (m)
L/B: 1.0
Footing pressure: 10.00 (kPa)
Embedment depth: 0.30 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: No
Time period for primary consolidation: N/A
Time period for second. settlements: N/A

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

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

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

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

where t_p is the duration of primary consolidation

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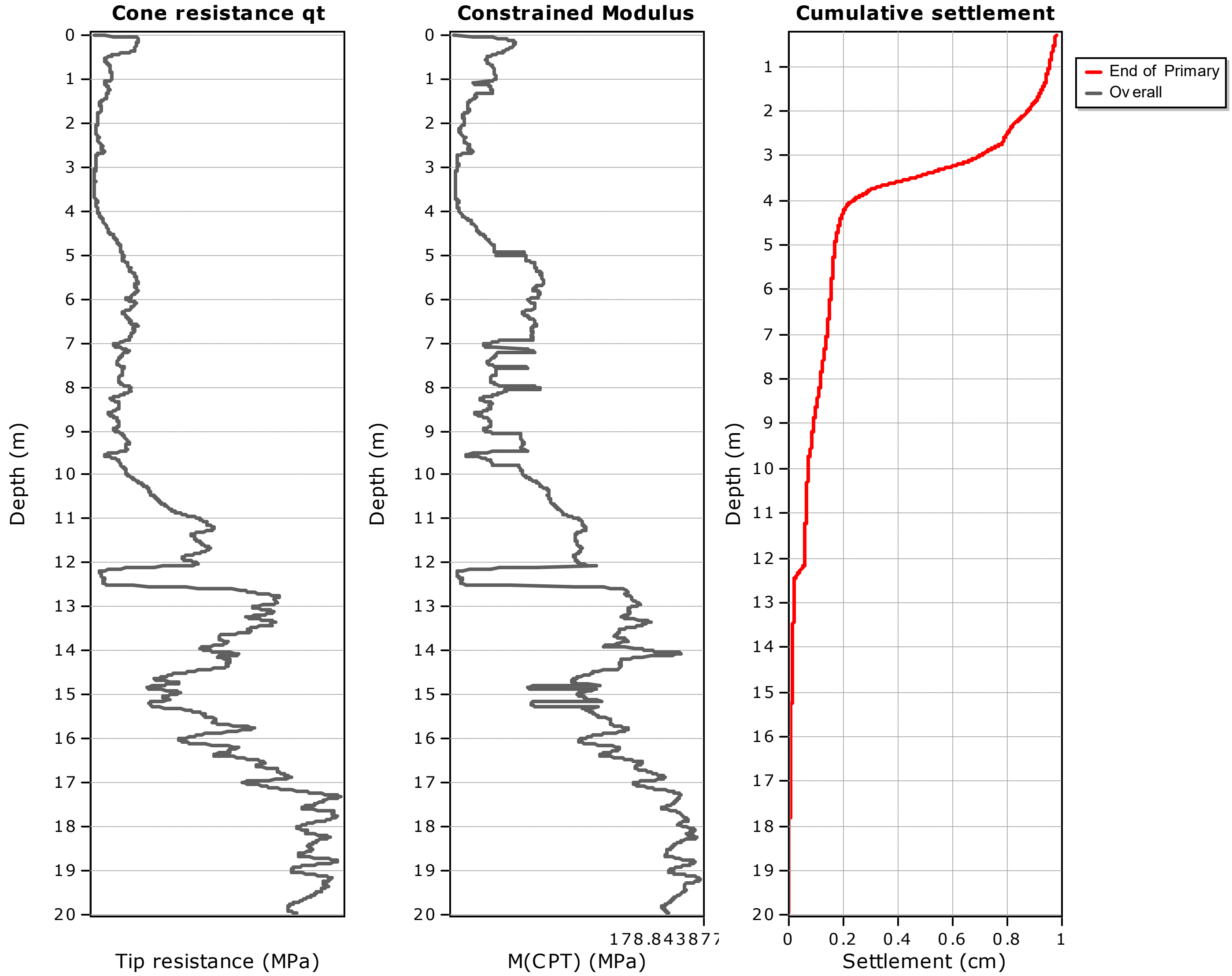
CPT: CPT11
Total depth: 19.95 m, Date: 24/01/2022
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project:
Location:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 15.00 (m)
L/B: 1.0
Footing pressure: 10.00 (kPa)
Embedment depth: 0.30 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: No
Time period for primary consolidation: N/A
Time period for second. settlements: N/A

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

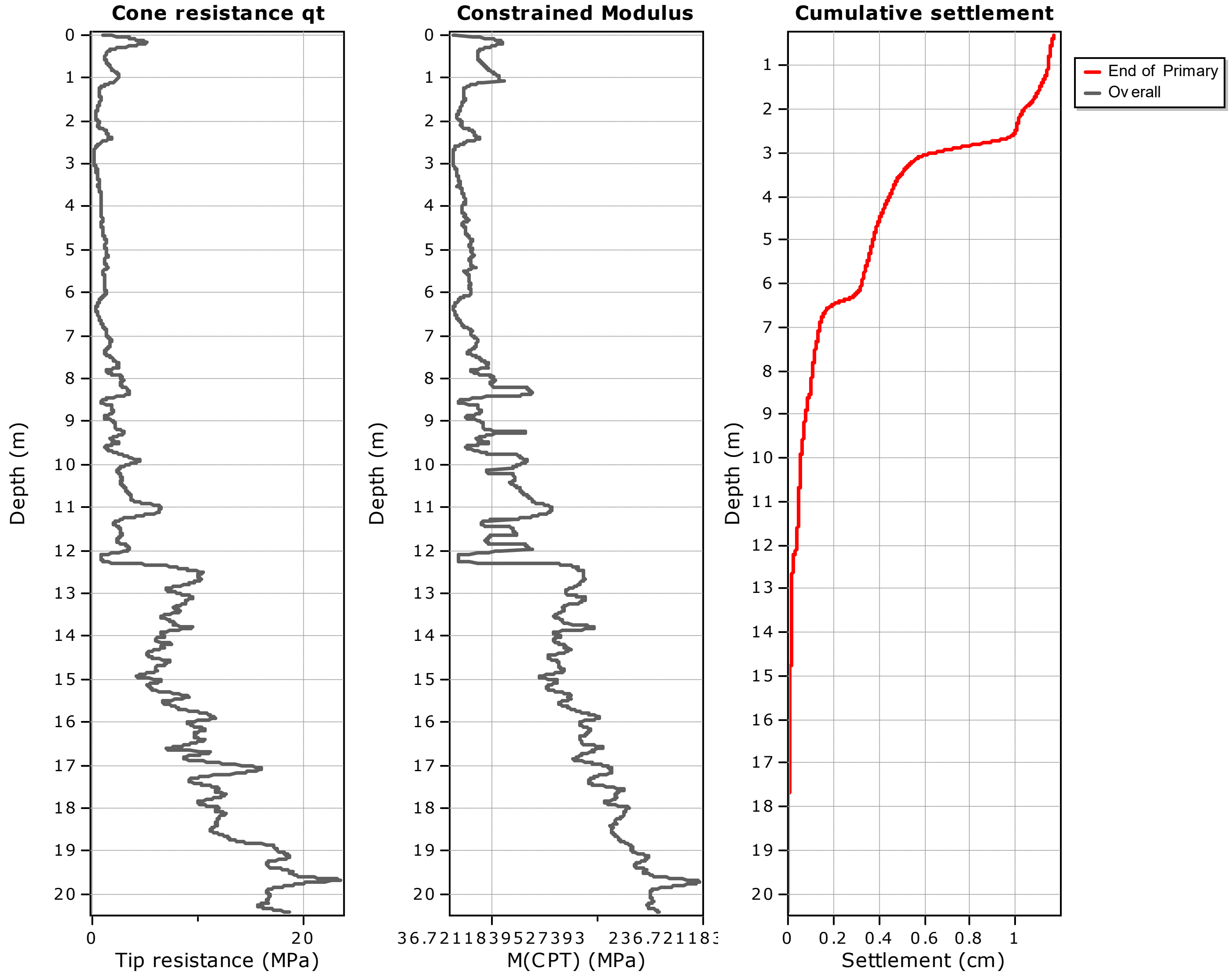
$$S = \sum \frac{\Delta \sigma_v}{M_{CPT}} \Delta z$$

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

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

where t_p is the duration of primary consolidation

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 15.00 (m)
L/B: 1.0
Footing pressure: 10.00 (kPa)
Embedment depth: 0.30 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: No
Time period for primary consolidation: N/A
Time period for second. settlements: N/A

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

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

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

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

where t_p is the duration of primary consolidation

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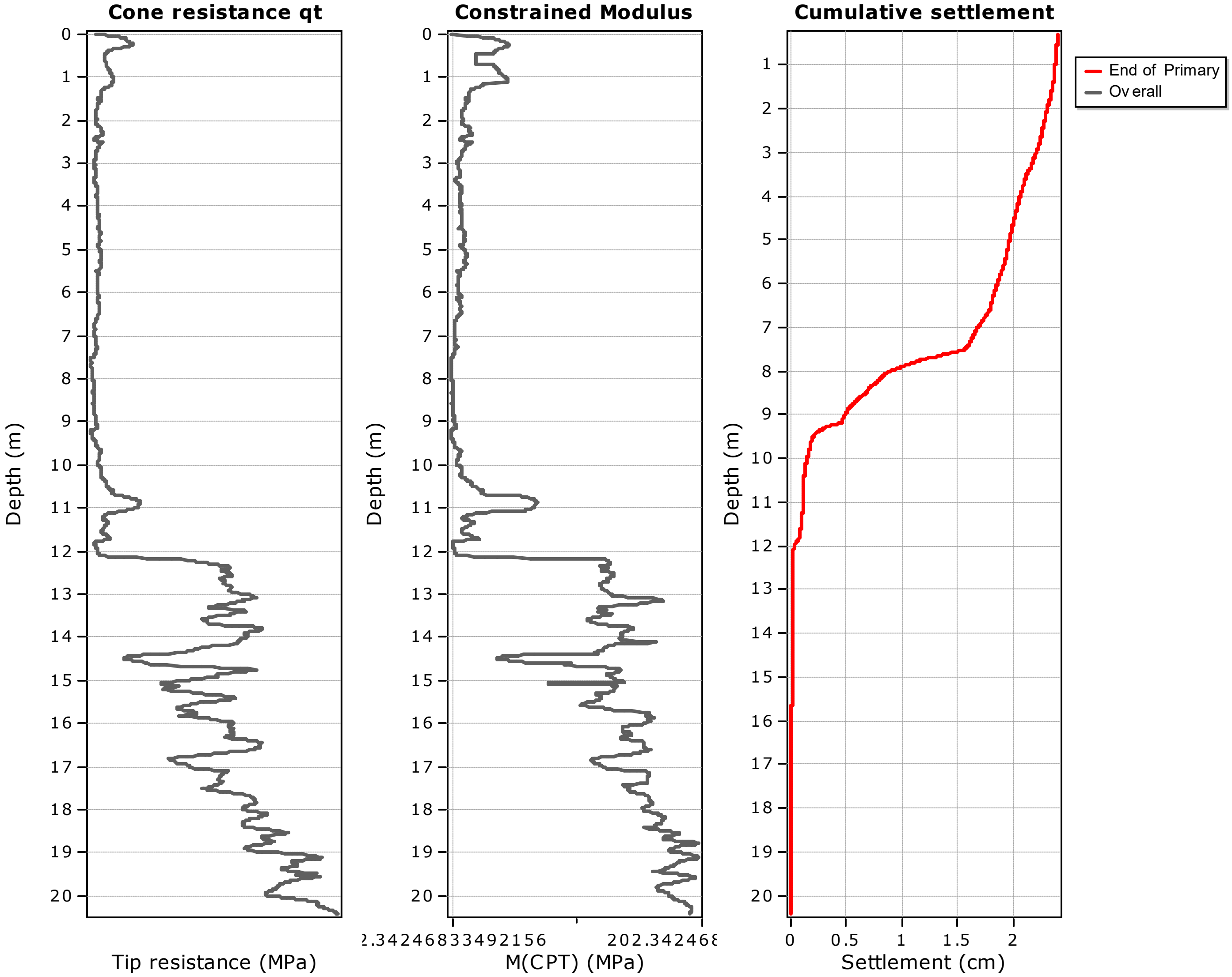
CPT: sCPT12
Total depth: 20.42 m, Date: 24/01/2022
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project:
Location:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 15.00 (m)
L/B: 1.0
Footing pressure: 10.00 (kPa)
Embedment depth: 0.30 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: No
Time period for primary consolidation: N/A
Time period for second. settlements: N/A

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

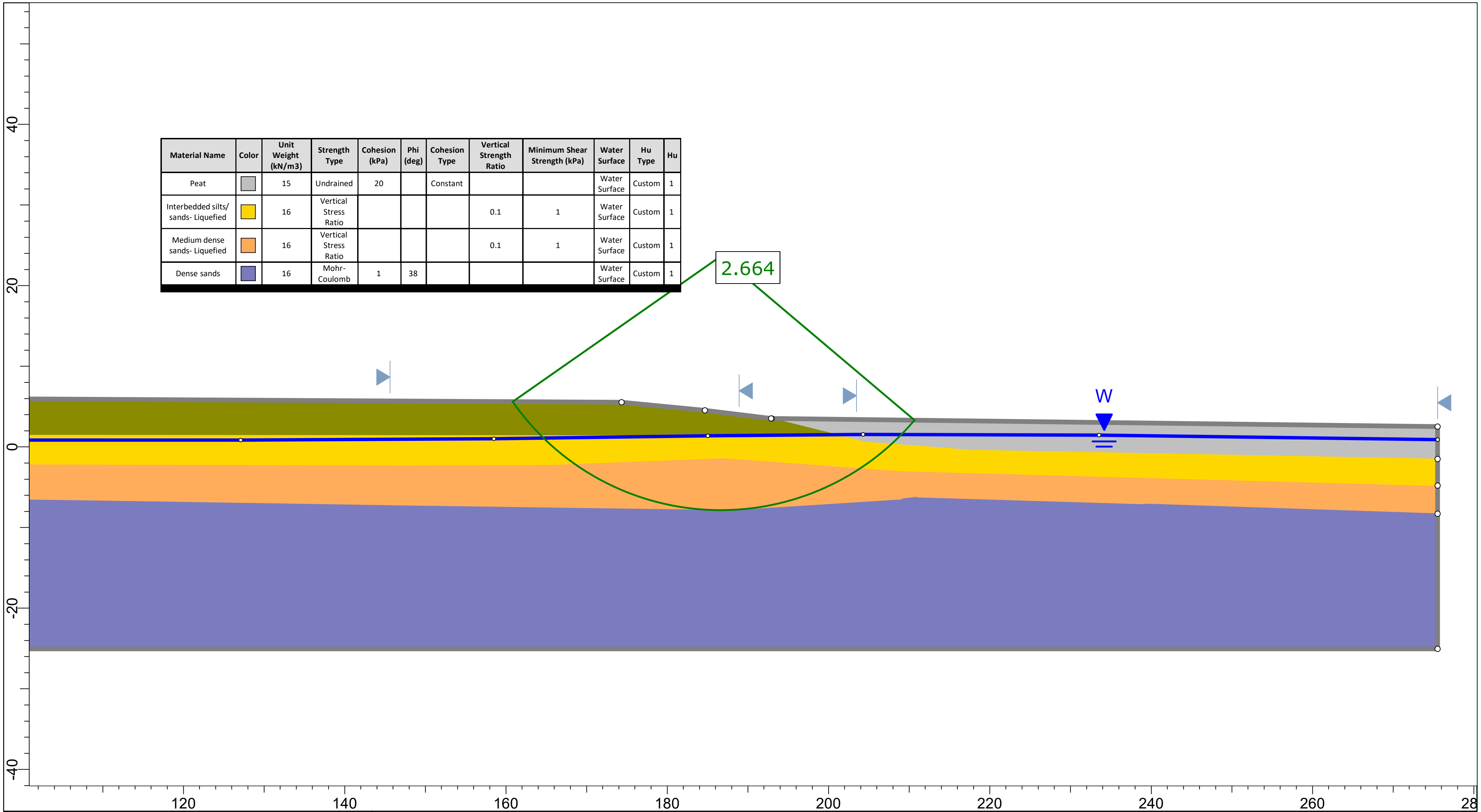
$$S = \sum \frac{\Delta\sigma_v}{M_{CPT}} \Delta z$$

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

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

where t_p is the duration of primary consolidation

Appendix F: Lateral Spread Analyses

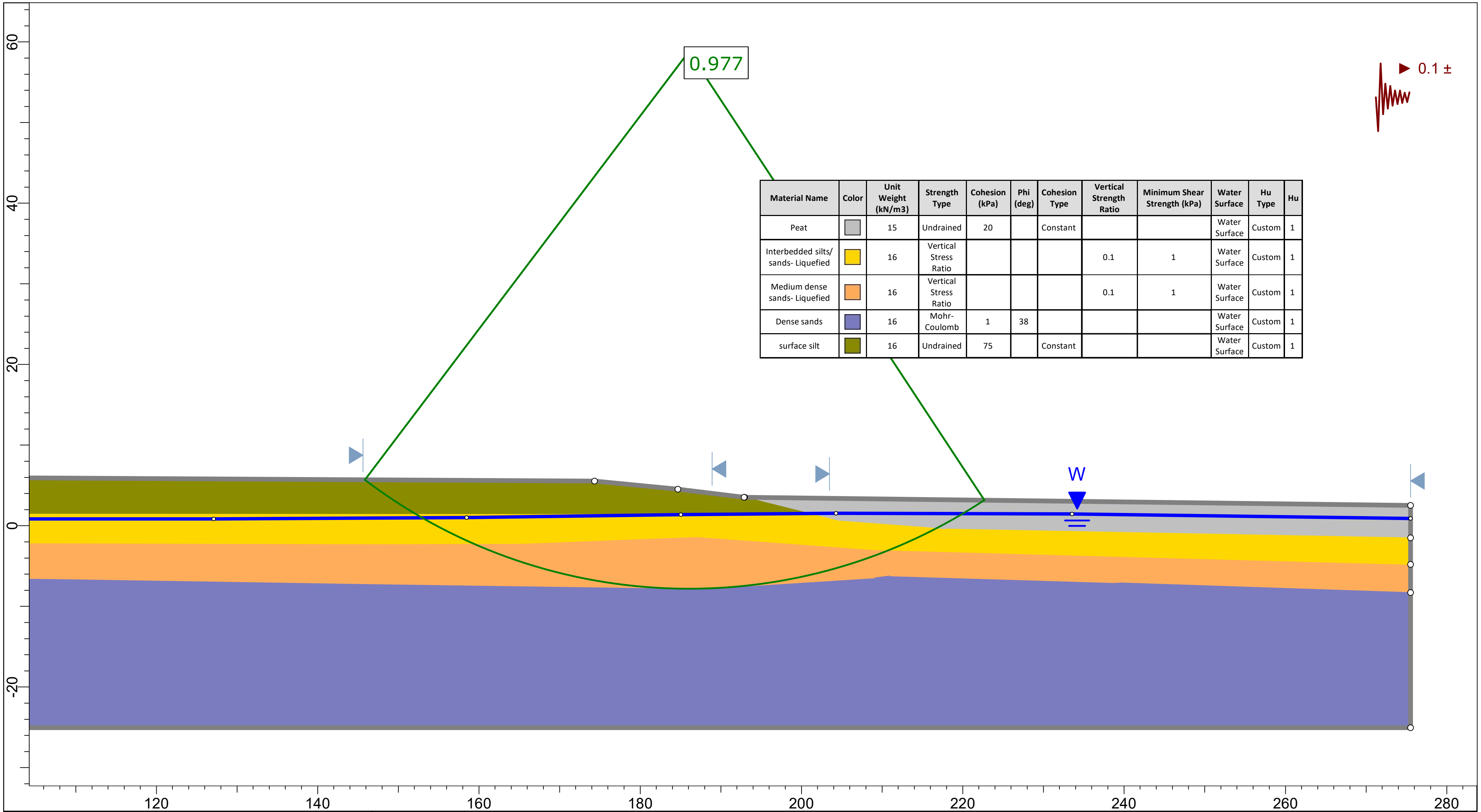


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Vertical Strength Ratio	Minimum Shear Strength (kPa)	Water Surface	Hu Type	Hu
Peat		15	Undrained	20		Constant			Water Surface	Custom	1
Interbedded silts/ sands- Liquefied		16	Vertical Stress Ratio				0.1	1	Water Surface	Custom	1
Medium dense sands- Liquefied		16	Vertical Stress Ratio				0.1	1	Water Surface	Custom	1
Dense sands		16	Mohr-Coulomb	1	38				Water Surface	Custom	1

CMW Geosciences

SLIDEINTERPRET 9.001

Project	Pencarrow Estate Section A - Flow Failure		
Group		*Scenario*	Lateral Spread
Drawn By	LGL	*Client*	Marsh
Date	01/02/22	*File Name*	A-A - test.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Vertical Strength Ratio	Minimum Shear Strength (kPa)	Water Surface	Hu Type	Hu
Peat		15	Undrained	20		Constant			Water Surface	Custom	1
Interbedded silts/ sands- Liquefied		16	Vertical Stress Ratio				0.1	1	Water Surface	Custom	1
Medium dense sands- Liquefied		16	Vertical Stress Ratio				0.1	1	Water Surface	Custom	1
Dense sands		16	Mohr-Coulomb	1	38				Water Surface	Custom	1
surface silt		16	Undrained	75		Constant			Water Surface	Custom	1

CMW Geosciences

SLIDEINTERPRET 9.001

Project	Pencarrow Estate Section A - Yield Acceleration		
Group		*Scenario*	Lateral Spread
Drawn By	LGL	*Client*	Marsh
Date	01/02/22	*File Name*	A-A - test.slmd

APPENDIX 3 – PRELIMINARY STORMWATER CALCULATIONS

DETAILED SOAKAGE SYSTEM DESIGN - CRATE SYSTEM - RAINSMART MODULAR TANK

Project No: 225216
Client: Momentum Planning & Design
Site: 1491 State Highway 2, Pongakawa
Date: 21/04/2022

System Details

Catchment Area	210	m²			
Volumetric Runoff Coefficient	0.9		Impervious Area Runoff Factor	0.00095	m/min
Soil K_h	100	mm/hr	per Geotech reccomendations	57	
Crate Width	0.4	m		28.5	
Crate Height	1.28	m	per Manufacturers specs		
Crate Length	0.715	m			
No. Crates Wide	6				
No. Crates Long	7				
Width of Infiltration Area	2.4	m			
Length of Infiltration Area	5.005	m			
Depth of Storage	1.28	m			
Porosity/Void Ratio	0.95		Use 0.95 for crate system		
Base Area Included In Calc	Yes				
Side Area Included In Calc	Yes				
Permeable Side Area	100%		Utilise this factor where part of trench side wall not permeable i.e. use 20% if only 20% of trench in permeable soil strata		

System Calcs

Base Area	12.01	m²
Side Area	9.48	m²
Total Infiltration Area	21.49	m²
Effective Storage Volume	14.61	m³

Storm Duration	Storm Mean Intensity (10yr)	Volume in (m³)	Volume Soaked (m³)	Additional Storage Required (m³)	Percentage of Storage provided (%)	Time to Drain (hrs)	Drains within 24hrs?
10	150.10	4.7	0.4	4.4	334%	2.0	
20	99.00	6.2	0.7	5.5	265%	2.6	
30	91.90	8.7	1.1	7.6	192%	3.5	
60	66.80	12.6	2.1	10.5	139%	4.9	**Yes**
120	44.90	17.0	4.3	12.7	115%	5.9	
360	24.30	27.6	12.9	14.7	100%	6.8	
720	15.90	36.1	25.8	10.3	142%	4.8	
1440	10.40	47.2	47.2	0.0		0.0	
2880	6.40	58.1	58.1	0.0		0.0	

PENCARROW POND DESIGN - BOPRC/TCC Method

Project: 225216
Site: Pencarrow Estate
Date: 25/03/2024
System: Detention Pond

POND VOLUME CALCS

Climate and Catchment Details

Water Quality Storm:	43	mm
2-year 1-hour rainfall:	43	mm
10-year 1-hour rainfall:	87	mm
Pre-development C:	0.3	
Post-development C:	0.7	
% Impervious:	55%	
Pre-development Catchment Area:	1.96	Ha
Post-development Catchment Area:	1.96	Ha

Calculate Pre-development flow rates

Pre-development Q_2:	0.07	m³/s
Pre-development Q_{10}:	0.14	m³/s

Calculate Extended Detention Volume

A_{wq}:	11025	m²
V_{wq}:	474	m³
ED Volume ($1.2V_{wq}$):	569	m³

Calculate Post-development flow rates

Post-development Q_2:	0.16	m³/s
Post-development Q_{10}:	0.33	m³/s

Calculate Pond Volumes

V_2:	886	m³
V_{10}:	1792	m³

DISCHARGE DESIGN CALCS

Extended Detention

If released over 24 hours, Q_{ED}:	0.007	m³/s
Q_{max} (assume $2Q_{ED}$):	0.013	m³
ED volume + WQV:	806	m³
Level at which WQV available:	5	m
Level at which volume available:	5.5	m
Try ED Orifice size:	0.085	m
Q:	0.011	
CHECK:	OK	

APPENDIX 4 – PRELIMINARY WASTEWATER CALCULATIONS

WASTEWATER - DEVELOPMENT DEMAND

Project No:	225216
Client:	Momentum Planning and Design
Site:	1491 State Highway 2, Pongakawa
Date:	27/03/2024

Residential wastewater demand

Dwellings	130	
Occupancy	5	people
Demand	200	l/p/day
Population	650	people
ADWF (l/d)	130000	l/d
ADWF (m^3/d)	130	m^3/d
ADWF (l/s)	1.50	l/s
Peaking Factor	5	
PWWF	7.52	l/s

Commercial wastewater demand

Staff/Users	200	people	
Assumed discharge	50	l/p/d	*Taken from table H4, NZS1547:2012 for non-resident motel/hotel staff*
ADWF (l/d)	10000	l/d	
ADWF (m^3/d)	10	m^3/d	
ADWF (l/s)	0.12	l/s	
Peaking Factor	5		
PWWF	0.58	l/s	

Total Wastewater demand

Average Daily Flow	**140.00**	**m^3/d**
ADWF (l/s)	1.62	**l/s**
Peak Residential	7.52	l/s
Peak Commercial	0.58	l/s
Total Peak	**8.10**	**l/s**

APPENDIX 5 – PRELIMINARY WATER SUPPLY CALCULATIONS

WATER SUPPLY - DEVELOPMENT DEMAND

LYSAGHT

Project No: 225216
Client: Momentum Planning and Design
Site: 1491 State Highway 2, Pongakawa
Date: 9/12/2022

Residential water demand			
Dwellings	130		
Occupancy	3	people	
Demand	220	l/p/day	
Population	390	people	
Average Daily Demand	85800	l/d	
	85.8	m3/d	
Peaking Factor	5		
Peak Hour Demand	4.97	l/s	
Commercial water demand			
Area	1600	m2	
Assumed demand	1.5	l/s/Ha	*From WBOPDC DC*
Average Daily Demand	20736	l/d	
	20.7	m3/d	
Peaking Factor	5		
Peak Hour Demand	1.20	l/s	
Total Water Demand			
Residential	4.97	l/s	
Commercial	1.20	l/s	
Total	**6.17**	**l/s**	

APPENDIX 6 – POWERCO COMMUNICATIONS

Jordy Hardacre

To: Daniel Hight
Subject: RE: Pongakawa - Plan Change for Residential Development - Power Supply

From: Evans Chogumaira <Evans.Chogumaira@powerco.co.nz>
Sent: Thursday, 28 April 2022 6:03 pm
To: CIW Planning Eastern <CIW.PlanningEastern@powerco.co.nz>
Cc: Gabriel Lim <Gabriel.Lim@powerco.co.nz>; Customer Works Eastern <CustomerWorksEastern@powerco.co.nz>
Subject: RE: Pongakawa - Plan Change for Residential Development - Power Supply

Hi

The proposed development can be connected to the existing network by extending the 11kV feeder (PKW1 Tainui feeder) from the boundary into the subdivision and installing one transformer (or two transformers if needed to manage LV voltage drop). This is based on total expected demand of 460kW from:

- 85-90 dwellings: approx. 360kW, and
- allowing 100kW for the commercial area.

Given the long term timeline for the development (up to 10 years), if other developments are committed and delivered in this area ahead of this residential development then potentially it may be necessary to upgrade the upstream network.

Regards

Evans

From: Customer Works Eastern <CustomerWorksEastern@powerco.co.nz>
Sent: Thursday, 28 April 2022 9:34 am
To: CIW Planning Eastern <CIW.PlanningEastern@powerco.co.nz>
Subject: FW: Pongakawa - Plan Change for Residential Development - Power Supply
Importance: High

Hi Team,

Can you please review the below and attached and provide Richard with feedback.

Many thanks,

Zoe Huygen
Customer Works Co-Ordinator
DDI +64 7 928 5652
Level 2, 152 Devonport Road, Tauranga 3110 | PO Box 13 075, Tauranga 3141
www.powerco.co.nz

From: Richard Coles <richard@mpad.co.nz>
Sent: Thursday, 21 April 2022 8:37 am
To: Customer Works Eastern <CustomerWorksEastern@powerco.co.nz>
Subject: Pongakawa - Plan Change for Residential Development - Power Supply
Importance: High

Good morning,

We are writing to you on behalf of our clients Kevin and Andrea Marsh who wish to rezoned their land from Rural to Residential. This is located on the north western side of Arawa Road opposite the existing residential zone.

The development area is area 1 on the attached plan where geotechnical investigations have been completed confirming the land is suitable for urban development. The ultimate development of this area following the plan change will likely take 10 years with approximately 85 to 90 dwellings established. There will also be a small commercial site (circ 2000m2) that will include a general store and also a doctors surgery.

Please note that the subdivision will occur in 3 Stages with the first stage with approximately 35-40 dwellings, the commercial site and a wastewater package treatment plant.

We are seeking some high level feedback in terms of the power reticulation in the area and to understand what upgrades may be necessary to service the Plan Change Area – stage 1 works in particular.

If you have any questions then please do not hesitate to contact me.

Kind Regards

Richard Coles
Director/Planner MNZPI
0274 325 154 richard@mpad.co.nz
www.mpad.co.nz

MOMENTUM
PLANNING AND DESIGN

LYSAGHT

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Email: jordy@lysaght.net.nz
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Appendix D

Vincent

From: Vincent
Sent: Friday, 23 August 2024 11:14 am
To: Vincent
Subject: FW: Further Waka Kotahi/WBOPDC traffic engagement - Plan Change 95 Pongakawa

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From: Tayla Cowper <tayla.cowper@nzta.govt.nz>
Sent: Wednesday, August 14, 2024 8:19 AM
To: Vincent <vincent@mpad.co.nz>; Logan Marsh <hobemarsh@gmail.com>
Subject: RE: Further Waka Kotahi/WBOPDC traffic engagement - Plan Change 95 Pongakawa

Kia ora,

As addressed and in addition to the comments stated in the email dated the 6th of August 2024, the New Zealand Transport Agency have considered that If Council are in a position to approve Plan Change 95, NZTA would seek the following:

- The detailed design is to be approved by NZTA. The design is to show the stormwater design, cross sections, guardrails, earthworks, and any retaining features in order to ensure this can be accommodated within the road reserve.
- A Safe System Audit is to be undertaken on the detailed design.
- The left turn lane pavement design is to be approved by NZTA. The design is to ensure that the seal join is located outside of the wheel path.
- The method for ensuring ghost line markings are avoided is to be approved by NZTA.
- As addressed in the NZTA initial submission, if Plan Change 95 is to be accepted NZTA seek that any upgrades or improvements to State Highway 2 are to be made a prerequisite to any stage of the proposal (whichever stage occurs first). NZTA would expect this to be a condition of any future resource consents following the plan change.

In addition to this, the following needs to be amended within the Safe System Audit;

- for each recommendation table:
  - change Safety Engineer to be 'NZTA Safety Engineer'
  - add a new line below 'NZTA Safety Engineer' to be called 'NZTA Network Manager'
  - add a new line below 'NZTA Network Manager' and above 'Client Decision' to be called 'NZTA System Manager'
- for the Safe System Audit Statement at the back of the report include new lines for the NZTA Network Manager and NZTA System Manger to be able to complete.

NZTA consider that subject to the above matters being volunteered by the applicant, and further demonstrated at detailed design stage to NZTA satisfaction, NZTA are therefore comfortable in-principle with the proposed intersection treatment.

Kind regards,

Tayla Cowper (she/her)

Intermediate Planner – Waikato/Bay of Plenty
Poutiaki Taiao | Environmental Planning

Email: tayla.cowper@nzta.govt.nz
Phone: 07 834 4684

Waka Kotahi NZ Transport Agency

Hamilton, Level 1, Deloitte Building, 24 Anzac Parade
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